San Luis Obispo Valley Basin Groundwater Sustainability Plan

Final

OCTOBER 2021 SAN LUIS OBISPO VALLEY GROUNDWATER BASIN GROUNDWATER SUSTAINABILITY AGENCIES

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OCTOBER 2021

Prepared by Water Systems Consulting, Inc.

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ACRONYMS & ABBREVIATIONS

Above Mean Sea Level	AMSL
Acre Feet	AF
Acre Feet per Year	AFY
Assembly Bill	AB
Cal Poly Weather Station 52	CPWS-52
California Code of Regulations	CCR
California Department of Fish and Wildlife	CDFW
California Department of Public Health	CDPH
California Endangered Species Act	CESA
California Environmental Data Exchange Network	CEDEN
California Fire and Resource Assessment Program Vegetation	FVEG
California Irrigation Management Information System	CIMIS
California Native Plant Protection Act	CNPPA
California Polytechnic State University	Cal Poly
California Public Utilities Commission	CPUC
California Regional Water Quality Control Board	CRWQCB
California Safe Drinking Water Information System	SDWIS
California State Groundwater Elevation Monitoring program	CASGEM
California State Water Resources Control Board	SWRCB
California Water Code	CWC
Central Coast Ambient Monitoring Program	CCAMP
Central Coast Groundwater Coalition	CCGC
Central Coast Regional Water Quality Control Board	CCRWQCB
City of San Luis Obispo	City of SLO
City of San Luis Obispo	City
Communication and Engagement Plan	C&E Plan
Consumptive Use Program Plus	CUP+
County of San Luis Obispo	County
County of San Luis Obispo Environmental Health Services	EHS
Crop Evapotranspiration	Etc
Cubic Feet Per Second	cfs
Cumulative departure from the mean	CDFM
Degrees Fahrenheit	°F
Department of Toxic Substance Control	DTSC
Department of Water Resources	DWR
Division of Drinking Water	DDW

Edna Ranch Mutual Water Company	ERMWC
Edna Valley Growers Ranch Mutual Water Company	EVGMWC
Endangered Species Act	ESA
Environmental Protection Agency	EPA
estimated applied water demand	Etaw
Evapotranspiration	Eto
feet/feet	ft/ft
Fiscal Year	FY
Gallons per day per foot	gpd/ft
Gallons per Minute	GPM
Golden State Water Company	GSWC
GPM per foot of drawdown	gpm/ft
Groundwater Ambient Monitoring and Assessment program	GAMA
Groundwater Communications Portal	GCP
Groundwater Management Plan	GMP
Groundwater Sustainability Agency	GSA
Groundwater Sustainability Commission	GSC
Groundwater Sustainability Plan	GSP
Groundwater/Surface water	GW/SW
Integrated Regional Water Management Plan	IRWMP
interconnected surface water	ISW
Interim Milestones	IMs
Land Use and Circulation Element	LUCE
Leaky Underground Fuel Tanks	LUFTs
Master Water Report	MWR
Maximum Contaminant Level	MCL
Measurable Objectives	MOs
Memorandum of Agreement	MOA
Memorandum of Understanding	MOU
Milligrams per Liter	Mg/L
Million Acre Feet	MAF
Million Gallons	MG
Million Gallons per Day	MGD
Minimum Thresholds	MTs
National Climate Data Center	NCDC
National Land Cover Database	NLCD
National Oceanic and Atmospheric Administration	NOAA
National Oceanic Atmospheric Administration, National Marine Fisheries Service	NOAA NMFS
National Water Information System	NWIS
Natural Resources Conservation Service	NRCS

One hundred cubic feet	CCF
Operations and Maintenance	O&M
Parts per billion	ppb
Parts per million	ppm
Polonio Pass Water Treatment Plant	PPWTP
Recycled Water	RW
Regional Water Quality Control Board	RWQCB
Representative Monitoring Sites	RMSs
Salt and Nutrient Management Plan	SNMP
San Luis Obispo	SLO
San Luis Obispo County Flood Control and Water Conservation District	SLOCFCWCD
San Luis Obispo County Integrated Regional Water Management Plan	IRWMP
San Luis Obispo Creek	SLO Creek
San Luis Obispo Regional Water Management Group	RWMG
San Luis Obispo Valley Groundwater Basin	SLO Basin
Secondary Maximum Contaminant Level	SCML
Senate Bill	SB
Soil Survey Geographic Database	SSURGO
Sphere of Influence	SOI
State Water Project	SWP
Sustainable Groundwater Management Act	SGMA
Sustainable Groundwater Management Planning	SGMP
Sustainable Groundwater Planning	SGWP
Sustainable Management Criteria	SMCs
tetrachloroethylene	PCE
Total Dissolved Solids	TDS
Total Maximum Daily Load	TMDL
Trichloroethylene	TCE
U.S. Department of Agriculture	USDA
Underground Storage Tanks	USTs
United States Fish and Wildlife Service	USFW
United States Geological Survey	USGS
Urban Water Management Plan	UWMP
Varian Ranch Mutual Water Company	VRMWC
Wastewater Treatment Plant	WWTP
Water Code Section	WCS
Water Master Plan	WMP
Water Planning Areas	WPA
Water Planning Areas	WPA
Water Quality Control Plan for the Central Coast Basin	Basin Plan
Water Resource Recovery Facility	WRRF

Water Resource Recovery Facility	WRRF
Water Resources Advisory Committee	WRAC
Water Supply Assessment	WSA
Water Treatment Plant	WTP
Well Construction Report	WCR
Western Regional Climate Center	WRCC

GROUNDWATER SUSTAINABILITY PLAN

Executive Summary

The Sustainable Groundwater Management Act (SGMA), Section 10720, et. seq., of the State Water Code, requires sustainable groundwater management in all high and medium priority basins. The San Luis Obispo Valley Groundwater Basin (SLO Basin) was designated as a high priority basin.

The SLO Basin Groundwater Sustainability Plan (GSP) was developed by two Groundwater Sustainability Agencies (GSAs) formed by the County of San Luis Obispo (County GSA) and the City of San Luis Obispo (City GSA). The GSAs entered into a Memorandum of Agreement (MOA) for the purposes of coordinating preparation of a single GSP for the SLO Basin. The MOA also established the Groundwater Sustainability Commission (GSC), which serves as an advisory body to the GSAs consisting of representatives from the County GSA and the City GSA, as well as representatives from the other signatories to the MOA (i.e., Golden State Water Company (GSWC), Edna Valley Growers Mutual Water Company (EVGMWC), Edna Ranch Mutual Water Company (ERMWC), and Varian Ranch Mutual Water Company (VRMWC).

IN THIS SECTION

Introduction

This document fulfills the GSP development requirement for the SLO Basin. This GSP describes and assesses the groundwater condition of the SLO Basin, develops quantifiable management objectives that account for the interests of the SLO Basin's beneficial groundwater uses and users, and identifies a group of projects and management actions that will allow the SLO Basin to achieve and maintain sustainability in the future.

Plan Area

The jurisdictional boundaries for the GSP correspond to Department of Water Resources (DWR, 2016) Bulletin 118 basin boundary for the SLO Basin as shown in Figure ES-1. The SLO Basin is oriented in a northwest-southeast direction and is composed of unconsolidated or loosely consolidated sedimentary deposits. It is approximately 14 miles long and 1.5 miles wide and covers a surface area of about 12,700 acres (19.9 square miles). The SLO Basin is bounded on the northeast by the relatively impermeable bedrock formations of the Santa Lucia Range, and on the southwest by the formations of the San Luis Range and the Edna fault system. The SLO Basin is commonly referenced as being composed of two distinct valleys, with the San Luis Valley in the northwest and the Edna Valley in the southeast. The San Luis Valley includes part of the City and California Polytechnic University (Cal Poly) jurisdictional boundaries, while the remainder of the valley is unincorporated land. Land use in the City is primarily municipal, residential, and industrial. The Edna Valley is entirely unincorporated and the primary land use in the Edna Valley is agricultural. During the past two decades, wine grapes have become the most significant crop type in the Edna Valley

The primary sources of water supply for uses in the basin include groundwater from the San Luis Obispo Valley Basin and surface water from Whale Rock Reservoir, Salinas Reservoir, Nacimiento Lake, and recycled water from the City's Water Recycling Program. Water users in the basin include municipalities, communities, rural domestic residences, and industrial, environmental, and agricultural users.

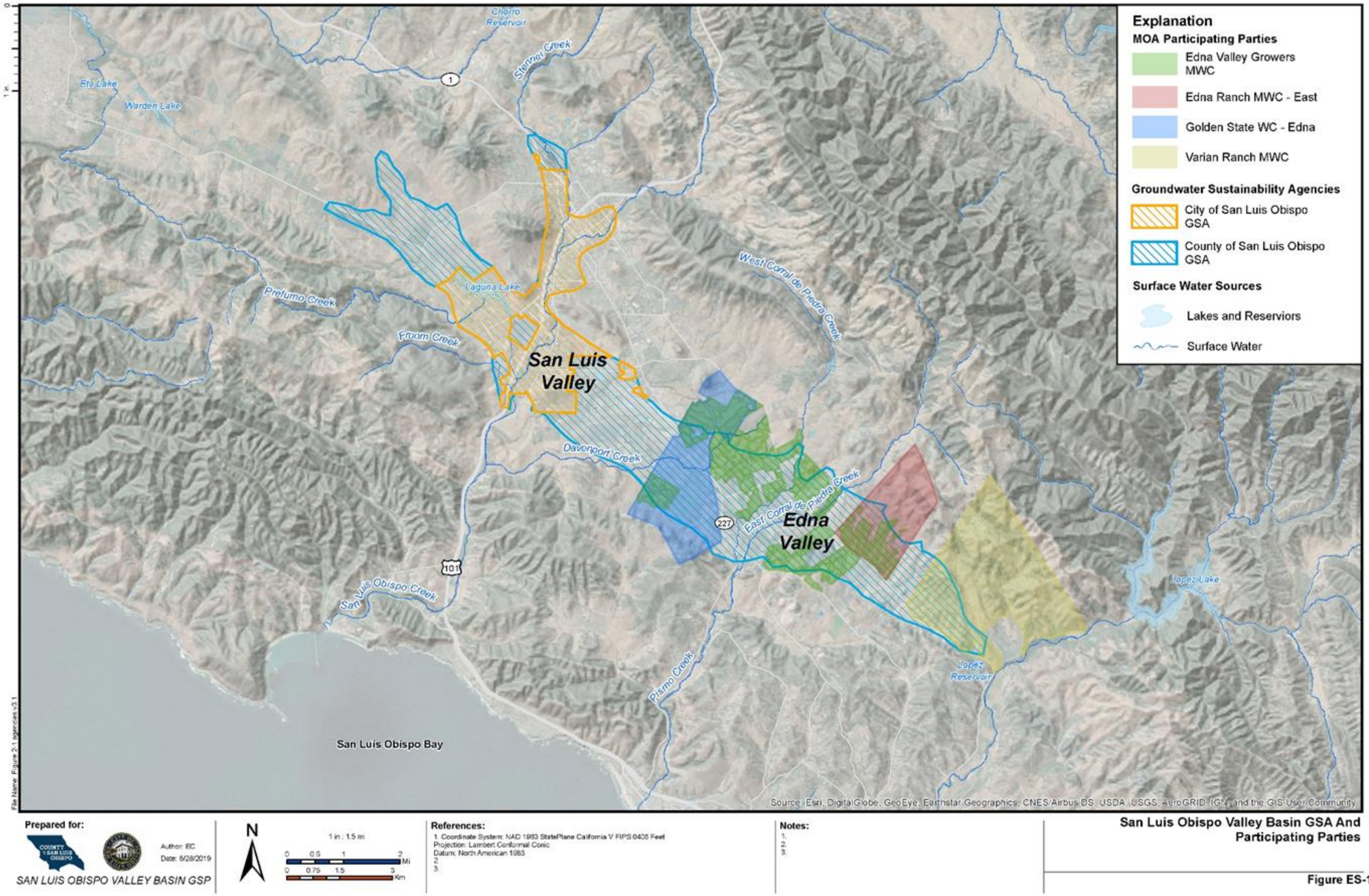


Figure ES-1. San Luis Obispo Valley Basin GSAs and Participating Parties

Outreach Efforts

A Communication and Engagement Plan (C&E Plan) was executed and includes the planned activities for engaging interested parties in SGMA implementation efforts in the San Luis Obispo Valley Basin.

The goals of the C&E plan are as follows:

- Create an inclusive and transparent participation experience that builds public trust in the GSP and optimizes participation among all stakeholders.
- Employ outreach methods that facilitate shared understanding of the importance of sustainable groundwater conditions and impacts on stakeholders.
- Communicate "early and often" and actively identify and eliminate barriers to participation.
- Develop a cost-effective, stakeholder-informed GSP supported by best-in-class technical data.

Outreach and communication throughout GSP development included regular presentations at GSC meetings, meetings with community groups, meetings with individual stakeholders, and community workshops. Comments from stakeholders were collected via the Groundwater Communications Portal (GCP), SLOWaterBasin.com, and the response to comments were also posted on SLOWaterBasin.com. and considered in the development of the GSP.

Figure ES-2 provides a summary of the engagement results regarding the stakeholder outreach touchpoints, stakeholder lists, stakeholder participation, and statistics for the SLOWaterBasin.com website.

STAKEHOLDER ENGAGEMENT RESULTS

Stakeholder Outreach Touchpoints

17	3	4	41	31	21
QUARTERLY GSC MEETINGS HELD	STAKEHOLDER WORKSHOPS HELD	NEWSLETTERS DISTRIBUTED	EMAIL BULLETINS DISTRIBUTED TO INTERESTED PARTIES LIST	EVENT PUBLIC NOTICES POSTED	STAKEHOLDER ORGS RECEIVED DIRECT OUTREACH

Stakeholder List

519	9/10
SUBSCRIBERS TO EMAIL LIST	STAKEHOLDER GROUPS REPRESENTED ON LIST

Stakeholder Participation

30	160+	70+
AVERAGE GSC MTG ATTENDANCE	STAKEHOLDER ATTENDANCE FOR THREE WORKSHOPS	PUBLIC COMMENTS RECEIVED

Project Website Performance— SLOWaterBasin.com

2.7k	50%	02:33	2.15	5.7k
TOTAL SESSIONS SINCE LAUNCH	AVERAGE VISITOR BOUNCE RATE	AVERAGE SESSION DURATION	AVERAGE PAGES PER SESSION	TOTAL PAGE VIEWS

Note: The Stakeholder Groups Represented is 9/10 due to the fact that Tribal interests were contacted and informed of the GSP development process, and that they indicated that they would engage in the Implementation Phase of the GSP

Figure ES-2. Stakeholder Communication and Engagement Summary

Basin Setting

The Basin covers approximately 20 square miles, and it is commonly referenced as being composed of two distinct valleys, with the San Luis Valley in the northwest and the Edna Valley in the southeast. Average annual precipitation ranges from approximately 18 inches throughout most of the Basin to about 22 inches in relatively higher elevation areas near the City and Cal Poly. San Luis Creek and its tributaries (Prefumo, Stenner, and Davenport Creeks) drain the San Luis Valley and its contributing watershed. East and West Corral de Piedras Creeks drain the Edna valley and its contributing watershed and join to form Pismo Creek immediately south of the Basin boundary. These creeks contribute an important component of recharge to the underlying aquifers.

For the purpose of this plan, the geologic units in the Basin and vicinity may be considered as two basic groups; 1) the Basin sediments; and 2) the consolidated bedrock formations surrounding and underlying the Basin. From a hydrogeologic standpoint, the most important strata in the Basin are the sedimentary basin fill deposits that define the vertical and lateral extents of the Basin. These include recent and older deposits of terrestrial sourced sediments, underlain in the Edna Valley by older marine sedimentary units. The sediments of the Edna Valley have significantly greater thickness (greater than 300 feet in the deepest parts) than those of the San Luis Valley (about 150 feet in the deepest parts). The aquifers beneath the two valleys are bounded by a high point in the underlying bedrock which rises to near the surface in the area along Hidden Springs Road; this bedrock high limits groundwater movement between Edna Valley and San Luis Valley to the uppermost portions of the aquifer.

The three formations that comprise the Basin aquifers are summarized in the basin setting, from youngest to oldest (or from top to bottom), are:

- **Recent Alluvium.** The Recent Alluvium is the mapped geologic unit composed of unconsolidated sediments of gravel, sand, silt, and clay, deposited by fluvial processes along the courses of San Luis Obispo Creek (SLO Creek), Davenport Creek, East and West Corral de Piedras Creeks, and their tributaries. Alluvium is present at the surface in most of the San Luis Valley, and along the combined riparian corridor of East and West Corral de Piedras Creeks in Edna Valley.
- **Paso Robles Formation.** The Paso Robles Formation underlies the Recent Alluvium throughout most of the Basin, and overlies the Pismo Formation where present. It was deposited in a terrestrial setting. It is composed of poorly sorted, unconsolidated to mildly consolidated sandstone, siltstone, and claystone. The Paso Robles Formation is exposed at the surface throughout much of the Edna Valley, except in the area around East and West Corral de Piedras Creeks, which have deposited Recent Alluvium on top of it.
- **Pismo Formation.** The Pismo Formation is a Pliocene-aged sequence of marine deposited sedimentary units composed of claystone, siltstone, sandstone, and conglomerate. It is the oldest geologic water-bearing unit with significance to the hydrogeology of the Basin. The Pismo Formation is extensive below the Paso Robles Formation in the Edna Valley. Thicknesses of Pismo Formation up to 400 feet are reported or observed in Edna Valley. The Pismo Formation does not crop out at the surface anywhere in the Basin.

All three of the geologic formations that comprise the Basin aquifer contain interbedded layers of silt, sand, gravel, and clay. There are no significant aquitards that vertically separate the three formations in the Basin over large areas. There may be deposits of clay and silt that are not laterally extensive that locally separate producing zones of two formations, but there is no recognized aquitard in the Basin that separates the aquifers over significant areas. In both the San Luis Valley and Edna Valley, wells are commonly screened across sands of multiple formations. The three formations that comprise the Basin aquifer essentially function as a single hydrogeologic unit. Eleven geologic cross sections are presented in Chapter 4 (Basin Setting) that detail the lithology of the Basin sediments.

The primary bedrock formations that crop out in the contributing watersheds to the Basin are the Monterey formation, the Obispo formation, and the Franciscan Assemblage. While fractures in consolidated rock may yield small quantities of water locally to wells, these formations are not considered to be aquifers for the purposes of this GSP.

Wells screened in the Alluvium and Paso Robles Formation have transmissivities ranging from about 5,000 to 158,000 gallons per day per foot (gpd/ft), and averaging over 42,000 gpd/ft. Wells screened in Paso Robles and Pismo Formations have transmissivities ranging from less than 1,000 to about 40,000 gpd/ft, and average about 10,000 gpd/ft.

There are several named creeks that flow across the Basin. In the San Luis Valley area of the Basin, these include SLO Creek, Stenner Creek, Prefumo Creek, Froom Creek, and Davenport Creek, in addition to smaller tributaries. In the Edna Valley creeks include East and West Corral de Piedras Creeks (which join to form Pismo Creek just south of the Basin Boundary), and Canada de Verde Creek in southeastern Edna Valley. The watersheds support important habitat for native fish and wildlife, including the federally threatened South-Central California Coast steelhead. Groundwater interaction with streams in the Basin is not well quantified, but it is recognized as an important component of recharge in the water budget.

The two surface water bodies of significance to the Basin are Laguna Lake and Righetti Reservoir. Laguna Lake is the only lake within the Basin. It is a naturally occurring lake just north of Los Osos Valley Road and west of Highway 101. The water in the lake is partially supplied by seasonal flow in Prefumo Creek, and partially supplied by subsurface groundwater inflow. Righetti Reservoir is a privately-owned reservoir formed by a dam on West Corral de Piedras Creek about 1.5 miles upstream from the Basin boundary, which impounds about 900 acre-feet of water, which is used primarily for irrigation.

Subsidence is the gradual settling or sinking of the earth's surface due to subsurface material movement at depth. It is frequently associated with groundwater pumping and is one of the undesirable results identified in SGMA. Subsidence has been historically documented in parts of the San Luis Valley. The most severe subsidence that has occurred in the Basin was in the 1990s along the Los Osos Valley Road corridor. The subsidence was a result of increased groundwater pumping in response to the 1987-1991 drought and caused damage to businesses and homes within that area. The City has discontinued significant pumping in this area, and subsidence has not been observed since.

Groundwater Conditions

Seven groundwater elevation contour maps that cover the entire Basin are presented, ranging in time from Spring 1954 to Fall 2019. Regional groundwater flow patterns are consistent across this period of record, with local declines in groundwater elevations observed in Edna Valley in recent years.

In the San Luis Valley portion of the Basin, the dominant groundwater flow direction is from higher elevations in the in the northwestern extent of the Basin southeastward toward the discharge area where SLO Creek leaves the Basin. In the Edna Valley portion of the Basin, the dominant groundwater flow direction is northwestward from the higher groundwater elevations in the southeastern part of the Basin (over 280 ft AMSL) to lower elevations in the San Luis Valley. There are also local areas of discharge coincident with the areas where SLO Creek and Pismo Creek tributaries leave the Basin. Groundwater elevation contours for Fall 2019 are displayed in Figure ES-3.

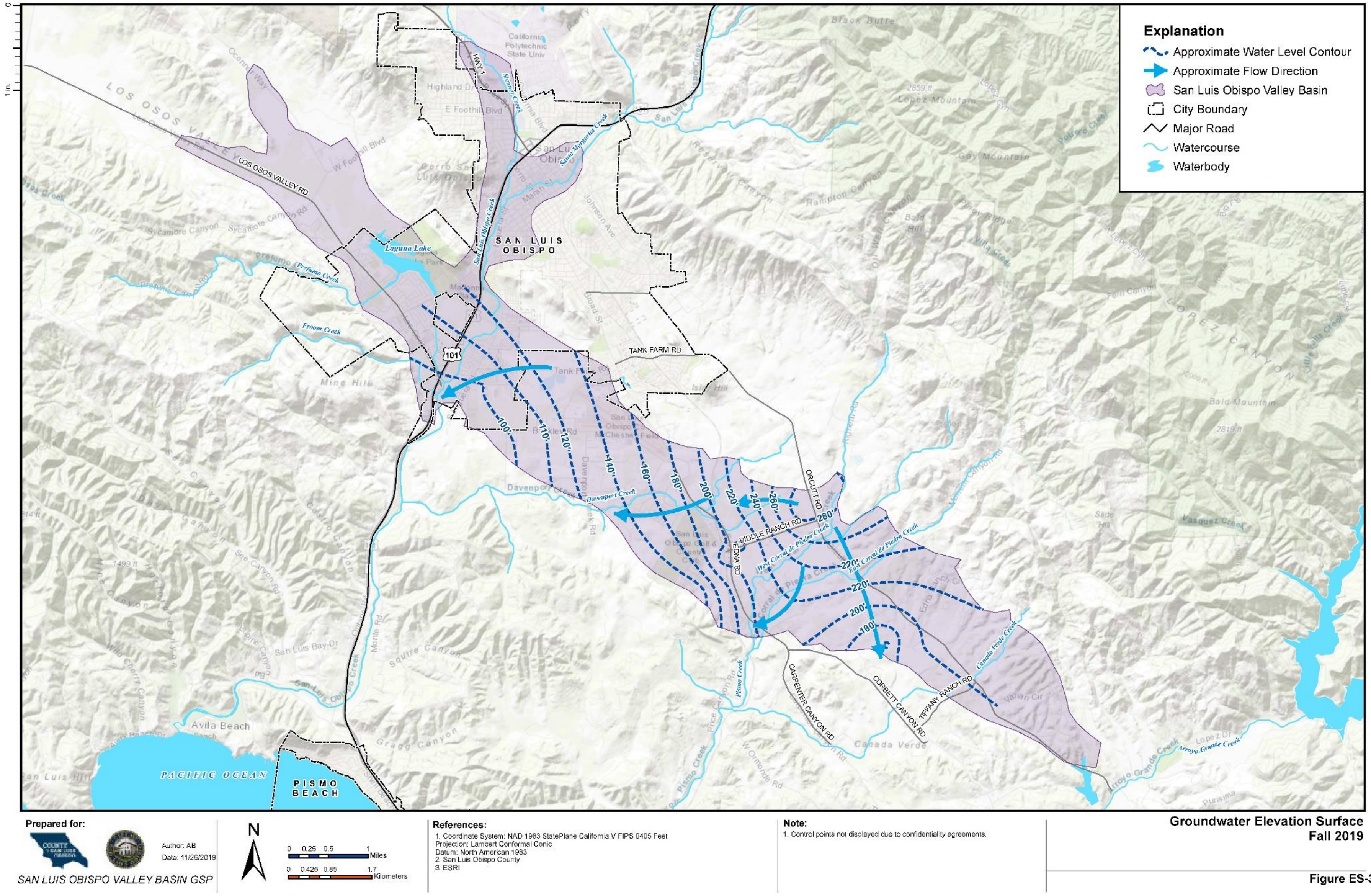


Figure ES-3. Groundwater Elevation Surface – Fall 2019

Hydrographs of groundwater elevations in various parts of the Basin display three distinct trends from data that extends back to the 1950s in some cases. The hydrographs for the wells in the San Luis Valley indicate that water levels in these wells, although somewhat variable in response to seasonal weather patterns, water use fluctuations, and longer-term dry weather periods, are essentially stable. There are no long-term trends indicating steadily declining or increasing water levels in this area. The wells in the vicinity of Highway 101 and Los Osos Valley Road also display water levels in relative equilibrium, with the exception of the early 1990s, when drought-related pumping and weather patterns resulted in noticeable declines in the water levels in this area (hydrographs 2 and 3 on Figure ES-4). A second distinct pattern is evident in hydrographs from wells in the area immediately east of the intersection of Biddle Ranch Road and Orcutt Road in Edna Valley, where West Corral de Piedras Creek enters the Basin (hydrographs 5 and 6 in Figure ES-4). The hydrographs of the two wells in this area display much greater volatility in response to seasonal and drought cycle fluctuations than the wells in San Luis Valley, with water levels fluctuating within a range of over 40 feet, as opposed to the range of 10 to 20 feet in the San Luis Valley wells. However, water levels appear to rebound to pre-drought levels when each drought cycle ends. Groundwater elevations displayed in these two hydrographs do not display a long-term decline of water levels. By contrast, several wells in the Edna Valley display steadily declining water levels during the past 15 to 20 years. Hydrographs for four wells (hydrographs 7, 8, 9, and 10 on Figure ES-4) in the Edna Valley display groundwater elevation declines of about 60 to 100 feet since the year 2000. Groundwater elevations in the Edna Valley displayed the largest historical declines in the Basin. This hydrograph pattern indicates that a reduction of groundwater storage has occurred over this period of record in the area defined by these well locations. It is understood that agricultural pumping has increased in Edna Valley during this time period, likely explaining the patterns of declining groundwater elevations in these hydrographs.

The primary sources of recharge to the Basin aquifer are areal infiltration of precipitation, subsurface inflow from surrounding bedrock, percolation of surface water from streams, and anthropogenic recharge (including percolation of wastewater treatment plant effluent, return flow from irrigation, and return flow from domestic septic systems). The primary sources of discharge from the Basin aquifer are pumping from wells, evapotranspiration by phreatophytes in areas of shallow groundwater table, and groundwater discharge to streams.

Surface water/groundwater interactions may represent a significant portion of the water budget of an aquifer system. A desktop analysis resulted in identification of two areas of SLO Creek that may seasonally gain water from the Alluvial Aquifer, which are the confluence of Stenner Creek and SLO Creek, and the reach of SLO Creek downstream from the Wastewater Treatment Plant to the confluence with Prefumo Creek. Several reaches of SLO Creek are identified that may occasionally lose water to the Alluvial Aquifer. Groundwater levels in the San Luis Valley part of the Basin are generally high enough that the creek is connected to the underlying aquifer. Along most of Corral de Piedras Creeks, by contrast, surface water levels are generally greater than 30 feet above the groundwater level, and the streams are considered disconnected from the underlying Alluvial Aquifer in this area. These analyses will benefit from additional surface water monitoring in the Basin which is identified within Chapter 7 (Monitoring Network). A desktop analysis is also presented that identifies potential Groundwater Dependent Ecosystems in the Basin.

Existing groundwater quality data is presented for Total Dissolved Solids, Arsenic, and Nitrates. Groundwater quality in the Basin aquifer is generally adequate for use as potable water supply and irrigation. TDS has a water quality objective goal of 900 mg/l promulgated in the Basin Plan; water quality results ranged from 180 to 3,100 mg/l with a median of 613 mg/l, and no trends of increasing TDS with time were observed. Nitrate (as N) has federally mandated MCL of 10 mg/l; water quality results ranged from below the detection limit to 80 mg/l; two sampling locations are identified with nitrate trends that have increased slightly in recent years, but most show no significant increases of nitrates with time. Arsenic has an MCL of 10 ug/l; concentrations ranged from below the detection limit to 28 ug/l, with an average value of 2.5 ug/l and a median value of 2 ug/l. Sampling locations with multiple data points displayed stable or decreasing concentrations of arsenic over the data period of record.

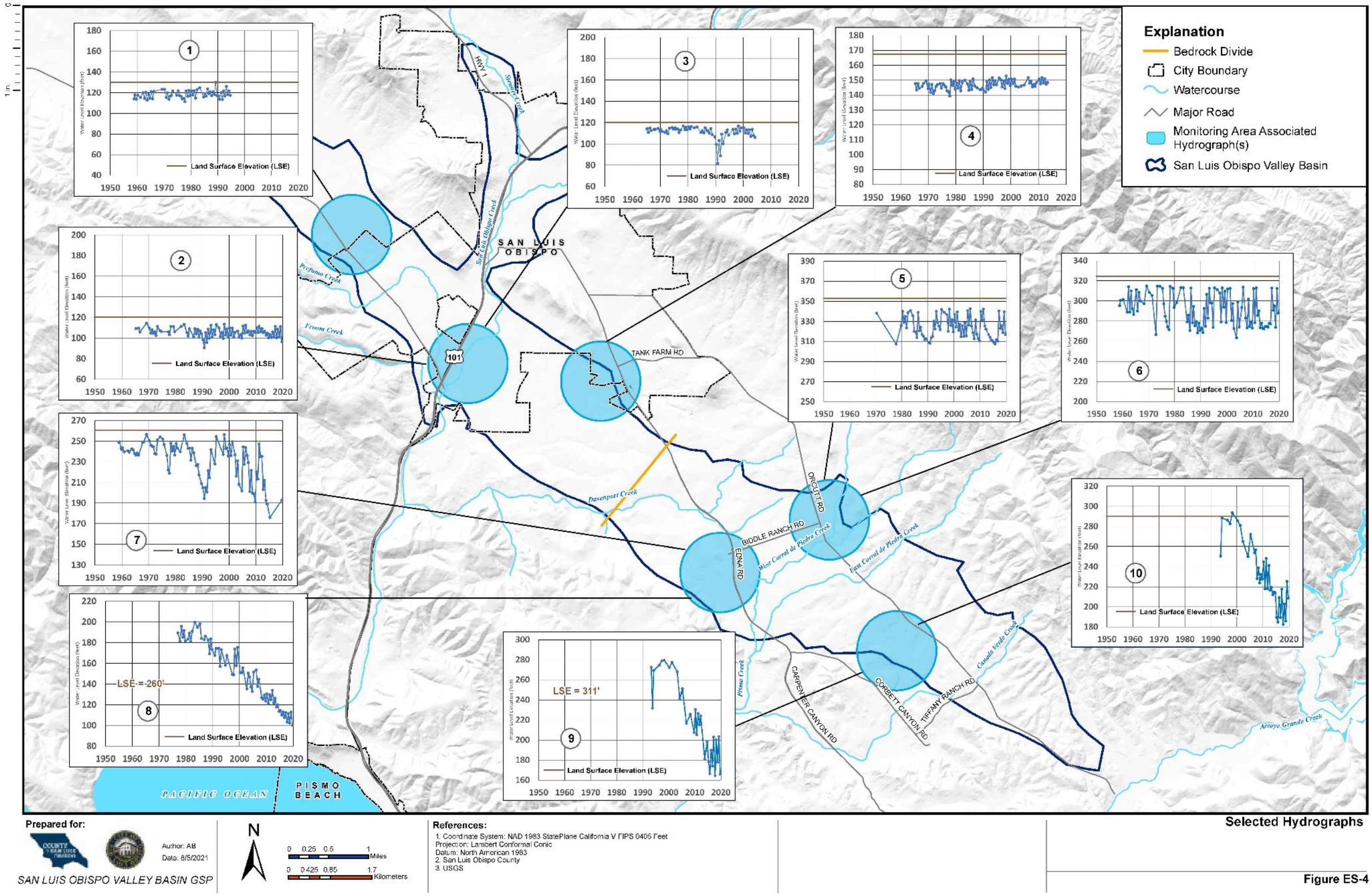


Figure ES-4. Selected Hydrographs

Water Budget

A water budget identifies and quantifies various components of the hydrologic cycle within a user-defined area, in this case the San Luis Obispo Valley Groundwater Basin. Analytical methods are used to generate historical and current water budgets. Analytical methods include the application of the water budget equation and the inventory method using spreadsheets, with groundwater flow estimates based on Darcy's Law and change in storage calculations based on the specific yield method.

The simplified expression of the water budget equation is:

INFLOW – OUTFLOW = CHANGE IN STORAGE

Separate water budgets are presented for both surface water and groundwater systems in the Basin. Separate water budgets were prepared for the San Luis Valley and Edna Valley, as well as a combined water budget for the entire Basin.

All components of inflow and outflow to the groundwater system were analyzed, with annual estimates of all water budget components generated for water years 1987 through 2019. Components of groundwater inflow include infiltration of precipitation, infiltration of applied urban water (i.e., lawn watering, landscaping, etc.), infiltration of applied water, percolation of streamflow, and subsurface inflow from the Basin boundaries. Components of groundwater outflow include urban groundwater pumping (municipal, domestic, and industrial), agricultural irrigation pumping, evapotranspiration of shallow groundwater, groundwater discharge to streams, and subsurface outflow along the alluvial corridors of the Basin creeks. A summary graph of the annual groundwater budgets from 1987 through 2019 are presented in Figure ES-5. A future water budget is generated from application of the calibrated integrated groundwater-surface model prepared in conjunction with this GSP.

The three most significant findings of the water budget analysis with respect to the preparation of the GSP are the following:

- First, it is documented that agricultural pumping in the Edna Valley has increased significantly in the period of record of the water budget analysis, from less than 2,500 Acre-feet per year (AFY) in 1987 to over 4,000 AFY in 2015 about a 60% increase. Other components of the water budget changed as well, but this is the single largest change of the various water budget components evaluated. This increase in agricultural pumping corresponds to the observed decline in groundwater elevations in monitored Edna Valley wells.
- Secondly, the sustainable yield was estimated to be 2,500 AFY for the San Luis Valley and 3,300 AFY for the Edna Valley.
- Thirdly, an estimate is made of the amount of annual groundwater overdraft for the two valleys of the Basin. The San Luis Valley is estimated to have a surplus of 700 AFY; the "surplus" is likely expressed as groundwater discharge to streams in the valley. The Edna Valley is estimated to have an annual average overdraft of 1,100 AFY. Because the presence of the bedrock ridge beneath the aquifer between Edna Valley and San Luis Valley limits flow between the subareas, the overdraft in Edna Valley is not significantly impacted by conditions of "surplus" in San Luis Valley. The overdraft estimate for Edna Valley may be viewed as an estimate of the gross amount of net pumping reduction and/or supply enhancement that should be targeted to reach sustainability in the Edna Valley.

The integrated surface water/groundwater model developed for this GSP was used to create a future water budget and was used to assess the potential effects of climate change over the SGMA planning horizon. Effects on the water budget due to climate change were found to be minor.

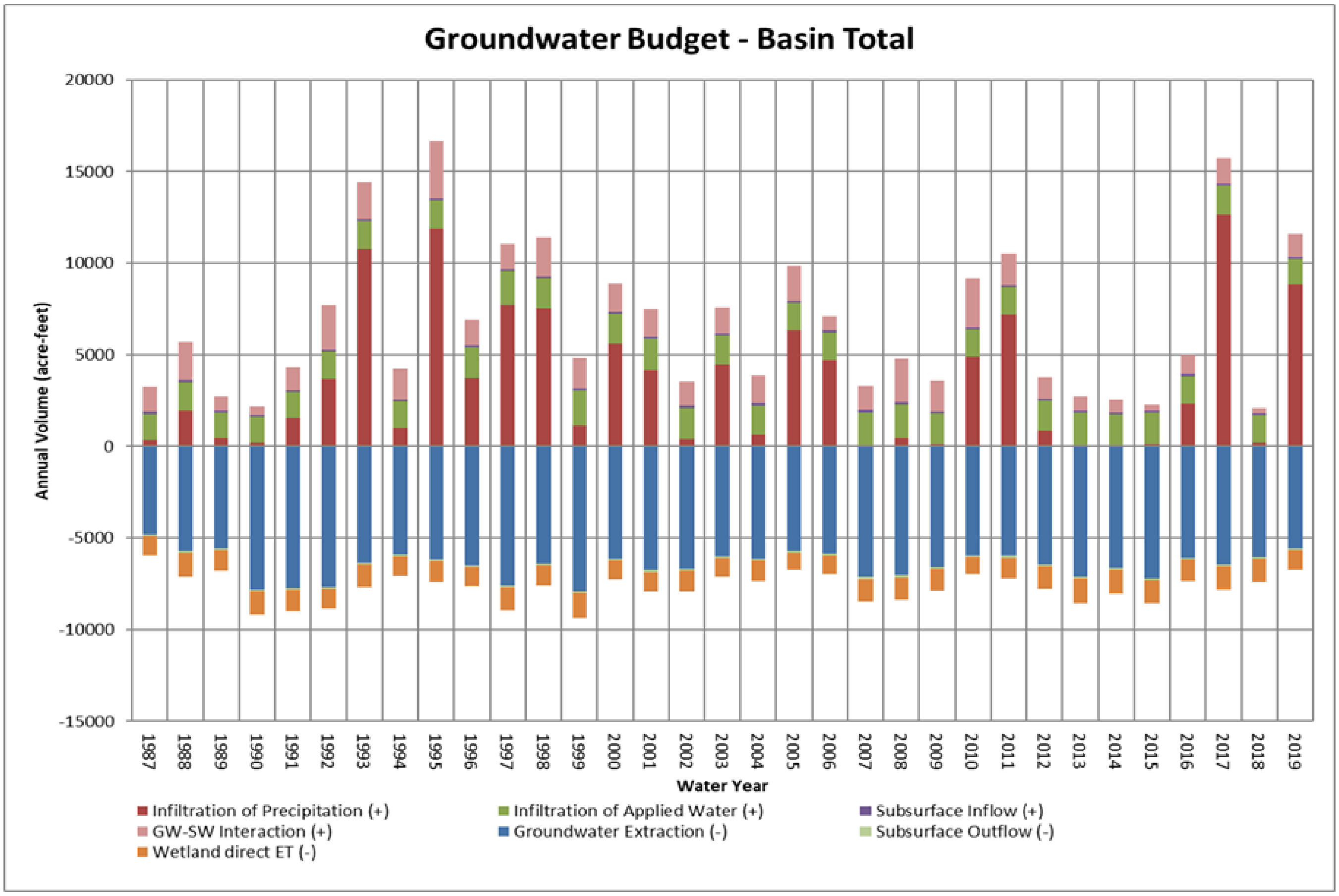


Figure ES-5. Groundwater Budget – Basin Total

Monitoring Network

Monitoring is a fundamental component of the GSP necessary to identify impacts to beneficial uses or Basin users, and to measure progress toward the achievement of any management goal. The monitoring networks must be capable of capturing data on a sufficient temporal and spatial distribution to demonstrate short-term, seasonal, and long-term trends in groundwater and related surface water conditions, and to yield representative information about groundwater conditions for GSP implementation.

The proposed monitoring network must be able to adequately measure changes in groundwater conditions to accomplish the following monitoring objectives:

- Demonstrate progress toward achieving measurable objectives.
- Monitor impacts to the beneficial uses and users of groundwater.
- Monitor changes in groundwater conditions relative to measurable objectives and minimum thresholds for sustainability indicators.
- Quantify annual changes in water budget components.

The monitoring network must provide adequate spatial resolution to properly monitor changes to groundwater and surface water conditions relative to measurable objectives and minimum thresholds within the Basin. The network must also provide data with sufficient temporal resolution to demonstrate short-term, seasonal, and long-term trends in groundwater and related surface water conditions.

There are three monitoring networks for the Basin: a groundwater level network, a groundwater quality network, and a surface water flow network.

- There are 40 monitoring wells in the GSP groundwater level monitoring network (Figure ES-6); 22 wells in the San Luis Valley and 18 wells in the Edna Valley. All of these wells will be used to generate groundwater elevation maps and hydrographs during ongoing monitoring during the SGMA planning horizon. Construction information is available for 31 of the 40 wells. Based on the available information, 16 of the wells are interpreted to be alluvial wells, while the remaining 24 wells tap into the Paso Robles Formation, Pismo Formation, or are mixed aquifer wells that utilize groundwater from more than one aquifer. Half of the wells are used for irrigation, seven are private domestic wells, and 13 are dedicated monitoring wells. Data gaps are discussed, as well as potential future improvements to the groundwater level network.
- The groundwater quality network consists of nine sites, which are all are Public Water System supply wells. As such, they have a history of water quality data established that can be used to compare with future data to assess trends. Water quality for these wells can be accessed using the GAMA Groundwater Information System. Data gaps are discussed, as are potential future improvements to the network.
- Surface water flow monitoring can provide valuable information for the Basin model and for evaluating potential depletion of interconnected surface water, which is one of the sustainability indicators. There are six permanent stream gages in or adjacent to the Basin, all within the San Luis Valley. These existing gaging stations only provide stage data, and not stream flow data. It is recommended that rating curves be established for these stream gages. In addition, recommendations are presented for up to five new stream gages to be established in both Edna Valley, where none currently exist, and San Luis Valley.

A subset of the monitoring network wells is defined as Representative Monitoring Sites (RMS), at which Sustainable Management Criteria are defined for the purpose of managing the Basin. Ten wells are identified as RMSs, and Sustainable Management Criteria (SMCs) are established for the relevant Sustainability indicators as discussed in the following section.

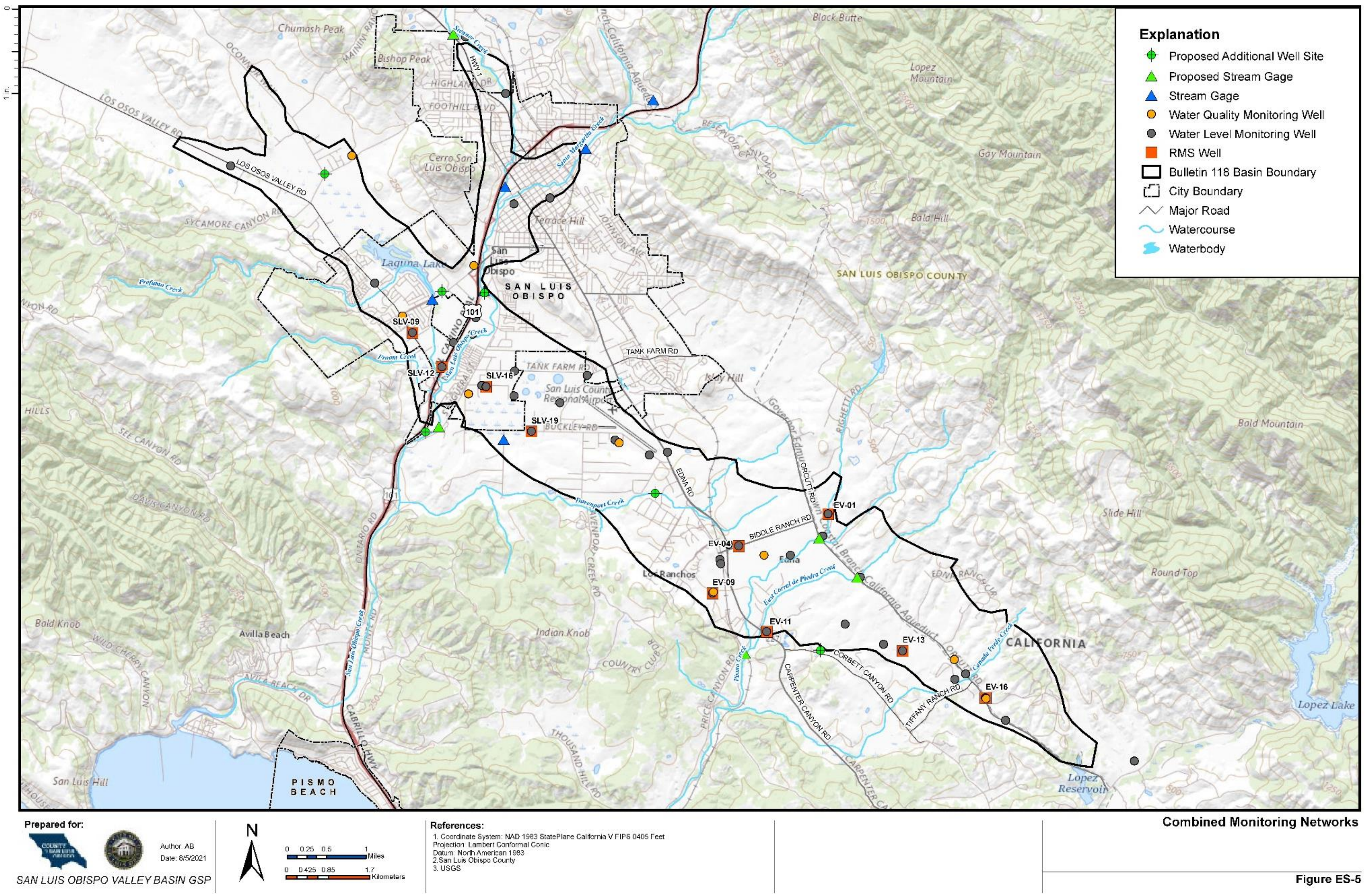


Figure ES-6. Monitoring Network

Sustainable Management Criteria

Defining Sustainable Management Criteria (SMC) requires technical analysis of historical data, and input from the affected stakeholders in the Basin. Data and methods used to develop the SMC are presented, and discussion is included describing how they influence beneficial uses and users. The SMCs presented in this GSP are based on currently available data and application of the best available science. Data gaps exist in the hydrogeologic conceptual model, and uncertainty caused by these data gaps was considered when developing the SMC. Due to uncertainty in the hydrogeologic conceptual model, these SMCs are considered initial criteria and will be reevaluated and potentially modified in the future as new data become available.

The SMCs include definition of Measurable Objectives (MOs), Minimum Thresholds (MTs), and undesirable results. These criteria define the future sustainable conditions in the Basin and guide the GSAs in development of policies, implementation of projects, and promulgation of management actions that will achieve these future conditions.

SMCs are developed for the following Sustainability Indicators, which are applicable in the Basin:

1. Chronic lowering of groundwater elevations
2. Reduction in groundwater storage
3. Degraded water quality
4. Land subsidence
5. Depletion of interconnected surface water

The sixth Sustainability Indicator, sea water intrusion, only applies to coastal basins, and is not applicable in the Basin.

MTs for the first two Sustainability Indicators, chronic lowering of groundwater elevations and reduction of groundwater in storage, are defined as minimum groundwater elevations as measured in the ten wells established as Representative Monitoring Sites in the Basin; the ten RMS locations are presented on Figure ES-6. MOs are defined as goals considered to be achievable after evaluation of historical data in the period of record for each RMS, and Interim Milestones (IMs) are interim goals to be assessed every 5 years when the GSPs are revised. All SMCs were developed after considerable stakeholder input during public meetings, and public comment to published draft chapters of the GSP. SMCs for these two Sustainability Indicators are summarized in Table ES-1.

MTs for the third Sustainability Indicator, degradation of water quality, are based on existing water quality regulatory criteria as measured in the nine wells established as water quality Representative Monitoring Sites (RMSs) in the Basin. (For water quality SMCs, MTs are equal to MOs). Identified potential contaminants of concern arsenic, nitrate, and volatile organic compounds TCE and PCE have federally mandated Maximum Contaminant Levels (MCLs) of 10 parts per billion (ppb), 10 parts per million (ppm), and 5 ppb, respectively. The MTs for those constituents were assigned to be equal to the MCLs. TDS has no MCL, but a water quality goal of 900 ppm is promulgated in the RWQCB Basin Plan; the MT for the constituent TDS was set at this level. MOs are defined as goals considered to be achievable after evaluation of historical data in the period of record for each RMS. All SMCs were developed after considerable stakeholder input during public meetings, and public comment to published draft chapters of the GSP. SMCs for these two Sustainability Indicators are summarized in Table ES-2 below.

Table ES-1. Summary of MTs, MOs, and IMs for SLO Basin RMSs

RMS	MT	MO	2020 WL	2027 IM	2032 IM	2037 IM	SUSTAINABILITY INDICATOR
SAN LUIS VALLEY							
SLV-09	102	110	119	110	110	110	Subsidence/Water Levels
SLV-16	70	100	111	100	100	100	Water Levels/Storage
SLV-19	80	110	123	110	110	110	Water Levels/Storage
SLV-12	96	105	105	105	105	105	SW-GW Interaction/Water Levels
EDNA VALLEY							
EV-09	82	164	146	150	155	160	Water Levels/Storage
EV-04	160	247	209	219	229	239	Water Levels/Storage
EV-13	172	248	215	223	231	238	Water Levels/Storage
EV-16	150	190	180	175	180	185	Water Levels/Storage
EV-01	263	314	290	314	314	314	SW-GW Interaction /Water levels
EV-11	177	227	219	227	227	227	SW-GW Interaction /Water levels

Note: All water level and interim milestone measurements refer to fall measurements.

Table ES-2. San Luis Obispo Valley Basin Groundwater Basin Water Quality Minimum Thresholds

ID	TDS MT (PPM)	NO3 MT (PPM)	ARSENIC MT (PPB)	TCE, PCE (PPB)
WQ-1	900	10	10	5
WQ-2	900	10	10	5
WQ-3	900	10	10	5
WQ-4	900	10	10	5
WQ-5	900	10	10	5
WQ-6	900	10	10	5
WQ-7	900	10	10	5
WQ-8	900	10	10	5
WQ-9	900	10	10	5

MTs for the fourth Sustainability Indicator, land subsidence, are based on data collected under the California state program of InSAR data, which measures land subsidence from space using satellite technology. There is no current measurable subsidence in the Basin. The MT is defined as no more than 0.1 feet of subsidence due to groundwater extraction in any given year, and a cumulative measured subsidence of 0.5 feet in any 5-year period.

MTs for the fifth Sustainability Indicator, depletion of interconnected surface water (ISW), were defined based on the language in SGMA that allows groundwater levels to be used as a proxy in place of the actual measurement of groundwater/surface water (GW/SW) flux, which is difficult to accurately quantify. Three RMS wells identified in the Basin are located immediately adjacent to SLO Creek and West Corral de Piedras Creek and were selected as appropriate RMS wells for ISW. These three wells have groundwater elevation data for a substantial period of record which indicate that there have been no trends of declining water levels in these areas. The management goal of the GSP for these wells is to prevent groundwater elevations from declining to levels lower than those observed in the historical record, thereby avoiding any significant increase in depletion of ISW over recent conditions Therefore, MTs for ISW wells were established at the observed low water level in the period of record, and MOs were defined at the observed high water level in the period of record, thus maintaining groundwater conditions near the creeks within the observed range of historical data, which will not induce significant additional depletion of ISW. Additional surface water gages are proposed for the surface water monitoring network. When installed, these gages will provide additional data to support these SMCs and improve the understanding of groundwater/surface water interaction during the implementation phase.

Projects and Management Actions

The projects and management actions concepts were developed over a series of working sessions with GSA staff, meetings with GSC members and in six public GSC meetings. Chapter 9 (Projects and Management Actions) describes the projects and management actions information to satisfy Sections 354.42 and 354.44 of the SGMA GSP Regulations (23 California Code of Regulations Section 350 et seq.).

A total of seven (7) projects were discussed in detail in this GSP and were centered around supplemental water sources that could be brought into the SLO Basin to mitigate the overdraft and are shown on Figure ES-7.

Four of the projects included the State Water Project (SWP) as a supplemental water supply to the SLO Basin. The Coastal Branch of the SWP conveys potable water from the California Aqueduct to San Luis Obispo and Santa Barbara Counties and transects the Edna Valley subarea and runs along Orcutt Road as shown in Figure ES-7. The recent adoption of the Water Management Tools Amendment to the SWP Contracts by the San Luis Obispo County Flood Control and Water Conservation District (SLOCFCWCD) and the Santa Barbara County Flood Control and Water Conservation District (SBCWCFCD) presents new opportunities for obtaining SWP water supply and delivery capacity to Edna Valley.

The remaining three projects utilize the City of SLO recycled water, Price Canyon discharge of treated water to Pismo Creek, and an adjacent groundwater basin as in-lieu water supply.

The projects were further evaluated with the integrated model to quantify the benefit of the projects with respect to the SMCs in the Edna Valley. The model results indicate that it is unlikely that any single project presented will, by itself, maintain water levels above the defined MTs at the RMSs. Therefore, multiple projects will likely need to be implemented.

The seven projects evaluated as part of the GSP are described in detail in Chapter 9 (Projects and Management Actions) and included:

- State Water Project for Edna Valley Agricultural Irrigation
- Stater Water Project Recharge Basin within the Edna Valley area.
- State Water Project to the Golden State Water Company
- State Water Project to the Edna and Varian Ranch Mutual Water Companies
- City of SLO Recycled Water for Edna Valley Agriculture
- Varian Ranch Mutual Water Company Arroyo Grande Subbasin Wells
- Price Canyon Discharge Relocation

The management actions in this plan call for the completion of the proposed monitoring network by installing new monitoring sites, development and implementation of a groundwater extraction metering and reporting plan, and the development of a demand management plan.

The proposed projects and management actions are intended to maintain groundwater levels above minimum thresholds through in-lieu pumping reductions or increased recharge.

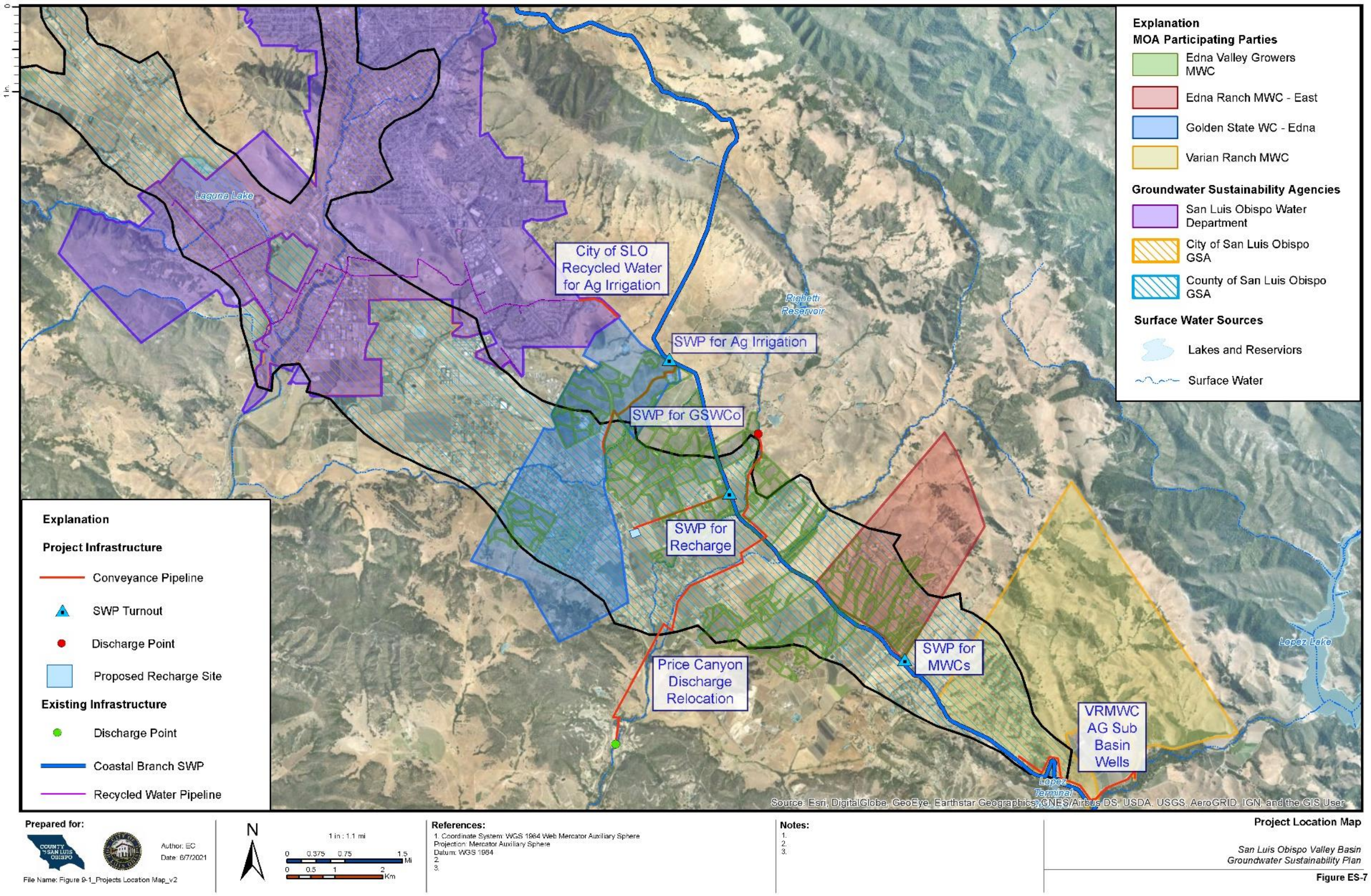


Figure ES-7. Project Location Map

Implementation Plan

This GSP lays out a roadmap for addressing all of the activities needed for GSP implementation between the years 2022 and 2042, focusing mainly on the activities during the first five years of implementation (2022 through 2027).

The implementation plan is based on current understanding of the Basin conditions and includes consideration of the projects and management actions included in Chapter 9 (Projects and Management Actions), as well as other actions that are needed to successfully implement the GSP including the following:

- GSP implementation, administration, and management
- Funding
- Reporting, including annual reports and 5-year evaluations and updates

Implementation of this GSP is estimated to cost approximately $965,000 per year for the first five years, excluding the development of the specific projects listed in Chapter 9 (Projects and Management Actions). Estimates of future annual implementation costs (Years 6 through 20) will be developed during future updates of the GSP, which will include the development of the various anticipated projects. The costs of specific projects and management actions will likely vary year by year, based in part on needed adaptive management activities.

The GSAs plan to perform a fee study to evaluate and provide recommendations for developing GSP implementation funding mechanisms. This study will include focused public outreach and meetings to educate and solicit input on the potential fee structures/funding mechanisms (i.e., pumping fees, assessments, or a combination of both). It is anticipated that the fee study will cover the costs associated with the Administration and Finance, Monitoring Network Implementation, and Reporting. The Fee Study is not anticipated to cover the costs associated with project implementation.

As part of GSP implementation, the GSAs will develop annual reports and more detailed five-year evaluations, which could lead to updates of the GSP. Chapter 10 (Implementation Plan) describes the reporting requirements for both the annual reports and five-year evaluations.

1

GROUNDWATER SUSTAINABILITY PLAN

Introduction To The SLO Basin GSP

The Sustainable Groundwater Management Act (SGMA), Section 10720, et. seq., of the State Water Code, requires sustainable groundwater management in all high and medium priority basins. The San Luis Obispo Valley Groundwater Basin (SLO Basin) was designated as a high priority basin.

To comply with and satisfy the requirements of SGMA, the following activities are mandated:

- Forming one or more Groundwater Sustainability Agencies (GSAs) by June 30, 2017 to cover the entire SLO Basin. In May 2017, both the City of San Luis Obispo (City) and the County of San Luis Obispo (County) each formed GSAs within their jurisdictions, resulting in full coverage of the SLO Basin.
- Developing a Groundwater Sustainability Plan (GSP) that covers the entire SLO Basin and is adopted by the GSAs by January 31, 2022.
- Implementing the GSP to achieve quantifiable objectives and sustainability within 20 years (by 2042).
- Annual reporting of groundwater conditions in the basin to the California Department of Water Resources (DWR).
- Periodic (every five years) evaluation of the GSP implementation by the GSAs.

IN THIS CHAPTER

1.1. Purpose of the Groundwater Sustainability Plan

This document fulfills the GSP development requirement for the SLO Basin. This GSP describes and assesses the groundwater condition of the SLO Basin, develops quantifiable management objectives that account for the interests of the SLO Basin's beneficial groundwater uses and users, and identifies a group of projects and management actions that will allow the SLO Basin to achieve and maintain sustainability in the future. Appendix A (DWR Element of the Plan Guide) identifies the location in this GSP where the statutory requirements of SGMA are addressed.

1.2. Description of the SLO Basin

This GSP covers the entire SLO Basin identified as Basin No. 3-009 in the DWR's Bulletin 118 (DWR, 2016). The SLO Basin lies in the southern portion of San Luis Obispo County. The SLO Basin is comprised of valleys of gentle flatlands and rolling hills ranging in elevation from approximately 100 to 500 feet Above Mean Sea Level (AMSL), surrounded by larger mountain ranges. A terrain map displaying the SLO Basin boundaries is presented in Figure 1-1, which also displays the watershed areas of the SLO Creek and Pismo Creek drainages, faults, and nearby groundwater basins symbolized by the SGMA 2019 Basin Prioritization Phase 1. Average annual precipitation ranges from approximately 18 inches throughout most of the SLO Basin to about 22 inches in higher elevation areas near the City and Cal Poly. The SLO Basin is within the watershed areas of the SLO Creek and Pismo Creek drainages, which are bounded on the northeast by the Santa Lucia Range and on the southwest by the formations of the San Luis Range and the Edna Fault. The SLO Basin is commonly referenced as being composed of two distinct valleys, with the San Luis Valley in the northwest and the Edna Valley in the southeast. The San Luis Valley lies within the SLO Creek drainage, and the Edna Valley lies predominately within the Pismo Creek drainage with a smaller area within the SLO Creek drainage.

There is a bedrock high that underlies the ground surface between the San Luis Valley and Edna Valley. The watershed divide and the bedrock high divide are not coincident. The sediments of the Edna Valley have significantly greater thickness than those of the San Luis Valley. Precipitation that falls west of the watershed divide ultimately flows to Davenport and SLO Creeks, and precipitation that falls east of that divide flows to Corral de Piedras Creek or the other small tributaries, which ultimately flow to Pismo Creek south of the SLO Basin.

San Luis Obispo and Pismo Creeks are the primary surface water features within the SLO Basin. Significant tributaries to the SLO Creek within the Basin include Prefumo Creek, Stenner Creek, and Davenport Creek. Significant tributaries to Pismo Creek include both the East and West branches of the Corral de Piedras Creek. Urban areas within the SLO Basin include the City of San Luis Obispo, Cal Poly, Edna, and Verde. Highway 101 is the most significant north-south highway in the Basin.

1.3. Basin Information

The DWR prioritized California's groundwater basins through the California Statewide Groundwater Elevation Monitoring (CASGEM) program and released the results in 2014. With the passage of SGMA, DWR redefined 54 groundwater basins based on requests for basin boundary modifications and classified the basins into four categories; high, medium, low, or very low priority. At this time the SLO Basin was classified as a medium priority basin.

DWR later reassessed the priority of the groundwater basins following the 2016 basin boundary modification, as required by the Water Code, and documented the results in the SGMA 2019 Basin Prioritization (DWR, 2019)). DWR followed the process and methods developed for the CASGEM 2014 Basin Prioritization and incorporated new data, to the extent data was available, and then amended the language of Water Code Section 10933(b)(8) (component 8) to include an analysis of adverse impacts on local habitat and local streamflow.

DWR reprioritized the basins based on the following components specified in Water Code Section 10933(b):

- The population overlying the basin or sub-basin.
- The rate of current and projected growth of the population overlying the basin or sub-basin.
- The number of public supply wells that draw from the basin or sub-basin.
- The total number of wells that draw from the basin or sub-basin.
- The irrigated acreage overlying the basin or sub-basin.
- The degree to which persons overlying the basin or sub-basin rely on groundwater as their primary source of water.
- Any documented impacts on the groundwater within the basin or sub-basin, including overdraft, subsidence, saline intrusion, and other water quality degradation.
- Any other information determined to be relevant by the department, including adverse impacts on local habitat and local streamflow.

With the addition of component 8, the SLO Basin was moved from a medium priority basin to a high priority basin not in critical overdraft and is required to submit a GSP to DWR by January 31, 2022. The change in priority is inconsequential, as medium priority basins are also required to submit a GSP to DWR by January 31, 2022.

Additional information about how each of these components were analyzed can be found in the 2019 SGMA Basin Prioritization Process and Results Document (DWR, 2019). DWR is required to provide updates on basin boundaries, basin priority and critically overdrafted basins every 5 years beginning in 2020 as part of the Bulletin 118 updates.

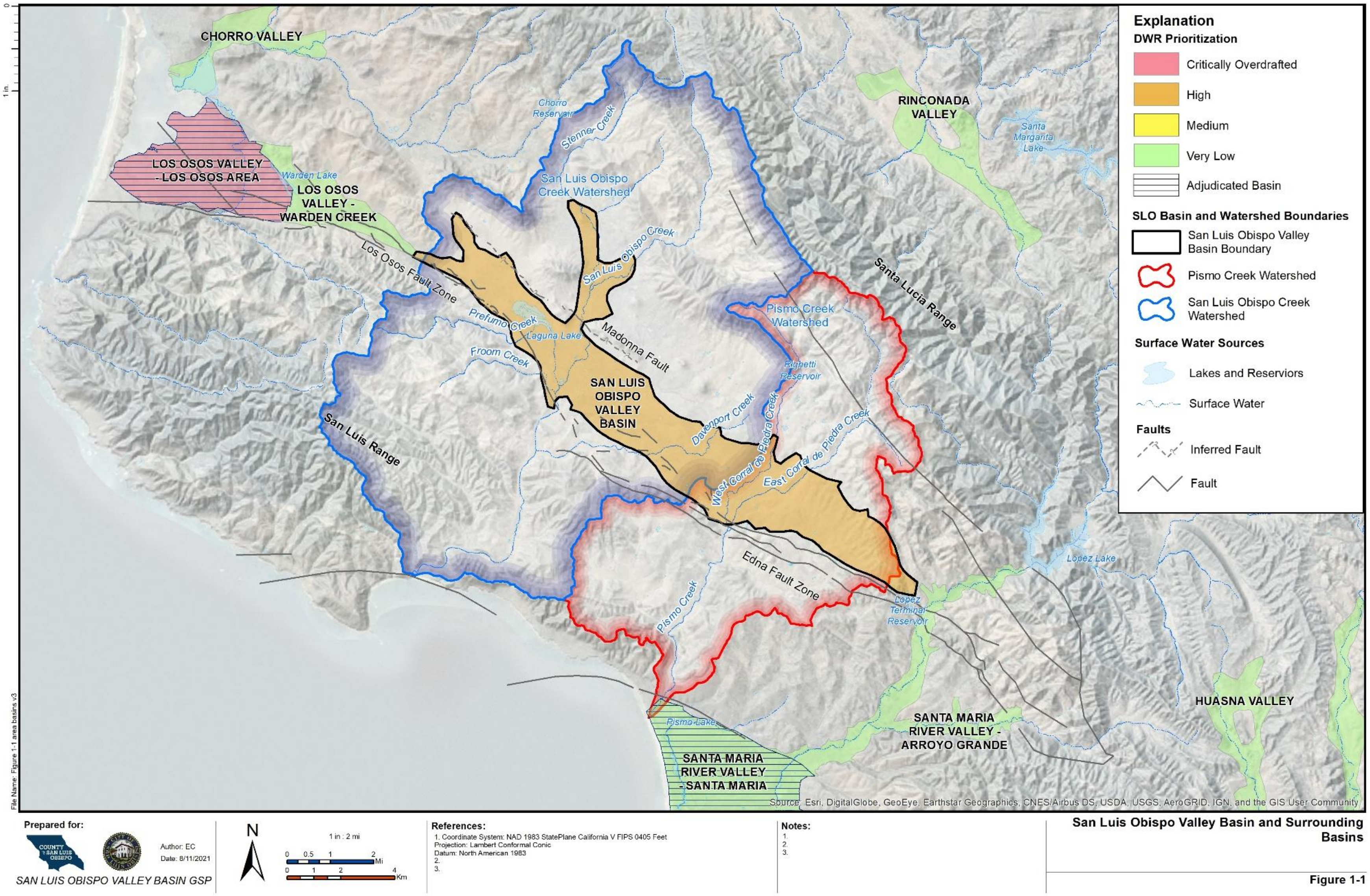


Figure 1-1. San Luis Obispo Valley Basin and Surrounding Basins

2

GROUNDWATER SUSTAINABILITY PLAN

Agency Information (§ 354.6)

On May 16, 2017, the City formed the City of San Luis Obispo Groundwater Sustainability Agency (City GSA) for the portion of the SLO Basin that lies within its City boundary (Appendix B). On May 23, 2017, the County formed the San Luis Obispo Valley Basin – County of San Luis Obispo Groundwater Sustainability Agency (County GSA) to cover all otherwise unrepresented areas within the SLO Basin (Appendix C).

The County, City, the Edna Valley Growers Mutual Water Company (EVGMWC), the Varian Ranch Mutual Water Company (VRMWC), the Edna Ranch Mutual Water Company (ERMWC) and the Golden State Water Company (GSWC) (each referred to individually a "Party" and collectively as the "Parties") entered into a Memorandum of Agreement Regarding Preparation of a GSP for the SLO Basin (MOA) effective as of January 25, 2018 (Appendix D). The MOA's purpose is for the City and County, with input from the other Parties (Participating Parties, to coordinate preparation of a single GSP for the entire SLO Basin pursuant to SGMA and other applicable provisions of law. Figure 2-1 shows the service area boundaries of each of the Parties and the GSA areas.

On October 16, 2018, the County GSA gave notice to DWR that it intends to develop a GSP in collaboration with the City GSA for the SLO Basin in accordance with California Water Code (CWC) Section 10727.8 and the Title 23, Section 353.6 of the California Code of Regulations (CCR).

IN THIS CHAPTER

- Agency Information and Governance Structure
- Notices and Communication

2.1. Agencies Names and Mailing Addresses

The following contact information is provided for each groundwater sustainability agency for the SLO Basin pursuant to California Water Code Section 10723.8.

COUNTY OF SAN LUIS OBISPO

COUNTY GOVERNMENT CENTER

1055 MONTEREY STREET

SAN LUIS OBISPO, CA 93408

ATTENTION: BLAINE REELY , GROUNDWATER SUSTAINABILITY DIRECTOR

ELECTRONIC MAIL ADDRESS: BREELY@CO.SLO.CA.US

CITY OF SAN LUIS OBISPO

UTILITIES DEPARTMENT

879 MORRO STREET

SAN LUIS OBISPO, CA 93401-2710

ATTENTION: AARON FLOYD, UTILITIES DIRECTOR

ELECTRONIC MAIL ADDRESS: AFLOYD@SLOCITY.ORG

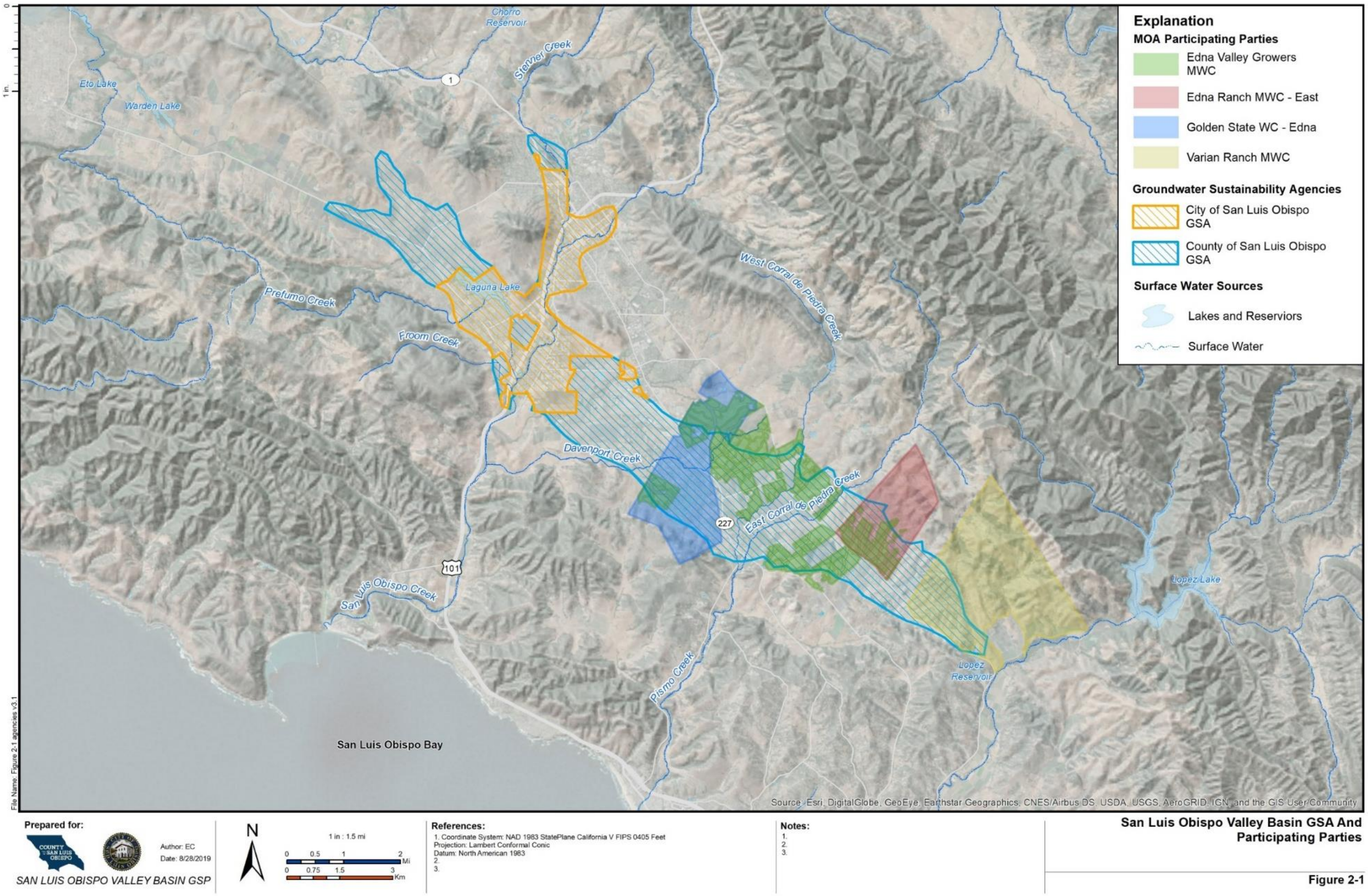


Figure 2-1. San Luis Obispo Valley Basin GSAs and Participating Parties

2.2. Agencies Organization and Management Structures

The MOA establishes the Groundwater Sustainability Commission (GSC) as an advisory body to the GSAs and the terms under which the City GSA and County GSA will jointly develop a single GSP, in coordination with the GSC. The GSC consists of representatives of the GSAs and the Participating Parties (i.e., EVGMWC, VRMWC, ERMWC, and GSWC). Each member of the GSC shall be entitled to one vote on any matter under consideration by the GSC. All recommendations submitted by the GSC to the City GSA and the County GSA shall be supported by a majority of the members, except for the recommendation to adopt the GSP or any amendments which shall be supported by at least four of the members.

The MOA provides that City and County staff will collaboratively participate in developing a GSP through, among other things, providing guidance to the GSP consultant, coordinating with the GSC, and engaging SLO Basin users and stakeholders. Once the GSP is developed, it will be considered for adoption by the GSAs (i.e., City Council and County Board of Supervisors) and subsequently submitted to DWR for approval. The MOA automatically terminates upon approval of the GSP by DWR. The organization and management structures of each of the Participating Parties are described in the following sections.

The MOA sets forth the process by which members of the GSC will be appointed / confirmed by each of the Parties but does not describe the process by which officers will be selected from among those members. Figure 2-2 shows the names of the current members and alternates appointed in accordance with the MOA and those selected as chair and vice chair by the GSC, and depicts the relationship of the GSAs and the Participating Parties and the overall governance structure for developing the GSP:

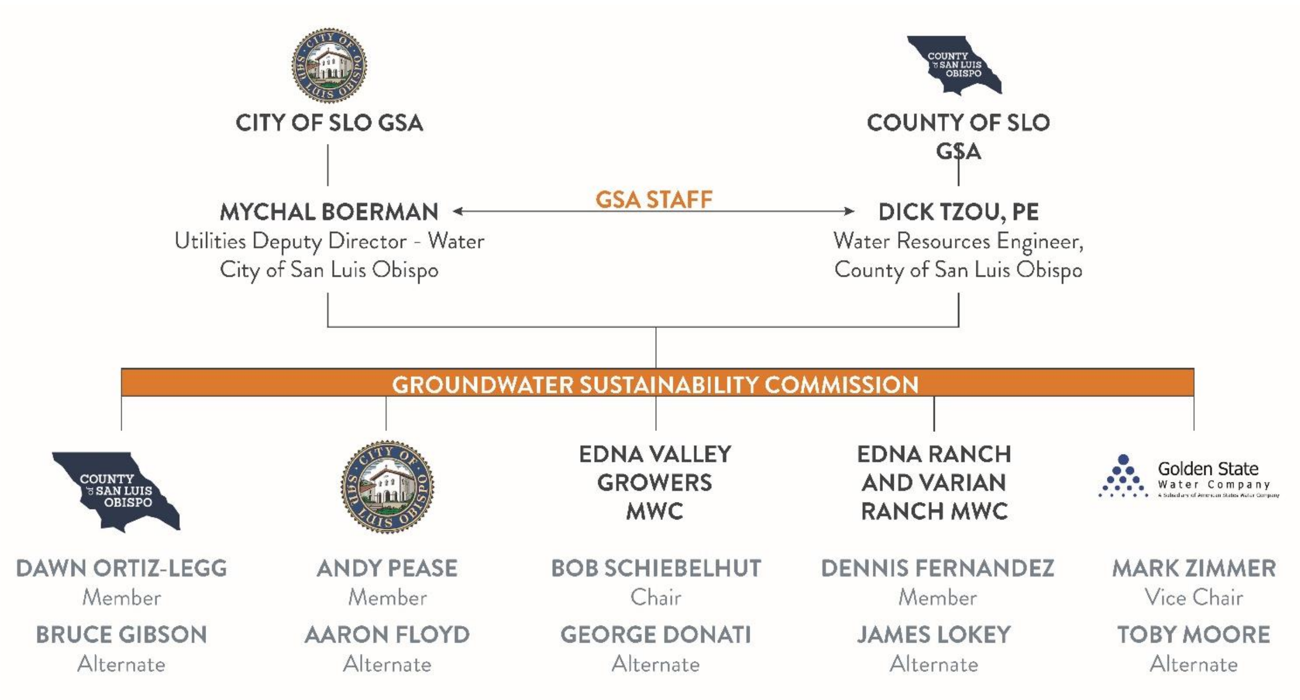


Figure 2-2. Groundwater Sustainability Commission (GSC)

2.2.1. County of San Luis Obispo

The County is a GSA and Party of the MOA. Members of the County Board of Supervisors currently sit on the GSC as a member and alternate member. The County is governed by a five-member Board of Supervisors representing five districts in the County. Board of Supervisor members are elected to staggered four-year terms.

2.2.2. City of San Luis Obispo

The City is a GSA and Party of the MOA. A member of the City Council and the Director of Utilities currently sit on the GSC as a member and alternate member, respectively. The City is an incorporated charter city and operates under "Council-Mayor-City Manager" form of municipal government. The five-member City Council consists of the directly-elected Mayor and four City Council Members. The Mayor is elected to a two-year term and Council Members are elected to four-year terms.

2.2.3. Other Participating Parties in the MOA

2.2.3.1. Edna Valley Growers Mutual Water Company

EVGMWC is a Party of the MOA and nominated a member and alternate member to participate in the GSC, both of which were confirmed by the County Board of Supervisors. Its member was selected as Chair of the GSC. EVGMWC represents the majority of the agricultural users in the unincorporated San Luis Obispo County within the Edna Valley portion of the SLO Basin.

2.2.3.2. Varian Ranch Mutual Water Company

VRMWC is a Party of the MOA and jointly nominated (with ERMWC) a member and alternate member to participate in the GSC, both of which were confirmed by the County Board of Supervisors. VRMWC provides water to the residents of unincorporated San Luis Obispo County and serves an area within the Edna Valley portion of SLO Basin as shown in Figure 2-1.

2.2.3.3. Edna Ranch Mutual Water Company

ERMWC is a Party of the MOA and jointly nominated (with VRMWC) a member and alternate member to participate in the GSC, both of which were confirmed by the County Board of Supervisors. ERMWC provides water to the residents of unincorporated San Luis Obispo County and serves an area within the Edna Valley portion of SLO Basin as shown in Figure 2-1.

2.2.3.4. Golden State Water Company

GSWC is a Party of the MOA and nominated a member and alternate member to participate in the GSC, both of which were confirmed by the County Board of Supervisors. Its member was selected as a Vice Chair of the GSC. GSWC is an Investor-Owned Utility regulated by the California Public Utilities Commission (CPUC) and subject to federal Sarbanes-Oxley requirements that hold companies to the highest levels of transparency. CPUC's authority to regulate water, electric, natural gas, and other public utilities subject to its jurisdiction derives from the California state constitution. GSWC provides water to the residents of unincorporated San Luis Obispo County and serves an area within the Edna Valley portion of SLO Basin as shown in Figure 2-1.

2.3. Authority of Agencies

The GSAs developing this coordinated GSP were formed in accordance with the requirements of California Water Code Section10723 et seq. The resolutions of formation for the GSAs and the Memorandum of Understanding (MOA) are included in Appendices B - D. The specific legal authorities for GSA formation and GSP implementation are summarized below.

2.3.1. Groundwater Sustainability Agencies

"Local agency" is defined pursuant to CWC Section 10721(n) as a local public agency that has water supply, water management, or land use responsibilities within a groundwater basin.

2.3.1.1. County of San Luis Obispo

The County was created as described in Government Code Section 460 which states that the state is divided into counties, the names, boundaries, and territorial subdivisions of which are declared in Title 3 of the Government Code. The County has land use authority over the unincorporated areas of the county, including areas overlying the SLO Basin. The County is therefore a local agency under CWC Section 10721(n) with the authority to establish itself as a GSA. Upon establishing itself as a GSA, the County obtains all the rights and authorities provided to GSAs under CWC Section 10725 et seq. The City and the County shall each be responsible for adopting the GSP and implementing the GSP within their respective service areas.

2.3.1.2. City of San Luis Obispo

The City is incorporated under the laws of the State of California. The City provides water supply and land use planning services to its residents. The City is therefore a local agency under CWC Section 10721(n) with the authority to establish itself as a GSA. Upon establishing itself as a party of the GSA, the City obtains all the rights and authorities provided to GSAs under CWC 10725 et seq. The City and the County shall each be responsible for adopting the GSP and implementing the GSP within their respective service areas.

2.3.2. Memorandum of Agreement

The MOA Parties entered into the MOA effective as of January 25, 2018. The MOA establishes the GSC as an advisory body to the GSAs and the terms under which the City GSA and County GSA will jointly develop a single GSP, in coordination with the GSC pursuant to SGMA and other applicable provisions of law. The GSC members consists of representatives of the GSAs and the Participating Parties (i.e., EVGMWC, VRMWC, ERMWC, and GSWC). City and County staff will collaboratively participate in developing a GSP through, among other things, providing guidance to the consultant, coordinating with the GSC, and engaging SLO Basin users and stakeholders. Each GSC member has one vote on the GSC. The County Board of Supervisors and the City Council may approve or reject any advisory opinion submitted by the GSC provided that in every case that the County Board of Supervisors or City Council rejects an advisory opinion of the GSC related to the contents or adoption of the GSP it shall do so only after holding a public hearing, at which time the members of the GSC shall have the right to appear and address the City Council and the County Board of Supervisors. The MOA automatically terminates upon approval of the GSP by DWR. The Parties may then decide to enter into a new agreement to coordinate GSP implementation. A copy of the MOA is included in Appendix D.

2.3.3. Coordination Agreements

Only a single GSP is developed by the City and County GSAs to cover the entire SLO Basin. Therefore, no coordination agreements with other GSAs are necessary because there is not multiple GSPs.

2.4. Contact Information for Plan Manager (§ 354.6)

Name: Blaine Reely, Groundwater Sustainability Director, County of San Luis Obispo
Phone Number: 805-781-5000 (main County directory)
Mailing address: County Government Center, 1055 Monterey Street, San Luis Obispo, CA 93408
Electronic mail address: breely@co.slo.ca.us

2.5. Notices and Communications (§ 354.10)

The outreach activities conducted to support GSP development are documented in Appendix E. A Communication and Engagement Plan (C&E Plan) was executed and includes the planned activities for engaging interested parties in SGMA implementation efforts in the San Luis Obispo Valley Basin (Appendix E). Appendix E includes a Communications and Engagement Implementation Workplan for SLO Basin GSP. The workplan details the target stakeholder categories, developed outreach goals and evaluation metrics, identified communication priorities schedule, and describes the outreach tools and materials that were used throughout the GSP development.

The goals of the C&E Plan are as follows:

- Create an inclusive and transparent participation experience that builds public trust in the GSP and optimizes participation among all stakeholders.
- Employ outreach methods that facilitate shared understanding of the importance of sustainable groundwater conditions and impacts on stakeholders.
- Communicate “early and often,” and actively identify and eliminate barriers to participation.
- Develop a cost-effective, stakeholder-informed GSP supported by best-in-class technical data.

Outreach and communication throughout GSP development included regular presentations at GSC meetings, meetings with community groups, meetings with individual stakeholders, and community workshops. Comments from stakeholders were collected via the Groundwater Communications Portal (GCP), SLOWaterBasin.com, and the response to comments were also posted on SLOWaterBasin.com. and considered in the development of the GSP. Table 2-1 lists the public meetings and events that were held throughout the development of the GSP where elements of the Plan were discussed or considered by the GSC and the GSAs. Figure 2-3 shown below provides a summary of the engagement results regarding the stakeholder outreach touchpoints, stakeholder lists, stakeholder participation, and statistics for the SLOWaterBasin.com website.

Table 2-1. List of Public Meetings and Workshops

EVENT	LOCATION	DATE	TIME
GSC Public Meeting	Ludwick Community Center	4/10/2019	03:30PM
GSC Public Meeting	Ludwick Community Center	6/12/2019	03:30PM
Stakeholder Workshop	Library Community Room	8/14/2019	03:00PM
GSC Public Meeting	Ludwick Community Center	9/11/2019	03:00PM
GSC Public Meeting	Ludwick Community Center	12/11/2019	03:30PM
GSC Public Meeting	Ludwick Community Center	3/11/2020	03:30PM
Stakeholder Workshop	Zoom Meeting	6/10/2020	03:30PM
GSC Public Meeting	Go to Meeting	7/8/2020	06:00PM
GSC Public Meeting	Go to Meeting	9/9/2020	03:00PM
Stakeholder Workshop:	Zoom Meeting	10/1/2020	03:30PM
GSC Public Meeting	Zoom Meeting	12/9/2020	03:00PM
GSC Public Meeting	Zoom Meeting	2/17/2021	03:00PM
GSC Public Meeting	Zoom Meeting	3/1/2021	03:30PM
GSC Public Meeting	Zoom Meeting	3/31/2021	03:30AM
GSC Public Meeting	Zoom Meeting	4/7/2021	03:00PM
GSC Public Meeting	Zoom Meeting	5/5/2021	03:00PM
GSC Public Meeting	Zoom Meeting	5/20/2021	03:00PM
GSC Public Meeting	Zoom Meeting	6/21/2021	03:30PM
GSC Public Meeting	Zoom Meeting	8/18/2021	03:30PM

STAKEHOLDER ENGAGEMENT RESULTS

Stakeholder Outreach Touchpoints

17 QUARTERLY GSC MEETINGS HELD

3 STAKEHOLDER WORKSHOPS HELD

4 NEWSLETTERS DISTRIBUTED

41 EMAIL BULLETINS DISTRIBUTED TO INTERESTED PARTIES LIST

31 EVENT PUBLIC NOTICES POSTED

21 STAKEHOLDER ORGS RECEIVED DIRECT OUTREACH

Stakeholder List

519 SUBSCRIBERS TO EMAIL LIST

9/10 STAKEHOLDER GROUPS REPRESENTED ON LIST

Stakeholder Participation

30 AVERAGE GSC MTG ATTENDANCE

160+ STAKEHOLDER ATTENDANCE FOR THREE WORKSHOPS

70+ PUBLIC COMMENTS RECEIVED

Project Website Performance— SLOWaterBasin.com

2.7k TOTAL SESSIONS SINCE LAUNCH

50% AVERAGE VISITOR BOUNCE RATE

02:33 AVERAGE SESSION DURATION

2.15 AVERAGE PAGES PER SESSION

5.7k TOTAL PAGE VIEWS

Note: The Stakeholder Groups Represented is 9/10 due to the fact that Tribal interests were contacted and informed of the GSP development process, and that they indicated that they would engage in the Implementation Phase of the GSP.

Figure 2-3. Stakeholder Communication and Engagement Summary

3

GROUNDWATER SUSTAINABILITY PLAN

Description of Plan Area (§ 354.8)

The SLO Basin is oriented in a northwest-southeast direction and is composed of unconsolidated or loosely consolidated sedimentary deposits. It is approximately 14 miles long and 1.5 miles wide and covers a surface area of about 12,700 acres (19.9 square miles).

The SLO Basin is bounded on the northeast by the relatively impermeable bedrock formations of the Santa Lucia Range, and on the southwest by the formations of the San Luis Range and the Edna fault system. The bottom of the SLO Basin is defined by the contact of permeable sediments with the impermeable bedrock Miocene-aged and Franciscan Assemblage rocks (DWR, 2003). The SLO Basin is commonly referenced as being composed of two distinct valleys, with the San Luis Valley in the northwest and the Edna Valley in the southeast.

IN THIS CHAPTER

- SLO Basin Information
- Jurisdictional Areas
- Land Use
- Existing Plans

3.1. SLO Basin Information

The San Luis Valley comprises approximately the northwestern half of the SLO Basin. It is the area of the SLO Basin drained by SLO Creek and its tributaries (Prefumo Creek and Stenner Creek west of Highway 101, Davenport Creek and smaller tributaries east of Highway 101). Surface drainage in San Luis Valley drains out of the SLO Basin, flowing to the south along the course of SLO Creek, toward the coast in the Avila Beach area, approximately along the course of Highway 101. The San Luis Valley includes part of the City and California Polytechnic State University (Cal Poly) jurisdictional boundaries, while the remainder of the San Luis Valley is unincorporated land. Land use in the City is primarily single- and multi-family residential, commercial, industrial, and a small amount of land in agricultural uses. The area in the northwest part of the SLO Basin, along Los Osos Valley Road, has significant areas of irrigated agriculture, primarily row crops.

The Edna Valley comprises approximately the southeastern half of the SLO Basin. The primary creeks that drain the SLO Basin are the east and west branches of Corral de Piedras Creek, which join to form Pismo Creek, draining south out of the Edna Valley into Price Canyon. In the 1960s a private reservoir with storage capacity of 552 AF was permitted and constructed on West Corral de Piedras Creek upstream of the Basin, which interrupted the natural runoff from the watershed upstream of the reservoir; in 1990 this reservoir was permitted an expansion to a storage capacity of 951 AF. Smaller unnamed tributaries drain south from the SLO Basin in the extreme southeastern part of Edna Valley, ultimately joining Pismo Creek. Some of the unincorporated lands in Edna Valley are served by various private water purveyors. The primary land use in the Edna Valley is agriculture. During the past two decades wine grapes have become the most significant crop type in the Edna Valley.

The physical definition of the SLO Basin boundary is the contact between the unconsolidated or loosely consolidated sediments and the basement rock of the Miocene-aged formations and Franciscan Assemblage. There is a topographic high point in the underlying bedrock between the San Luis and Edna Valley subareas. The watershed divide and the bedrock high are not coincident. The sediments of the Edna Valley have significantly greater thickness than those of the San Luis Valley. Precipitation that falls west of that divide ultimately flows to Davenport and SLO Creeks, and precipitation that falls east of that divide flows to Corral de Piedras Creek or the other small tributaries, ultimately flowing to Pismo Creek south of the SLO Basin.

The primary weather patterns for the SLO Basin derive from seasonal patterns of atmospheric conditions that originate over the Pacific Ocean and move inland. As storm fronts move in from the coast, rainfall in the area falls more heavily in the mountains, and the SLO Basin itself receives less rainfall because of a muted rain shadow effect. Average annual precipitation ranges from approximately 18 inches throughout most of the SLO Basin to about 22 inches in higher elevation areas near the City and Cal Poly. Figure 3-1 presents the time series of annual precipitation for the period of record from 1870 to 2018 at the Cal Poly weather station No. 52. The average historical rainfall at this location to date is 21.69 inches, with a standard deviation of 8.75 inches. The historical maximum is 49.99 inches, which occurred in 1884. The historical minimum is 4.56 inches, which occurred in 2013.

3.2. Adjudicated Areas

The SLO Basin is not an adjudicated basin.

3.3. Jurisdictional Areas

In addition to MOA Parties, there are several entities that have some degree of water management authority in the SLO Basin. Each entity is discussed below.

3.3.1. Federal Jurisdictions

There are no federal agencies with land holdings in the SLO Basin.

3.3.2. Tribal Jurisdiction

The two prominent Native American tribes in the County are the Obispeño Chumash and Salinan Indian Tribes. The Chumash occupied the coast between San Luis Obispo and northwestern Los Angeles County, inland to the San Joaquin Valley. They were divided into two broad groups, of which the Obispeño were the northern group. The Salinan were northern neighbors of the Chumash, and although the presence of a firm boundary between the Chumash and the Salinan is uncertain, ethnographic accounts have placed Salinan territories in the northern portion of the County. However, these two tribes do not have any recognized tribal land in the SLO Basin.

3.3.3. State Jurisdiction

The State of California University system owns and operates land that is associated with Cal Poly located in the northern edge of the SLO Basin off Hwy 1. Cal Poly is a significant user of local water resources utilizing both groundwater and surface water. In addition to on-site wells which are used for landscape irrigation and agricultural irrigation, Cal Poly has water rights to Whale Rock Reservoir which is primarily used to meet the campus' potable water needs. Water from Whale Rock is treated at the City's Water Treatment Plant and delivered through shared infrastructure from the City's Water Treatment Plant to the campus. The City treats the wastewater generated from Cal Poly. There are no California State Parks or other State-owned lands or entities located within the SLO Basin.

3.3.4. County Jurisdiction

The County of San Luis Obispo and the associated San Luis Obispo County Flood Control and Water Conservation District (SLOCFCWCD) (see section under Special Districts below) have jurisdiction over the entire County including the SLO Basin. The County owns approximately 300 acres of land in the SLO Basin which is primarily located in the vicinity of the SLO County Airport.

3.3.5. City and Local Jurisdictions

The City is centrally located in the SLO Basin and has land and water management authority over its incorporated area. The City has three primary water supply sources including Whale Rock Reservoir, Salinas Reservoir, and Nacimiento Reservoir, with recycled water (for irrigation) and groundwater serving as supplemental sources. Three major mutual water companies exist in the SLO Basin: Edna Valley Growers, Varian Ranch, and Edna Ranch Mutual Water Companies. One investor-owned utility exists within the SLO Basin: Golden State Water Company. GSWC provides groundwater that is pumped from the Edna Valley Basin to residential and agricultural customers.

3.3.6. Special Districts

The San Luis Obispo County Flood Control and Water Conservation District is a special act district governed by the County Board of Supervisors pursuant to the San Luis Obispo County Flood Control and Water Conservation District Act. It has jurisdiction over all of the County including the SLO Basin and was established as a resource to help individuals and communities in San Luis Obispo County identify and address flooding problems with the purpose *"to provide for control, disposition and distribution of the flood and storm waters of the district and of streams flowing into the district...".*

3.4. Land Use

The County, City, and State have land use authority in the SLO basin within their respective jurisdictions. Land use information for the SLO Basin was based on DWR's land use database (DWR, 2014). The 2014 land use in the SLO Basin is shown on Figure 3-2 and is summarized by group in Table 3-1. All land use categories except native vegetation listed in Table 3-1 are provided by DWR (DWR, 2014). The areas of the basin that did not have a land use designation were assumed to be native vegetation.

Table 3-1. Agricultural Land Use Categories Defined for the SLO Basin by DWR (2014)

LAND USE CATEGORY	ACRES
Citrus and subtropical	136
Deciduous fruits and nuts	21
Grain and hay crops	183
Idle	713
Pasture	179
Truck nursery and berry crops	1079
Urban	6,412
Vineyard	1,929
Young perennial	2
Native vegetation	<1
TOTAL	**10,656**

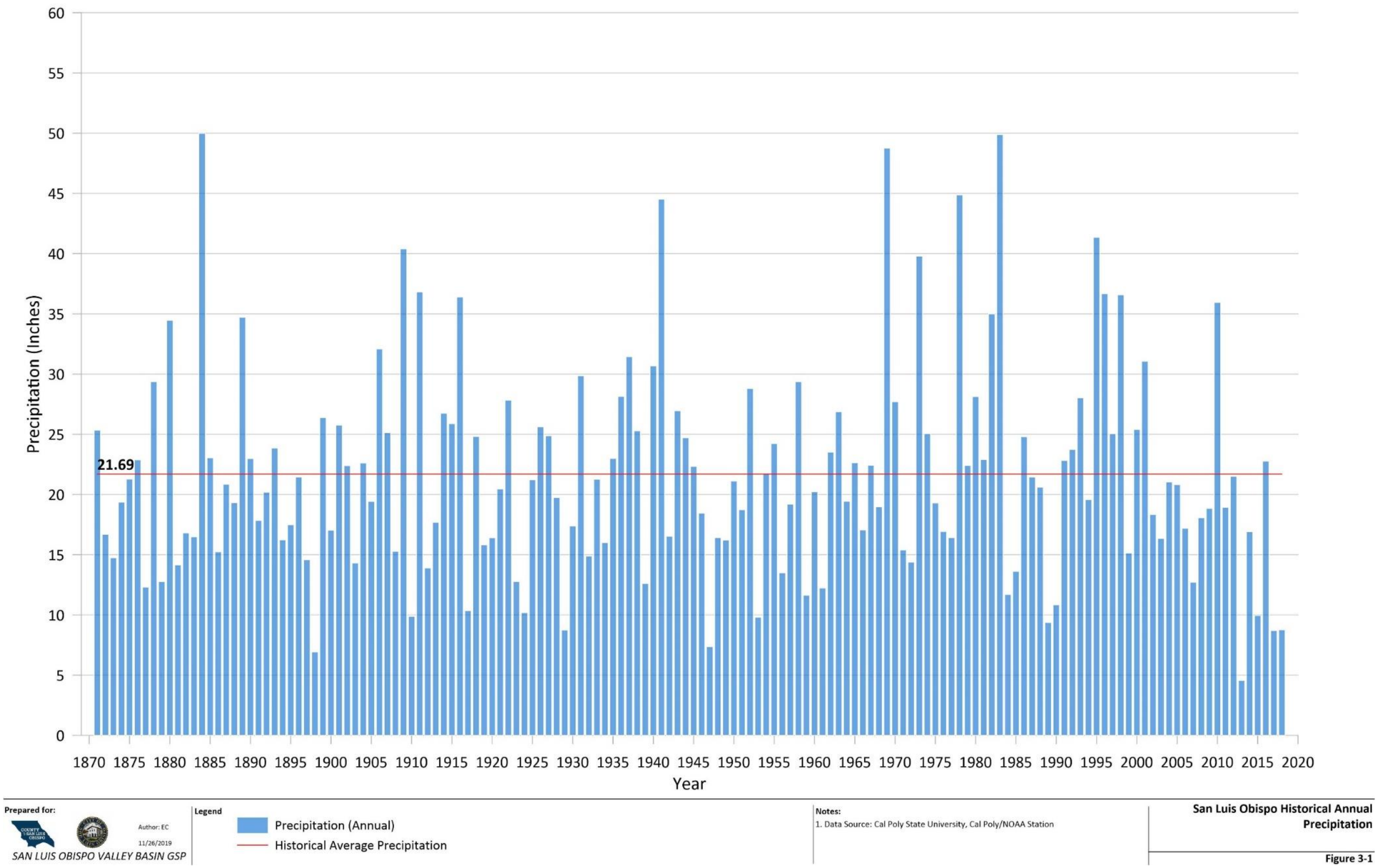


Figure 3-1. San Luis Obispo Historical Annual Precipitation

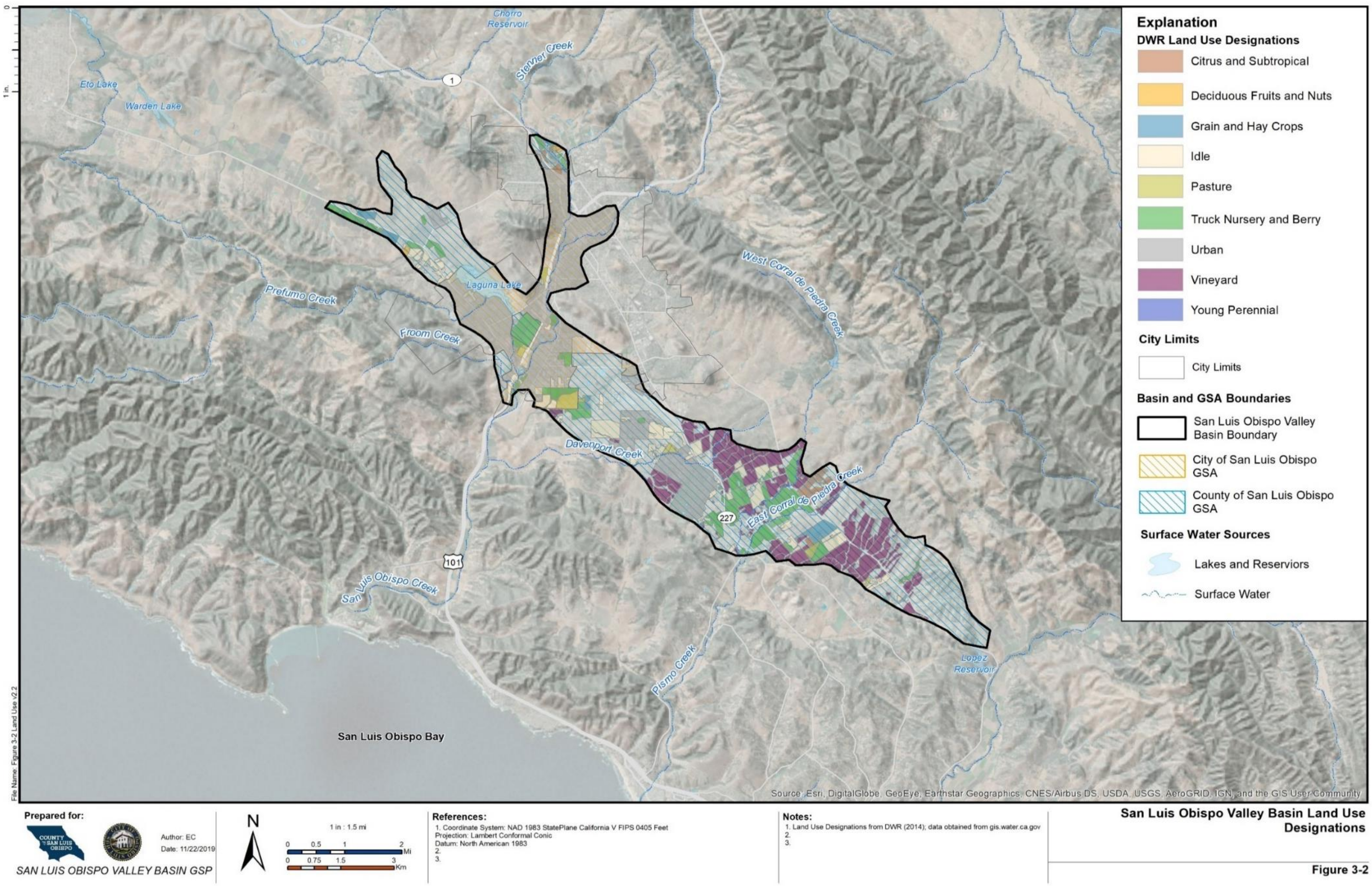


Figure 3-2. San Luis Obispo Valley Basin Existing Land Use Designations

3.4.1. Water Source Types

Entities in the SLO Basin utilize three types of water sources to meet the demands: groundwater, surface water, and recycled water. Excluding the City and Cal Poly, all water demand in the SLO Basin is met with groundwater. Cal Poly has rights to 33.71% of water from Whale Rock Reservoir and the rest of their water supply comes from local groundwater. The City has an entitlement to water from the Nacimiento Water Project, rights to Salinas Reservoir (Santa Margarita Lake), rights to 55.05% of water in Whale Rock Reservoir, SLO Basin groundwater, and recycled water from its Water Resource Recovery Facility (WRRF). The City has imported supplies from Salinas Reservoir, located near the community of Santa Margarita, since 1944, Whale Rock Reservoir, located near the community of Cayucos, since 1961, and Nacimiento Reservoir since 2011. Table 3-2 summarizes the surface water supply available from each source and Figure 3-3 shows the location of water supply source types within the SLO Basin.

Table 3-2. Summary of Surface Water Supply Sources Available to the SLO Basin

<table>
<tr><th>SUPPLY SOURCES</th><th>AMOUNT AVAILABLE (AFY)</th></tr>
<tr><td>Nacimiento Reservoir- City</td><td>5,482[1]</td></tr>
<tr><td>Salinas Reservoir - City</td><td rowspan="2">4,910[1]</td></tr>
<tr><td>Whale Rock Reservoir - City</td></tr>
<tr><td>Recycled Water - City</td><td>~1,000[1]</td></tr>
<tr><td>TOTAL</td><td>11,392</td></tr>
</table>

[1] City of San Luis Obispo, General Plan, Water and Wastewater Management Element, 2018.

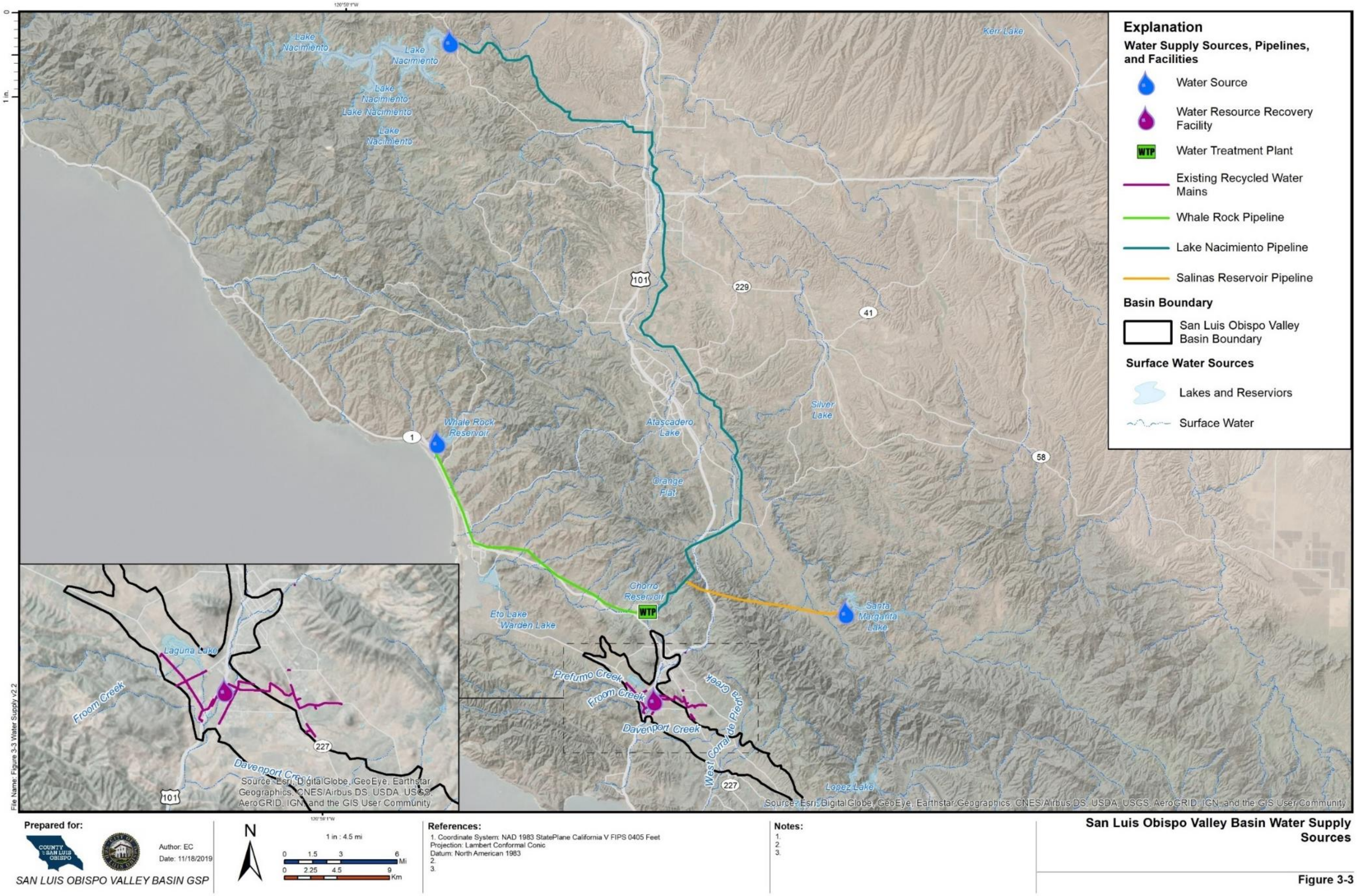


Figure 3-3. San Luis Obispo Valley Basin Water Supply Sources

3.4.2. Water Source Sectors

Water demand in the SLO Basin is organized into the six water use sectors identified in the GSP Regulations. These include:

- **Urban.** Urban water use is assigned to non-agricultural water uses in the City and census-designated places. Domestic use outside of census-designated places is not considered urban use.
- **Industrial.** There is limited industrial use in the SLO Basin. The DWR land use designations in the SLO Basin does not include industrial uses.
- **Agricultural.** This is the largest groundwater use sector in the SLO Basin by water demand.
- **Managed wetlands.** There are several managed wetlands in the SLO Basin that are managed by both federal, state, and local agencies. In general, wetlands in the area are managed by the following agencies: (1) City of San Luis Obispo, (2) California Department of Fish and Wildlife, (3) California State Water Resources Control Board, (4) U.S. Fish and Wildlife Service, and (5) U.S. Army Corps of Engineers. The wetlands and natural vegetation areas that are potentially dependent ecosystems include Laguna Lake and reaches of the SLO Creek, Prefumo Creek, Stenner Creek, Davenport Creek, East and West Corral De Piedra Creeks, and Pismo Creek. Water use for these ecologically sensitive areas is addressed in Chapter 5 (Groundwater Conditions), Chapter 6 (Water Budget), and Chapter 8 (Sustainable Management Criteria).
- **Managed recharge.** There is no managed recharge in the SLO Basin. Recycled water discharge to creeks and applied irrigation is included in the urban water use sector.
- **Native vegetation.** This is the largest water use sector in the SLO Basin by land area. This sector includes rural residential areas.

Figure 3-4 shows the distribution of the water use sectors and potential groundwater dependent ecosystems in the SLO Basin.

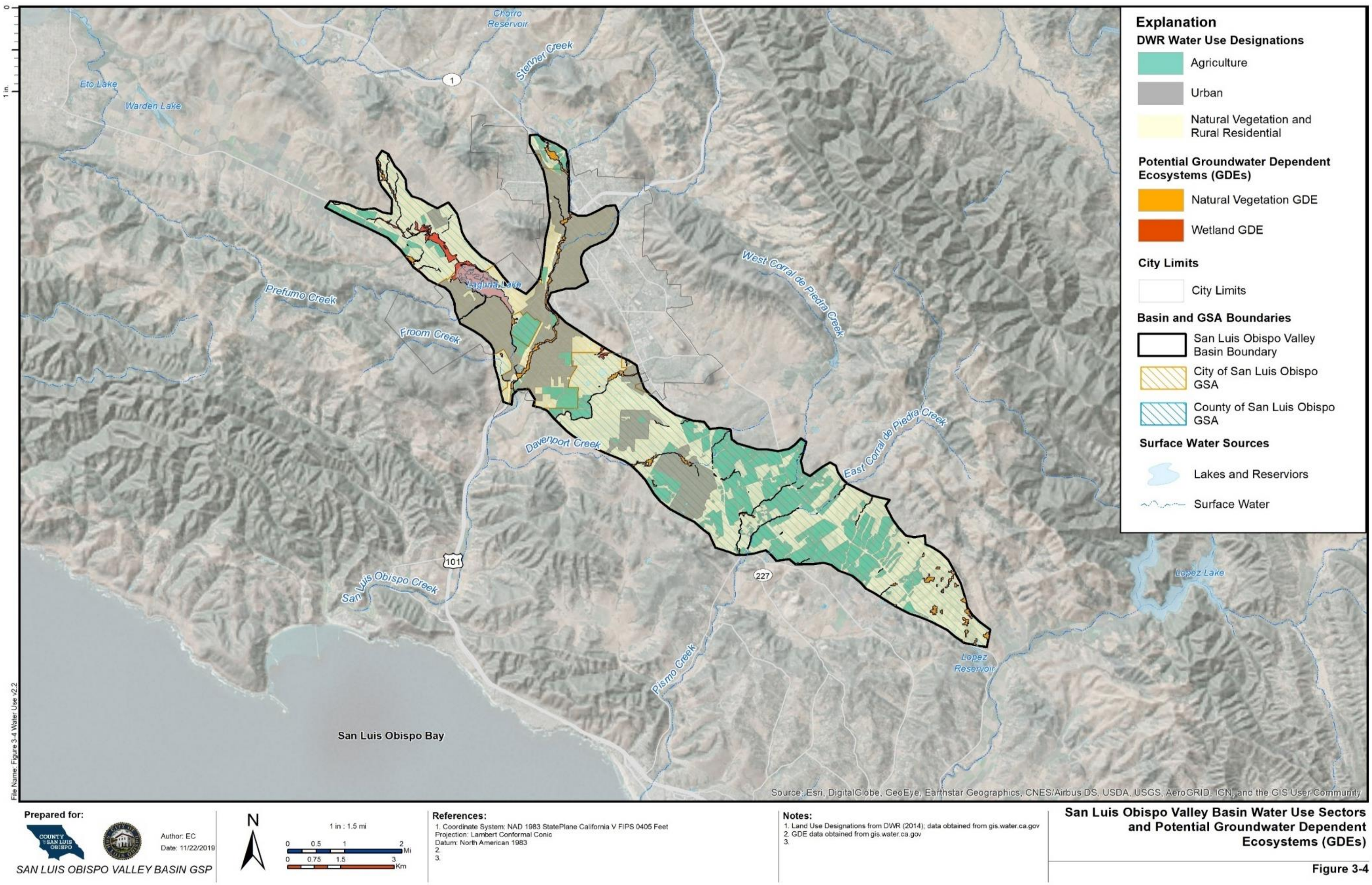


Figure 3-4. San Luis Obispo Valley Basin Water Use Sectors

3.5. Density of Wells

Well types, well depth data, and well distribution data were downloaded from DWR's well completion report map application (DWR, 2016). DWR categorizes wells in this mapping application as either domestic, production, or public supply. These categories are based on the well use information submitted with the well logs to DWR. Well information was also collected from County of San Luis Obispo Environmental Health Services (EHS). The EHS dataset was compiled from information gained from the well construction permit application process. Table 3-3 summarizes the types of wells by use for all well logs submitted to DWR and EHS.

Table 3-3. DWR and County Wells

WELL DATA SOURCE	TYPE OF WELL	TOTAL NO. OF WELLS
DWR	Domestic	75
	Production	71
	Public Supply	24
	Total	*170*
County EHS	Domestic Private	355
	Domestic Public	43
	Irrigation	231
	Total	*629*[1]

Notes:

1. The County EHS database may contain duplicates that are also included in the DWR database.

Figure 3-5, Figure 3-6, and Figure 3-7 show the density of wells in the SLO Basin by their types of use. The DWR data used to develop these maps is not necessarily the same set of well data held by EHS as shown in Figure 3-8. DWR data was used to develop maps of well densities because they are organized for easy mapping of well density per square mile. These maps should be considered representative of well distributions but are not definitive. It is also important to note that both the DWR and EHS well databases are not updated with information regarding well status and the well locations are not verified in the field. Therefore, it is uncertain whether the wells in these databases are currently active or have been abandoned or destroyed.

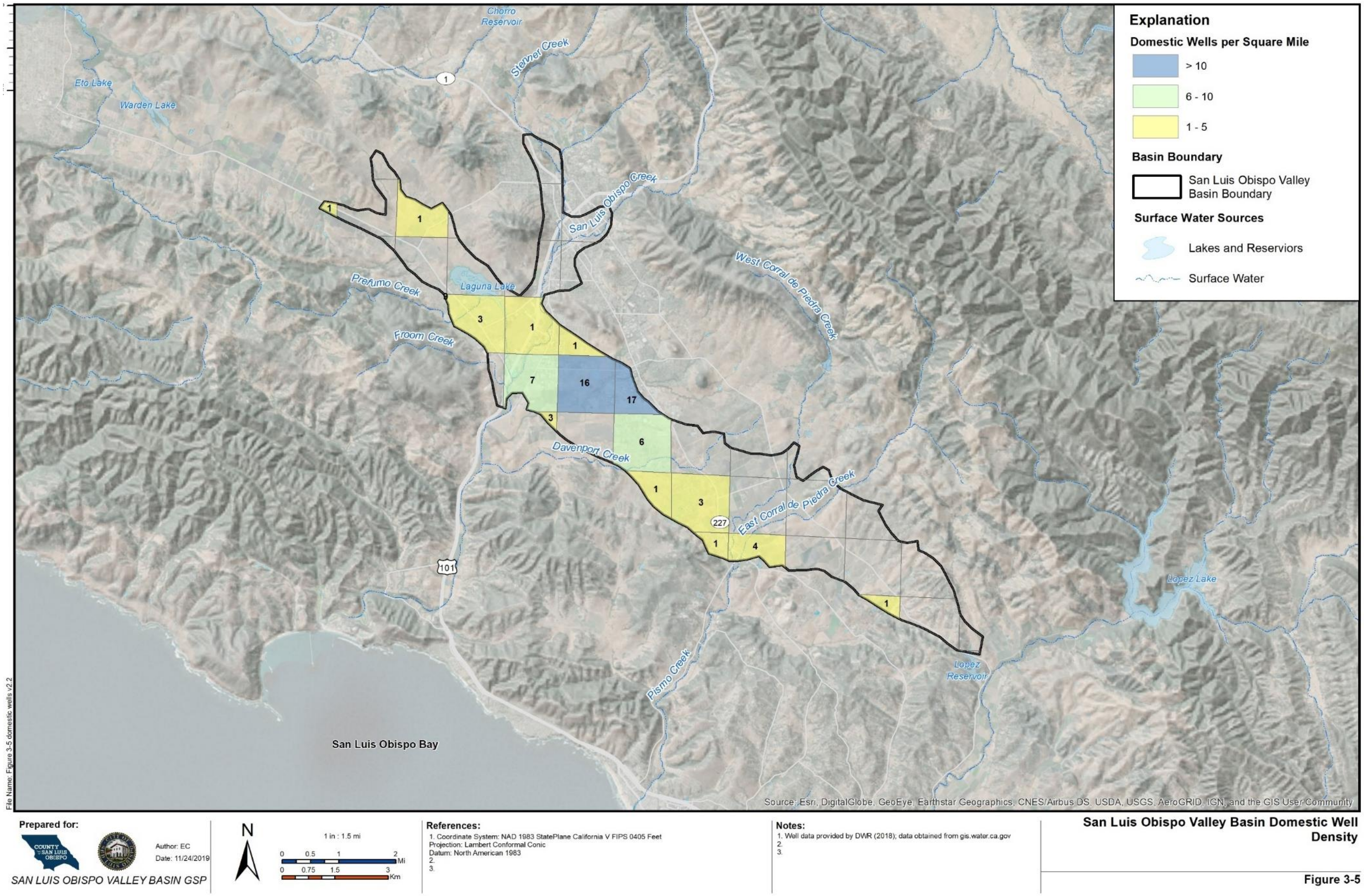


Figure 3-5. San Luis Obispo Valley Basin Domestic Well Density

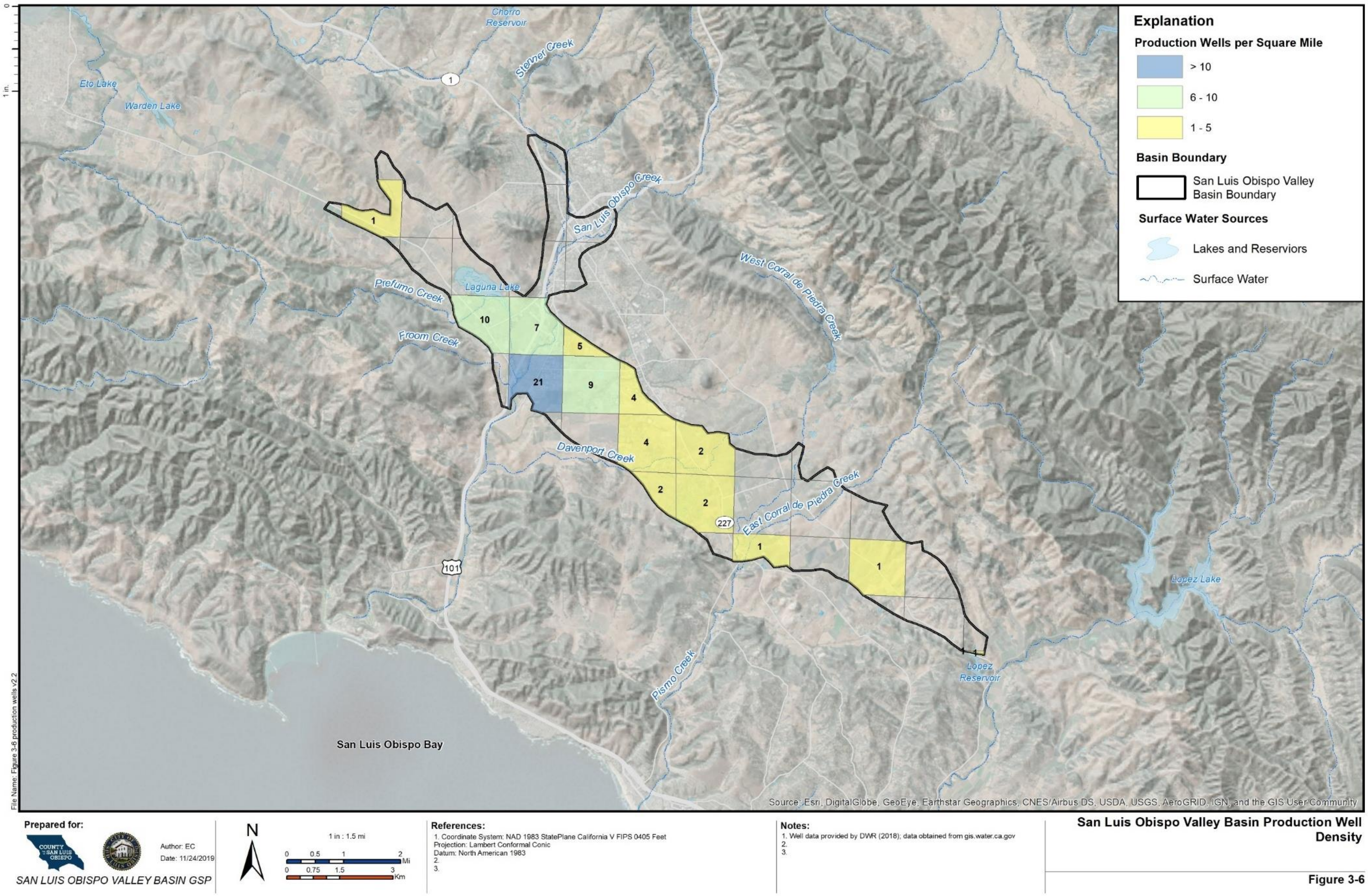


Figure 3-6. San Luis Obispo Valley Basin Production Well Density

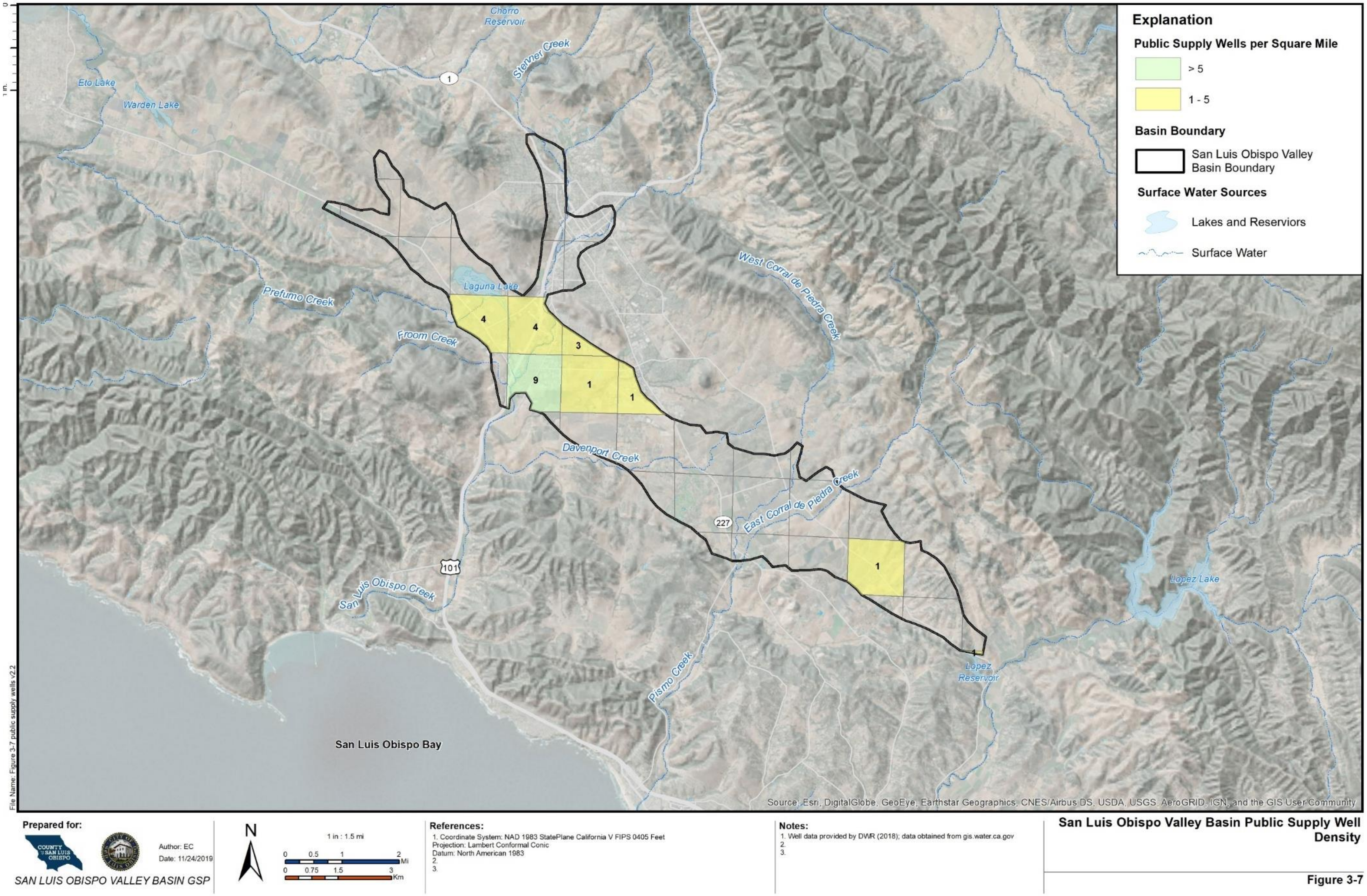


Figure 3-7. San Luis Obispo Valley Basin Public Supply Well Density

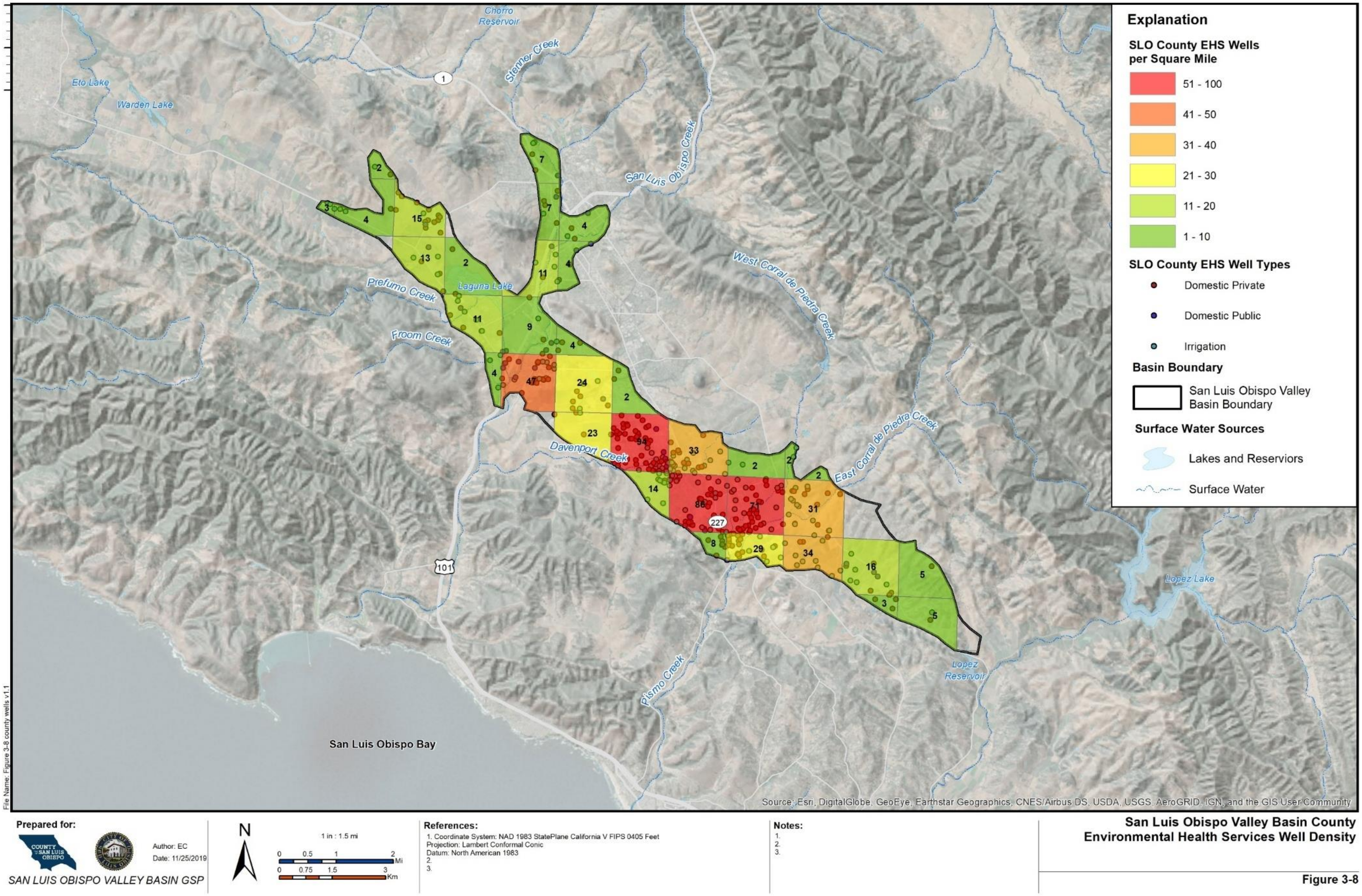


Figure 3-8. San Luis Obispo Valley Basin County Environmental Health Services Well Density

3.6. Existing Monitoring and Management Programs

3.6.1. Service Area Population

Groundwater levels and quality are currently measured in the SLO Basin by the SLOFCWCD and a variety of other agencies as described below. Figure 3-9 shows the locations of monitored wells identified in the Groundwater Ambient Monitoring and Assessment (GAMA) program (i.e., publicly available data) that are monitored by several public agencies, the SLOFCWCD, and the Central Coast Regional Water Quality Control Board (CCRWQCB) Irrigated Lands Program. The monitoring network also includes other wells in the area designated as private that are not shown on this map (Figure 3-8). Additional evaluation of the current monitoring program will be conducted for the GSP to establish a representative monitoring network of public and private wells that will be used during plan implementation to track groundwater elevations and ensure that minimum thresholds have not been exceeded.

3.6.1.1. Groundwater Level Monitoring

The SLOFCWCD has been monitoring groundwater levels county-wide on a semi-annual basis for more than 50 years to support general planning and for engineering purposes. Groundwater level measurements are taken once in the spring and once in the fall. The monitoring takes place from a voluntary network of wells. In the SLO Basin, there are 16 active wells in this program (Figure 3-9). The voluntary monitoring network has changed over time as access to wells has been lost or new wells have been added to the network.

3.6.1.2. Groundwater Quality Monitoring

Groundwater quality is monitored/reported under several different programs and by different agencies including:

- Municipal and community water purveyors that collect water quality samples on a routine basis for compliance monitoring and reporting to the California State Water Resources Control Board (SWRCB) Division of Drinking Water (DDW).
- The USGS who collects water quality data on a routine basis under the GAMA program. These data are stored in the State's GeoTracker GAMA system.
- There are multiple sites that are monitoring groundwater quality as part of investigation or compliance monitoring programs through the CCRWQCB. See Figure 3-9 for CCRWQCB well monitoring locations through the GeoTracker GAMA system.
- The CCRWQCB under Agricultural Order No. R3-2017-0002, a Conditional Waiver of Waste Discharge Requirements for Discharges from Irrigated Lands, requires all growers to implement groundwater monitoring, either individually or as part of a cooperative regional monitoring program. Growers electing to implement individual monitoring (i.e., not participating in the regional monitoring program implemented by the Central Coast Groundwater Coalition [CCGC] within the SLO Basin) are required to test all on-farm domestic wells and the primary irrigation supply wells for nitrate or nitrate plus nitrite, and general minerals (including, but not limited to, TDS, sodium, chloride, and sulfate).
- California Water Data Library contains groundwater level and water quality monitoring station information. The data available from this resource has been used above.

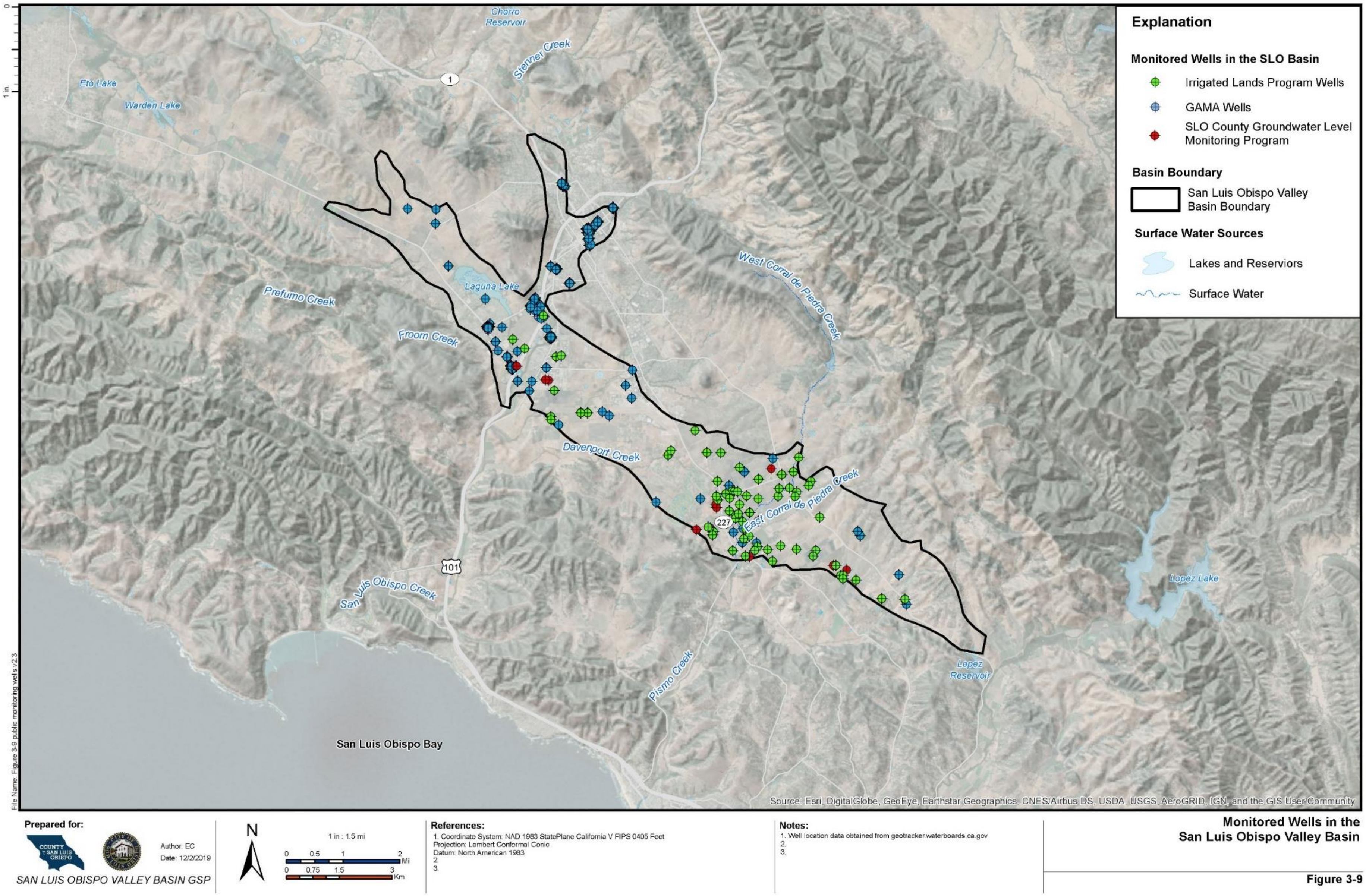


Figure 3-9. Monitored Wells in the San Luis Obispo Valley Basin

3.6.1.3. Surface Water Monitoring

The Water Resources Division of the SLO County Public Works maintains six (6) real-time data monitoring stream gauges within the SLO Creek watershed and all except Andrews St. Bridge are located within the SLO Basin. As summarized in Table 3-4, each stream gauge measures stage at 15-minute intervals. Stage-discharge relationships, or rating curves, for each of the five stream gauge stations were generated as part of the San Luis Obispo Creek Watershed Hydrology and Hydraulic Model Calibration Study (Questa Engineering Corporation, 2007). More recently (2018/2019), Central Coast Salmon Enhancement has approximated rating curves for the Andrews St., Elks Lane, and Stenner Creek gauge stations based on recorded stage data and measured flows. The locations of the five County gauges are presented in Figure 3-10.

In addition to the County gauges, the City of San Luis Obispo routinely estimates flow at four locations (RW-4, RW-5, RW-7, RW-8) along San Luis Obispo Creek in the vicinity of the City's WRRF outfall as part of its National Pollutant Discharge Elimination System permitting program. RW-8 at South Higuera Bridge is located outside of the SLO Basin. Flow at the four locations (RW-4, RW-5, RW-7, and RW-8) is calculated weekly from April through the end of October based on the depth measurements recorded along the creek cross-section and are located within the Basin.

Table 3-4. Stream Gauges and Summary of Records Available

STREAM GAGE	SOURCE	DATA RECORDED	DATA INTERVAL	YEAR DATA BEGINS	DATUM[1]
Andrews St Bridge	SLO County	Stage	15 Minutes	2006	NAVD 88
Stenner Creek at Nipomo	SLO County	Stage	15 Minutes	2005	NAVD 88
Elks Ln	SLO County	Stage	15 Minutes	2005	NAVD 88
Madonna Rd	SLO County	Stage	15 Minutes	2005	NAVD 88
E. Fork at Jespersen Rd	SLO County	Stage	15 Minutes	2005	NAVD 88
Marsh Street Bridge	SLO County	Stage	15 Minutes	2019	NAVD 88
RW-4	City of SLO	Depth, Flow	Weekly	2005	-
RW-5	City of SLO	Depth, Flow	Weekly	2005	-
RW-7	City of SLO	Depth, Flow	Weekly	2005	-
RW-8	City of SLO	Depth, Flow	Weekly	2005	-

[1]Prior to 5/23/2017 County data was recorded on NGVD 29 datum. Conversion is 2.86 feet.

3.6.1.4. Surface Water Monitoring

Climate monitoring in the SLO Basin includes stations that collect data related to temperature, evapotranspiration, relative humidity, atmospheric pressure, precipitation, and other climate parameters. Four stations monitored by San Luis Obispo County Public Works collect one or more climate parameters in the SLO Basin. The locations of these stations are shown on Figure 3-10.

The National Climatic Data Center has three stations within the County of San Luis Obispo and one station within the SLO Basin that collect climate data. These stations do not have extensive historic data. The station with the most precipitation data not associated with the National Climatic Data Center, Cal Poly Weather Station 52 (CPWS-52), began recording data in 1870. The Cal Poly Weather Station 52 measures daily temperatures and other climate parameters in addition to precipitation. Daily records are available from April 1986 to present. Table 3-5 lists the climate stations and summary of records available.

The long-term precipitation and cumulative departure from the mean (CDFM) measurements at CPWS-52 are shown in Figure 3-11 from– 1870 - 2018. Average annual precipitation at this station varies from approximately 7 to 55 inches with a mean annual average precipitation of 21.95 inches. The longest dry period on record occurred from 1943 – 1965 and the longest wet period on record occurred from 1899 – 1916. Table 3-6 provides a summary of average monthly rainfall, temperature, and evapotranspiration (ET_0) for the SLO Basin at CPWS-52 from 1987 to 2018.

Table 3-5. Weather Station Information and Summary of Records Available

STATION	SOURCE	DATA RECORDED	DATA INTERVAL	YEAR DATA BEGINS
Cal Poly Weather Station 52	CIMIS	Precipitation, Temperature, Evapotranspiration	Daily	1986
SLO Reservoir	SLO County	Precipitation	12-Hour	2005
The Gas Company	SLO County	Precipitation	12-Hour	2005
South Portal	SLO County	Precipitation	12-Hour	2005
SLO County Farm Bureau	Weather Element	Precipitation, Temperature	Daily	2015

Table 3-6. Average Monthly Climate Summary 1987 – 2018 at Cal Poly Weather Station 52

MONTH	AVERAGE PRECIPITATION (INCHES)	AVERAGE ET_0 (INCHES)	AVERAGE TEMPERATURE (°F)
January	4.24	2.29	54
February	4.07	2.54	54
March	3.27	3.85	56
April	1.04	4.93	57
May	0.53	5.67	59
June	0.22	6.13	62
July	0.12	6.24	64
August	0.03	5.79	64
September	0.21	4.81	64
October	1.16	3.93	63
November	1.49	2.74	58
December	3.42	2.18	53

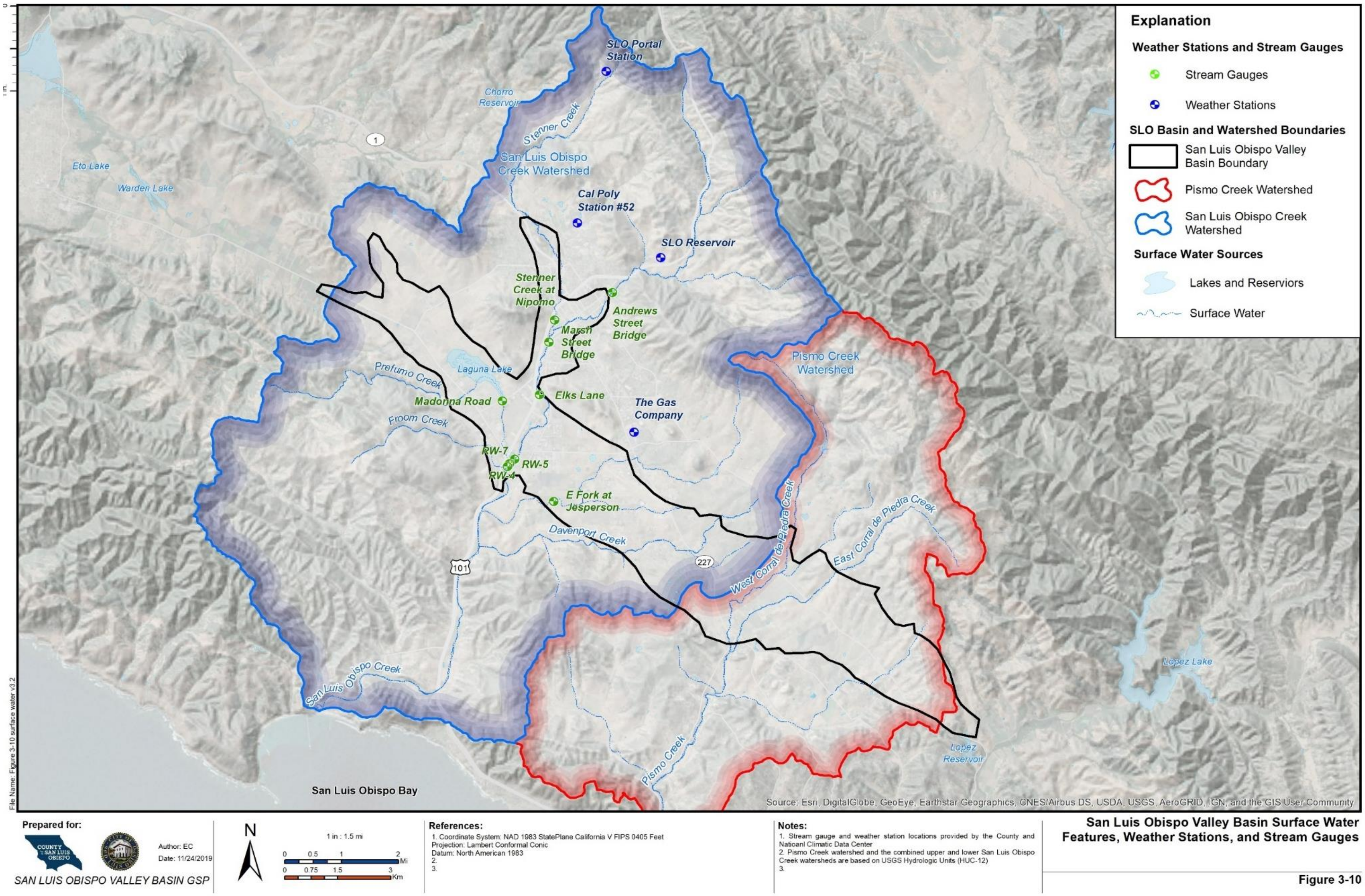


Figure 3-10. San Luis Obispo Valley Basin Surface Water Features, Weather Stations, and Stream Gauges

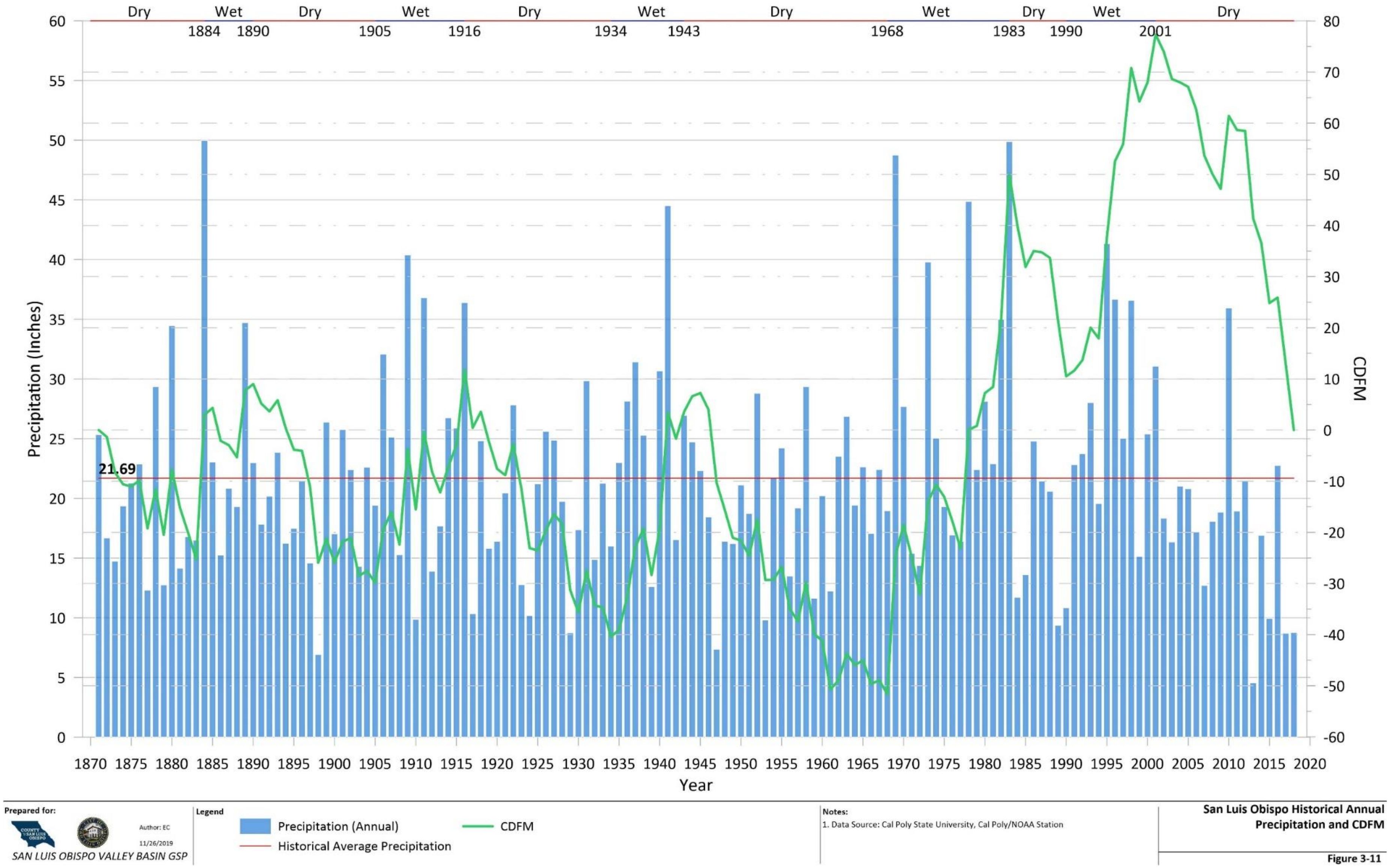


Figure 3-11. San Luis Obispo Valley Basin Historical Annual Precipitation and CDFM

3.6.2. Existing Management Plans

There are numerous groundwater and water management plans, studies, and reports that cover either the whole or portion of the SLO Basin. These documents are described in the following subsections, along with brief descriptions of how they relate to the management of current water supply, projected water supplies, and land use.

3.6.2.1. SLO Basin Characterization and Monitoring Well Installation

The SLO Basin Characterization and Monitoring Well Installation (GSI Water Solutions, 2018) documents the available published reports, private well reports, well completion reports, geologic logs, and other data that were reviewed to generate a comprehensive compilation of the current understanding of the hydrogeologic setting of the SLO Basin. This information is intended to provide the basis of knowledge for future planning and management activities performed under the requirements of GMA, including the development of a hydrogeologic conceptual model, construction of a numerical groundwater model, and development of a GSP.

3.6.2.2. San Luis Obispo County Master Water Report (2012)

The County's Master Water Report (MWR) (Carollo, 2012) is a compilation of the current and future water resource management activities being undertaken by various entities within the County and is organized by Water Planning Areas (WPA). The MWR explores how these activities interrelate, analyzes current and future supplies and demands, identifies future water management strategies and ways to optimize existing strategies, and documents the role of the MWR in supporting other water resource planning efforts. The MWR evaluates and compares the available water supplies to the water demands for the different water planning areas.

This was accomplished by reviewing or developing the following:

- Current water supplies and demands based on available information
- Forecast water demands and water supplies available in the future under current land use policies and designations
- Criteria under which there is a shortfall when looking at supplies versus demands
- Criteria for analyzing potential water resource management strategies, projects, programs, or policies
- Potential water resource management strategies, projects, programs, or policies to resolve potential supply deficiencies

3.6.2.3. San Luis Obispo County Integrated Regional Water Management Plan (2014)

The San Luis Obispo County Integrated Regional Water Management Plan (IRWMP) was initially developed and adopted by the SLOFCWCD in 2005 (GEI Consultants, 2005), and has been updated several times. The SLOFCWCD, in cooperation with the SLOFCWCD's San Luis Obispo Regional Water Management Group (RWMG), prepared the 2019 IRWMP (San Luis Obispo County Flood Control and Water Conservation District , 2020) to align the region's water resources management planning efforts with the State's planning efforts. The IRWMP is used to support the region's water resource management planning and the submittal of grant applications to fund these efforts.

The IRWMP includes goals and objectives that provide the basis for decision-making and are used to evaluate project benefits. The goals and objectives reflect input from interested stakeholders on the region's major water resources issues. These goals and objectives help secure and enhance the water supply reliability, water quality, ecosystems, groundwater, flood management and water-related communication efforts across the entire region. In addition, the IRWMP identifies resource management strategies, recognizes other funding opportunities, and includes a list of action items (projects, programs, and studies) that agencies around the region are undertaking to achieve and further these goals and objectives.

3.6.2.4. City of San Luis Obispo 2015 Urban Water Management Plan (2016)

The City's Urban Water Management Plan (UWMP) (City of San Luis Obispo, 2016) describes the City's current and future water demands, identifies current water supply sources, and assesses supply reliability for the City. The UWMP describes the City's use of groundwater and its support for efforts to avoid overdraft by developing additional sources. The UWMP provides a forecast of future growth, water demand, and water sources for the City through 2035. These sources include water conservation, the Nacimiento Water Project, Salinas Reservoir (Santa Margarita Lake), Whale Rock Reservoir, SLO Basin groundwater, and recycled water from the WRRF.

3.6.3. Existing Groundwater Regulatory Programs

3.6.3.1. Groundwater Export Ordinance (2015)

In 2015, County of San Luis Obispo adopted an Exportation of Groundwater ordinance (County Code Chapter 8.95) that requires a permit for the export of groundwater out of a groundwater basin or out of the County. An export permit is only approved if the Department of Public Works Director or his/her designee finds that moving the water would not have any adverse impacts to groundwater resources, such as causing aquifer levels to drop, disrupting the flow of neighboring wells, or resulting in seawater intrusion. Export permits are only valid for one year.

3.6.3.2. Countywide Water Conservation Program Resolution 2015-288 (2015)

This ordinance identifies areas of severe decline in groundwater elevation and those properties overlying these areas would be further restricted from planting new or expanding irrigated agriculture except for those converting irrigated agriculture on the same property into a different crop type. This resolution applies to the Nipomo Mesa Water Conservation Area which is part of the Santa Maria Groundwater Basin, the Los Osos Groundwater Basin, and the Paso Robles Groundwater Basin. Therefore, it is not applicable to the SLO Basin.

3.6.3.3. Agricultural Order R3-2017-002 (2017)

In 2017 the CCRWQCB issued Agricultural Order No. R3-2017-0002, a Conditional Waiver of Waste Discharge Requirements for Discharges from Irrigated Lands. The permit requires that growers implement practices to reduce nitrate leaching into groundwater and improve surface receiving water quality. Specific requirements for individual growers are structured into three tiers based on the relative risk their operations pose to water quality.

Growers must enroll, pay fees, and meet various monitoring and reporting requirements according to the tier to which they are assigned. All growers are required to implement groundwater monitoring, either individually or as part of a cooperative regional monitoring program. Growers electing to implement individual monitoring (i.e., not participating in the regional monitoring program implanted by the Central Coast Groundwater Coalition [CCGC]) are required to test all on-farm domestic wells and the primary irrigation supply wells for nitrate or nitrate plus nitrite, and general minerals (including, but not limited to, TDS, sodium, chloride, and sulfate).

3.6.3.4. Water Quality Control Plan for the Central Coast Basins (2017)

The Water Quality Control Plan for the Central Coastal Basin (Basin Plan) was most recently updated in September 2017 by the SWRCB (Regional Water Quality Control Board, Central Coast Region, 2017). The objective of the Basin Plan is to outline how the quality of the surface water and groundwater in the Central Coast Region should be managed to provide the highest water quality reasonably possible.

The Basin Plan lists beneficial users, describes the water quality that must be maintained to allow those uses, provides an implementation plan, details SWRCB and CCRWQCB plans and policies to protect water quality, and a statewide surveillance and monitoring program as well as regional surveillance and monitoring programs.

Present and potential future beneficial uses for inland waters in the SLO Basin are: surface water and groundwater as municipal supply (water for community, military or individual water supplies); agricultural; groundwater recharge; recreational water contact and non-contact; sport fishing; warm fresh water habitat; wildlife habitat; rare threatened or endangered species; and spawning, reproduction, and/or early development of fish.

Water Quality Objectives for both groundwater (drinking water and irrigation) and surface water are provided in the Basin Plan.

3.6.3.5. California DWR Well Standards (1991)

Under the CWC Sections 13700 to 13806, DWR has the responsibility for developing well construction standards. DWR maintains these standards to ensure that the construction of a well does not result in deterioration of groundwater quality. California Well Standards, published as DWR Bulletin 74, represent minimum standards for well construction, alteration, and destruction to protect groundwater. Cities, counties, and water agencies in California have regulatory authority over wells and can adopt local well ordinances that meet or exceed the statewide Well Standards. When a well is constructed, modified or destroyed a well completion report is required to be submitted to DWR.

3.6.3.6. Requirements for New Wells (2017)

Senate Bill 252 became effective on January 1, 2018 but was repealed as of January 1, 2022. SB 252 required well permit applicants in critically overdrafted basins to include information about the proposed well, such as location, depth, and pumping capacity. The bill also requires the permitting agency to make the information easily accessible to the public and the GSA. As of 2019, these requirements are under review by DWR. This bill is not applicable because the SLO Basin is not a critically overdrafted basin.

3.6.3.7. County of San Luis Obispo Well Construction Ordinance

The County of San Luis Obispo under County Code Chapter 8.40 incorporates standards set forth in DWR Bulletin No. 74 and includes local standards governing water seal depths.

3.6.3.8. Title 22 Drinking Water Program (2018)

The 2018 SWRCB DDW regulates public water systems in the State to ensure the delivery of safe drinking water to the public. A public water system is defined as a system for the provision of water for human consumption through pipes or other constructed conveyances that has 15 or more service connections or regularly serves at least 25 individuals daily at least 60 days out of the year. Private domestic wells, wells associated with drinking water systems with less than 15 residential service connections, and industrial and irrigation wells are not regulated by the DDW. Additional information regarding the public water systems can be found using the following link: https://sdwis.waterboards.ca.gov/PDWW/JSP/WaterSystems.jsp?PointOfContactType=none&number=&name=&county=San%20Luis%20Obispo

DDW enforces the monitoring requirements established in Title 22 of CCR for public water system wells, and all the data collected must be reported to the DDW. Title 22 also designates the regulatory limits (e.g., maximum contaminant levels [MCLs]) for various waterborne contaminants, including volatile organic compounds, non-volatile synthetic organic compounds, inorganic chemicals, radionuclides, disinfection byproducts, general physical constituents, and other parameters.

3.6.3.9. Waterway Management Plan – San Luis Obispo Creek Watershed (2003)

The San Luis Obispo Creek Watershed Waterway Management Plan was created in response to several damaging floods that occurred in 1969, 1973, and 1995 that caused widespread damage throughout the watershed that includes out-of-bank flooding and extensive bank erosion. This plan identifies management problems and needs of the waterways, detailed hydrologic analyses of the watershed and its main tributaries. The plan also presents a Stream Management and Maintenance Program for the waterways of the watershed that outlines the planning, design, and permitting required to fully implement the program and a Drainage Design Manual that contains revised policies for floodplain and stream corridor management and redesigned flows for stream channels within the City boundary.

3.6.3.10. Incorporation Into GSP

Information in these various plans mentioned above has been incorporated into this GSP for consideration in the development of Sustainability Goals, when setting Minimum Thresholds and Measurable Objectives, and was considered during development of Projects and Management Actions to provide consistency among the above listed plans to achieve groundwater sustainability in the SLO Basin.

3.6.3.11. Limits to Operation Flexibility

Some of the existing management plans and ordinances will limit operational flexibility. These limits to operational flexibility have already been incorporated into the sustainability projects and programs included in this GSP.

Examples of limits on operational flexibility include:

- The Groundwater Export Ordinance requires county approval to export groundwater out of the SLO Basin. This is likely not a significant limitation because exporting groundwater out of the SLO Basin hinders sustainability.
- Title 22 Drinking Water Program regulates the quality of water that can be recharged into the SLO Basin.

3.7. Conjunctive Use Programs

There are no active conjunctive use programs currently operating within SLO Basin.

3.8. Land Use Plans

The County and City have land use authority in the SLO Basin and the other MOA Parties do not. However, SGMA requires the GSAs to consider land use documents by the overlying governing agencies when making decisions. Government Code Sections 65350.5 and 65352 require review and consideration of groundwater requirements before the adoption or any substantial amendment of a city's or county's general plan. The planning agency shall review and consider GSPs and any proposed action should refer to the GSA and GSP. Land use is an important factor in water management as described below. The following sections provide a general description of these land use plans and how implementation may affect groundwater supply.

3.8.1. Service Area Population

The General Plan (City of San Luis Obispo, 2018) is the principal tool the City uses when evaluating municipal service improvements and land use proposals. Every service the City provides to its citizens can trace its roots back to goals and policies found in the General Plan. General Plan goals, policies, and implementation measures are based on an assessment of current and future needs and available resources. The land use element designates the general distribution and intensity of land uses, including the location and type of housing, businesses, industry, open space, and education, public buildings, and parks. Figure 3-12 shows the City's Land Use Map.

The City manages its housing supply growth so that it does not exceed one percent per year on average, excluding dwellings affordable to residents with extremely low, very low, or low incomes, as defined by the Housing Element. The City decided to adopt a Water and Wastewater Management Element addressing water resources and wastewater services because of the vital role of these resources and the far-reaching impacts of water policies on community growth and character. This element translates the Land Use Element's capacity for development into potential demand for water supply and wastewater services. This element outlines how the City plans to provide adequate water and wastewater services for its citizens, consistent with the goals and policies of other General Plan elements. As stated in the General Plan, the City has an adequate water supply to serve the community's existing and future water needs. The City envisions groundwater playing an important role in ensuring continued resiliency in its water supply portfolio.

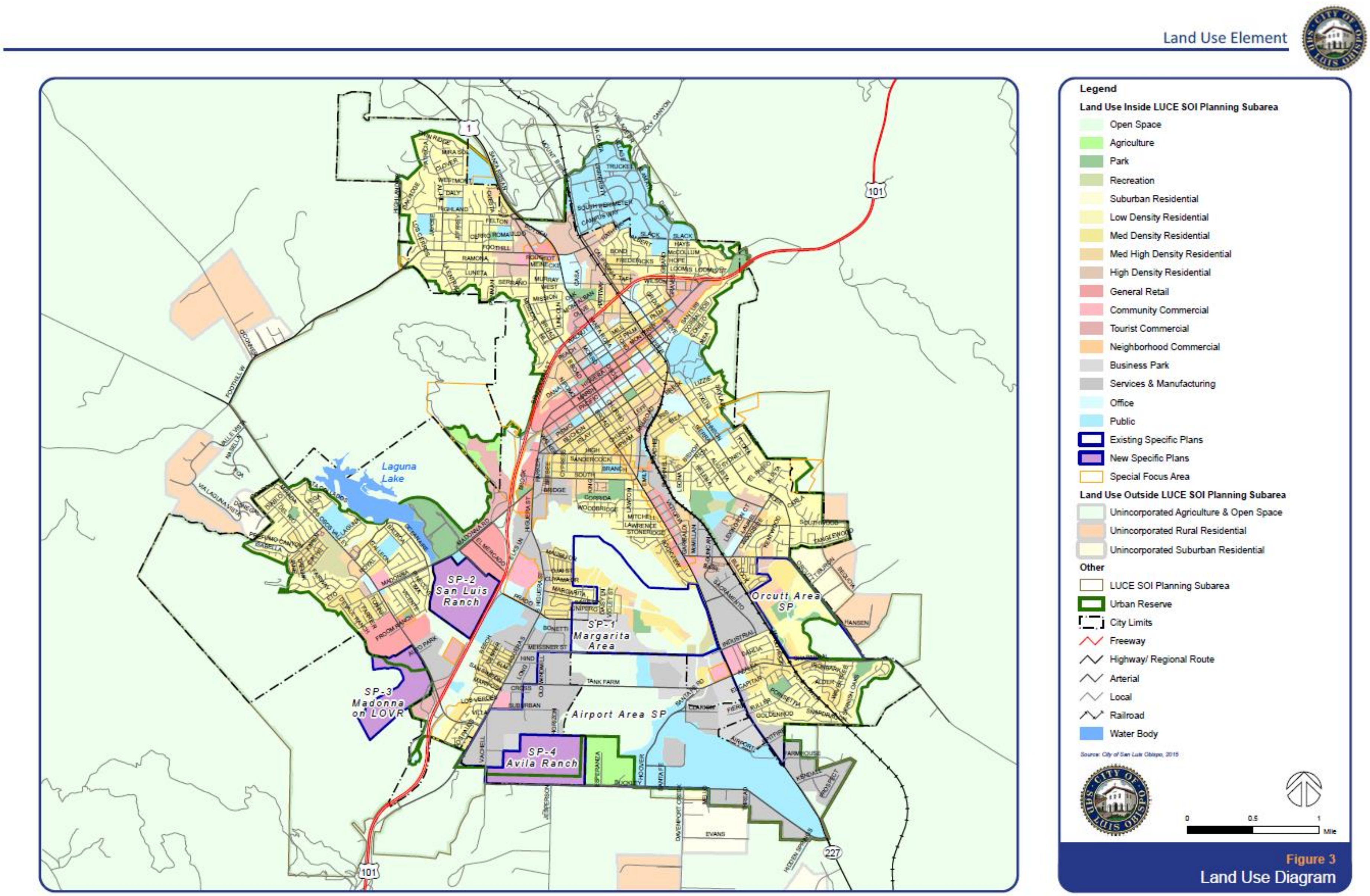


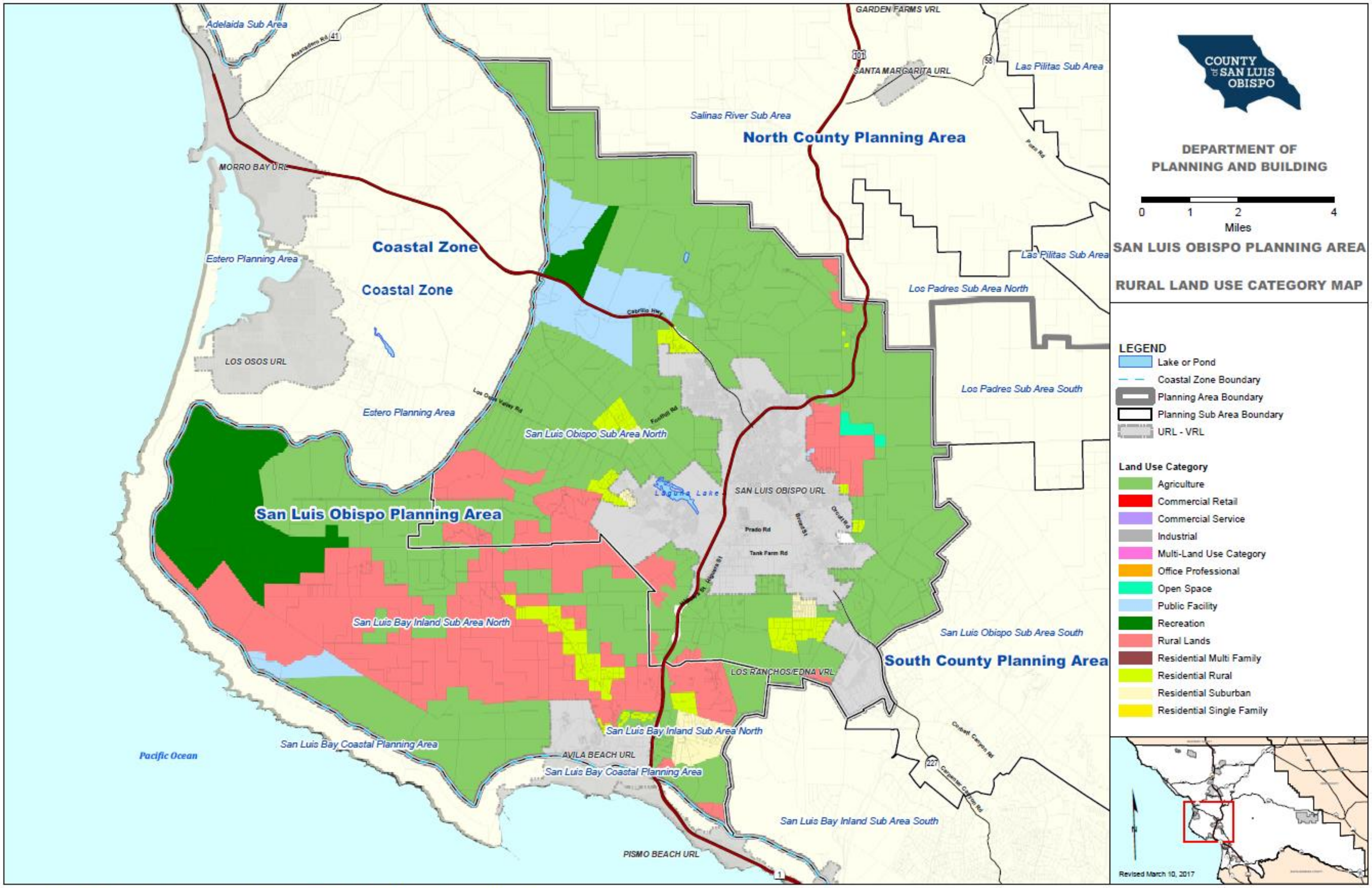
Figure 3-12. City Land Use Map

3.8.2. County of San Luis Obispo General Plan

The 2014 County General Plan contains three pertinent elements that are related to land use and water supply. Pertinent sections include the Land Use, Agricultural, and Inland Area Plans elements. The County's General Plan also contains programs that are specific, non-mandatory actions or policies recommended by the Land Use and Circulation Element (LUCE) to achieve community or area wide objectives. Implementing each LUCE program is the responsibility of the County or other public agency that is identified in the program. Programs are recommended actions rather than mandatory requirements. Implementation of any program by the County should be based on consideration of community needs and substantial community support for the program and its related cost.

The SLO Basin is within the San Luis Obispo Planning Area and South County Planning Area. The planning areas do not conform to the SLO Basin boundaries but do provide a general representation of the land use in the areas. Figure 3-13 and Figure 3-14 shows the planning areas and land uses.

The General Plan Framework for Planning does not provide tabular assessment of land use types and acres, or population projection estimates within the San Luis Obispo Planning Area and South County Planning Area. Therefore, projected demands and supplies based on land use aren't identified for the SLO Basin in the Land Use element.



Sources: County of San Luis Obispo, Department of Planning and Building, ParcelQuest, USGS National Hydrography Dataset, California Department of Finance

Figure 3-13. County Land Use Map (San Luis Obispo Planning Area)

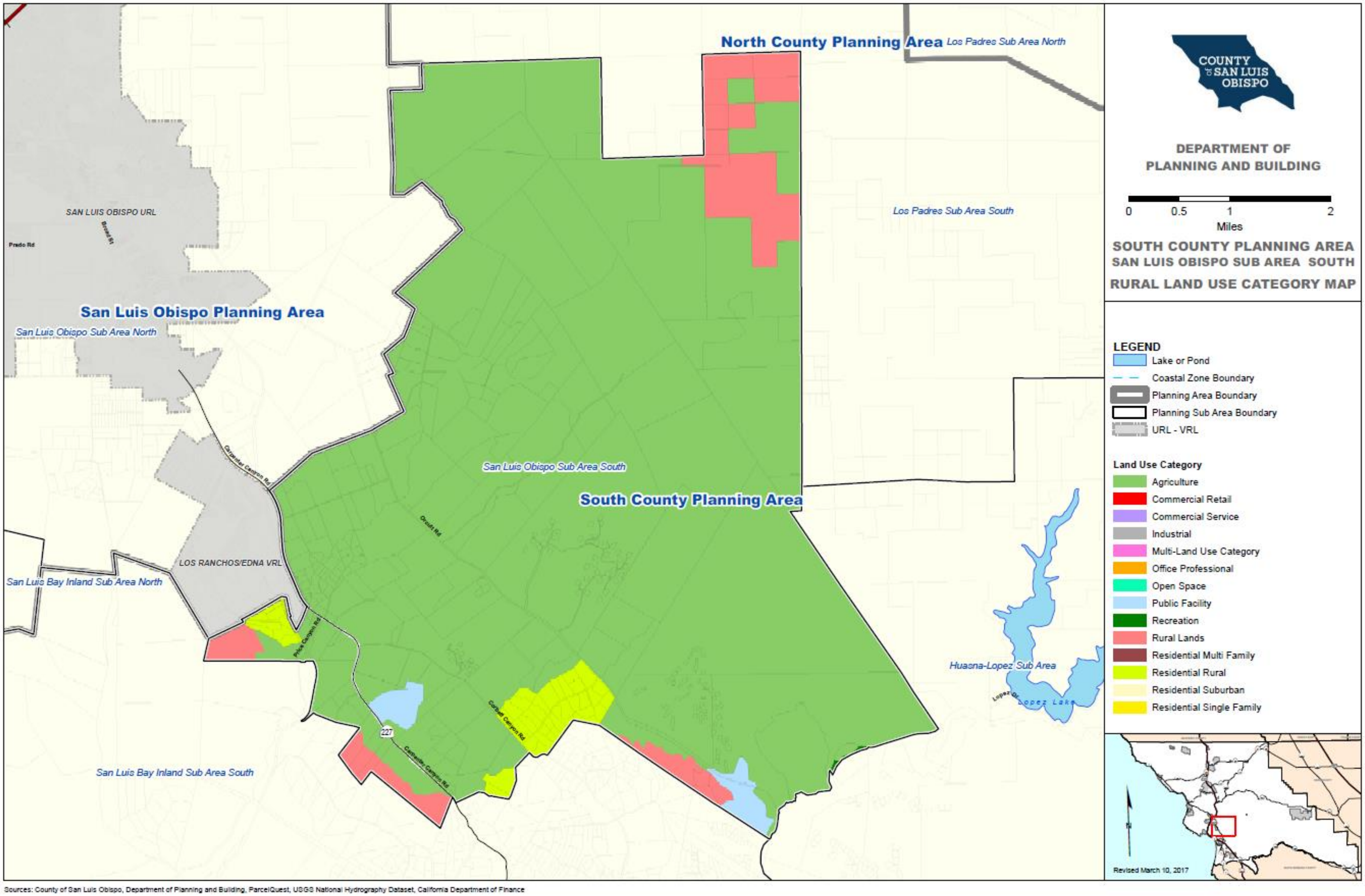


Figure 3-14. County Land Use Map (South County Planning Area)

3.8.3. Los Ranchos/Edna Village Plan

More specifically, the Los Ranchos/Edna Village Plan establishes a vision for the future that will guide land use and transportation over the next 20 years. This village plan is part of Part III of the LUCE of the County General Plan within the San Luis Obispo Planning Area. The Framework for Planning (LUCE Part I) is the central policy document, while this plan contains programs more specifically applicable to the Los Ranchos/Edna village area. In accordance with the Framework for Planning, allowable densities (intensity of land use) are established (Figure 3-15). The San Luis Obispo Area Plan contains regional land use and circulation goals, policies, and programs that also apply to Los Ranchos/Edna. Table 3-7 and summarize the acreage and distribution of each land use category in Los Ranchos/Edna village. Rural land use acreage is summarized in the Framework for Planning.

Table 3-7. Los Ranchos/Edna Land Use Acreage

LAND USE CATEGORIES	ACREAGE
Agriculture	0
Rural Lands	0
Recreation	235
Open Space	0
Residential Rural	394
Residential Suburban	259
Residential Single Family	59
Residential Multi-Family	0
Office and Professional	0
Commercial Retail	0
Commercial Services	0
Industrial	0
Public Facilities	10
Dalidio Ranch	0
TOTAL	**957**

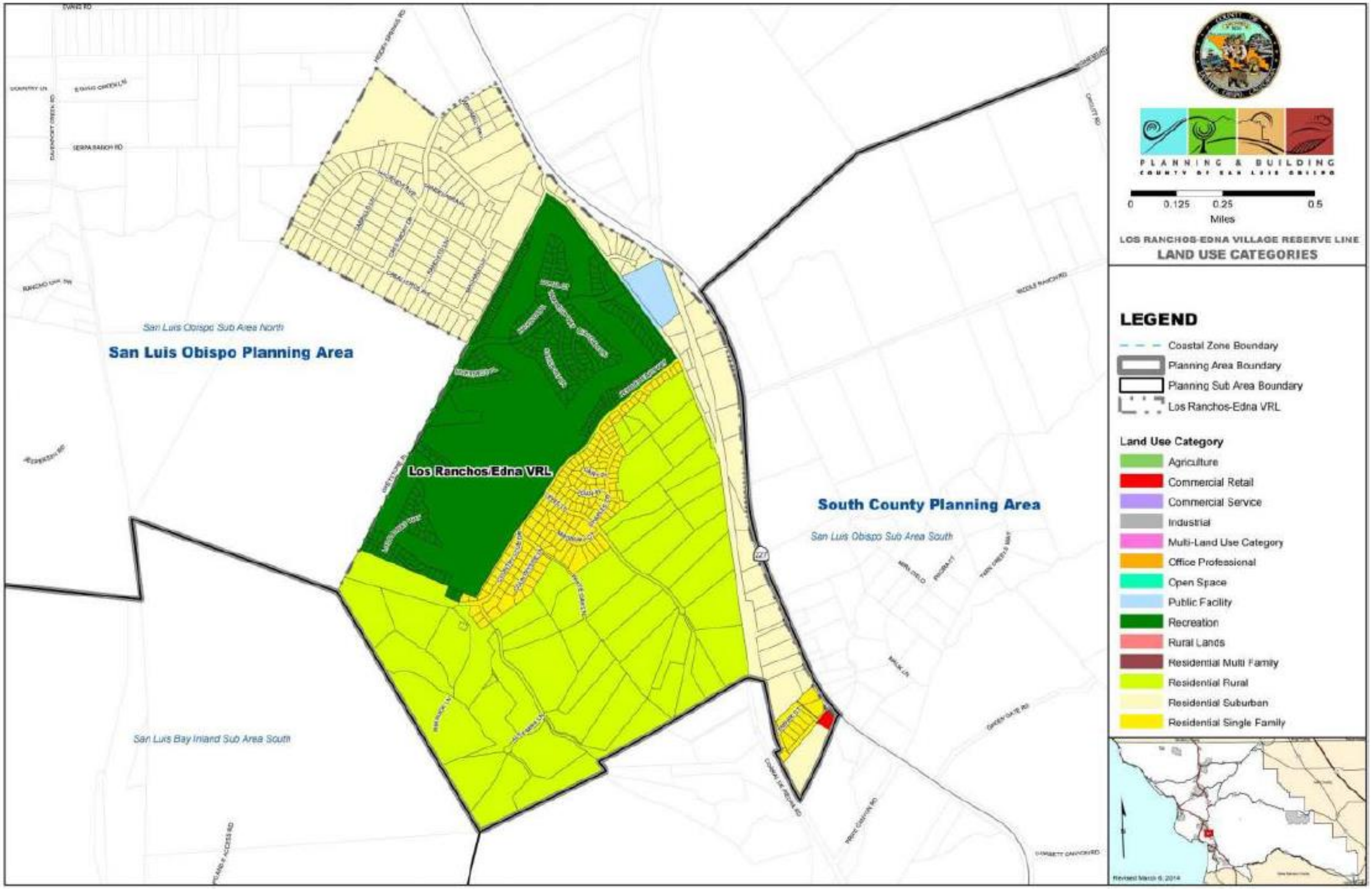


Figure 3-15. Los Ranchos/Edna Land Use Map

4

GROUNDWATER SUSTAINABILITY PLAN

Basin Setting (§354.14)

This chapter describes the geologic setting of the San Luis Obispo Valley Groundwater Basin (SLO Basin), including the Basin boundaries, geologic formations and structures, principal aquifer units, geologic cross sections, and hydraulic parameter data.

The information presented in this chapter, when considered with the information presented in Chapter 5 (Groundwater Conditions) and Chapter 6 (Water Budget), comprises the basis of the Hydrogeologic Conceptual Model (HCM) of the Basin.

IN THIS CHAPTER

- Basin Information
- Regional Geology
- Aquifer Description

This section draws upon previously published studies, primarily a hydrogeologic and geologic investigation prepared by GSI for the SLOCFCWCD in 2018, as well as a 1997 draft report, “San Luis-Edna Groundwater Basin Study, Draft Report” (DWR, 1997), which was prepared but never finalized for official publication, and a 1991 report by Boyle Engineering (Ground Water Basin Evaluation) that was prepared for the City of San Luis Obispo. The data and information presented in this section is not intended to be exhaustive but is a summary of the relevant and important aspects of the Basin geology that influence groundwater sustainability. More detailed information can be found in the original reports discussed above. This section presents the framework for subsequent sections on groundwater conditions and water budgets.

4.1. Introduction

As part of the GSP process, a numerical groundwater model was developed for the Basin to use as a tool in the planning process (Appendix G). Much of the information comprising the HCM presented in Chapters 4, 5, and 6 of the GSP is applied directly to the development of the groundwater model. Physical data on the geology and hydrogeologic parameters of the Basin presented in Chapter 4 (Basin Setting) are used to develop the model structure and parameterization while data on presented in Chapter 5 (Groundwater Conditions) and Chapter 6 (Water Budget) are used in model calibration.

Multiple sources and types of data are presented in Chapters 4, 5, and 6. Some of this data, such as rainfall amounts, depth to groundwater, and depth to bedrock, is directly measurable and involves a low degree of uncertainty. Other data, such as aquifer transmissivity, is based on calculations and interpretations of observed data, but is not directly measurable, and therefore involves a greater amount of uncertainty than direct measurements. And finally, values presented in the water budget are primarily derived from analysis of related data; almost none of the water budget components are directly measurable, and as a result, involve more uncertainty than the previously discussed data types.

4.2. Basin Topography and Boundaries

The Basin is oriented in a northwest-southeast direction and is composed of unconsolidated or loosely consolidated sedimentary deposits. It is approximately 14 miles long and 1.5 miles wide. It covers a surface area of about 12,700 acres (19.9 square miles). The Basin is bounded on the northeast by the relatively impermeable bedrock formations of the Santa Lucia Range, and on the southwest by the formations of the San Luis Range and the Edna fault system. The bottom of the Basin is defined by the contact of permeable sediments with the impermeable bedrock Miocene-aged and Franciscan Assemblage rocks (DWR, 2003). A topographic map displaying the Basin boundaries is presented in Figure 4-1, which also displays the watershed areas of the SLO Creek and Pismo Creek drainages. An aerial photo of the Basin area is presented in Figure 4-2. Elevations within the Basin range from over 500 feet above mean seal level in the southeastern extent of Edna Valley, to under 100 feet above mean sea level where SLO Creek flows out of the Basin.

The Basin is commonly referenced as being composed of two distinct valleys, with the San Luis Valley in the northwest and the Edna Valley in the southeast. The San Luis Valley comprises approximately the northwestern half of the Basin. It is the area of the Basin drained by SLO Creek and its tributaries (Prefumo Creek and Stenner Creek west of Highway 101, Davenport Creek and smaller tributaries east of Highway 101). Surface drainage in San Luis Valley drains out of the Basin flowing to the south along the course of SLO Creek toward the coast in the Avila Beach area, approximately along the course of Highway 101. The San Luis Valley includes part of the City and Cal Poly jurisdictional boundaries, while the remainder of the valley is unincorporated land. Land use in the City is primarily municipal, residential, and industrial. The area in the northwest part of the Basin, along Los Osos Valley Road, has significant areas of irrigated agriculture, primarily row crops.

The Edna Valley comprises approximately the southeastern half of the Basin. The primary creeks that drain the Basin are the east and west branches of Corral de Piedras Creek; the Corral de Piedras Creek tributaries join to form Pismo Creek, draining south out of the Edna Valley into Price Canyon. Canada de Verde Creek is also a significant tributary that flows south out of the Basin in the extreme southeastern part of Edna Valley, ultimately joining Pismo Creek (Figure 4-1 and Figure 4-2). The Edna Valley includes unincorporated lands, including lands associated with various private water purveyors. The primary land use in the Edna Valley is agriculture. During the past two decades, wine grapes have become the most significant crop type in the Edna Valley.

The primary weather patterns for the Basin are derived from seasonal patterns of atmospheric conditions that originate over the Pacific Ocean and move inland. As storm fronts move in from the coast, rainfall in the area falls more heavily in the mountains, and the Basin itself receives less rainfall because of a muted rain shadow effect. Average annual precipitation ranges from approximately 18 inches throughout most of the Basin to about 22 inches in relatively higher elevation areas near the City and Cal Poly (Figure 4-3). The time series of annual precipitation for the period of record from 1871 to 2018 at the Cal Poly weather station is presented in Figure 3-11. The average rainfall at this location is 21.69 inches, with a standard deviation of 8.71 inches. The historical maximum is 49.99 inches, which occurred in 1884. The historical minimum is 4.56 inches, which occurred in 2013.

The physical definition of the Basin boundary is the occurrence of unconsolidated or loosely consolidated saturated sediments down to the contact with the basement rock of the Miocene-aged formations and Franciscan Assemblage. (The geologic units will be described in more detail Section 4-5.) Figure 4-4 presents a surface defining the bottom boundary of the Basin, based on the elevation of bedrock surface below the Basin sediments. There is a topographic high point in the underlying bedrock elevation between the San Luis Valley and Edna Valley sub-areas; physical details of this bedrock feature are delineated in the technical memo describing a geophysical survey investigation in this area performed as part of the GSP process (Cleath-Harris Geologists, 2019), included in Appendix G. As shown, the watershed divide and the bedrock high are not coincident.

Figure 4-5 presents contours of total thickness of the Basin sediments; the inset figure displays the thickness of sediments in a longitudinal cross section. It is apparent from Figure 4-6 that the sediments of the Edna Valley have significantly greater thickness than those of the San Luis Valley. The longitudinal profile of the Basin from the northwest on the left of the figure to the southeast on the right indicates the watershed divide present in the vicinity of Biddle Ranch Road, indicated on Figure 4-4 and Figure 4-5. Precipitation that falls west of that divide ultimately flows to Davenport and SLO Creeks, and precipitation that falls east of that divide flows to Corral de Piedras Creek or the other small tributaries, ultimately flowing to Pismo Creek south of the Basin.

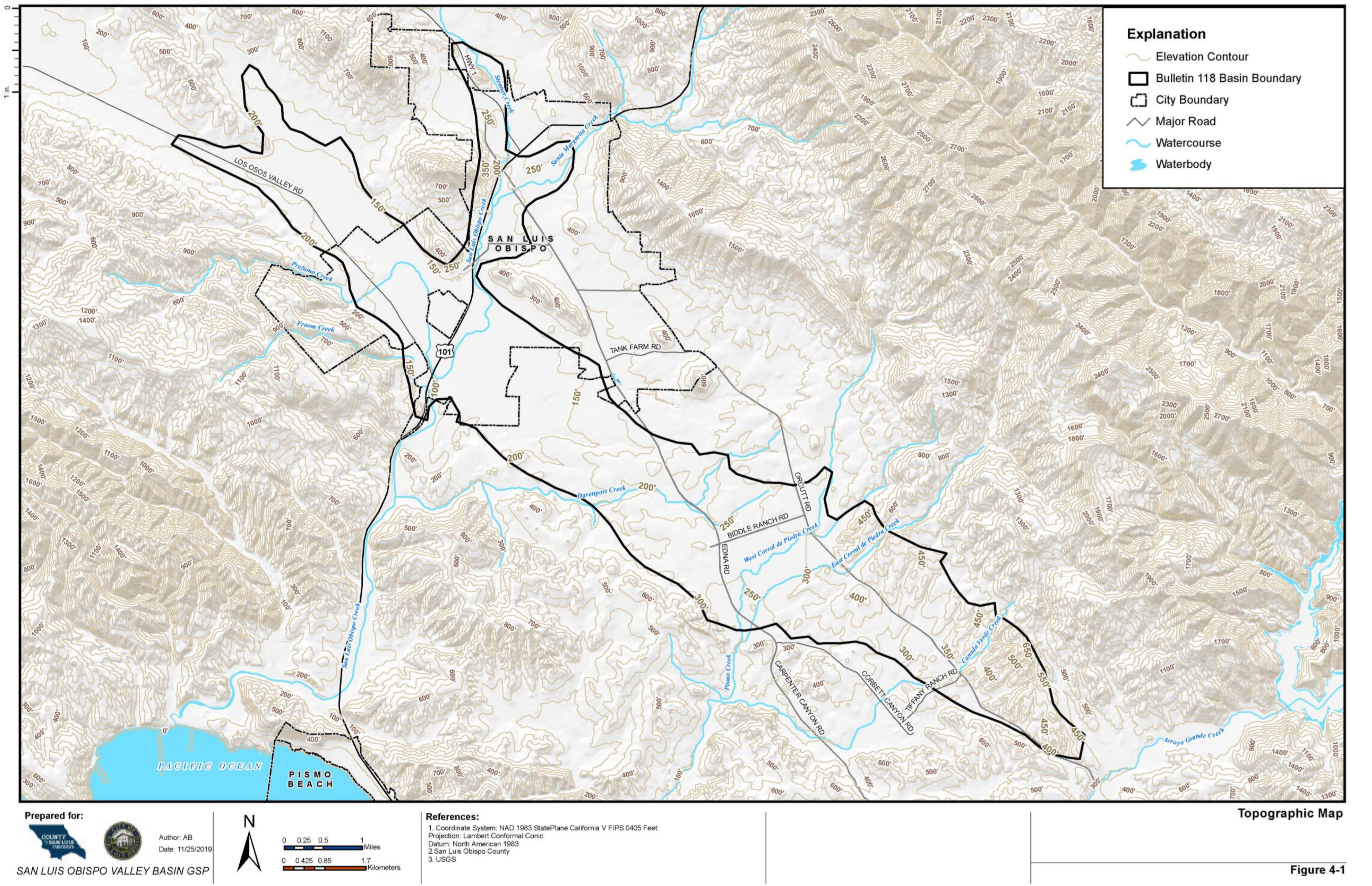


Figure 4-1. Topographic Map

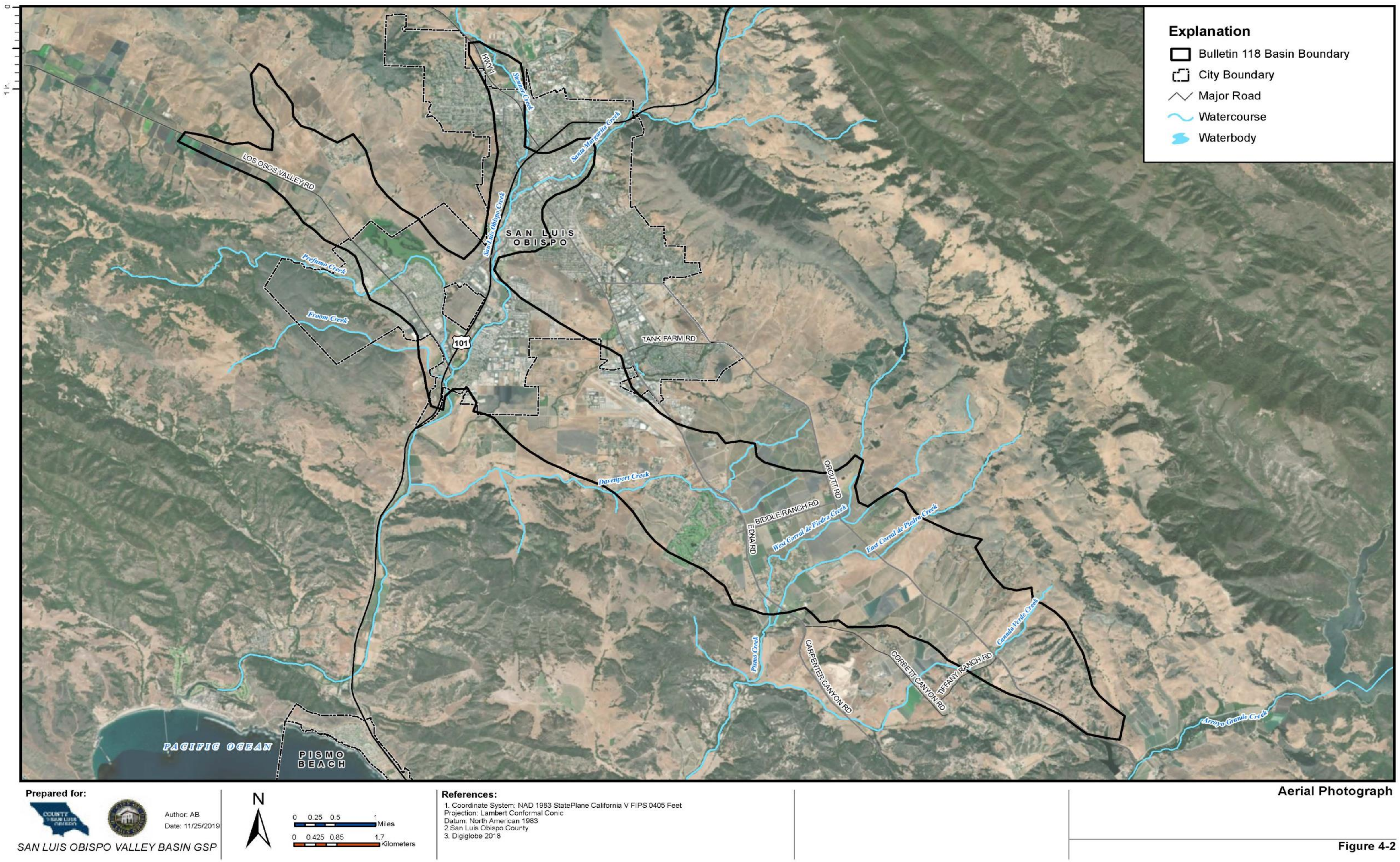


Figure 4-2. Aerial Photograph

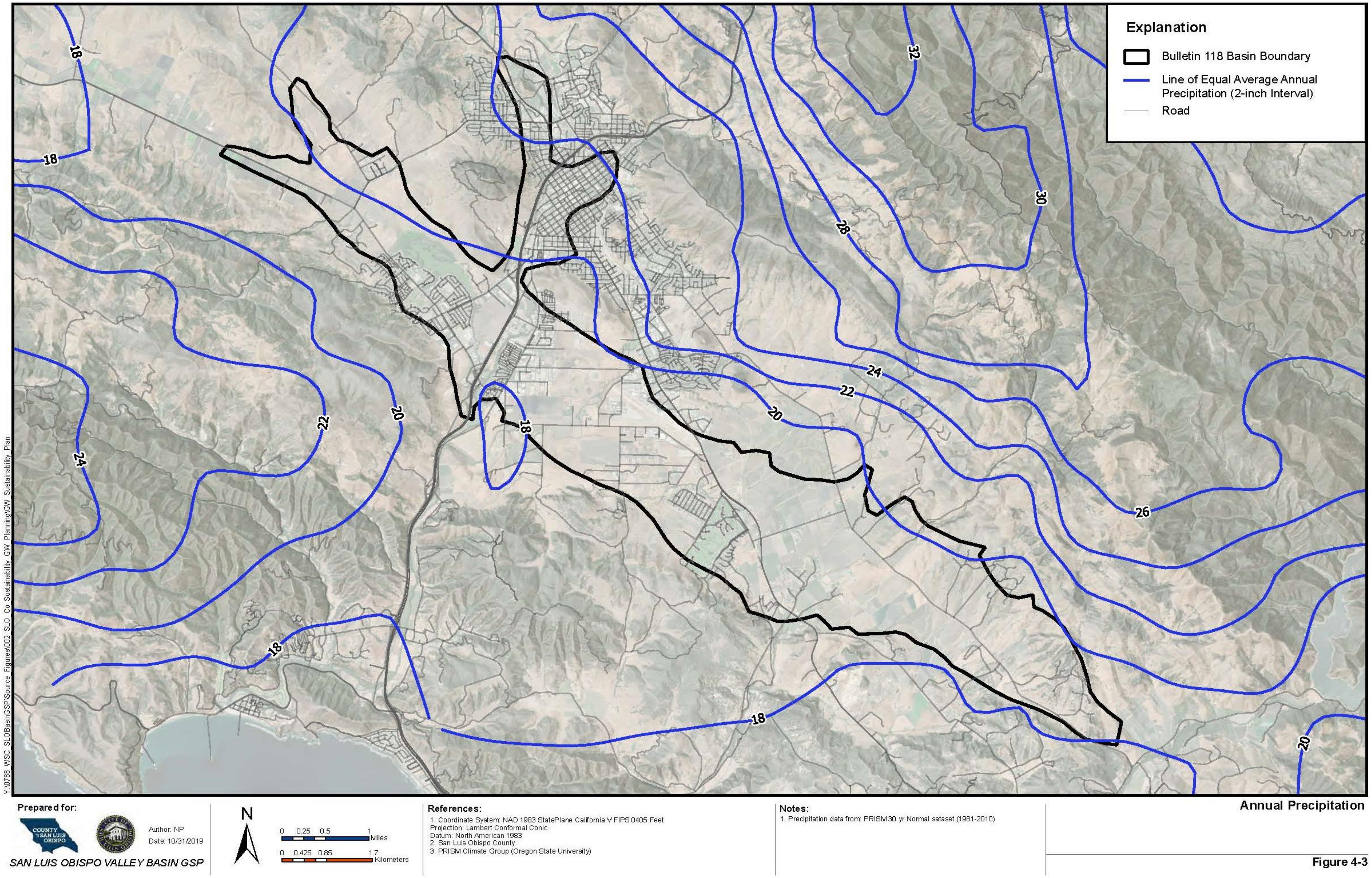


Figure 4-3. Annual Precipitation

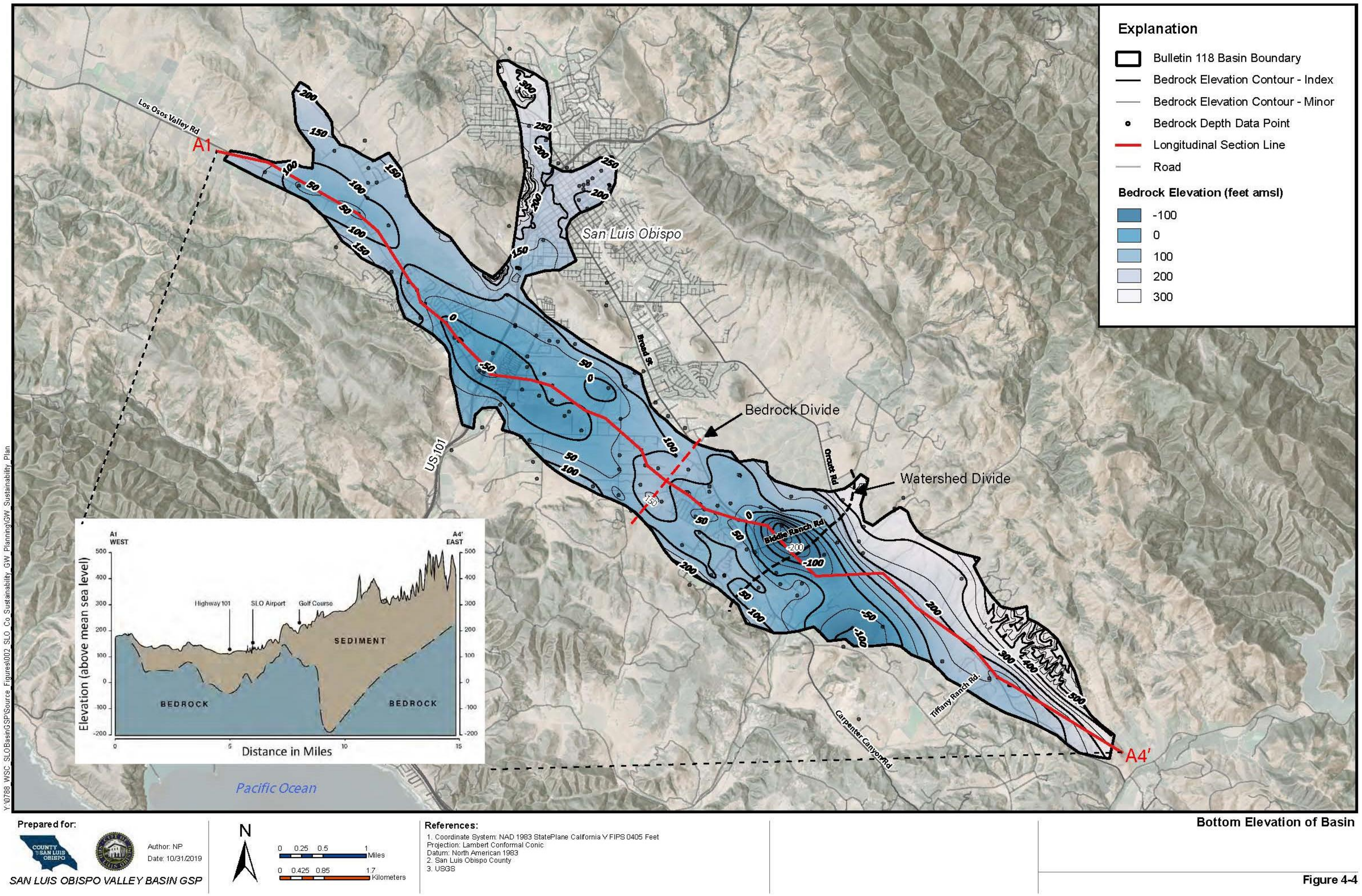


Figure 4-4. Bottom Elevation of Basin

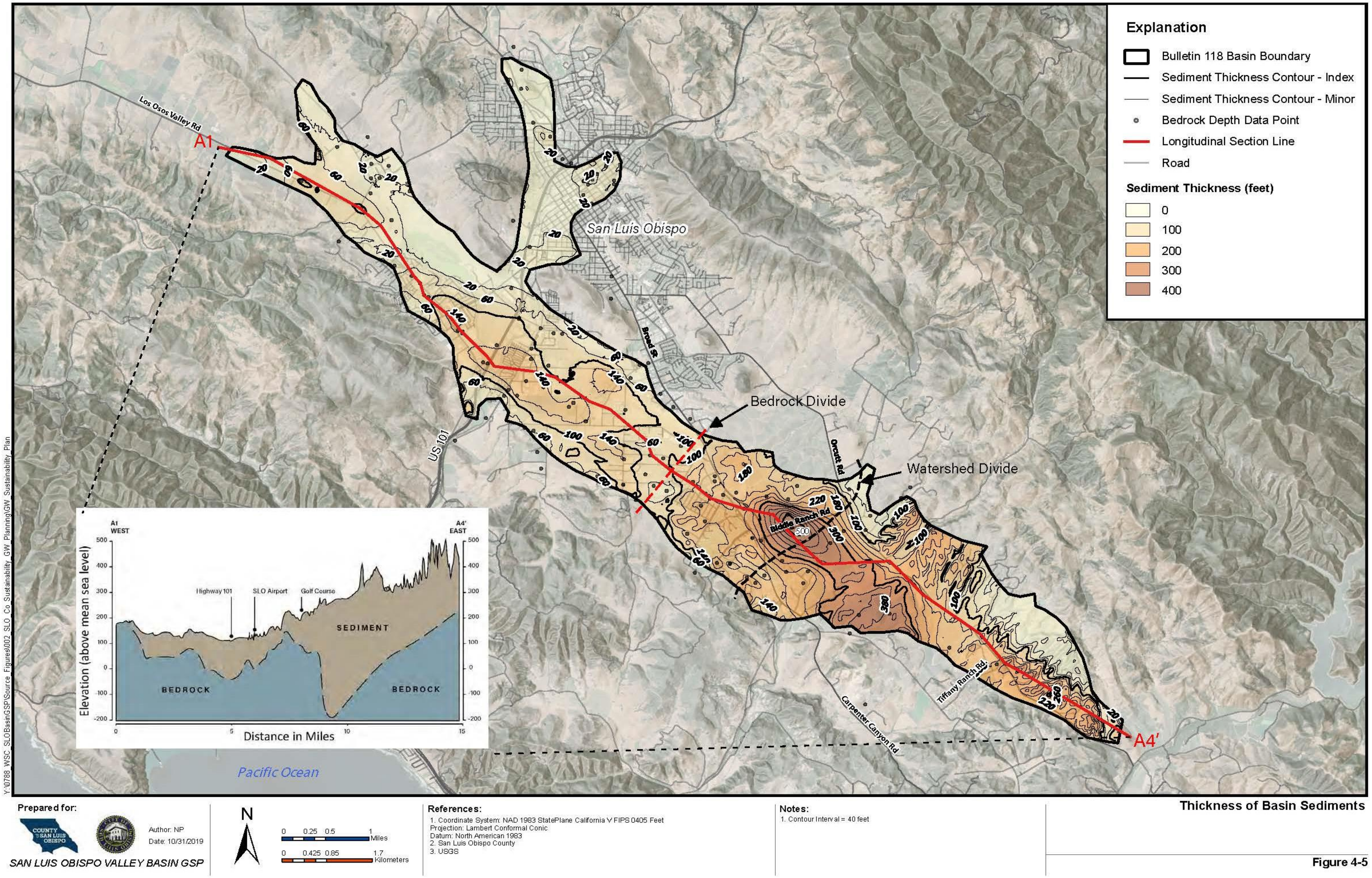


Figure 4-5. Thickness of Basin Sediments

4.3. Primary Users of Groundwater

The primary groundwater users in the Basin include municipal, agricultural, and domestic (i.e., rural residential, small community water systems, and small commercial entities). These entities are discussed in more detail in Chapter 2 (Agency Information) of this report. The City currently receives most of its supply from surface water sources including Whale Rock Reservoir, Santa Margarita Reservoir, and Nacimiento Reservoir (Figure 3-3). However, it maintains its network of production wells in standby mode for emergency supply and intends to utilize groundwater as a resource to meet future water demand. The mutual and private water companies, domestic and agricultural users in the Edna Valley rely almost exclusively on groundwater, although some have water rights along East and West Corral de Piedras Creeks. No surface water points of diversion along SLO Creek are present in the Basin.

4.4. Soils Infiltration Potential

Saturated hydraulic conductivity of surficial soils is a good indicator of the soil's infiltration potential. Soil data from the U.S. Department of Agriculture (USDA) Natural Resources Conservation Service (NRCS) Soil Survey Geographic Database (SSURGO) (USDA-NRCS, 2007) is shown by the four hydrologic groups on Figure 4-6. The soil hydrologic group is an assessment of soil infiltration rates that is determined by the water transmitting properties of the soil, which includes hydraulic conductivity and percentage of clays in the soil relative to sands and gravels.

The groups are defined as:

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

A higher soil infiltration capacity does not necessarily correlate to higher transmissivity in the underlying aquifer, but it may correlate to greater recharge potential in localized areas. This will be discussed in more detail in Chapter 5 (Groundwater Conditions).

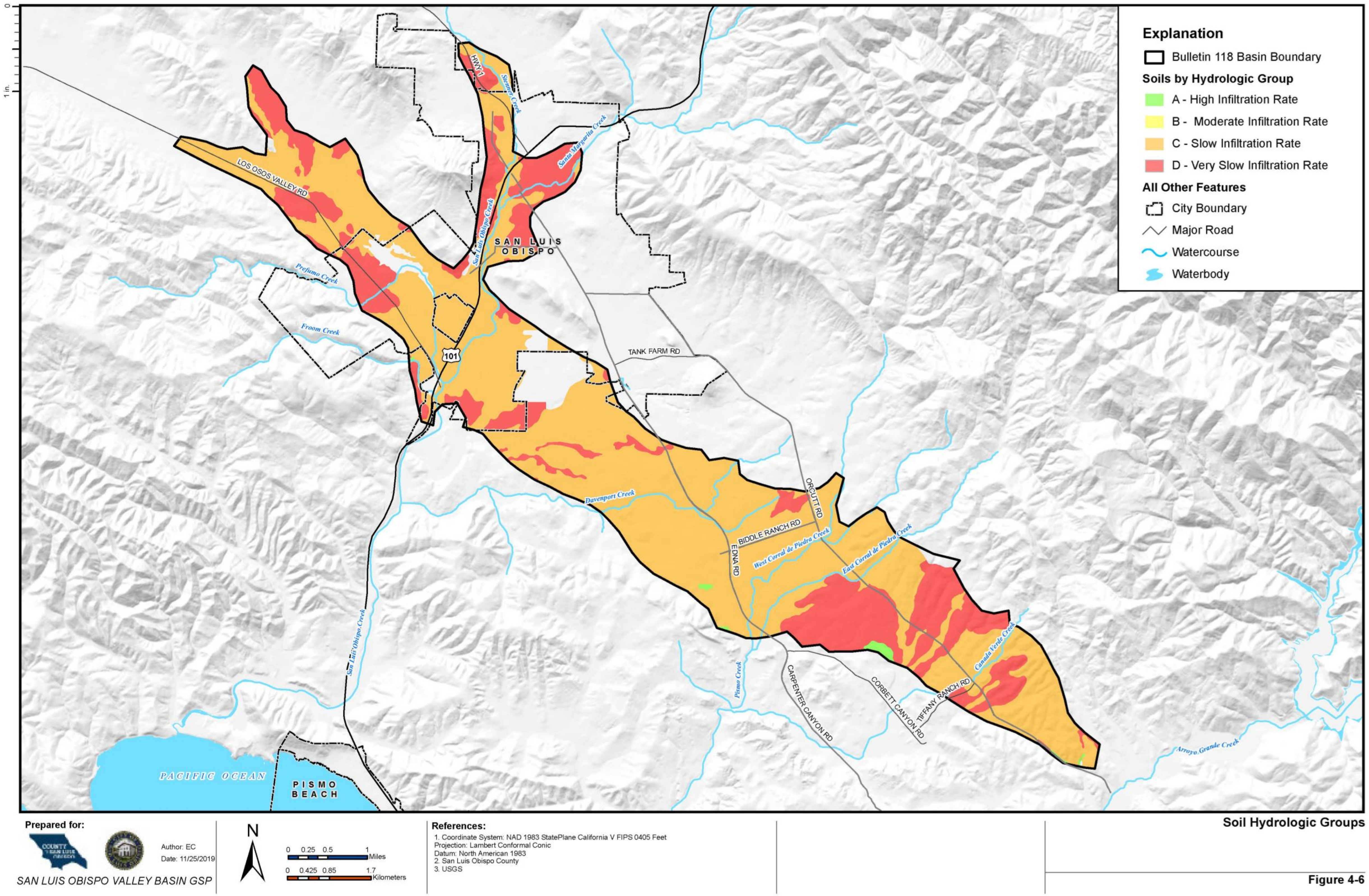


Figure 4-6. Soil Hydrologic Groups

4.5. Regional Geology

This section provides a description of the geologic formations and structures in the Basin. These descriptions are summarized from previously published reports. Figure 4-7 displays a stratigraphic column presenting the significant geologic formations within the Basin. Figure 4-8 presents a surficial geologic map of the Basin and surrounding area. Figure 4-9 displays the locations of lithologic data used for this plan, and the section lines corresponding to cross sections in the following figures. Geologic cross sections are presented in Figure 4-10 through Figure 4-21. The selected geologic cross sections illustrate the relationship of the geologic formations that comprise the Basin and the geologic formations that underlie and bound the Basin. The cross sections displayed on Figure 4-10 through Figure 4-21 were directly adopted from the SLO Basin Characterization Report (GSI Water Solutions, 2018).

4.5.1. Regional Geologic Structures

The primary geologic structures of significance to the hydrogeology of the Basin are the Edna Fault Zone and the adjacent Los Osos Fault Zone, which together form the southwestern boundary of the Basin through the uplift of the Franciscan and Monterey Formation strata in the San Luis Range southwest of the faults. The Edna and Los Osos Faults are normal faults, indicating primary displacement motion is vertical rather than lateral (Figure 4-8). There are some disconnected and unnamed fault splays mapped in the area south of the airport.

4.5.2. Geologic Formations within the Basin

For the purpose of this plan, the geologic units in the Basin and vicinity may be considered as two basic groups; the Basin sediments and the consolidated bedrock formations surrounding and underlying the Basin. The consolidated bedrock formations range in age and composition from (1) Jurassic-aged serpentine and marine sediments to (2) Tertiary-aged marine and volcanic depositions. Compared to the saturated sediments that comprise the Basin aquifers, the consolidated bedrock formations are not considered to be significantly water-bearing. Although bedding plane and/or structural fractures in these rocks may yield small amounts of water to wells, they do not represent a significant portion of the pumping in the area. The delineation of the Basin boundaries is defined both laterally and vertically by the contacts of the Basin sedimentary formations with the consolidated bedrock formations. From a hydrogeologic standpoint, the most important strata in the Basin are the sedimentary basin fill deposits that define the vertical and lateral extents of the Basin. These include recent and older deposits of terrestrial sourced sediments, underlain in the Edna Valley by older marine sedimentary units. Figure 4-7 presents a stratigraphic column of the significant local geologic units. Figure 4-8 presents a map of the Basin vicinity (assembled from a mosaic of the Dibblee maps from the San Luis Obispo, Pismo Beach, Lopez Mountain, and Arroyo Grande NE quadrangles) showing where the various formations crop out at the surface. Fault data displayed in Figure 4-8 were acquired via the USGS Earthquake Hazards Program (USGS, 2004). The Quaternary fault and fold database from which the shapefiles are derived was published in 2006 and cites a wide variety of published sources. Fault traces within the shapefile represent surficial deformation caused by earthquakes during the Quaternary Period (the last 1.6 million years). Figure 4-8 also displays the Basin boundaries defined in DWR Bulletin 118. Inspection of Figure 4-8 indicates that the Bulletin 118 Boundary lines for the Basin boundary do not match up precisely with the most recently mapped extent of the water-bearing formations based on (GSI Water Solutions, 2018). This is likely an artifact of previous mapping being performed at a larger (statewide) scale. The water-bearing sedimentary formations and the non-water-bearing bedrock formations are briefly described below.

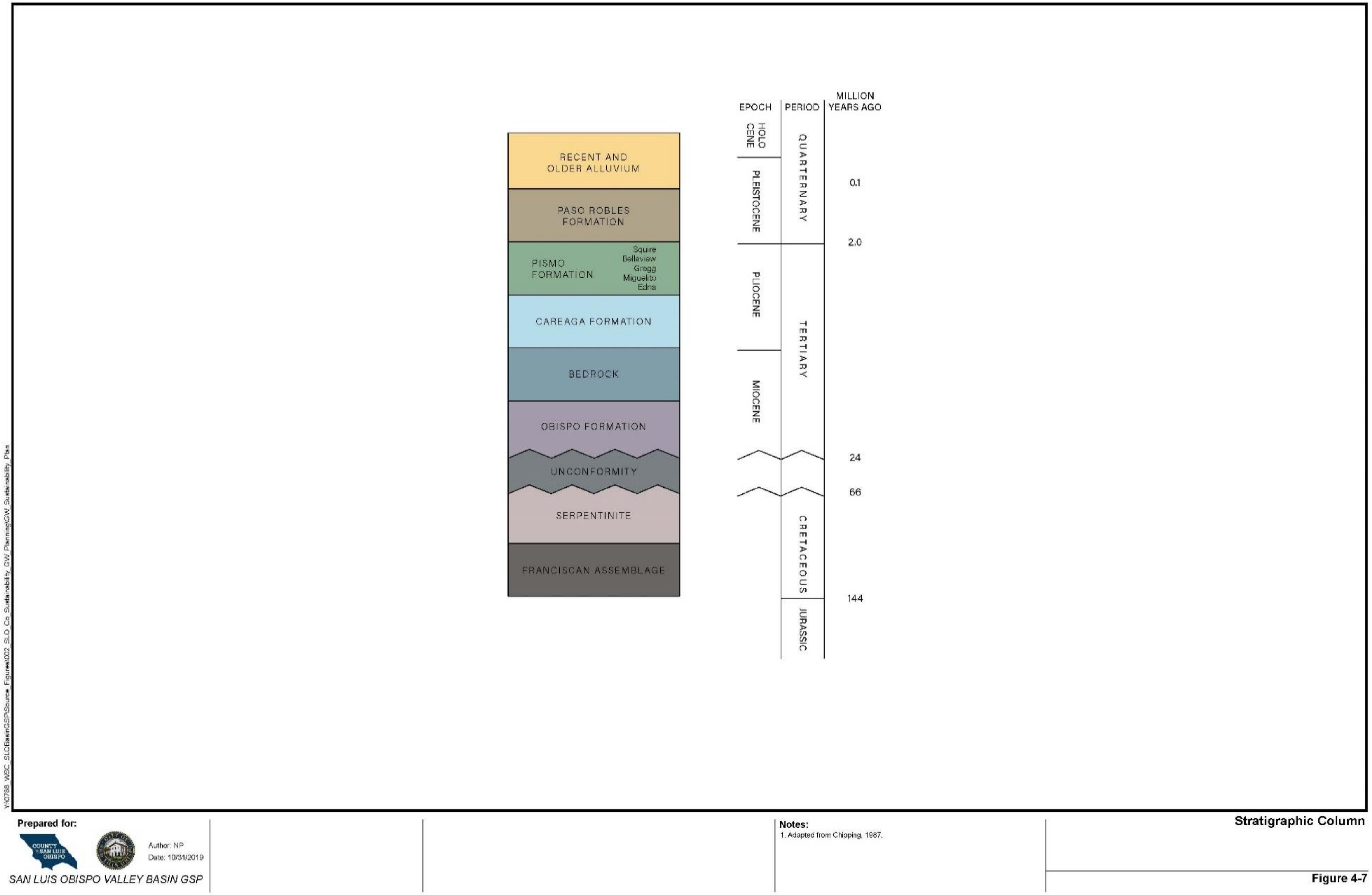


Figure 4-7. Stratigraphic Column

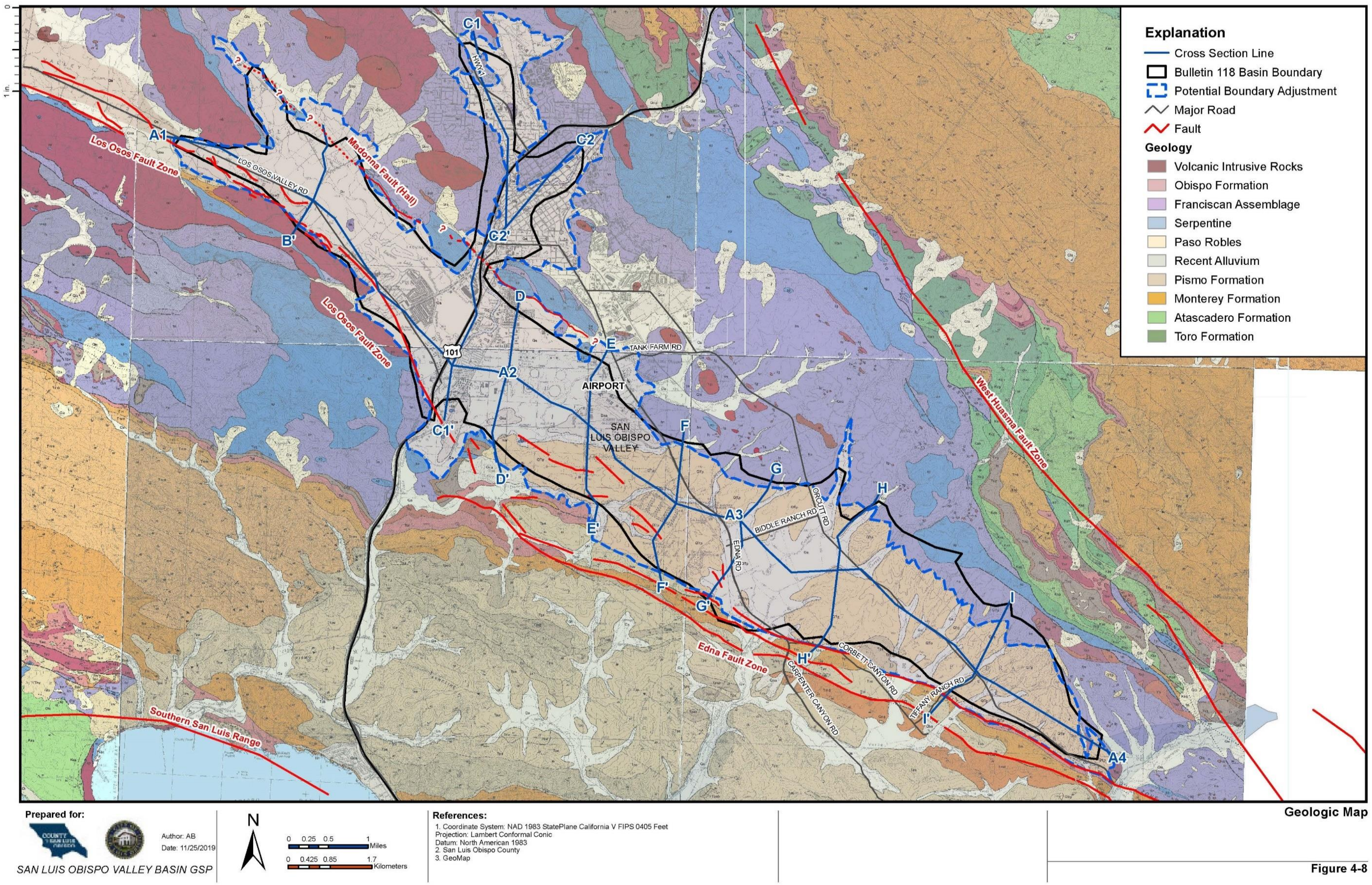


Figure 4-8. Geologic Map

4.5.2.1. Alluvium

The Recent Alluvium is the mapped geologic unit composed of unconsolidated sediments of gravel, sand, silt, and clay, deposited by fluvial processes along the courses of SLO Creek, Davenport Creek, East and West Corral de Piedras Creeks, and their tributaries. Lenses of sand and gravel are the productive strata within the Recent Alluvium. These strata have no significant lateral continuity across large areas of subsurface within the Basin. Thickness of Recent Alluvium may range from just a few feet to more than 50 feet. Well pumping rates may range from less than 10 gallons per minute (gpm) to more than 100 gpm. However, wells screened exclusively in Recent Alluvium are generally less productive than wells that screen significant thicknesses of the Paso Robles and/or Pismo Formations.

4.5.2.2. Paso Robles Formation

The Paso Robles Formation underlies the Recent Alluvium throughout most of the Basin, and overlies the Pismo Formation where present. It is composed of poorly sorted, unconsolidated to mildly consolidated sandstone, siltstone, and claystone, with thin beds of volcanic tuff in some areas. The Paso Robles Formation was deposited in a terrestrial setting on a mildly sloping floodplain that has been faulted, uplifted, and eroded since deposition. The Paso Robles Formation is exposed at the surface throughout much of the Edna Valley, except in areas where existing streams have deposited Recent Alluvium on top of it. It is not readily distinguishable from alluvium in geophysical well logs. Locally, the Paso Robles Formation is sometimes distinguished as being yellow in color, with sticky clay. DWR Well Completion Reports with these types of descriptions generally were identified as Paso Robles Formation for the purpose of interpreting the geology in the cross sections. However, it was sometimes difficult to distinguish between Recent Alluvium and Paso Robles Formation in driller's descriptions, and professional judgment and broader context within the Basin were often used when defining the contact between these two units. Wells that screen both the Recent Alluvium and Paso Robles Formation have reported yields from less than 100 to over 500 gpm.

4.5.2.3. Pismo Formation

The oldest geologic water-bearing unit with significance to the hydrogeology of the Basin is the Pismo Formation. The Pismo Formation is a Pliocene-aged sequence of marine deposited sedimentary units composed of claystone, siltstone, sandstone, and conglomerate. There are five recognized members of the Pismo Formation (Figure 4-7). While all members are part of the Pismo Formation, each member reflects different depositional environments, and the variations in geology may affect the hydrogeologic characteristics of the strata.

From the oldest to youngest, the members are:

- The Edna Member, which lies unconformably atop the Monterey Formation, and is locally bituminous (hydrocarbon-bearing)
- The Miguelito Member, primarily composed of thinly bedded grey or brown siltstones and claystones
- The Gragg Member, usually described as a medium-grained sandstone
- The Bellview Member, composed of interbedded fine-grained sandstones and claystones
- The Squire Member, generally described as a medium- to coarse-grained fossiliferous sandstone of white to grey sands

Previous reports have identified the significant thicknesses of sand at depth beneath the Paso Robles Formation in the Edna Valley as the Squire Member of the Pismo Formation. However, it is not clear whether these are accurately assigned as Squire. Other members of the Pismo Formation may be part of the sequence, and there is some ambiguity as to the actual member assignment. Even in the adjacent Pismo Beach and Arroyo Grande NE quadrangle geologic (Dibblee, 2006) (Dibblee, 2006), there is ambiguity in the geologic nomenclature. In the adjacent geologic maps these quadrangles, a continuous exposure of this unit across the boundary between the two maps is referred to as Pismo Formation in one map (Dibblee, 2006), and Squire Sandstone in the other (Dibblee, 2006). Therefore, it is probably more accurate to generally refer to these units as the Pismo Formation, and not to specifically identify the member designations. This convention will be followed for the remainder of this report.

The Pismo Formation is extensive below the Paso Robles Formation in the Edna Valley. Thicknesses of Pismo Formation up to 400 feet are reported or observed in well completion reports and in the cross sections (Figure 4-5). The presence of sea shells in the lithologic descriptions of well completion reports is clearly diagnostic of the Pismo Formation because of its marine origin. Many of the well completion reports in the Edna Valley document the presence of water-bearing blue and green sands beneath the Paso Robles Formation, and these are considered to be largely diagnostic of the Pismo Formation as well. Wells that are completed in both the Paso Robles and Pismo Formations are reported to yield from less than 100 gpm to approximately 700 gpm.

4.5.3. Geologic Formations Surrounding the Basin

Older geologic formations that underlie the Basin sediments typically have lower permeability and/or porosity and are generally considered non-water-bearing. In some cases, these older beds may occasionally yield flow adequate for local or domestic needs, but wells drilled into these units are also often dry or produce groundwater less than 10 gpm. Generally, the water quality from the bedrock units is poor in comparison to the Basin sediments. In general, the geologic units underlying the basin include Tertiary-age consolidated sedimentary and volcanic beds (Monterey and Obispo Formations), and Cretaceous-age sedimentary and metamorphic rocks (Franciscan Assemblage).

4.5.3.1. Monterey Formation

The Monterey Formation is a thinly bedded siliceous shale, with layers of chert in some locations. In other areas of the County outside of the Basin, the Monterey Formation is the source of significant oil production. While fractures in consolidated rock may yield small quantities of water to wells, the Monterey Formation is not considered to be an aquifer for the purposes of this GSP. Regionally, the unit thickness is as great as 2,000 feet, and the unit is often highly deformed. Water wells completed in the Monterey Formation are occasionally productive if a sufficient thickness of highly deformed and fractured shale is encountered. More often, however, the Monterey shale produces groundwater to wells in very low quantities. Groundwater produced from the Monterey Formation often has high concentrations of Total Dissolved Solids (TDS), hydrogen sulfide, total organic carbon, and manganese.

4.5.3.2. Obispo Formation

The Obispo Formation and associated Tertiary volcanics are composed of materials associated with volcanic activity along tectonic plate margins approximately 20 to 25 million years ago. The Obispo Formation is composed of ash and other material expelled during volcanic eruptions. Although fractures in consolidated volcanic rock may yield small quantities of water to wells, the Obispo Formation is not considered to be an aquifer for the purposes of this GSP.

4.5.3.3. Franciscan Assemblage

The Franciscan Assemblage contains the oldest rocks in the Basin area, ranging in age from late Jurassic through Cretaceous (150 to 66 million years ago). The rocks include a heterogeneous collection of basalts, which have been altered through high-pressure metamorphosis associated with subduction of the oceanic crust beneath the North American Plate before the creation of the San Andreas Fault. The current assemblage includes ophiolites, which weather to serpentinites and are common in the San Luis and Santa Lucia Ranges. Although fractures may yield small quantities of water to wells, the Franciscan Assemblage is not considered to be an aquifer for the purposes of this GSP.

4.6. Principal Aquifers and Aquitards

Water-bearing sand and gravel beds that may be laterally and vertically discontinuous are generally grouped together into zones that are referred to as aquifers. The aquifers can be vertically separated by fine-grained zones that can impede movement of groundwater between aquifers, referred to as aquitards.

Three aquifers exist in the Basin:

- **Alluvial Aquifer** – A relatively continuous aquifer comprising alluvial sediments that underlie the SLO Creek and tributary streams, as well as East and West Corral de Piedras Creeks and tributary streams;
- **Paso Robles Formation Aquifer** – An interbedded aquifer comprised of terrestrially-derived sand and gravel lenses in the Paso Robles Formation.
- **Pismo Formation Aquifer** - An interbedded aquifer comprised of marine sand and gravel lenses in the Pismo Formation.

There are no significant aquitards that vertically separate the three aquifers in the Basin over large areas. There may be deposits of clay and silt that are not laterally extensive that locally separate two aquifers, but there is no recognized aquitard in the Basin that separates the aquifers over significant areas.

4.6.1. Cross Sections

Eleven cross sections (Figures 4-10 – 4-21) were prepared for this report; three (A1-A2, A2-A3, A3-A4) are oriented along the longitudinal axis of the Basin and eight (B-B' through I-I') are oriented across the Basin, perpendicular to the longitudinal axis (Figure 4-9). All lithologic data was reviewed during the selection of the section line locations. The cross sections display lithology, interpretations of geologic contacts based on available data, well screen intervals, and interpreted and mapped faults. If the geologic interpretation was not clear from the points on the cross section lines, nearby data from other locations was reviewed to provide broader geologic context. Each geologic cross section is discussed in the following paragraphs. The longitudinal axis of the Basin is much longer than the cross basin section lines, the longitudinal axis was divided into three separate cross sections for the sake of clarity and presentation of detail.

As part of the work performed for the GSP, CHG performed a passive seismic geophysical plan in the area along Buckley Road south of the airport (Appendix G). Data from this plan resulted in slight adjustments in three of the previously developed cross sections.

These data have been incorporated into the following cross sections:

- **Cross Section A1-A2** (Figure 4-10) extends approximately 6.5 miles from the northwest extent of the Basin at its boundary with the Los Osos Basin to about 1 mile east of Highway 101. Land surface elevation is about 200 feet AMSL at the northwest extent, and slopes gently downward to about 120 feet AMSL at the southeast extent. Recent Alluvium is exposed at the surface for the entire length of this cross section, ranging in thickness from less than 50 feet near the Los Osos Valley Basin boundary to about 80 feet near the center of the section. The Paso Robles Formation is relatively thin in the northeast where it has been significantly eroded by the alluvium but thickens to approximately 70 feet in the southeastern part of the section. Marine sands of the Pismo Formation occur below the Paso Robles Formation in the southeastern part of the section, with a maximum thickness of about 50 feet.
- **Cross Section A2-A3** (Figure 4-11) extends approximately 4 miles along the longitudinal Basin axis, starting near Tank Farm Road and cutting obliquely across Buckley Road to just past Edna Road in the southeast. Land surface elevation ranges from approximately 120 feet AMSL in the northwest to more than 270 feet AMSL in the southwest. Along the northwest half of the section line, alluvium is exposed at the surface, with an approximate thickness of 40 to 50 feet. The alluvium is primarily underlain by the Paso Robles Formation with thicknesses ranging from approximately 40 to 80 feet. Just southeast of the airport, the Paso Robles Formation is exposed at the surface, beginning at the point where there is a noticeable rise in land surface elevation. This is approximately coincident with the maximum elevation of the underlying bedrock formations (the bedrock divide that approximates the dividing line between the Edna Valley and the San Luis Valley). A recent geophysical investigation by Cleath-Harris Geologists in the area of the high bedrock elevation has provided greater detail on the Basin geometry in this area. The thickness of the Paso Robles Formation in this area is up to 120 feet. Pismo Formation sediments underlie the Paso Robles Formation in this area, with thickness of about 50 feet in the area of Davenport Creek. The Pismo Formation thickness starts to increase significantly along this section line to the southeast, with about 250 feet of Pismo sediments evident at the southeastern extent of the section line. Several of the borings in this section indicate wells are partially or completely screened in bedrock formations, indicating that the relatively thin saturated portions of the water-bearing sediments did not yield enough water for the purposes of the wells.
- **Cross section A3-A4** (Figure 4-12) extends about 6.5 miles along the Basin axis from approximately Biddle Ranch Road to the southeast extent of the Basin. Land surface elevation rises from about 250 feet AMSL on the northwest end of the section to over 500 feet AMSL in the southeast. Relatively thin occurrences (40 feet or less) of Recent Alluvium associated with Corral de Piedras Creek and its tributaries are evident in some areas on the western half of this section. In the southeastern extent of the section, the Paso Robles Formation crops out at the surface where the land is beginning to rise to the northern mountains and is dissected by small streams and valleys in this area. The Pismo Formation sediments reach their maximum thickness of more than 400 feet along the northwestern extent of this section; the thickness of the Pismo gradually thins to about 90 feet at the southwestern extent of the section.
- **Cross section B-B'** (Figure 4-13) extends about 1.5 miles across the Basin perpendicular to the Basin axis in the vicinity of Foothill Boulevard and Los Osos Valley Road. The section line has a land surface elevation of about 180 feet AMSL on the northern end, sloping downward to about 130 feet AMSL along the Basin's long axis, and rising again to about 230 feet AMSL on the southern end. Recent Alluvium is exposed at the surface along this entire section, with thicknesses of about 20 to 30 feet. In the northern half of the section, alluvium is deposited directly on underlying basement rock. In the southern half of the section, the Paso Robles Formation underlies the alluvium with a maximum thickness of about 45 feet. The southern extent of the section crosses the Los Osos Fault Zone.

- **Cross Section C1-C1'** (Figure 4-14) extends from the northern lobes of the Basin boundary, which are formed from alluvium from Stenner and SLO Creeks, and trends southward approximately 5.5 miles across the Basin from Cal Poly through the City, approximately along the path of Highway 101. Land surface elevation is about 350 feet at the northern end of the section line on some noticeable hilltops along the line, and slopes downward to an approximate altitude of 80 feet on the southern end. Most of the northern extent of this section has alluvium of about 20 to 40 feet of thickness deposited directly on underlying bedrock. Only in the southernmost 1½ miles of the section line, where it crosses the main body of the Basin, do Paso Robles Formation sediments underlie the alluvium. The Paso Robles Formation is about 90 feet thick here, and it is in turn underlain by about 60 feet of Pismo Formation sediments.
- **Cross Section C2-C2'** (Figure 4-15) extends about 1½ miles southward through the eastern lobe of the northern part of San Luis Valley. Alluvium is deposited directly on top of basement rock along this section. Alluvium is thin here, ranging from less than 10 feet to about 40 feet.
- **Cross Section D-D'** (Figure 4-16) extends about 2.5 miles southward from a prominent serpentine ridge in the north to the southern Basin boundary. Land surface elevation is about 160 feet on the northern end of the section, sloping down to about 110 feet in the Basin center, and rising to about 180 feet on the southern end. Recent Alluvium is exposed at the surface along most of this section, reaching a maximum thickness of about 80 feet. The alluvium is deposited directly on basement rock through the northern half of the section. In the southern half of the section, approximately 20 to 30 feet of Paso Robles Formation underlies the alluvium. Near the southern extent of the Basin, the section line crosses into the combined Edna-Los Osos Fault Zone, at which point the land surface elevation rises steeply and the Paso Robles Formation crops out at the surface due to the upthrown formations south of the faults.
- **Cross Section E-E'** (Figure 4-17) extends about 2½ miles across the Basin in the vicinity of the airport and the area south of Buckley Road. Land surface elevation ranges from about 170 feet on the northern end to 230 feet in the southern end. In the northern half of this section, Recent Alluvium are exposed at the surface. In the southern half, the Paso Robles Formation is exposed. Alluvial thickness in the northern half of the section ranges from about 20 to 70 feet and is underlain by about 30 to 35 feet of Paso Robles Formation. In the southern half of the section, it crosses into the Edna-Los Osos Fault Zone, and the Paso Robles Formation is upthrown to the point that it is exposed at the surface. Paso Robles Formation thickness ranges from 50 feet to about 100 feet. Sediments of the Pismo Formation underlie the Paso Robles Formation in this area and are about 25 to 70 feet thick.
- **Cross Section F-F'** (Figure 4-18) extends about 2 miles north to south in the western extent of the Edna Valley area. The Paso Robles Formation is exposed at the surface along most of this section. One small pod of alluvium associated with Davenport Creek is evident in the center of the section. The Paso Robles Formation has a maximum thickness of about 175 feet in this section. It is underlain by about 50 to 60 feet of Pismo Formation sediments in the area north of the Edna Fault Zone. To the south, the section line extends into the Edna Fault Zone. South of the fault, the formations are upthrown, resulting in a small area of Pismo Formation sediments exposed at the surface.
- **Cross Section G-G'** (Figure 4-19) extends about 2 miles through the heart of the Edna Valley area. Land surface elevation ranges from about 300 feet on the north end to more than 350 feet on the south end. A thin veneer of alluvium, about 20 feet thick, that is associated with Corral de Piedras Creek and tributaries is exposed at the surface along much of this section. The Paso Robles Formation crops out in the north of the section and underlies the alluvium with an average thickness of about 50 to 60 feet. The Pismo Formation displays its largest thickness along this section, with a maximum thickness of about 450 feet near where this section intersects with cross section A3-A4. The southern end of the section line crosses into the Edna Fault zone, and

sediments are displaced such that the Pismo Formation sediments are exposed at the surface on the southern slopes of the Basin in this area.

- **Cross Section H-H'** (Figure 4-20) extends approximately 2½ miles through the Edna Valley. Land surface is approximately 350 feet on the northern end, sloping downward to about 230 feet near Corbett Canyon Road, then quickly rising to nearly 400 feet on the south end of the section on the upthrown side of the Edna Fault. The Paso Robles Formation is exposed at the surface for nearly the entire section. The section line crosses a small exposure of Recent Alluvium associated with Corral de Piedras Creek. In the northern half of the section, the Paso Robles Formation sediments are deposited directly on the basement rock formations, with a maximum thickness of about 80 feet. In the southern half of the section, the basement rock elevation plunges and the thickness of the Paso Robles Formation is about 150 to 230 feet. The Pismo Formation underlies the Paso Robles Formation sediments in the southern half of the section, with a maximum thickness of about 200 feet. In the Corbett Canyon area, the section crosses the Edna Fault; south of the fault the basement rock formations are thrust up to the surface and represent the boundary of the Basin.
- **Cross Section I-I'** (Figure 4-21) crosses the southern extent of the Edna Valley. The northern part of the section lies along the lower slopes of the Santa Lucia Range and displays Paso Robles Formation sediments deposited on top of bedrock formations. A small pod of Recent Alluvium associated with Corral de Piedras Creek is displayed. Along the center of the Edna Valley, the Paso Robles Formation thickness is about 200 feet, and is underlain by about 100 feet of Pismo Formation sediments. The section crosses the Edna Fault Zone, which shows Pismo Formation sediments upthrown to land surface on the south side of one fault splay, and bedrock of the Monterey Formation upthrown to land surface elevation south of a second fault splay.

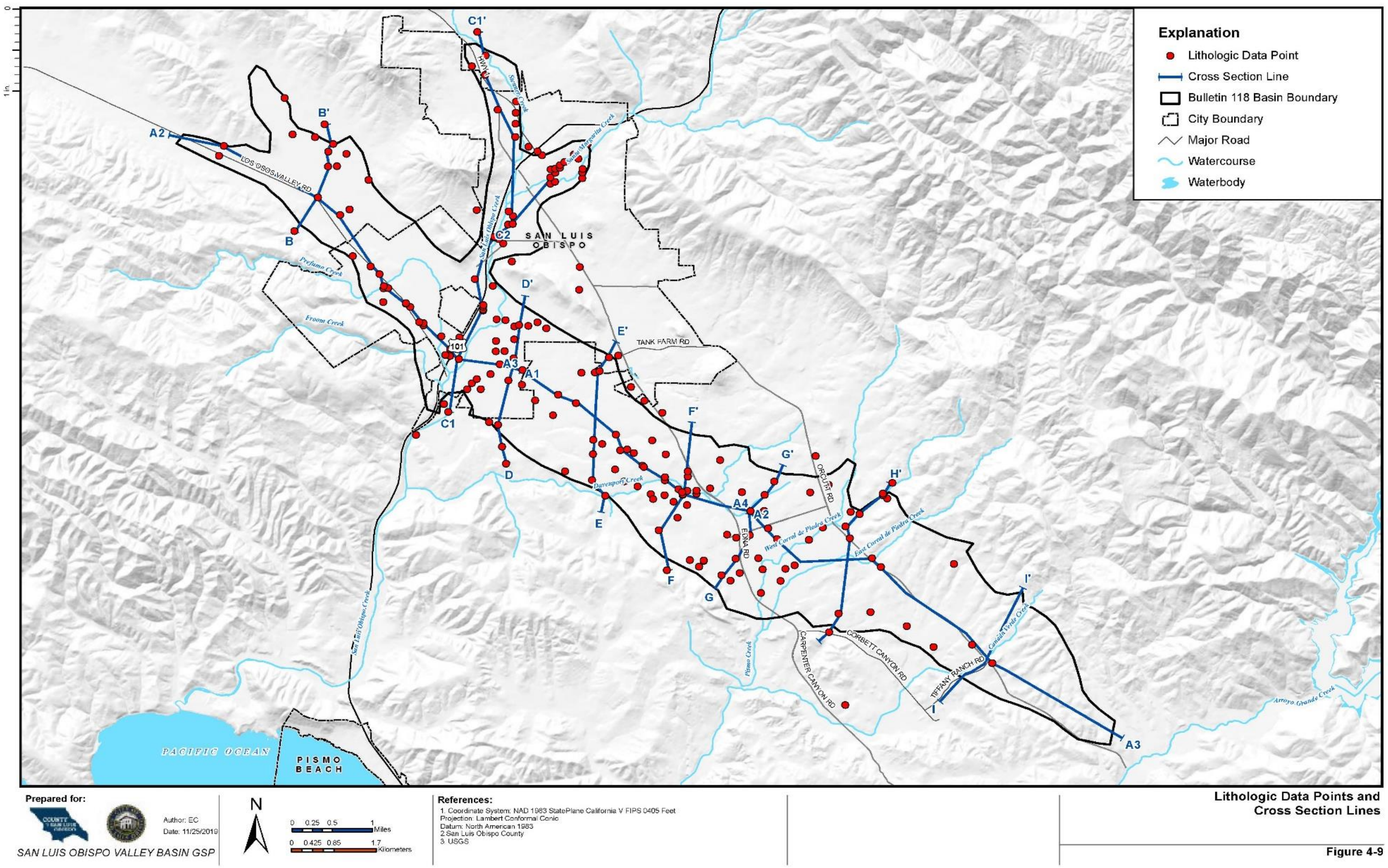


Figure 4-9. Lithologic Data Points and Cross Section Lines

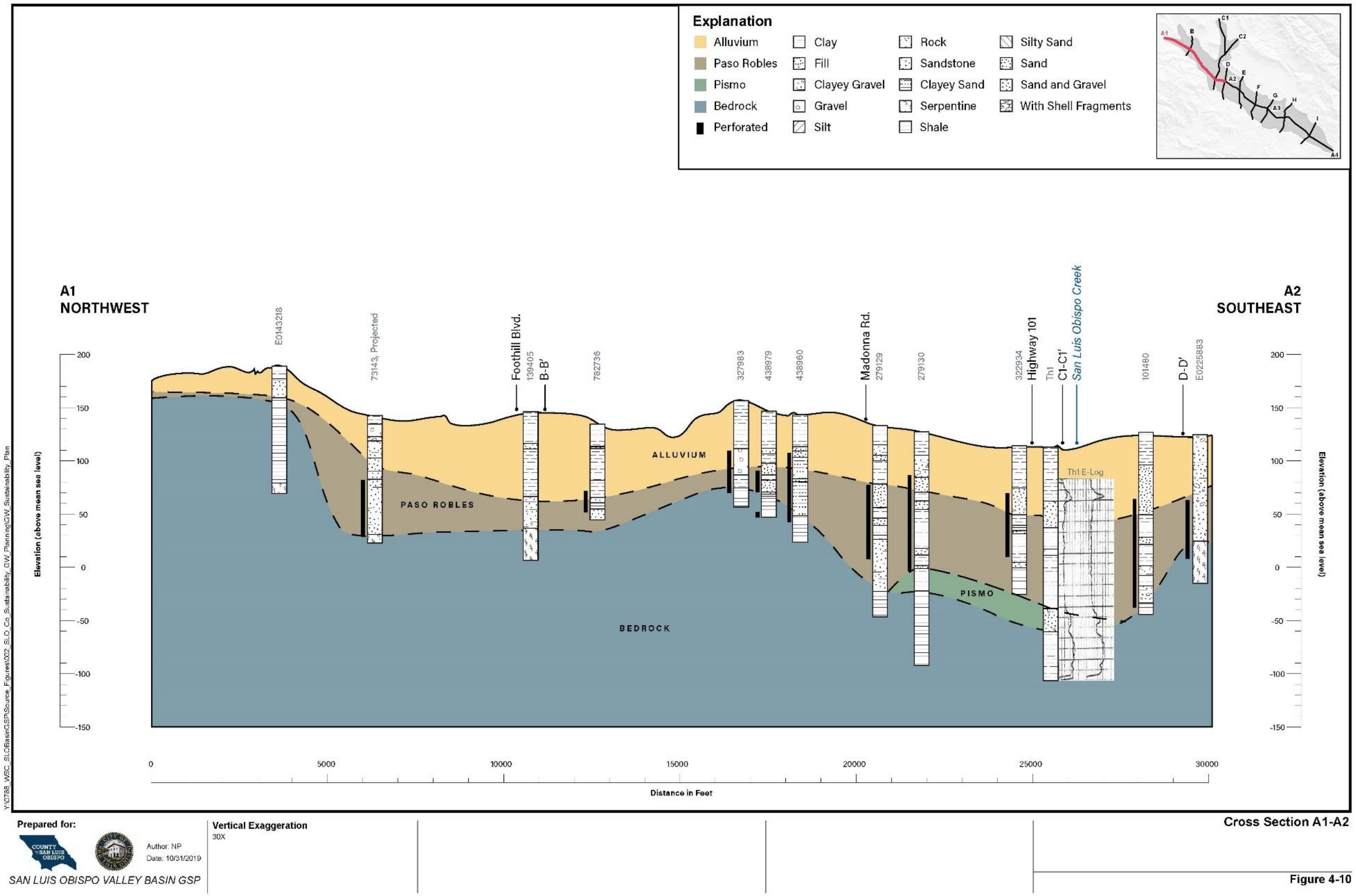


Figure 4-10. Cross Section A1-A2

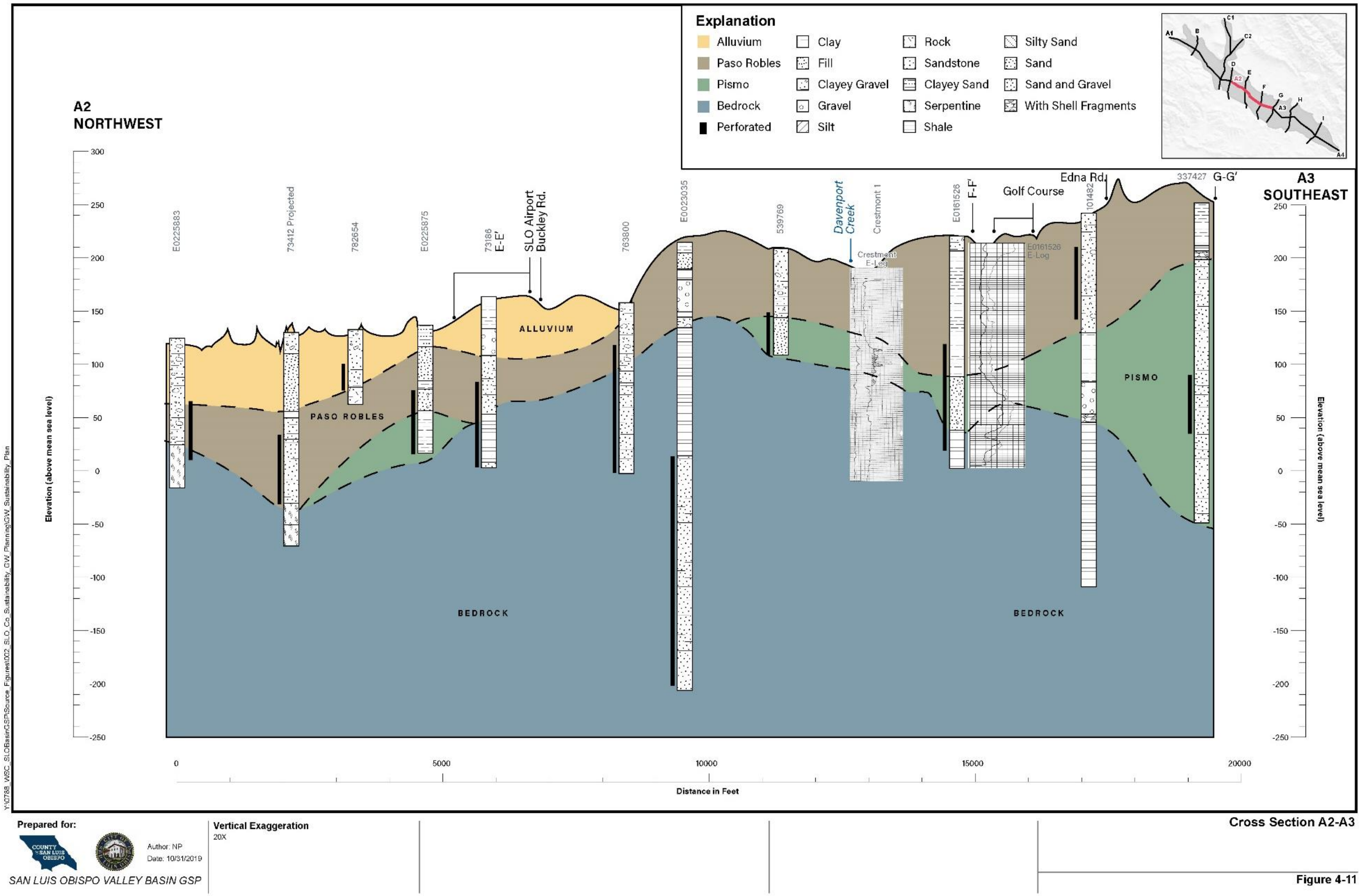


Figure 4-11. Cross Section A2-A3

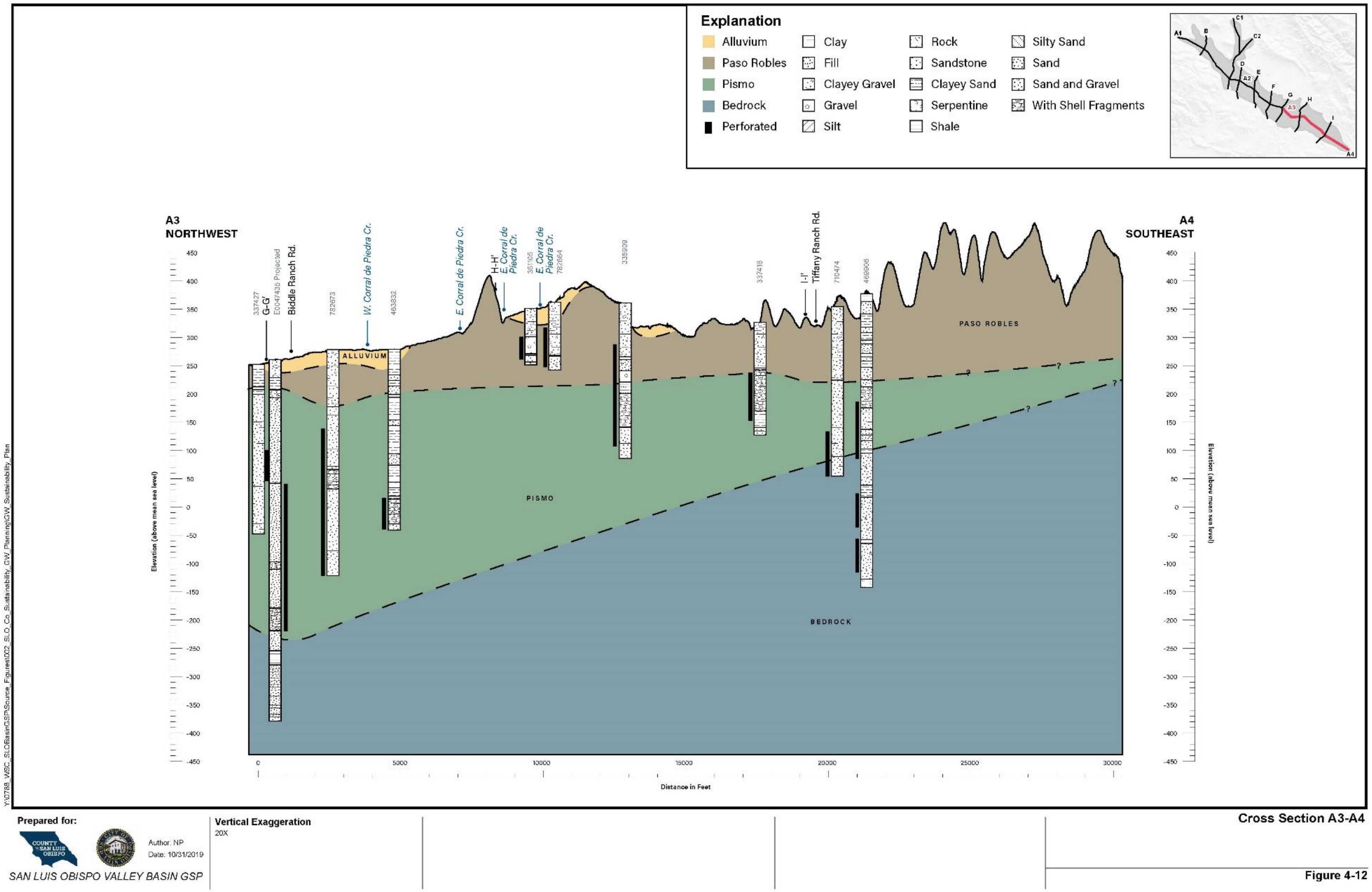


Figure 4-12. Cross Section A3-A4

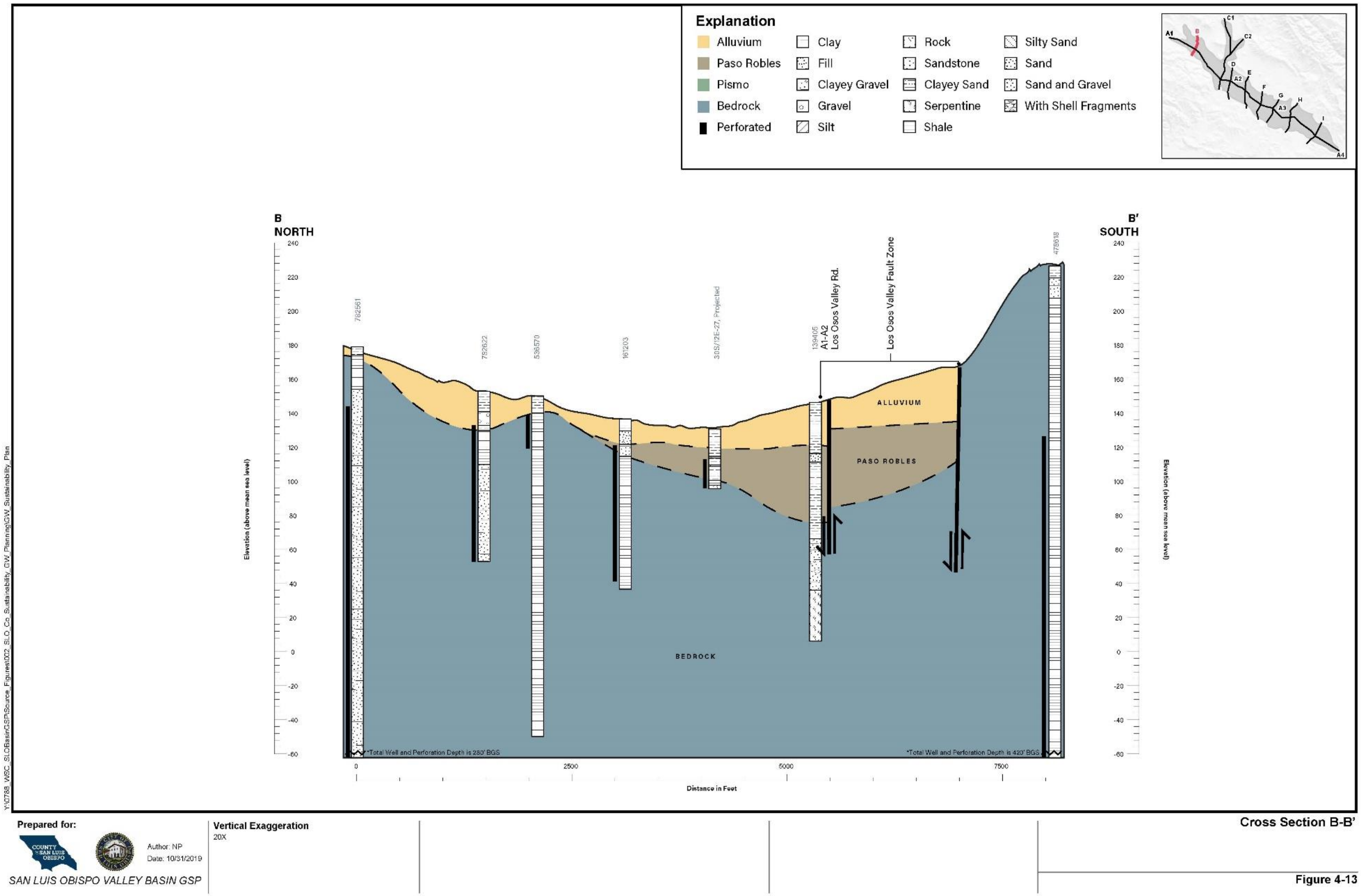


Figure 4-13. Cross Section B-B'

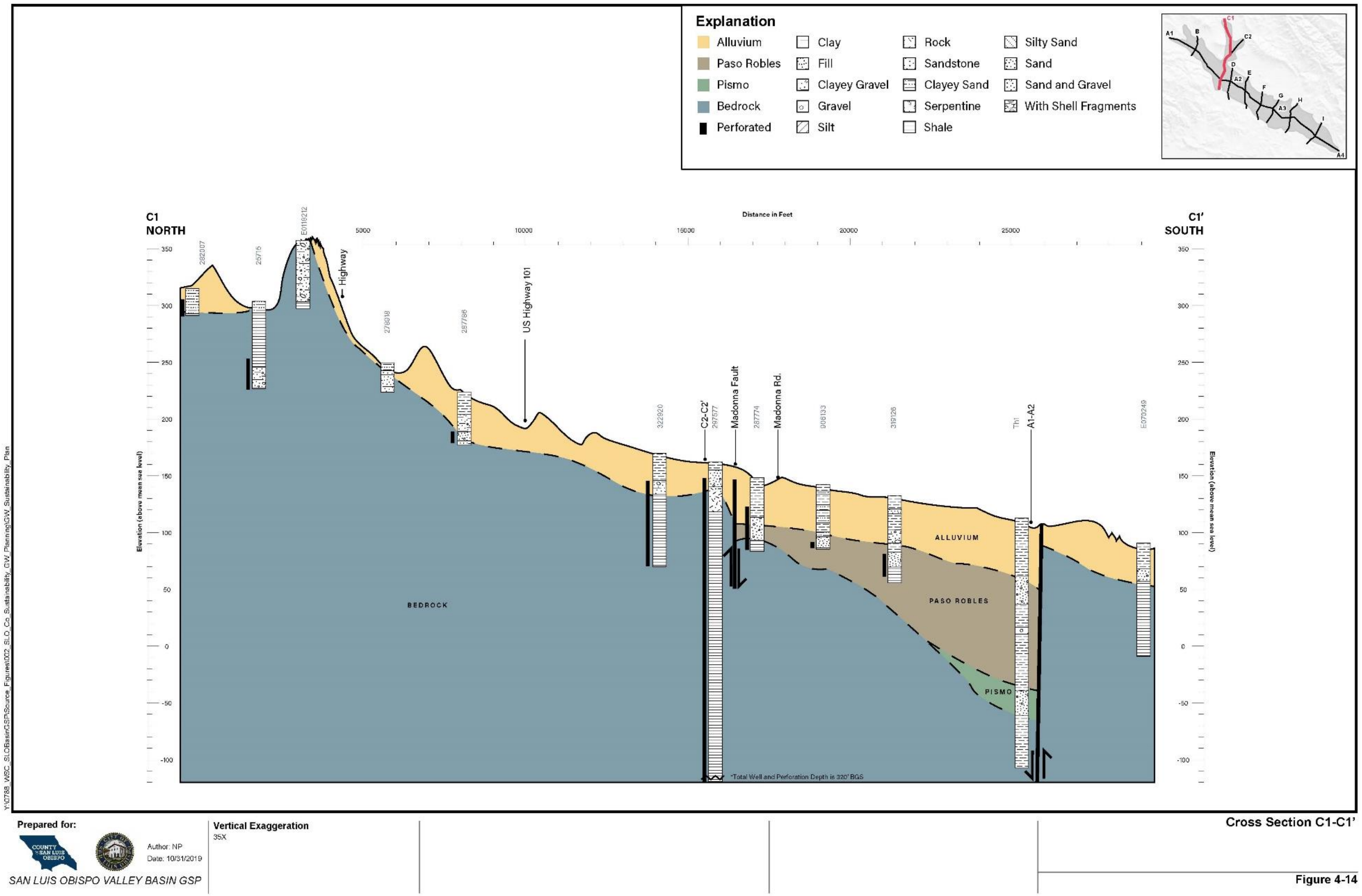


Figure 4-14. Cross Section C1-C1'

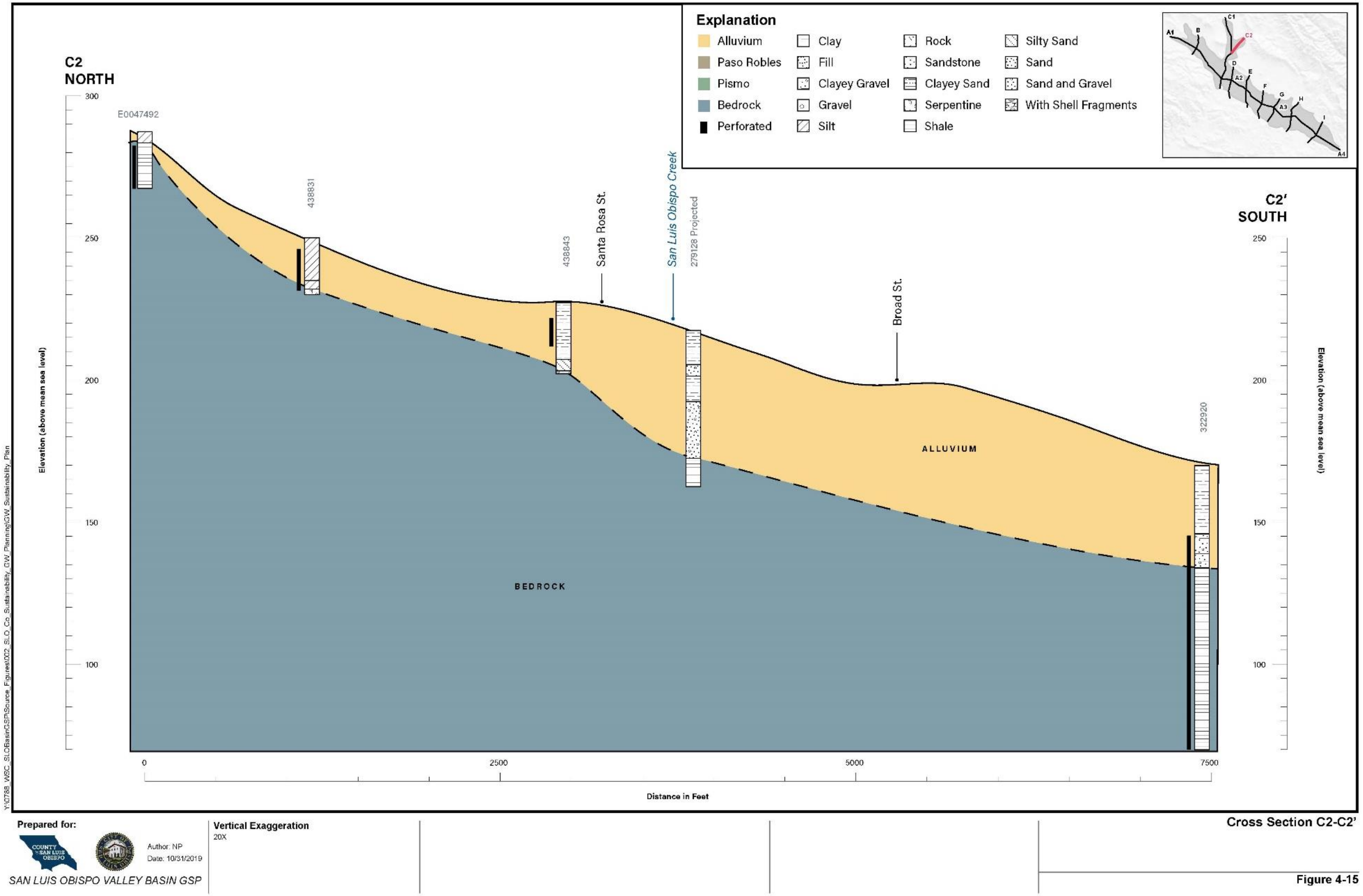


Figure 4-15. Cross Section C2-C2'

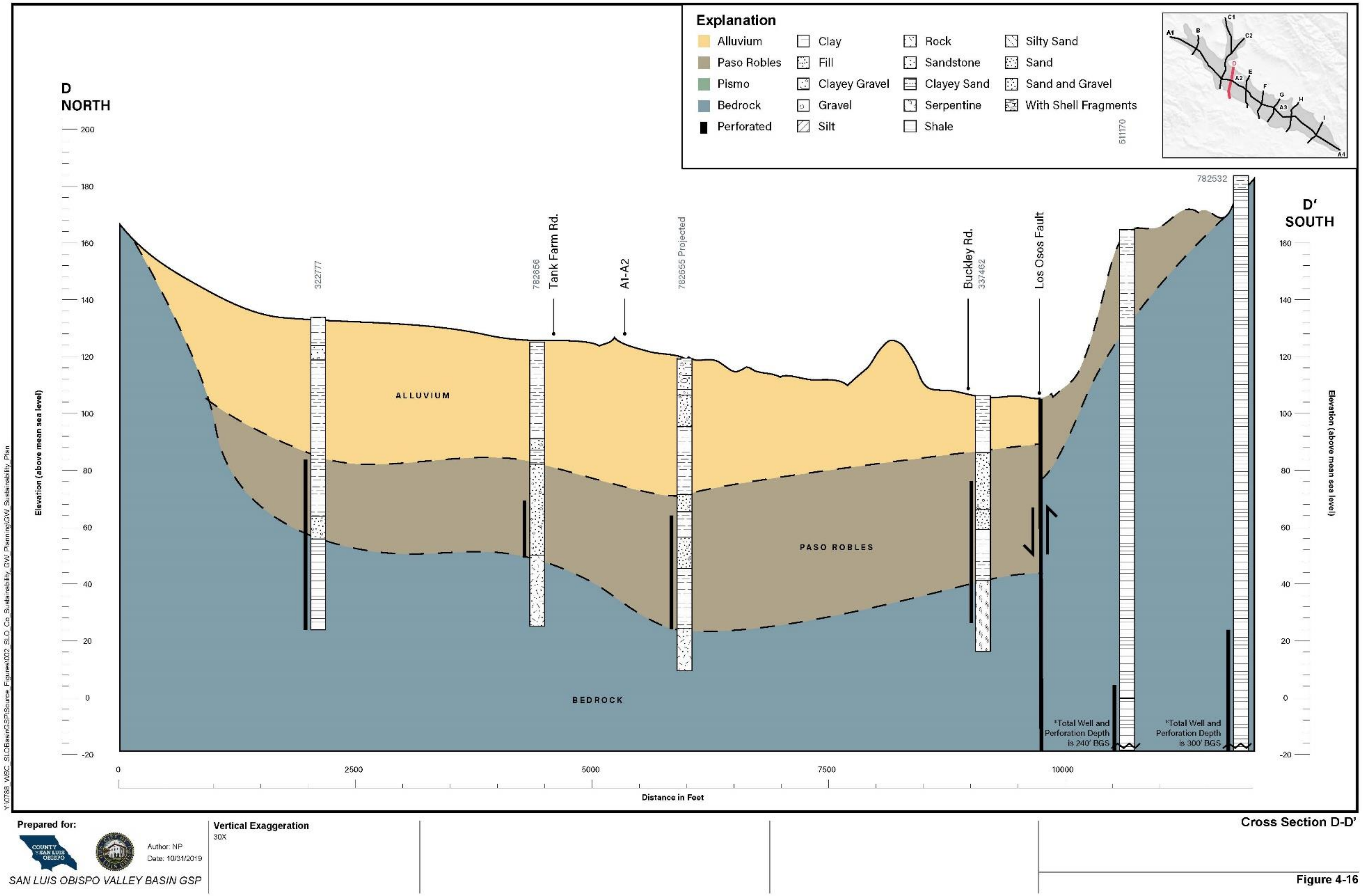


Figure 4-16. Cross Section D-D'

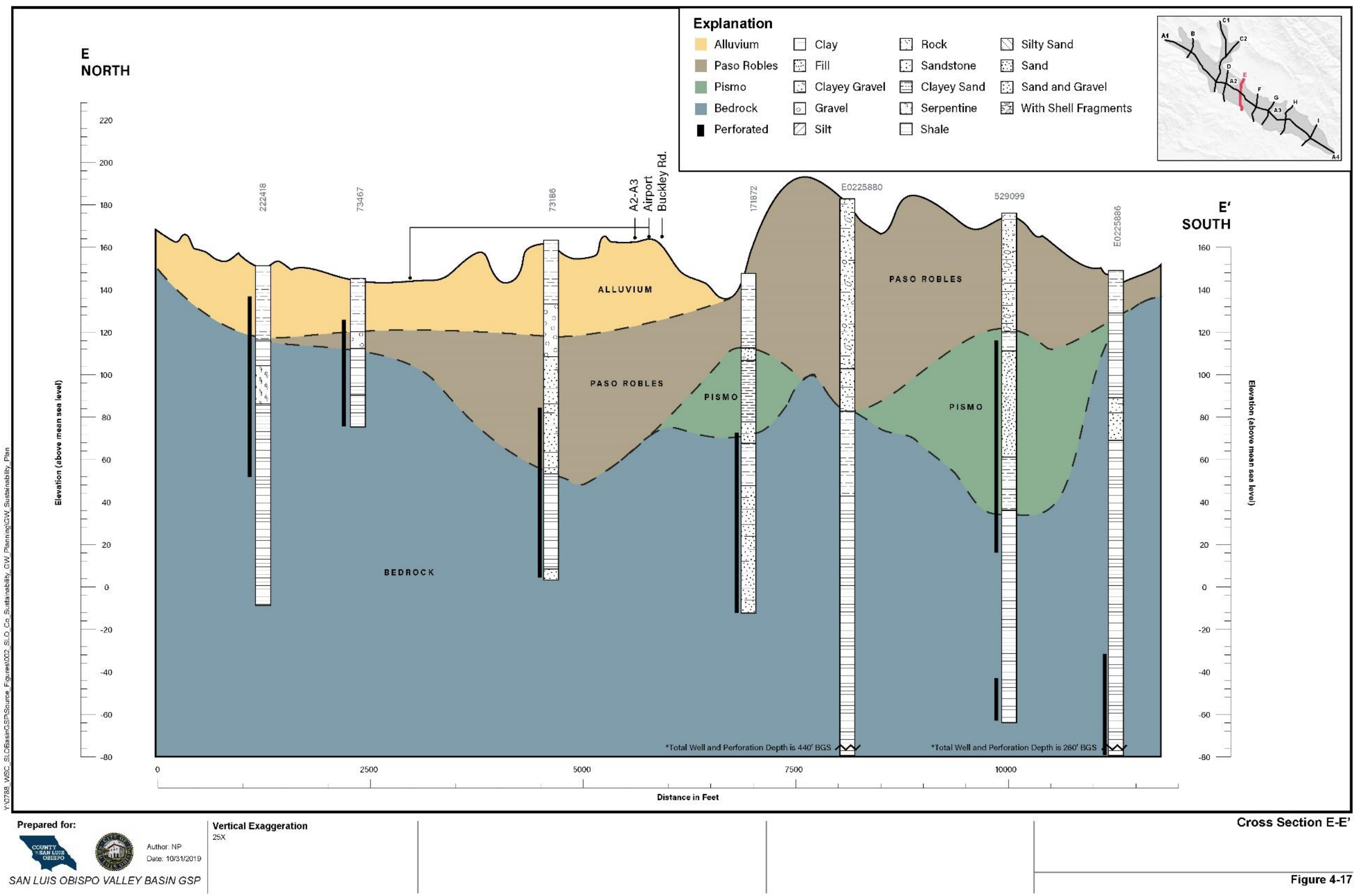


Figure 4-17. Cross Section E-E'

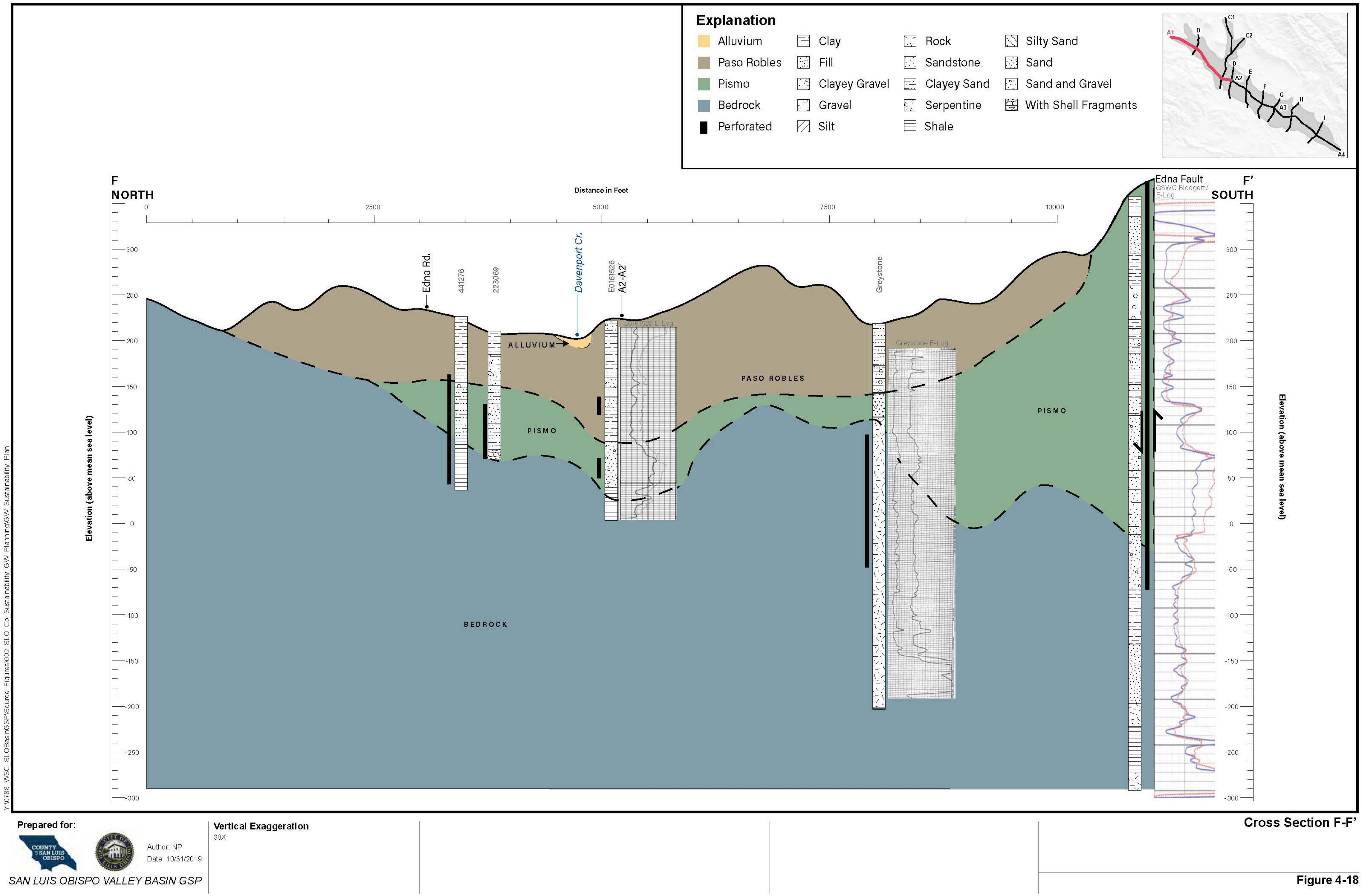


Figure 4-18. Cross Section F-F'

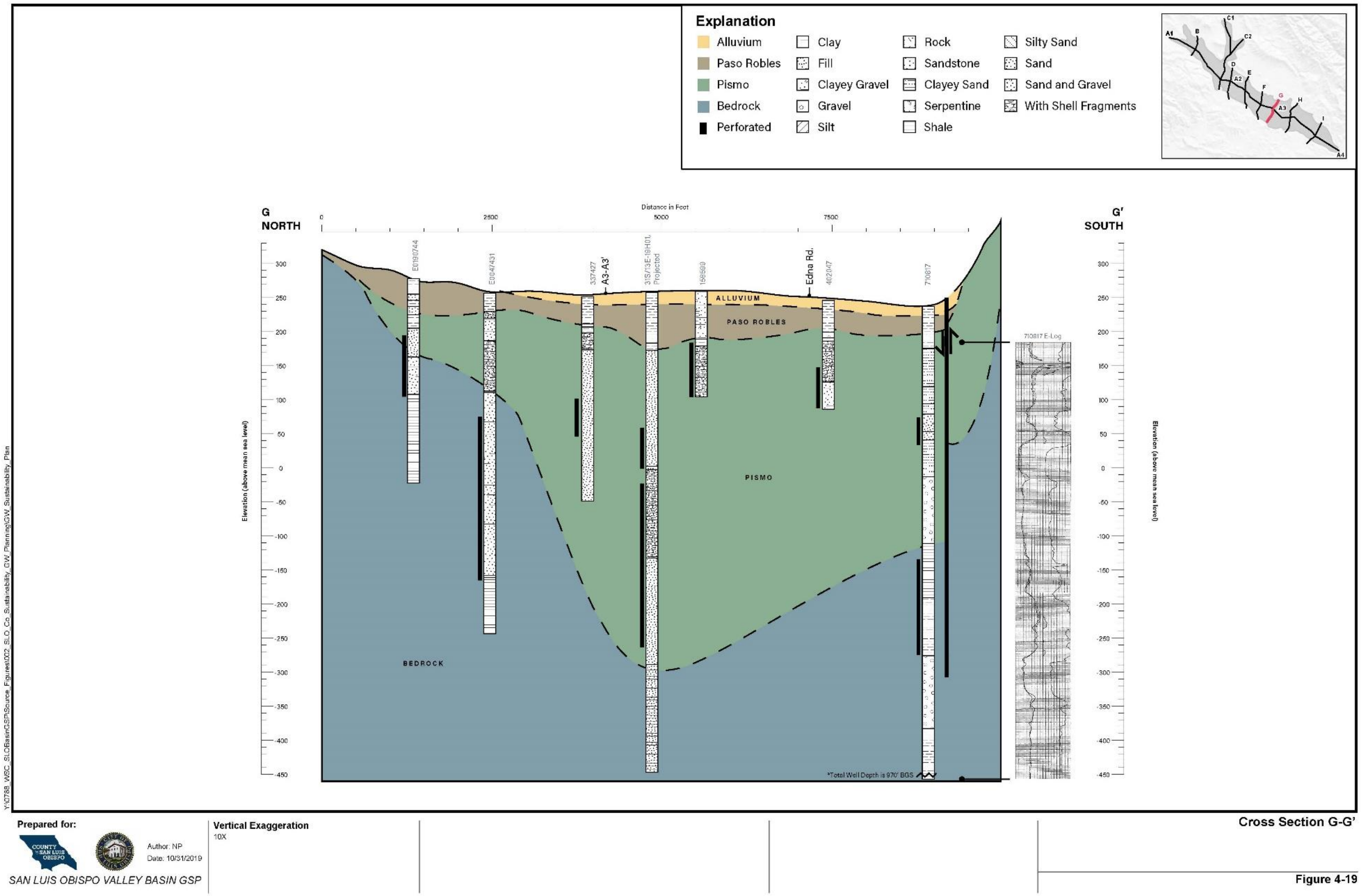


Figure 4-19. Cross Section G-G'

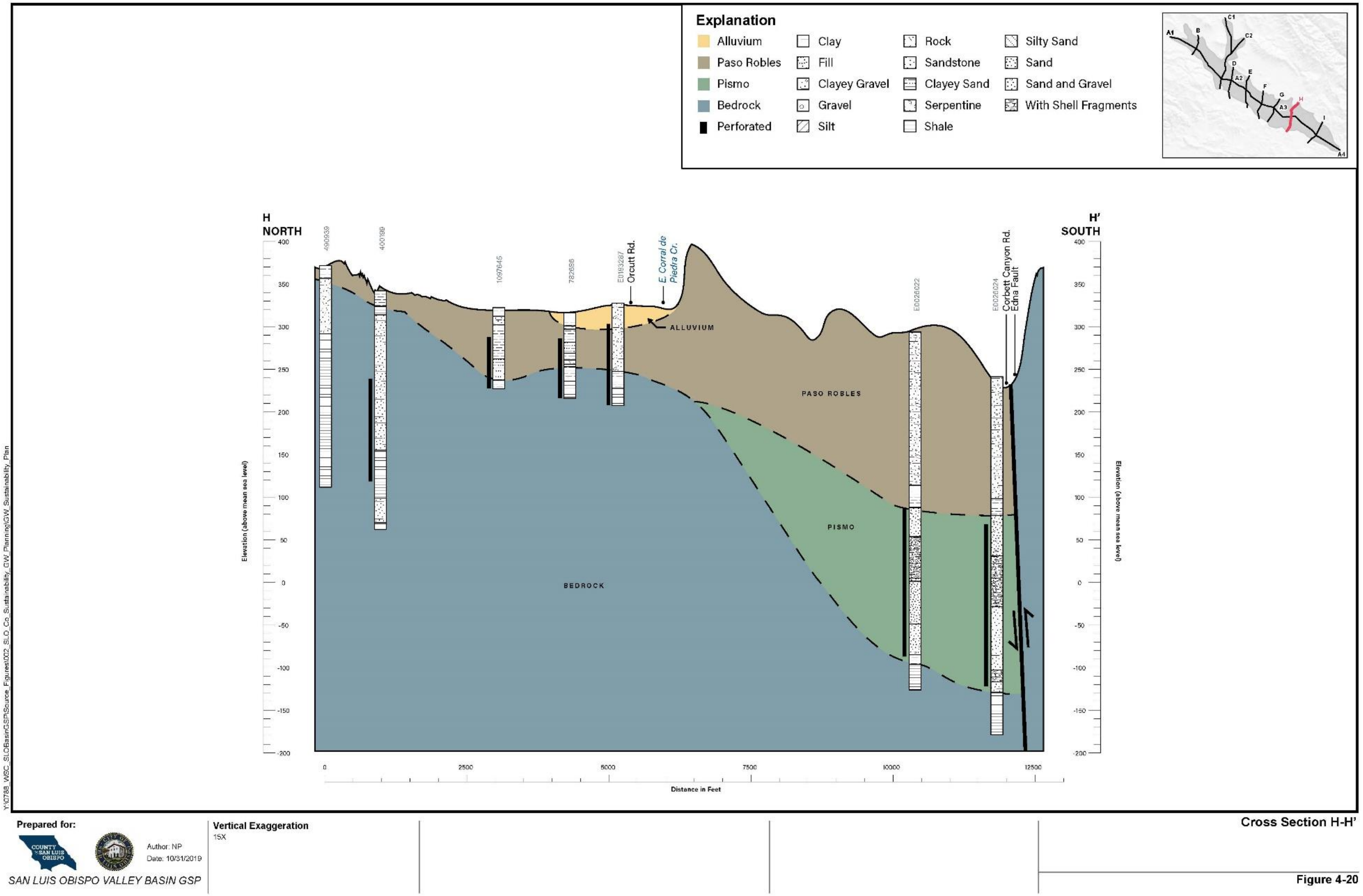


Figure 4-20. Cross Section H-H'

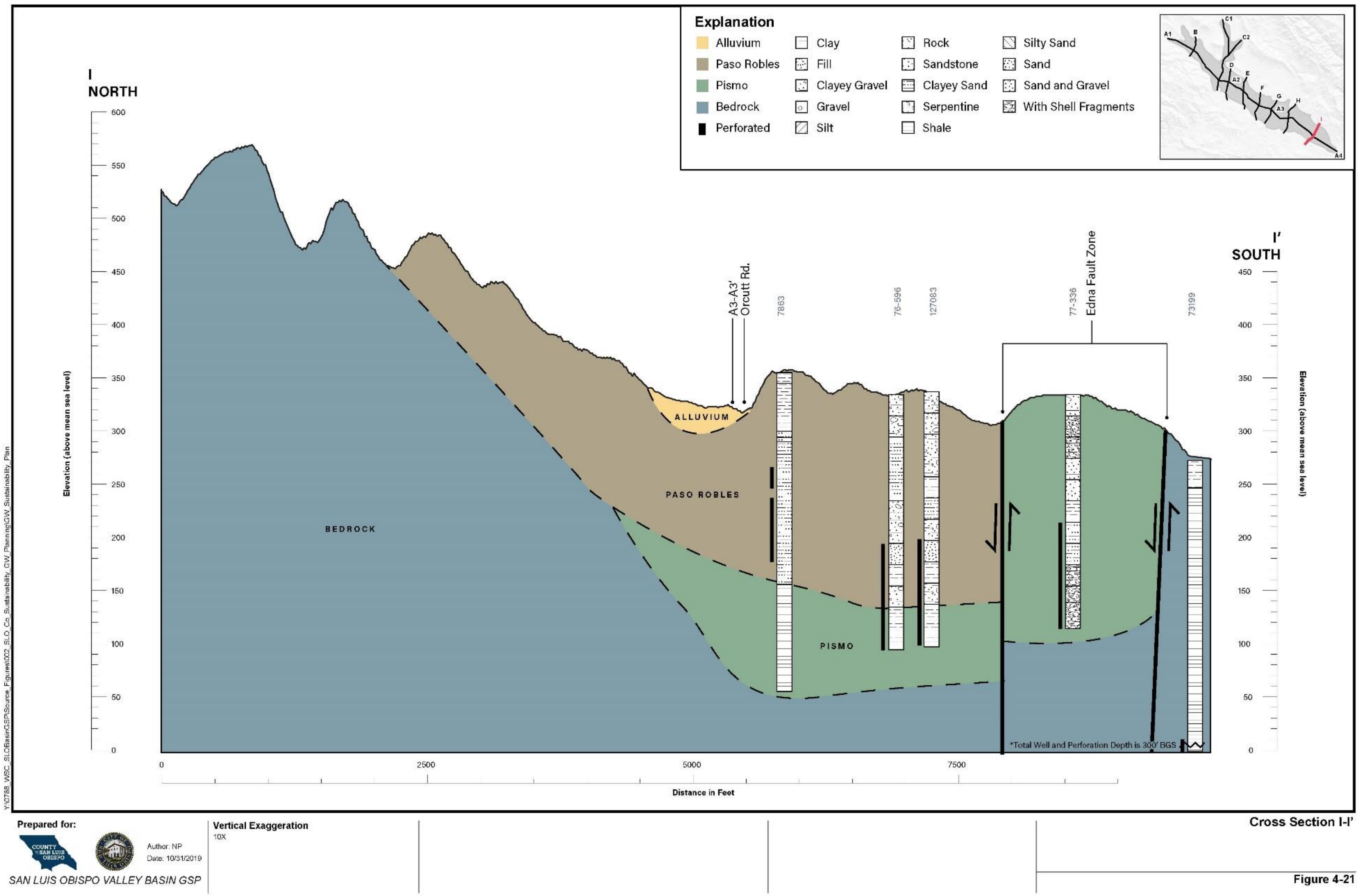


Figure 4-21. Cross Section I-I'

4.6.2. Aquifer Characteristics

The relative productivity of an aquifer can be expressed in terms of transmissivity, hydraulic conductivity, or specific capacity. The most robust method is measuring transmissivity using a long-term (frequently 24 hours or more) constant-rate pumping test. Water level drawdown data collected during this test can be analyzed and used to calculate transmissivity. Specific capacity is a simple measure of flow rate (gpm) divided by drawdown (feet), routinely measured by well service contractors during well maintenance and reported in units of gpm per foot of drawdown (gpm/ft). Specific capacity measurements may be affected by well construction details, and, therefore, are not only related to aquifer characteristics. Nevertheless, the following commonly accepted empirical relationships allows transmissivity to be estimated from specific capacity measurements.

T (GPD/FT) = SC (GPM/FT) * (1,500 – 2,000), where

T = Transmissivity (gpd/ft)

SC = Specific Capacity (gpm/ft)

1500 – 2000 = Empirical factor,
(1,500 used for unconfined, 2,000 for confined aquifer)

Data summarizing these parameters from water wells throughout the Basin were compiled. The data was obtained from Previous regional studies or reports, previous pumping tests and well service information provided by local stakeholders. All available reports and documents that were made available through data requests, report reviews, etc., were reviewed for technical information, and included in this summary if the data were judged to be sufficient.

DWR reports a range of irrigation well pumping rates from 300 to 600 gpm, and a range of specific capacity values of 15 to 20 gpm/ft for the Basin, corresponding to transmissivity estimates from 22,500 to 40,000 gallons per day per foot (gpd/ft) (DWR, 1958). Boyle evaluated five constant-rate aquifer tests for City wells, all in the San Luis Valley, and reported transmissivity values ranging from 11,200 to 71,000 gpd/ft, with an average of 41,240 gpd/ft (Boyle Engineering, 1991). DWR in 1997 discussed the range of hydraulic conductivity values used in the preparation of its groundwater model, which averaged about 15 ft/day in the San Luis Valley, and about 6 ft/day in the Edna area (DWR, 1997).

Figure 4-22 displays the spatial distribution of the available data locations for well tests in the Basin. Inspection of Figure 4-22 indicates a good spatial coverage of locations, with reasonable data density throughout the Basin.

Table 4-1 presents a compilation of all constant rate aquifer test data compiled during the preparation of this GSP. Table 4-2 presents a compilation of the specific capacity data. This information is used in the groundwater model development, and in the technical work supporting preparation of the GSP for the Basin.

Table 4-1 presents a data summary for the constant rate aquifer test that was available, including information on pumping rate, static and pumping water levels, screened intervals, total depth, and formations screened. It was not always readily apparent which formations are screened from the available data, and sometimes well screens may span more than one formation. If there is uncertainty regarding this designation, it is indicated with a question mark in Table 4-1. Calculated transmissivity values range from less than 1,000 gpd/ft to a maximum of 158,400 gpd/ft. (The highest reported transmissivity value of 158,400 gpd/ft is an outlier and was likely influenced by recharge from a nearby stream.

Table 4-2 presents all available information for the specific capacity well tests identified. Table 4-2 includes a transmissivity estimate based on the empirical relationship discussed previously.

Data presented in Table 4-1 and Table 4-2 indicate that wells screened in the Alluvium and Paso Robles Formation have transmissivities ranging from about 5,000 to 158,000 gallons per day per foot (gpd/ft), and averaging over 42,000 gpd/ft. Wells screened in Paso Robles and Pismo Formations have transmissivities ranging from less than 1,000 to about 40,000 gpd/ft, and average about 10,000 gpd/ft.

4.6.3. Aquitards

An aquitard is a layer of low permeability, usually comprised of fine-grained materials such as clay or silt, which vertically separates adjacent layers of higher permeability formations that may serve as aquifers. Although there is some amount of clay present in nearly all of the boring logs reviewed for this plan, there are no formally defined or laterally continuous clay layers that function as aquitards within the Basin. In the San Luis Valley, wells are commonly screened across both the Recent Alluvium and the underlying Paso Robles Formation, and these two formations essentially function as a single hydrogeologic unit is this area. Similarly, in the Edna Valley, wells are commonly screened across both the Paso Robles Formation and the underlying Pismo Formation, and these two formations essentially function as a single hydrogeologic unit is this area.

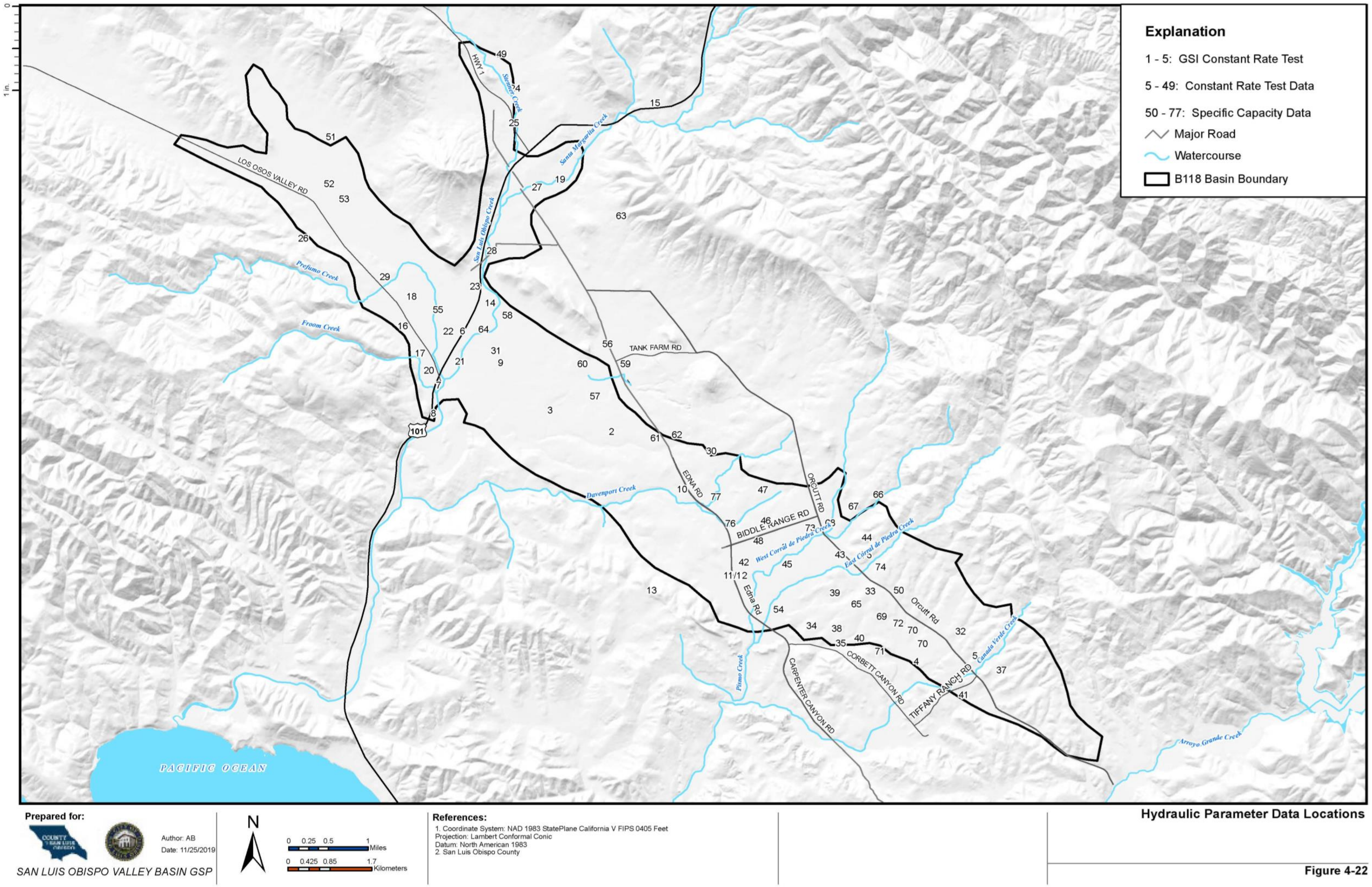


Figure 4-22. Hydraulic Parameter Data Locations

Table 4-1. San Luis Obispo Valley Groundwater Basin Water Well Pump Test Data Summary

Label No.	Date Drilled	Pump Test Date	Pumping Rate (GPM)	Static Water Level (feet bgs)	Pumping Water Level (feet bgs)	Drawdown (feet)	Specific Capacity (gpm/foot)	Est. Transmissivity (gpd/foot)	Screen Length (feet)	Hydraulic Conductivity (ft/day)	Total Depth (feet)	Perforations	Formation Screened
1		7/31/2017	60	74.3	133	58.7	1.02	2,880 - 4,525	280	1.37 - 2.15	440	180-200; 240-380; 320-440	Pismo
2		8/8/2017	27	21	27.5	6.5	4.2	3,605 - 4,620			98		Paso Robles
3		8/24/2017	55	15.58	78	62.42	0.9	3,227 - 4,840					Paso Robles
4		11/21/2017	265	67.6	155.2	87.6	3.03	1,600	300	2.82 - 3.11	500	200-500	Pismo
5	12/4/2017	12/9/2017	37	132	144.9	12.9	2.87	5,692 - 9,678	200	3.8 - 6.5	300	90-290	Paso Robles/Pismo
6	2/7/2003	2/18-21/2003	350	7.5	39.6	32.1	11	23,100	60	51.3	145	45-85; 115-135	Alluvium/Paso Robles
7	1/31/2003	2/6/2003	400-450	8.92	28.67	19.75	33.3	66,600	45	197.3	80	25-70	Alluvium/Paso Robles
8	2/10/2003	2/19/2003	250	5.5	28.92	23.42	9.3	18,600	30	82.7	70	30-60	Alluvium/Paso Robles
9	4/18/1996	4/19-21/1996	3.7	11.86	23.36	11.5	0.32	187	15	1.7	70	52-67	Alluvium
10	1/23/2013	2/5-9/2013	135	46.78	114.41	67.63	2	3,992	60	8.9		80-100; 140-180	Paso Robles/Pismo
11	8/18/1992	5/31/1992	656	52.4	122.3	69.90	9.38	5,773	200	3.8	440	130-190; 290-430	Pismo/Bedrock
12	4/4/2001	5/9/2001	500	70	85	15	33.33	66,667	180	49.4	520	160-200; 370-510	Pismo/Bedrock
13		5/12-16/2014	149	258.25	295.1	36.85	4.35	8,700	190	6.1	550	280-420; 490-540	Pismo/Obispo or Bedrock
14	6/15/1988	6/30/1988	135	20.5	25.9	5.4	25	50,000	20	333.3	80	50-70	Alluvium/Paso Robles
15	7/12/1988	7/15/1988	80	24	42	18	4.44	8,889	30	39.5	57	27-57	Alluvium
16	7/22/1988	7/26/1988	300	11.5	Incomplete Data						140	40-130	Alluvium/Paso Robles
17	4/20/1989	5/16/1989	250	11.5	53.3	41.8	5.98	15,000	70	28.6	140	60-130	Alluvium/Paso Robles
18	7/27/1988	9/2/1988	95	22	59	37.0	2.57	5,135	70	9.8	180	55-125	Alluvium/Paso Robles
19	7/25/1988	8/4/1988	70	24	27.3	3.3	21.21	42,424	20	282.8	48	28-48	Alluvium
20	10/6/1989	10/24/1989	375	10.42	33.58	23.16	16.19	21,300	95	29.9	175	60-120; 140-175	Paso Robles/Pismo
21	6/28/1989	7/6/1989	200	10.4	38.5	28.1	7.12	21,120	60	46.9	175	50-90; 150-170	Alluvium/Paso Robles
22	4/26/1989	5/10/1989	900	11	39.3	28.3	31.80	63,604	80	106.0	140	42-122	Alluvium/Paso Robles
23		6/14/1989	500	20	47	27	18.52	37,037			60	?	Alluvium
24	12/22/1989	12/27/1989	50	11	31.2	20.2	2.48	4,950	15	44.0	53	33-48	Bedrock
25	4/18/1989	4/20/1989	100	14	26	12	8.33	16,667	10	222.2	44	34-44	Alluvium
26		7/18/1986	60	55	280	225	0.27	533	80	0.9	296	220-300	Bedrock
27		5/15/1989	80	9.92	31	21.08	3.80	26,400	20	176	49	29-49	Alluvium
28		4/22/1993	165	19.63	33.4	13.77	11.98	87,120	30	387.2	65	30-60	Alluvium
29		10/10/1990	25	39.5	78.5	39	0.64	400	80	0.67	145	60-140	Paso Robles
30		7/20/2011	20	46.5	272	225.5	0.09	177	140	0.169	300	160-300	Bedrock
31		6/26/1991	100	20	58	38	2.63	24,000	40	80	140	90-130	Paso Robles
32		4/12/1994	90	53.46	120	66.54	1.35	2,640	85	4.141	170	85-170	Pismo
33		6/26/1989	596	51.2	147.5	96.3	6.19	3,311	280	1.577	400	60-120; 160-360; 380-400	Paso Robles/Squire
34		6/15/2007	350	65.5	138	72.5	4.83	10,266				200-?	
35		6/15/2007	300	37.5	134	96.5	3.11	7,401				170-?	
36		6/9/1985	295	36.25	98.45	62.2	4.74	33,807			240		Paso Robles/Pismo
37		2/10/1997	300	110.2(?)	131.3	21.2	14.15	39,600	220	24	490	190-290; 350-410; 430-490	Pismo
38		8/6/2014	150	166	215	49	3.06	3,046			300		
39		8/7/2014	158	171	219	48	3.29	3,627			310		
40		12/12/2008	170	116	186	70	2.43	5,081					
41		12/22/2005	350	39.6	82	42.4	8.25	18,480	230	10.71	430?	200-430	
42		6/29/2016	150	131.8	226.1	94.3	1.59	10,850	100	14.47	290	180-280	Pismo
43		6/30/1993	100	39.66	78.83	39.17	2.55	1,508	60	3.35	110	50-110	Paso Robles
44		7/21/1993	70	10.5	21.5	11	6.36	2,174	40	7.25	100	20-40; 80-100	Paso Robles/Bedrock
45		3/25/2008	200	76.7	219.3	142.6	1.40	3,105	200	2.07	400	130-170; 220-380	Pismo
46		4/3/2007	300	34.6	112.3	77.7	3.86	9,542	260	4.89	480	220-480	Bedrock
47		4/9/2007	400	28.3	78	49.7	8.05	26,400	240	14.67	420	180-420	Pismo
48		12/17/2015	150	114	266	152	0.99	851 - 1,414	?		299	?	Pismo
49		10/28/2010	600	26.5	32.3	5.8	103.45	158,400					Alluvium/Paso Robles

Table 4-2. San Luis Obispo Valley Groundwater Basin Water Well Specific Capacity Data Summary

Label No.	Specific Capacity Test Date	Pumping Rate (GPM)	Static Water Level (feet bgs)	Pumping Water Level (feet bgs)	Drawdown (feet)	Specific Capacity (gpm/foot)	Duration (hours)	Est. Transmissivity (gpd/foot)	Screen Length (feet)	Estimated Hydraulic Conductivity (ft/day)	Total Depth (feet)	Perforations	Formation Screened
50		435				6-10		10,000-20,000			250?		Paso Robles/Pismo
51	May 1999	12	10	24	14	0.86	4	1,714	?		30		Alluvium
52	2002	18	19	63	44	0.41	12	818			86		Alluvium/Paso Robles
53	2003	3.5	16	42	26	0.13	72	269			80		Alluvium/Paso Robles
54	7/18/1966	130			60	2.17	20	4,333	30	19.3	90	60-90	Paso Robles
55	4/15/1987	200			30	6.67	12	13,333	30	59.3	110	80-110	Paso Robles
56	12/22/1972	60			30	2	8	4,000	25	21.3	75	50-75	Alluvium
57	1980	24			110	0.22	8	436	80	0.7	160	80-160	Bedrock
58	9/11/1991	15			13	1.15	8	2,308	40	7.7	90	50-90	Alluvium
59	9/12/1959	1.25			8	0.16	4	313	10	4.2	28	18-28	Alluvium
60	3/4/1957	45			18	2.5	12	5,000	17	39.2	37	20-37	Alluvium
61	3/15/1961	12			6	2	5	4,000	5	106.7	85	40-43; 75-77	Alluvium/Paso Robles
62	3/30/1956	8			4	2	2	4,000	15	35.6	32	17-32	Paso Robles
63	9/18/1989	5			20	0.25	1	500	10	6.7	50	40-50	Bedrock
64	8/29/1990	4			14	0.29	4	571	30	2.5	50	20-50	Alluvium
65	8/7/2014	47	206	257	51	0.92	1.5	1,843			340		Unknown
66	7/21/1993	75	22	33	11	6.82	4	13,636	50	36.36	100	50-100	Bedrock
67	7/23/1993	69	11	16.25	5.25	13.14	4.5	26,286	55	63.72	100	25-65; 85-100	Paso Robles/Bedrock
68	July 1993?	32	40	95?			4				120	60-120	Paso Robles
69	7/19/2012	83	45	87	42	2.0							Paso Robles/Pismo
	5/19/2014	104	82	123	41	2.5							
	4/24/2017	109	178	212	34	3.2							
70	5/9/2014	94	182	196	14	6.7							Paso Robles/Pismo
	4/24/2017	124	85	117	32	3.9							
71	4/24/2017	206	100	123	23	9.0							Paso Robles/Pismo
72	7/19/2012	320	98	101	3	106.7							Paso Robles/Pismo
	5/19/14	367	133	183	50	7.3							
	4/24/17	483	104	141	37	13.1							
73	12/5/12	93	86	101	15	6.2							Paso Robles/Pismo
	5/19/14	55	140	65	12	4.6							
	4/24/17	81	50	152	15	5.4							
74	12/11/12	23	55	57	2	15.5							Paso Robles/Pismo
	4/24/17	30	25	26	1	30.0							
75	12/11/2012	17	62	66	4	4.7							Paso Robles/Pismo
76	12/5/2012	133	73	98	25	5.3							Paso Robles/Pismo
	5/19/14	104	96	152	56	1.9							
	4/24/17	127	89	126	37	3.4							
77	12/5/2012	96	71	98	27	3.6							Paso Robles/Pismo
	5/19/14	91	94	123	29	3.1							
	4/24/17	91	85	99	14	6.5							
34	7/19/2012	183	107	135	28	6.5							Paso Robles/Pismo
	5/19/14	169	86	132	46	3.7							
	4/24/17	259	75	135	60	4.3							
33	4/24/2017	311	116	176	60	5.2							Paso Robles/Pismo
1	4/24/2017	65	29	49	20	3.3							Paso Robles/Pismo

4.7. Surface Water Bodies

Surface water/groundwater interactions represent a small, but significant, portion of the water budget of an aquifer system. In the Basin, these interactions occur primarily at streams and lakes.

As previously discussed, there are several named creeks that flow across the Basin. In the San Luis Valley area of the Basin, these include San Luis Obispo Creek, Stenner Creek, Prefumo Creek, Froom Creek, and Davenport Creek, in addition to smaller unnamed tributaries. In the Edna Valley these include East and West Corral de Piedras Creeks (which join to form Pismo Creek just south of the Basin Boundary), and Canada de Verde Creek in southeastern Edna Valley. The watersheds support important habitat for native fish and wildlife, including the federally threatened South-Central California Coast steelhead (Oncorhynchus mykiss) (Stillwater Sciences, 2014).

Laguna Lake is the only lake in the Basin. It is a naturally occurring lake just north of Los Osos Valley Road and west of Highway 101. The downstream outlet of the lake flows into the Prefumo Creek culvert under Madonna Road. In the past, flashboards were used to maintain water elevation in the lake to support recreation and maintain wildlife habitat. However, these are no longer used. The water in the lake is partially supplied by seasonal flow in Prefumo Creek, which flows into Laguna Lake. and at least partially supplied by subsurface groundwater inflow.

Groundwater interaction with streams in the Basin is not well quantified, but it is recognized as an important component of recharge in the water budget. Where the water table is above the streambed and slopes toward the stream, the stream receives groundwater flow from the aquifer; this is known as a gaining reach (i.e., the stream gains flow as it moves through the reach). Where the water table is beneath the streambed and slopes away from the stream, the stream loses water to the aquifer; this is known as a losing reach. During seasonal dry flow conditions, it is clear that groundwater elevation is deeper than the streambed. Therefore, it is generally understood that the streams in the Basin discharge to the underlying aquifer, at least in the first part of the wet-weather flow season. If there is constant seasonal surface water flow, it is possible that groundwater elevations may rise to the point that they are higher than the stream elevation, and the creek may become a seasonally gaining stream in some reaches. Groundwater modeling can help evaluate surface water groundwater interaction.

The amount of flow in surface water/groundwater interaction is difficult to quantify. Boyle assumed that 10 percent of the measured surface water flow coming into the Basin in San Luis Obispo Creek and Stenner Creek was recharged to the aquifer and used an average rate of 430 acre-feet/yr (AFY) (Boyle Engineering, 1991). In its draft report, DWR reports model-generated estimates ranging from streams gaining 2,700 AFY from the aquifer to streams losing 680 AFY to the aquifer (DWR, 1997).

The County, through its coordination with Zone 9 of the SLCFCWCD and the City, maintains a network of five stream gauges in the San Luis Valley Basin to record heights of flow throughout the year for flood warning purposes (Figure 3-10). The gauges were constructed in November 2001 and have periods of record from that year to the present. Continuous data monitoring of height of flow at the gages is recorded, but equivalent discharge (cubic feet per second) is not recorded.

4.8. Subsidence Potential

Subsidence is the gradual settling or sinking of the earth's surface due to material movement at depth in a location, and may be associated with groundwater pumping, and is one of the undesirable results identified in SGMA. Subsidence has been documented in parts of the San Luis Valley. The most severe subsidence that has occurred in the Basin was in the 1990s along the Los Osos Valley Road corridor. Subsidence occurred within young organic soil (i.e., peat) in response to extraction of groundwater within a relatively shallow aquifer that resulted in significant settlement of the ground surface. The settlement caused local damage to businesses and homes in that area as local groundwater pumping dewatered the soft soil units beneath buildings and the surrounding area. Subsidence of more than 1 foot of settlement of the ground surface in some locations damaged buildings and resulted in reconstruction or retrofitting buildings.

Another area of known subsidence is along the shores of Laguna Lake. Homes located along the shoreline have experienced settlement that has cracked foundations, patios, and window and door openings. Many homes in that area have been retrofitted to address the settlement. While the subsidence near Laguna Lake is not specifically related to extraction of groundwater, lowering of the groundwater table in that area could result in further settlement and subsidence.

The historical manifestation of subsidence generally has been limited to the area along Los Osos Valley Road and downstream, where there are compressible soil types that were particularly vulnerable to large settlements in response to lowering of the local groundwater table. This history emphasizes the importance of considering subsurface conditions that may be associated with subsidence. Not all soil and rocks are vulnerable to the type of subsidence that occurred along Los Osos Valley Road. The potential for subsidence to occur, and the severity of the subsidence, is dependent on the geology, groundwater levels, and the properties of the soil and rock that may be dewatered in association with groundwater pumping. The subsidence evaluation consisted of a review of published data and studies performed by local, state, and federal agencies, as well as a familiarity of local geology and soil. The following is a summary of the key findings.

DWR identifies the Basin as having a low subsidence potential. However, historical subsidence is known to have occurred in specific geographic areas of the Basin because of groundwater pumping or lowered groundwater levels due to drought. The Basin was evaluated on the basis of the extent of known and mapped geologic units within the Basin (Yeh and Associates, 2017).

The relative potential for subsidence was divided into three categories and delineated as shown in Figure 4-23**.**

- **Category 1.** Category 1 has the highest likelihood of future subsidence if subject to lowered groundwater levels in the future. Based on a review of public data and consultant reports, alluvium mapped in these areas contains young organic soil known in areas around Los Osos Valley Road, Laguna Lake, and low-lying wetland areas near Tank Farm Road. These areas are known to have experienced historical subsidence or to contain soft or organic soil and were identified as having a potential for subsidence in relation to geology and groundwater pumping. These areas are identified as Category 1 in Figure 4-23, with star symbols marking approximate areas of known historical subsidence. Extraction of groundwater resources in these areas could cause further subsidence.
- **Category 2.** Low-lying topographic areas in the Basin that are mapped as young alluvial soil were identified as potentially containing soft or organic soil layers that may have a potential for subsidence in relation to groundwater pumping, but currently there is no historical or subsurface information to further evaluate those areas. Those areas are mostly located along Prefumo Creek and San Luis Obispo Creek and the main drainages through the west end of the Edna Valley near Price Canyon. These areas are identified as Category 2 in in Figure 4-23. This screening criteria recognizes the unconsolidated nature typical of young alluvium that has been mapped in these areas potentially could subside because of compaction of the aquifer if groundwater levels were lowered.
- **Category 3.** Geographic areas in the Basin that were mapped as bedrock or older surficial sediments and are not known to be underlain by young organic soil or young alluvium, were identified as Category 3 in Figure 4-23. These areas were evaluated and characterized as not having factors known to be susceptible to subsidence in relation to groundwater pumping. Generally, these are upland areas where bedrock is shallow or where bedrock is mapped at the ground surface, such as in the areas around the airport and Orcutt Road (in Figure 4-23).

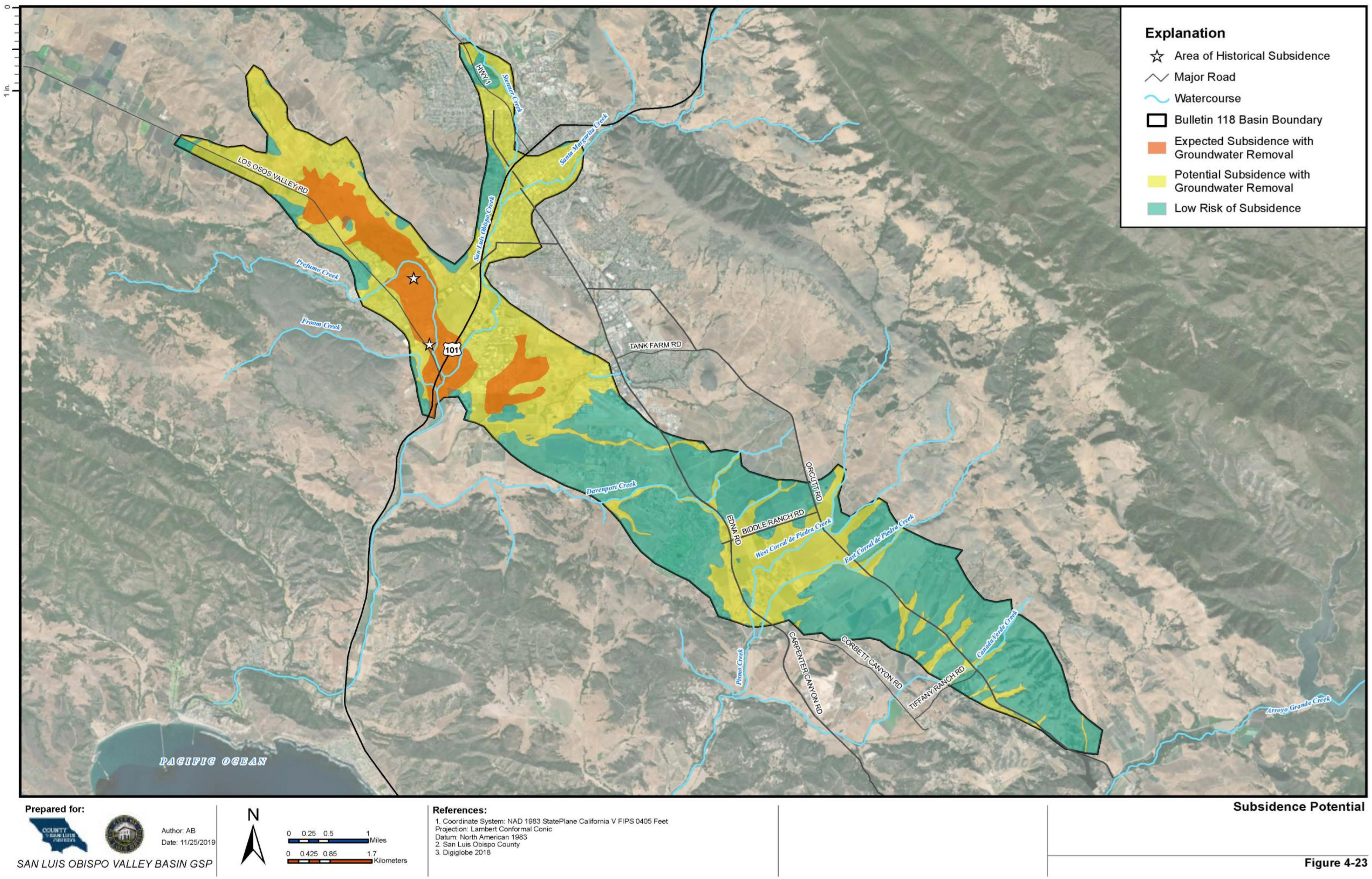


Figure 4-23. Subsidence Potential

5

GROUNDWATER SUSTAINABILITY PLAN

Groundwater Conditions (§354.16)

This chapter describes the current and historical groundwater conditions in the Alluvial Aquifer, the Paso Robles Formation Aquifer, and the Pismo Formation Aquifer in the San Luis Obispo Valley Groundwater Basin.

IN THIS CHAPTER

- Groundwater Elevations
- Groundwater Recharge and Discharge
- Interconnected Surface Water
- Groundwater Dependent Ecosystems

In accordance with the SGMA GSP Regulations Section 354.16, current conditions are any conditions occurring after January 1, 2015. By implication, historical conditions are any conditions occurring prior to January 1, 2015. This Chapter focuses on information required by the GSP regulations and information that is important for developing an effective plan to achieve sustainability. The organization of Chapter 5 aligns with the six sustainability indicators specified in the GSP regulations, including:

1. Chronic lowering of groundwater elevations;
2. Groundwater storage reductions;
3. Seawater intrusion;
4. Land Subsidence;
5. Depletion of interconnected surface waters, and;
6. Degradation of groundwater quality.

5.1. Groundwater Elevations and Interpretation

As discussed in Chapter 4 (Basin Setting), information from available boring logs indicates that there is no regional or laterally extensive aquitard separating the Alluvial Aquifer, Paso Robles Formation aquifer, and Pismo Formation aquifer in the Basin. In the San Luis Valley, a physical distinction between Alluvium and Paso Robles Formation is often not apparent, and information from well completion reports in the Basin indicate that wells are regularly screened across productive strata in both formations, which effectively function as a single hydrogeologic unit. Likewise, in the Edna Valley, information from well completion reports indicates that wells are routinely screened across productive strata in both the Paso Robles Formation Aquifer and the Pismo Formation Aquifer, which effectively function as a single hydrogeologic unit. Boyle states that there is no strict boundary between the Alluvial Aquifer and the Paso Robles Formation Aquifer in the Buckley Road area (Boyle Engineering, 1991). DWR states that all the sediments in the Subbasin are in hydraulic continuity. Because there is no available groundwater elevation data specific to the three individual aquifers, and because these formations appear to function as combined hydrogeologic units, groundwater elevation data are combined and presented as a single groundwater elevation map for each time period presented (DWR, 1997).

In general, the primary direction of groundwater flow in the Basin is from the area of highest groundwater elevations in the Edna Valley northwestward toward San Luis Obispo Creek, where the flow leaves the Basin along the stream course. Groundwater in the northwestern areas of the Basin near the City of San Luis Obispo boundary and Los Osos Valley Road flows southeastward toward the San Luis Obispo Creek alluvium. In the southeastern portion of the Basin there are also local areas of flow discharging from the Basin along Pismo Creek tributaries of East and West Corral de Piedras Creek, and alluvium of other smaller tributaries further to the south. Groundwater Elevation maps for various recent and historical time periods are presented and discussed in the following sections.

5.1.1. Fall 1954 Groundwater Elevations

DWR published a series of maps depicting groundwater elevations for various basins in the County, including groundwater elevations in the San Luis Obispo Valley Groundwater Basin for fall 1954 (Figure 5-1), with contours based on field measurements of over 40 control points in the Basin (DWR, 1958). Groundwater flow direction arrows were added to Figure 5-1 to illustrate the primary direction of flow in the Basin. This is the oldest Basin-wide groundwater elevation data available. In the Los Osos Valley portion of the Basin, this map displays dominant groundwater flow direction from higher elevations in the in the northwestern extent of the Basin southeastward toward the discharge area where San Luis Obispo Creek leaves the Basin. The hydraulic gradient (the ratio of horizontal distance along the groundwater flow path to the change in elevation) in this area is approximately 0.004 feet/feet (ft/ft). In the Edna Valley portion of the Basin, the dominant groundwater flow direction is northwestward from the higher groundwater elevations in the southeastern part of the Basin (over 280 ft AMSL) to lower elevations (less than 110 feet AMSL) where San Luis Obispo Creek exits the Basin. The gradient across this area is steeper than in Los Osos Valley, approximately 0.009 ft/ft. This map also displays local areas of discharge coincident with the areas where San Luis Obispo Creek and Pismo Creek tributaries leave the Basin.

5.1.2. Spring 1990 Groundwater Elevations

Boyle (1991) presents water level elevation contour maps for the spring of 1986 and 1990, based on water level data collected from 18 control points in the field. A digitized recreation of the Boyle groundwater elevation contours for spring of 1990 is presented in Figure 5-2 and displays patterns of groundwater flow direction in the Basin similar to those exhibited in the DWR 1954 map, although the flow gradient does not appear to be as steep as it is in the 1954 map. The year 1990 was in the midst of a significant period of drought in the Basin. The northwestward gradient across the central area of the Basin is approximately 0.006 ft/ft. Contours for the spring of 1986 are not re-presented in this report, but 1986 represents wetter conditions than the 1990 map, and it is noted in Boyle (1991) that there is a difference of approximately 10 feet of elevation between the two maps, representing the variation in water levels observed between wet and dry weather cycles in this time period. The contours in Figure 5-2 do not display an area of discharge where Corral de Piedras Creeks leave the Basin, but this is likely due to a lack of control points in this area.

5.1.3. Modeled 1990s Groundwater Elevations

In its draft report, DWR (1997) used a computer groundwater model to generate a series of modeled water level maps representing wet, dry, and average weather conditions. The model results are not re-presented in this GSP, but a review of the draft report indicates the maps display the same general flow direction patterns as the DWR (1958) and Boyle (1991) maps, which were based on data collected in the field. Water level elevations in the San Luis Valley in wet years were approximately 10 to 20 feet higher than in dry years. In the Edna Valley, the difference in groundwater elevations between wet and dry years was greater, approximately 20 to 30 feet.

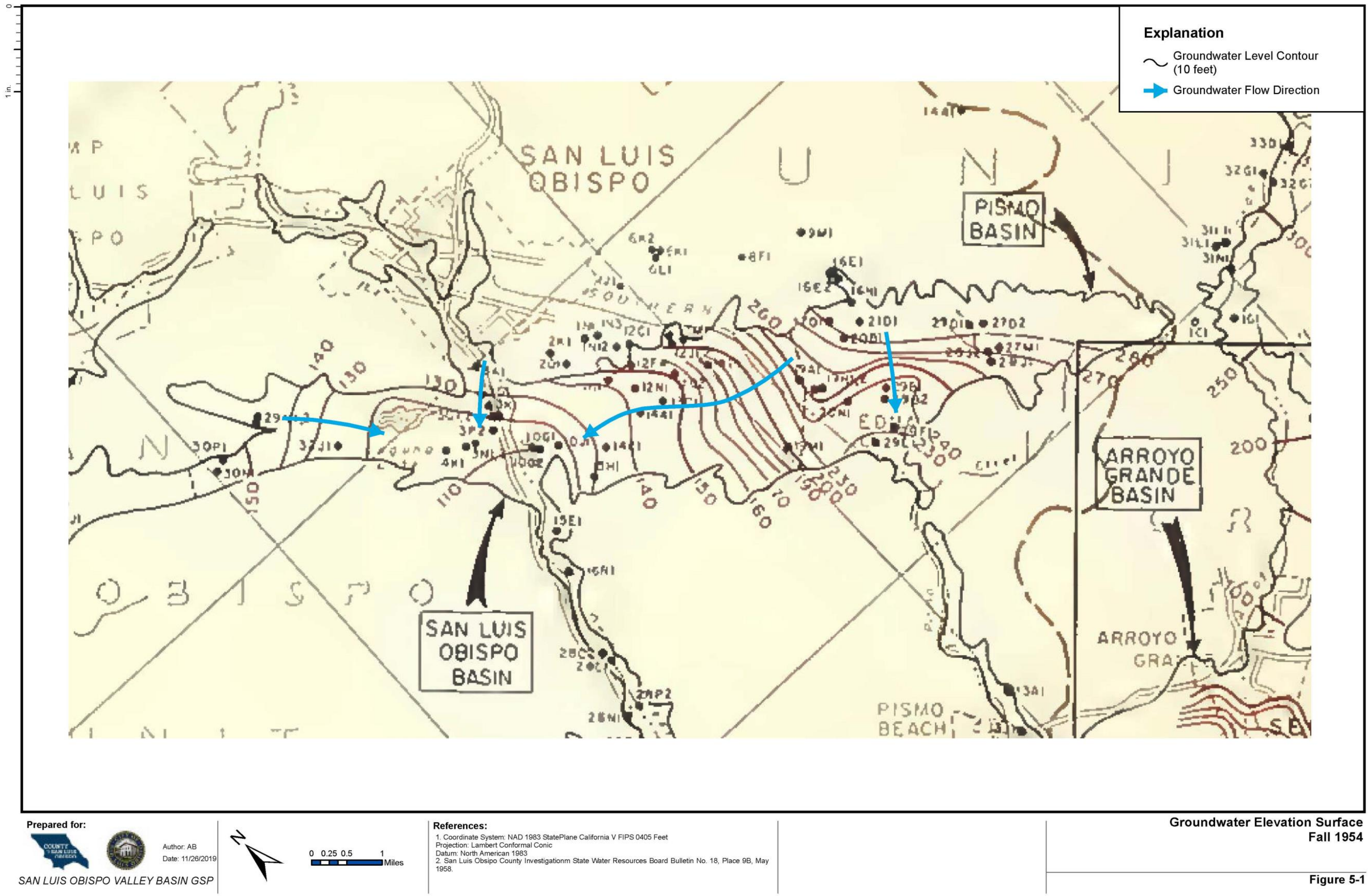


Figure 5-1. Groundwater Elevation Surface Fall 1954

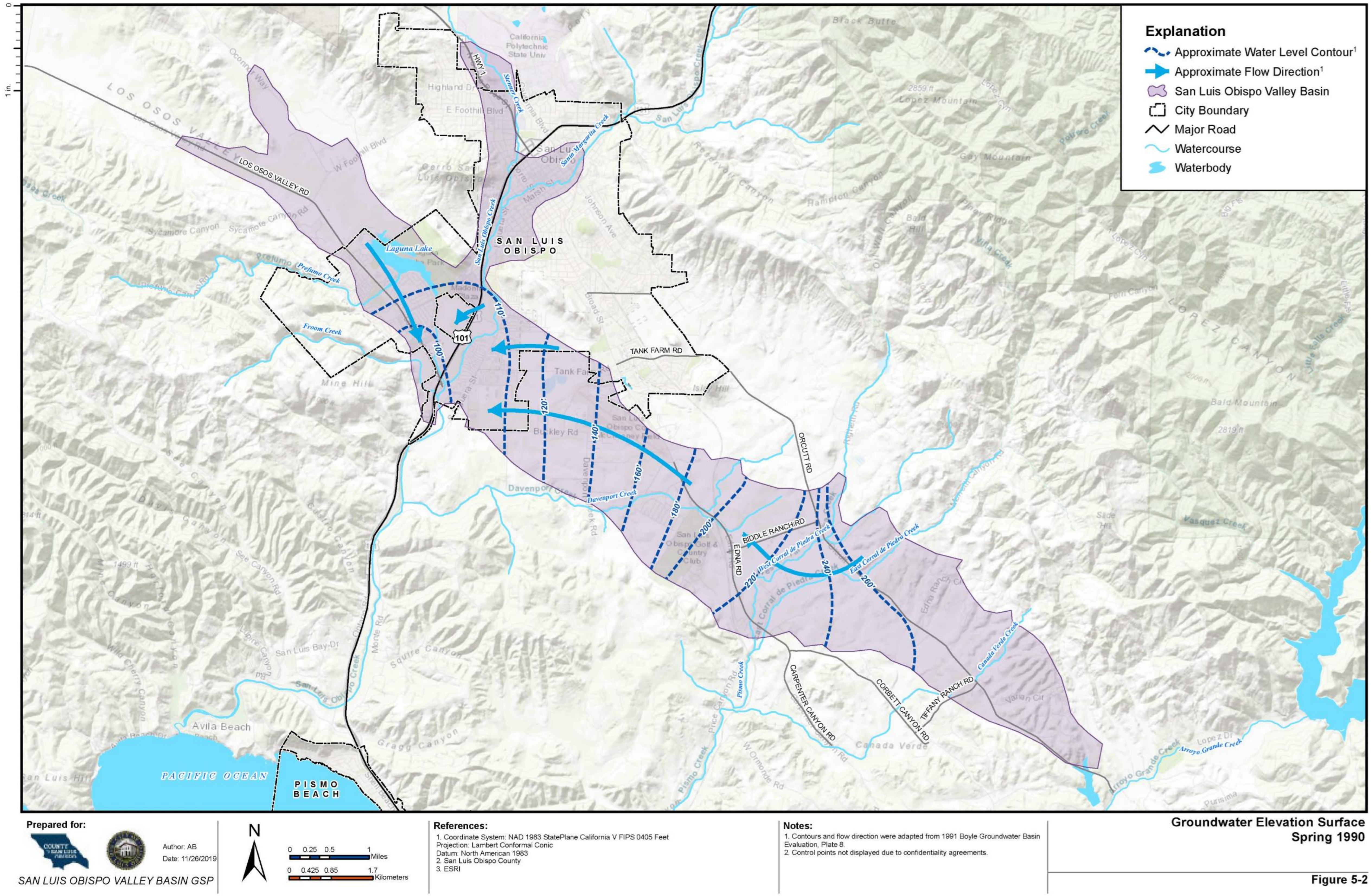


Figure 5-2. Groundwater Elevation Surface Spring 1990

5.1.4. Spring 1997 Groundwater Elevations

More recent groundwater level data collected as a part of San Luis Obispo County's groundwater monitoring program were obtained and used to generate groundwater elevation maps to evaluate more recent conditions. The following assessment of groundwater elevation conditions is based primarily on data from the San Luis Obispo County Flood Control and Water Conservation District's (SLOFCWCD) groundwater monitoring program. Groundwater levels are measured through a network of public and private wells in the Basin. Figure 5-33 through Figure 5-7 presents the contours generated from the data for the Spring 1997, Spring 2011, Spring 2015, Spring 2019, and Fall 2019 monitoring events.

The set of wells used in the groundwater elevation assessment were selected based on the following criteria:

- The wells have groundwater elevation data for the periods of record of interest;
- Groundwater elevation data were deemed representative of static conditions.

Additional information on the monitoring network is provided in Chapter 7(Monitoring Networks).

Based on available data, the following information is presented in subsequent subsections.

- Groundwater elevation contour maps for spring 1997, 2011, 2015, 2019, and Fall 2019;
- A map depicting the change in groundwater elevation between 1997 and 2011;
- A map depicting the change in groundwater elevation between 2011 and 2015;
- A map depicting the change in groundwater elevation between 2015 and 2019;
- Hydrographs for select wells with publicly available data.

Figure 5-33 presents a groundwater surface map for Spring 1997 based on field data collected by the SLOCFCWCD (control points are not displayed to maintain confidentiality agreements negotiated with well owners). The southeast (near Lopez Lake) and northwest (Los Osos Valley) areas of the Basin had no wells monitored during these events to calculate water levels, so contours are not presented for those areas. Several features on this map are apparent. First, a pronounced groundwater mound is evident at the location where West Corral de Piedras Creek enters the Basin in Edna Valley, near the corner of Biddle Ranch Road and Orcutt Road; three control points are present in this area, providing reliable documentation for water levels in this vicinity. This indicates that this is a groundwater recharge area. The regional northwesterly flow direction apparent in the previously discussed water level maps is still evident here; the groundwater flow gradient is about 0.011 ft/ft, somewhat steeper than the Spring 1990 gradient presented by Boyle.

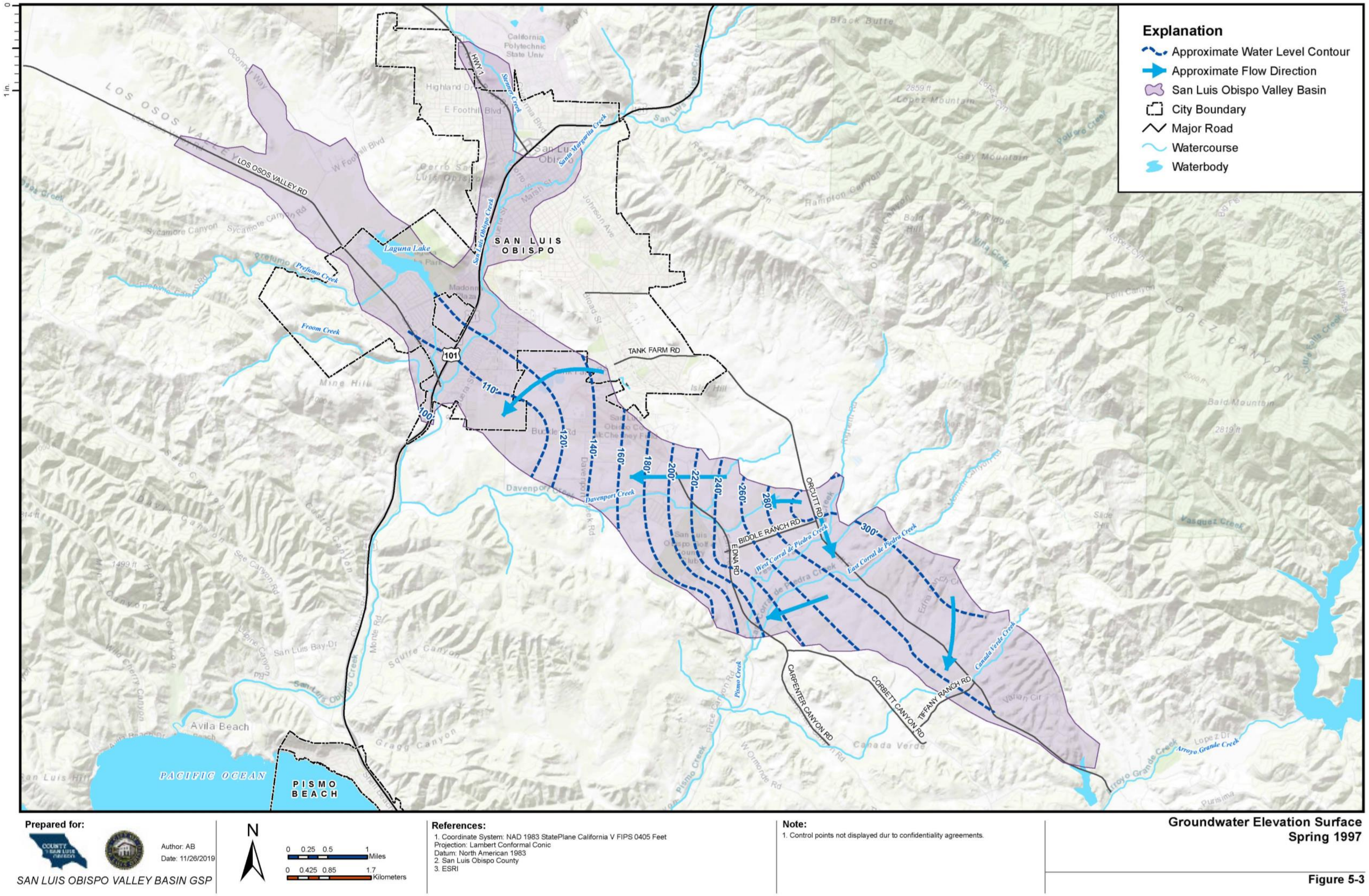


Figure 5-3 Groundwater Elevation Surface Spring 1997

5.1.5. Spring 2011 Groundwater Elevations

Spring 2011 represents a time period just prior to the recent drought, but after the expansion of agricultural pumping in Edna Valley, as discussed further in Chapter 6 (Water Budget). As such, effects of the recent drought should not yet be apparent, but reduced groundwater levels due to expanded agricultural pumping should be evident.

Figure 5-4 displays groundwater elevation contours for Spring 2011. The groundwater mound near Biddle Ranch Road and Orcutt Road is again evident, with a maximum groundwater elevation of over 320 feet. Groundwater flow direction appears to indicate areas of discharge from the Basin in Edna Valley along Corral de Piedras Creeks and Canada Verde Creek, and along San Luis Obispo Creek in San Luis Valley. The area near Edna Road and Biddle Ranch Road indicates a steep local gradient, likely associated with local pumping. The contour near the exit of Corral de Piedras Creeks is 180 feet. The gradient across the central Basin is almost identical to the Spring 1997 map, about 0.011 ft/ft. The gradient is much shallower in the San Luis Valley part of the Basin.

5.1.6. Spring 2015 Groundwater Elevations

Figure 5-5 presents groundwater elevation contours for Spring 2015. Spring 2015 represents a time period in the midst of the recent drought, and after the expansion of agricultural pumping in Edna Valley.

The effects of the drought are apparent upon close inspection of the contours in Figure 5-5. In the Edna Valley, the maximum contour of the recharge area near Orcutt Road and Biddle Ranch Road is 280 feet, about 40 feet lower than in the Spring 2011 map. The contours immediately west of the mound are still steep, but flatten out significantly along Davenport Creek, resulting in a much shallower gradient in this area than in the Spring 2011 map. Contours east of the mound along Orcutt Road are 20 to 40 feet lower than in the Spring 2011 map. In the San Luis Valley, a 100-foot contour is evident near the exit of San Luis Obispo Creek from the Basin, which is about 10 feet lower than the contour in the Spring 2011 map.

5.1.7. Spring 2019 Groundwater Elevations

Figure 5-6 presents a groundwater surface elevation map for Spring 2019. Spring 2019 represents a time period at the end of seasonal winter rains, and after the end of the recent drought. Rebounds of groundwater elevations from the drought are apparent upon inspection of the contours. In the Edna Valley, the maximum contour of the recharge area near Orcutt Road and Biddle Ranch Road is 300 feet, about 20 feet higher than in the Spring 2015 map. Contours east of the mound are about 20 feet higher than in the Spring 2015 map. Contours along Davenport Creek are about 20 feet higher than in the Spring 2015 map. The elevation at Edna Road and Biddle Ranch Road is about 230 feet, over 50 feet higher than in the Spring 2015 map.

5.1.8. Fall 2019 Groundwater Elevations

Figure 5-7 presents a groundwater surface elevation map for Fall of 2019. This time period represents recent conditions at the end of the summer dry season for comparison against the spring conditions. Overall, the contours indicate lower groundwater levels than those displayed in the Spring 2019 map. Groundwater contours east of the recharge mound at West Corral de Piedras are about 20 feet lower than the Spring 2019 map. The groundwater elevation at Edna Road and Biddle Ranch Road is about 220 feet, approximately 10-20 feet lower than in the Spring 2019 map.

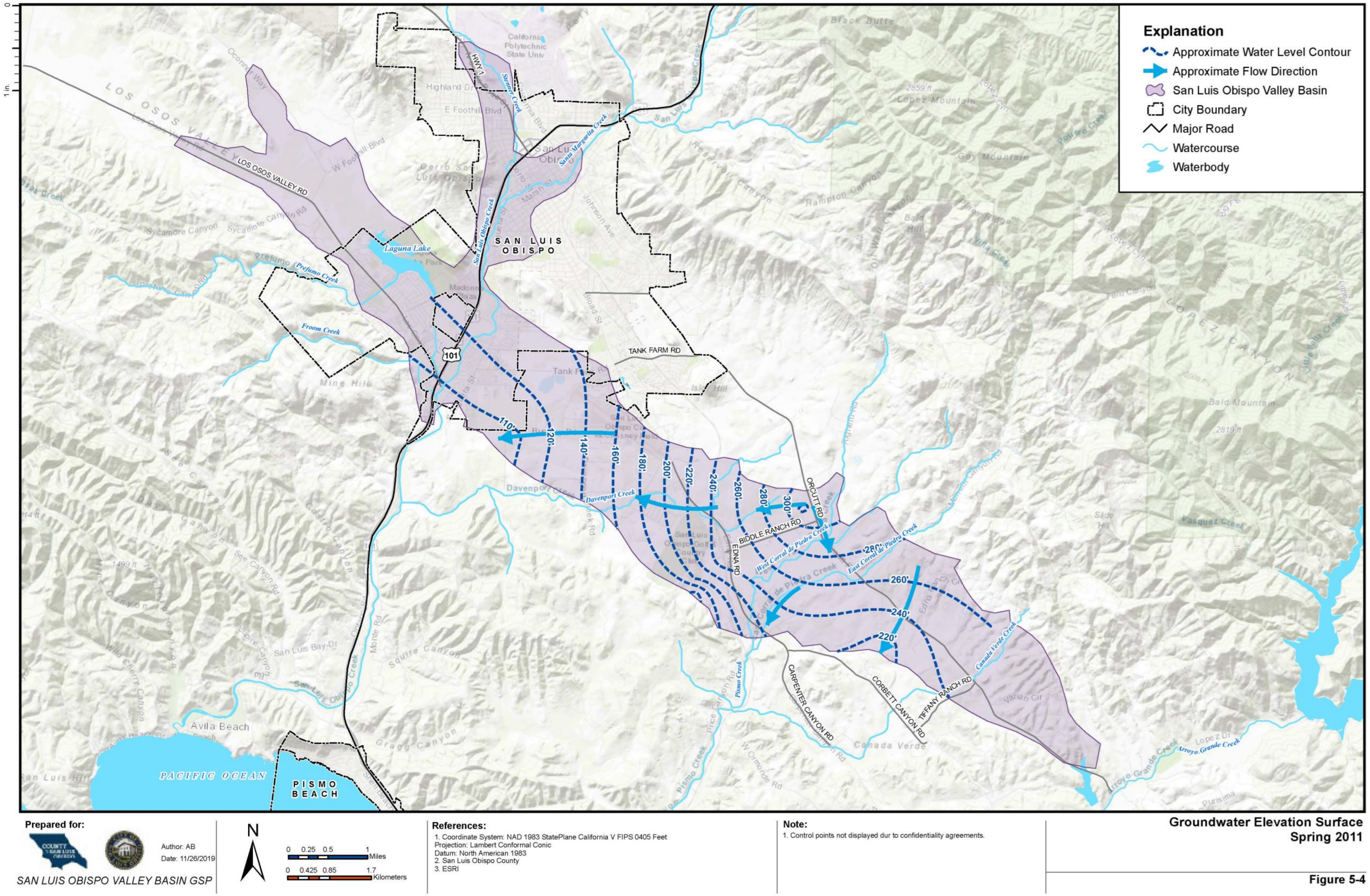


Figure 5-4 Groundwater Elevation Surface Spring 2011

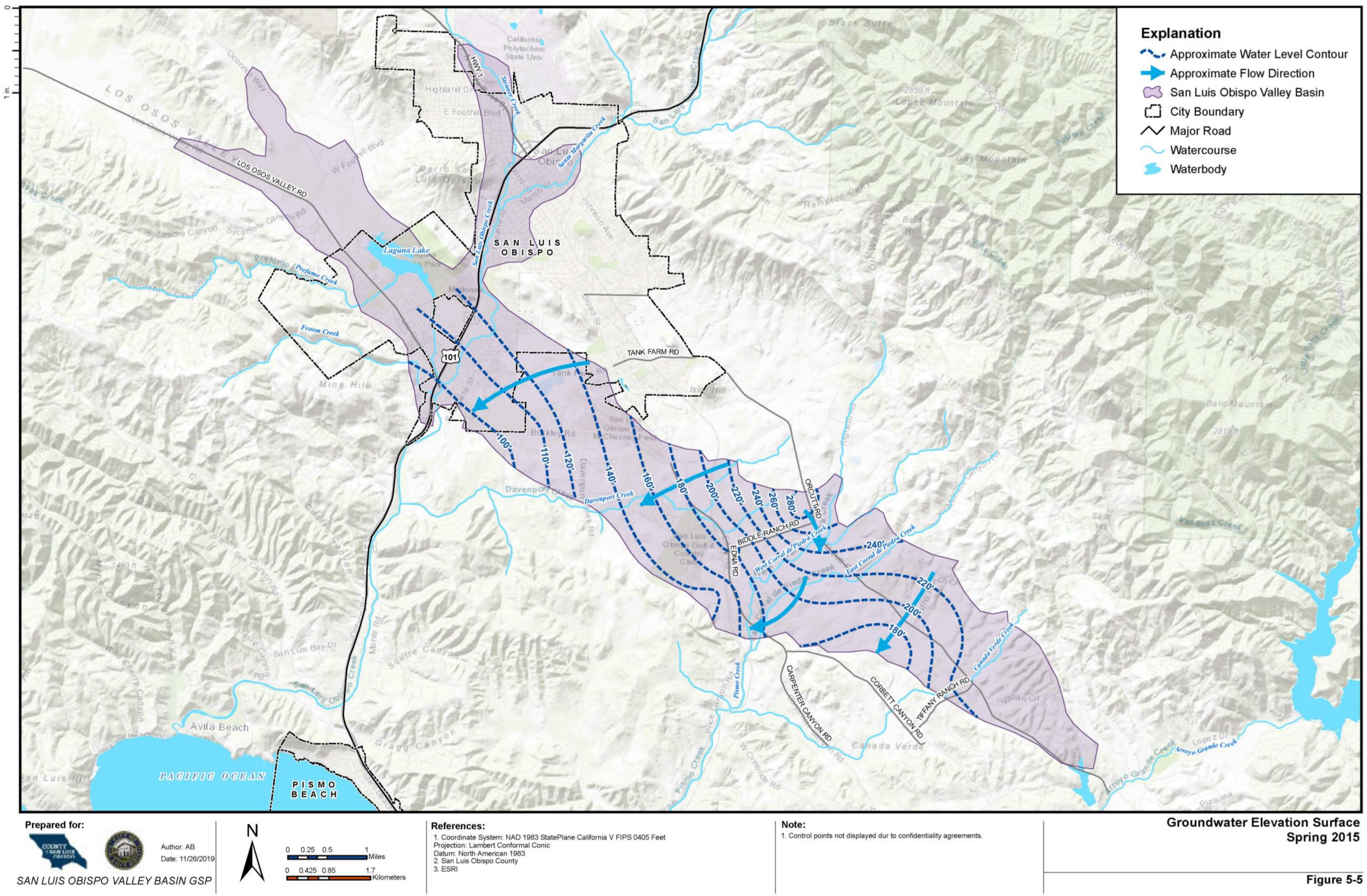


Figure 5-5 Groundwater Elevation Surface Spring 2015

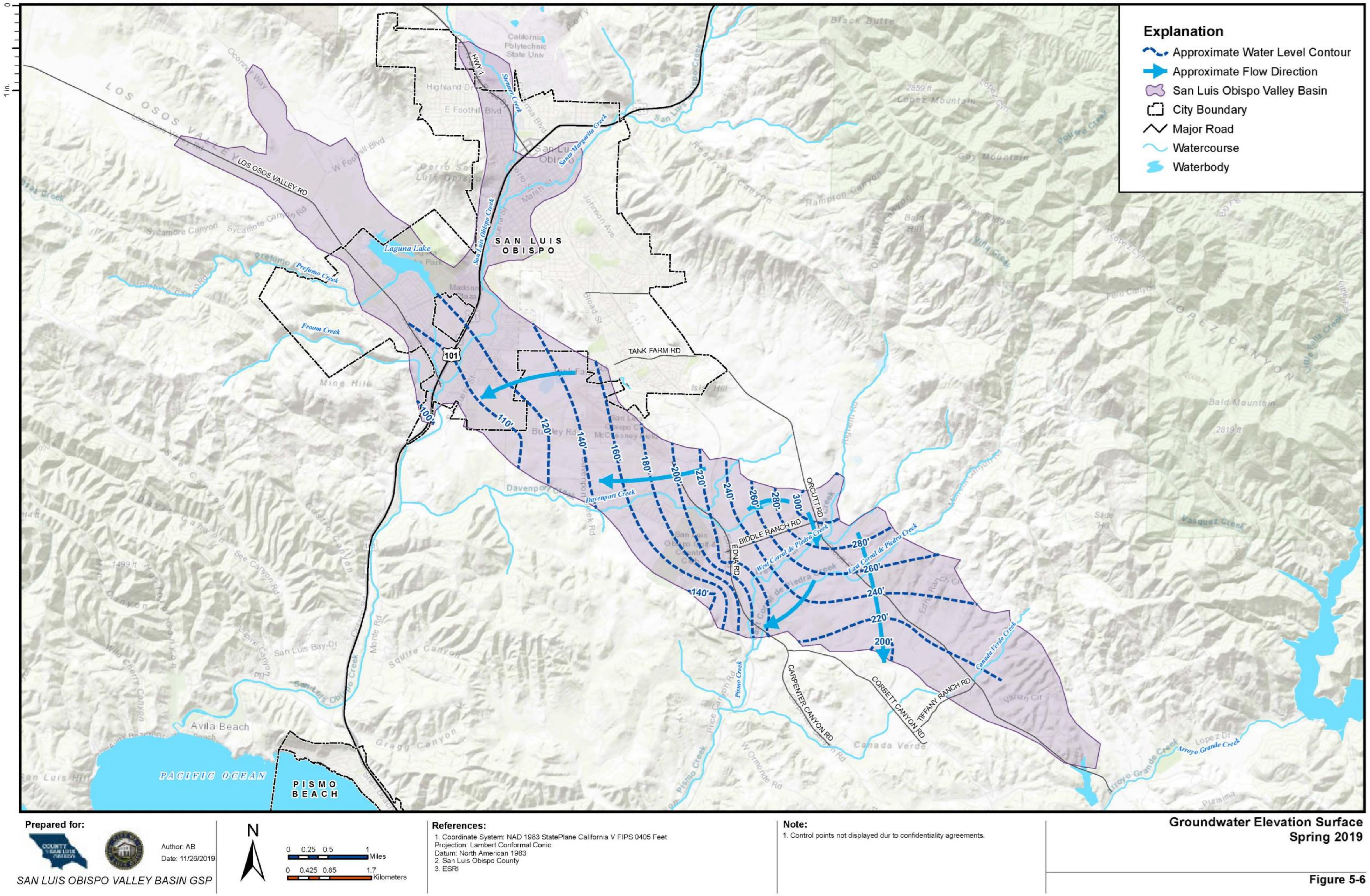


Figure 5-6 Groundwater Elevation Surface Spring 2019

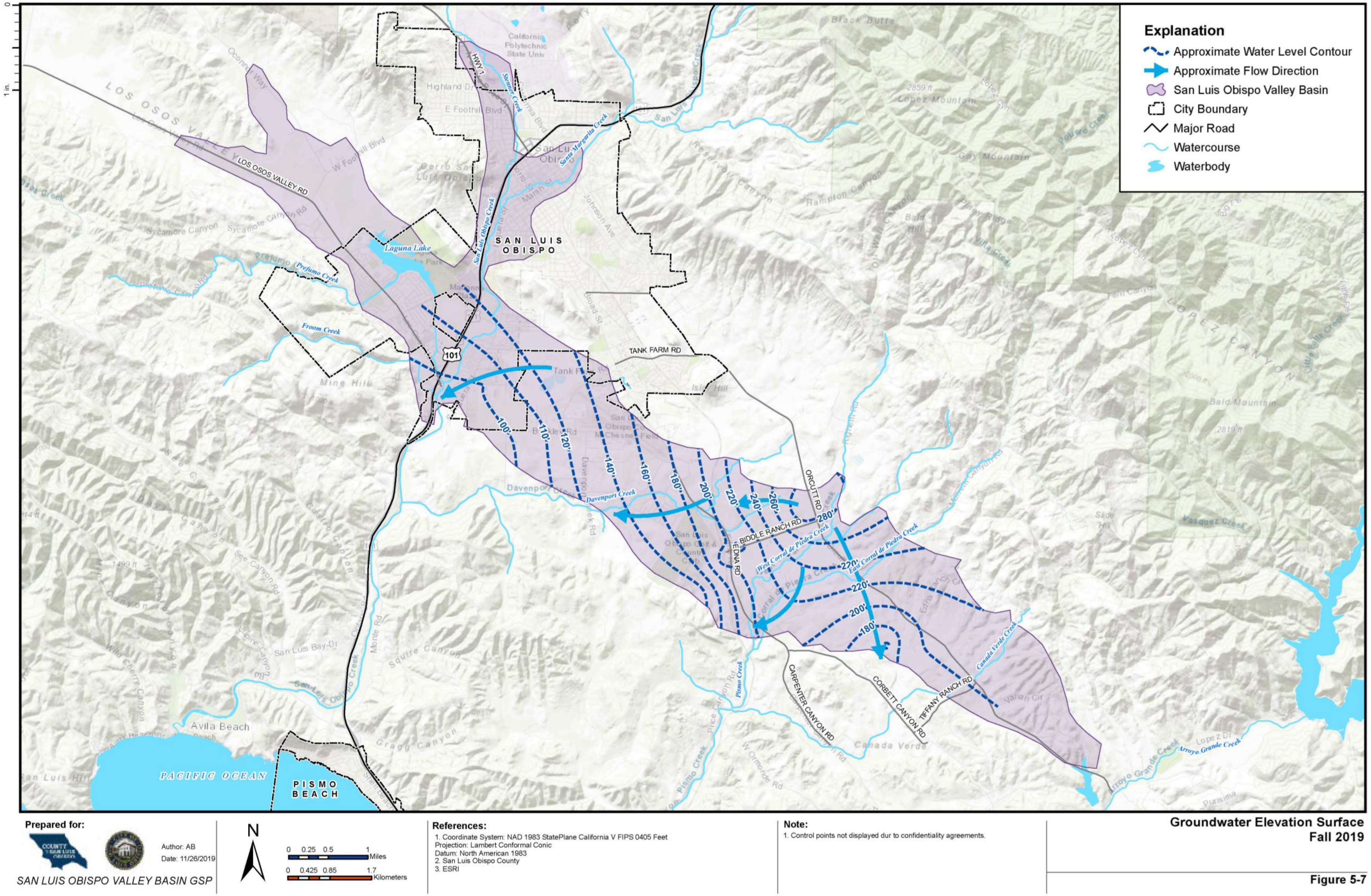


Figure 5-7 Groundwater Elevation Surface Fall 2019

5.1.9. Changes in Groundwater Elevation

In order to demonstrate how groundwater elevations have varied over the recent history of the Basin, a series of maps were generated that display changes in groundwater elevation. These maps were developed by comparing groundwater elevations from one year to another and calculating the differences in elevation over the specified time period. It should be noted that the results of this analysis are largely dependent on the density of data points, and should be viewed as indicative of general trends, not necessarily as accurate in specific areas where little data is available.

The first time period selected compares changes in groundwater elevation from 1997 through 2011. The year 1997 was selected as a starting point because it is assumed to represent conditions prior to the significant expansion of agricultural groundwater pumping in the Basin. The year 2011 was selected as the end point because it represents conditions prior the start of the recent drought. Calculated changes in groundwater elevation over this 14-year period are presented in Figure 5-88. This figure indicates a maximum decline in groundwater elevation of over 60 feet in the Edna Valley, southeast of East Corral de Piedras Creek between Orcutt Road and Corbett Canyon Road. The calculated groundwater elevation shows declining groundwater levels to the northwest of this location. No significant declines are indicated northwest of Biddle Ranch Road over this time period.

The next time period selected compares changes in groundwater elevation from 2011 through 2015. This time period was selected to capture the start of the drought to a point four years into the drought, thereby capturing the period of greatest groundwater elevation change. Calculated changes in groundwater elevation over this 4-year period are presented in Figure 5-99. This figure indicates a maximum decline in groundwater elevation of over 80 feet located in the Edna Valley, near the intersection of Edna Road and Biddle Ranch Road. The calculated reductions in groundwater elevation decline in all directions from this location. No significant declines are indicated in the San Luis Valley portion of the Basin over this time period.

The next time period selected compares changes in groundwater elevation from 2015 through 2019. This time period was selected to capture the potential recovery of the Basin following the drought. Calculated changes in groundwater elevation over this 3-year period are presented in Figure 5-10. Groundwater elevations are shown to have rebounded throughout the entire area in which data was available. The greatest increase in groundwater elevation is coincident with the area of greatest declines from 2011-2015, near the intersection of Edna Road and Biddle Ranch Road.

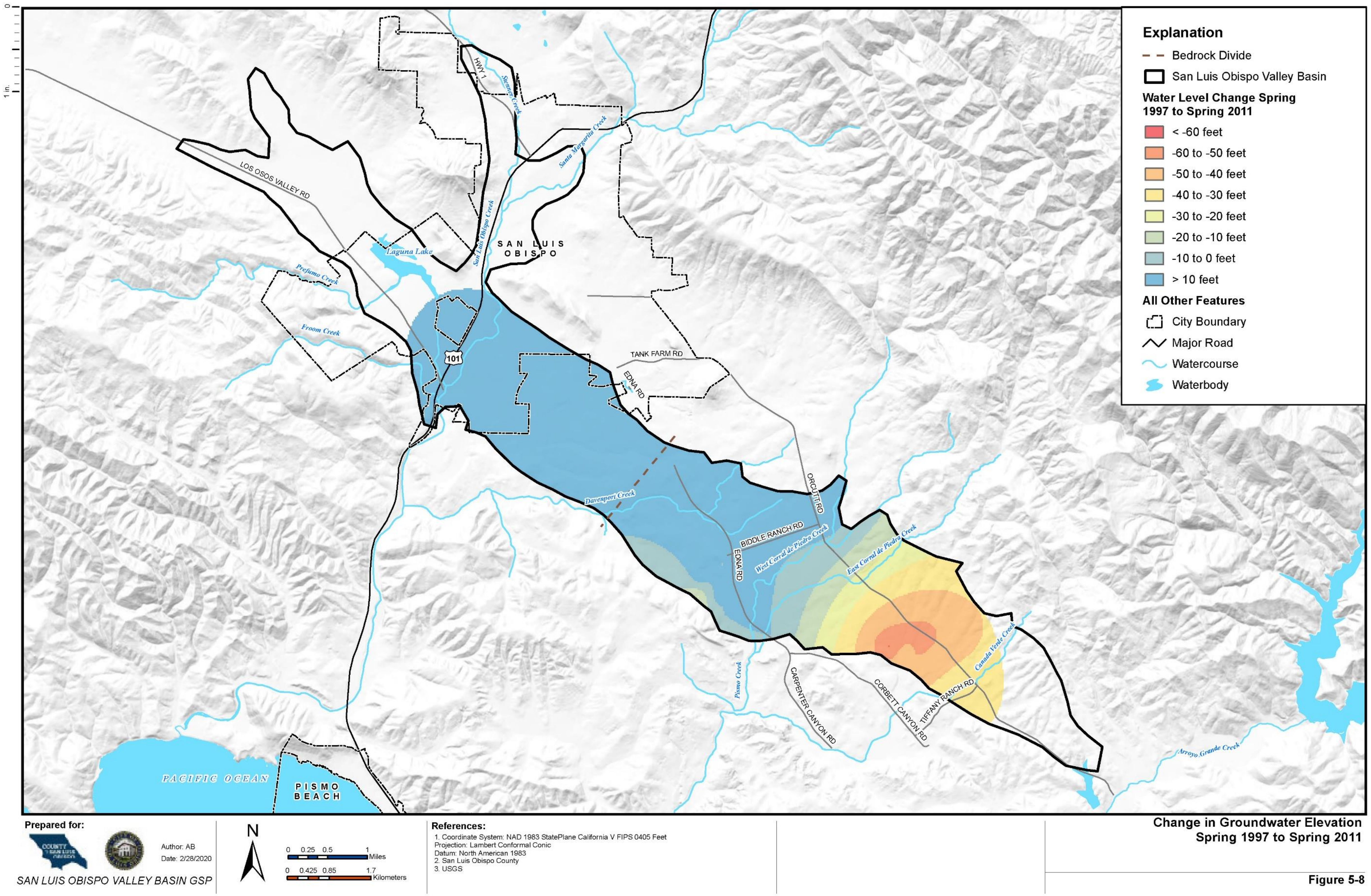


Figure 5-8 Change in Groundwater Elevation Spring 1997 to Spring 2011

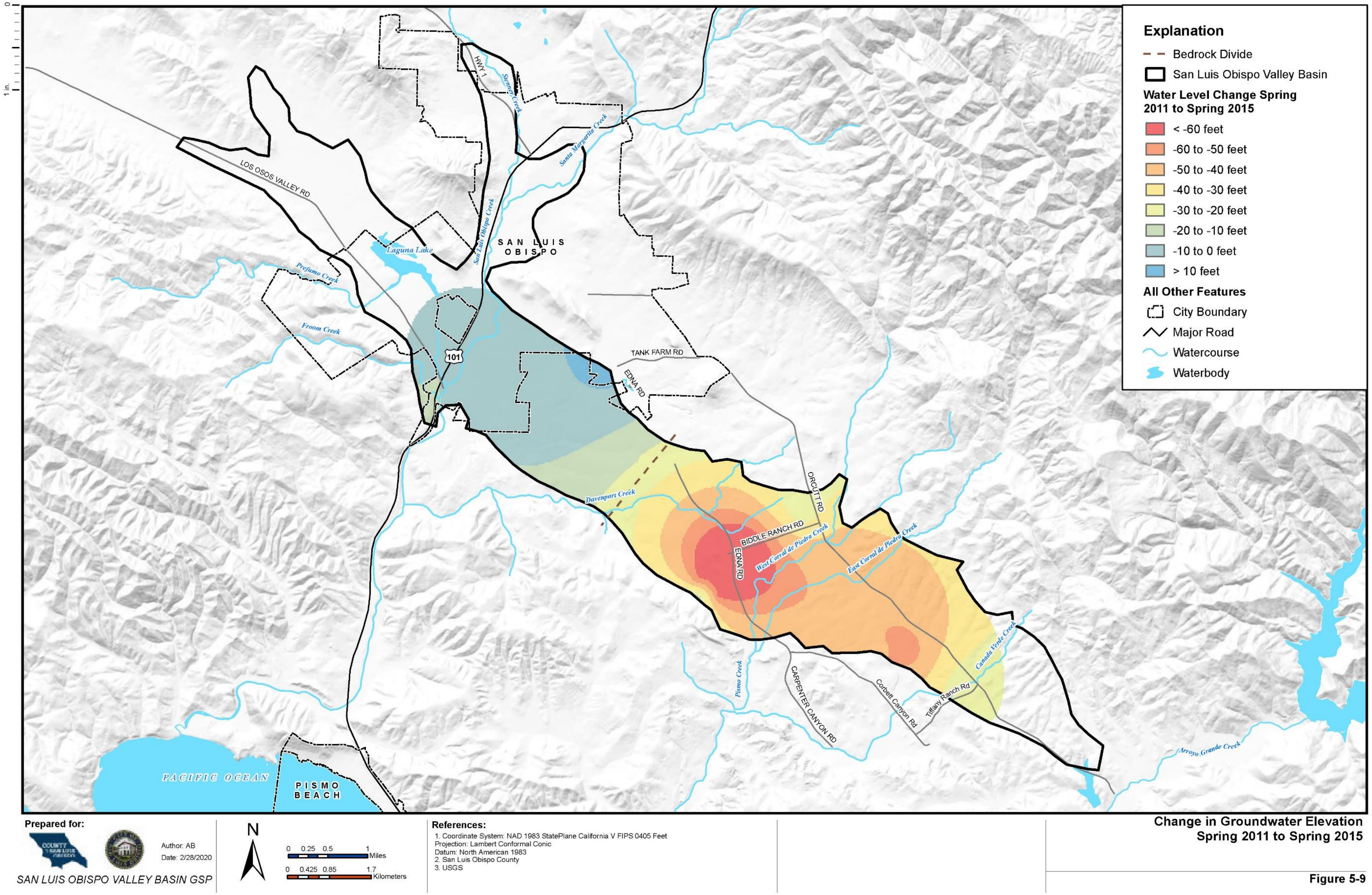


Figure 5-9 Change in Groundwater Elevation Spring 2011 to Spring 2015

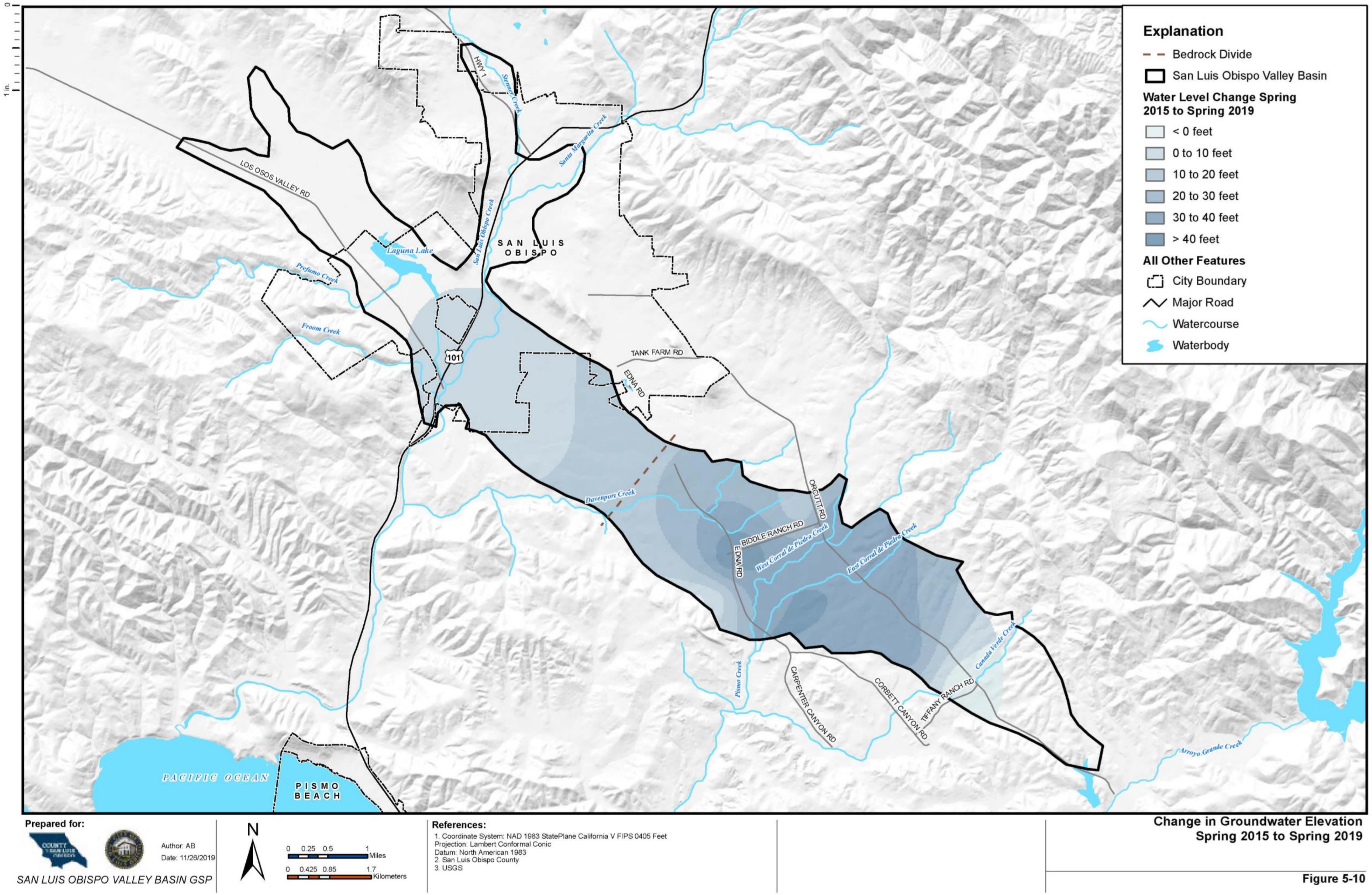


Figure 5-10. Change in Groundwater Elevation Spring 2015 to Spring 2019

5.1.10. Vertical Groundwater Gradients

Vertical groundwater gradients are calculated by measuring the difference in head at a single location between specific and distinct strata or aquifers. The characterization of vertical gradients may have implications with respect to characterization of flow between aquifers, migration of contaminant plumes, and other technical details describing groundwater flow in specific areas. In order to accurately characterize vertical groundwater gradient, it is necessary to have two (or more) piezometers sited at the same location, with each piezometer screened across a unique interval that does not overlap with the screened interval of the other piezometers(s). If heads at one such piezometer are higher than the other(s), the vertical flow direction can be established since groundwater flows from areas of higher heads to areas of lower heads. However, because such a “well cluster” must be specifically designed and installed as part of a broader investigation, limited data exists to assess vertical groundwater gradients. Previous hydrologic studies of the Basin, (Boyle Engineering, 1991) (DWR, 1997), indicate that groundwater elevations are generally higher in the Alluvial Aquifer than the underlying Paso Robles Formation Aquifer, resulting in groundwater flow from the Alluvial Aquifer to the underlying Paso Robles Formation aquifer (although this may change seasonally). The lack of nested or clustered piezometers to assess vertical gradients in the Basin is a data gap that is discussed further in Chapter 7 (Monitoring Network).

There are no paired wells that provide specific data comparing water levels in wells screening the bedrock and the Basin sediments. However, from a conceptual standpoint, the Monterey Formation is assumed to receive rainfall recharge in the surrounding mountains at higher elevations than the Basin sediments. For this reason, it is assumed that an upward vertical flow gradient exists between the bedrock and the overlying Basin sediments. Because the bedrock formations are significantly less productive than the Basin sediments, the rate of this flux is not expected to be significant.

5.2. Groundwater Elevation Hydrographs

The San Luis Valley and the Edna Valley are characterized by different patterns of groundwater use. In the San Luis Valley, groundwater use has been dominated by municipal and industrial use, with total groundwater use decreasing since the 1990s, as the City has diversified its surface water supplies, and placed most of its wells on standby status. During this time several in-City agricultural operations have also been developed into housing and commercial districts and now rely on the City’s surface water supplies in place of groundwater pumping. In the Edna Valley, groundwater use is dominated by agricultural use, with total use increasing since the 1990s. During the past 15 to 20 years, wine grapes have supplanted other crop types (such as pasture grass and row crops) as the dominant agricultural use within the Edna Valley. Available water level data was reviewed, and data from wells with the longest period of record are presented in Figure 5-11 and discussed in this section. Most of the data was obtained from the County’s groundwater monitoring network database.

Figure 5-11 presents groundwater elevation hydrographs for the ten wells throughout the Basin with the longest period of record. State well identification numbers are not displayed for reasons of owner confidentiality. Three distinct patterns are evident in different areas of the Basin and are discussed below.

The hydrographs for the wells in the San Luis Valley indicate that water levels in these wells, although somewhat variable in response to seasonal weather patterns, water use fluctuations, and longer-term dry weather periods, are essentially stable. There are no long-term trends indicating steadily declining or increasing water levels in this area. The wells along Los Osos Valley Road (hydrographs 1 and 2 on Figure 5-11) display fluctuations within a range of less than 20 feet over a period of record from the late 1950s to the mid-1990s. This period includes the drought of the late 1980s to early 1990s. The well just west of the intersection of Tank Farm Road and Orcutt Road (hydrograph 4 in Figure 5-11) displays a similar pattern, with water level variations within a range of about 10 feet from 1965 to 2013. The wells in the vicinity of Highway 101 and Los Osos Valley Road (hydrograph 3 in Figure 5-11) also display water levels in relative equilibrium, with the exception of the early 1990s, when drought-related pumping and weather patterns resulted in noticeable declines in the water level in this well. These water levels recovered to their pre-drought levels by the mid-1990s. The long-term stability of groundwater elevations in these hydrographs indicates that groundwater extractions and natural discharge in the areas of these wells are in approximate equilibrium with natural recharge and subsurface capture, and that no trends of decreasing groundwater storage are evident.

A second distinct pattern is evident in hydrographs from wells in the area immediately east of the intersection of Biddle Ranch Road and Orcutt Road, where West Corral de Piedras Creek enters the Basin (hydrographs 5 and 6 in Figure 5-11). The hydrographs of the two wells in this area display much greater volatility in response to seasonal and drought cycle fluctuations than the wells in San Luis Valley, with water levels fluctuating within a range of over 40 feet, as opposed to the range of 10 to 20 feet in the San Luis Valley wells. However, water levels appear to rebound to pre-drought levels when each drought cycle ends. Groundwater elevations displayed in these two hydrographs do not display a long-term decline of water levels. This pattern is likely associated with local recharge of the aquifer derived from percolation of stream water in West Corral de Piedras Creek as it leaves the mountains and enters the Basin.

By contrast, several wells in the Edna Valley display steadily declining water levels during the past 15 to 20 years. Hydrographs for four wells (hydrographs 7, 8, 9, and 10 on Figure 5-11) in the Edna Valley display groundwater elevation declines of about 60 to 100 feet since the year 2000. Groundwater elevations in the Edna Valley displayed the largest historical declines in the Basin. This hydrograph pattern indicates that a reduction of groundwater storage has occurred over this period of record in the area defined by these well locations. It is understood and will be discussed in greater detail in Chapter 6 (Water Budget), that agricultural pumping has increased in Edna Valley during this time period, likely explaining the patterns of declining groundwater elevations in these hydrographs.

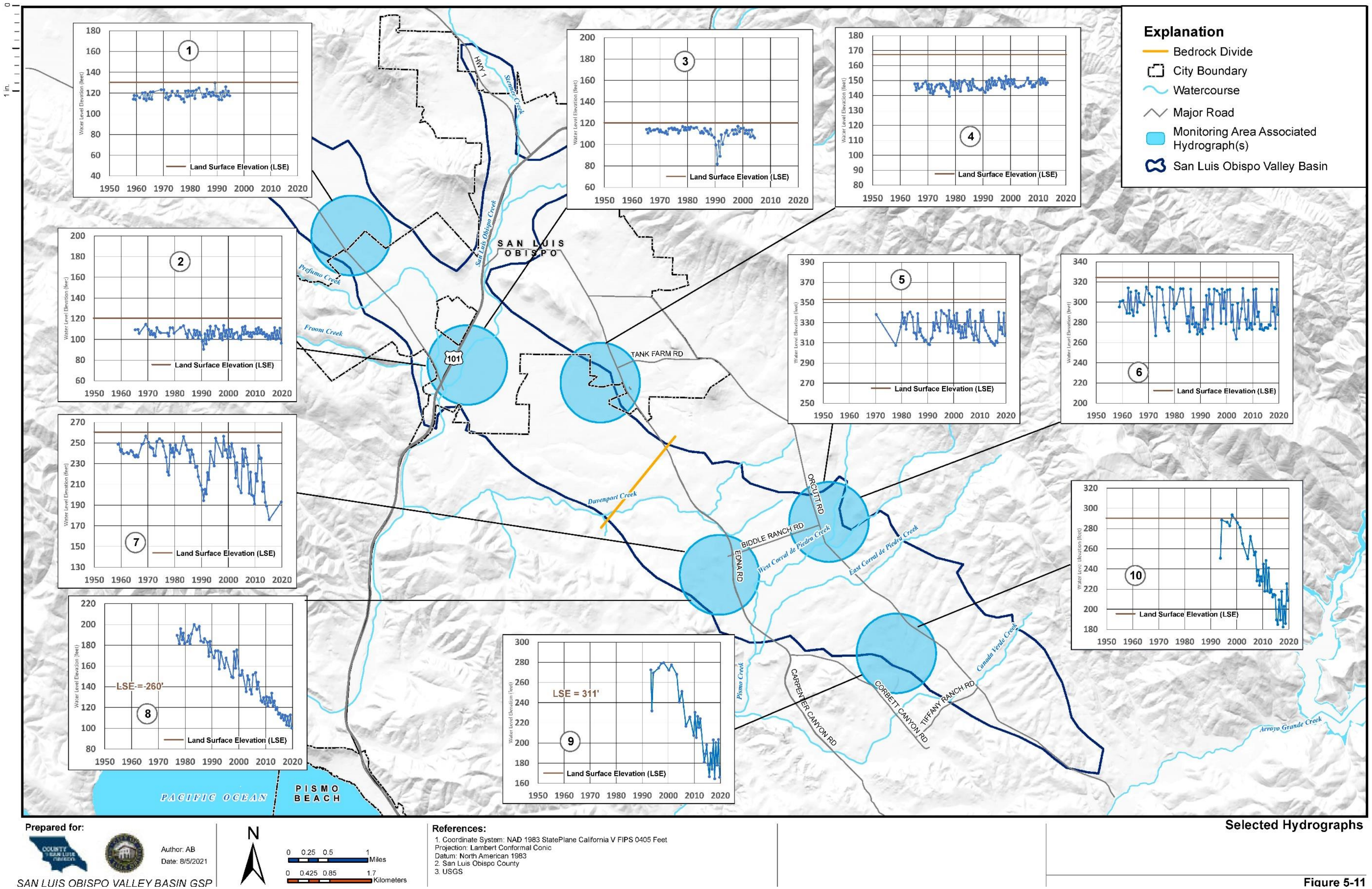


Figure 5-11. Selected Hydrographs

5.3. Groundwater Recharge and Discharge Areas

Areas of significant areal recharge and discharge within the Basin are discussed below. Quantitative information about all natural and anthropogenic recharge and discharge is provided in Chapter 6 (Water Budget).

5.3.1. Groundwater Recharge Areas

In general, natural areal recharge occurs via the following processes:

1. Distributed areal infiltration of precipitation,
2. Subsurface inflow from adjacent "non-water bearing bedrock"
3. Infiltration of surface water from streams and creeks, and
4. Anthropogenic recharge

The following sections discuss each of these components.

5.3.1.1. Infiltration of Precipitation

Areal infiltration of precipitation is a significant component of recharge in the Basin. Water that does not run off to stream or get taken up via evapotranspiration migrates vertically downward through the unsaturated zone until it reaches the water table. By leveraging available GIS data that defines key factors such as topography and soil type, locations with higher likelihood of recharge from precipitation have been identified. These examinations are desktop studies and therefore are conceptual in nature, and any recharge project would need a site-specific field characterization and feasibility study before implementation. Still, although they differ in scope and approach, the results of these studies provide an initial effort at identifying areas that may have the intrinsic physical characteristics to allow greater amounts of precipitation-based recharge in the Basin.

Stillwater Sciences (Stillwater), in cooperation with the Upper Salinas-Las Tablas Resource Conservation District (USLTRCD), published a grant funded study (Stillwater Sciences, 2015) designed to improve data gaps in the County's Integrated Regional Water Management (IRWM) plan. The Percolation Zone Study of Pilot-Study Groundwater Basins in San Luis Obispo County, California identified areas with relatively high natural percolation potential that, through management actions, could enhance local groundwater supplies for human and ecological benefits to the aquatic environment for steelhead habitat. The study used existing data in a GIS analysis to identify potentially favorable areas for enhanced recharge projects in the combined San Luis Obispo Creek and Pismo Creek Watershed. The results of the Stillwater-USLTRCD study are presented in Figure 5-12. The analysis indicates that approximately 2,220 acres in the Basin are categorized with high potential for intrinsic percolation, and 6,583 acres have medium potential. Conceptually, areas with higher potential for intrinsic percolation would transmit a higher percentage of rainfall to aquifer recharge. The largest area in the Basin that is classified with high recharge potential is the alluvium along East and West Corral de Piedras Creeks in the Edna Valley.

The University of California (UC) at Davis and the UC Cooperative Extension published a study in 2015 that also uses existing GIS data to identify areas potentially favorable for enhanced groundwater recharge projects (U.C. Davis Cooperative Extension, 2015). While the Stillwater study focused on local San Luis Obispo stream corridors and emphasized fish habitat conditions, the UC study is statewide in scope includes more than 17.5 million acres, is scientifically peer reviewed, and focuses on the possibilities of using fallow agricultural land as temporary percolation basins during periods when excess surface water is available. The UC study developed a methodology to determine a Soil Agricultural Groundwater Banking Index (SAGBI) to assign an index value to agricultural lands through the state. The SAGBI analysis incorporates deep percolation, root zone residence time, topography, chemical limitations (salinity), and soil surface conditions into its analysis. The results of the SAGBI analysis in the Basin are presented in Figure 5-13. Areas with excellent recharge properties are shown in green. Areas with poor recharge properties are shown in red. Not all land is classified, but similar to the Stillwater map in Figure 5-12, this map provides guidance on where natural recharge likely occurs.

The two studies discussed herein yield similar results in the Basin, particularly in Edna Valley. The Stillwater study identifies much of the drainage area of East and West Corral de Piedras Creeks in the Basin, as well as the alluvium of smaller streams to the southeast, as having high recharge potential. The SAGBI study identifies very similar areas in Edna Valley as having a moderately to good index value. These two studies, with differing methodologies, study areas, and objectives, converge on the characterization of the same portions of Edna Valley as having high natural recharge potential. By extension, areas with high natural recharge potential would be favorable locations to investigate the feasibility of enhanced recharge projects. If source water is available, water in these areas would have a higher likelihood of percolating to the underlying aquifers.

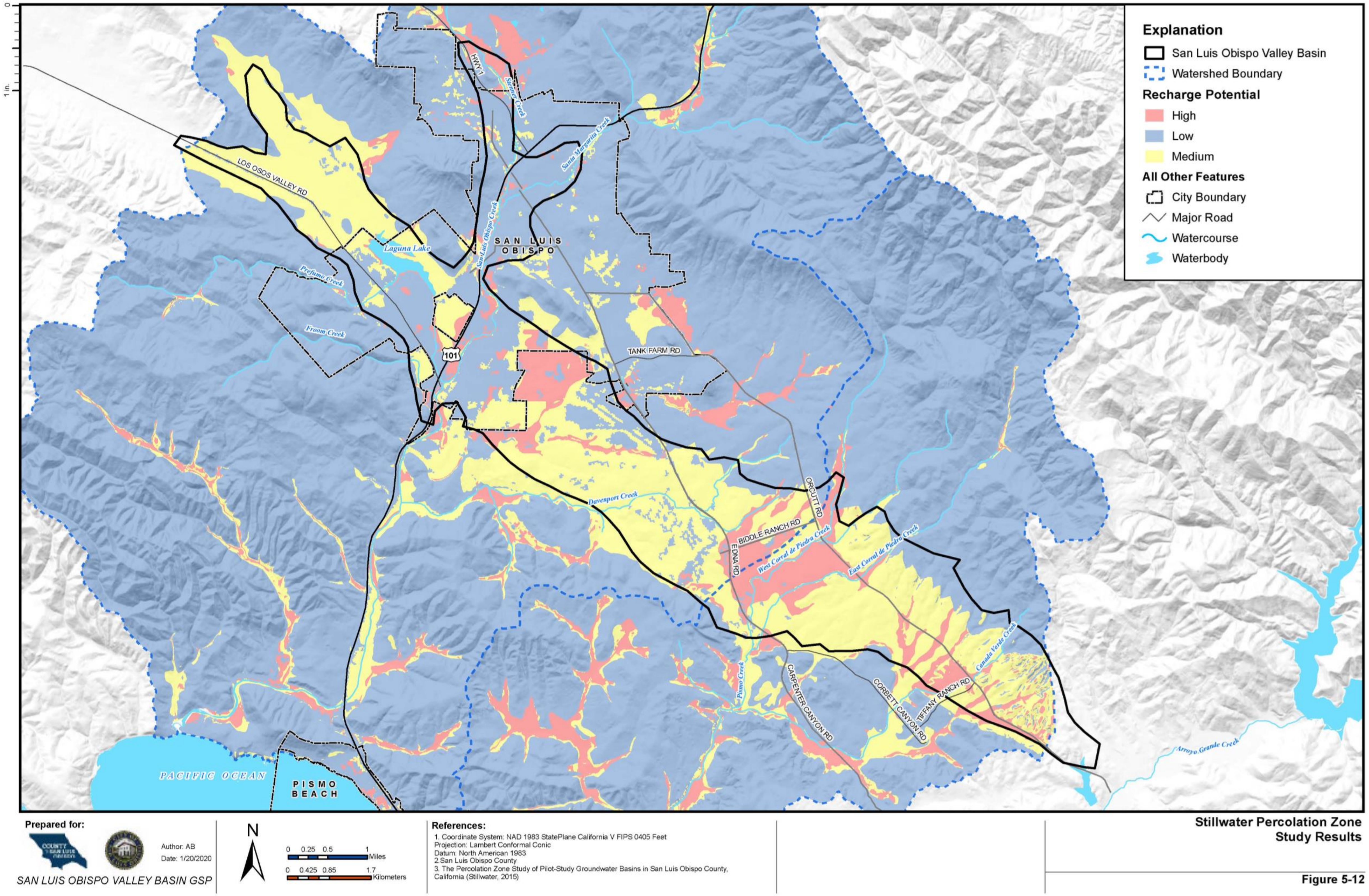


Figure 5-12. Stillwater Percolation Zone Study Results

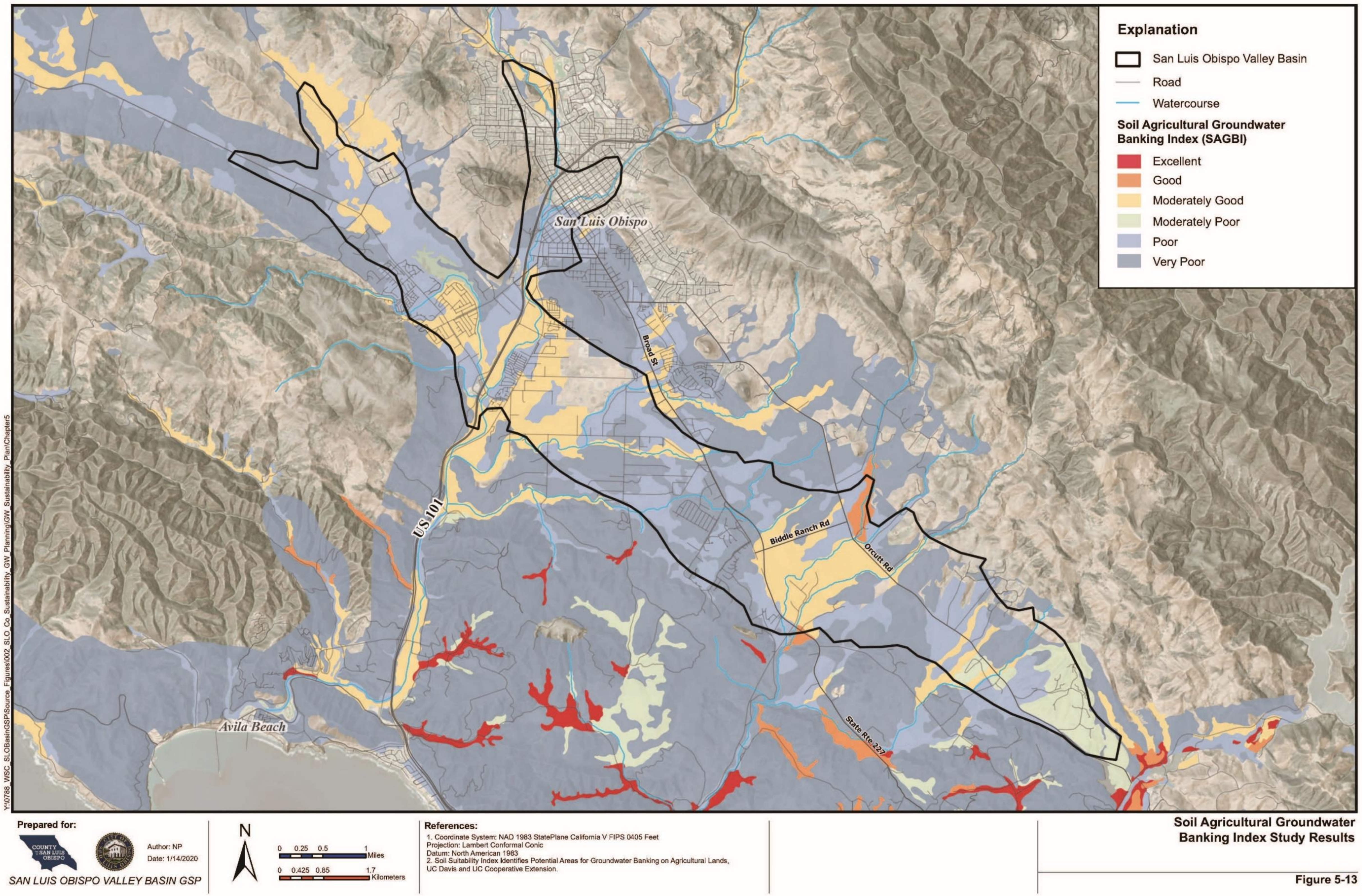


Figure 5-13. Soil Agricultural Groundwater Banking Index Study Results

5.3.1.2. Subsurface Inflow

Subsurface inflow is the flow of groundwater from the surrounding bedrock into the basin sediments. This process is sometimes referred to as mountain front recharge. Groundwater flows from areas of high head to areas of lower head, and water levels in the mountains are at a higher elevation than the Basin. Flow across the basin boundary is predominantly via highly conductive, but random and discontinuous fracture systems. The rate of subsurface inflow to the Basin from the surrounding hill and mountain area varies considerably from year to year depending upon precipitation (intensity, frequency and duration, seasonal totals, etc.) and groundwater level gradients. There are no available published or unpublished inflow data for the hill and mountain areas surrounding the Basin. An estimate of this component of recharge is presented in Chapter 6 (Water Budget).

5.3.1.3. Percolation of Streamflow

Percolation of streamflow is a locally significant source of recharge in areas where the local creeks flow through the Basin. Water levels in wells monitored by the County in the area where Corral de Piedras Creeks flow through the Basin reflect this phenomenon, as discussed in the previous discussion of water level elevations in the Basin. Groundwater recharge from percolation of streamflow is thought to occur in the area along Davenport Creek, near Buckley Road as well. Most wells in this vicinity are on the order of 100 feet deep, which is too deep to be screened only in the local alluvium; these wells are assumed to screen the Paso Robles Formation Aquifer. During the seasonal winter rains when the creeks are flowing, groundwater levels are at approximately the same level as the water in the creek. During the dry season, water levels decrease to about 15 to 20 feet below land surface. Therefore, the alluvium appears to recharge the underlying Paso Robles Formation in this area. It is likely that similar processes contribute to recharge via percolation of streamflow along the San Luis Obispo Creek corridor as well. Specific isolated monitoring of alluvial wells compared to the underlying aquifers' water levels could clarify this recharge component.

5.3.1.4. Anthropogenic Recharge

Significant anthropogenic recharge occurs via the three processes discussed below:

1. Percolation of treated wastewater treatment plant (WWTP) effluent,
2. Percolation of return flow from agricultural irrigation, and
3. Percolation of return flow from domestic septic fields.

A wastewater treatment plant serving the City of San Luis Obispo operates within the Basin on Prado Road along San Luis Obispo Creek. Treated wastewater effluent from this plant is discharged to San Luis Obispo Creek and used in the City's recycled water system for irrigation and construction-related uses. The County operates a small WWTP near the golf course in the service area of Golden State Water Company and uses the effluent largely to irrigate the golf course. Residences in Edna Valley beyond the City or County WWTP service area dispose of wastewater via septic tanks. Water from septic fields can percolate into the underlying aquifers.

Irrigated agriculture is prevalent in the Basin, especially along Los Osos Valley Road and in Edna Valley. Return flows from irrigated agriculture occur when water is supplied to the irrigated crops in excess of the crop's water demand. This is done to avoid excess build-up of salts in the soil and overcome non-uniformity in the irrigation distribution system. These are all general standard practices.

5.3.2. Groundwater Discharge Areas

Natural groundwater discharge occurs as groundwater discharge from the basin into springs, seeps and wetlands, subsurface outflows, and by evapotranspiration (ET) by phreatophytes. Figure 5-16 includes the locations of significant active springs, seeps, and wetlands within or adjacent to the Basin identified from previous studies or included on USGS topographic maps covering the watershed area. There are no mapped springs or seeps located within the Basin boundaries; most are located at higher elevations in the surrounding mountain areas.

Natural groundwater discharge can also occur as discharge from the aquifer directly to streams. Groundwater discharge to streams and potential groundwater dependent ecosystems (GDEs) are discussed in Section 5.8. In contrast to mapped springs and seeps, whose source water generally comes from bedrock formations in the mountains, groundwater discharge to streams is derived from the alluvium. Discharge to springs or streams can vary seasonally as precipitation and stream conditions change throughout the year. Groundwater discharge to the Corral de Piedras Creeks occur seasonally at the location where the creeks leave the basin, where relatively impermeable bedrock rises to the surface along the Edna Fault, causing groundwater to daylight at this location, at least in the wet season. Subsurface outflow and ET by phreatophytes are discussed in Chapter 6 (Water Budget).

5.4. Change in Groundwater Storage

Changes in groundwater storage for the Alluvial Aquifer and Paso Robles Formation Aquifer are correlated with changes in groundwater elevation, previously discussed, and are addressed in Chapter 6 (Water Budget).

5.5. Seawater Intrusion

Seawater intrusion is not an applicable sustainability indicator for the Basin. The Basin is not adjacent to the Pacific Ocean, a bay, or inlet.

5.6. Subsidence

Land subsidence is the lowering of the land surface. While several human-induced and natural causes of subsidence exist, the only process applicable to the GSP is subsidence due to lowered groundwater elevations caused by groundwater pumping. Historical incidence of subsidence within the Basin was discussed in Chapter 4 (Basin Setting).

Direct measurements of subsidence have not been made in the Basin using extensometers or repeat benchmark calibration; however, interferometric synthetic aperture radar (InSAR) has been used in the County to remotely map subsidence and DWR is expected to continue to collect InSAR data. This technology uses radar images taken from satellites that are used to map changes in land surface elevation. One study done in the area, which evaluates the time period between spring 1997 and fall 1997 (Valentine, 1999), did not report any measurable subsidence within the Basin. Subsidence as a sustainability indicator will be addressed further in Chapter 8 (Sustainable Management Criteria).

5.7. Interconnected Surface Water

Surface water/groundwater interactions may represent a significant, portion of the water budget of an aquifer system. Where the water table is above the streambed and slopes toward the stream, the stream receives groundwater from the aquifer; that is called a gaining reach (i.e., it gains flow as it moves through the reach). Where the water table is beneath the streambed and slopes away from the stream, the stream loses water to the aquifer; that is called a losing reach. In addition, a stream may be disconnected from the regional aquifer system if the elevation of streamflow and alluvium is significantly higher than the elevation of the water table in the underlying aquifer.

The spatial extent of interconnected surface water in the Basin was evaluated using water level data from wells screened in the Recent Alluvium and Paso Robles Formation Aquifer adjacent to the Basin creeks and streams. In accordance with the SGMA GSP Regulations Section 351(o), "Interconnected surface water refers to surface water that is hydraulically connected at any point by a continuous saturated zone to the underlying aquifer and the overlying surface water is not completely depleted". The interconnected surface water analysis for the Basin consisted of comparing average springtime water level elevations in wells adjacent to the San Luis Obispo Creek with the elevation of the adjacent San Luis Obispo Creek channel. In cases where average springtime water levels were greater than the elevation of the adjacent San Luis Obispo Creek channel, the stream reach was considered as potentially 'gaining'. In cases where average springtime water levels were below the adjacent channel elevation, the stream reach was considered 'losing' and potentially 'disconnected'. It is important to recognize that the results of these analyses may reflect conditions that occur occasionally, in response to precipitation events. They may not be representative of long-term average conditions.

The analysis outlined above resulted in identification of two areas of San Luis Obispo Creek that occasionally 'gain' water from the Alluvial Aquifer; the confluence of Stenner Creek and San Luis Obispo Creek, and the reach of San Luis Obispo Creek downstream from the Wastewater Treatment Plant to the confluence with Prefumo Creek. These are displayed in Figure 5-14. Several reaches of San Luis Obispo Creek are identified that occasionally 'lose' water to the Alluvial Aquifer. Groundwater levels in the San Luis Valley part of the Basin are generally high enough that the creek is connected to the underlying aquifer. Along most of Corral de Piedras Creeks, by contrast, surface water levels are generally greater than 30 feet above the groundwater level, and the streams are considered seasonally disconnected from the underlying Alluvial Aquifer in this area.

Evaluation of groundwater elevation hydrographs provides additional insight into the character of interconnected surface water in San Luis Valley and Edna Valley. The differences between the surface water regimes of the two subareas of the Basin are discussed below.

Figure 5-14 presents a hydrograph of City of SLO Well on Calle Joaquin Street, referenced as SLV-12 in Chapter 7 (Monitoring Network). This well is located near both Prefumo Creek and San Luis Obispo Creek, the main streams draining the San Luis Valley part of the Basin. Data presented on this hydrograph date back to 1992, the end of the drought conditions spanning the late 1980s and early 1990s. Inspection of this data indicates that groundwater elevations are very close to land surface in this area (Future monitoring recommendations include surveying the monitoring well and channel elevations so that this can be confirmed). This is indicative that the water level elevations are likely correlated to surface water conditions in the adjacent stream, and that there is an interconnection between surface water and groundwater at this location. Seasonal variations in groundwater elevations of about 6 to 7 feet are evident in the hydrograph. But no long-term trends of declining groundwater elevations are displayed. This indicates that the character of the surface water/groundwater interaction at this location is likely unchanged in the 30-year period since the early 1990s.

Figure 5-15 presents hydrographs of two wells located adjacent to West Corral de Piedras Creek in the Edna Valley subarea of the Basin. One of the wells (EV-01) is located near the location where the creek enters the Basin, and the other well (EV-11, the CASGEM Greengate Well) is located about 1.8 miles south, near where the creek exits the Basin. Because of their proximity to the creek, it is assumed that the high groundwater elevations correspond to periods of surface water flow being present in the channel, and further assumed that these groundwater elevations are close to the stream channel elevation, although there is no streamflow data to confirm this. Data gaps and recommendations for improved stream flow monitoring and channel surveying are discussed in Chapter 7 (Monitoring Network). Water level data for EV-01 dates back to the late 1950s, while data for EV-11 only extends back to 2011. The data for EV-01 indicates a pattern of seasonal variability, wherein large swings in water level elevations of nearly 50 feet are routinely observed between spring and fall of the same year. Extended dry periods such as those of 1988-1992, and the recent drought from 2012-2016, are evident as prolonged periods when the groundwater elevations remain at their approximate historical lows for years at a time. One significant feature of the EV-01 hydrograph is that the essential water level trends have remained unchanged throughout the entire period of record. The average high-water levels and the average low water levels are the same now as they were in the 1960s and 1970s, even though significant changes in land use and groundwater usage have occurred over this period. The seasonal and drought period low groundwater elevations are over fifty feet below ground surface. This suggests that the aquifer at these locations is at least seasonally disconnected from the stream during dry summer and fall months. The period of record displayed in the hydrograph for EV-11 is not nearly as extensive as that for EV-01 but displays some similar features. The 2012-2016 drought is evident as a prolonged period wherein the water levels are over 50 feet below land surface. This suggests that during extended dry periods (I.e., more than single season variation), the aquifer may be disconnected from the stream. However, by 2018, when the seasonal low water level in EV-01 declines about 50 feet to a typical seasonal low elevation, the water levels in EV-11 only decline to about 20-30 feet below the previous high values. This suggests that EV-11 only becomes disconnected from the stream during lengthy drought periods, and not necessarily on a seasonal basis. In this area the Basin sediments are juxtaposed against the Edna Fault and the mountain bedrock on the south side of the Basin, which may force groundwater flow to daylight in this area. This would explain the relative lack of range in seasonal fluctuation in groundwater elevations in this area. Improved stream flow monitoring and channel surveying as discussed in Chapter 7 (Monitoring Network) are recommended to better understand the interactions.

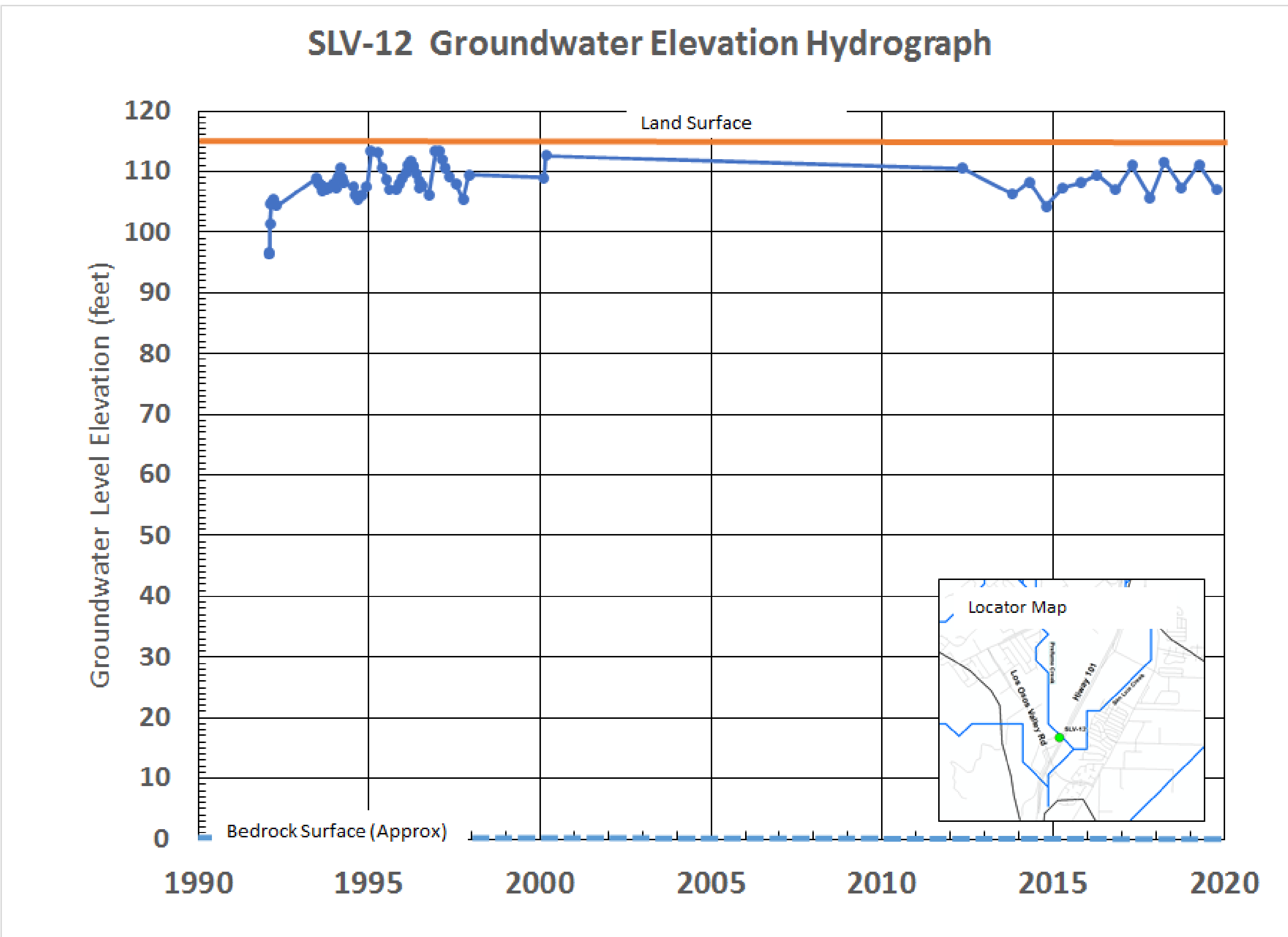


Figure 5-14. Groundwater Elevation Hydrograph (SLV-12)

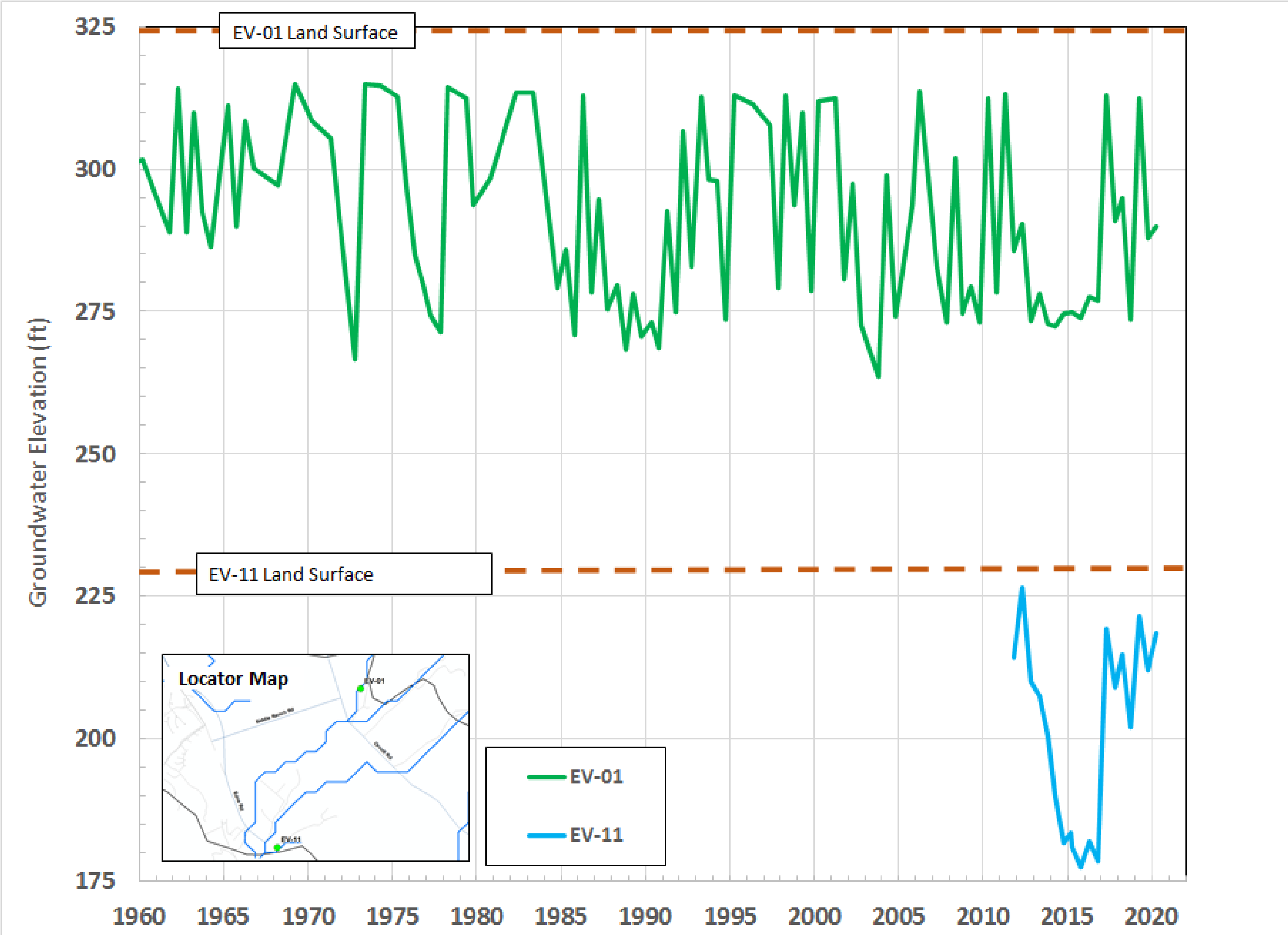


Figure 5-15. Hydrographs of Wells Adjacent to West Corral de Piedras Creek

5.7.1. Depletion of Interconnected Surface Water

Groundwater withdrawals are balanced by a combination of reductions in groundwater storage and changes in the rate of exchange across hydrologic boundaries. In the case of surface water depletion, this rate change could be due to reductions in rates of groundwater discharge to surface water, and increased rates of surface water percolation to groundwater. Seasonal variation in rates of groundwater discharge to surface water or surface water percolation to groundwater occur naturally throughout any given year, as driven by the natural hydrologic cycle. However, they can also be affected by anthropogenic actions. Since, as presented in the discussion of hydrographs in Section 5.7, there have been no long-term water level declines in San Luis Valley, it is therefore concluded that no long-term depletion of interconnected surface water due to groundwater management has occurred in this area. As discussed in the hydrograph analysis of alluvial wells in the Edna Valley, Corral de Piedras Creek appears to be regularly (seasonally) disconnected from the groundwater in the underlying aquifer since the 1950s. Additional monitoring data is proposed in Chapter 7 (Monitoring Network) and Chapter 10 (Implementation Plan), including surveying of channel elevations proximate to nearby well elevation, establishment of additional stream gages, development of rating curves for existing flood stage gages, and other actions.

5.8. Potential Groundwater Dependent Ecosystems

The SGMA GSP Regulations Section 351.16 require identification of groundwater dependent ecosystems within the Basin. Several datasets were utilized to identify the spatial extent of potential groundwater dependent ecosystems (GDEs) in the Basin, as discussed in the following sections. In accordance with the SGMA GSP Regulations Section 351 (o), "groundwater dependent ecosystems refers to ecological communities or species that depend on groundwater emerging from aquifers or on groundwater occurring near the ground surface". In areas where the water table is sufficiently high, groundwater discharge may occur as evapotranspiration (ET) from phreatophyte vegetation within these GDEs. The overall distribution of potential GDEs within the Basin has been initially estimated in the Natural Communities Commonly Associated with Groundwater (NCCAG) dataset (DWR, 2018). This dataset was reviewed by Stillwater Sciences, and a Technical Memo generated (Stillwater Sciences, 2020) that is included as Appendix F, and the resulting distribution of potential GDEs is shown in Figure 5-17. There has been no verification that the locations shown on this map constitute GDEs. Additional field reconnaissance is necessary to verify the existence and extent of these potential GDEs and may be considered as part of the monitoring effort for future planning efforts.

5.8.1. Hydrology

5.8.1.1. Overview of GDE Relevant Surface and Groundwater Hydrology

Instream flows in San Luis and Pismo Creeks can be divided into wet season flows, typically occurring from January to April, and dry season flows, typically from June to October. Short transitional periods occur between the wet and dry seasons. Wet season instream flows originate from a range of sources including precipitation-driven surface runoff events, water draining from surface depressions or wetlands, shallow subsurface flows (e.g., soil), and groundwater discharge. Dry season instream flows, however, are likely fed primarily by groundwater discharge. As groundwater levels fall over the dry season, so do the corresponding instream flows. If groundwater elevations remain above instream water elevations, groundwater discharges into the stream and surface flows continue through the dry season (creating perennial streams). If groundwater elevations fall below the streambed elevation, the stream can go dry. Streams that typically flow in the wet season and dry up in the dry season are termed intermittent. Over time, streams can transition from historically perennial to intermittent conditions due to climactic changes or groundwater pumping (Barlow, 2012). Dry season flows supported by groundwater are critical for the survival of various special status species, including the federally threatened California red-legged frog (Rana draytonii) and Steelhead (Oncorhynchus mykiss).

San Luis Obispo Creek and Pismo Creek are underlain by the Alluvial Aquifer, the Paso Robles Formation Aquifer, and the Pismo Formation Aquifer, as previously discussed. These aquifers have hydraulic connection to one another, and to surface waters, but the degree of connection varies spatially. Aquifers can include confined aquifers, unconfined aquifers, and perched aquifers, as discussed in Chapter 4 (Basin Setting). Aquifers can discharge into ponds, lakes or creeks or vice versa. In the San Luis Obispo Valley Groundwater Basin, little data exists to characterize the connection between surface water and groundwater.

While the groundwater in the San Luis Valley and Edna Valley is hydraulically connected, a shallow subsurface bedrock high between the two sub-areas partially isolates the deeper portions of the two aquifers (Figure 5-10 and Figure 5-11). Groundwater in the Edna Valley flows both towards the San Luis Valley in the northwest portion of the basin and towards Price Canyon in the southwest portion of the basin. Groundwater flowing towards Price Canyon rises to the surface as it approaches the bedrock constriction of Price Canyon and the Edna fault system. The 1954 DWR groundwater elevation map (Figure 5-1) best illustrates the pre-development groundwater flow from the Edna Valley both towards San Luis Obispo and into Price Canyon. Observations of stream conditions indicate a perennial reach of Pismo Creek that flows through Price Canyon and supports year-round critical habitat for threatened steelhead just south of the Basin boundary. A conceptual explanation for this is that groundwater from the Edna subarea flows towards the discharge area at Price Canyon and rises to the surface (daylights) as the groundwater flow encounters the impermeable zone of the Edna Fault and the bedrock outside of the Basin. Piezometers in this area could confirm this interpretation of observed stream conditions.

5.8.1.2. Losing and Gaining Reaches

Streams are often subdivided into losing and gaining reaches to describe their interaction of surface water in the stream with groundwater in the underlying aquifer. In a losing reach water flows from the stream to the groundwater, while in a gaining reach water flows from the groundwater into the stream. The connection between losing reaches to the regional aquifer may be unclear as water can be trapped in perched aquifers above the regional water table. Figure 5-16 shows the likely extent of known gaining and losing reaches in San Luis and Pismo Creeks during typical dry season conditions.

This map is compiled from various data sources, including:

- A field survey of wet and dry reaches of San Luis Obispo Creek (Bennett, 2015),
- Field surveys and flow measurements of Pismo Creek (Balance Hydrologics, 2008),
- An instream flow study of Pismo Creek (Stillwater Sciences 2012),
- A regional instream flow assessment that included San Luis and Pismo Creeks (Stillwater Sciences, 2014),
- Spring and summer low flow measurements in San Luis and Pismo Creeks (2015–2018) (Creek Lands Conservation, 2019), and
- Consideration of the effects of local geologic features such as bedrock outcrops and faults, both of which can force deeper groundwater to the surface.

The effect of faults and bedrock outcrops can be localized or extend for some distance downstream. Portions of the San Luis and Pismo Creeks and their tributaries for which no data exist are left unhighlighted in Figure 5-16. In general, the extent of losing or gaining reaches can vary by season, water year type, or pumping conditions. East and West Corral de Piedras Creeks on the north-east side of the basin may be dry, and disconnected from the underlying aquifer in the spring and summer during drier years but be flowing, losing reaches in wetter years (Creek Lands Conservation, 2019). (To be clear, a stream segment can be a losing reach even if it is not hydraulically connected to the aquifer, since the stream will be losing surface flow to the subsurface via percolation.) In contrast, gaining reaches shown on San Luis Obispo Creek are fairly consistent across water year types (Bennett, 2015) (Creek Lands Conservation, 2019). Figure 5-16 is based on limited data sources. Improved surface flow monitoring is recommended to refine and update the extent of losing and gaining reaches, as well as to provide data for unhighlighted reaches.

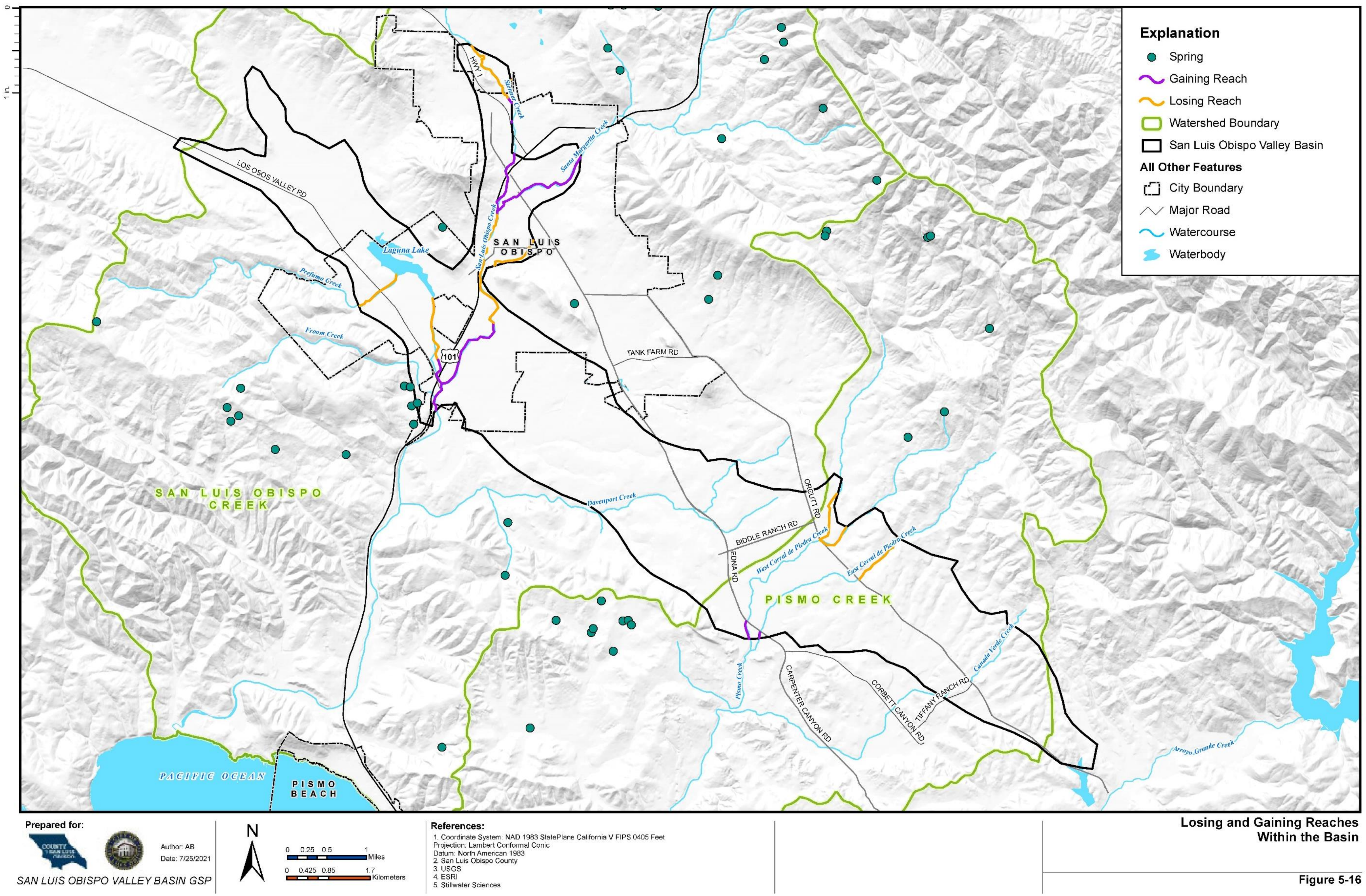


Figure 5-16. Losing and Gaining Reaches Within the Basin

5.8.2. Vegetation and Wetland Groundwater Dependent Identification

DWR has compiled a statewide Natural Communities Commonly Associated with Groundwater (NCCAG) database (DWR, 2018). This database identifies potentially groundwater dependent ecosystems based on the best available vegetation and wetland data (Klausmeyer, 2018). DWR identifies potentially groundwater dependent wetland areas using National Wetland Inventory (NWI) wetland data (USFWS, 2018). These data were evaluated and assessed to accurately capture wetland and riverine features. In the Basin, the best available vegetation mapping data set was from the California Fire and Resource Assessment Program Vegetation (FVEG), (California Department of Forestry and Fire Protection, 2015). FVEG is a remotely sensed dataset that classifies vegetation to coarse types (i.e., the California Wildlife Habitat Relationship System). Given the limitations of this dataset to accurately capture and identify vegetation using a precise classification system, it was deemed inappropriate for use in determining potential GDEs. Instead, a manual assessment of vegetation with potential groundwater dependence was conducted using National Agricultural Imagery Program 2018 color aerial imagery (NAIP (National Agricultural Imagery Program), 2018). Vegetation communities identified as potentially groundwater dependent included riparian trees and shrubs, and oak woodlands. Oak woodlands were considered potentially groundwater dependent due to their deep rooting depths (up to 70 feet (Lewis, 1964)).

Potential vegetation and wetland GDEs were retained if the underlying depth to water in 2019 was inferred to be 30 feet or shallower based on the existing well network (Figure 5-17). Depth to groundwater was interpolated from seventeen wells for which groundwater level data was available in the spring of 2019 (Figure 5-6). The depth to groundwater estimated in Figure 5-17 is assumed to represent regional groundwater levels; however, the screening depth is known for only 6 of the 17 of the wells. Wells where the screened depth is unknown may be measuring groundwater levels for deeper aquifers that are unconnected to the shallow groundwater system, and thus groundwater deeper than 30 ft for a given well may not reflect the absence of shallow groundwater, but instead reflects the absence of data. To determine the hydraulic connectivity between potential perched aquifers to the regional aquifer, additional monitoring with nested piezometers could be utilized.

For the purposes of differentiating between potential and unlikely GDE's, different assumptions were made for the San Luis Valley versus Edna Valley in areas of no groundwater data. In the San Luis Valley, underlying San Luis Obispo Creek, it was assumed that the depth to regional groundwater was less than 30 feet because the limited available data indicate that groundwater in this sub-area is generally relatively shallow. In the Edna Valley (underlying Pismo Creek), it was assumed that the depth to regional groundwater was more than 30 feet because the limited available data indicate that the groundwater in this sub-area is generally deeper; therefore, much of the area of the lower reaches of East and West Corral de Piedras Creeks is unlikely to have GDEs. One exception to this assumption was made on upper East Corral de Piedra, where the conditions were assumed to be similar to those on upper West Corral de Piedra, where wet conditions have been observed to persist into late spring or early summer (Stillwater Sciences, 2014) (Balance Hydrologics, 2008). The 30-foot depth criterion is consistent with guidance provided by The Nature Conservancy (Rohde, 2019) for identifying GDEs. Additionally, the area where East and West Corral de Piedras Creeks leave the Basin near Price Canyon has groundwater elevation data within 30 feet of the streams, as a result, these areas are presented as having potential GDEs.

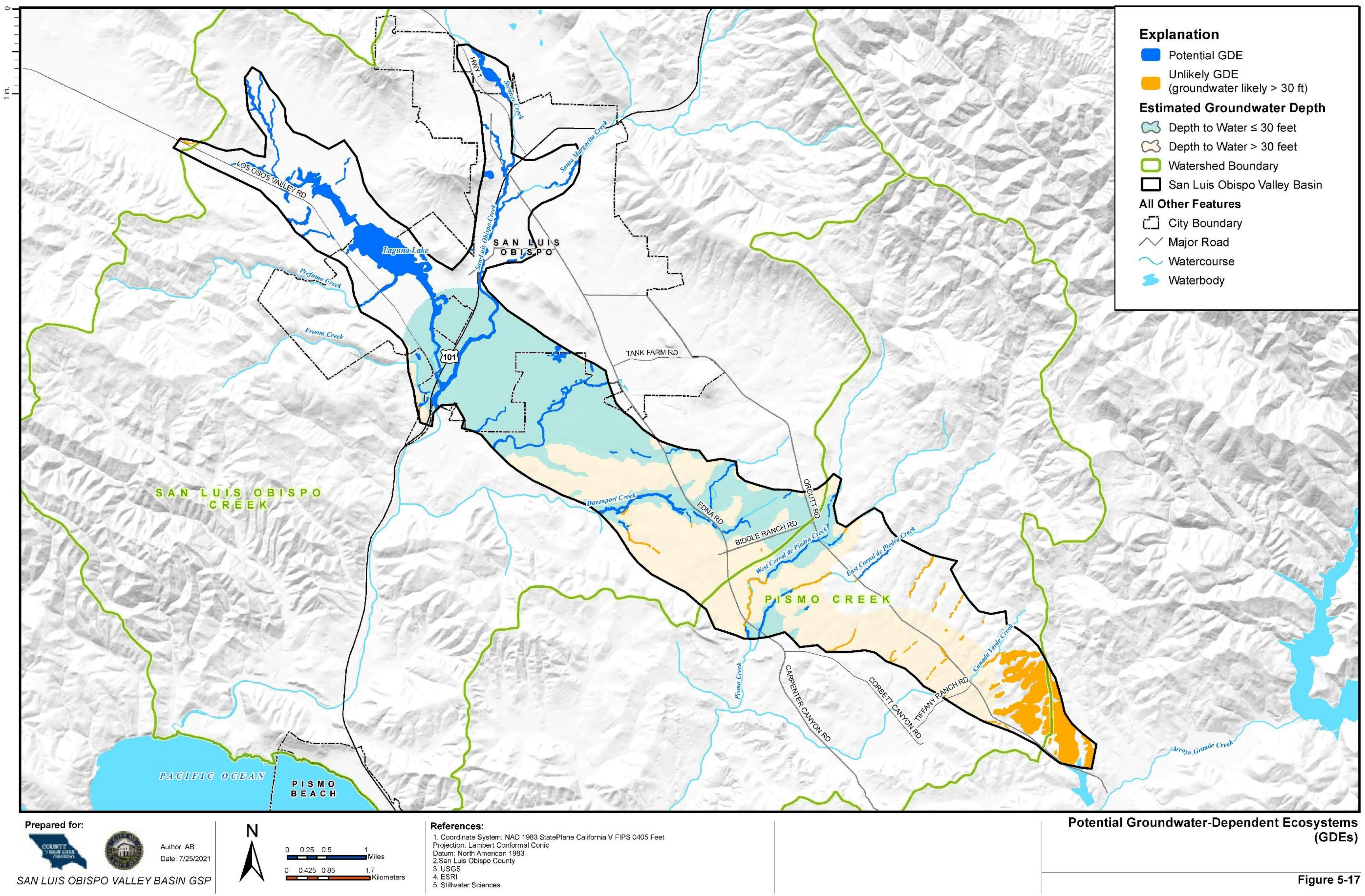


Figure 5-17. Potential Groundwater-Dependent Ecosystems (GDEs)

5.8.3. Identification of Special Status Species and Sensitive Natural Communities Associates with GDEs

For the purposes of this GSP, special-status species are defined as those:

- Listed, proposed, or under review as endangered or threatened under the federal Endangered Species Act (ESA) or the California Endangered Species Act (CESA);
- Designated by California Department of Fish and Wildlife (CDFW) as a Species of Special Concern;
- Designated by CDFW as Fully Protected under the California Fish and Game Code (Sections 3511, 4700, 5050, and 5515);
- Protected under the Federal Bald and Golden Eagle Protection Act;
- Designated as rare under the California Native Plant Protection Act (CNPPA); and/or
- Included on CDFW's most recent Special Vascular Plants, Bryophytes, and Lichens List (CDFW, 2019) with a California Rare Plant Rank (CRPR) of 1, 2, 3, or 4.

In addition, sensitive natural communities are defined as:

- Vegetation communities identified as critically imperiled (S1), imperiled (S2), or vulnerable (S3) on the most recent California Sensitive Natural Communities List (CDFW, 2019).

To determine the terrestrial and aquatic special-status species that may utilize potential GDE units overlying the Basin, Stillwater ecologists queried existing databases on regional and local occurrences and distributions of special-status species. Databases accessed include the California Natural Diversity Database (CNDDB) (CDFW, 2019). (eBird, 2017), and TNC freshwater species list (The Nature Conservancy, (TNC), 2019). Spatial database queries were centered on the potential GDEs plus a 1-mile buffer. Stillwater's ecologists reviewed the database query results and identified special-status species and sensitive natural communities with the potential to occur within or to be associated with the vegetation and aquatic communities in or immediately adjacent to the potential GDEs. The table in Appendix F lists these special-status species and sensitive natural communities, describes their habitat preferences and potential dependence on GDEs, and identifies known nearby occurrences (Appendix F - Table 1). Wildlife species were evaluated for potential groundwater dependence using the Critical Species Lookbook (Rohde, 2019).

The San Luis Obispo Valley Groundwater Basin supports steelhead belonging to the South-Central California Coast Distinct Population Segment (DPS) which is federally listed as "threatened." Within this DPS, the population of steelhead within the San Luis Obispo Creek, and Pismo Creek portions of the groundwater basin have both been identified as Core 1 populations which means they have the highest priority for recovery actions, have a known ability or potential to support viable populations, and have the capacity to respond to recovery actions ((National Marine Fisheries Service, (NMFS), 2013)). One critical recovery action listed by NMFS includes the management of groundwater extractions for protection and restoration of natural surface flow patterns to ensure surface flows allow for essential steelhead habitat functions (National Marine Fisheries Service, (NMFS), 2013).

Based on criteria promulgated by The Nature Conservancy (TNC), the San Luis Obispo Valley Groundwater Basin was determined to have high ecological value because: (1) the known occurrence and presence of suitable habitat for several special-status species including the Core 1 population status of South-Central California Coast Steelhead DPS and several special-status plants and animals that are directly or indirectly dependent on groundwater (Appendix F - Table 1); and (2) the vulnerability of these species and their habitat to changes in groundwater levels (Rohde, 2019).

5.9. Groundwater Quality Distribution and Trends

Groundwater quality samples have been collected and analyzed throughout the Basin for various studies and programs and are collected on a regular basis for compliance with regulatory programs.

Water quality data surveyed for this GSP were collected from:

- The California Safe Drinking Water Information System (SDWIS), a repository for public water system water quality data,
- The National Water Quality Monitoring Council water quality portal (this includes data from the recently decommissioned EPA STORET database, the USGS, and other federal and state entities [Note: in the Basin the agencies include USGS, California Environmental Data Exchange Network (CEDEN), and Central Coast Ambient Monitoring Program {CCAMP}]), and
- The California State Water Resources Control Board (SWRCB) GeoTracker GAMA database.

In general, the quality of groundwater in the Basin is good. Water quality trends in the Basin are stable, with no significant trends of ongoing deterioration of water quality based on the Regional Water Quality Control Board's Basin Objectives, outlined in the Water Quality Control Plan for the Central Coast Basin (Regional Water Quality Control Board, 2017). The Basin Plan takes all beneficial uses into account and establishes measurable goals to ensure healthy aquatic habitat, sustainable land management, and clean groundwater. The distribution, concentrations, and trends of some of the most commonly cited major water quality constituents are presented in the following sections.

5.9.1. Groundwater Quality Suitability for Drinking Water

Groundwater in the Basin is generally suitable for drinking water purposes. Groundwater quality data was evaluated from the SDWIS and GeoTracker GAMA datasets. The data reviewed includes 2,885 sampling events from 403 supply wells and monitoring wells in the Basin, collected between June 1953 and September 2019. Primary drinking water standards Maximum Contaminant Levels (MCLs) and Secondary MCLs (SMCLs) are established by Federal and State agencies. MCLs are legally enforceable standards, while SMCLs are guidelines established for nonhazardous aesthetic considerations such as taste, odor, and color. Primary water quality standard exceedances in the Basin include exceedance of the MCL for nitrate, which equaled or exceeded the standard in 269 samples out of 2,605 samples (or 10% of samples, with 190 of the exceedances occurring in four wells), and exceedance of the MCL for arsenic, which exceeded the MCL in 30 out of 771 samples (or 4% of samples collected). The SMCL for total dissolved solids (TDS) was equaled or exceeded in 126 out of 843 samples (or 15% of total samples). In the case of public water supply systems, these water quality exceedances are effectively mitigated with seasonal well use, treatment, or water blending practices to reduce the constituent concentrations to below their respective water quality standard. In general, these statistics meet the Central Coast Water Board Basin Plan measurable goals that by 2025, 80% of groundwater will be clean, and the remaining 20% will exhibit positive trends in key parameters.

5.9.2. Distribution and Concentrations of Point Sources of Groundwater Constituents

Potential point sources of groundwater quality degradation due to release of anthropogenic contaminants were identified using the State Water Resources Control Board (SWRCB) Geotracker website. Waste Discharge permits were also reviewed from on-line regional SWRCB websites Table 5-1 summarizes information from these websites for open/active sites. Figure 5-18 shows the locations of these open groundwater contaminant point source cases, and the locations of completed/case closed sites. Based on available information there are no mapped ground-water contamination plumes at these sites.

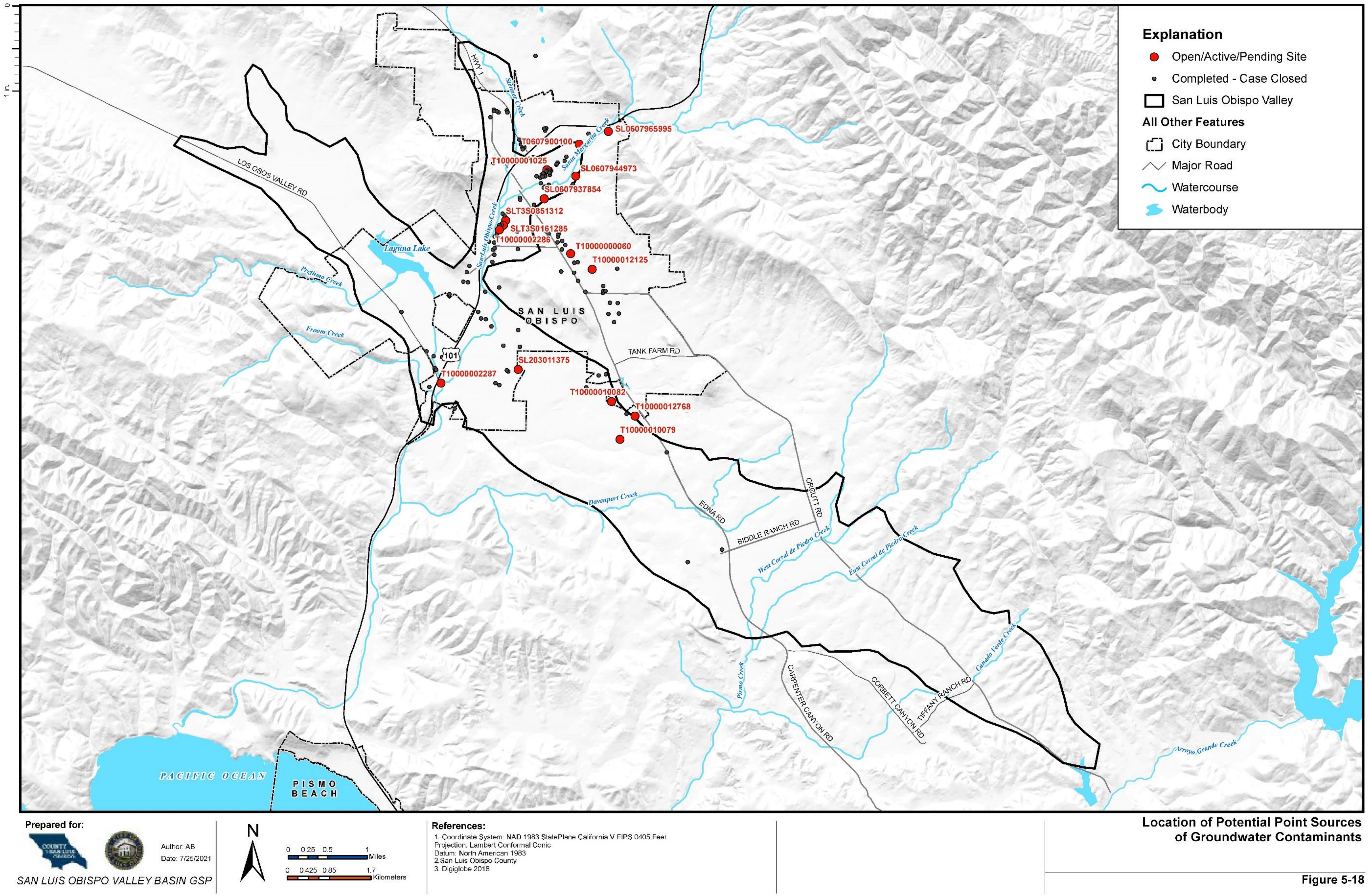


Figure 5-18. Location of Potential Point Sources of Groundwater Contaminants

Table 5-1. Potential Point Sources of Groundwater Contamination

SITE ID	SITE NAME	CASE TYPE	STATUS	CONSTITUENT(S) OF CONCERN (COCS)	POTENTIALLY AFFECTED MEDIA
T0607900100	American Gas and Tire	LUST Cleanup Site	Open - Verification Monitoring	Benzene, Gasoline, MTBE / TBA / Other Fuel Oxygenates	Aquifer used for drinking water supply
SL203011375	Chevron (Former UNOCAL) - Tank Farm Road Bulk Storage	Cleanup Program Site	Open - Remediation	Arsenic, Lead, Asphalt, Crude Oil, Other Petroleum	Contaminated Surface / Structure, Other Groundwater (uses other than drinking water), Soil, Surface water
T10000002287	Conoco Phillips site # 5143	Cleanup Program Site	Open - Site Assessment	Crude Oil, Diesel, Gasoline	Soil
SL0607944973	COP Pipeline at San Luis Drive	Cleanup Program Site	Open - Assessment & Interim Remedial Action	Crude Oil	Other Groundwater (uses other than drinking water), Well used for drinking water supply
T10000001025	KIMBALL MOTORS	Cleanup Program Site	Open - Verification Monitoring	Other Chlorinated Hydrocarbons, Tetrachloroethylene (PCE), Trichloroethylene (TCE), Vinyl chloride	Aquifer used for drinking water supply, Soil
SLT3S0851312	MODEL INDUSTRIAL SUPPLY	Cleanup Program Site	Open - Site Assessment		Aquifer used for drinking water supply
SLT3S0161285	PG&E-FORMER MANUFACTURED GAS PLANT-SAN LUIS OBISPO	Cleanup Program Site	Open - Remediation		Aquifer used for drinking water supply
SL0607937854	PISMO ST. AND MORRO ST. PIPELINE RELEASE	Cleanup Program Site	Open - Site Assessment	Crude Oil	Aquifer used for drinking water supply
T10000012768	SAN LUIS COUNTY RGNL	Non-Case Information	Pending Review	Per- and Polyfluoroalkyl Substances (PFAS)	
T10000002286	South Higuera St & Pismo St Pipeline (Chevron Site 351317)	Cleanup Program Site	Open - Site Assessment	Crude Oil, Diesel, Gasoline	Aquifer used for drinking water supply, Soil
T10000010079	Thread Lane Properties, LLC	Cleanup Program Site	Open - Site Assessment		
SL0607965995	TRACT 1259	Cleanup Program Site	Open - Assessment & Interim Remedial Action	Crude Oil	Aquifer used for drinking water supply
T10000000060	Union Pacific Railroad - Round House/Pond Site	Cleanup Program Site	Open - Inactive	Waste Oil / Motor / Hydraulic / Lubricating	Other Groundwater (uses other than drinking water), Soil
T10000012125	UPRR Tie Fire	Non-Case Information	Pending Review		
T10000010082	Volny Investment Company	Cleanup Program Site	Open - Site Assessment		

5.9.3. Distribution and Concentrations of Diffuse or Natural Groundwater Constituents

The distribution and concentration of several constituents of concern are discussed in the following subsections. Groundwater quality data was evaluated from the SDWIS and GeoTracker GAMA datasets. The data reviewed includes 2,884 sampling events from 403 wells in the Basin, collected between June 1953 and June 2019. Each of the constituents are compared to their drinking water standard, if applicable, or their Basin Plan Median Groundwater Quality Objective (RWQCB Objective) (Regional Water Quality Control Board, Central Coast Region, 2017). This GSP focuses only on constituents that might be impacted by groundwater management activities. The constituents discussed below are chosen because they have either a drinking water standard, a known effect on crops, or concentrations have been observed above either the drinking water standard or the level that affects crops.

5.9.3.1. Total Dissolved Solids

TDS is defined as the total amount of mobile charged ions, including minerals, salts or metals, dissolved in a given volume of water and is commonly expressed in terms of milligrams per liter (mg/L). Specific ions of salts such as chloride, sulfate, and sodium may be evaluated independently, but all are included in the TDS analysis, so TDS concentrations are correlated to concentrations of these specific ions. Therefore, TDS is selected as a general indicator of groundwater quality in the Basin. TDS is a constituent of concern in groundwater because it has been detected at concentrations greater than its RWQCB Basin Objective of 900 mg/l in the Basin. The TDS Secondary MCL has been established for color, odor and taste, rather than human health effects. This Secondary MCL includes a recommended standard of 500 mg/L, an upper limit of 1,000 mg/L and a short-term limit of 1,500 mg/l. TDS water quality results ranged from 180 to 3,100 mg/l with an average of 727 mg/l and a median of 613 mg/l.

The distribution and trends of TDS concentrations in the Basin groundwater are presented Figure 5-19. TDS concentrations are color coded and represent the average result if multiple samples are documented. Most of the samples with the highest values (dark red in the figure) are outside or on the edge of the Basin. This is consistent with observations that groundwater from the Basin sediments generally has better water quality than groundwater from bedrock wells. Eleven wells with the greatest amount of data over time were selected. Graphs displaying TDS concentration with time are included on Figure 5-19. Most of these graphs do not display any upward trends in TDS concentrations with time. The sustainability projects and management actions implemented as part of this GSP are not anticipated to increase groundwater TDS concentrations in wells that are currently below the SMC.

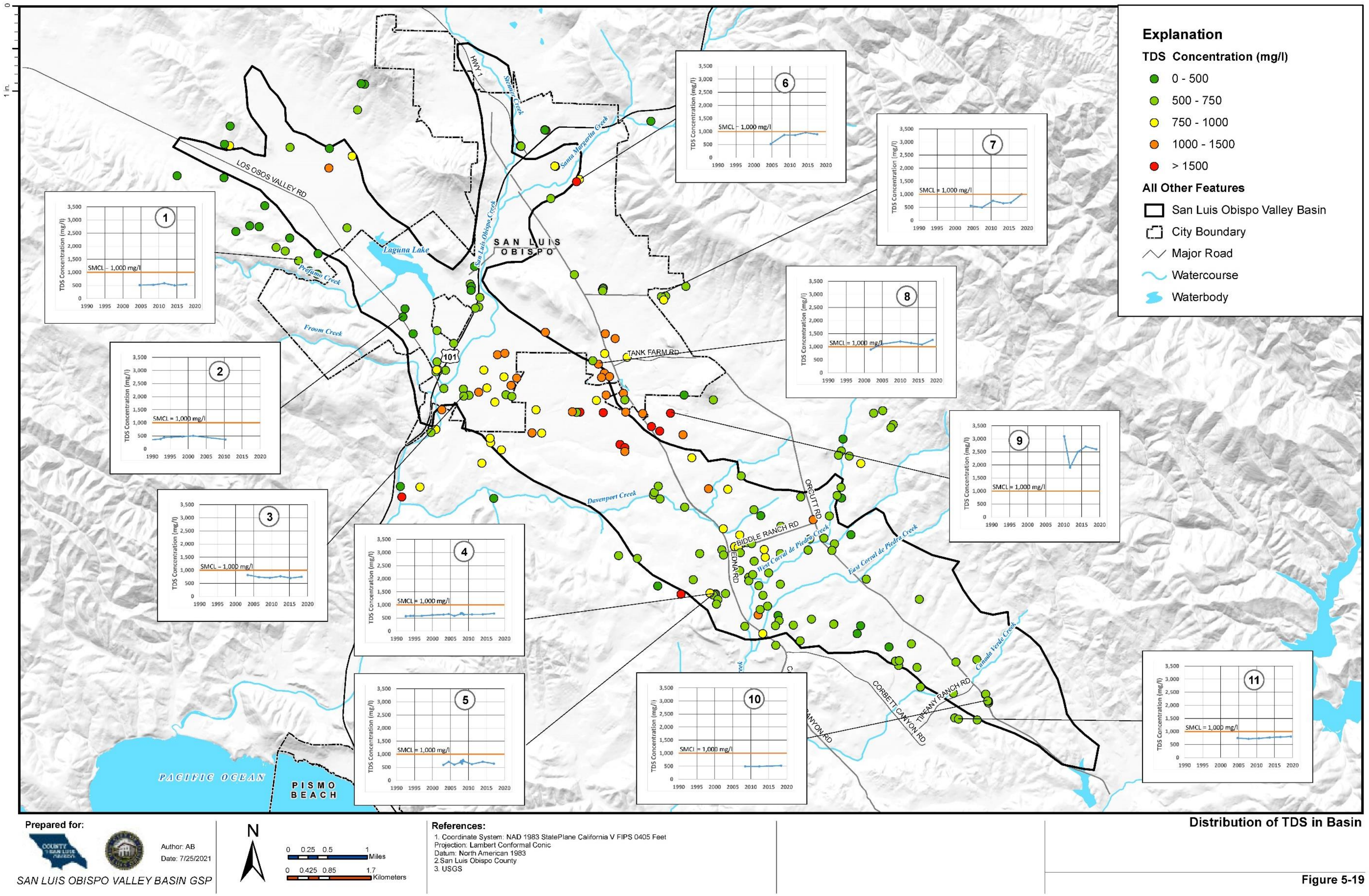


Figure 5-19. Distribution of TDS in Basin

5.9.3.2. Nitrates

Nitrate (as Nitrogen) is a widespread contaminant in California groundwater. Although it does occur naturally at low concentrations, high levels of nitrate in groundwater are associated with agricultural activities, septic systems, confined animal facilities, landscape fertilizers and wastewater treatment facilities. Nitrate is the primary form of nitrogen detected in groundwater. It is soluble in water and can easily pass through soil to the groundwater table. Nitrate can persist in groundwater for decades and accumulate to high levels as more nitrogen is applied to the land surface each year. It is a Primary Drinking Water Standard constituent with an MCL of 10 mg/l.

Nitrate is a constituent of concern in groundwater because it has been detected at concentrations greater than its RWQCB Basin Objectives of 5 mg/l (as N) in the Basin. The Nitrate MCL has been established at 10 mg/l (as N). Overall, nitrate water quality results ranged from below the detection limit to 80 mg/l (as N) with an average of 3.9 mg/l (as N) and a median value of 2.0 mg/l (as N).

Figure 5-20 presents occurrences and trends for nitrate in the Basin groundwater. Wells with the most sampling data over time were selected for presentation. The color-coded symbols represent the average result if multiple samples are documented. Most of the chemographs displayed on Figure 5-20 indicate concentrations of nitrate well below the MCL, and do not indicate trends of increasing concentrations with time. Chemographs labelled number 4 and 5 on Figure 5-20 do appear to indicate a slight upward trend in nitrate (as nitrogen) concentrations over the data period of record. Sustainability projects and management actions implemented as part of this GSP are not anticipated to increase nitrate concentrations in groundwater in a well that would otherwise remain below the MCL to increase above the MCL.

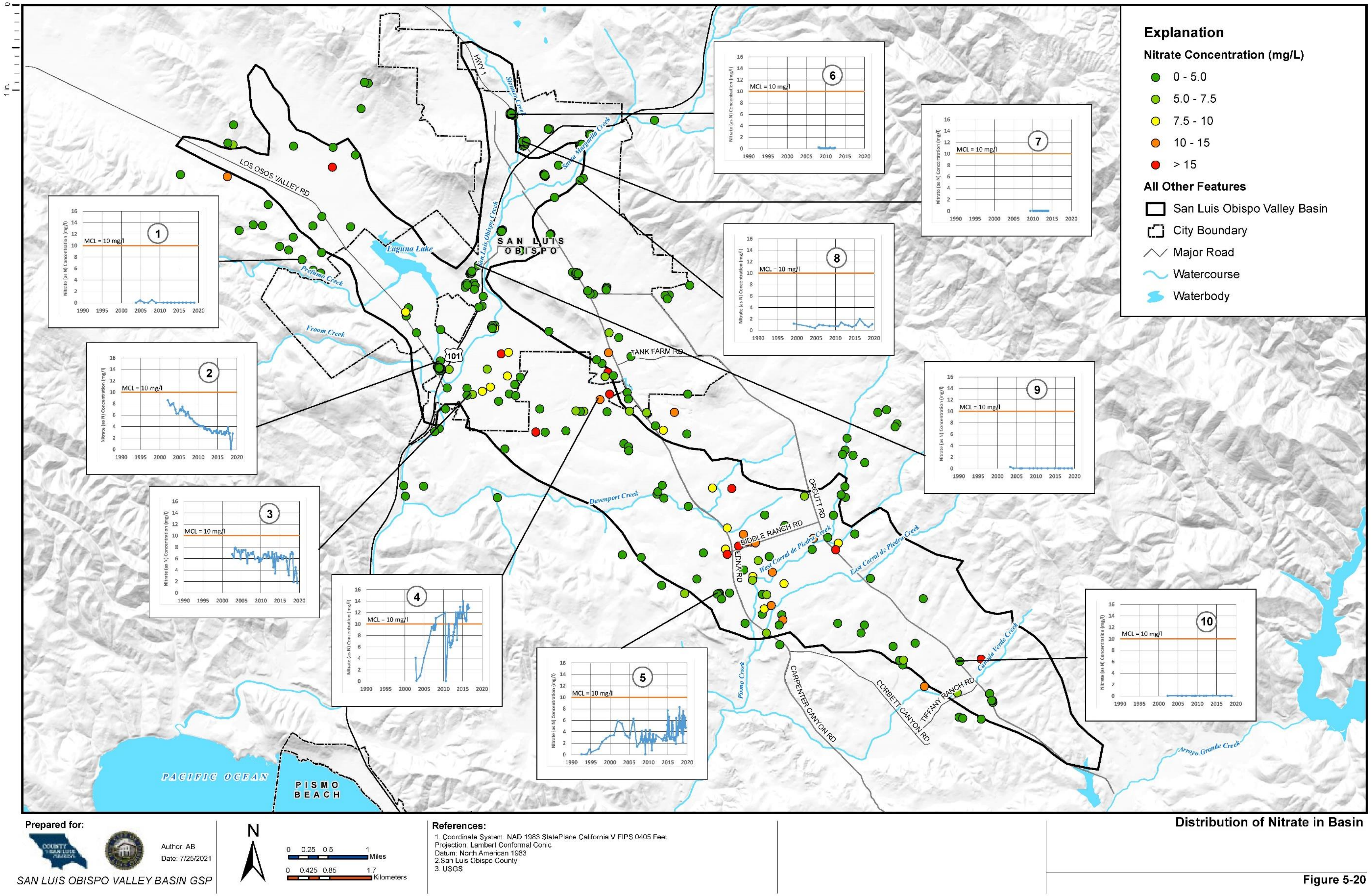


Figure 5-20. Distribution of Nitrate in Basin

5.9.3.3. Arsenic

Arsenic is also a common contaminant in California groundwater. Although it does occur naturally at low concentrations, elevated levels of arsenic in groundwater may be associated with pesticide use, mining activities, and release of industrial effluent. Arsenic has a Primary Drinking Water Standard with an MCL of 10 ug/l. Overall, arsenic concentrations ranged from below the detection limit to 28 ug/l, with an average value of 2.5 ug/l and a median value of 2 ug/l.

Figure 5-21 presents occurrences and trends for arsenic in the Basin groundwater from wells with the most arsenic analytical data over time. The color-coded symbols represent the average result if multiple samples are documented. Wells screened in the bedrock aquifers may be expected to have higher natural arsenic concentrations than wells screened in Basin sediments due to increased degrees of mineralization in these waters. Most of the chemographs displayed show stable or decreasing concentrations of arsenic over the data period of record. (Graph number 1 shows a slight increase over time but is still below the MCL). Sustainability projects and management actions implemented as part of this GSP are not anticipated to directly cause arsenic concentrations in groundwater in a well that would otherwise remain below the MCL to increase above the MCL.

5.9.3.4. Boron

Boron is an unregulated constituent and therefore does not have a regulatory standard. However, boron is a constituent of concern because elevated boron concentrations in water can damage crops and affect plant growth. Boron has been detected at concentrations greater than its RWQCB Basin Objective of 200 micrograms per liter (ug/l). Boron water quality results ranged from non-detect to 2,500 ug/l with an average of 0.16 ug/l and a median value of 0.12.

Boron concentrations in the Alluvial Aquifer have been relatively consistent throughout the period of record. Boron concentrations in the Paso Robles Formation Aquifer have generally remained steady or declined slightly over the period of record. Sustainability projects and management actions implemented as part of this GSP are not anticipated to directly cause boron concentrations in groundwater in a well to increase.

5.9.3.5. Other Constituents

Other constituents found in exceedance of their respective regulatory standard include arsenic, iron, gross alpha, manganese, selenium, and sulfate. Each of these exceedances occurred in samples from a small number of wells, indicating isolated occurrences of these elevated constituent concentrations rather than widespread occurrences, affecting the entire Basin. Isolated concentrations of arsenic, iron, gross alpha, and sulfate in the Basin have been relatively consistent throughout the period of record. Selenium concentrations have generally declined since 2007. There are not enough data to determine the trend of the elevated manganese concentrations in the Basin. Sustainability projects and management actions implemented as part of this GSP are not anticipated to directly cause concentrations of any of these constituents in groundwater to increase.

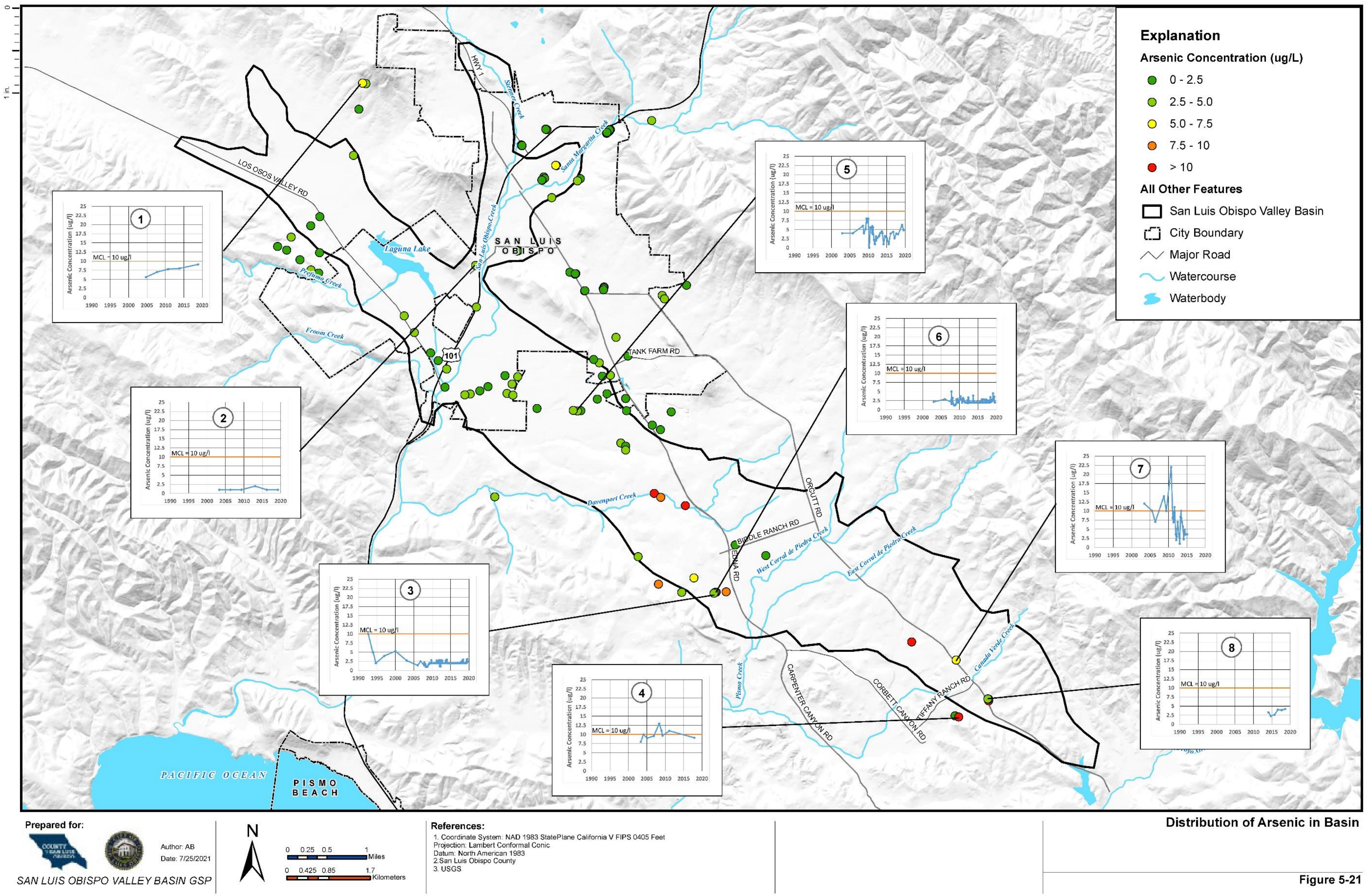


Figure 5-21. Distribution of Arsenic in Basin

6

GROUNDWATER SUSTAINABILITY PLAN

Water Budget (§354.18)

The purpose of a water budget is to provide an accounting and assessment of the total annual volume of groundwater and surface water entering and leaving the basin, including historical, current, and projected water budget conditions, and the change in volume stored. Both numerical and analytical methods have been used during water budget preparations for the GSP.

The analytical method refers to application of the water budget equation and the inventory method using spreadsheets, with groundwater flow estimates based on Darcy's Law and change in storage calculations based on the specific yield method.

Numerical methods refer to surface water and groundwater flow modeling, which provide a dynamic and more rigorous analysis of both surface-groundwater interactions and the impacts from pumping on groundwater in storage. The historical and current analytical groundwater budget was used as part of the basin conceptual model to calibrate and interpret the numerical model GSFLOW which is documented in Appendix F. This chapter presents the analytical water budget for the historical and current conditions and the projected water budgets were developed using the GSFLOW model developed for this GSP (Appendix F).

IN THIS CHAPTER

- Historical Water Budget
- Current Water Budget
- Sustainable Yield Estimate
- Estimated Overdraft
- Projected Water Budget

6.1. Introduction

A water budget identifies and quantifies various components of the hydrologic cycle within a user-defined area, in this case the San Luis Obispo Valley Groundwater Basin. Water circulates between the atmospheric system, land surface system, surface water bodies, and the groundwater system, as shown in Figure 6-1 (DWR, 2016) The water budget equation used for the analytical method is as follows:

INFLOW – OUTFLOW = CHANGE IN STORAGE

Inflow is the sum of all surface water and groundwater entering the Basin and outflow is the sum of all surface water and groundwater leaving the Basin. The difference between total inflow and total outflow over a selected time period is equal to the change in total storage (surface water and groundwater) within the Basin over the same period. Components of inflow and outflow represented in the water budget are shown in Figure 6-2. Not all the components shown are needed for the San Luis Obispo Valley Groundwater Basin GSP. A key using letters to represent components in this water budget has been added to Figure 6-2 for reference with the main water budget tables. Some components have been modified and renamed from the original DWR figure to better represent this specific water budget.

The water budget equation given above is simple in concept, but it is challenging to measure and account for all the components of inflow and outflow within a Basin. Some of these components can be measured or estimated independently, while others are calculated using the water budget equation.

The water budget for this GSP has been prepared for the two subareas that cover the Basin, the San Luis Valley subarea and the Edna Valley subarea (Figure 6-3). Subareas are not to be confused with subbasins and are defined for this water budget analysis. They are then combined into a single water budget for the entire Basin. Both subarea water budgets and the Basin water budget are included herein. Surface water (combined atmospheric, land surface, and stream systems) and groundwater budgets have been prepared for each subarea and for the Basin. The subarea approach for water budget calculations follows the approach used by prior investigators (Boyle Engineering, 1991) (DWR, 1997).

As presented in Chapter 4 (Basin Setting), there is a topographic high point in bedrock elevations underlying the Basin that creates a bedrock high between the San Luis Valley and Edna Valley subareas (Figure 4-4). This bedrock high partially isolates the deeper portions of the Basin aquifers (Figure 4-5) and restricts underflow between the two subareas. Figure 6-3 shows the San Luis Valley and Edna Valley subareas used for the water budget, with the subarea boundary located along Hidden Springs Road. Note that the boundary between the subareas is shifted slightly to the west of the bedrock high (Figure 6-3) in order to better correlate with overlying land use. Land use for 2016 (DWR, 2016) is shown on the map to help illustrate differences across the subarea boundary. Immediately west of the subarea boundary is rural residential land and the County airport. To the east of the subarea boundary are residential subdivisions, a golf course, and irrigated agricultural lands. The two subareas of the Basin are hydrologically distinct, as evidenced by the differences in watershed area (Figure 3-10), sediment thickness (Figure 4-4), and water level hydrographs (Figure 5-11). The groundwater budgets are also very different between the subareas and separating the two is necessary to properly characterize the Basin. The two subarea water budgets have also been combined to create a total Basin water budget.

The San Luis Valley subarea is 6,773 acres (10.6 square miles), and the Edna Valley subarea is 5,948 acres (9.3 square miles), with a total Basin area of 12,271 acres (19.2 square miles). The San Luis Valley subarea receives surface inflow from a watershed of 28,823 acres (45 square miles) and the Edna Valley subarea receives surface inflow from a watershed of 10,145 acres (15.9 square miles). The watershed divide between San Luis Obispo Creek and Pismo Creek is not coincident with the bedrock high or subarea boundary, and watershed area draining to Davenport Creek in the Edna Valley subarea is part of the San Luis Obispo Creek watershed (Figure 3-10).

Table 6-1, Table 6-2, and Table 6-3 present the historical surface water and groundwater budgets for the San Luis Valley subarea, the Edna Valley subarea, and the Basin total, respectively. Bar graphs are included in Figure 6-4 through Figure 6-9. The three main water budget tables contain a detailed accounting of the water budget for the Basin and will be referred to throughout this chapter. A letter key has been added to provide a visual reference with Figure 6-3.

Note that Figure 6-3 breaks the water budget into four components (atmospheric system, land surface system, river & stream system, and groundwater system). The atmospheric system transfers evaporation to precipitation and overlies the other systems. The land surface system is the portion of the water budget that includes land surface and the unsaturated zone extending to the top of the groundwater system. The rivers & streams system is the portion of the water budget that includes rivers, streams, conveyance facilities and diversion ditches, and lakes and reservoirs. The atmospheric, land surface, and river & streams water budgets for this Basins have been combined into a single surface water budget. As a result, not all the components in Figure 6-3 have corresponding budget items listed for the Basin. For example, the runoff and return flow components of the land surface system into the river & stream system in Figure 6-3 are part of the surface water outflow component (Labeled “L”).

The six bar graphs are graphical representations of the water budget that allow quick comparisons of the various budget quantities but are not individually referenced. Figure 6-4, Figure 6-5, and Figure 6-6 illustrate the surface water budget portions of Table 6-1, Table 6-2, and Table 6-3, while Figure 6-7, Figure 6-8, and Figure 6-9 illustrate the groundwater budget portions of the tables. Water budget climate, historical time period, methodology, sustainable yield, and overdraft interpretation are also presented in this chapter.

Some general observations on the water budget are worth noting. First, the surface water budget for the two subareas shows similar patterns of increasing and decreasing total flow from year to year, which is expected given similar precipitation with somewhat proportional stream flow. The San Luis Valley subarea surface water budget is close to double the Edna Valley surface water budget, however. This is due to a larger watershed area for the San Luis Valley subarea and to the significant volume of surface water imported from outside of the Basin by the City of San Luis Obispo. Secondly, the groundwater budget for the Edna Valley subarea shows high groundwater recharge events during all wet years, which is expected, while the San Luis Obispo shows a more attenuated response, with some wet years (1993, 2017) providing greater recharge than others. This is because during some wet years, the aquifers in the San Luis Valley subarea fill up to the point where there is no more available storage volume, and therefore no additional recharge occurs (also inferred by the relatively flat water level hydrographs in Figure 5-11). In 1993 and 2017, there was sufficient storage room following drought to allow greater recharge than during wet years when the subarea was effectively full.

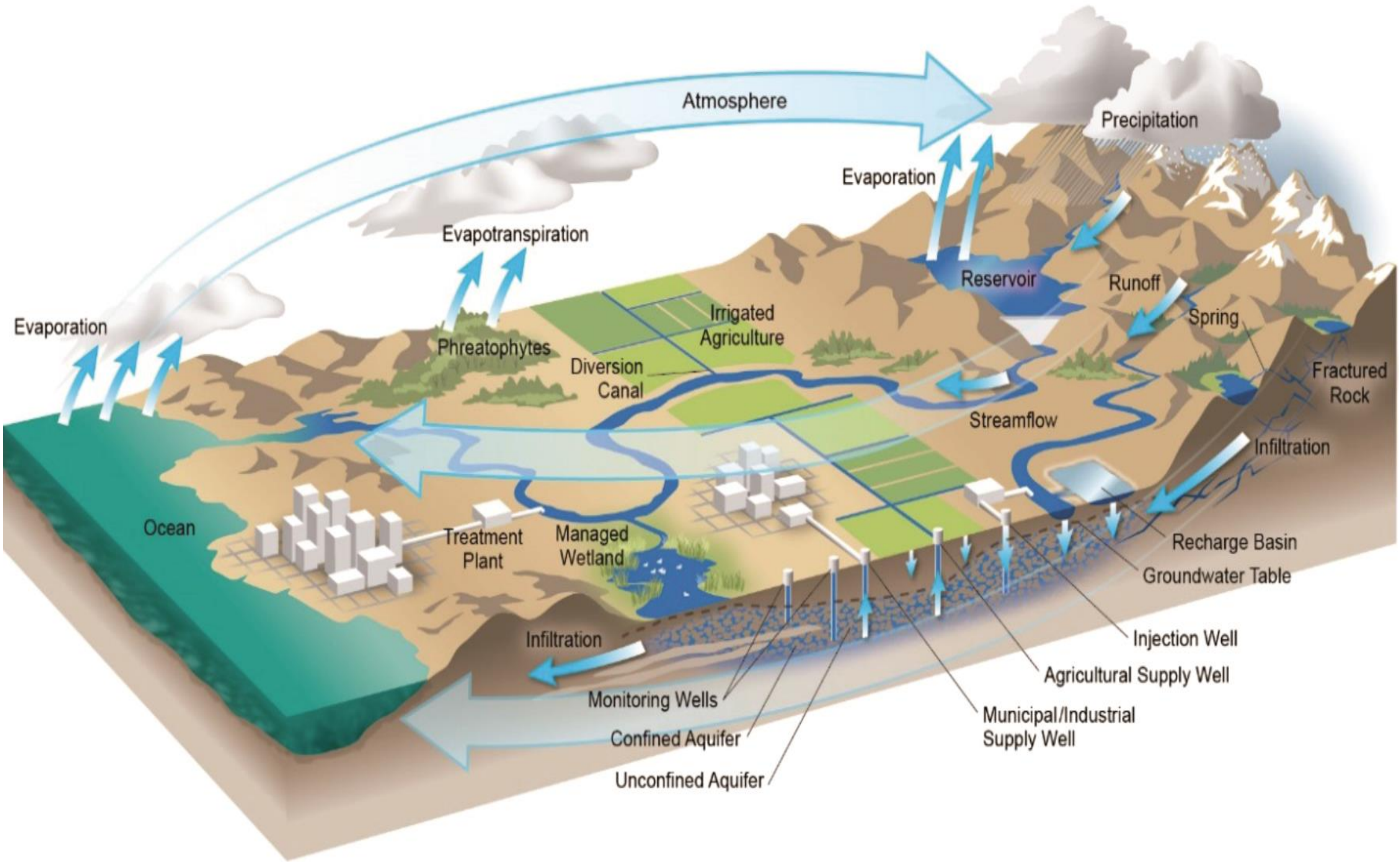


Figure 6-1. The Hydrologic Cycle. Source: Department of Water Resources (DWR, 2016)

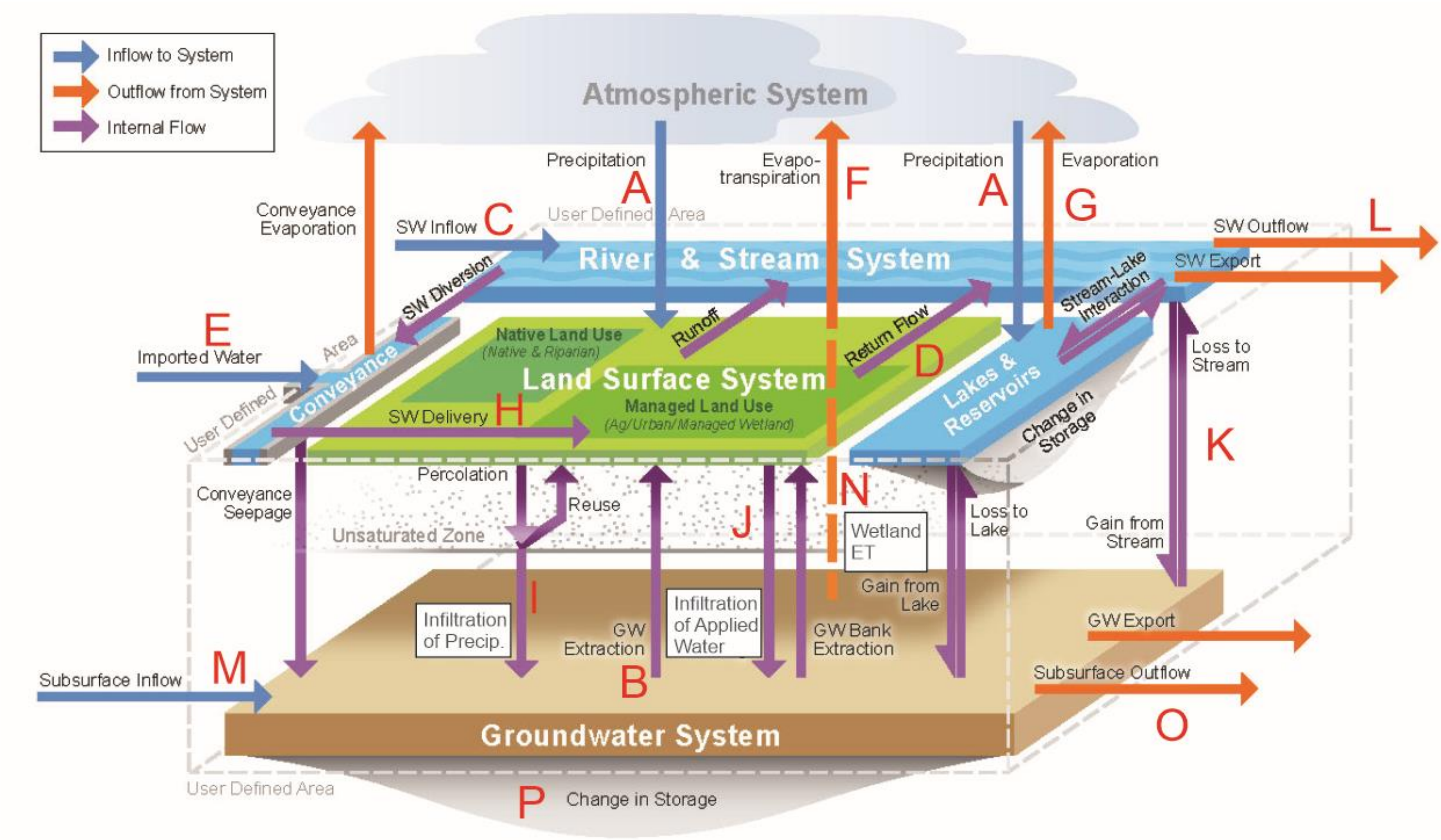


Figure 6-2. Components of the Water Budget. Source: Modified from Department of Water Resources (DWR, 2016)

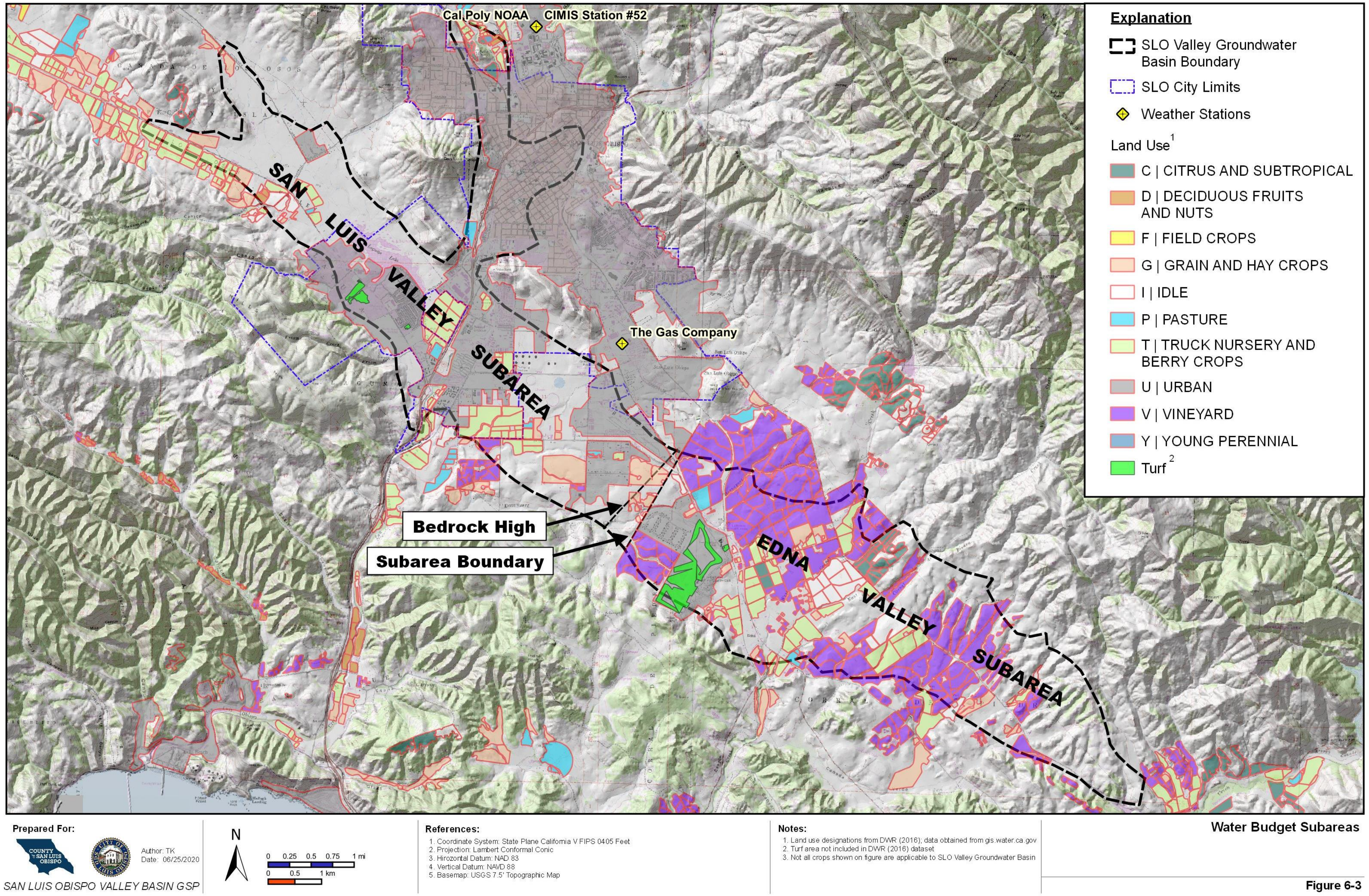


Figure 6-3. Water Budget Subareas

Table 6-1. Historical Water Budget - San Luis Valley Subarea

	SURFACE WATER INFLOW (AF)							SURFACE WATER OUTFLOW (AF)											GROUNDWATER INFLOW (AF)						GROUNDWATER OUTFLOW (AF)					
WATER YEAR	PRECIPITATION	GW EXTRACTIONS (URBAN)	GW EXTRACTIONS (AG)	STREAM INFLOW	WASTEWATER DISCHARGE	LOCAL IMPORTED SUPPLIES	TOTAL IN	ET OF PRECIPITATION	ET OF APPLIED WATER (URBAN)	ET OF APPLIED WATER (AG)	WETLAND/LAKE RIPARIAN ET	SURFACE WATER DELIVERY OFFSET	INFILTRATION OF PRECIPITATION	INFILT. OF APPLIED WATER (URBAN)	INFILT. OF APPLIED WATER (AG)	GW-SW INTERACTION	STREAM OUTFLOW	TOTAL OUT	INFILTRATION OF PRECIPITATION	INFILT. OF APPLIED WATER (URBAN)	INFILT. OF APPLIED WATER (AG)	GW-SW INTERACTION	SUBSURFACE INFLOW	TOTAL IN	GW EXTRACTIONS (URBAN)	GW EXTRACTIONS (AG)	WETLAND DIRECT ET	SUBSURFACE OUTFLOW	TOTAL OUT	CHANGE IN GW STORAGE (AF)
KEY	A	B	B	C	D	E		F	F	F	F/G	H	I	J	J	K	L		I	J	J	K	M		B	B	N	O		P
1987	7,720	410	1,300	6,410	5,520	8,490	29,850	7,450	2,850	1,050	740	5,520	220	530	260	1,090	10,150	29,860	220	530	260	1,090	340	2,440	410	1,300	1,050	120	2,880	-440
1988	10,080	430	1,750	9,660	5,320	8,180	35,420	8,540	2,780	1,410	780	5,320	1,260	520	350	1,640	12,840	35,440	1,260	520	350	1,640	340	4,110	430	1,750	1,320	120	3,620	490
1989	7,850	660	1,580	3,600	4,070	6,020	23,780	7,550	2,180	1,270	380	4,070	250	430	310	610	6,730	23,780	250	430	310	610	340	1,940	660	1,580	1,130	120	3,490	-1,550
1990	6,790	2,180	1,850	2,140	1,970	1,280	16,210	6,660	1,200	1,490	410	1,970	110	290	370	360	3,360	16,220	110	290	370	360	340	1,470	2,180	1,850	1,250	120	5,400	-3,930
1991	9,450	2,350	1,790	5,790	2,520	1,960	23,860	8,250	1,460	1,440	380	2,520	980	320	350	980	7,160	23,840	980	320	350	980	340	2,970	2,350	1,790	1,190	120	5,450	-2,480
1992	11,250	2,240	1,820	11,250	3,070	2,910	32,540	8,590	1,720	1,460	700	3,070	2,200	360	360	1,910	12,160	32,530	2,200	360	360	1,910	340	5,170	2,240	1,820	1,090	120	5,270	-100
1993	15,700	1,030	1,790	17,350	3,630	4,980	44,480	8,640	1,980	1,440	660	3,630	5,950	400	350	1,210	20,210	44,470	5,950	400	350	1,210	340	8,250	1,030	1,790	1,190	120	4,130	4,120
1994	8,620	790	1,690	7,640	3,750	5,400	27,890	7,900	2,030	1,360	740	3,750	580	410	330	1,300	9,480	27,880	580	410	330	1,300	340	2,960	790	1,690	1,090	120	3,690	-730
1995	16,930	660	1,870	26,690	3,780	5,590	55,520	8,630	2,060	1,500	540	3,780	6,070	410	370	1,870	30,300	55,530	6,070	410	370	1,870	340	9,060	660	1,870	1,110	120	3,760	5,300
1996	11,740	740	1,910	11,930	4,210	6,160	36,690	8,530	2,250	1,530	680	4,210	1,820	440	380	830	16,010	36,680	1,820	440	380	830	340	3,810	740	1,910	1,040	120	3,810	0
1997	15,930	780	2,280	17,670	4,400	6,440	47,500	8,580	2,370	1,830	690	4,400	2,690	460	450	530	25,510	47,510	2,690	460	450	530	340	4,470	780	2,280	1,290	120	4,470	0
1998	16,930	680	1,870	26,460	4,150	6,130	56,220	8,580	2,230	1,500	520	4,150	1,770	440	370	790	35,880	56,230	1,770	440	370	790	340	3,710	680	1,870	1,040	120	3,710	0
1999	8,670	660	2,510	7,720	4,350	6,470	30,380	7,870	2,340	2,020	810	4,350	650	450	500	1,310	10,100	30,400	650	450	500	1,310	340	3,250	660	2,510	1,330	120	4,620	-1,370
2000	12,620	670	1,810	13,130	4,410	6,560	39,200	8,530	2,360	1,450	670	4,410	2,950	450	360	920	17,090	39,190	2,950	450	360	920	340	5,020	670	1,810	1,040	120	3,640	1,380
2001	12,470	710	1,740	12,920	4,250	6,270	38,360	8,570	2,290	1,400	670	4,250	1,590	440	340	900	17,900	38,350	1,590	440	340	900	340	3,610	710	1,740	1,040	120	3,610	0
2002	7,510	630	1,850	6,130	4,530	6,340	26,990	7,240	2,000	1,490	770	4,530	220	440	360	1,040	8,900	26,990	220	440	360	1,040	340	2,400	630	1,850	1,140	120	3,740	-1,340
2003	11,630	610	1,470	11,780	4,610	6,300	36,400	8,640	1,860	1,180	680	4,610	2,490	440	290	820	15,390	36,400	2,490	440	290	820	340	4,380	610	1,470	1,040	120	3,240	1,140
2004	8,140	620	1,500	6,990	4,340	6,740	28,330	7,780	2,560	1,200	760	4,340	300	460	290	1,190	9,450	28,330	300	460	290	1,190	340	2,580	620	1,500	1,140	120	3,380	-800
2005	15,120	620	1,370	16,560	5,390	6,250	45,310	8,720	1,040	1,100	600	5,390	1,850	440	270	1,160	24,730	45,300	1,850	440	270	1,160	340	4,060	620	1,370	950	120	3,060	1,000
2006	13,180	610	1,280	6,500	4,950	6,280	32,800	8,710	1,500	1,030	660	4,950	1,580	440	250	450	13,220	32,790	1,580	440	250	450	340	3,060	610	1,280	1,050	120	3,060	0
2007	4,340	610	1,510	6,140	4,200	6,840	23,640	4,330	2,770	1,210	840	4,200	0	480	290	1,040	8,440	23,600	0	480	290	1,040	340	2,150	610	1,510	1,250	120	3,490	-1,340
2008	7,800	520	1,550	11,030	4,010	6,730	31,640	7,540	2,770	1,250	790	4,010	210	470	300	1,870	12,410	31,620	210	470	300	1,870	340	3,190	520	1,550	1,260	120	3,450	-260
2009	5,890	560	1,430	7,670	3,930	6,580	26,060	5,840	2,740	1,150	790	3,930	40	480	280	1,300	9,500	26,050	40	480	280	1,300	340	2,440	560	1,430	1,140	120	3,250	-810
2010	11,980	580	1,160	22,860	4,160	5,860	46,600	8,680	1,850	940	650	4,160	2,590	450	220	1,600	25,460	46,600	2,590	450	220	1,600	340	5,200	580	1,160	960	120	2,820	2,380
2011	16,930	530	1,260	21,360	4,480	5,530	50,090	8,750	1,170	1,020	610	4,480	1,400	430	240	640	31,350	50,090	1,400	430	240	640	340	3,050	530	1,260	1,150	120	3,060	-10
2012	8,470	530	1,420	5,430	3,950	5,770	25,570	7,940	1,910	1,150	770	3,950	430	450	270	920	7,770	25,560	430	450	270	920	340	2,410	530	1,420	1,200	120	3,270	-860
2013	5,290	510	1,790	3,670	4,060	6,330	21,650	5,260	2,320	1,450	430	4,060	30	470	340	620	6,670	21,650	30	470	340	620	340	1,800	510	1,790	1,350	120	3,770	-1,970
2014	5,220	540	1,560	3,270	3,660	6,190	20,440	5,190	2,620	1,260	420	3,660	20	470	300	560	5,940	20,440	20	470	300	560	340	1,690	540	1,560	1,290	120	3,510	-1,820
2015	5,960	400	1,680	1,620	3,420	5,750	18,830	5,900	2,300	1,360	410	3,420	50	440	330	270	4,340	18,820	50	440	330	270	340	1,430	400	1,680	1,270	120	3,470	-2,040
2016	10,150	400	1,690	4,850	3,550	5,490	26,130	8,490	1,920	1,360	730	3,550	1,350	430	330	820	7,130	26,110	1,350	430	330	820	340	3,270	400	1,690	1,170	120	3,380	-110
2017	16,930	400	1,550	18,450	4,400	5,370	47,100	8,730	960	1,250	590	4,400	6,910	440	300	550	22,970	47,100	6,910	440	300	550	340	8,540	400	1,550	1,260	120	3,330	5,210
2018	6,980	400	1,190	2,630	3,330	5,790	20,320	6,870	2,430	970	800	3,330	90	450	230	180	4,970	20,320	90	450	230	180	340	1,290	400	1,190	1,270	120	2,980	-1,690
2019	15,040	400	1,030	16,360	4,360	5,080	42,270	8,800	720	830	630	4,360	4,430	420	200	490	21,400	42,280	4,430	420	200	490	340	5,880	400	1,030	1,070	120	2,620	3,260

Type Year: Dry / Below Normal / Above Normal / Wet

AF = Acre-Feet; KEY = Referenced Components on Figure 6-2

Table 6-2. Historical Water Budget - Edna Valley Subarea

	SURFACE WATER INFLOW (AF)					SURFACE WATER OUTFLOW (AF)										GROUNDWATER INFLOW (AF)						GROUNDWATER OUTFLOW (AF)				
WATER YEAR	PRECIPITATION	GW EXTRACTIONS (URBAN)	GW EXTRACTIONS (AG)	STREAM INFLOW	TOTAL IN	ET OF PRECIPITATION	ET OF APPLIED WATER (URBAN)	ET OF APPLIED WATER (AG)	RIPARIAN ET	INFILTRATION OF PRECIPITATION	INFILT. OF APPLIED WATER (URBAN)	INFILT. OF APPLIED WATER (AG)	GW-SW INTERACTION	STREAM OUTFLOW	TOTAL OUT	INFILTRATION OF PRECIPITATION	INFILT. OF APPLIED WATER (URBAN)	INFILT. OF APPLIED WATER (AG)	GW-SW INTERACTION	SUBSURFACE INFLOW	TOTAL IN	GW EXTRACTIONS (URBAN)	GW EXTRACTIONS (AG)	SUBSURFACE OUTFLOW	TOTAL OUT	In some areas it is RMS in other areas RMSs, please ensure
KEY	**A**	**B**	**B**	**C**		**F**	**F**	**F**	**F**	**I**	**J**	**J**	**K**	**L**		**I**	**J**	**J**	**K**	**M**		**B**	**B**	**O**		**P**
1987	6,780	630	2,450	2,150	12,010	6,610	450	2,000	40	140	190	440	300	1,840	12,010	140	190	440	300	110	1,180	630	2,450	100	3,180	-2,000
1988	8,860	760	2,750	3,240	15,610	7,970	560	2,240	40	660	210	510	450	2,960	15,600	660	210	510	450	110	1,940	760	2,750	100	3,610	-1,670
1989	6,900	640	2,670	1,210	11,420	6,670	470	2,190	20	180	180	480	170	1,070	11,430	180	180	480	170	110	1,120	640	2,670	100	3,410	-2,290
1990	5,960	740	3,040	730	10,470	5,860	530	2,490	20	90	220	550	100	620	10,480	90	220	550	100	110	1,070	740	3,040	100	3,880	-2,810
1991	8,300	760	2,810	1,940	13,810	7,550	530	2,300	20	570	240	510	270	1,840	13,830	570	240	510	270	110	1,700	760	2,810	100	3,670	-1,970
1992	9,880	790	2,810	3,770	17,250	8,030	530	2,300	40	1,460	270	510	530	3,590	17,260	1,460	270	510	530	110	2,880	790	2,810	100	3,700	-820
1993	13,780	840	2,710	5,810	23,140	8,000	570	2,220	40	4,800	290	490	810	5,940	23,160	4,800	290	490	810	110	6,500	840	2,710	100	3,650	2,850
1994	7,570	760	2,640	2,560	13,530	7,050	500	2,170	40	400	270	470	360	2,280	13,540	400	270	470	360	110	1,610	760	2,640	100	3,500	-1,890
1995	14,870	820	2,820	8,930	27,440	7,930	550	2,320	40	5,740	280	500	1,250	8,840	27,450	5,740	280	500	1,250	110	7,880	820	2,820	100	3,740	4,140
1996	10,310	850	3,000	3,990	18,150	7,880	550	2,470	40	1,920	310	530	560	3,900	18,160	1,920	310	530	560	110	3,430	850	3,000	100	3,950	-520
1997	13,990	1,030	3,460	5,910	24,390	7,840	690	2,850	40	5,010	350	610	830	6,190	24,410	5,010	350	610	830	110	6,910	1,030	3,460	100	4,590	2,320
1998	14,870	860	3,000	9,730	28,460	7,790	570	2,480	40	5,750	300	520	1,360	9,660	28,470	5,750	300	520	1,360	110	8,040	860	3,000	100	3,960	4,080
1999	7,620	1,020	3,720	2,590	14,950	6,990	690	3,070	40	470	340	650	360	2,340	14,950	470	340	650	360	110	1,930	1,020	3,720	100	4,840	-2,910
2000	11,080	940	2,700	4,400	19,120	7,710	600	2,230	40	2,650	350	480	620	4,470	19,150	2,650	350	480	620	110	4,210	940	2,700	100	3,740	470
2001	10,950	980	3,320	4,330	19,580	7,670	630	2,750	40	2,550	360	570	610	4,400	19,580	2,550	360	570	610	110	4,200	980	3,320	100	4,400	-200
2002	6,600	960	3,220	2,060	12,840	6,400	630	2,660	40	170	340	570	290	1,760	12,860	170	340	570	290	110	1,480	960	3,220	100	4,280	-2,800
2003	10,220	870	3,030	3,950	18,070	7,600	570	2,500	40	2,000	320	520	550	3,970	18,070	2,000	320	520	550	110	3,500	870	3,030	100	4,000	-500
2004	7,150	970	3,040	2,340	13,500	6,740	630	2,520	40	320	350	530	330	2,070	13,530	320	350	530	330	110	1,640	970	3,040	100	4,110	-2,470
2005	13,280	840	2,870	5,540	22,530	7,610	550	2,370	40	4,450	300	500	780	5,930	22,530	4,450	300	500	780	110	6,140	840	2,870	100	3,810	2,330
2006	11,570	900	3,040	2,180	17,690	7,580	590	2,520	40	3,100	320	530	310	2,730	17,720	3,100	320	530	310	110	4,370	900	3,040	100	4,040	330
2007	3,810	1,180	3,830	2,160	10,980	3,800	770	3,170	40	0	430	660	300	1,820	10,990	0	430	660	300	110	1,500	1,180	3,830	100	5,110	-3,610
2008	6,850	1,210	3,750	3,750	15,560	6,580	780	3,100	40	220	440	650	520	3,230	15,560	220	440	650	520	110	1,940	1,210	3,750	100	5,060	-3,120
2009	5,170	950	3,660	2,740	12,520	5,100	650	3,040	40	50	310	620	380	2,330	12,520	50	310	620	380	110	1,470	950	3,660	100	4,710	-3,240
2010	10,520	820	3,360	7,490	22,190	7,560	550	2,790	40	2,260	270	570	1,050	7,100	22,190	2,260	270	570	1,050	110	4,260	820	3,360	100	4,280	-20
2011	14,870	840	3,330	7,840	26,880	7,550	580	2,760	40	5,760	270	570	1,100	8,260	26,890	5,760	270	570	1,100	110	7,810	840	3,330	100	4,270	3,540
2012	7,440	940	3,560	1,810	13,750	6,830	650	2,950	40	450	290	610	250	1,660	13,730	450	290	610	250	110	1,710	940	3,560	100	4,600	-2,890
2013	4,640	1,040	3,780	1,260	10,720	4,600	740	3,120	20	40	310	660	180	1,070	10,740	40	310	660	180	110	1,300	1,040	3,780	100	4,920	-3,620
2014	4,590	960	3,580	1,120	10,250	4,550	680	2,960	20	30	280	620	160	950	10,250	30	280	620	160	110	1,200	960	3,580	100	4,640	-3,440
2015	5,230	880	4,230	490	10,830	5,160	650	3,500	20	60	230	720	70	410	10,820	60	230	720	70	110	1,190	880	4,230	100	5,210	-4,020
2016	8,920	790	3,200	1,560	14,470	7,550	580	2,680	40	980	220	530	220	1,680	14,480	980	220	530	220	110	2,060	790	3,200	100	4,090	-2,030
2017	14,870	850	3,640	6,240	25,600	7,570	640	3,030	40	5,730	220	610	870	6,890	25,600	5,730	220	610	870	110	7,540	850	3,640	100	4,590	2,950
2018	6,130	880	3,550	650	11,210	6,020	650	2,960	40	90	240	590	90	540	11,220	90	240	590	90	110	1,120	880	3,550	100	4,530	-3,410
2019	13,210	770	3,350	5,480	22,810	7,630	580	2,800	40	4,370	210	550	770	5,870	22,820	4,370	210	550	770	110	6,010	770	3,350	100	4,220	1,790

Type Year: Dry / Below Normal / Above Normal / Wet

AF = Acre-Feet; KEY = Referenced Components on Figure 6-2

Table 6-3. Historical Water Budget - San Luis Obispo Valley Groundwater Basin

	SURFACE WATER INFLOW (GW)							SURFACE WATER OUTFLOW (GW)												GROUNDWATER INFLOW (GW)						GROUNDWATER OUTFLOW (GW)					
WATER YEAR	PRECIPITATION	GW EXTRACTIONS (URBAN)	GW EXTRACTIONS (AG)	STREAM INFLOW	WASTEWATER DISCHARGE	LOCAL IMPORTED SUPPLIES	TOTAL IN	ET OF PRECIPITATION	ET OF APPLIED WATER (URBAN)	ET OF APPLIED WATER (AG)	WETLAND/LAKE RIPARIAN ET	SURFACE WATER DELIVERIES	INFILTRATION OF PRECIPITATION	INFILT. OF APPLIED WATER (URBAN)	INFILT. OF APPLIED WATER (AG)	GW-SW INTERACTION	STREAM OUTFLOW	TOTAL OUT	INFILTRATION OF PRECIPITATION	INFILT. OF APPLIED WATER (URBAN)	INFILT. OF APPLIED WATER(AG)	GW-SW INTERACTION	SUBSURFACE INFLOW	TOTAL IN	GW EXTRACTIONS (URBAN)	GW EXTRACTIONS (AG)	WETLAND DIRECT ET	SUBSURFACE OUTFLOW	TOTAL OUT	CHANGE IN GW STORAGE (AF)
KEY	A	B	B	C	D	E		F	F	F	F/G	H	I	J	J	K	L		I	J	J	K	M		B	B	N	O		P
1987	14,500	1,040	3,750	8,560	5,520	8,490	41,860	14,060	3,300	3,050	780	5,520	360	720	700	1,390	11,990	41,870	360	720	700	1,390	450	3,620	1,040	3,750	1,050	220	6,060	-2,440
1988	18,940	1,190	4,500	12,900	5,320	8,180	51,030	16,510	3,340	3,650	820	5,320	1,920	730	860	2,090	15,800	51,040	1,920	730	860	2,090	450	6,050	1,190	4,500	1,320	220	7,230	-1,180
1989	14,750	1,300	4,250	4,810	4,070	6,020	35,200	14,220	2,650	3,460	400	4,070	430	610	790	780	7,800	35,210	430	610	790	780	450	3,060	1,300	4,250	1,130	220	6,900	-3,840
1990	12,750	2,920	4,890	2,870	1,970	1,280	26,680	12,520	1,730	3,980	430	1,970	200	510	920	460	3,980	26,700	200	510	920	460	450	2,540	2,920	4,890	1,250	220	9,280	-6,740
1991	17,750	3,110	4,600	7,730	2,520	1,960	37,670	15,800	1,990	3,740	400	2,520	1,550	560	860	1,250	9,000	37,670	1,550	560	860	1,250	450	4,670	3,110	4,600	1,190	220	9,120	-4,450
1992	21,130	3,030	4,630	15,020	3,070	2,910	49,790	16,620	2,250	3,760	740	3,070	3,660	630	870	2,440	15,750	49,790	3,660	630	870	2,440	450	8,050	3,030	4,630	1,090	220	8,970	-920
1993	29,480	1,870	4,500	23,160	3,630	4,980	67,620	16,640	2,550	3,660	700	3,630	10,750	690	840	2,020	26,150	67,630	10,750	690	840	2,020	450	14,750	1,870	4,500	1,190	220	7,780	6,970
1994	16,190	1,550	4,330	10,200	3,750	5,400	41,420	14,950	2,530	3,530	780	3,750	980	680	800	1,660	11,760	41,420	980	680	800	1,660	450	4,570	1,550	4,330	1,090	220	7,190	-2,620
1995	31,800	1,480	4,690	35,620	3,780	5,590	82,960	16,560	2,610	3,820	580	3,780	11,810	690	870	3,120	39,140	82,980	11,810	690	870	3,120	450	16,940	1,480	4,690	1,110	220	7,500	9,440
1996	22,050	1,590	4,910	15,920	4,210	6,160	54,840	16,410	2,800	4,000	720	4,210	3,740	750	910	1,390	19,910	54,840	3,740	750	910	1,390	450	7,240	1,590	4,910	1,040	220	7,760	-520
1997	29,920	1,810	5,740	23,580	4,400	6,440	71,890	16,420	3,060	4,680	730	4,400	7,700	810	1,060	1,360	31,700	71,920	7,700	810	1,060	1,360	450	11,380	1,810	5,740	1,290	220	9,060	2,320
1998	31,800	1,540	4,870	36,190	4,150	6,130	84,680	16,370	2,800	3,980	560	4,150	7,520	740	890	2,150	45,540	84,700	7,520	740	890	2,150	450	11,750	1,540	4,870	1,040	220	7,670	4,080
1999	16,290	1,680	6,230	10,310	4,350	6,470	45,330	14,860	3,030	5,090	850	4,350	1,120	790	1,150	1,670	12,440	45,350	1,120	790	1,150	1,670	450	5,180	1,680	6,230	1,330	220	9,460	-4,280
2000	23,700	1,610	4,510	17,530	4,410	6,560	58,320	16,240	2,960	3,680	710	4,410	5,600	800	840	1,540	21,560	58,340	5,600	800	840	1,540	450	9,230	1,610	4,510	1,040	220	7,380	1,850
2001	23,420	1,690	5,060	17,250	4,250	6,270	57,940	16,240	2,920	4,150	710	4,250	4,140	800	910	1,510	22,300	57,930	4,140	800	910	1,510	450	7,810	1,690	5,060	1,040	220	8,010	-200
2002	14,110	1,590	5,070	8,190	4,530	6,340	39,830	13,640	2,630	4,150	810	4,530	390	780	930	1,330	10,660	39,850	390	780	930	1,330	450	3,880	1,590	5,070	1,140	220	8,020	-4,140
2003	21,850	1,480	4,500	15,730	4,610	6,300	54,470	16,240	2,430	3,680	720	4,610	4,490	760	810	1,370	19,360	54,470	4,490	760	810	1,370	450	7,880	1,480	4,500	1,040	220	7,240	640
2004	15,290	1,590	4,540	9,330	4,340	6,740	41,830	14,520	3,190	3,720	800	4,340	620	810	820	1,520	11,520	41,860	620	810	820	1,520	450	4,220	1,590	4,540	1,140	220	7,490	-3,270
2005	28,400	1,460	4,240	22,100	5,390	6,250	67,840	16,330	1,590	3,470	640	5,390	6,300	740	770	1,940	30,660	67,830	6,300	740	770	1,940	450	10,200	1,460	4,240	950	220	6,870	3,330
2006	24,750	1,510	4,320	8,680	4,950	6,280	50,490	16,290	2,090	3,550	700	4,950	4,680	760	780	760	15,950	50,510	4,680	760	780	760	450	7,430	1,510	4,320	1,050	220	7,100	330
2007	8,150	1,790	5,340	8,300	4,200	6,840	34,620	8,130	3,540	4,380	880	4,200	0	910	950	1,340	10,260	34,590	0	910	950	1,340	450	3,650	1,790	5,340	1,250	220	8,600	-4,950
2008	14,650	1,730	5,300	14,780	4,010	6,730	47,200	14,120	3,550	4,350	830	4,010	430	910	950	2,390	15,640	47,180	430	910	950	2,390	450	5,130	1,730	5,300	1,260	220	8,510	-3,380
2009	11,060	1,510	5,090	10,410	3,930	6,580	38,580	10,940	3,390	4,190	830	3,930	90	790	900	1,680	11,830	38,570	90	790	900	1,680	450	3,910	1,510	5,090	1,140	220	7,960	-4,050
2010	22,500	1,400	4,520	30,350	4,160	5,860	68,790	16,240	2,400	3,730	690	4,160	4,850	720	790	2,650	32,560	68,790	4,850	720	790	2,650	450	9,460	1,400	4,520	960	220	7,100	2,360
2011	31,800	1,370	4,590	29,200	4,480	5,530	76,970	16,300	1,750	3,780	650	4,480	7,160	700	810	1,740	39,610	76,980	7,160	700	810	1,740	450	10,860	1,370	4,590	1,150	220	7,330	3,530
2012	15,910	1,470	4,980	7,240	3,950	5,770	39,320	14,770	2,560	4,100	810	3,950	880	740	880	1,170	9,430	39,290	880	740	880	1,170	450	4,120	1,470	4,980	1,200	220	7,870	-3,750
2013	9,930	1,550	5,570	4,930	4,060	6,330	32,370	9,860	3,060	4,570	450	4,060	70	780	1,000	800	7,740	32,390	70	780	1,000	800	450	3,100	1,550	5,570	1,350	220	8,690	-5,590
2014	9,810	1,500	5,140	4,390	3,660	6,190	30,690	9,740	3,300	4,220	440	3,660	50	750	920	720	6,890	30,690	50	750	920	720	450	2,890	1,500	5,140	1,290	220	8,150	-5,260
2015	11,190	1,280	5,910	2,110	3,420	5,750	29,660	11,060	2,950	4,860	430	3,420	110	670	1,050	340	4,750	29,640	110	670	1,050	340	450	2,620	1,280	5,910	1,270	220	8,680	-6,060
2016	19,070	1,190	4,890	6,410	3,550	5,490	40,600	16,040	2,500	4,040	770	3,550	2,330	650	860	1,040	8,810	40,590	2,330	650	860	1,040	450	5,330	1,190	4,890	1,170	220	7,470	-2,140
2017	31,800	1,250	5,190	24,690	4,400	5,370	72,700	16,300	1,600	4,280	630	4,400	12,640	660	910	1,420	29,860	72,700	12,640	660	910	1,420	450	16,080	1,250	5,190	1,260	220	7,920	8,160
2018	13,110	1,280	4,740	3,280	3,330	5,790	31,530	12,890	3,080	3,930	840	3,330	180	690	820	270	5,510	31,540	180	690	820	270	450	2,410	1,280	4,740	1,270	220	7,510	-5,100
2019	28,250	1,170	4,380	21,840	4,360	5,080	65,080	16,430	1,300	3,630	670	4,360	8,800	630	750	1,260	27,270	65,100	8,800	630	750	1,260	450	11,890	1,170	4,380	1,070	220	6,840	5,050

Type Year: Dry / Below Normal / Above Normal / Wet

AF = Acre-Feet; KEY = Referenced Components on Figure 6-2

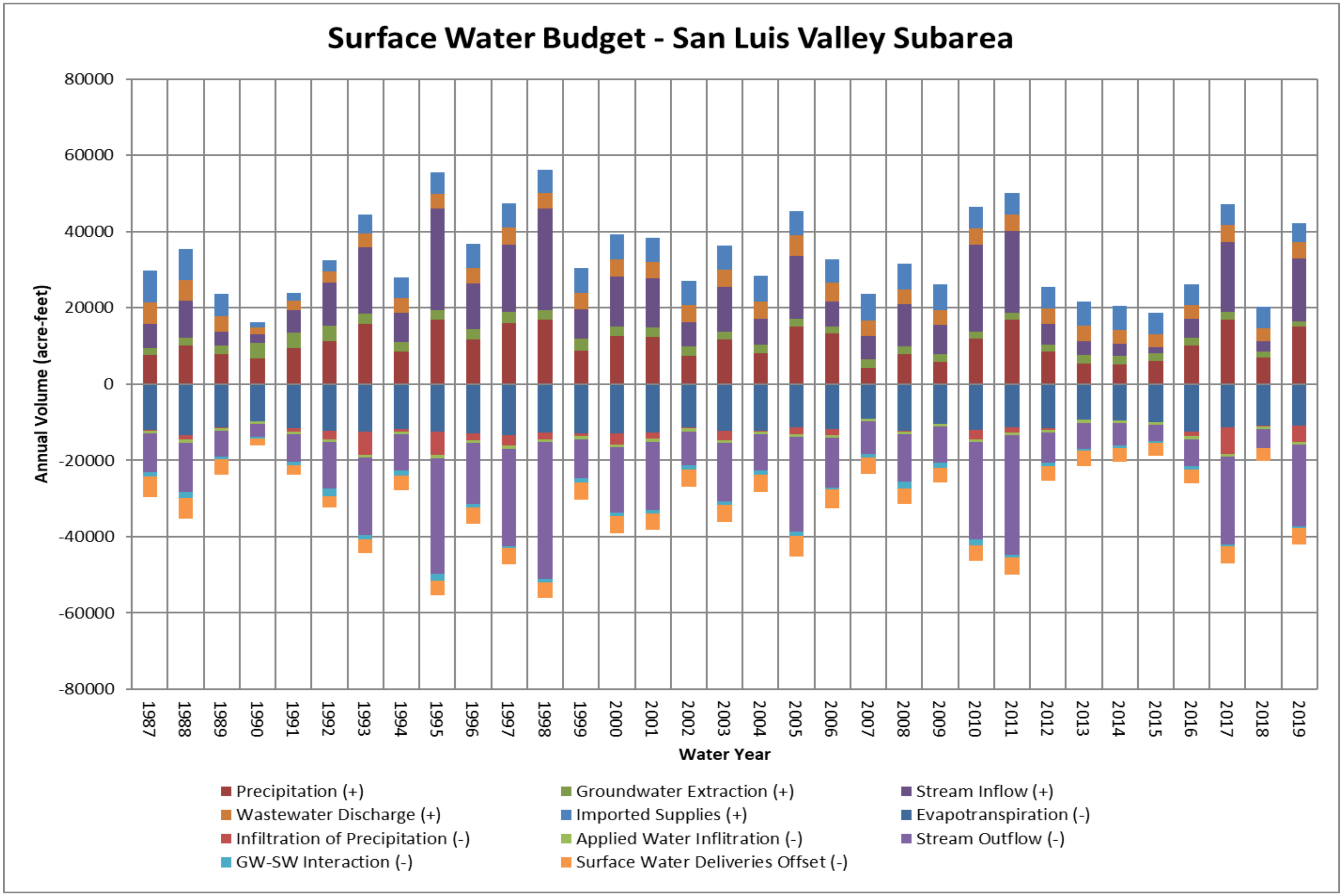


Figure 6-4. Surface Water Budget – San Luis Valley Subarea

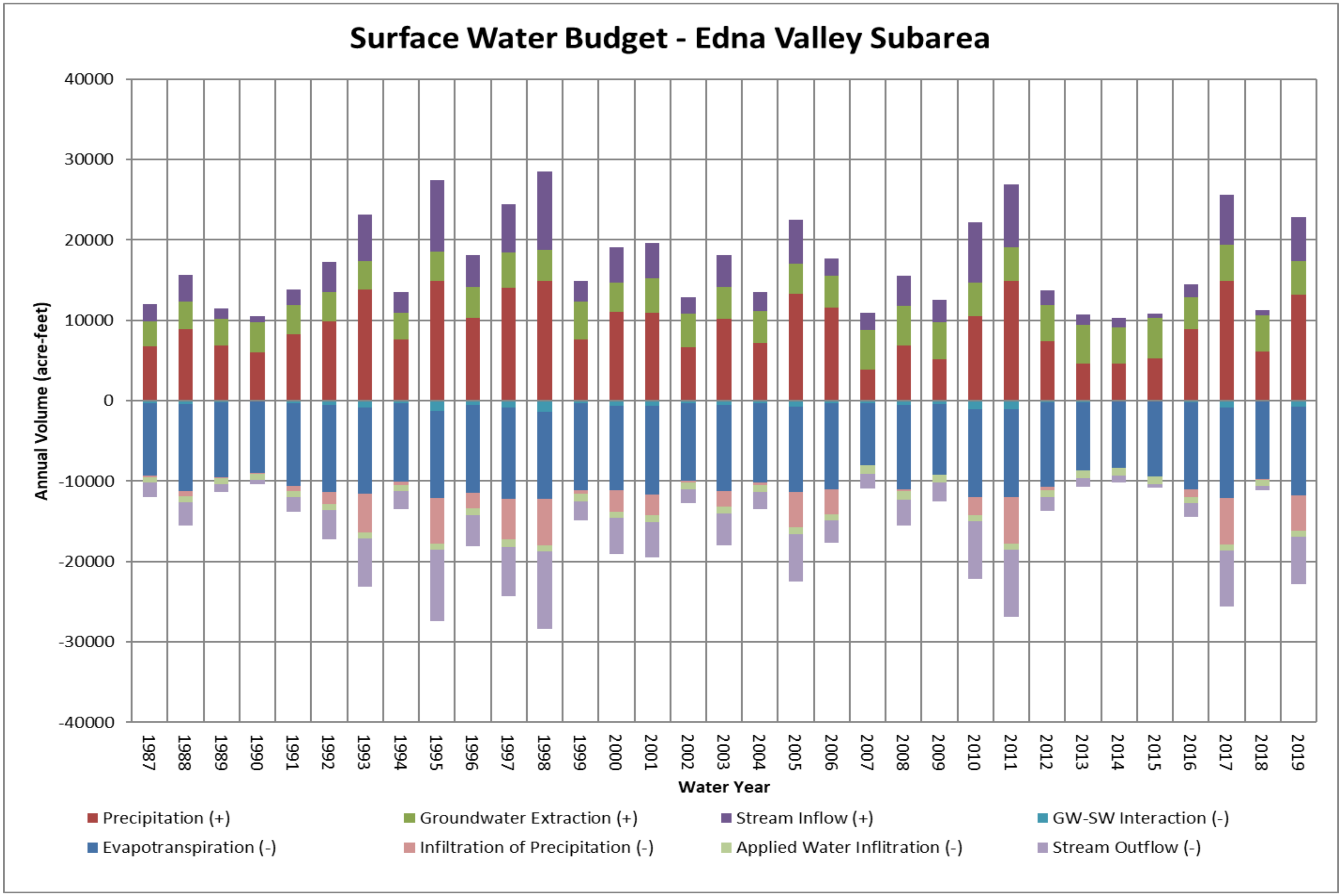


Figure 6-5. Surface Water Budget – Edna Valley Subarea

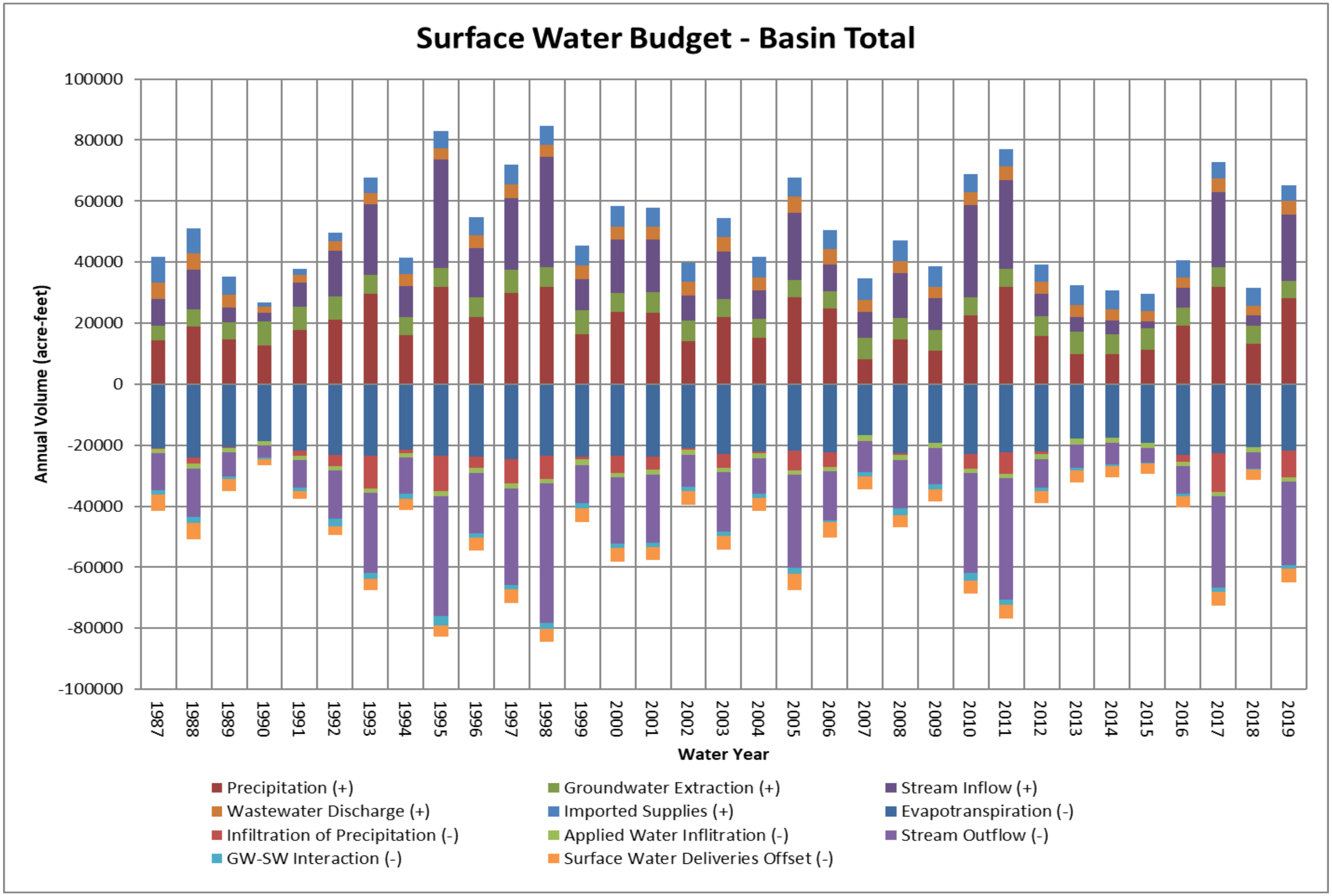


Figure 6-6. Surface Water Budget – Basin Total

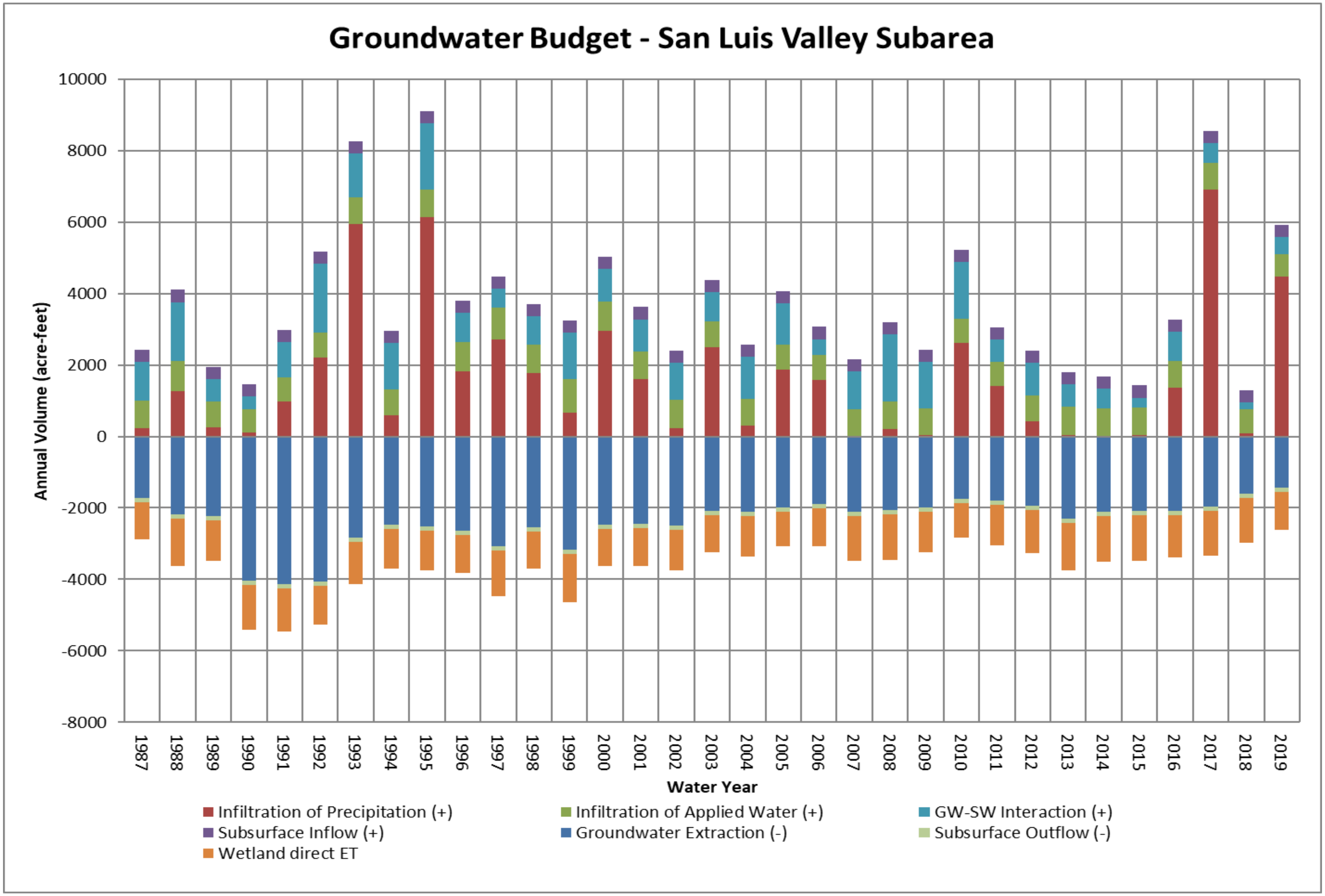


Figure 6-7. Groundwater Budget – San Luis Valley Subarea

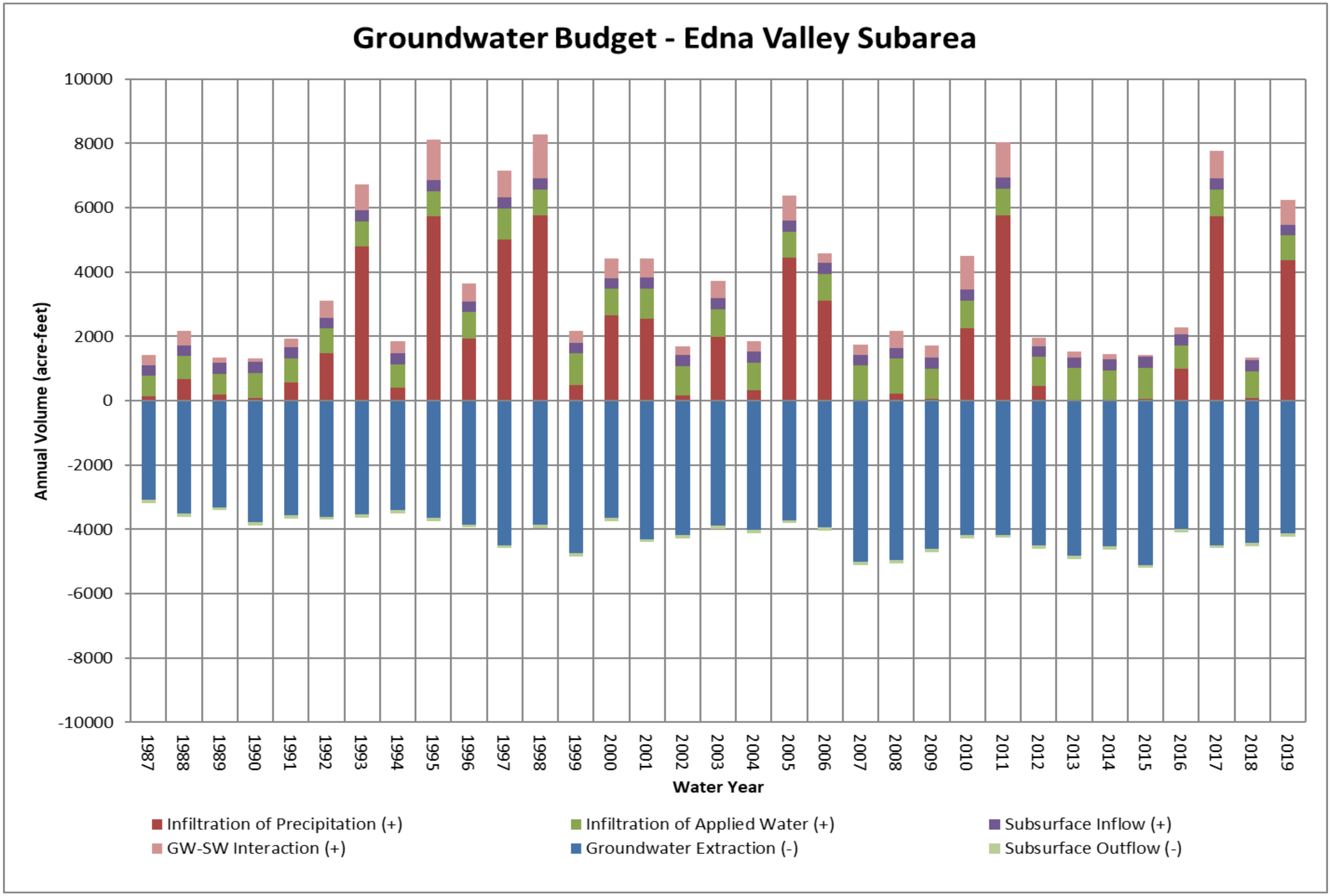


Figure 6-8. Groundwater Budget – Edna Valley Subarea

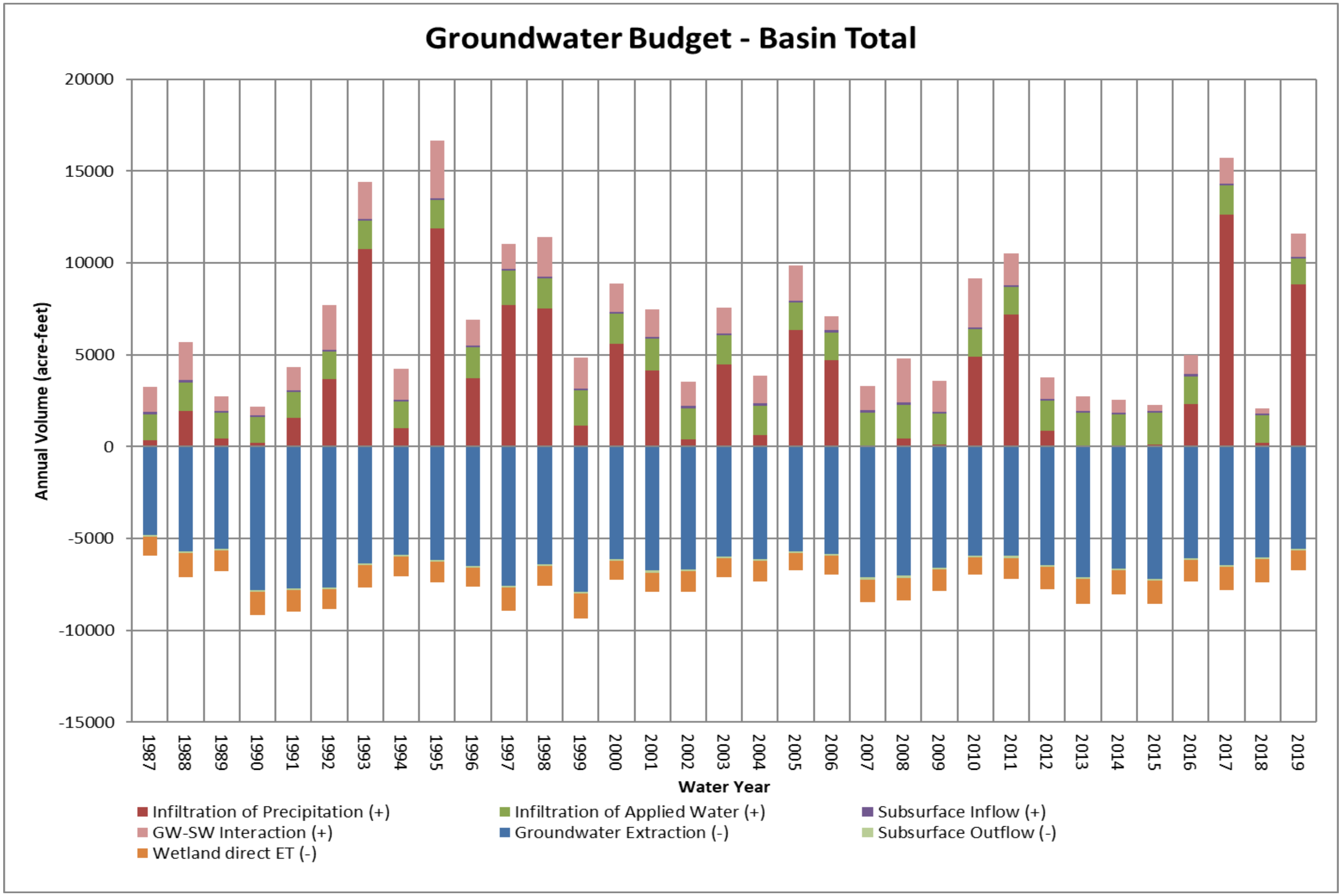


Figure 6-9. Groundwater Budget - Basin Total

6.2. Climate

Climate is one of the principal measures of water supply conditions and is used for hydrologic base period definition and for developing evapotranspiration estimates. The main component of climate monitoring in the Basin is rainfall, with records at the Cal Poly NOAA Station (formerly Cal Poly #1) beginning in the 1870-71 rainfall year. Rainfall is used in the water budget for establishing the hydrologic base period needed for representing long-term water supply conditions.

Another climate parameter used in the water budget is evapotranspiration. Evapotranspiration is calculated from a combination of monitored parameters, such as air temperature, wind speed, solar radiation, vapor pressure, and relative humidity. These parameters, along with precipitation, have been monitored at CIMIS Station #52 (San Luis Obispo – Cal Poly) since 1986. The water budget uses crop evapotranspiration for estimating the applied irrigation requirements for crops (Section 6.3.4.2). Cal Poly, the San Luis Valley, and the Edna Valley are all within DWR reference evapotranspiration Zone 6, which is one of 18 climate zones in California based on long-term monthly average reference evapotranspiration (CIMS, 2019).

6.2.1. Historical Climate/Base Period

The historical rainfall record at the Cal Poly NOAA Station has been used to define a period of years, referred to as a base period, which represents long-term hydrologic conditions. As described by DWR (DWR, 2002):

> ***The base period should be representative of long-term hydrologic conditions, encompassing dry, wet, and average years of precipitation. It must be contained in the historical record and should include recent cultural conditions to assist in determining projected Basin operations. To minimize the amount of water in transit in the zone of aeration, the beginning and end of the base period should be preceded by comparatively similar rainfall quantities.***

The historical rainfall record for the Cal Poly NOAA Station, which is the longest record in the San Luis Obispo area, was presented in Figure 3-11. The water year in San Luis Obispo County for rainfall runs from July 1 through June 30 (also referred to as rainfall year), while other hydrologic data is reported from October 1 through September 30 (San Luis Obispo County Department of Public Works, 2005). These conventions are maintained for the water budget, and water years are referenced herein based on the ending year.

The hydrologic base period selected to represent historical climatic conditions for the Basin encompasses the years 1987 through 2019 (33 years). Average precipitation at the Cal Poly NOAA gage over this base period was 21.76 inches, compared to the long-term average of 21.95 inches, and included wet, average, and dry periods (Figure 6-10). These periods are visually defined by the movement of the cumulative departure from mean precipitation curve, which declines over dry periods, is flat through average periods, and rises over wet periods.

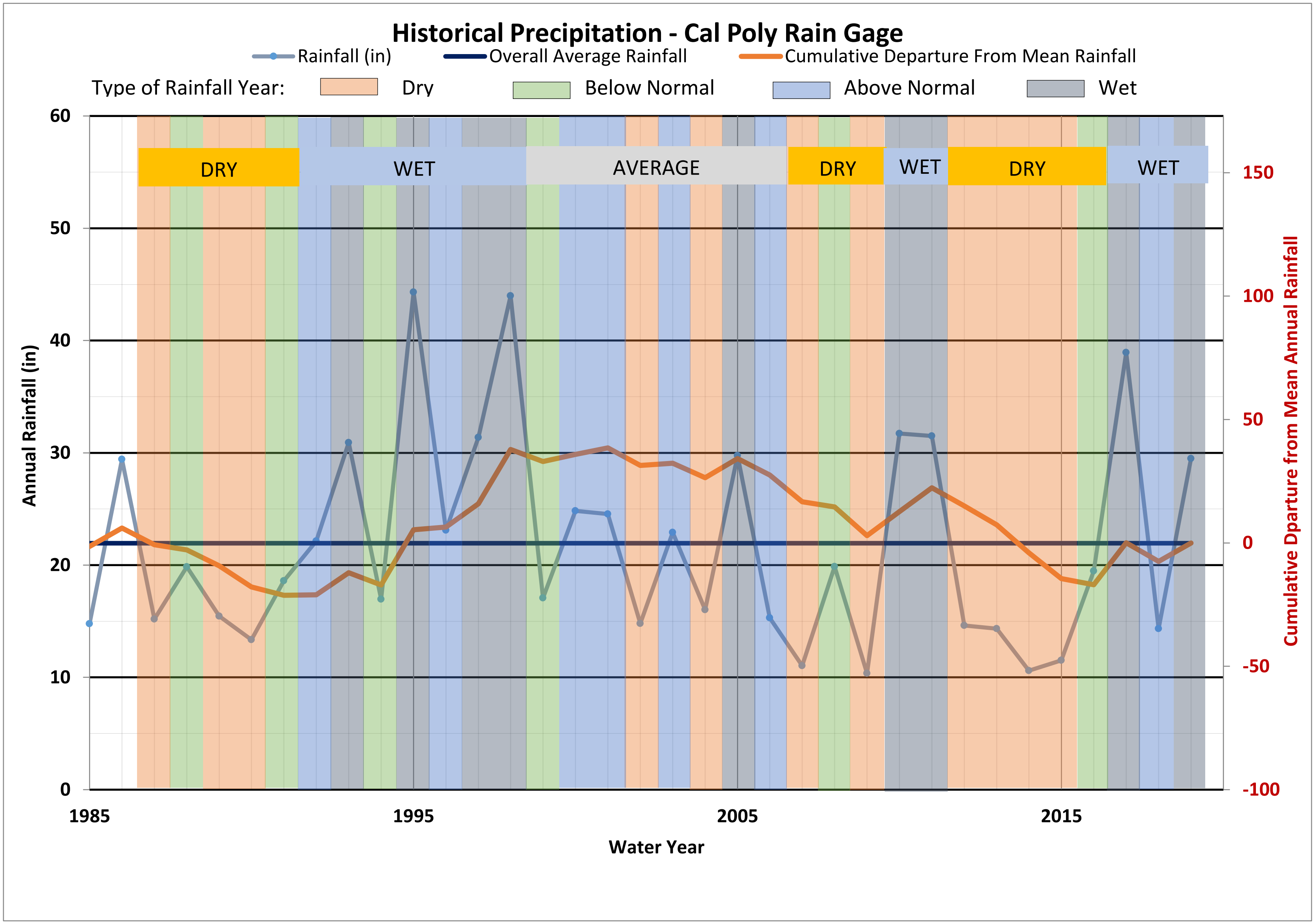


Figure 6-10. 1987-2019 Historical Base Period Climate

Water year types for this water budget have been developed and classified based on annual precipitation as a percentage of the previous 30-year average precipitation. Each July 1 through June 30 rainfall year of the historical base period was given a ranking of 1 (wettest) through 30 (driest) based on a comparison to a 30-year (rolling) data set. The minimum precipitation threshold for wet type years was assigned based on the average for the 10th ranked year (26.3 inches). The maximum precipitation threshold for dry type years was assigned based on the average for the 21st ranked year (16.8 inches). Below normal (from 16.8 to less than 20.5 inches) represents the 16th through 20th ranked years, while above normal (from 20.5 to 26.3 inches) represents the 10th through 15th ranked years. Note that the division between below normal and above normal rainfall (20.5 inches) is less than the average over the base period (21.76 inches) because there are more below average rainfall years than above average years. The water year types were developed from Cal Poly NOAA rainfall records, with one exception. The exception is the 2006 rainfall year, which would be classified as dry based on 15.31 inches reported at Cal Poly NOAA, but which is considered above normal when reviewing other local rain gages, including the Gas Company rain gage (23.35 inches in 2006).

The base period includes recent cultural conditions, such as expanded recycled water use by the City and water conservation by Basin users in response to the recent drought period. Differences between water in transit in the vadose zone (deep percolation of precipitation and stream seepage) are minimal, based on comparing the two rainfall years leading up to the beginning and ending of the base period. The 1985 and 1986 rainfall years leading in the base period have 14.77 inches and 29.43 inches, respectively, compared to 14.34 and 29.48 inches of rainfall at the end of the base period in 2018 and 2019 (Figure 6-10).

There are other rainfall gages in the Basin (Table 3-5 and Figure 3-10), and an isohyetal map of average annual rainfall is shown in Figure 4-3. The average annual precipitation across the Basin between 1981 and 2010 was approximately 19 inches (Figure 4-3), compared to the Cal Poly NOAA rainfall gage, which averaged 23.03 inches over that same period.

Although the water budget uses the Cal Poly NOAA gage (formerly Cal Poly #1) to identify the historical base period and water year types due to the extensive period of record, the Gas Company rain gage is used in water budget calculations that involve precipitation volumes to account for the difference between rainfall at the Cal Poly NOAA gage and the Basin. A correlation between rainfall data at the Gas Company and Cal Poly NOAA gages was performed to estimate rainfall prior to 2006 for the historical water budget (Figure 6-11). Based on linear regression using data recorded between 2006 and 2019, rainfall at the Gas Company gage is approximately 90 percent of rainfall at the Cal Poly NOAA gage. No precipitation data was recorded for the Gas Company rain gage prior to 2006, and the 90 percent correlation was used to estimate precipitation at the gage between 1987 and 2005 to complete the historical base period. Climate data from CIMIS Station #52 (located within same enclosure as the Cal Poly NOAA rain gage) has been used for evapotranspiration and applied agricultural water estimates.

Table 6-4 presents the annual rainfall for the historical water budget. Average annual rainfall within the Basin over the historical base period is estimated to be 19.6 inches. This average closely matches the estimated value for average rainfall across the Basin on the 30-year isohyetal map (Figure 4-3).

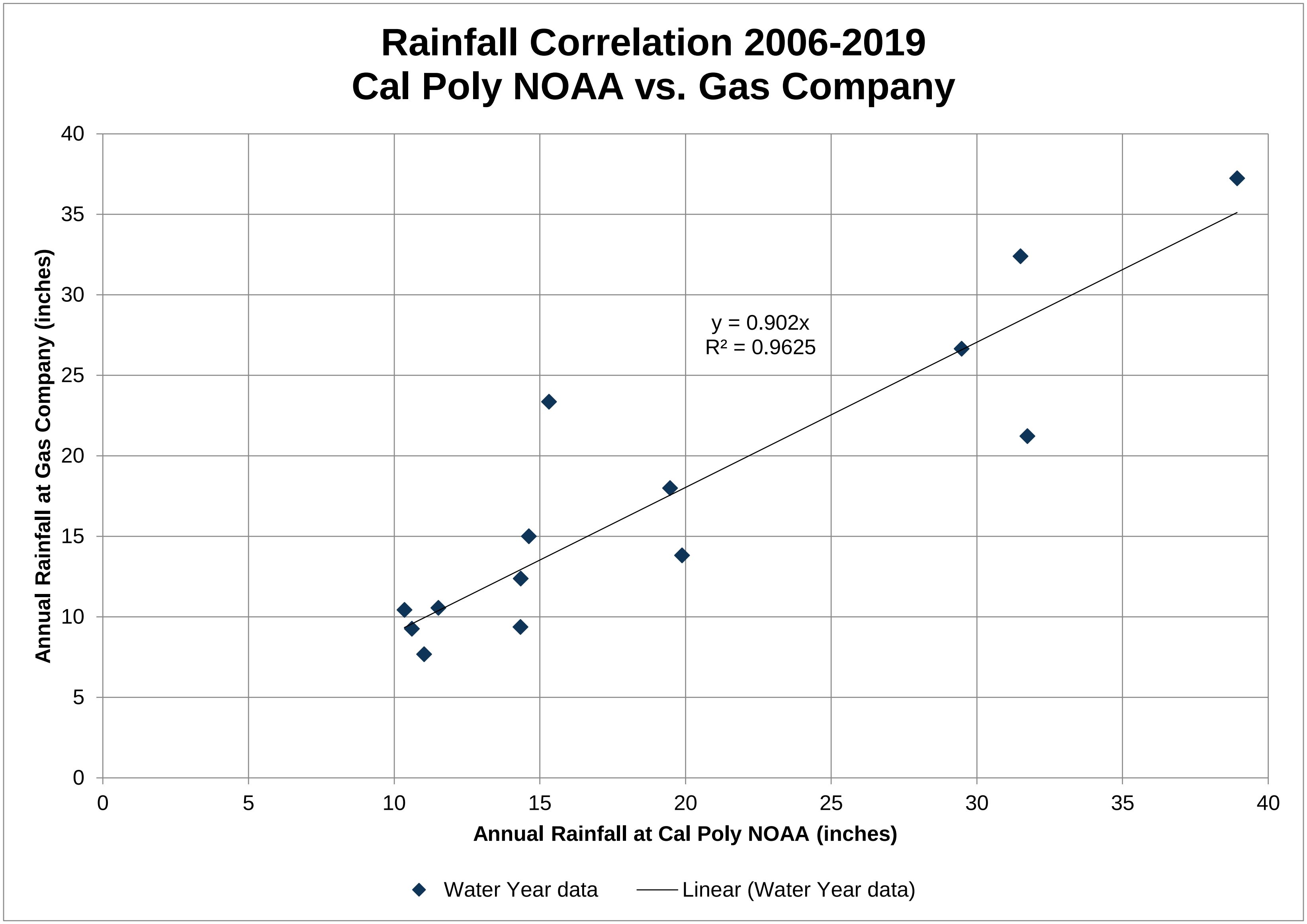


Figure 6-11. Rainfall Correlation Cal Poly NOAA vs. Gas Company

Table 6-4. Historical Base Period Rainfall

YEAR	TYPE	CAL POLY NOAA RAINFALL (IN.)	GAS COMPANY RAINFALL (IN.)
1987	Dry	15.19	13.67
1988	Below Normal	19.85	17.87
1989	Dry	15.46	13.91
1990	Dry	13.36	12.02
1991	Below Normal	18.6	16.74
1992	Above Normal	22.14	19.93
1993	Wet	30.9	27.81
1994	Below Normal	16.96	15.26
1995	Wet	44.31	39.88
1996	Above Normal	23.11	20.8
1997	Wet	31.36	28.22
1998	Wet	43.98	39.58
1999	Below Normal	17.07	15.36
2000	Above Normal	24.84	22.36
2001	Above Normal	24.54	22.09
2002	Dry	14.79	13.31
2003	Above Normal	22.9	20.61
2004	Dry	16.02	14.42
2005	Wet	29.76	26.78
2006	Above Normal*	15.31	23.35
2007	Dry	11.03	7.68
2008	Below Normal	19.88	13.82
2009	Dry	10.35	10.43
2010	Wet	31.73	21.22
2011	Wet	31.5	32.4
2012	Dry	14.62	15
2013	Dry	14.33	9.37
2014	Dry	10.61	9.25
2015	Dry	11.52	10.55
2016	Below Normal	19.47	17.99
2017	Wet	38.93	37.23
2018	Dry	14.34	12.37
2019	Wet	29.48	26.65
AVERAGE		**21.8**	**19.6**

Gas Company Estimates in blue (approximately 90% of Cal Poly)

*2006 type year based on Gas Company gage reporting

6.3. Water Budget Data Sources

The following sources and types of data have been used for the water budget:

- Hydrogeologic and geologic studies and maps
- Groundwater monitoring reports
- County stream flow gages
- County and NOAA precipitation stations
- PRISM 30-year normal dataset (1981-2010)
- CIMIS weather station data
- Aerial Imagery
- County water level monitoring program
- San Luis Obispo City, County and DWR land use data and planning documentation
- County Ag commissioner's office data sets
- County Water Master Plan
- Geotracker Groundwater Information System
- Stakeholder supplied information
- Environmental Impact Reports
- Water rights filings
- SRWQCB Drinking Water Division Water systems
- Wastewater discharge reports

6.4. Historical Water Budget

In accordance with GSP regulations, the historical water budget shall quantify the following, either through direct measurement or estimates based on data (reference to location of data in Chapter 6 also listed):

1. Total surface water entering and leaving a Basin by water source type (Table 6-3).
2. Inflow to the groundwater system by water source type, including subsurface groundwater inflow and infiltration of precipitation, applied water, and surface water systems, such as lakes, streams, rivers, canals, springs, and conveyance systems (Table 6-3).
3. Outflows from the groundwater system by water use sector, including evapotranspiration, groundwater extraction, groundwater discharge to surface water sources, and subsurface groundwater outflow (Table 6-3).
4. The change in annual volume of groundwater in storage between seasonal high conditions (Table 6-3).
5. If overdraft occurs, as defined in Bulletin 118, the water budget shall include a quantification of overdraft over a period of years during which water year and water supply conditions approximate average conditions (Section 6.4.9).
6. The water year type associated with the annual supply, demand, and change in groundwater stored (Table 6-3).
7. An estimate of sustainable yield for the Basin (Section 6.4.8).

6.4.1. Historical Time Period

The time period over which the historical water budget is estimated is the hydrologic base period from 1987-2019 (33 years). Groundwater storage calculations using the specific yield method were performed for 1986, 1990, 1995, 1998, 2005, 2011, 2014, and 2019. These years include the beginning and ending years in the base period, along with sufficient intervening years to characterize change in storage trends through the base period.

6.4.2. Historical Land Use

Land use is one of the primary data sets used in developing a water budget. Several types of land use/land cover in the basin have been used to estimate components of the water budget. For example, the acreages of various crops are multiplied by their respective water use factors to estimate agricultural groundwater extractions and acreages of various land covers are multiplied by empirical correlations to estimate their respective evapotranspiration and percolation of precipitation.

The land uses/land covers including the following:

- Irrigated Agriculture
  - Citrus
  - Deciduous
  - Pasture
  - Vegetable
  - Vineyard
- Native Vegetation
  - Brush, trees, native grasses
  - Wetlands/open water
- Urban/Suburban
  - Developed (City, subdivisions)
  - Open space (parks, empty lots)
  - Turf (golf courses, play fields)

Irrigated Agriculture

Irrigated crop acreage was estimated from aerial imagery of the Basin for the following years: 1987, 1994, 1999, 2003, 2005, 2007, 2009, 2010, and 2011. San Luis Obispo County land use data was used for crop acreage from 2013 to 2018. DWR land use surveys for 1985, 1995, and 2014 were also reviewed during the interpretation of aerial imagery. Figure 6-12 shows an example of the County irrigated crop data set for 2016. Some of the irrigated acreage is located outside of the Basin boundary, but it is assumed that these areas are supplied by wells located within the Basin.

Irrigated acreage for years in the historical base period without aerial imagery, surveys, or County data were estimated from the nearest available year with data. Acreages for irrigated crops, estimated from aerial imagery and County datasets within the historical base period are shown in Table 6-5.

Table 6-5. Irrigated Agriculture Acreages

CROP TYPE	1987	1994	1999	2003	2005	2007	2009	2010	2011	2013	2014	2015	2016	2017	2018
SAN LUIS VALLEY SUBAREA (ACRES)															
Citrus	26	26	30	51	49	49	49	49	49	45	44	44	44	46	46
Deciduous	12	12	12	12	12	12	12	12	12	67	21	17	17	17	17
Pasture	33	22	27	28	28	28	28	28	28	28	37	37	53	28	28
Vegetable	594	766	880	647	592	487	526	494	495	488	490	532	593	492	363
Vineyard	0	5	6	6	8	58	58	58	58	92	86	86	86	86	86
Subtotal	665	831	955	744	689	634	673	641	642	720	678	716	793	669	540
EDNA VALLEY SUBAREA (ACRES)															
Citrus	12	6	47	49	51	51	53	49	105	105	111	111	191	191	210
Deciduous	0	0	0	0	0	0	0	0	0	0	2	2	2	4	3
Pasture	138	19	19	19	19	19	19	19	19	16	19	19	15	14	13
Vegetable	533	703	685	686	646	699	663	679	647	671	670	691	394	505	453
Vineyard	1,180	1,344	1,900	2,252	2,297	2,377	2,377	2,372	2,380	2,423	2,419	2,419	2,454	2,415	2,323
Subtotal	1,863	2,072	2,651	3,006	3,013	3,146	3,112	3,119	3,151	3,215	3,221	3,242	3,056	3,129	3,002

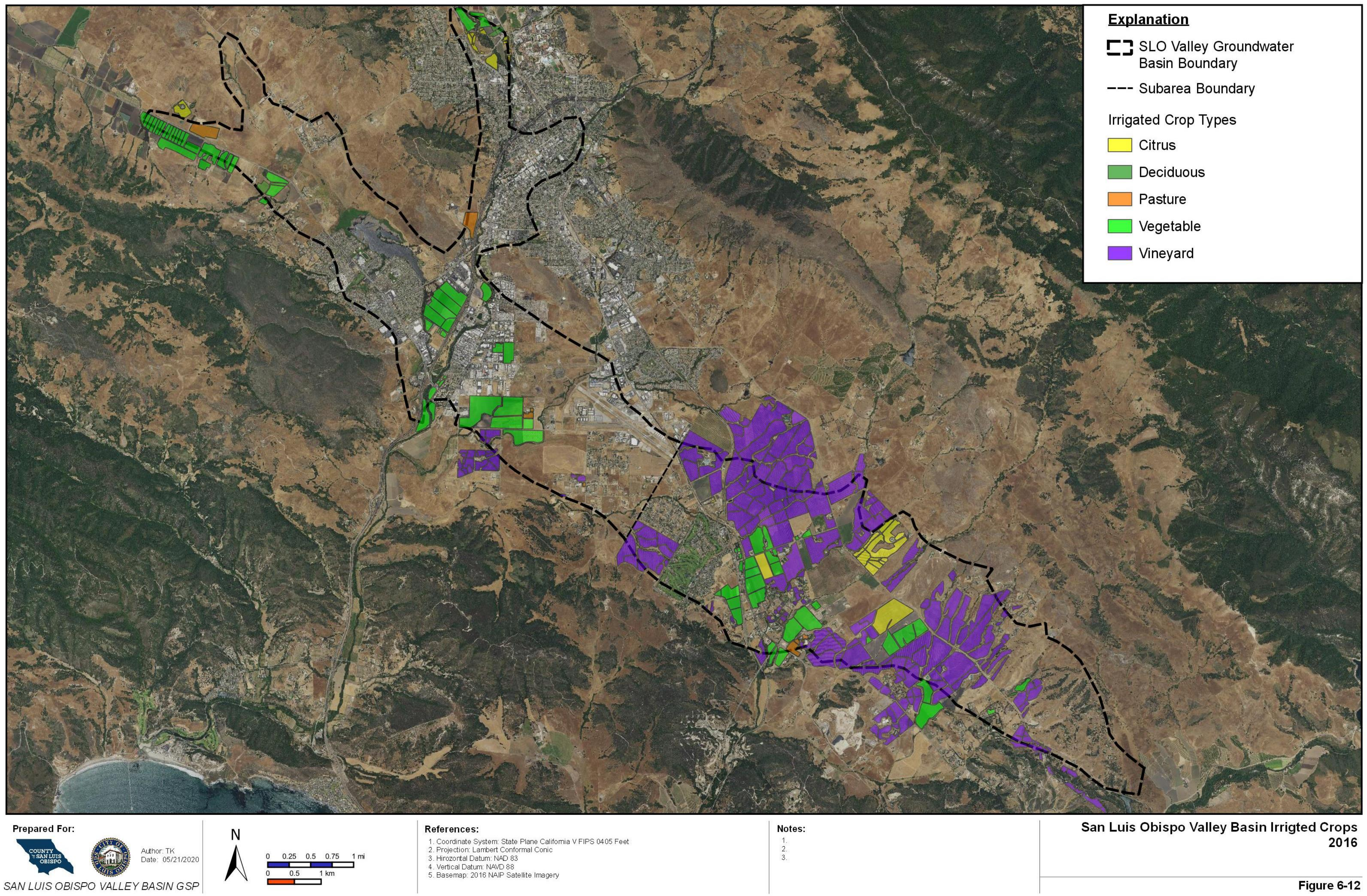


Figure 6-12. San Luis Obispo Valley Basin Irrigated Crops 2016

Native Vegetation and Urban Areas

Native vegetation acreages were compiled using data sets from the National Land Cover Database (NLCD), which is derived primarily from satellite imagery. The years for which NLCD coverage is available are 2001, 2004, 2006, 2008, 2011, 2013, and 2016. Adjustments to the acreages in the NLCD data were performed to reconcile with the agricultural acreages and urban turf areas (golf course, play fields) compiled using the aerial imagery and crop survey data set. Where the NLCD data sets showed less agricultural acreage than the aerial imagery, the native vegetation (brush, trees, grassland) acreage was reduced so the total basin acreage remained constant. The estimated acreages for native vegetation and urban areas, along with irrigated agriculture interpolated from Table 6-5, are presented in Table 6-6 below.

Table 6-6. Land Cover Acreages

LAND COVER	2001	2004	2006	2008	2011	2013	2016
SAN LUIS VALLEY SUBAREA (ACRES)							
Native - brush, trees, grassland	2,315	2,450	2,482	2,466	2,386	2,315	2,203
Native - wetlands/open water	566	566	573	571	569	569	575
Urban - Developed	2,150	2,142	2,219	2,219	2,325	2,312	2,353
Urban - Open Space	870	875	841	841	829	835	825
Urban - Turf	23	23	23	23	23	23	23
Irrigated Agriculture	849	716	636	653	642	720	793
Subarea Total	6,773	6,773	6,773	6,773	6,773	6,773	6,773
EDNA VALLEY SUBAREA (ACRES)							
Native - brush, trees, grassland	2,659	2,473	2,406	2,356	2,333	2,266	2,423
Native - wetlands/open water	13	17	13	13	15	13	13
Urban - Developed	230	230	232	232	232	235	237
Urban - Open Space	77	77	77	77	77	78	79
Urban - Turf	141	141	141	141	141	141	141
Irrigated Agriculture	2,829	3,010	3,079	3,129	3,150	3,215	3,056
SUBAREA TOTAL	**5,948**	**5,948**	**5,948**	**5,948**	**5,948**	**5,948**	**5,948**

6.4.3. Historical Surface Water Budget

The surface water system is represented by water at the land surface within the boundaries of the Basin. Surface water systems for the water budget include streams and Laguna Lake.

6.4.3.1. Components of Surface Water Inflow

The surface water budget includes the following sources of inflow:

- Local Supplies
  - Precipitation
  - Groundwater extractions
  - Stream inflow at Basin boundary

  - Groundwater-Surface Water Interactions
  - Treated wastewater discharge into streams
- Local Imported Supplies
  - Nacimiento Project Water
  - Salinas Reservoir Water
  - Whale Rock Reservoir Water

Precipitation

Precipitation occurs as rainfall. The annual volume of rainfall within the Basin has been estimated by multiplying the rainfall year totals in Table 6-4 by each Basin subarea. Rainfall volumes falling within the Basin boundary are shown as precipitation in the surface water inflow budget of Table 6-1, Table 6-2, and Table 6-3.

Groundwater Extractions

Groundwater extractions are included in the surface water budget as inflow because after extraction groundwater is distributed and applied at land surface. The surface water budget includes the land surface system and rivers & streams system (Figure 6-2). These extractions are the divided into Urban and Agricultural water use sectors and match the groundwater extraction outflow values from the groundwater budget. Details on data collection and groundwater pumping estimates are provided in the Section 6.4.5 Historical Groundwater Budget.

Stream Inflow at Basin Boundary

Inflow along stream channels at the Basin boundary has been estimated based on paired watershed methodology. The total watershed area drained by the Basin was divided into 15 sub-watershed areas, one of which was the subarea drained by San Luis Obispo Creek upstream of the Andrews Street gage (sub-watershed 1, Figure 6-13). Flow from 2007 through 2018 at the Andrews Street gage was reconstructed using stage records and a stage-discharge curve. The resulting annual flows were then processed using a watershed area factor and an isohyetal factor to estimate annual flows for each of the other 14 subareas. The watershed area factor was the ratio of the watershed area for which flow was being estimated to the Andrews Street gage watershed area. The isohyetal factor addressed differences between the average annual rainfall across each of the sub-watersheds being compared (Figure 6-13) and consisted of the ratio of average annual precipitation over 15 inches between sub-watersheds. Correlation between rainfall and runoff for the paired watersheds is shown in Figure 6-14. A drought period adjustment was also made for 1989-1991 inflow estimates (Figure 6-14) consisting of 3,000 AFY less inflow for the San Luis Valley subarea and 1,000 AFY less inflow for the Edna Valley subarea. Once these factors were applied, the estimated stream flow entering the respective SLO subarea watershed and Edna Valley subarea watershed were totaled.

Stream inflow on the West Coral de Piedra sub-watershed 5 (Figure 6-13) was reduced to account for surface water diversions. There is a permitted reservoir where surface water diversion is utilized mainly for agricultural irrigation (SWRCB, 1990). The stream inflow adjustment consisted of correlating the total reported diversions from Statements of Diversion and Use between 2010 and 2018 with annual precipitation and applying the correlation to other years in the base period (the r-squared value of the correlation is 0.71). Reported annual surface water diversions ranged from 14 acre-feet to 900 acre-feet, with average annual diversion over the base period estimated at 350 acre-feet per year (AFY), including estimated reservoir evaporation which was added to the diversion. The resulting estimated stream inflow estimates for the historical base period are shown in the surface water budget of Table 6-1, Table 6-2, and Table 6-3.

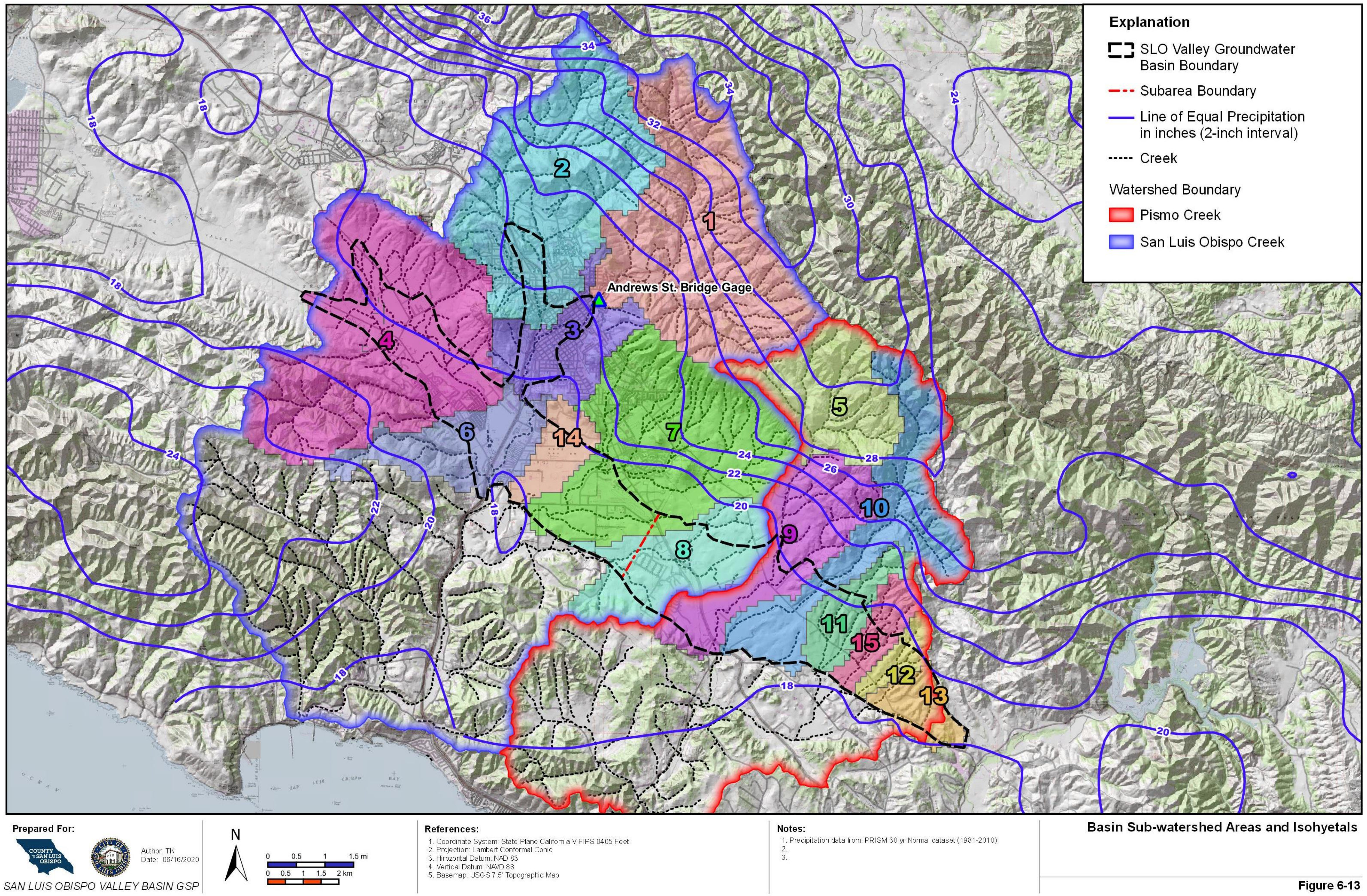


Figure 6-13. Basin Sub-watershed Areas and Isohyetals

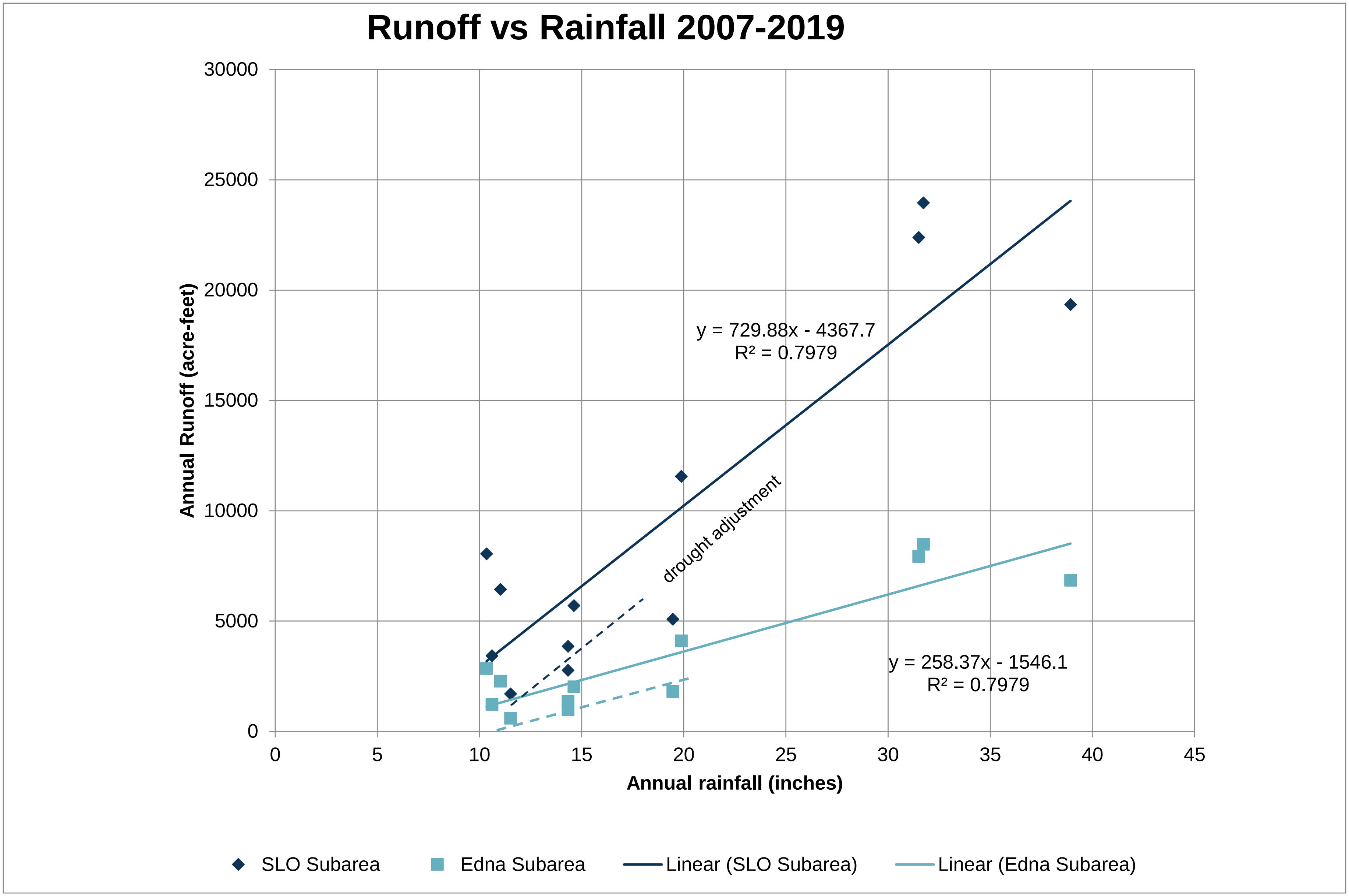


Figure 6-14. Runoff vs Rainfall Correlation for Subareas

Groundwater-Surface Water Interaction (Net)

Groundwater-surface water interactions take place primarily along stream channels and lake/wetland areas. When groundwater is rising into streams (gaining reaches of a stream), the interaction is a surface water budget inflow and a groundwater budget outflow. Conversely, when stream flow is percolating to groundwater (losing reaches of a stream), the interaction is a surface water budget outflow and groundwater budget inflow. As discussed in the hydrograph analysis presented in Section 5.7, San Luis Obispo Creek is assumed to be a gaining stream through much of the Basin, while Edna Valley streams are typically losing reaches, or seasonally disconnected from the aquifer. The Basin-wide water budget has combined the gaining and losing stream reaches into single (net) term, the result of which are net losing streams in the Basin which is an outflow component of the surface water budget and inflow component of the groundwater budget. Net groundwater-surface water interaction was estimated by adjusting the percent of stream inflow that recharges groundwater while optimizing the water balance. The optimization consisted of minimizing the sum of squares of the residual error between the calculated change in storage and measured change in storage.

Treated wastewater discharge to streams

The City of San Luis Obispo discharges treated wastewater into San Luis Obispo Creek. Available records of wastewater treatment plant discharges have been compiled by water year. Daily discharge records provided by the City were compiled for water years 2001-2019. For water years 1987-2000, treated wastewater discharges were estimated as a nominal 65 percent of total City water deliveries, based on the average ratio of annual wastewater flows to water deliveries in the years 2001-2019. The treated wastewater discharges to San Luis Obispo creek are presented in the surface water budget of Table 6-1.

Local Imported Supplies

The City of San Luis Obispo imports water from three reservoirs. Surface water deliveries from Salinas and Whale Rock reservoirs occurred through the historical base period, while Nacimiento reservoir water deliveries to the City began in 2011. Surface water reservoirs have historically provided most of the water supply used by the City. Local imported water supplies are based on City records and Boyle (Boyle Engineering, 1991). Local imported supplies are presented in the surface water budget of Table 6-1.

Cal Poly imports surface water and also pumps groundwater for agricultural irrigation. Fields overlying and adjacent to the Basin are typically irrigated with groundwater, while imported surface water is generally used for irrigation outside of the Basin boundary. Therefore, only the local imported supplies used for potable water deliveries by the City have been accounted for in the GSP water budgets.

6.4.4. Components of Surface Water Outflow

The surface water budget includes the following sources of outflow:

- Evapotranspiration of Precipitation
- Evapotranspiration of Applied Water
- Infiltration of Precipitation
- Infiltration of Applied Water
- Surface Water Deliveries Offset
- Wetland/Lake ET
- Groundwater-Surface Water Interaction
- Stream outflow (runoff)

Evapotranspiration of Precipitation

The fate of precipitation that falls within the Basin boundaries can be divided into three components: evapotranspiration, infiltration, and runoff. Of these three, infiltration has the greatest influence on the groundwater budget and ultimately, the Basin sustainable yield. Therefore, the approach to estimating the fate of precipitation uses a methodology focused primarily on infiltration, but from which the other two components may also be estimated. This methodology is based on work by Blaney (Blaney, 1933) (Blaney, 1963), and which has been used for other analytical water budgets in major studies of central coast Basins (DWR, 2002) and (Fugro West and Cleath & Associates, 2002).

Evapotranspiration is the evaporation of water from surfaces and the transpiration of water from plants. The first seasonal rains falling on the Basin are mostly evaporated directly from surfaces (vegetative canopy, soil, urban area hardscapes) and used to replenish soil moisture deficits that accumulate during the dry season. For the Arroyo Grande – Nipomo Mesa area of the Santa Maria groundwater Basin, DWR assumed that precipitation could begin to infiltrate to groundwater (deep percolate) only after 11 inches of annual precipitation had fallen in urban and agricultural irrigation areas, and when 17 inches of rainfall had fallen in areas of native vegetation. In the Paso Robles groundwater Basin, an estimated 12 inches of annual rainfall was needed for infiltration below agricultural lands, while 18 inches of rainfall was needed for infiltration beneath native ground cover and urban/suburban areas (Fugro West and Cleath & Associates, 2002).

These threshold values for minimum annual rainfall prior to infiltration are assumed to approximate the annual evapotranspiration of precipitation. Once these thresholds are exceeded, infiltration to groundwater and runoff would become dominant. It is recognized that a portion of the initial annual rainfall may result in runoff, depending on rain intensity, but this is assumed to be offset by the portion of the late season rainfall that is evapotranspired. Since infiltration is the critical component of precipitation with respect to the Basin safe yield, offsetting of early wet season runoff with late wet season evapotranspiration in the water budget is considered a reasonable approach.

The specific thresholds for annual rainfall that is estimated to evapotranspire prior to infiltration and runoff have been developed from Blaney's field studies. Evapotranspiration of precipitation has been estimated by multiplying land use/land cover acreages by the infiltration threshold values. Results of these estimates are shown in the surface water budget of Table 6-1, Table 6-2, and Table 6-3. Additional details of the methodology are provided in section 6.4.5.1 (Components of Groundwater Inflow).

Evapotranspiration of Applied Water

The evapotranspiration of applied irrigation water has been divided into urban and agricultural sectors. Urban applied water includes residential outdoor irrigation, urban recycled water use, and golf course/play field irrigation. Much of the urban applied water is accounted for by City of San Luis Obispo or other water purveyor records. Estimation of applied water for urban and agricultural irrigation not supplied by purveyors involves a soil-moisture balance approach discussed in section 6.4.5.2 (Components of Groundwater Outflow).

Most water applied for irrigation is taken up by plants and transpired. Some water, however, is lost to evaporation or infiltrates to groundwater as return flow. The evapotranspiration of applied irrigation water has been calculated by subtracting the estimated return flow from the applied water estimates. Both applied water and return flow estimates are presented under the historical groundwater budget section. Results of the calculations of evapotranspiration of applied water are shown in the surface water budget of Table 6-1, Table 6-2, and Table 6-3.

Riparian Corridor Evapotranspiration

Riparian plant communities present along the creeks can access surface flows and creek underflow. Riparian areas are included within the native brush, trees, and grasses acreage for the subareas (Table 6-6). Besides evapotranspiration of precipitation, however, an additional 0.8 acre-feet per acre of consumptive water use is estimated for riparian corridors (Fugro West and Cleath & Associates, 2002); (Robinson, 1958) that lie within potential Groundwater Dependent Ecosystems, which cover approximately 200 acres in the San Luis Valley subarea and 50 acres in the Edna Valley subarea (Figure 5-15). Riparian corridor water use during severe drought is reduced a nominal 50 percent to reflect lack of creek underflow. Riparian evapotranspiration is included in Table 6-1, Table 6-2, and Table 6-3.

Infiltration of Precipitation and Applied Water

Infiltration of precipitation and applied water are both outflow components from the surface water budget and inflow components to the groundwater budget. Discussion of these components is provided in Section 6.4.5.1 (Components of Groundwater Inflow).

Surface Water Deliveries Offset

When imported surface water is brought into the Basin from local supplies (Salinas Reservoir, Whale Rock Reservoir, and Nacimiento Reservoir), it is counted as surface water inflow. This imported water is then provided to customers through surface water deliveries from the City's water treatment plant. After residential and business use, most of the delivered water is conveyed by sewer to the wastewater treatment plant for recycling and discharge into San Luis Obispo Creek. Since wastewater discharges to the creek are also counted as surface water inflow, an offset factor is needed to avoid double counting that portion of imported surface water. The surface water deliveries offset is an outflow equal to the wastewater discharges inflow and is shown in the surface water budget of Table 6-1.

Laguna Lake

Laguna Lake is an approximate 100-acre open water body within the San Luis Valley subarea (Figure 3-10). There are an additional 100 acres of adjacent wetlands connected to the lake. Evaporation from the water surface and transpiration by phreatophytes in the wetlands are included in the water budget as surface water outflow. Local pan evaporation is estimated at 70 inches per year (for all years), with a reservoir coefficient of 0.7, based on a review of information from nearby reservoirs (San Luis Obispo County Department of Public Works, 2005). The resulting estimated annual evaporation rate for this water budget component is 4.1 feet (not including offset from direct precipitation). Evapotranspiration by phreatophytes were estimated to use lake water at a rate equal to irrigated pasture applied water demand. Results for Wetland/Lake ET outflow from the surface water budget are shown in Figure 6-1. As with riparian water use, during severe drought the lake and wetland evapotranspiration is reduced by 50 percent.

Groundwater-Surface Water Interaction (Net)

Groundwater-surface water interaction involves both surface water and groundwater budgets. For losing stream, the net interaction may be an outflow component for the surface water budget and an inflow component for the groundwater budget. Details of the methodology used to develop the groundwater-surface water interaction are presented in Section 6.4.5.1

Stream Outflow from Basin

Stream outflow from each subarea was estimated using the water balance method and compared to available flow records. No significant changes to surface water in storage are assumed in the water budget from year to year. Storm water runoff exits the Basin annually, and Laguna Lake storage fluctuations are considered minor compared to the total surface water budget. Surface water supply reservoirs are outside of the Basin boundary.

Using the water budget equation, stream outflow is estimated as the difference between total surface water inflow and all other components of surface water outflow. Results of stream outflow calculations are presented in the main water budget Tables.

There are limited annual stream flow records available for comparison to the estimates in the historical surface water budget. For the San Luis Valley subarea, the only applicable published records for stream outflow from the San Luis Valley subarea are two years of data recorded on Lower San Luis Obispo Creek at San Luis Bay Drive. In the 1971 water year, 20.46 inches of rainfall was recorded at Cal Poly and approximately 14,000 acre-feet of stream flow was reported at the San Luis Bay Drive gage (records missing in October). In the 1972 water year, 12.42 inches of rainfall was recorded at Cal Poly with 4,260 acre-feet of stream flow at the San Luis Bay Drive gage (San Luis Obispo County Engineering Department, 1974). These two years are outside of the historical water budget base period, and a comparison of flow for water years with similar precipitation suggests that the estimated Basin outflows are reasonable.

Measured annual flows on Pismo Creek downstream of the Basin boundary are also available for only two water years, 1991 and 1992 (Balance Hydrologics, 2008). These are years within the historical base period, although the flows were measured at Highway 101, where Pismo Creek has a watershed of 38 square miles, compared to 25 square miles upstream of the Basin boundary. Estimated outflow in the water budget from the Edna Valley subarea for 1991 and 1992 are lower than the flows measured at Highway 101, as would be expected. Table 6-7 shows the stream outflow comparisons.

Table 6-7. Stream Outflow Comparison

LOCATION	WATER YEAR	PRECIPITATION AT CAL POLY (IN.)	FLOW (ACRE-FEET)
San Luis Obispo Creek at San Luis Bay Drive gage	1971	20.46	13,705*
San Luis Valley subarea stream outflow estimate	2003	22.9	15,390
San Luis Obispo Creek at San Luis Bay Drive gage	1972	12.42	4,260
San Luis Valley subarea stream outflow estimate	1990	13.36	3,360
Pismo Creek at Highway 101 gage	1991	18.6	2,033
Edna Valley subarea stream outflow estimate			1,840
Pismo Creek at Highway 101 gage	1992	22.14	4,640
Edna Valley subarea stream outflow estimate			3,590

*October 1970 missing – estimate 300 acre-feet = approx. 14,000 acre-feet for year

6.4.5. Historical Groundwater Budget

The groundwater budget includes the following sources of inflow:

- Infiltration of Precipitation
- Groundwater-Surface Water Interaction
- Subsurface Inflow
- Infiltration of Applied Water

The groundwater budget includes the following sources of outflow:

- Groundwater Extractions
- Subsurface Outflow
- Groundwater-Surface Water Interaction

6.4.5.1. Components of Groundwater Inflow

Infiltration of Precipitation

Infiltration of precipitation refers to the amount of rainfall that directly recharges groundwater after moving through the soil and unsaturated zone (Figure 6-2). Direct measurement of infiltration has not been performed in the Basin, and estimates have been prepared based on prior work by Blaney (1933) in Ventura County Basins and Blaney et al. (1963) in the Lompoc Area. These studies involved soil moisture measurements at rainfall penetration test plots with various types of land cover, and the resulting deep percolation versus rainfall correlations have been considered applicable to central coast Basins (DWR, 2002) (Fugro West and Cleath & Associates, 2002). The work by Blaney is several decades old, however, modeling efforts have shown the generalizations are relatively accurate for semi-arid climates (Rosenberg, 2001). The main advantage of Blaney's approach is that it is based on direct measurements of infiltration of precipitation.

Criteria based on Blaney et al. (1963) were used for analytical water budgets in the Santa Maria Valley and Tri-Cities Mesa areas, where it was assumed that precipitation could infiltrate only in urban and agricultural areas when 11 inches of precipitation had fallen annually, and on areas of native vegetation when 17 inches of precipitation had fallen annually. Any amount of rainfall above 30 inches annually was not considered to contribute to deep percolation of precipitation, regardless of the land use classification (DWR, 2002). Correlations between infiltration and annual rainfall based on Blaney (1933) were also used for the 2002 Paso Robles groundwater Basin analytical water budget (Fugro West and Cleath & Associates, 2002).

Estimates for infiltration of precipitation for the SLO Basin have been developed by applying Blaney correlations that restrict deep percolation to precipitation in agricultural areas that occurs after 11-12 inches of rainfall, and in native vegetation areas after approximately 18 inches of rainfall. Native vegetation was the most restrictive land cover for infiltration when tested by Blaney due to high initial soil moisture deficiencies.

Urban areas were not part of the original studies by Blaney. The low permeability of hardscape (buildings and paving) limits infiltration and increases surface evaporation, compared to other types of land cover, but hardscape also increases runoff, which can lead to greater infiltration in adjacent areas receiving the runoff. Therefore, the infiltration threshold was set higher than irrigated agricultural land, but not as high as native grasslands. The Blaney correlation that produces infiltration between irrigated agriculture and native grassland is the curve for non-irrigated grain, with an infiltration threshold of approximately 14 inches of rainfall. Figure 6-15 plots the data collected by Blaney (1933).

As with prior work by the DWR in northern Santa Barbara and southern San Luis Obispo Counties, rainfall above 30 inches was not considered to contribute to deep percolation in the Basin (DWR, 2002). Infiltration of precipitation results are shown in the water budget tables and graphs.

The land use classifications for which infiltration thresholds have been developed for this GSP include citrus, deciduous, pasture, vegetable, vineyard, native brush/grassland (includes riparian corridors), wetland, urban developed/open space, and Urban turf. The minimum rainfall needed before infiltration of precipitation can occur for various land uses and covers are summarized in Table 6-8.

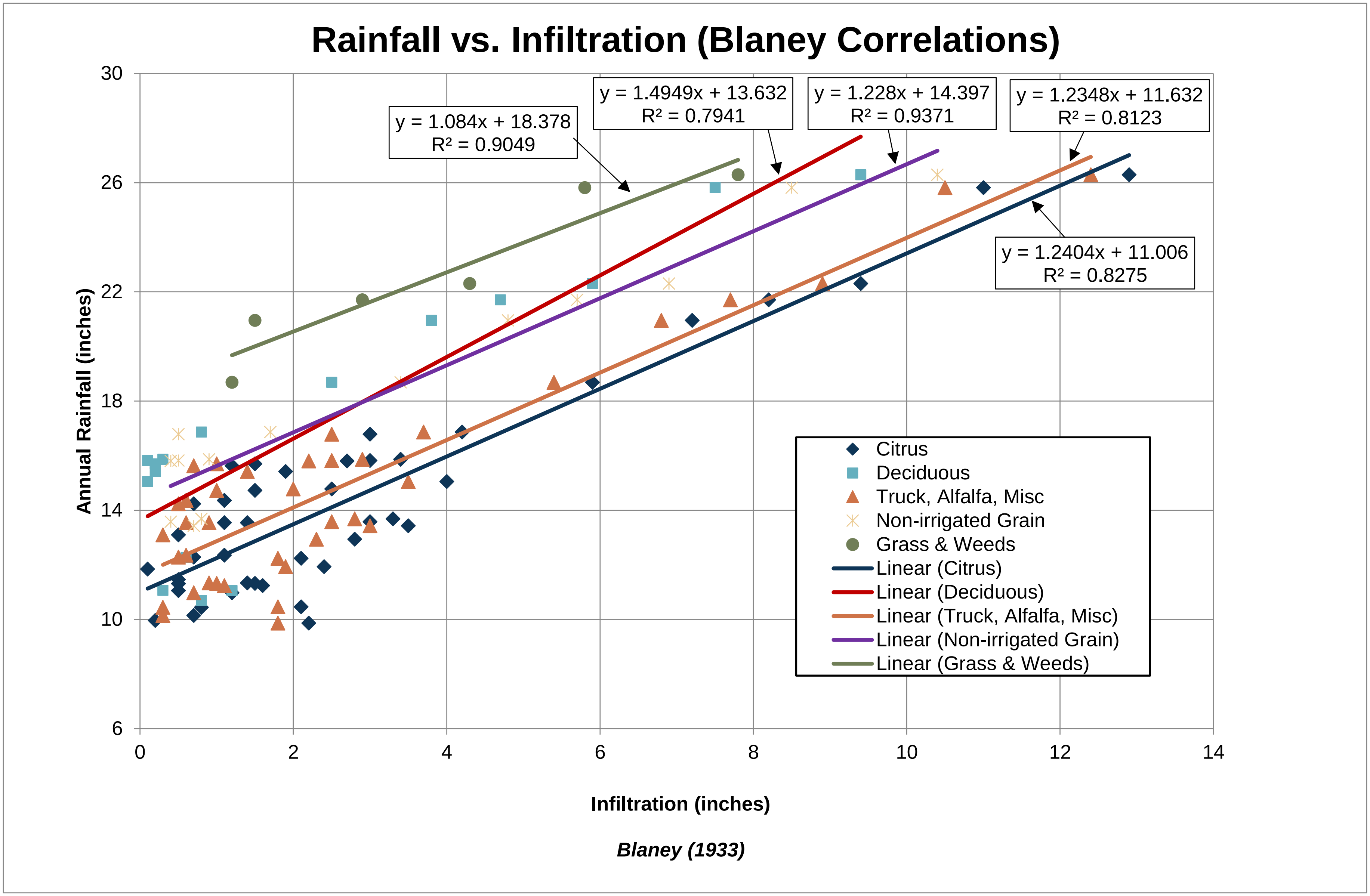


Figure 6-15. Rainfall vs Infiltration

Table 6-8. Minimum Rainfall for Infiltration

LAND USE/COVER	INFILTRATION THRESHOLD (IN.)
Citrus	11.0
Deciduous	13.6
Pasture	11.6
Vegetable	11.6
Vineyard	13.6
Native brush/grassland	18.4
Wetland*	11.6
Urban developed/open space	14.4
Urban turf	11.6

* ET of precipitation prior to runoff (no infiltration)

Wetland soils are assumed to be close to field capacity due to shallow groundwater and the infiltration threshold is only used for estimating ET in the surface water budget, with the remaining precipitation as runoff (mainly into Laguna Lake).

Groundwater-Surface Water Interaction (Net)

As previously mentioned, groundwater-surface water Interaction involves both components of the surface water and groundwater budgets. The net interaction is an outflow component of the surface water budget and inflow component of the groundwater budget (losing streams).

The groundwater-surface water interaction component is estimated using a mass balance approach for the Edna Valley subarea by adjusting the percent of stream inflow that percolates to groundwater (as Basin recharge) while minimizing the sum of squares of the residual error between the calculated change in storage and the measured change in storage (specific yield method) for multiple years. A similar optimization was performed for the San Luis Valley subarea except a variable percentage was used depending on the type of year (a greater percentage of stream flow percolation during lower rainfall years). A spill mechanism was developed in the budget to allow groundwater outflow to streams when storage reached full capacity, which was set to a nominal 37,000 acre-feet based on historical storage estimates using the specific yield method. The groundwater-surface water interaction estimates are in the water budget tables. Additional details of the calibration methodology used to minimize the residual error are presented in Change in Storage (Section 6.4.7).

Subsurface inflow

Subsurface inflow from bedrock surrounding the groundwater Basin flows into both subareas. Subsurface inflows were estimated using Darcy's Law, which is an empirical formula describing the flow of fluid though a porous material, and expressed as:

$$Q = -K\frac{dh}{dl}A$$

Where:

Q = groundwater discharge rate through a cross-sectional area of the porous material

K = hydraulic conductivity of the material

$\frac{dh}{dl}$ = hydraulic gradient at the cross-section

A = cross-sectional area

The negative sign denotes that flow is in the direction of decreasing pressure. Since groundwater pressures are greater within the bedrock hills surrounding the Basin than beneath the alluvial valleys, there is subsurface inflow to the Basin from bedrock. Similarly, groundwater elevations in the Edna Valley subarea are greater than in the San Luis Valley subarea and the direction of subsurface flow is from the Edna Valley to the San Luis Valley. The application of Darcy's Law to estimate subsurface inflow from bedrock involves simplification and assumptions of uniformity in the subsurface. The Basin boundary was divided into six reaches, each representing different boundary conditions. Cross-sectional areas for boundary flows were based on the length of each reach times the average thickness of adjacent saturated Basin sediments determined from cross-sections presented in Chapter 4 (Basin Setting). Hydraulic gradients for each reach were developed by averaging topographic slopes between a line along the Basin boundary and a line drawn at a 5,000-foot setback from the Basin boundary, and assuming the hydraulic gradient paralleled these slopes. Hydraulic conductivity was estimated for each reach based on the bedrock type, a review of pumping test data in the SLO Basin Characterization Report (GSI Water Solutions, 2018), and structural features. Table 6-9 summarizes the results of subsurface inflow estimates. Bedrock subsurface inflow reaches are shown on Figure 6-16.

Table 6-9. Subsurface Inflow Estimates

REACH	BEDROCK FORMATION	BOUNDARY DESCRIPTION	LENGTH FT	THICKNESS FT	HYDRAULIC GRADIENT FT/FT	HYDRAULIC CONDUCTIVITY FT/DAY	INFLOW AFY
1	KJf melange w/serp.	Depositional	43,900	100	0.05	0.05	90
2	Monterey/Lower Pismo	Edna fault	38,100	200	0.01	0.03	30
3	KJf melange w/serp.	Depositional	88,300	20	0.09	0.05	130
4	JKf metavolcanics	Los Osos fault	28,600	40	0.09	0.2	220
5	KJf melange w/serp.	Los Osos fault	12,200	60	0.05	0.05	20
6	Obispo/Rincon w/ serp.	Depositional	9,500	60	0.06	0.05	10
			SAN LUIS VALLEY SUBAREA				**320**
			EDNA VALLEY SUBAREA				**110**
			BASIN TOTAL				**430**

Note: KJf - Franciscan Assemblage
Serp. = serpentinite
AFY = acre-feet per year

Basin boundary types for evaluating subsurface inflow are depositional or fault-bounded. Depositional boundaries occur where Basin sediments gradually thin toward the Basin boundary, while fault boundaries are where Basin sediments are abruptly offset by faulting. Fault boundaries are generally on the south side of the Basin, while depositional boundaries are on the north side. Geologic-cross sections presented in Chapter 4 (Basin Setting) were used for reference in this analysis. Thicknesses at the Basin boundary are estimated from Basin cross-sections presented in Chapter 4 (Basin Setting).

The hydraulic conductivity of bedrock across the Basin boundary was estimated at a nominal 0.05 feet per day, with two exceptions (Table 6-9). The Franciscan Assemblage metavolcanics are more permeable where fractured along the Los Osos fault zone (southwest Basin boundary; Figure 4-8) and are assigned a greater hydraulic conductivity. The Edna fault (Figure 4-8) offsets sedimentary beds along the Basin boundary and is interpreted to create a barrier to groundwater flow, corresponding to lower permeability.

Subsurface inflow to the San Luis Valley subarea also takes place as Basin cross-flow from the Edna Valley subarea. A subsurface profile of the bedrock high was developed as part of this GSP using geophysical methods (Cleath-Harris Geologists, 2019). Darcy's Law was used to estimate subsurface flow based on a cross-sectional area of 140,000 square feet (approximately 3,500 feet in length and 40 feet saturated depth), a typical hydraulic gradient perpendicular to the boundary of 0.004 feet per foot (average of high and low values from 1986 and 2019 water level contour maps) and an estimated hydraulic conductivity for the sediments of 7 ft/day from local pumping tests listed in the SLO Basin Characterization Report (GSI Water Solutions, 2018). The resulting estimated average subsurface flow from the Edna Valley subarea to the San Luis Valley subarea is 30 AFY.

Infiltration of Applied Water (Return Flows)

Estimates for infiltration of applied water include urban return flow and agricultural return flow. Urban return flow comes from water delivered for domestic or commercial/industrial uses that infiltrates to groundwater, mainly through landscape/turf irrigation and septic system discharges (includes suburban/rural residential return flow and recycled water return flow). Urban return flow does not include City wastewater that is discharged to San Luis Obispo Creek, which is accounted for in the surface water budget. Agricultural return flows come from applied irrigation water to crops.

The first step in estimating urban return flows was to separate all delivered water (groundwater pumped from the Basin and imported surface water supplies) into indoor and outdoor use. An estimated 5 percent of indoor use is assumed to be consumptive use (95 percent return flow; (EPA, 2008)), while 85 percent of outdoor use is consumed (15 percent return flow) based on the typical range of estimates for other local Basins (DWR, 2002) (Fugro West and Cleath & Associates, 2002). Almost all Indoor water use drains to septic systems or sewer systems. Outdoor water use is generally for irrigation, most of which evapotranspires into the atmosphere.

The distribution of indoor to outdoor water use will vary based on the user. City customers are estimated to average 70 percent indoor use and 30 percent outdoor use, based on approximately 65 percent of delivered water reaching the wastewater treatment plant (with 5 percent indoor consumptive use). Large parcel residential water users outside of City limits tend to use a greater percentage of water for outdoor use than City residents. Businesses served by small water companies can have a wide range of indoor and outdoor distribution and were assigned values based on the results of a local study on business water use (City of San Luis Obispo, 2000).

The indoor and outdoor water use and associated return flows from water use by City, suburban/rural residential, and small water systems were compiled, together with estimated return flow from recycled water use. Infiltration of Applied Water estimates for urban and agricultural sectors are presented in the historical water budget Table 6-1, Table 6-2, and Table 6-3.

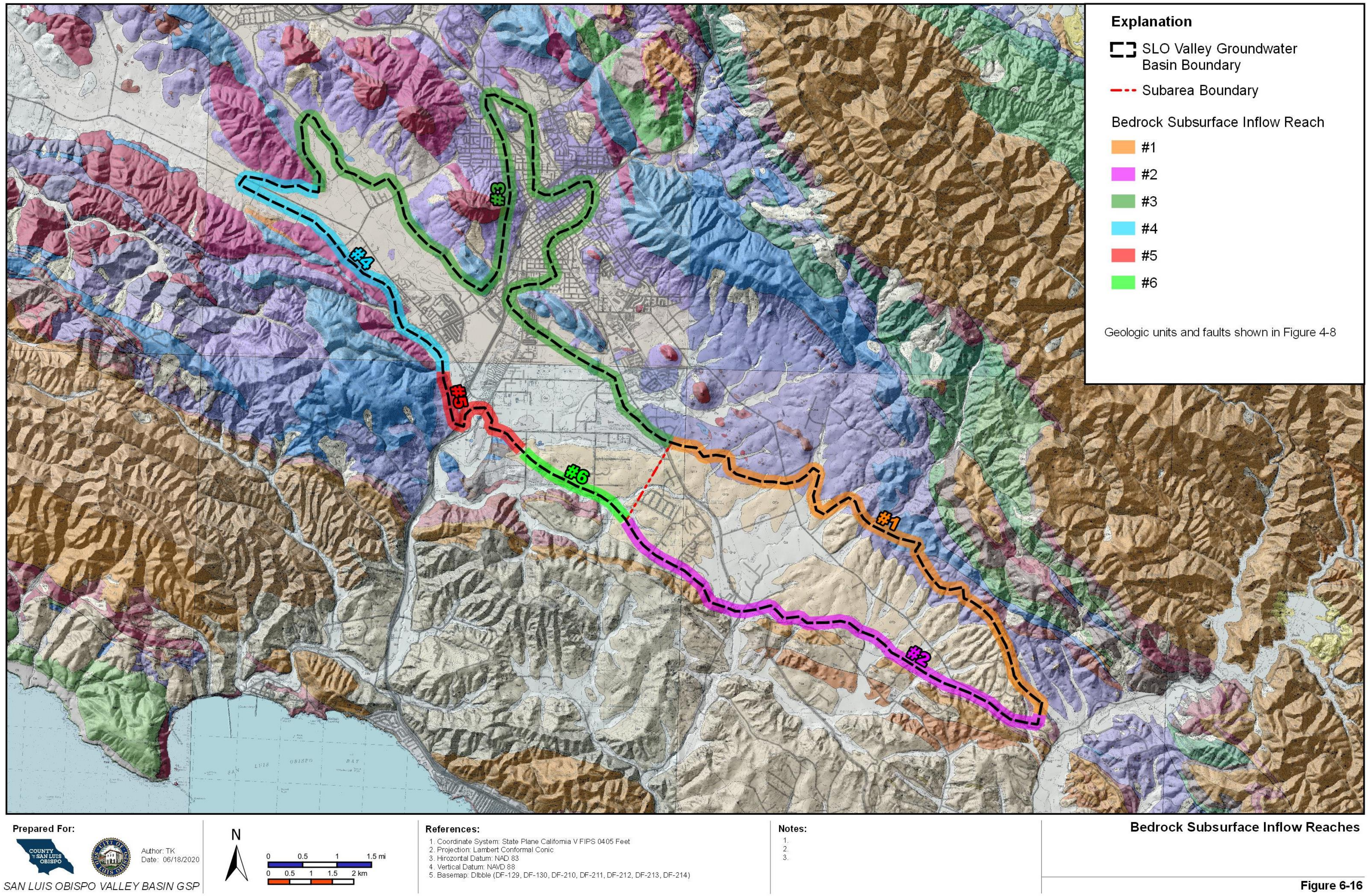


Figure 6-16. Bedrock Subsurface Inflow Reaches

6.4.5.2. Components of Groundwater Outflow

Urban Groundwater Extractions

Groundwater extraction from wells is the primary component of outflow in the groundwater budget. Estimates for historical pumping were derived from various sources, including purveyor records, land use data and water duty factors, and daily soil-moisture budgets.

Available purveyor records (meter records) were obtained from the following Basin users:

- City of San Luis Obispo
- Golden State Water Company
- Edna Valley East Mutual Water Company
- Varian Ranch Mutual Water Company

Production records ranged from weekly to quarterly and were compiled to reflect the water year per GSP requirements. The City used groundwater from wells between 1989 and 2014, with the highest use in water years 1990, 1991, and 1992, averaging 1,830 AFY. Overall City groundwater use averaged 405 AFY between 1989 and 2014. Golden State Water Company averaged 335 AFY over the historical base period (1987-2019), although average water use over the last 5 water years is approximately 210 AFY. Edna Valley East MWC and Varian Ranch MWC have averaged approximately 100 AFY combined since reaching full development in the late 1990s, with 80 AFY combined over the last 5 years.

There are also 42 small water systems, mostly in the San Luis Valley subarea, which use groundwater from wells. Each water system was assigned a use category, and a corresponding water use factor. For example, groundwater use for commercial service connections were assigned water use based on building square footage (from aerial image review), with a 0.06 acre-foot per year per square foot use factor. Water use factors for local use categories were obtained from the results of a study conducted by the City of San Luis Obispo utilities conservation office (City of San Luis Obispo, 2000). The water use estimate was developed for current conditions, as almost all water companies were active throughout the historical base period. The total amount of water used by small water systems in the Basin is estimated at 270 AFY, with the majority of use (260 AFY) in the San Luis Valley subarea. Less than 10 of the 42 small water systems using groundwater are connected to the City sewer.

Urban groundwater extractions have also been used for golf course irrigation (turf). Laguna Lake golf course was served entirely by groundwater wells through 2007, with recycled water use from the City beginning in 2008. San Luis Country Club uses a combination of recycled water use from County Service Area 18 and groundwater. The groundwater extractions and recycled water use components of urban turf irrigation are accounted for separately in the water budget. Estimates for turf irrigation water demand used the same daily soil moisture balance program as crop irrigation (see Agricultural Irrigation).

Rural Residential Groundwater Extractions

Rural residential groundwater use was estimated based on the number of residences identified on aerial images outside of water company service areas. Each rural residence was assigned a water use of 0.8 AFY, consistent with the San Luis Obispo County Master Water Plan (Carollo, 2012). As a comparison, the City study reported residential use for large parcels (>0.26 acres) at 0.6 AFY (City of San Luis Obispo, 2000), which is similar to the average estimated use per service connection in the Golden State Water Company service area over the historical base period. Water use per connection at Varian Ranch MWC and Edna Valley East MWC has ranged from 0.6 to 1.5 AFY, averaging approximately 1 acre-foot per year over the historical base period defined in Section 6.1.1.

Aerial images for 1986, 1994, 2009, and 2018 were reviewed for rural residential development. The estimated number of residences outside of water company service areas was compiled, and resulting computed rural residential water use for these years is presented in Table 6-10.

Table 6-10. Rural Residential Water Use

YEAR	SLO SUBAREA	EDNA SUBAREA	BASIN TOTAL
ESTIMATED NUMBER OF RESIDENCES[1]			
1986	108	54	162
1994	119	61	180
2009	162	145	307
2018	173	158	331
ESTIMATED WATER USE (AFY)[2]			
1986	86	43	130
1994	95	49	144
2009	130	116	246
2018	138	126	265

[1]outside of water company service areas

[2]based on 0.8 AFY per residence

Agricultural Groundwater Extractions

Groundwater use for agricultural irrigation has been estimated using the DWR Consumptive Use Program Plus (CUP+)(DWR, 2015) which is a crop water use estimator that uses a daily soil moisture balance. CUP+ was developed as part of the 2013 California Water Plan Update to help growers and agencies estimate the net irrigation water needed to produce a crop.

Daily climate data from CIMIS Station #52 (San Luis Obispo) from 1986 to 2019 were used by the CUP+ program, along with estimates for various crop and soil parameters. The climate data is used to determine local reference evapotranspiration (ETo) on a daily basis. Crop coefficients are then estimated for up to four growth stages (initial, rapid, mid-season, late-season) which determine the crop evapotranspiration (ETc) values. Lastly, the CUP+ program uses variables related to the soil and crop type to determine the estimated applied water demand (ETaw), which is equivalent to the net irrigation requirement. Figure 6-17 shows the annual ETaw for various crops during the historical base period, along with the reference evapotranspiration (ETo) and precipitation at CIMIS Station #52.

Crop types were grouped according to the classification used by County Agricultural Commissioner's Office for crops overlying the Basin. These crop types included citrus, deciduous (non-vineyard), pasture, vegetable, and vineyard. A turf grass classification was added for estimating Urban sector water demand served by groundwater. The CUP+ program provides monthly water demand for each crop type during the hydrologic base period (1987-2019). Low, medium, and high consumptive use of applied irrigation water estimates are presented in Table 6-11. Low and high consumptive use are the respective annual minimum and maximum estimates over the base period, while medium consumptive use is the average. The CUP+ applied water requirement for vegetables was reduced by 40 percent to account for fallow acreage, which is not in production at any given time, based on historical aerial image review.

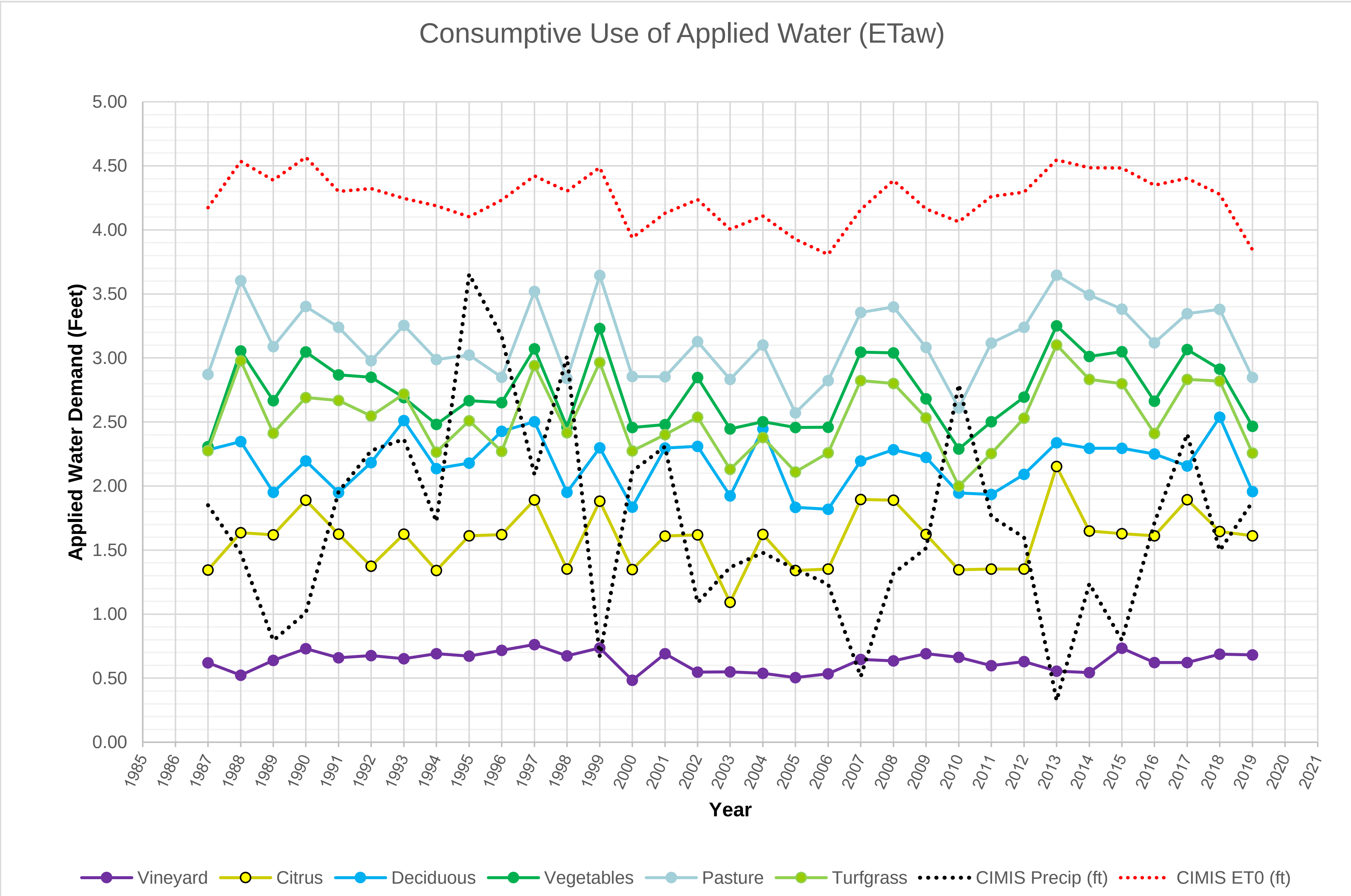


Figure 6-17. Consumptive Use of Applied Water

Table 6-11. Consumptive Use of Applied Water

	ACRE-FEET PER ACRE PER YEAR		
CROP TYPE	LOW	MED	HIGH
Citrus	1.1	1.6	2.2
Deciduous	1.8	2.2	2.5
Pasture	2.6	3.1	3.7
Vegetables*	1.4	1.6	2.0
Vineyard	0.5	0.6	0.8
Turfgrass	2	2.6	4.1

*60 percent of ETaw to account for fallow fields

As previously discussed in section 6.4.2 (Historical Land Use), the distribution of crop acreage was determined by a review and correlation of DWR and County crop surveys with aerial imagery. Crop acreages were interpolated between the years with data.

Applied water demand volumes were calculated by multiplying the annual acreage for each crop by the average annual applied water demand during each year. The final applied water estimates used for the water budget were adjusted to include efficiency (with system leakage) factors of 80 percent for drip/micro emitter and high-efficiency sprinkler irrigation (citrus, deciduous, vineyard, and turfgrass) and 75 percent for mostly sprinkler with some drip irrigation (pasture and vegetables). The estimated groundwater extractions for agricultural water use are shown in the main water budget Table 6-1, Table 6-2, and Table 6-3.

Wetland Direct ET

There are approximately 570 acres of wetlands and open water in the San Luis subarea (Table 6-6), of which approximately 100 acres are open water and 100 acres are wetlands directly connected to Laguna Lake (based on aerial image review) and part of the surface water budget. The remaining 370 acres of wetlands, most of which extend northwest of Laguna Lake into the Los Osos Valley, are assumed to be areas with seasonally shallow groundwater where evapotranspiration by native grasses effectively draws from the groundwater reservoir.

The water demand of wetlands through direct groundwater use is assumed to be equivalent to average consumptive use of irrigated pasture as shown in Table 6-11. Any rainfall over 11.6 inches (Table 6-8) also contributes to meeting wetland water demand. Wetland direct ET estimates are shown in Table 6-1.

Subsurface Outflow

Subsurface outflow from Basin sediments occurs as underflow along the main creek channels (San Luis Obispo Creek and Pismo Creek). Outflow volumes were estimated using Darcy's Law (Section 6.4.5.1). Table 6-12 presents the parameters used for subsurface outflow estimates.

Table 6-12. Subsurface Outflow Estimates

	CROSS-SECTIONAL AREA	HYDRAULIC GRADIENT	HYDRAULIC CONDUCTIVITY	OUTFLOW
LOCATION	FT²	FT/FT	FT/DAY	AFY
San Luis Obispo Creek	46,800	0.004	65	100
Pismo Creek*	20,600	0.01	20	35

*begins at confluence of West Corral and East Corral de Piedra Creeks

Cross sectional areas for outflow were based on the estimated width and saturated depth of alluvial deposits in the vicinity of where the creeks exit the groundwater Basin. Hydraulic gradients are the approximate grade of the stream channel, and the hydraulic conductivities are based on pumping tests (GSI Water Solutions, 2018) (Cleath-Harris Geologists, 2018). Additional subsurface outflow from the San Luis Valley subarea occurs along Davenport Creek and East Fork Creek but would be significantly less than San Luis Obispo Creek due to shallower and less permeable alluvial deposits. Total average subsurface outflow from the San Luis Valley subarea is estimated at 100 AFY from San Luis Obispo Creek and a nominal 20 AFY from the smaller tributaries, for a total of 120 AFY. Subsurface outflow from the Edna Valley subarea along the Canada Verde drainage and tributaries is estimated to be similar to Pismo Creek (35 AFY), for a total subsurface outflow from that subarea of 90 AFY (35 AFY each from Pismo Creek and Canada Verde, and 20 AFY to San Luis Valley.)

6.4.6. Total Groundwater in Storage

Groundwater is stored within the pore space of Basin sediments. The Specific yield is a ratio of the volume of pore water that will drain under the influence of gravity to the total volume of saturated sediments. The specific yield method for estimating groundwater in storage is the product of total saturated Basin volume and average specific yield. Calculation of total groundwater in storage for selected years was performed based on the specific yield method.

Estimates of specific yield for Basin sediments were obtained based on a review of 21 representative well logs. The lithology for each well log was correlated with specific yield values reported for sediment types in San Luis Obispo County (Johnson, 1967). A summary of the correlations is shown in Table 6-13. Locations of well logs used for the specific yield correlations are shown in the referenced cross-sections from the SLO Basin Characterization Report (GSI Water Solutions, 2018).

Groundwater in storage calculations were performed for the Spring conditions of 1986, 1990, 1995, 1998, 2011, 2014, and 2019 using the specific yield method. Water level contours for each year were prepared based on available water level data from various sources, including the SLCFCWCD water level monitoring program, Geotracker Groundwater Information System data, groundwater monitoring reports, Stakeholder provided information, and Environmental Impact Reports. Water level contour maps for the Spring 1986 and Spring 2019 are shown in Figure 6-18 and Figure 6-19.

The water level contours for storage calculations extend to the Basin boundaries. Groundwater levels in the San Luis Valley subarea may contour at, or slightly above, ground surface in areas where wetlands are present, and there are no major differences between Spring 1986 and Spring 2019 water levels. In the Edna Valley subarea, water level contours show some notable areas of decline between 1986 and 2019 near the intersection of Edna Road (Highway 227) and Biddle Ranch Road and at the southeast end of the Basin. Declines in these areas are also shown for other time intervals in Figure 5-8 and Figure 5-9 of Chapter 5 (Groundwater Conditions). Of note, however, is that Spring 2019 water levels shown in Figure 6-18 are lower near the intersection of Edna and Biddle Ranch Road than for the same period shown in Figure 5-6. This is because Figure 5-6 contours pressure in a shallow alluvial aquifer in this area while Figure 6-19 contours pressure in the deeper Pismo Formation aquifer that is the main supply aquifer for irrigation, and more appropriate for water budget storage calculations.

Table 6-13. Specific Yield Averages

		AQUIFER SPECIFIC YIELD (PERCENT)		
WELL ID	**BASIN CROSS-SECTION**	**QAL**	**QTP**	**PISMO**
139405	B-B'	3.0	4.7	
158599	G-G'	6.8	6.9	18.0
279128	C2-C2'	11.0		
279130	A1-A2	8.2	6.5	3.0
287786	C1-C1'	7.2		
319126	C1-C1'	5.5	11.7	
438979	A1-A2	4.4	8.1	
469906	A3-A4		12.0	10.7
529099	E-E'		8.1	11.2
68734	A2-A3		5.9	8.0
710817	G-G'	3.0	5.0	10.8
73143	A1-A2	12.7	5.8	
782309	A2-A3	7.1	10.5	15.8
782656	D-D'	5.0	16.0	
e026022	H-H'		7.4	18.6
e0047435	G-G'	6.6	4.5	17.6
e0115806	offset I-I'		9.1	16.2
e0161526	F-F'		5.4	15.6
e0183287	H-H'	3.0	7.0	
e0225875	A2-A3	3.6	17.3	10.1
TH1	C1-C1'	5.9	8.9	18.0
AVERAGE SPECIFIC YIELD		**6.2**	**8.5**	**13.4**
BASIN AVERAGE (WEIGHTED)		**10.5**		
SAN LUIS VALLEY SUBAREA (WEIGHTED)		**8.0**		
EDNA VALLEY SUBAREA (WEIGHTED)		**11.7**		

Notes: Cross-sections shown in SLO Basin Characterization Report (GS1 Water Solutions, 2018)
Qal = alluvium; QTp = Paso Robles Formation; Pismo = Pismo Formation
Weighted averages based on penetrated thicknesses of aquifer type.

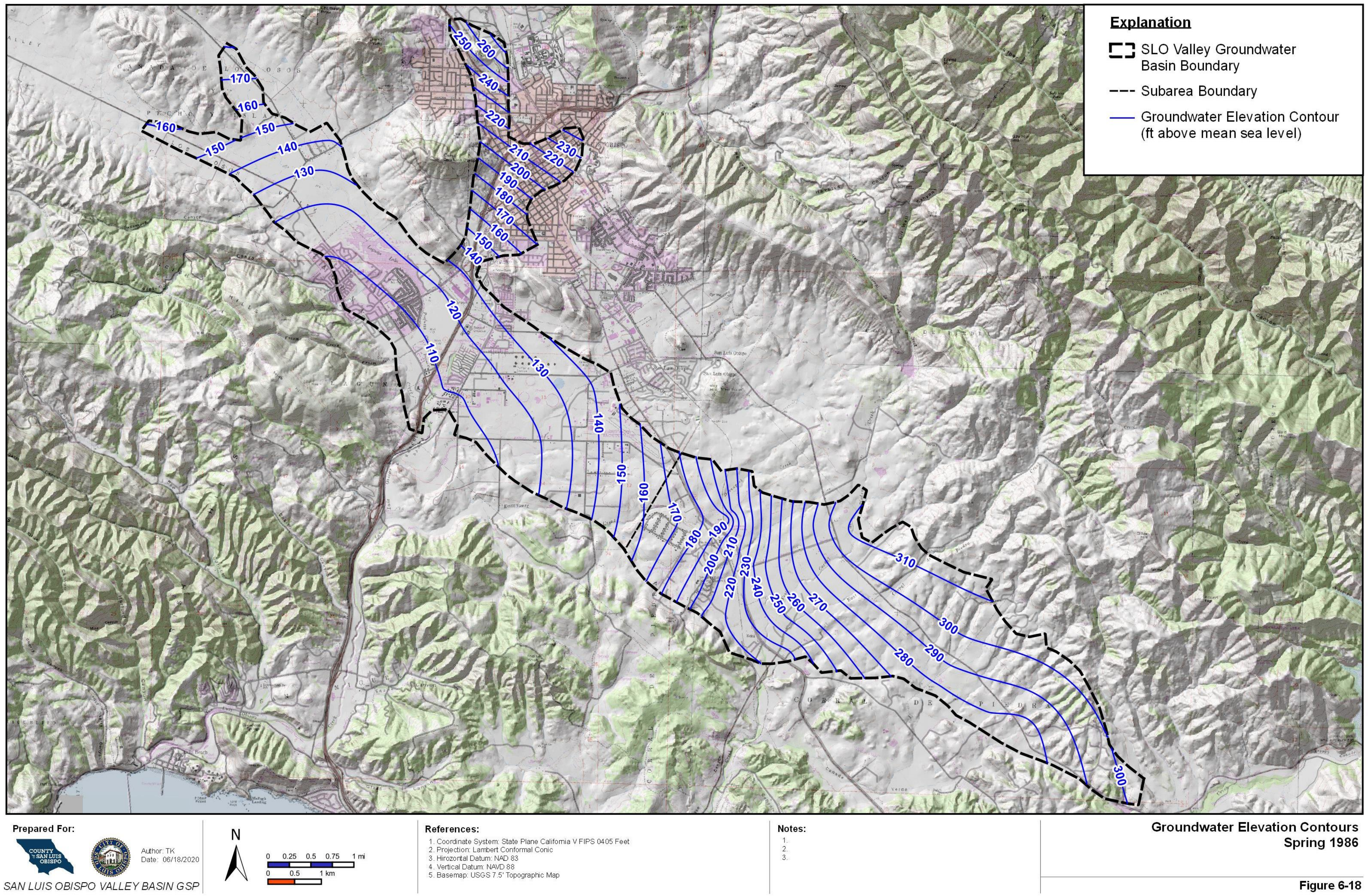


Figure 6-18. Groundwater Elevation Contours Spring 1986

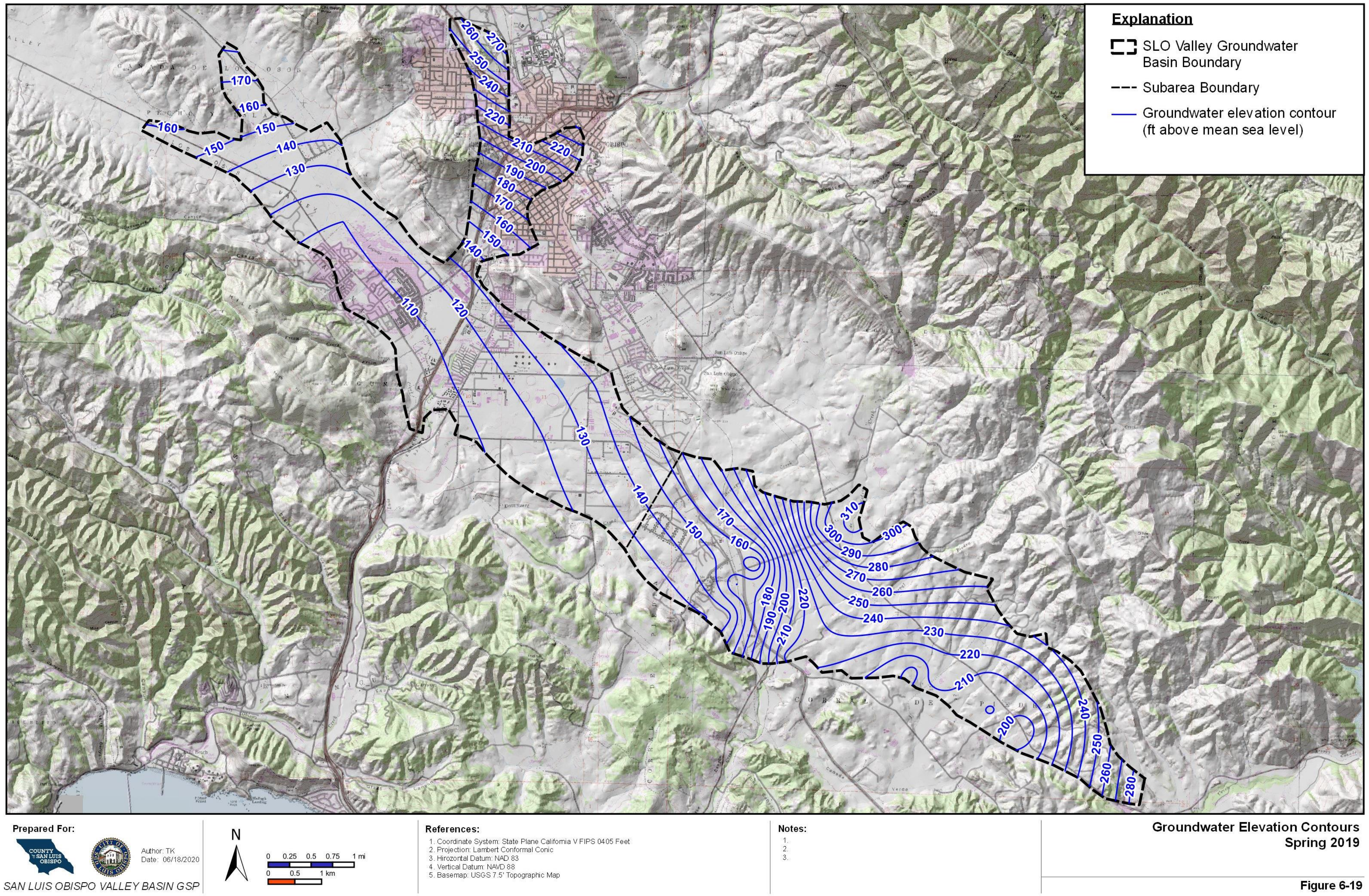


Figure 6-19. Groundwater Elevation Contours Spring 2019

The water level contour maps and the base of permeable sediments were processed for volume calculation using Surfer, a grid-based mapping and graphic program. The methodology consisted of gridding and trimming surfaces to the Basin subarea boundaries, followed by volume calculation between surfaces. The gross volumes obtained were then multiplied by the representative specific yield for each subarea. An example of the methodology showing gridded surfaces for Spring 2019 water levels and the base of permeable sediments is presented in Figure 6-20. Estimated total storage volumes for selected years using the specific yield method are listed in Table 6-14.

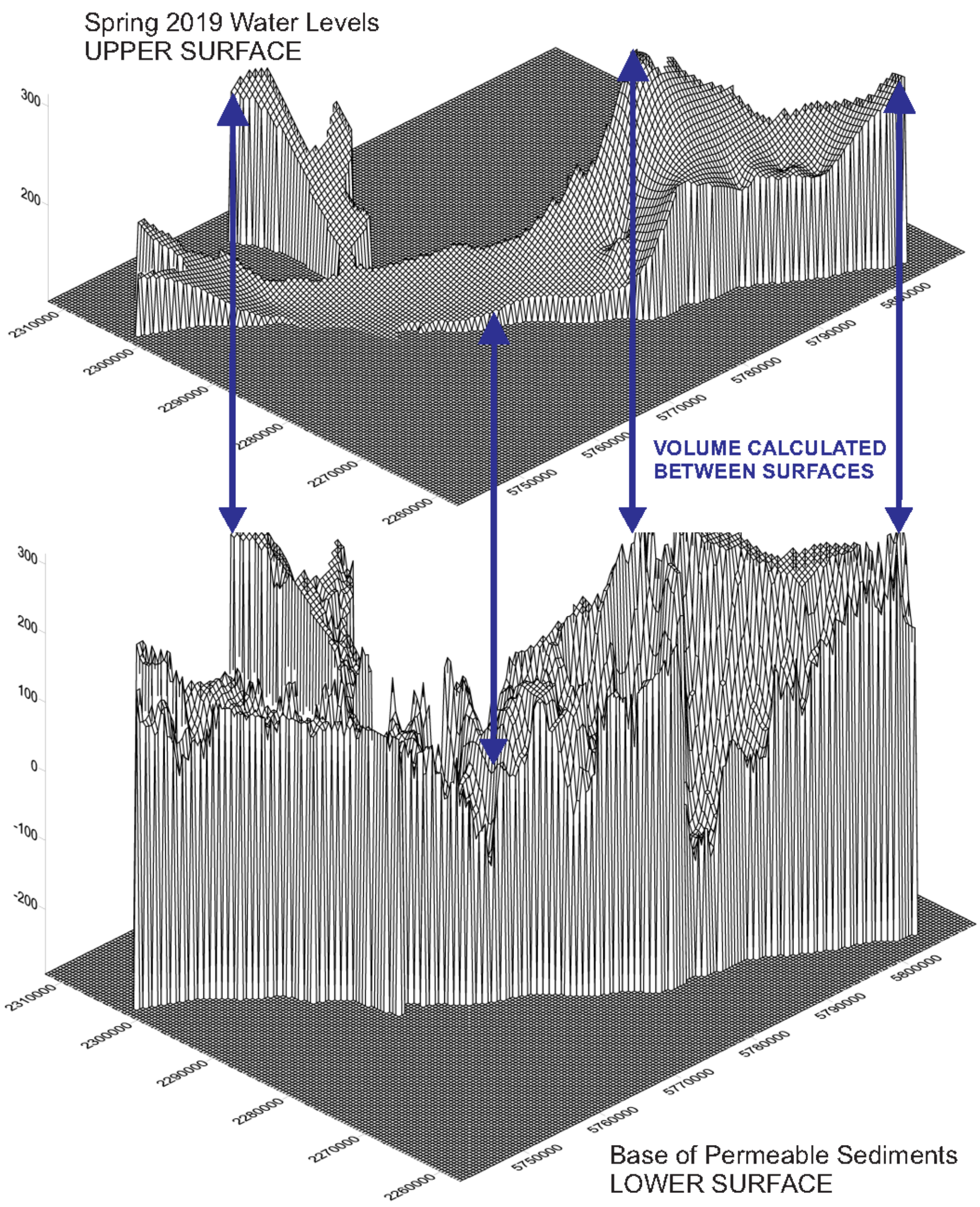


Figure 6-20. Storage Volume Grids

Table 6-14. Spring Groundwater Storage Estimates

YEAR	SLO SUBAREA (ACRE-FEET)	EDNA SUBAREA (ACRE-FEET)	BASIN TOTAL (ACRE-FEET)
1986	36,310	132,840	169,150
1990	31,560	119,950	151,510
1995	36,750	131,020	167,770
1998	36,990	133,010	170,000
2005	38,080	126,210	164,290
2011	35,910	120,220	156,130
2014	34,280	104,950	139,230
2019	34,940	105,630	140,570

The groundwater storage estimates for the Basin are greater than previously reported, which was 23,300 acre-feet for the San Luis Valley subarea and 46,000 acre-feet for the Edna Valley subarea (Boyle Engineering, 1991). The Draft DWR study estimated an average storage of 16,000 acre-feet for the San Luis Valley subarea and 34,000 acre-feet for the Edna valley subarea (DWR, 1997). The increases are due primarily to improvements in characterizing Basin saturated thicknesses, specific yield, and methodology.

For example, the average saturated thickness of Basin sediments in the Edna Valley is listed as 102.9 feet by Boyle (1991). For Spring 1990, the average thickness of saturated sediments in the Edna Valley subarea using the base of permeable sediments in the SLO Basin Characterization Report (GSI Water Solutions, 2018) and Surfer gridding methodology is estimated to be approximately 150 feet, an increase of 50 percent. The estimated average specific yield value for the Edna Valley subarea is also close to 30 percent greater for GSP storage calculations (11.7 percent) than the prior estimate (9.1 percent). An additional 30-35 percent decrease in Basin storage areas was also incorporated into the prior methodology through the application of a subsurface configuration factor, which was not clearly described. (Boyle Engineering, 1991).

Increases in total groundwater in storage between prior work and current estimates does not imply an increase in sustainable yield or basin recharge rate. The purpose of total storage estimates for the water budget is to provide an independent calculation of change in storage over time, which is a critical part of the water budget equation.

6.4.7. Change in Storage

Balancing the water budget is the final step in water budget development.

As previously mentioned, the water budget equation is as follows:

INFLOW – OUTFLOW = CHANGE IN STORAGE

The annual change in storage for the surface water budget is assumed to be zero, as surface flow moves quickly through the basin and any differences in storage are minor compared to the total budget. Therefore, the surface water balance equation can be simplified as INFLOW = OUTFLOW and was used to estimate the stream outflow component of the surface water budget.

For the groundwater budget, groundwater-surface water interaction (as stream flow seepage) was adjusted to approximate the change in storage calculated using the specific yield method discussed above. The difference between the estimated change in storage shown in the water budget and the measured change in storage using the specific yield method is the mass balance error. Change in storage is reported between seasonal high (Spring) conditions per GSP regulations.

Change in storage and mass balance error for the groundwater budget is shown in Table 6-15. Figure 6-21 shows total storage using the water budget and specific yield method.

Table 6-15. Change in Storage Comparison – Historical Base Period 1987 – 2019

	WATER BUDGET	SPECIFIC YIELD METHOD	MASS BALANCE ERROR		
SUBAREA	CHANGE IN STORAGE (ACRE-FEET)		ACRE-FEET	AFY	PERCENT*
San Luis Valley subarea	690	-1,370	2,060	62	6
Edna Valley Subarea	-27,440	-27,210	-230	-7	0

*Percent of total subarea water budget

The difference in change in storage estimates between the water budget and the specific yield method is approximately 60 AFY for the San Luis Valley subarea over the historical base. The water budget estimates a 690 acre-foot gain in storage, compared to a 1,370 acre-foot decline in storage using the specific yield method. A review of the contour maps indicates that the decline in San Luis Valley subarea storage shown by the specific yield method is due to the effects of groundwater level declines in the Edna Valley subarea being contoured across the bedrock high into the San Luis Valley subarea (Figure 6-18 and Figure 6-19). There are no hydrographs for water levels in the bedrock high area, and the extent to which water level declines in the Edna Valley subarea have influenced water levels in the eastern portion of the San Luis Valley subarea is uncertain. Available water level hydrographs do not show overall water level declines west of the bedrock high (Figure 5-11).

The difference in change in storage estimates between the water budget and the specific yield method is less than 10 AFY for the Edna Valley subarea over the historical base period. The water budget estimates a 27,440 acre-foot decline in storage, compared to a 27,210 acre-foot decline in storage using the specific yield method. The change in storage mass balance error for the Basin historical groundwater budget is less than 100 acre-feet per year, which is reasonable for the purposes of preliminary sustainable yield estimates.

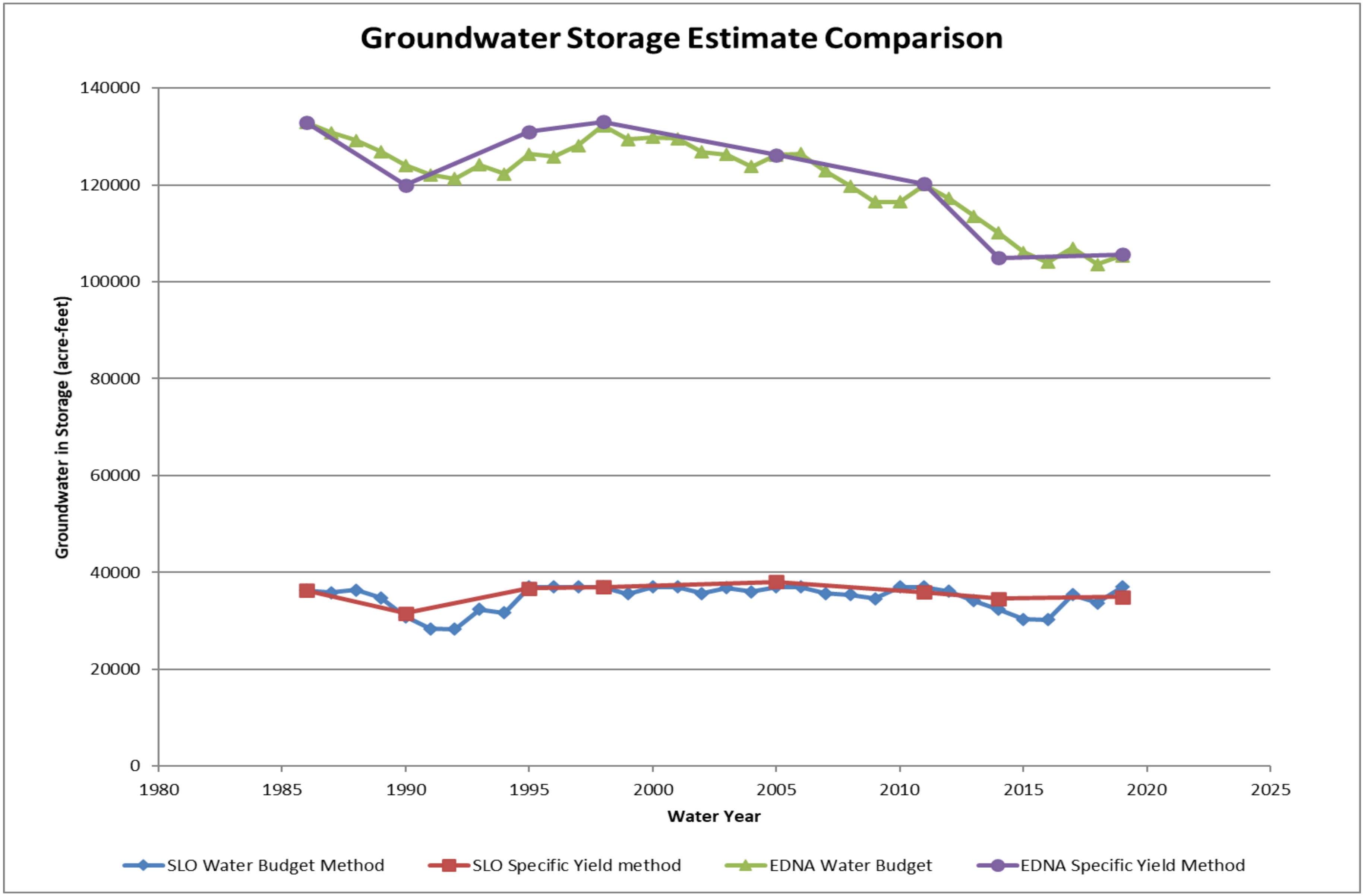


Figure 6-21. Groundwater Storage Estimate Comparison for Basin Subareas

6.4.8. Preliminary Sustainable Yield Estimate

The sustainable yield is the maximum quantity of water, calculated over a base period representative of long-term conditions in the Basin and including any temporary surplus, that can be withdrawn annually from a groundwater supply without causing an undesirable result. Temporary surplus is the amount of water that may be pumped from an aquifer to make room to store future water that would otherwise be evaporated from shallow groundwater table or discharged from the aquifer to area creeks. Undesirable results will be defined for six sustainable management criteria in Chapter 8 (Sustainable Management Criteria). Examples of potential undesirable results are related to long-term declines in water levels and associated loss in groundwater in storage.

Estimating sustainable yield includes evaluating historical, current, and projected water budget conditions. The analytical water budget method utilized in this analysis evaluates historical and current conditions and provides a preliminary estimate for the Basin sustainable yield. The projected water budget will be evaluated using the Basin numerical model presented later in the projected water budget section of the chapter, at which time the minimum thresholds for the sustainable management criteria can be incorporated and the final sustainable yield will be determined. The preliminary sustainability estimate can be used for planning potential projects and management action scenarios for the Basin numerical model.

The preliminary sustainable yield of the Basin has been estimated separately for each of the subareas. The Edna Valley subarea has experienced cumulative storage declines since 1998, while the San Luis Valley subarea experiences minimal storage declines during drought but recovers and is typically close to full storage capacity (Figure 6-21).

For the Edna Valley subarea, sustainable yield is estimated as the amount of long-term recharge (groundwater inflow) to the Basin over the historical base period (3,400 AFY) minus subsurface outflow (100 AFY). The resulting preliminary sustainable yield is estimated at a 3,300 AFY.

The San Luis Valley subarea has not experienced cumulative and persistent storage declines. Long-term average recharge to groundwater in the San Luis Valley subarea is estimated to be 3,700 AFY, of which an estimated 1,200 AFY is used by wetlands, leaving 2,500 AFY for withdrawal without long-term declines in storage (subsurface outflow is supported by wastewater discharges). The historical recharge to the subarea may be less than the sustainable yield, however, average annual recharge can increase with storage declines, particularly in a Basin that is at or near storage capacity.

The San Luis Valley subarea did experience significant undesirable results due to land subsidence during the period of high groundwater use and associated storage decline toward the end of the 1987-91 drought. Average groundwater production from 1990-1992 was 3,960 AFY. Land subsidence is not necessarily a risk over the entire subarea and would generally require historical storage declines to be exceeded in affected areas for additional subsidence to occur. However, without mitigation for land subsidence or specific projects that increase recharge during dry periods, the preliminary sustainable yield of the San Luis Valley subarea is estimated at 2,500 AFY, based on the long-term average recharge of 3,700 AFY minus 1,200 AFY used by wetlands. Figure 6-15 summarizes the preliminary sustainable yield estimates.

Table 6-16. Preliminary Sustainable Yield Estimate (AFY)

SAN LUIS VALLEY SUBAREA	**2,500**
EDNA VALLEY SUBAREA	**3,300**
BASIN TOTAL	**5,800**

The above values are lower overall than historical estimates by Boyle (1991) and DWR (1997). Boyle estimated 5,900 AFY of sustainable yield for the Basin while DWR estimated 2,000-2,500 for the San Luis Valley subarea and 4,000-4,500 for the Edna Valley Subarea.

6.4.9. Quantification of Overdraft

Overdraft is the condition of a groundwater Basin or subbasin where the amount of water withdrawn by pumping exceeds the amount of water that recharges a Basin over a period of years, during which the water supply conditions approximate average conditions.

While the 33-year historical base period is representative of the long-term climatic conditions needed for estimating sustainable yield, a shorter period is appropriate for characterizing water supply conditions with respect to Basin withdrawals and overdraft. Over the last 10 years the City has introduced recycled water use at Laguna golf course (historically irrigated by groundwater) and has stopped pumping groundwater from the San Luis Valley subarea, while total irrigated agriculture in the Edna Valley subarea has leveled off after increasing from the beginning of the historical base period through the mid-2000’s (Table 6-5). Overdraft for GSP planning purposes has been estimated as the difference between sustainable yield and average groundwater withdrawals over the last 10 years (2010-2019), with an adjustment in the San Luis Valley subarea to account for reductions in agricultural acreage due to recent development.

Groundwater extractions in the San Luis Valley subarea (adjusted for recent development) have averaged 1,800 AFY since 2010, which is 700 AFY less than the average recharge of 2,500 AFY over the same representative period, indicating a surplus of groundwater for the subarea. In the Edna Valley subarea, groundwater pumping has averaged 4,400 AFY since 2010, which is 1,100 AFY more than the sustainable yield of 3,300 AFY for the subarea. The Edna Valley subarea is an estimated 1,100 AFY in overdraft. Total Basin overdraft is estimated at 400 AFY. Table 6-16 summarizes the overdraft estimates.

Table 6-17. Estimated Overdraft (AFY)

SAN LUIS VALLEY SUBAREA	**-700***
EDNA VALLEY SUBAREA	**1,100**
BASIN TOTAL	**400**

*surplus

In comparison, prior work (Boyle Engineering, 1991) concluded that there was short-term overdraft in the Basin and that withdrawals in excess of sustainable yield was a common occurrence. However, during the period from 1978-1990, the Basin was not considered in a state of sustained overdraft. The Draft 1997 DWR study does not address overdraft, although there is a net deficit in the basin water budget for the 1969-1977 base period, a surplus for the 1983 water budget, and a deficit for the 1990 water budget. The draft DWR report concluded that additional water beyond the long-term dependable yield could be extracted from the Basin, but that there could be adverse impacts.

6.5. Current Water Budget

The current water budget quantifies inflows and outflows for the Basin based on the last four years of the historical water budget, from 2016 to 2019. These years provide the most recent population, land use, and hydrologic conditions. Recent Basin conditions have been characterized by above average rainfall, along with a decrease in urban extractions and imported surface water supplies assumed to be associated with greater conservation awareness by the public during the 2012-2016 drought. There have also been declines in agricultural acreage and associated groundwater extractions in the San Luis Valley subarea associated with urban development.

Comparisons of the current water budget to the 1987-2019 historical surface water budget used for the preliminary sustainable yield estimates for the two subareas and total Basin are shown in Table 6-17 through Table 6-19. Bar graphs showing the same information are shown in Figure 6-22 through Figure 6-26. As expected, the average annual water budget inflows and outflows are greater under current conditions than the historical base period, primarily due to greater rainfall. There has been more groundwater inflow than outflow under the current water budget in the San Luis Valley subarea, leading to increased groundwater in storage. In the Edna valley subarea, the outflow has been slightly greater than inflow under the current water budget, with relatively little change to groundwater in storage since the end of the recent drought (Figure 6-21). As noted above, groundwater extractions for agriculture in the San Luis Valley subarea have declined between the historical and current water budgets.

Table 6-18. Current Water Budget - San Luis Valley Subarea

SURFACE WATER BUDGET	HISTORICAL AVERAGE (1987-2019)	CURRENT (2016-2019)
INFLOW	**AFY**	
Precipitation	10,580	12,280
Groundwater extractions (Urban)	740	400
Groundwater extractions (Ag)	1,630	1,370
Stream Inflow at Basin Boundaries	10,720	10,570
Wastewater discharge to streams	4,080	3,910
Local Imported Supplies	5,820	5,430
TOTAL IN	**33,580**	**33,960**
OUTFLOW	**AFY**	
ET of precipitation	7,770	8,220
ET of Applied Water (Urban)	2,050	1,510
ET of Applied Water (Ag)	1,310	1,100
ET of Lake/Wetland/Riparian	650	690
Surface Water Delivery Offset	4,080	3,910
Infiltration of Precipitation	1,610	3,190
Infiltration of Applied Water (Urban)	440	440
Infiltration of Applied Water (ag)	320	260
GW-SW interaction (net)	970	510
Stream outflow at Basin boundary	14,390	14,120
TOTAL OUT	**33,580**	**33,960**
GROUNDWATER BUDGET	HISTORICAL AVERAGE (1987-2019)	CURRENT (2016-2019)
INFLOW	**AFY**	
Infiltration of precipitation	1,610	3,190
Urban water return flow	440	440
Agricultural return flow	320	260
GW-SW interaction (net)	970	510
Subsurface from bedrock	340	340
TOTAL IN	**3,670**	**4,750**
OUTFLOW	**AFY**	
Groundwater extractions (Urban)	740	400
Groundwater extractions (Ag)	1,630	1,370
Wetland direct ET	1,160	1,190
Subsurface outflow	120	120
TOTAL OUT	**3,650**	**3,080**

Table 6-19. Current Water Budget - Edna Valley Subarea

SURFACE WATER BUDGET	HISTORICAL (1987-2019)	CURRENT (2016-2019)
INFLOW	**AFY**	
Precipitation	9,300	10,780
Groundwater extractions (Urban)	880	820
Groundwater extractions (Ag)	3,210	3,440
Stream Inflow at Basin Boundaries	3,630	3,480
TOTAL IN	**17,020**	**18,520**
OUTFLOW	**AFY**	
ET of precipitation	6,910	7,200
ET of Applied Water (Urban)	600	610
ET of Applied Water (Ag)	2,650	2,870
ET of Riparian	40	40
Infiltration of Precipitation	1,890	2,800
Infiltration of Applied Water (Urban)	280	210
Infiltration of Applied Water (ag)	560	570
GW-SW interaction (net)	510	490
Stream outflow at Basin boundary	3,580	3,750
TOTAL OUT	**17,020**	**18,520**
GROUNDWATER BUDGET	**HISTORICAL AVERAGE (1987-2019)**	**CURRENT (2016-2019)**
INFLOW	**AFY**	
Infiltration of precipitation	1,890	2,800
Urban water return flow	290	220
Agricultural return flow	560	570
GW-SW interaction (net)	510	490
Subsurface from bedrock	110	110
TOTAL IN	**3,360**	**4,180**
OUTFLOW	**AFY**	
Groundwater extractions (Urban)	880	820
Groundwater extractions (Ag)	3,210	3,440
Subsurface outflow	100	100
TOTAL OUT	**4,190**	**4,360**

Table 6-20. Current Water Budget - Basin Total

SURFACE WATER BUDGET	HISTORICAL AVERAGE (1987-2019)	CURRENT (2016-2019)
INFLOW	**AFY**	
Precipitation	19,880	23,060
Groundwater extractions (Urban)	1,620	1,220
Groundwater extractions (Ag)	4,840	4,810
Stream Inflow at Basin Boundaries	14,350	14,050
Wastewater discharge to streams	4,080	3,910
Local Imported Supplies	5,820	5,430
TOTAL IN	**50,600**	**52,480**
OUTFLOW	**AFY**	
ET of precipitation	14,680	15,420
ET of Applied Water (Urban)	2,650	2,120
ET of Applied Water (Ag)	3,960	3,970
ET of Lake/Wetland/Riparian	690	730
Surface Water Delivery Offset	4,080	3,910
Infiltration of Precipitation	3,500	5,990
Infiltration of Applied Water (Urban)	720	650
Infiltration of Applied Water (ag)	880	830
GW-SW interaction (net)	1,480	1,000
Stream outflow at Basin boundary	17,970	17,870
TOTAL OUT	**50,600**	**52,480**
GROUNDWATER BUDGET	**HISTORICAL AVERAGE (1987-2019)**	**CURRENT (2016-2019)**
INFLOW	**AFY**	
Infiltration of precipitation	3,500	5,990
Urban water return flow	730	660
Agricultural return flow	880	830
GW-SW interaction (net)	1,480	1,000
Subsurface from bedrock	450	450
TOTAL IN	**7,030**	**8,930**
OUTFLOW	**AFY**	
Groundwater extractions (Urban)	1,620	1,220
Groundwater extractions (Ag)	4,840	4,810
Wetland direct ET	1,160	1,190
Subsurface outflow	220	220
TOTAL OUT	**7,840**	**7,440**

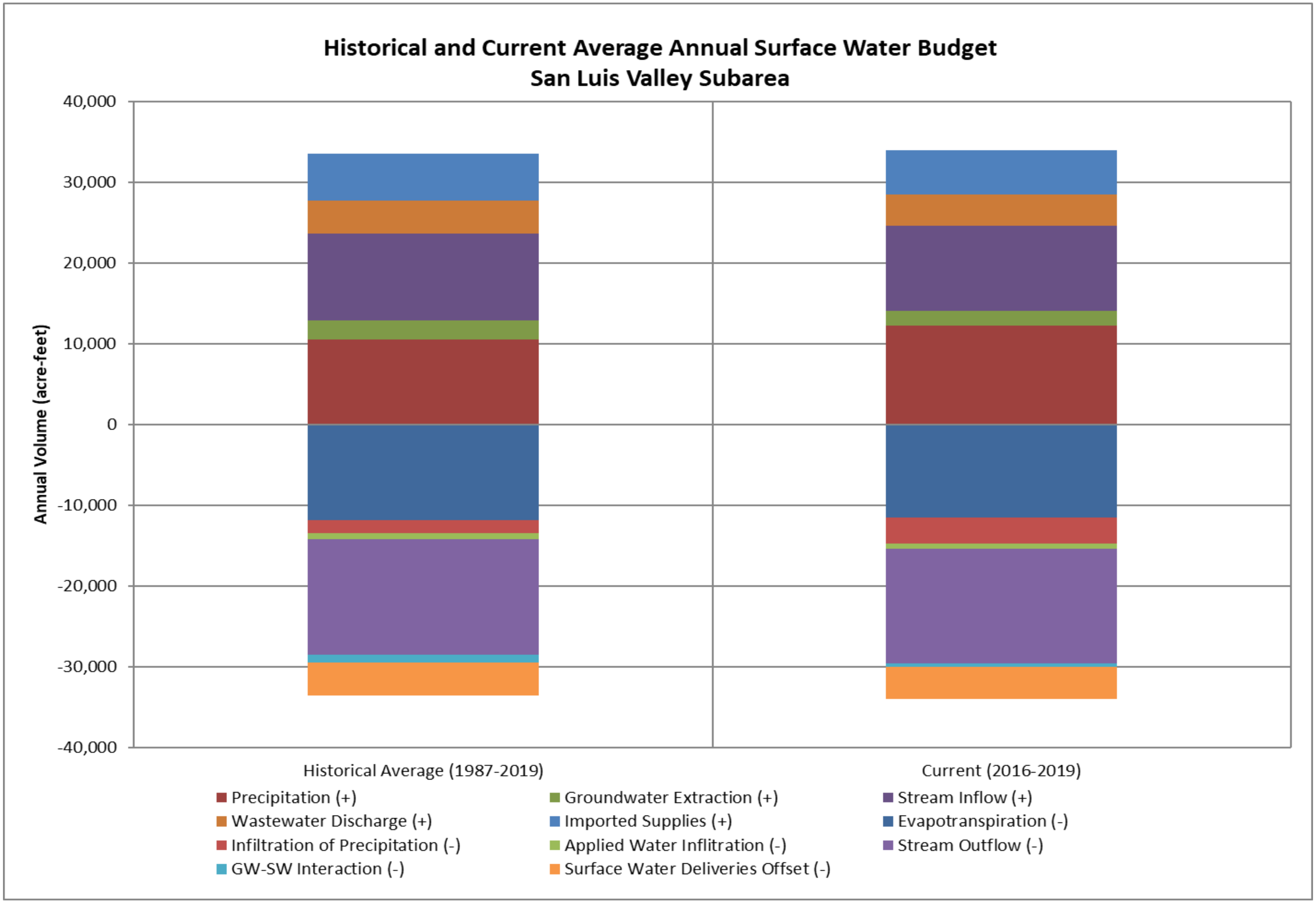


Figure 6-22. Historical and Current Average Annual Surface Water Budget – San Luis Valley Subarea

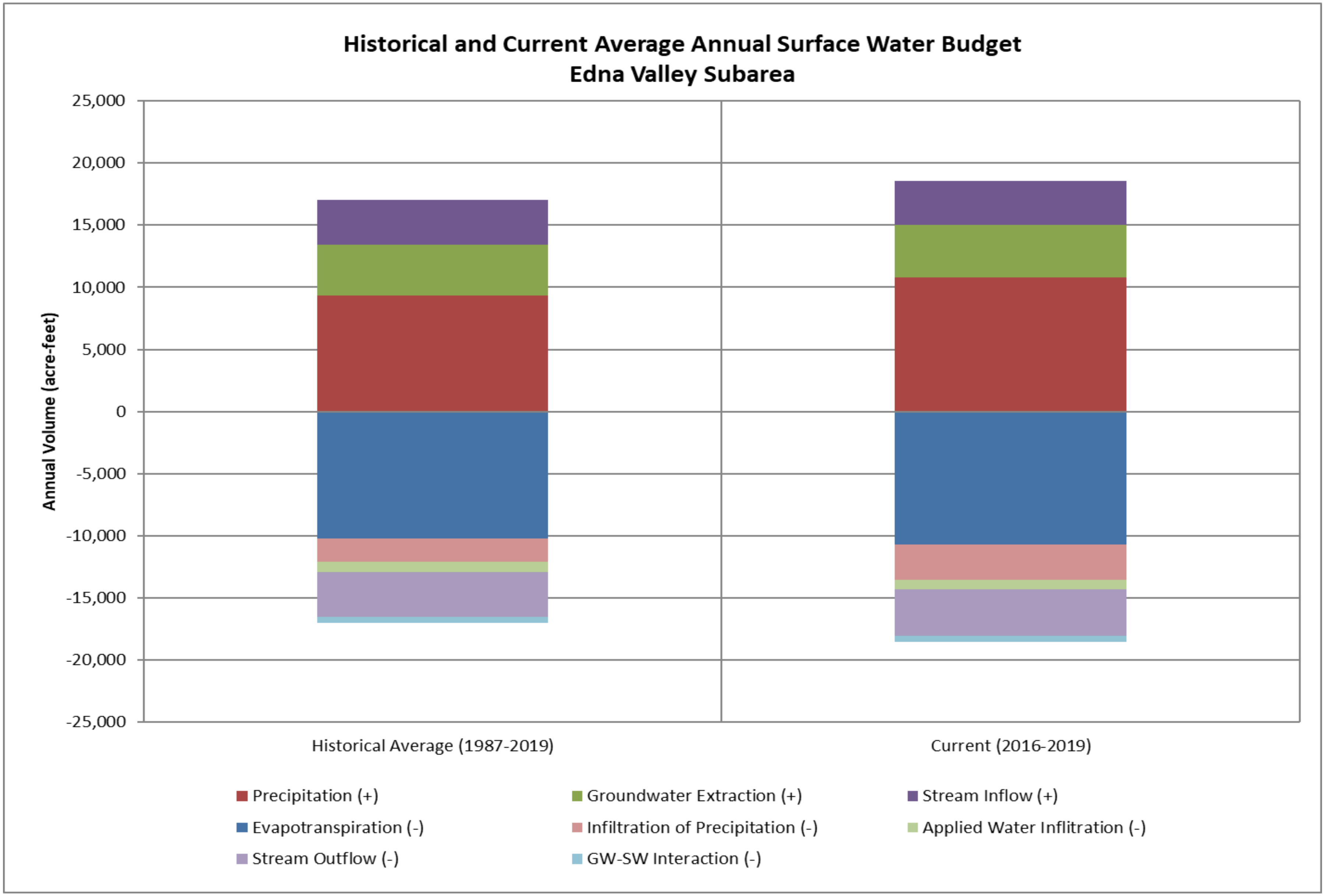


Figure 6-23. Historical and Current Average Annual Surface Water Budget – Edna Valley Subarea

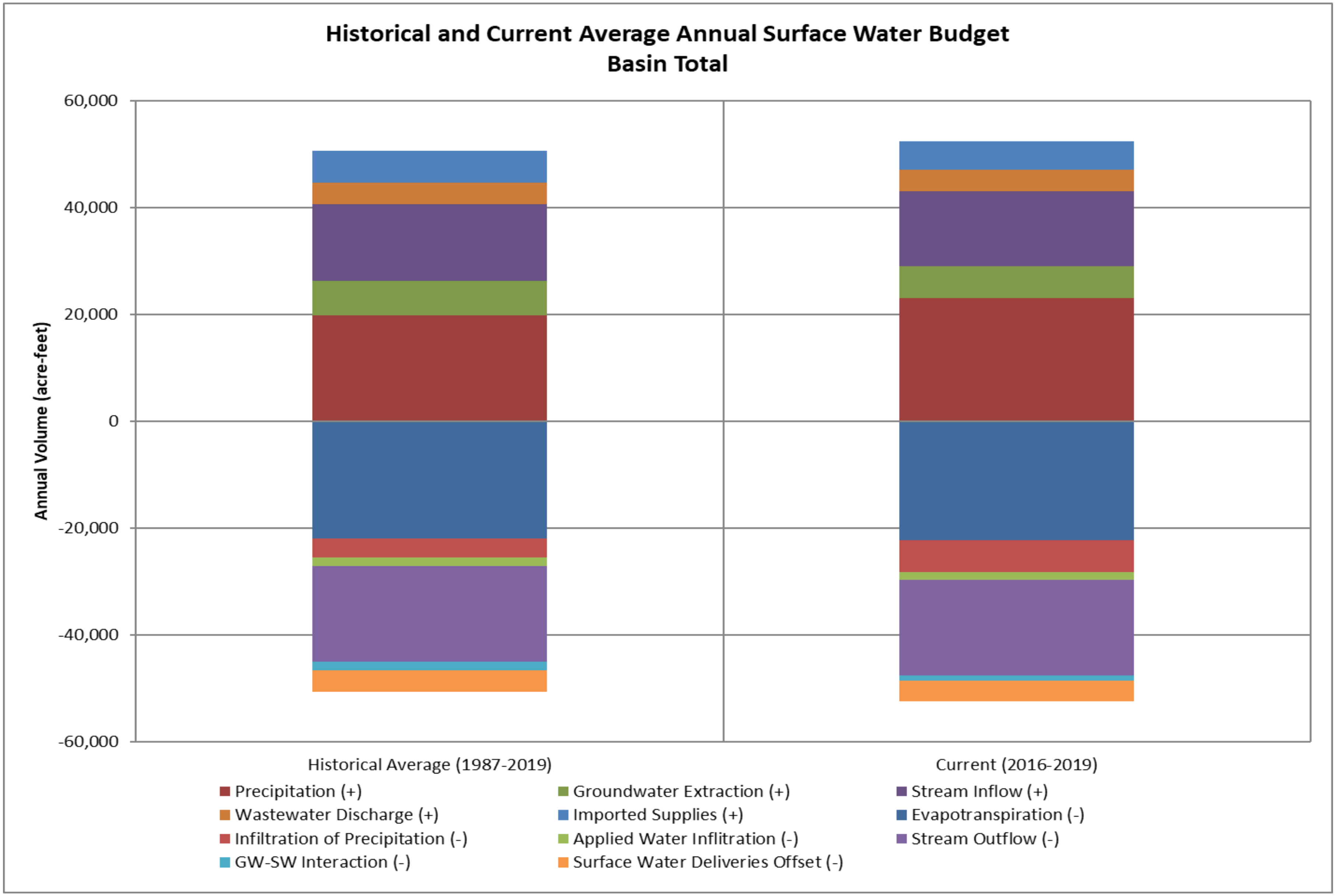


Figure 6-24. Historical and Current Average Annual Surface Water Budget – Basin Total

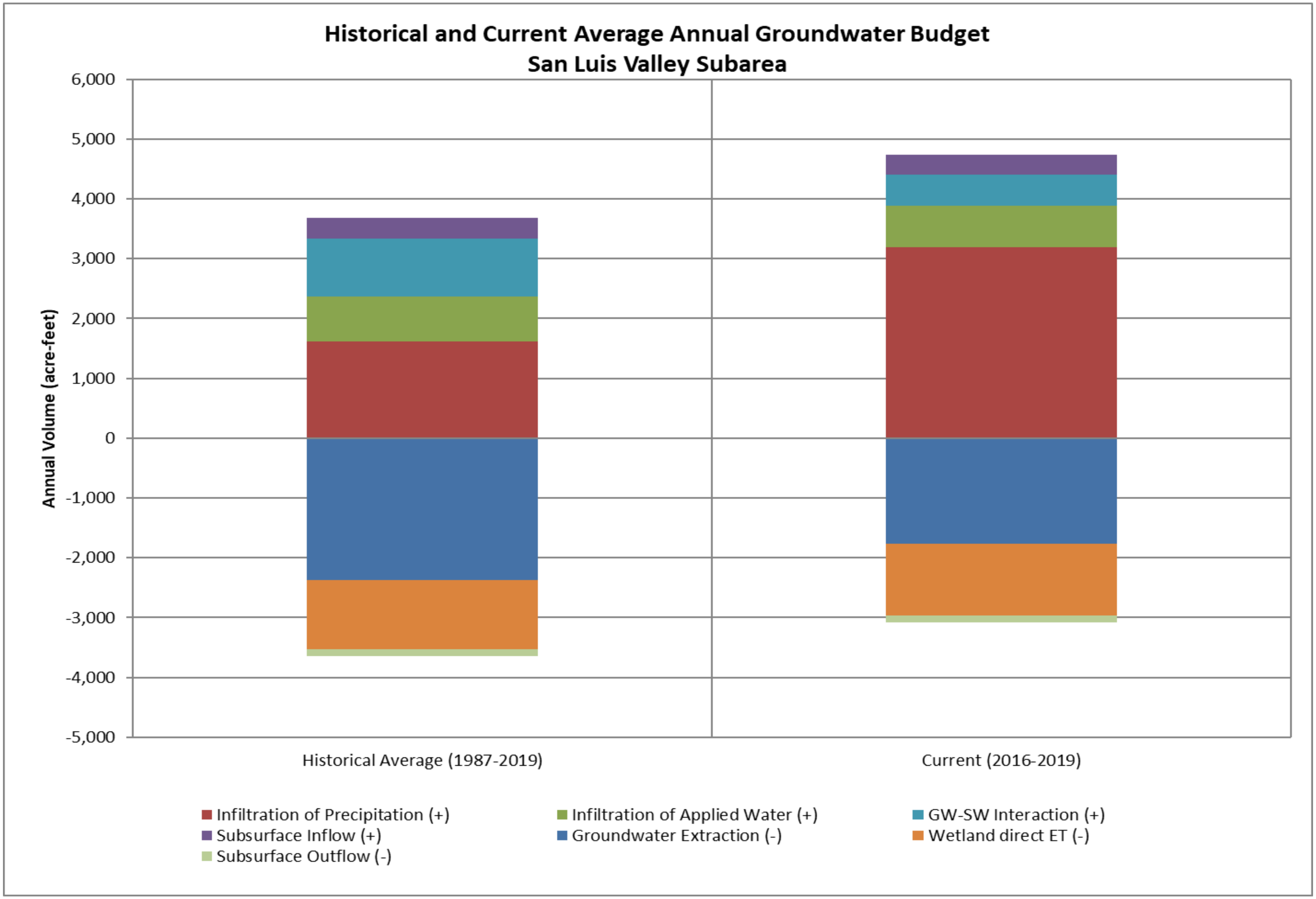


Figure 6-25. Historical and Current Average Annual Groundwater Budget – San Luis Valley Subarea

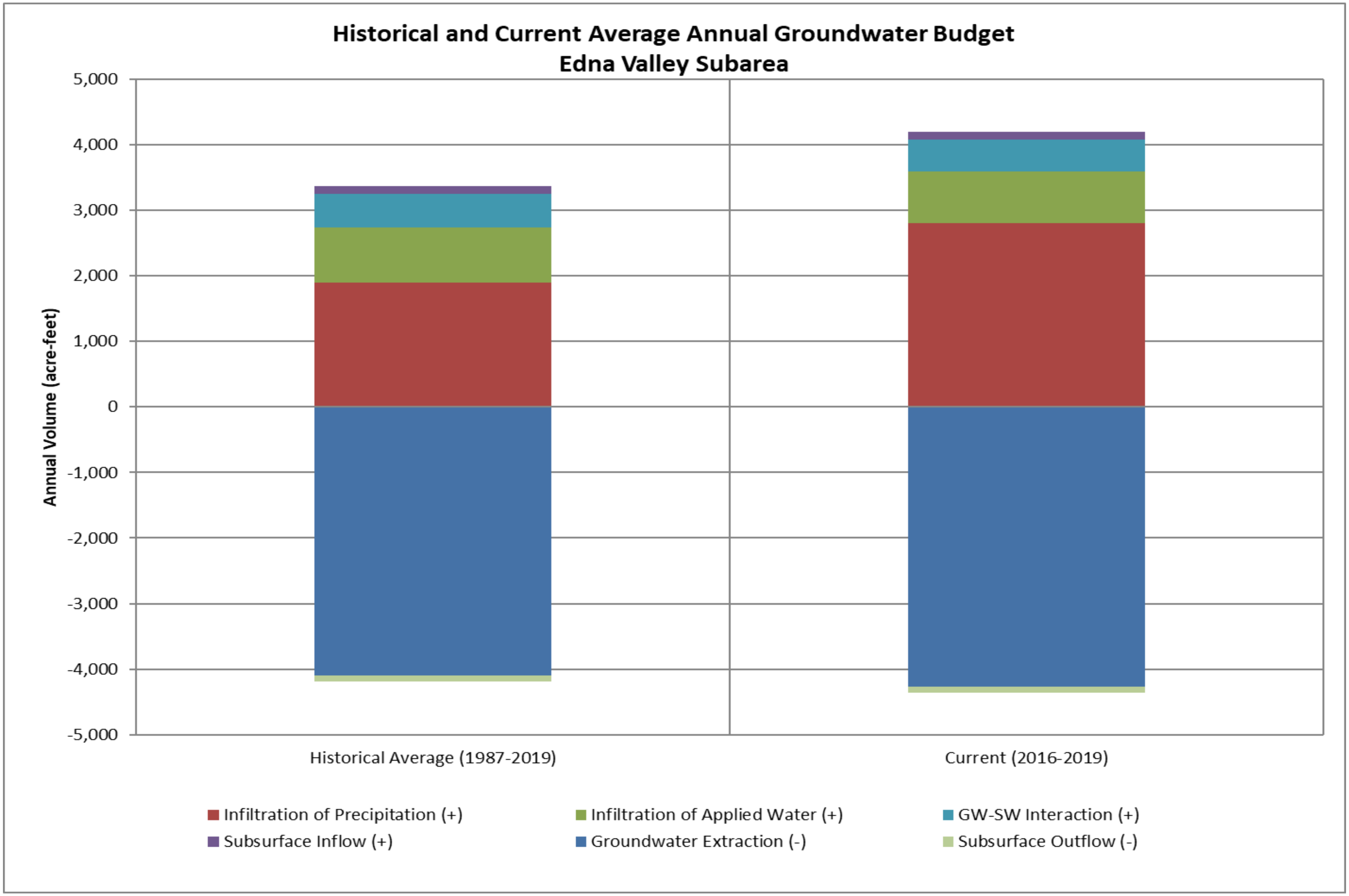


Figure 6-26. Historical and Current Average Annual Groundwater Budget – Edna Valley Subarea

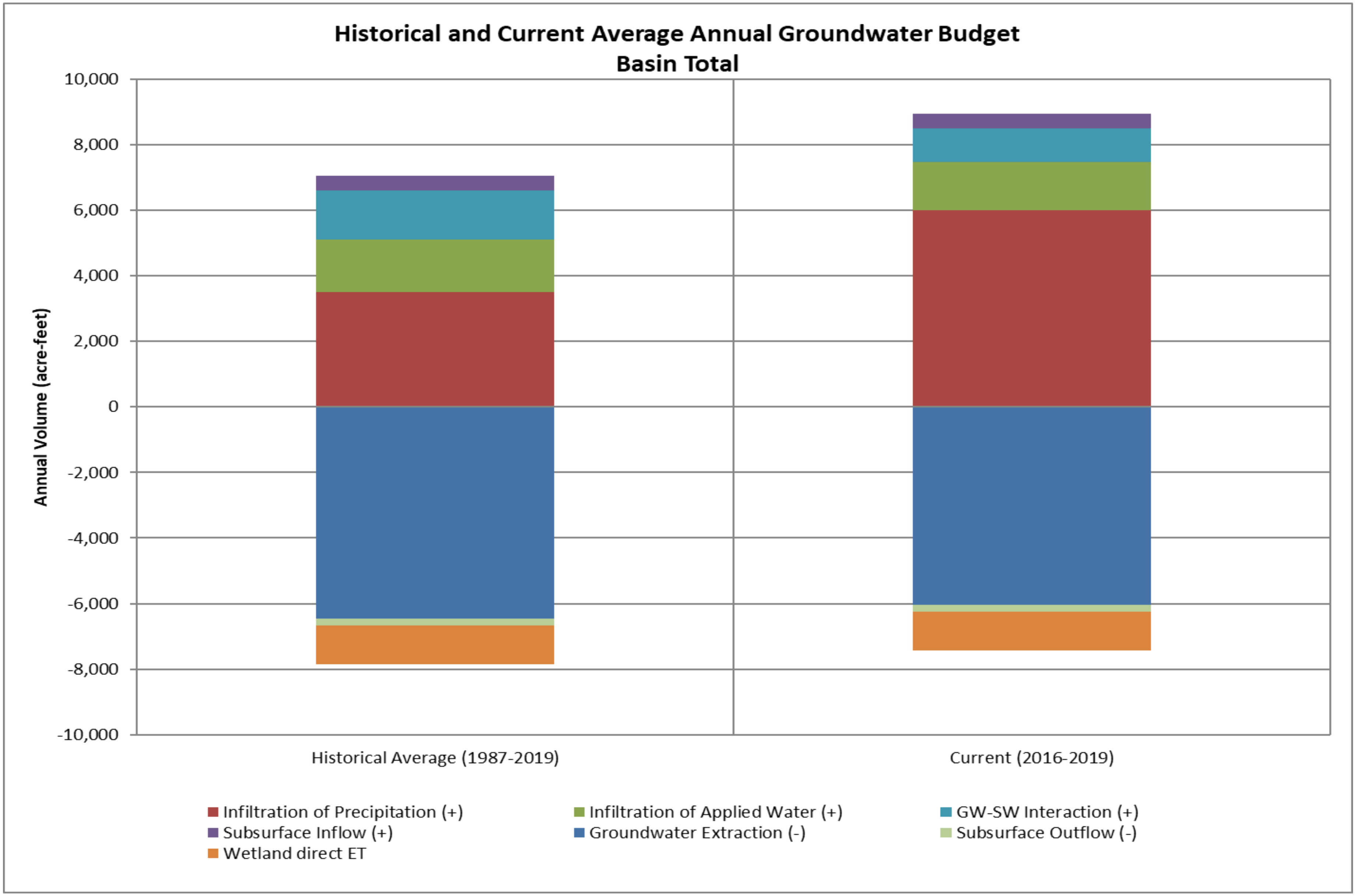


Figure 6-27. Annual Groundwater Budget – Basin Total

6.6. Projected Water Budget

SGMA Regulations require the development of a future surface water and groundwater budget to estimate future baseline conditions of supply, demand, and aquifer response to Basin groundwater use. The future water budget provides a baseline against which management actions will be evaluated over the GSP implementation period from 2022 to 2042. Future water budgets were developed using the GSFLOW model developed for this GSP (Appendix G). Each simulation was run continuously through the historical calibration period (water years 1987-2019) through the end of the predictive simulation period (water years 2020 through 2044). Assumptions and details of the model simulations are provided in the following sections.

6.6.1. Assumptions Used in Future Water Budget Development

SGMA regulations mandate the development of a future groundwater budget to estimate future baseline conditions of supply, demand, and aquifer response to Basin pumping. The future water budget provides a baseline against which management actions may be evaluated during the GSP implementation period. Future water budgets were developed using the Basin GSFLOW integrated model.

As per Section 354.18(c)(3)(A) of the SGMA GSP regulations, the future water budget should be based on 50 years of historical climate data. The GSP GSFLOW model and historical water budget analysis is based on 33 years of historical data rather than 50 years of data. As detailed in Section 6.2.1., this is judged to be a representative historical period spanning a variety of hydrologic year types and is the best available information for groundwater planning purposes. Therefore, the future water budget is based on this time series rather than a 50-year time series of data.

Assumptions about future groundwater supplies and demands are described in the following subsections.

6.6.1.1. Future Water Demand Assumptions

For the purpose of evaluating the effects of climate change and future baseline water budget development, the assumption is made that there will be no increase in irrigated acreage or agricultural pumping over the SGMA planning horizon. Agricultural pumping is maintained at Water Year 2019 levels. Representatives of agricultural stakeholders have been involved in the GSP planning process from the beginning, including representation on the GSC, active involvement in public meetings, and significant contributions through the public comment process. In the Edna Valley, it is understood by the agricultural stakeholders that the path to sustainability likely requires a decrease in agricultural pumping. In accordance with Section 354.18 (c)(3)(B) of the SGMA GSP Regulations, the most recently available land use (in this case, crop acreage) and crop coefficient information is used as the baseline condition for estimating future agricultural irrigation water demand. For the GSP, the most recent crop acreage data was obtained from the office of the San Luis Obispo County Agricultural Commissioner and is described in Section 6.4.2 (Historical Land Use).

The assumption is also made that municipal pumping in the baseline predictive period will remain at current levels (Water Year 2019 pumping values). The City does not currently pump groundwater to supply their service area. Although City population may increase, at present this would not require increased groundwater pumping. The City may resume groundwater use in the future to augment the water supply for their service area. However, with the San Luis Valley water budget in surplus as previously described, there is likely available capacity for the aquifer to provide supply in the San Luis Valley in the future. Also, space for municipal expansion is frequently made possible by retirement of agricultural land, which results in lower pumping in the Basin. Several areas within the City are currently under development and transitioning land from agricultural use to residential and commercial uses.

Additionally, rural domestic de minimis pumping is assumed to remain at current levels; there are no significant development plans in County-administered parts of the Basin. Additionally, this is a small portion of the overall water budget (2-4% of total pumping), and minor revisions to this pumping category will not significantly affect model results.

6.6.1.2. Future Climate Assumptions

For the baseline predictive scenario, the historical time series of climatological model input parameters for water years 1995 through 2019 was repeated for the predictive model period of water years 2020 through 2044. The 1995 – 2019 historical period includes several different water year types, including representation of the recent drought.

For the climate change predictive scenario, SGMA GSP Regulations require incorporating future climate estimates into the future water budget. To meet this requirement, DWR developed an approach for incorporating reasonably expected, spatially gridded changes to monthly precipitation and reference ETo (DWR 2018). The approach for addressing future climate change developed by DWR was used in the future water budget modeling for the Basin. The changes are presented as separate monthly change factors for both precipitation and ETo and are intended to be applied to historical time series within the climatological base period through 2011. Specifically, precipitation and ETo change factors were applied to historical climate data for the period 1995-2019 for modeling the future water budget.

DWR provides several sets of change factors representing potential climate conditions in 2030 and 2070. The SLO Basin used the 2070 climate conditions to develop a future water budget. Consistent with DWR recommendations, datasets of monthly 2070 change factors for the SLO Basin area were applied to precipitation and ETo data from the historical base period to develop monthly time series of precipitation and ETo, which were then used to simulate future hydrology conditions.

6.6.2. Projected Future Water Budget

6.6.2.1. Future Surface Water Budget

The future surface water budget includes average inflows from local imported supplies, average inflows from local supplies, average stream outflows, and average stream percolation to groundwater. Table 6-21 summarize the average components of the historical average and projected surface water budget. Because the timeline of preparing the GSP chapters required completions prior to the completion of the integrated surface water/groundwater model, the historical average values and the current values presented in Table 6-21 and Table 6-22 are taken from the analytical water budget analysis presented in this chapter. The future water budget values presented are taken from the average 2020-2044 GSFLOW model output for the climate change scenario. These are different methods of analysis, and as a result some of the future water budget results are different in magnitude and, in some cases, water budget component categories, from the analytical water budget results. Differences in values between some of the component categories of the water budget may be attributable to differences in estimation methods between the analytical approach and the modeling approach. In addition, many of the differences relate to the surface water/groundwater component of the water budget, which has a lack of reliable data during the historical period of record. If future water budgets are developed using the model, past and future estimates will likely be more consistent.

Table 6-21 Projected Future Annual Surface Water Inflows to Basin (AFY)

SURFACE WATER BUDGET	HISTORICAL AVERAGE (1987-2019)	CURRENT (2016-2019)	FUTURE (2020-2044 ANNUAL AVERAGE)
INFLOW	**AFY**		
Precipitation	19,880	23,060	18,182
Groundwater extractions (Urban)	1,620	1,220	1,238
Groundwater extractions (Ag)	4,840	4,810	4,374
Stream Inflow at Basin Boundaries	14,350	14,050	9,295
Wastewater discharge to streams	4,080	3,910	3,910
Local Imported Supplies	5,820	5,430	5,430
TOTAL IN	**50,600**	**52,480**	**42,429**
OUTFLOW	**AFY**		
ET of Precipitation	14,680	15,420	12,612
ET of Lake/Wetland/Riparian	690	730	
ET of Applied Water (Urban)	2,650	2,120	1,919
ET of Applied Water (Ag)	3,960	3,970	3,512
WWTP Effluent Offset	4,080	3,910	3,910
Infiltration of Precipitation	3,500	5,990	2,606
Infiltration of Applied Water (Urban)	720	650	559
Infiltration of Applied Water (ag)	880	830	862
GW-SW interaction (net)	1,480	1,000	2,534
Stream outflow at Basin boundary	17,970	17,870	13,744
TOTAL OUT	**50,600**	**52,480**	**42,258**

Inspection of values in the future surface water budget and groundwater budgets in Tables 6-21 and 6-22 reveal some differences between the model-generated future water budget values and the analytically estimated past and current water budgets. As mentioned previously, the two approaches to analyzing a water budget are quite different. Still, the differences merit some discussion. First, it is important to remember that the current water budget represents water years 2016-2019, which was a relatively wet period coming out of the 2012-2016 drought. The historical average period includes a 33-year period with slightly higher pumping values, and also includes both the period prior to recent water level declines (prior to the mid-1990s) as well as periods of documented water level declines (mid-1990s through present). The future water budget encompasses a 25-year period using the assumptions previously discussed. For the future water budget, the inflows and outflows are approximately balanced, as one would expect to see. However, the total inflow and outflows for the future water budget (about 42,300 AFY) are about 17% lower than the historical average (50,600 AFY). The largest water budget component difference between the two budgets is the surface water inflow value, wherein the model-derived value for this parameter for the future water budget is 9,295 AFY, which is about 65% of the analytical estimate. The PRMS model may underestimate the baseflow component of streamflow, which could explain some of this discrepancy, or the analytical approach may have overestimated runoff when correlating sub-watershed flows to the Andres. However, as has been discussed previously in this chapter, there was almost no direct flow measurement data available for model calibration; all data was calculated based on theoretical estimates equating stage to discharge, which incorporates a significant degree of uncertainty into this component of the surface water budget. Improvement in the surface flow monitoring network will help to better define this component. Additionally, it is important to realize that this discrepancy in the surface water budget does not translate into a comparable magnitude of discrepancy in the Groundwater budget. Particularly in SLO Basin, where the Basin is oriented perpendicular to the direction of streamflow, high flows move into and out of the Basin quickly, and do not have the same magnitude of influence on the groundwater budget as is expressed in the surface water budget.

6.6.2.2. Future Groundwater Budget

Projected groundwater budget components are computed using the GSFLOW integrated surface water/groundwater flow model to simulate average conditions over the implementation period. Table 6-22 summarizes the projected annual groundwater budget for the SLO Basin.

Table 6-22 Future Water Budget

GROUNDWATER BUDGET	HISTORICAL AVERAGE (1987-2019)	CURRENT (2016-2019)	FUTURE
INFLOW	**AFY**		
Infiltration of precipitation	3,500	5,990	2,606
Infiltration of Applied Water (Urban)	730	660	559
Infiltration of Applied Water (ag)	880	830	862
GW-SW interaction (net)	1,480	1,000	2,534
Subsurface from bedrock	450	450	1,093
TOTAL IN	**7,030**	**8,930**	**7,654**
OUTFLOW			
Groundwater extractions (Urban)	1,620	1,220	1,238
Groundwater extractions (Ag)	4,840	4,810	4,374
Wetland direct ET	1,160	1,190	2,807
Subsurface outflow	220	220	326
TOTAL OUT	**7,840**	**7,440**	**8,745**
CHANGE IN STORAGE	**-810**	**1,490**	**-1,091**

Comparison of the three groundwater budgets indicates some differences in the component estimates between the future model-derived water budget and the analytical estimates for the historical average and current conditions. For example, infiltration of precipitation is lower in the future water budget (2,606 AFY) than in the historical water budget (3,500 AFY), but GW-SW interaction is higher in the future period (2,534 AFY) than in the historical period (1,480). But if these two water budget components are considered additively as a broader conceptual category of precipitation-based recharge, the combined value for the historical period is 4,980 AFY and the combined value for the future period is 5,140 AFY. These values are quite close, so it is the partition of this broader category where the two water budget estimates differ.

However, if the change in storage is values are inspected, they make intuitive sense given the understanding of conditions in the Basin since the 1980s. The historical average change in storage (-810 AFY) is lower than the future change in storage (-1,091 AFY); this corresponds to the fact that the historical period includes an 8 to 10 year period prior to the more recent decline of water levels observed in Edna Valley. The current period water budget indicates an increase of groundwater in storage of 1,490 AFY, which corresponds to the observed rise in water levels in Edna Valley since the end of the 2012 to 2016 drought. And finally, the change in storage value for the future water budget (-1,091 AFY), which assumes current levels of groundwater pumping, approximately corresponds to the estimate of overdraft for Edna Valley (1,100 AFY) presented in the water budget previously in this chapter. Differences in the surface water-influenced terms of the water budget may be improved when the surface water monitor network is expanded during the implementation phase of the GSP.

6.6.2.3. Impact Assessment of Climate Change

In order to assess the effect that climate change may have on groundwater elevations in the Basin, the following methodology was used. A baseline predictive scenario was simulated in which no projects or management actions were simulated, Basin pumping was maintained at the levels documented for water year 2019, and climate conditions from water years 1995 to 2019 were repeated for the predictive period of water years 2020 through 2044. Then a climate change scenario was incorporated in which a meteorological input into the GSFLOW model was changed as per guidance from DWR. Comparisons of these two scenarios provides an indication of potential impacts on Basin conditions from climate change.

The model was applied to evaluate the possible effects of climate change using the following methodology. A brief comparison was made between precipitation input and water level results between the baseline predictive run and the baseline run with climate change factors incorporated into the future predictive model simulation. Modeled precipitation in the Basin averaged 20.28 inches per year in the baseline run, and 20.74 inches per year in the climate change run, with DWR factors applied to climatological inputs. Water level results in the ten RMS well sites in the Basin, discussed further in Chapter 7 (Monitoring Network). The average of groundwater elevations at the ten RMS wells was 3.4 feet higher in the climate change scenario run than in the baseline run. This indicates that climate change is not a significant factor that needs to be considered in the Basin over the SGMA planning horizon.

6.6.2.4. Future Sustainable Yield and Overdraft

The sustainable yield of the Basin was estimated at 5,800 AFY (2,500 AFY for San Luis Valley and 3,300 AFY for Edna Valley) based on a review of data for the period from water year 1987 through water year 2019. The projects and management actions described in Chapter 9 (Projects and Management Actions), and implementation plan as described in Chapter 10 (Implementation Plan), are developed with the objective of reducing groundwater pumping in the Edna Valley such that there is no overdraft on a long-term basis. Absent any significant changes in land use patterns or climatological factors, there is no reason to expect that the sustainable yield estimate developed in this chapter will vary significantly prior to the next scheduled revision and update of this GSP. An update of the water budget and sustainable yield estimate may be recommended at the next update of the GSP, particularly if significant drought conditions are experienced in the coming years; if it becomes arguable that we are entering a new drought of record, that would constitute new climatological conditions that would necessitate a revision of the sustainable yield estimate. However, for the current planning period it is assumed that the future sustainable yield estimate will be approximately equal to that presented previously in this chapter.

7

GROUNDWATER SUSTAINABILITY PLAN

Monitoring Networks (§354.32 & §354.34)

This chapter describes the proposed monitoring networks for the GSP in accordance with SGMA regulations in Sub article 4: Monitoring Networks.

Monitoring is a fundamental component of the GSP necessary to identify impacts to beneficial uses or Basin users, and to measure progress toward the achievement of any management goal. The monitoring networks must be capable of capturing data on a sufficient temporal and spatial distribution to demonstrate short-term, seasonal, and long-term trends in groundwater and related surface water conditions, and to yield representative information about groundwater conditions for GSP implementation. There are three monitoring networks for the Basin: a groundwater level network, a groundwater quality network, and a surface water flow network.

IN THIS CHAPTER

7.1. Introduction

Chapter 7 describes the monitoring objectives, rationale, protocols, and data reporting requirements of the monitoring networks. Monitoring requirements for sustainability indicators are presented, and data gaps are identified, along with steps to be taken to fill the data gaps before the first five-year assessment.

The following is a list of applicable SGMA sustainability indicators that will be monitored in the Basin:

- Chronic lowering of groundwater levels.
- Reduction in groundwater storage.
- Degradation of groundwater quality.
- Land subsidence.
- Depletion of interconnected surface water (includes potential impacts to GDEs).

Sustainability indicators are discussed in detail in Chapter 8 (Sustainability Management Criteria). This monitoring networks chapter focuses on the monitoring sites and data collection needed to support the evaluation of each sustainability indicator.

7.2. Monitoring Objectives

The proposed monitoring network must be able to adequately measure changes in groundwater conditions to accomplish the following monitoring objectives:

- Demonstrate progress toward achieving measurable objectives.
- Monitor impacts to the beneficial uses and users of groundwater.
- Monitor changes in groundwater conditions relative to measurable objectives and minimum thresholds for sustainability indicators.
- Quantify annual changes in water budget components.

The monitoring network must provide adequate spatial resolution to properly monitor changes to groundwater and surface water conditions relative to measurable objectives and sustainability indicators within the Basin. The network must also provide data with sufficient temporal resolution to demonstrate short-term, seasonal and long-term trends in groundwater and related surface conditions.

7.2.1. Management Areas

Although there are differences in land use and associated water budgets between the San Luis Valley and Edna Valley subareas, as described in Chapter 6 (Water Budget), separate management areas have not been formally established. The monitoring network includes representative wells across the Basin for which minimum thresholds and measurable objective have been selected based on local conditions, as described in Chapter 8 (Sustainability Management Criteria).

7.2.2. Representative Monitoring Sites

Monitoring sites are the individual locations within a monitoring network and consist of groundwater wells and stream gages. While a monitoring network uses a sufficient number of sites to observe the overall groundwater conditions and the effects of Basin management projects, a subset of the monitoring sites may be used as representative for meeting the monitoring objectives for specific sustainability criteria.

Representative Monitoring Sites are the locations at which sustainability indicators are monitored, and for which quantitative values for minimum thresholds, measurable objectives, and interim milestones are defined.

The criteria that were used to determine which wells to utilize are as follows:

- A minimum 10-year period of record of historical measurements spanning wet and dry periods.
- Available well information (well depth, screened interval).
- Access considerations.
- Proximity and frequency of nearby pumping wells.
- Spatial distribution relative to the applicable sustainability indicators.
- Groundwater use.
- Impacts on beneficial uses and Basin users.

7.2.3. Scientific Rationale

GSP monitoring program development is based on a combination of SGMA monitoring networks Best Management Practices (BMPs), local hydrogeology, and the monitoring requirements for individual sustainability criteria.

Some of the SGMA monitoring network BMPs implemented for this GSP include the following:

- Defining the monitoring objectives.
- Utilizing existing monitoring networks and data sources to the greatest extent possible to meet those objectives.
- Adjusting the temporal/spatial coverage to provide monitoring data consistent with the need.
- Efficient use of representative monitoring sites to provide data for more than one sustainability indicator.

County monitoring programs that existed before SGMA include sites that do not meet SGMA monitoring network BMPs with respect to known construction information, such as wells with no available Well Construction Report (WCR) and active wells that are used for groundwater supply. While not prohibiting the use of these wells as a monitoring site, SGMA regulations require that the GSP identify sites that do not meet BMPs and describe the nature of the divergence. If the monitoring network uses wells that lack construction information, the GSP shall include a schedule for acquiring monitoring wells with the necessary information or shall demonstrate that such information is not necessary to understand or manage groundwater in the Basin.

As discussed in Chapters 4 (Basin Setting) and 5 (Groundwater Conditions), information from available boring logs indicates that there is no regional or laterally extensive aquitard separating the Alluvial aquifer, Paso Robles Formation aquifer, and Pismo Formation aquifer in the Basin. In the San Luis Valley, a physical distinction between Alluvium and Paso Robles Formation sediments is often not apparent, and information from WCRs indicates that wells are regularly screened across productive strata in both formations, which effectively function as a single hydrogeologic unit. DWR also concluded that there are no continuous confining layers, and unconfined groundwater table conditions essentially prevail throughout the Basin, including the Edna Valley (DWR, 1997). A minor exception is recognized in Chapter 6 (Water Budget) (Section 6.3.5) near the intersection of Biddle Ranch Road and Edna Road, where there is a shallow (semi-perched) alluvial aquifer tapped by a former windmill well. Therefore, with respect to groundwater level monitoring, data collected from wells completed in one or more of the three principal aquifers (Alluvium, Paso Robles Formation, and Pismo Formation) can be used collectively for groundwater elevation contouring and storage estimates. Obtaining well construction information for all monitoring network wells is not an immediate necessity and will be addressed (see Section 7.6).

7.2.4. Existing Monitoring Programs

Existing monitoring programs are discussed in Chapter 3 (Description of Plan Area). Figure 3-9 shows the locations of monitoring wells identified in the GAMA program (publicly available groundwater quality data), the SLOFCWCD semi-annual groundwater level program, and the CCRWQCB Irrigated Lands Regulatory Program (groundwater quality data). A total of 12 existing SLOFCWCD monitoring wells are used as part of the GSP groundwater level monitoring network described in the following sections. There are also groundwater level and quality data collected for various contaminant investigations and monitoring programs that are publicly available from the SWRCB Geotracker website.

7.2.5. Groundwater Level Monitoring Network

Groundwater level monitoring is a fundamental tool in characterizing Basin hydrology. Groundwater levels (often reported as elevations relative to a reference point) in wells are measures of the hydraulic head in an aquifer. Groundwater moves in the direction of decreasing head (downgradient), and groundwater elevation contours can be used to show the general direction and hydraulic gradient associated with groundwater movement. Changes in the amount of groundwater in storage within an aquifer can also be estimated based on changes in hydraulic head, along with other parameters.

There are 40 monitoring wells in the GSP groundwater level monitoring network, 22 wells in the San Luis Valley and 18 wells in the Edna Valley (Figure 7-1 and Table 7-1). Construction information is available for 31 of the 40 wells. Based on the available information, 16 of the wells are interpreted to be alluvial wells, while the remaining 24 wells tap into the Paso Robles Formation, Pismo Formation, or are mixed aquifer wells that utilize groundwater from more than one aquifer. Half the wells are used for irrigation, seven are private domestic wells, and 13 are dedicated monitoring wells.

Groundwater levels may be used as a proxy for monitoring other sustainability indicators (besides chronic lowering of water levels) provided that significant correlation exists between groundwater elevations and the sustainability indicator for which the groundwater elevations serve as a proxy. Ten of the groundwater level monitoring network wells are Representative Monitoring Site (RMS) wells used for evaluating sustainability criteria. Six representative monitoring site wells are used for evaluating chronic lowering of groundwater level and reduction of groundwater in storage, which is correlated with groundwater levels (Chapter 6, Section 6.3.5). Two wells are used for evaluating subsidence, which is correlated with groundwater levels in the area being monitored (Chapter 4, Section 4.7), and three wells are used to evaluate depletion of interconnected surface water, which is correlated with groundwater levels (Chapter 5, Section 5.7). One of the wells used to evaluate depletion of interconnected surface water is also a representative monitoring site for subsidence. The sustainability criteria and associated minimum thresholds and measurable objectives are presented in Chapter 8 (Sustainable Management Criteria).

7.3. Monitoring Networks

This section introduces the proposed GSP monitoring networks and describes the networks in relation to the following SGMA sustainability indicators applicable to the Basin:

- Chronic lowering of groundwater levels.
- Reduction of groundwater in storage.
- Groundwater quality degradation.
- Land subsidence.
- Depletion of interconnected surface water (includes potential impacts to GDEs).

The GSP monitoring program consists of three separate networks, one for groundwater levels, one for groundwater quality, and one for surface water flow. Each network is described below.

7.3.1. Groundwater Level Monitoring Network

SGMA regulations do not require a specific density of monitoring wells, other than being sufficient to represent groundwater conditions for GSP Implementation. The monitoring network well density is roughly 20 wells per 10 square miles, which is 10 times greater density than guidelines for the statewide CASGEM program. There are currently sufficient wells in the network to provide information for overall sustainable management of the Basin, although some local data gaps have been identified that will be addressed during GSP implementation.

A groundwater level monitoring well is recommended in the Foothill Boulevard/O'Conner Way area to improve groundwater level contour control and associated groundwater storage estimates in the Los Osos Valley area within the Basin. Other groundwater level monitoring locations are recommended for their proximity to potential GDEs and are in the vicinity of existing or proposed stream gage locations. The background and rationale for the GDE-related monitoring sites are presented in Appendix F (Stillwater Sciences, 2020).

Table 7-1 presents the GSP groundwater level monitoring network wells. Table 7-2 presents additional areas recommended for groundwater level monitoring. Figure 7-1 shows the location of the existing groundwater level monitoring wells and the recommended additional monitoring areas.

Table 7-1. Groundwater Level Monitoring Network

LOCAL ID[1]	TRS / STATE ID[2]	WELL DEPTH (FEET)	SCREEN INTERVAL (FEET)	RP ELEV.[3] (FEET AMSL)	FIRST DATA YEAR	LAST DATA YEAR	DATA PERIOD (YEARS)	DATA COUNT	AQUIFER[4]	WELL CRITERIA[5]	WELL USE[6]	GSA
SLV-01	30S/12E-23E	(pending)	(pending)	304			(pending)		Qa	ISW, T	MW	County
SLV-02	30S/12E-22G	(pending)	(pending)	276			(pending)		Qa		MW	City
SLV-03	30S/12E-30P			153					Qa		IRR-I	County
SLV-04	**30S/12E-35B1**	48	28-48	215.6	1991	2020	29	38	Qa		IRR-A	City
SLV-05	30S/12E-35D	52	32-52	187	1990	2018	28	7	Qa	ISW, T	IRR-A	City
SLV-06	31S/12E-04D	85	45-85	150	1989		1	1	Qa	T	MW	City
SLV-07	31S/12E-04K	125	55-125	139.5	1992	2000	8	46	Qpr		PS-I	City
SLV-08	31S/12E-03K	70	50-70	128	1988	2020	32	2	Qpr		IRR-A	City
SLV-09	**31S/12E-4R1**	130	40-130	129.5	1988	2020	32	48	Qa/Qpr	SUB	PS-I	City
SLV-10	31S/12E-3Q	48		131	2017	2020	3	82	Qa		MW	City
SLV-11	**31S/12E-3P1**	61		119	1990	2006	16	31	Qa		MW	City
SLV-12	**31S/12E-10D3**	175	50-90; 150-170	109.2	1992	2020	28	72	Qa/Qpr/Tps	ISW, SUB, T	IRR-A	City[7]
SLV-13	31S/12E-11D	40	5-40	121.75	1996	2020	24	49	Qa	T, ISW	MW	City
SLV-14	31S/12E-12E	20	5-20	144.68	1990	2020	30	60	Qa		MW	County
SLV-15	**31S/12E-10G2**	190		122	1965	2020	55	90	Qpr		IRR-A	City[7]
SLV-16	**31S/12E-10H3**	165	65-165	122	1984	2020	36	68	Qpr	WL	DOM-A	City[7]
SLV-17	31S/12E-11M	100	60-100	119.78	1996	2020	24	73	Qpr		MW	County
SLV-18	31S/12E-11K	30	6-21	133.28	1990	2020	30	59	Qa		MW	County
SLV-19	**31S/12E-14C1**			128	1958	2020	62	98	Qpr	WL, ISW, T	IRR-A	County
SLV-20	31S/13E-18D			202					Qa		MW	County
SLV-21	31S/12E-13A	60	50-60	178.68	2018	2018	1		Qpr		MW	County
SLV-22	31S/12E-13C	100	11-100	178	2004	2020	16	2	Qpr/Kjf	T	IRR-I	County
EV-01	**31S/13E-16N1**	72		324	1958	2020	62	99	Qa	ISW, T	DOM-A	County[7]
EV-02	31S/13E-20A	75		305					Qa	ISW	IRR-I	County
EV-03	**31S/13E-19H4**	250	178-250	254					Qpr/Tps		IRR-A	County
EV-04	**31S/13E-19H1**			262	1958	2020	62	100	Tps	WL, GWS, T	IRR-A	County[7]
EV-05	31S/13E-20G	400	120-400	280					Tps		IRR-I	County
EV-06	**31S/13E-19J1**			251	1998	2020	22	44	Qpr		DOM-I	County[7]
EV-07	**31S/13E-19J2**			250	1998	2020	22	45	Tps		DOM-A	County[7]
EV-08	31S/13E-21L			350					Qa	ISW, T	IRR-A	County
EV-09	**31S/13E-19R3**	440	130-190; 290-430	239	1974	2020	46	45	Tps/Tm	WL, GWS	PS-A	County[7]
EV-10	31S/13E-28F	340	200-330	344					Qpr/Tps		IRR-A	County
EV-11	**31S/13E-20F6**	150	55-150	230	2011	2020	9		Qpr/Tm	ISW, T	MW	County[7]
EV-12	**31S/13E-28J3**	600		303	1993	2020	27	39	Qpr/Tps		IRR-A	County[7]
EV-13	**31S/13E-27M3**	400	130-380	289	1993	2020	27	34	Qpr/Tps	WL, GWS	IRR-A	County[7]
EV-14	31S/13E-27R	300	90-290	319	2017	2020	3	6	Qpr/Tps	T	MW	County
EV-15	31S/13E-27Q			307	1989	2020	31	9	Qpr/Tps		DOM-I	County
EV-16	31S/13E-35D	260	200-260	323	1988	2020	32	188	Tps	WL, GWS	PS-A	County
EV-17	31S/13E-35F	260	200-260	333	2014	2020	6	66	Tps/Kjf		PS-I	County
EV-18	**31S/13E-36R1**			327	1968	2020	52	99	(out of Basin)		IRR-A	County

Notes:

1. Representative Monitoring Sites are in **bold**. Wells with known State Well Completion Reports are underlined.
2. TRS = Township Range Section and ¼-¼ section listed, State Well ID bolded where applicable.
3. Reference Point elevations from various sources with variable accuracy.
4. Principal Aquifers are Quaternary Alluvium (Qa), Quaternary Paso Robles Formation (Qpr), and Tertiary Pismo Formation (Tps). Other bedrock aquifers (non-Basin sediments) are Tertiary Monterey Formation (Tm) and Cretaceous-Jurassic Franciscan Assemblage (KJf). Aquifers are inferred where construction information is not available.
5. Representative well criteria include Subsidence (SUB), Chronic Water Level Decline (WL), and Groundwater Storage Decline (GSW). Other criteria are Transducer site (T), and Interconnected Surface Water (ISW) indicator evaluation site, which may be paired with nearby existing or proposed stream gage. Transducer installations are pending funding and well owner authorization. Measurement frequency is semi-annual for all wells except Transducer sites (T), which are measured daily.
6. Well Use includes Monitoring Well (MW), Irrigation Well (IRR), Public Supply Well (PS), and Domestic Well (DOM). Modifiers are Active (A) or Inactive (I). Information for some wells inferred pending confirmation
7. Indicates the well is currently in the SLOCFCWCD Water Level Program.

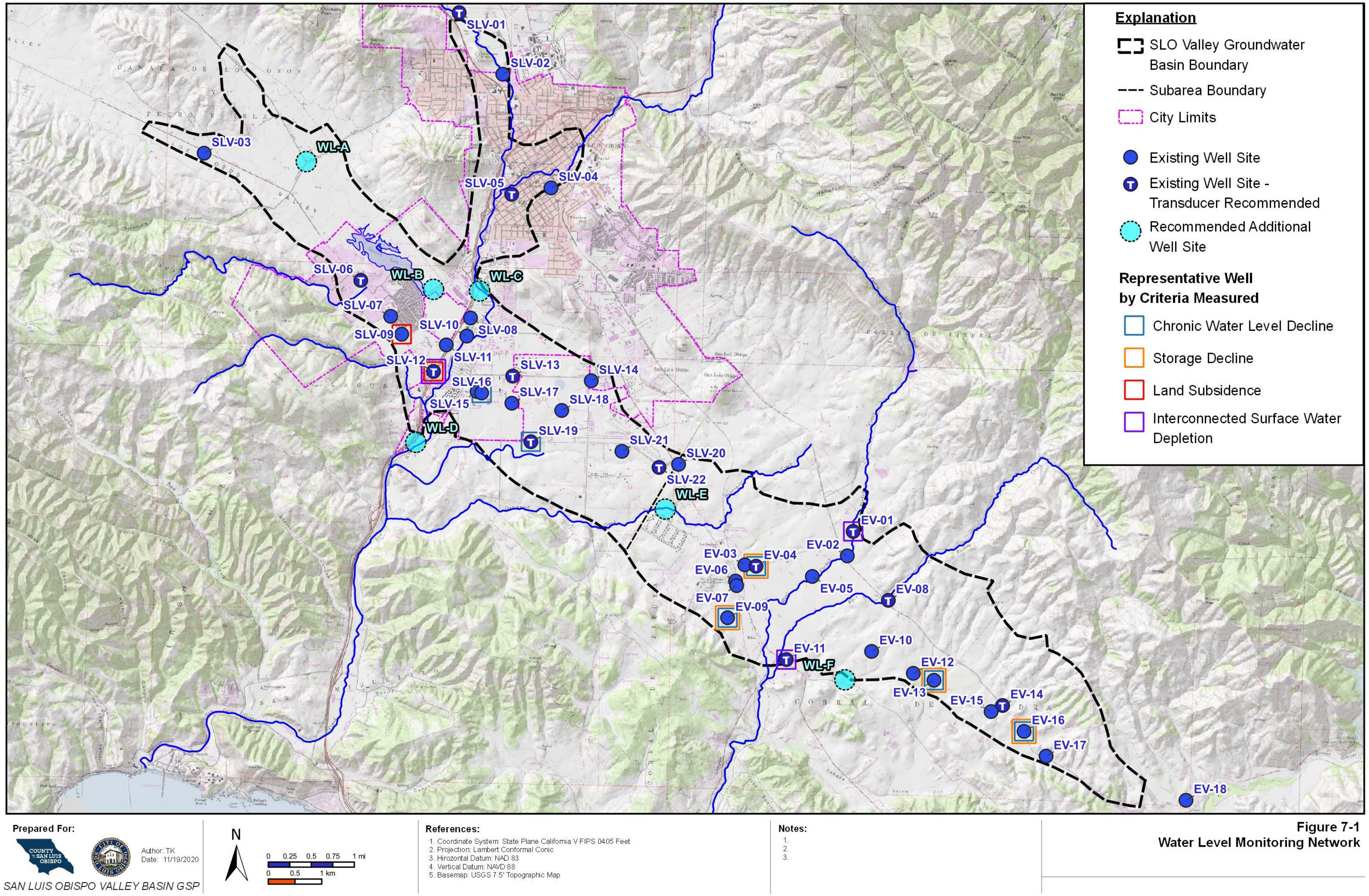


Figure 7-1. Water Level Monitoring Network

Table 7-2. Recommended Groundwater Level Monitoring Network Additions

WATER LEVEL DATA GAP ID	LOCATION	PURPOSE
WL-A	Near Foothill Blvd. and O'Connor Way	Groundwater elevation contours and storage
WL-B	Madonna Road near Laguna Lake	ISW evaluation
WL-C	Elks Lane south of SLO Creek Bridge	ISW evaluation
WL-D	South Higuera near old Highway Bridge	ISW evaluation
WL-E	Davenport Creek east of Crestmont Road	ISW evaluation
WL-F	Corbett Canyon Road near Canada Verde	ISW evaluation

7.3.2. Groundwater Quality Monitoring Network

Groundwater quality monitoring refers to the periodic collection and chemical or physical analysis of groundwater from wells. As discussed in Chapter 5 (Groundwater Conditions) in Section 5.9, the quality of groundwater in the Basin is generally good. Groundwater quality trends in the Basin are stable, with no significant trends of ongoing deterioration of groundwater quality based on the Central Coast Basin Plan.

Groundwater quality networks should be designed to demonstrate that the degraded groundwater quality sustainability indicator is being observed for the purposes of meeting the sustainability goal (DWR, 2016). In other words, the main purpose of the groundwater quality monitoring network is to support the determination of whether the degradation of groundwater quality is occurring at the monitoring sites, based on the sustainability indicator constituents and minimum thresholds selected. This GSP groundwater quality network is also designed to utilize existing monitoring programs to the greatest degree possible (DWR, 2016).

Sustainability indicator constituents selected for groundwater quality are Total Dissolved Solids (TDS), Nitrate, and Arsenic. These constituents were introduced in Chapter 5 (Groundwater Conditions) in Section 5.9.3 as diffuse or naturally occurring in the Basin and are further discussed in relation to sustainability indicators in Section 7.3.4 and in Chapter 8 (Sustainable Management Criteria). Two other water quality constituents associated with notable contaminant plumes in the South San Luis Obispo and Buckley Road areas (Figure 7-2 and Section 7.3.4) will also be monitored within the GSP water quality network, but not as sustainability indicators.

The groundwater quality network consists of nine sites (Figure 7-2), which are all are Public Water System supply wells. Water quality for these wells can be accessed using the GAMA Groundwater Information System. Wells in the Irrigated Lands Regulatory Program were evaluated for potential inclusion in the GSP monitoring program, however, the irrigation wells have not historically been sampled for groundwater quality at regular intervals, therefore no historical record of groundwater quality data exists. In addition, Agricultural Order 4.0 of the Irrigated Lands Regulatory Program is currently in draft form and under review. Selection of specific wells regulated under that program would not be recommended until the program is implemented and monitoring data is available for review. By comparison, the public water system wells have a history of groundwater quality data and specific wells are sampled at regular intervals for the three indicators recommended for groundwater quality monitoring in Chapter 8 (Sustainable Management Criteria) – TDS, Nitrate, and Arsenic.

7.3.2.1. Groundwater Quality Monitoring Data Gaps

Current groundwater quality monitoring within the Basin is sufficient to collect the spatial and historical data needed to determine groundwater quality trends for groundwater quality indicators. The GAMA database includes 120 wells within the Basin boundaries that have been monitored for groundwater quality in the last three years. The nine wells selected (Figure 7-2) provide representative Basin coverage but can be supplemented with other data if needed to support sustainability indicator evaluation. The water quality network wells are used collectively to provide the metric for use with the groundwater quality degradation sustainability indicator in Chapter 8 (Sustainable Management Criteria). No data gaps in groundwater quality monitoring are currently identified.

Table 7-3 presents the GSP groundwater quality monitoring network. Figure 7-2 show the locations of the groundwater quality monitoring wells.

Table 7-3. Groundwater Quality Monitoring Network

LOCAL ID	STATE ID[1]	FIRST DATA YEAR	LAST DATA YEAR	DATA PERIOD (YEARS)	DATA COUNT (TDS)[2]	DATA COUNT (N)[3]	DATA COUNT (AS)[4]	GSA
WQ-1	4000206-003	2003	2019	16	4	12	5	County
WQ-2	4000780-001	2002	2019	17	5	21	6	City
WQ-3	4010009-004	1989	2019	30	8	42	8	City
WQ-4	4000604-001	2002	2020	18	6	69	6	City
WQ-5[5]	4000734-001	2004	2020	16	4	21	6	County
WQ-6	4000819-001	2017	2020	3	3	4	1	City
WQ-7	4010023-008	1992	2020	28	19	142	148	County
WQ-8	4000202-001	2003	2018	15	5	23	27	County
WQ-9	4000765-001	2002	2019	17	7	19	36	County

Notes: Data accessed on GAMA Groundwater Information System

1. State ID for public water system
2. TDS = Total Dissolved Solids – typically measured every three years
3. N = Nitrate-Nitrogen – typically measured every year or quarterly
4. As = Arsenic – variable from monthly to every three years
5. WQ-5 also used to track TCE (see Section 8.2.4)

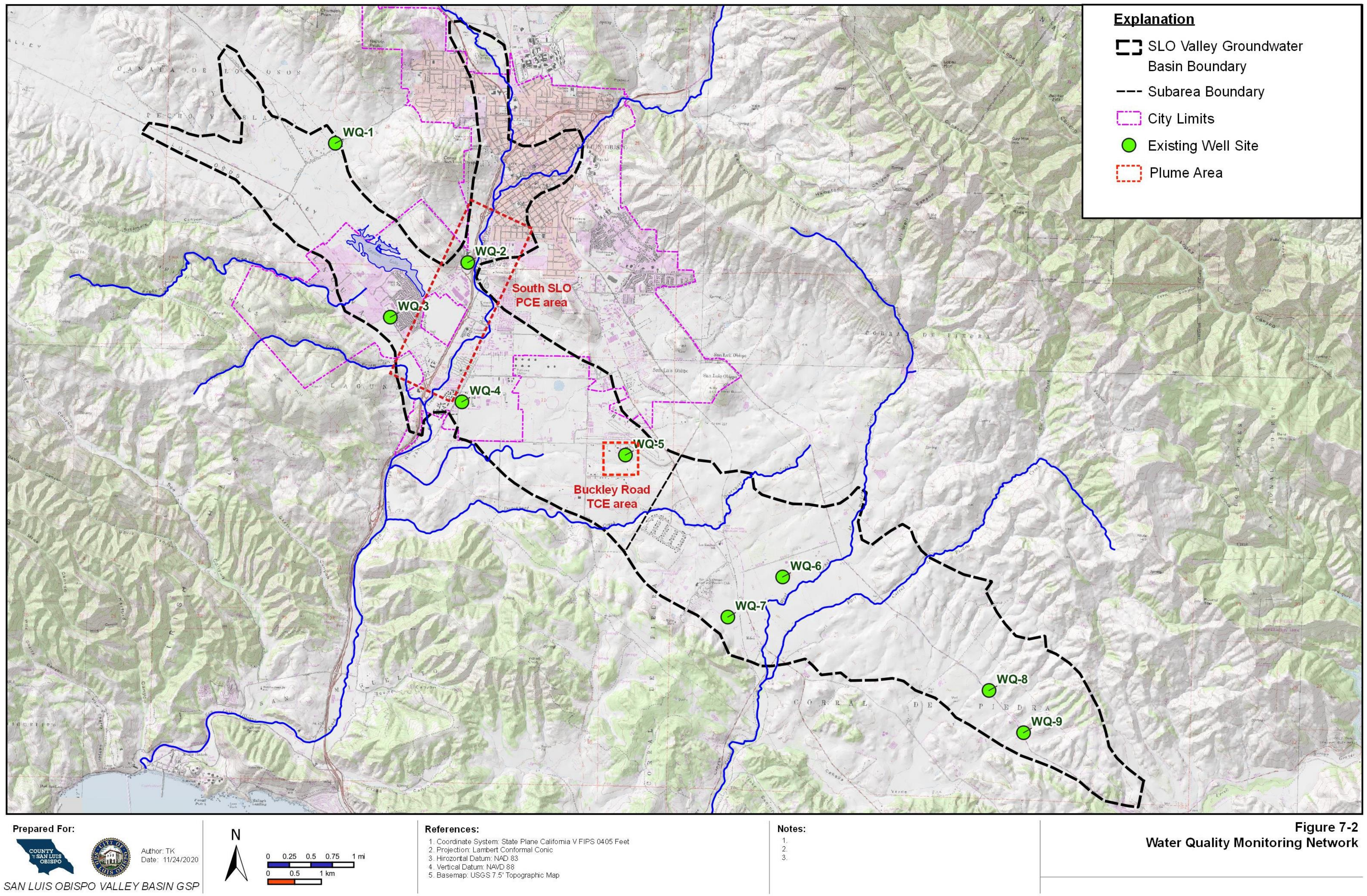


Figure 7-2. Water Quality Monitoring Network

7.3.3. Surface Water Flow Monitoring Network

Surface water flow monitoring can provide valuable information for the Basin model and for evaluating potential depletion of interconnected surface water for groundwater dependent ecosystems (GDEs), which is one of the sustainability indicators. The evaluation of surface water connectivity with the Basin and relevance to GDEs is described in Appendix F (Stillwater Sciences, 2020) that includes recommendations for the surface water flow monitoring sites identified in this chapter.

As summarized in Chapter 3 (Description of Plan Area), there are six permanent stream gages in or adjacent to the Basin, all within the San Luis Valley subarea watershed (Figure 7-3). The existing gaging stations only provide stage data, and not actual stream flow data. Stream stage is the height of water level in the stream above an arbitrary point, usually at or below the stream bed. Stage data can be useful for identifying flow and no-flow conditions, flood stage alerts, and analyzing the timing of precipitation and runoff in watersheds. Streamflow data is critical for quantifying Basin recharge from stream seepage as part of the water budget/model and for addressing depletion of interconnected surface water sustainability indicators related to GDEs.

Stage data can be converted to streamflow through the use of a rating curve, which incorporates information that is specific to each site, including the cross-sectional area of the channel and the average surface water velocity for a given flow stage. A description of the methodology for monitoring surface water flow in natural channels is presented in Appendix H. There are partial rating curve approximations for three of the sites based on actual streamflow measurements (Section 3.6.1.3). A modeling approach to estimating rating curves was performed by Questa Engineering (2007), but the results of that study have not been validated with field measurements.

7.3.3.1. Surface Flow Monitoring Data Gaps

The existing gages are all in the San Luis Valley subarea watershed, where the majority of potential GDEs have been identified (Figure 5-15). There are currently no surface flow monitoring sites in the Edna Valley subarea, which is the subarea subject to overdraft as described in Chapter 6 (Water Budget). Data gaps for surface water flow monitoring with respect to interconnected surface water depletion, GDEs, and the water budget are identified on Stenner Creek near the upstream Basin boundary, on San Luis Obispo Creek near the downstream Basin boundary, and on Pismo Creek near the downstream Basin boundary (Appendix H). Three stream gages are recommended for installation to fill these data gaps adjacent to the Basin boundaries. In addition, two more stream gage sites are recommended on East Corral de Piedra Creek and West Corral de Piedra Creek at Orcutt Road to fill a data gap in the water budget in the Edna Valley. Stream gages on these two principal drainages, along with a gage downstream of their confluence on Pismo Creek, will provide important information on stream seepage in the Edna Valley for the water budget/Basin model, and will allow a direct comparison of streamflow between the two watersheds, one of which has a permitted reservoir upstream of Orcutt Road as described in Chapter 6 (Water Budget) in Section 6.3.3.1. Rating curve development is recommended for all stream gages to provide the stream flow information needed for the water budget/model and sustainability indicator evaluation.

Table 7-4 presents the GSP surface water flow monitoring network. Table 7-5 presents recommended sites for additional stream gages. For the most robust data collection program, each stream gage should be paired with an alluvial piezometer to define both groundwater elevation and surface water elevation simultaneously, which is currently not the case. Figure 7-3 shows the locations of the existing gages, recommended gages, and the nearby groundwater level monitoring sites (both existing and recommended) that can be used to evaluate interconnected surface water depletion and GDE indicators (see Section 7.3.6 and Appendix H).

Table 7-4. Existing Surface Water Flow Monitoring Network

LOCAL ID	WATER COURSE	LOCATION	FIRST DATA YEAR	DATA INTERVAL	DATA PERIOD (YEARS)	GSA
SG-745	San Luis Obispo Creek	Andrews St. Bridge	2006	15-minutes	14	City
SG-781	Stenner Creek	Nipomo Street	2005	15-minutes	15	City
SG-790	San Luis Obispo Creek	Marsh Street	2019	15-minutes	1	City
SG-740	San Luis Obispo Creek	Elks Lane	2005	15-minutes	15	City
SG-778	Prefumo Creek	Madonna Road	2005	15-minutes	15	City
SG-783	East Fork Creek	Jesperson Road	2005	15-minutes	15	County

Table 7-5. Recommended Surface Water Monitoring Network Additions

SURFACE WATER FLOW GAP ID	LOCATION	PURPOSE
SG-A	Stenner Creek at Stenner Creek Road	Water Budget, Surface water connectivity, GDE indicator evaluation
SG-B	San Luis Obispo Creek at Old Highway Bridge	Water Budget, Surface water connectivity, GDE indicator evaluation
SG-C	West Corral de Piedra Creek at Orcutt Road	Water Budget
SG-D	East Corral de Piedra Creek at Orcutt Road	Water Budget
SG-E	Pismo Creek at Railroad Crossing	Water Budget, Surface water connectivity, GDE indicator evaluation

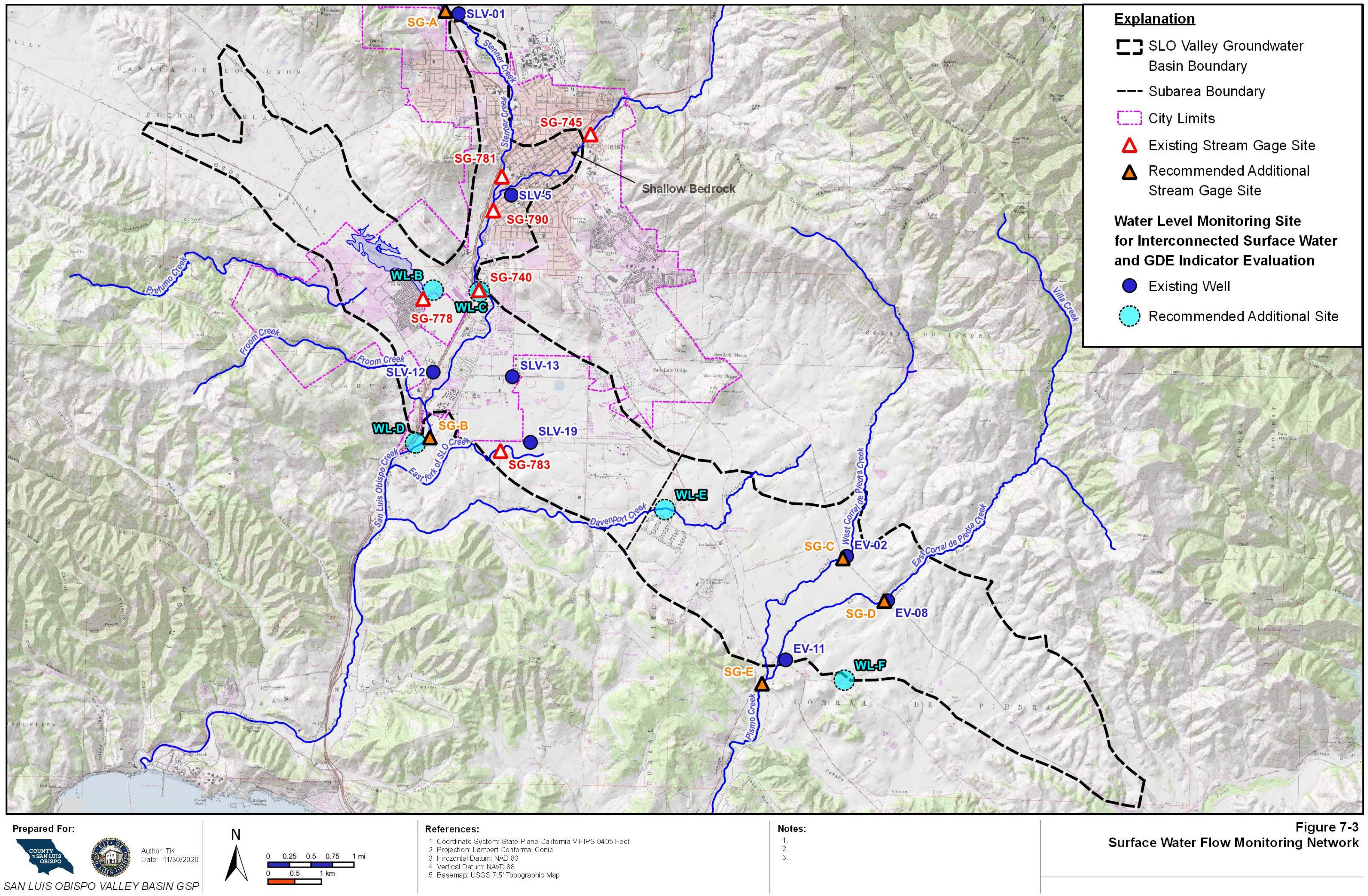


Figure 7-3. Surface Water Flow Monitoring Network

7.4. Sustainability Indicator Monitoring

Sustainability indicators are the effects caused by groundwater conditions occurring throughout the Basin that, when significant and unreasonable, become undesirable results.

The SGMA sustainability indicators for GSP implementation are as follows:

- Chronic lowering of groundwater levels.
- Reduction in groundwater storage.
- Seawater Intrusion (this indicator is not applicable to Basin).
- Degraded groundwater quality.
- Land subsidence.
- Depletion of interconnected surface water.

7.4.1. Chronic Lowering of Groundwater Levels

Chronic lowering of groundwater levels can lead to a significant and unreasonable depletion of the water supply. All of the groundwater level monitoring network wells can be used for evaluating chronic lowering of groundwater levels, with a selected subset of six RMSs formally assigned to assess Minimum Thresholds and Measurable Objectives in Chapter 8 (Sustainable Management Criteria). Groundwater monitoring network wells not included in the subset of RMSs are included in the network primarily for preparing groundwater level contour maps, which are used for evaluating hydraulic gradient and groundwater flow direction. Groundwater level contour maps can reveal groundwater pumping depressions that result from lowering of groundwater levels and can also be used to calculate change in groundwater storage. The area where chronic lowering of water levels has been occurring is in the Edna Valley as shown in Chapter 5 (Groundwater Conditions) on Figure 5-11. Four of the six representative wells focus on this area (Figure 7-1).

Static groundwater level measurements shall be collected at least two times per year, to represent seasonal low and seasonal high groundwater conditions. Historically, the semi-annual groundwater level program conducted by SLOFCWCD has measured groundwater levels in April and October of each year. This schedule will be maintained for the GSP.

In addition, 12 wells have been recommended (based on spatial distribution, equipment access, and interconnected surface water/GDE applications; Figure 7-1) for pressure transducer installation to automatically record groundwater levels on a daily basis, providing more detailed information on short-term trends, seasonal high and low conditions, and interconnected surface water depletion. Pressure transducers are instruments that record water levels automatically at pre-determined intervals. They are installed below the water surface in a well and use the pressure of the overlying water column to produce a depth to water measurement. Pressure transducers are a very efficient means of collecting groundwater level data at frequent intervals. The recommended transducer locations are listed in Table 7-1.

7.4.2. Reduction of Groundwater Storage

Groundwater storage and water levels are directly correlated, and chronic lowering of water levels also leads to a reduction of groundwater storage. Change in groundwater storage will be monitored using the overall monitoring network, while selected representative wells will track reduction of groundwater storage as the sustainability indicator.

The comprehensive 40-well monitoring network will be used to contour groundwater elevations for seasonal high conditions, from which annual spring groundwater storage estimates will be estimated and the annual change in storage reported as required for Annual Reports. Groundwater storage will be calculated using the specific yield method, which is the product of total saturated Basin volume and average specific yield. The saturated Basin volume is the volume between a groundwater elevation contour map for a specific period (such as Spring 2019) and the base of permeable sediments (Chapter 6; Section 6.3.5). Representative Monitoring Sites that will be used for monitoring reductions in groundwater storage are listed in Table 7-1 and shown in Figure 7-1. Chapter 8 discusses the Minimum Thresholds and Measurable Objectives assigned to the representative wells.

7.4.3. Seawater Intrusion

The Basin is not susceptible to seawater intrusion and will not be monitored for that indicator.

7.4.4. Degraded Groundwater Quality

The significant and unreasonable degradation of water quality would be an undesirable result. As discussed in Section 7.2.2, groundwater quality constituents in the Basin that have been selected for groundwater quality indicator monitoring include TDS, Nitrate, and Arsenic. Selenium has been observed at concentrations that affect well operations at individual wells in the Basin, but it does not appear to be a widespread issue throughout the Basin (Chapter 5; Section 5.9.3.5). The selected water quality indicators represent common constituents of concern in relation to groundwater production for domestic, municipal and agricultural use that will be assessed by the monitoring network. TDS is selected as a general indicator of groundwater quality in the Basin. Nitrate is a widespread contaminant in California groundwater and selected due to its presence across the Basin associated with agricultural activities, septic systems, landscape fertilizer and wastewater treatment facilities. Arsenic is selected to represent naturally occurring contaminants in the Basin. Other constituents of concern may be added to the list during GSP implementation. The sites currently best suited for evaluating trends over time are public supply wells. Sampling intervals vary by well and by constituent, ranging from every three years to monthly, but longer historical records are available, compared to other types of wells.

The significant and unreasonable degradation of water quality includes the migration of contaminant plumes that impair water supplies. There are two anthropogenic contaminant plumes that underly multiple properties and are under investigation within the Basin. These include a tetrachloroethylene (PCE) plume, also known as the South San Luis Obispo (SLO) PCE Plume, and a trichloroethylene (TCE) plume, also known as the Buckley Road Area plume (Figure 7-2).

7.4.4.1. South SLO PCE Plume

PCE is primarily used as a solvent at dry cleaning establishments and has a maximum contaminant level in drinking water of 5 micrograms per liter. Dissolved PCE in groundwater has been detected underlying portions of the City of San Luis Obispo, mainly south of the confluence of San Luis Obispo Creek and Stenner Creek. There have been several site investigations and documented PCE releases at various locations within the City. Historical site investigations date to the early 1990's, with regional investigations in 2005 (QPS, 2005) and 2013-2015 (URS, 2013), (URS, 2015). The Department of Toxic Substance Control (DTSC) and the Regional Water Quality Control Board (RWQCB) have provided most of the regulatory oversight related to site investigations and clean-up efforts since the early 1990's. Currently, the City has initiated a comprehensive PCE investigation, including monitoring well constructions, with Proposition 1 grant funding. Representative wells from the future PCE monitoring well network will be selected for inclusion with the GSP groundwater quality network specifically for tracking PCE in the Basin.

7.4.4.2. Buckley Road Area TCE Plume

TCE has a variety of uses, typically as an industrial solvent/degreaser. The maximum contaminant level for TCE in drinking water is 5 micrograms per liter. In 2013, the RWQCB initiated an investigation into the source of TCE detected in two supply wells in the industrial area of Buckley Road and Thread Lane. County of San Luis Obispo Environmental Health Services also began a sampling program following TCE detection above the maximum contaminant level in groundwater from a residential supply well in 2015. Information from these and subsequent investigations, including investigation at the San Luis Obispo County Airport north of Buckley Road, indicated that the likely source of TCE was the industrial area of Buckley Road and Thread Lane. These investigations were summarized in a public notice from the RWQCB dated January 15, 2019. One of the supply wells selected for the groundwater quality network (WQ-5) is in the industrial area and both historically and currently reports TCE concentrations above the maximum contaminant level (24 micrograms per liter TCE reported in April 2020). Currently, the RWQCB is enforcing a replacement water program to provide treatment for wells impacted by the TCE plume. A web page has been established by the Water Board to provide the latest information to the public and can be accessed at https://www.waterboards.ca.gov/centralcoast/water_issues/hot_topics/tce_pce_info/tce_pce_index.html. The TCE plume will be monitored for the GSP through tracking the concentration reported at WQ-5 and observing published plume maps over time. A general trend of decreasing TCE concentration, along with plume containment, would be measures of success in plume management.

7.4.5. Land Subsidence

Land subsidence can lead to undesirable results when it interferes with surface land uses. Land subsidence is frequently associated with groundwater pumping and has been documented in the San Luis Valley subarea (see Chapter 4; Section 4.7 and Chapter 6; Section 6.7.3). The purpose of land subsidence monitoring is to identify the rate and extent of land subsidence and to provide data for sustainability criteria thresholds. DWR maintains a land subsidence dataset derived from Interferometric Synthetic Aperture Radar (InSAR) data from satellite imagery. InSAR is a remote sensing method used to measure land-surface elevations over large areas, with accuracy on the order of centimeters to millimeters. InSAR uses satellites that emit and measure electromagnetic waves that reflect off of the earth's surface to produce synthetic aperture radar images with a spatial resolution of about 100 meters by 100 meters. Vertical displacement values associated with land subsidence can be estimated by comparing these images over time.

The DWR land subsidence dataset shows vertical displacement from 2015-2019 in California groundwater basins. The raster GIS dataset covers the entire Basin, with no data gaps. The dataset shows minimal vertical displacement of less than an inch from 2015-2019 throughout the Basin. Continued evaluation of Basin land subsidence through monitoring the available InSAR data is planned. In addition, two representative monitoring site wells have been identified for land subsidence monitoring based on the historical area of land subsidence in the Basin (Chapter 4; Section 4.7) and are included in Table 7-2. Groundwater level can be a proxy for land subsidence because the process is typically not reversible and maintaining groundwater levels above historic lows in areas susceptible to land subsidence can protect against future undesirable results and is described in Chapter 8 (Sustainable Management Criteria).

7.4.6. Depletion of Interconnected Surface Water

Surface water provides beneficial uses, and depletion of interconnected surface water due to groundwater pumping can result in undesirable results by impacting these beneficial uses.

The purpose of monitoring for depletion of interconnected surface water is to characterize the following:

- Flow conditions including surface water discharge, surface water head, and baseflow contribution.

- Identifying the approximate date and location where ephemeral or intermittent flowing streams cease to flow.
- Historical change in conditions due to variations in stream discharge and regional groundwater extraction.
- Other factors that may be necessary to identify adverse impacts on beneficial uses of the surface water.

One of the beneficial uses of surface water is the environmental water demand which supports riverine, riparian, and wetland ecosystems. Locations where surface water is interconnected with groundwater have the potential for supporting GDEs, which are ecological communities or species that depend on groundwater emerging from aquifers (rising into streams or lakes) or on groundwater occurring near ground surface where it may be used by riparian vegetation, wetland vegetation, or oak woodlands.

Depending on location and time of year, GDEs that overlie the Basin can be supported by a range of water sources including direct precipitation, surface runoff, shallow subsurface flow, and groundwater. Shallow subsurface flow can vary from short-term precipitation and runoff driven flow (e.g., bank storage and other macro-pores filled during a precipitation event that drain on the order of days to weeks) to flow that is directly connected to groundwater (e.g., baseflow as groundwater discharge into streams during the dry season). Because GDEs overlying the Basin are supported by a wider range of surface and groundwater hydrological processes in the wet season, monitoring of sustainability indicators that support GDEs (i.e., conditions near interconnected surface water) should focus on the late spring baseflow period and summer/early fall dry season. Primary groundwater dependence for GDEs is more likely during the late summer and early fall dry season, although in some reaches irrigation return flow may also be a factor. If the groundwater conditions that support GDEs are met in the late spring and dry summer and fall seasons, sufficient groundwater is more likely also be available in the wet season to sustain GDEs (see Appendix H).

There are six existing County stream gages within, or adjacent to the Basin (Table 7-4, Figure 7-3). The existing gages only report stage, as discussed in Section 7.2.3. An additional five stream gages are proposed, both for water budget and interconnected surface water flow data gaps (Table 7-5). Rating curves, which correlate stage with stream flows, should be developed for all RMS stream gage sites. In addition, groundwater level monitoring is recommended near the stream gages sites, and at additional sites for riparian and wetland/marsh GDE types (Figure 7-3). Table 7-6 shows the pairing between the stream gages and the nearby water level monitoring sites for interconnected surface water that supports potential GDEs evaluation (both existing and recommended).

The wells in Table 7-6 used for monitoring of ISW that may support GDEs need to be in locations that are representative of groundwater levels in the riparian zones. A few of the existing wells (SLV-5, SLV-19, EV-11) are not immediately adjacent to their paired stream gage but may have a sufficient hydraulic connection to local riparian conditions to be useful for GDE indicator evaluation. The data for each paired monitoring well and stream gage would be supplemented with field surveys (discussed below), to evaluate the suitability of the monitoring sites.

In addition to streamflow and groundwater level monitoring, streamflow surveys are recommended across a range of seasons and water year types to identify losing and gaining reaches with the Basin. Identifying losing and gaining reaches is fundamental to understanding surface water-groundwater connectivity. Losing reaches occur in Basin recharge areas that are typically dry during the summer and late fall. Gaining reaches occur in Basin discharge areas where groundwater is contributing to surface water flow. Groundwater pumping that lowers groundwater levels in an aquifer beneath a creek channel may deplete surface water by either expanding a losing reach or contracting a gaining reach, depending on the depth of the water table and the permeability of the stream bed. The streamflow surveys characterize the extent of gaining and losing reaches and help evaluate depletion of interconnected streamflow. This type of data collection is conducted by measuring instream flow in multiple locations along a reach of creek in a short period of time and examining the loss or gain of stream flow rates along the length of the stream channel.

Table 7-6. Proposed Interconnected Surface Water Monitoring Locations

STREAM GAGE	MONITORING WELL	AREA
SG–745	(none - bedrock)	SLO Creek near upstream Basin boundary
SG-781	SLV-5	Stenner Creek above SLO Creek confluence
SG-790	SLV-5	SLO Creek below Stenner Creek confluence
SG-740	WL-C	SLO Creek at Elks Lane
SG-778	WL-B	Prefumo Creek at Laguna Lake outlet
SG-783	SLV-19	East Fork SLO Creek at Jesperson Lane
SG-A	SLV-01	Stenner Creek near upstream Basin boundary
SG-B	WL-D	SLO Creek near downstream Basin boundary
SG-C	EV-2	West Corral de Piedra at Orcutt Road
SG-D	EV-8	East Corral de Piedra at Orcutt Road
SG-E	EV-11	Pismo Creek at downstream Basin boundary
(none)	SLV-12	Calle Joaquin
(none)	SLV-13	Tank Farm Road
(none)	WL-E	Davenport Creek near Crestmont Road
(none)	WL-F	Corbett Canyon Road near Canada Verde

7.5. Monitoring Technical and Reporting Standards

Monitoring technical and reporting standards include a description of the protocols, standards for monitoring sites, and data collection methods.

7.5.1. Groundwater Levels

Monitoring protocols and data collection methods for groundwater level monitoring and reporting are described in the attached Appendix H, and are based on SGMA monitoring protocols, standards and sites BMPs, USGS data collection methods, and practical experience. Wells used for monitoring program sites have been constructed according to applicable construction standards, although not all the information required under the BMPs is available for every site. Table 7-2 lists the pertinent information available for the monitoring sites.

7.5.2. Groundwater Quality

Monitoring protocols and standards for groundwater quality sampling sites are those required for public water systems from which the groundwater quality data is obtained. Sample collection and field tests shall be performed by appropriately trained personnel as required by California Code of Regulations Title 22, Section 64415. All wells used for public supply are expected to meet applicable construction standards.

7.5.3. Surface Water Flow

As previously discussed, the existing gaging stations only provide stage data, and not actual stream flow data. Stage data can be converted to streamflow through the use of a rating curve, which incorporates information that is specific to each site, including the cross-sectional area of the channel and the average surface water velocity for a given flow stage. These rating curves are developed using depth profiles and flow velocity measurements during storm-runoff events (Appendix H). Rating curves may need to be revised periodically as they can shift due to changes in channel geometry. Protocols and data collection methods will be based on applicable USGS standards and SLOFCWCD standards.

7.5.4. Monitoring Frequency

Monitoring frequency is the time interval between data collection. Seasonal fluctuations relating to groundwater levels or quality are typically on quarterly or semi-annual cycles, correlating with seasonal precipitation, recharge, groundwater levels, and well production. The monitoring schedule for groundwater levels collected under the GSP groundwater level monitoring program will coincide with seasonal groundwater level fluctuations, with higher levels (i.e., elevations) in April (Spring) and lower levels in October (Fall). A semi-annual monitoring frequency provides a measure of seasonal cycles, which can then be distinguishable from the long-term trends. At the transducer-monitored locations, groundwater level measurements will be recorded automatically on a daily basis and downloaded during the regular semi-annual groundwater level monitoring events. Daily measurements provide the same time-step as the Basin model and will also allow direct correlation with daily stream flow data. Ultimately, more of the wells in the monitoring network will be equipped with continuous measurement transducers than are currently equipped.

The monitoring frequency for groundwater quality sampling is variable and based on the schedule determined by the regulating agency (County Environmental Health Services for small public water systems and the State Division of Drinking Water for large public systems). TDS is typically monitored every three years, while nitrate and arsenic may be monitored annually, quarterly, or even monthly at vulnerable systems. The frequency selected for monitoring individual constituents at each system is sufficient to protect public health, and therefore considered sufficient for Basin management purposes.

Surface monitoring network frequency is a near-continuous record of flow stage, collected at 15-minute intervals. The stage data can then be converted to average daily flow (cubic feet per second) using a rating curve. Automatic gaging equipment (e.g., radar sensors or bubbler gages) at proposed flow monitoring locations will maintain the near-continuous monitoring frequency. Rating curves are needed at all gage sites, which requires manual flow measurements over a range of stream stages. New and existing wells listed in Table 7-6 used for interconnected surface water that could affect GDEs may also be equipped with groundwater level transducers, either upon construction (for network additions) or when the recommended nearby stream gage is installed. If continuous groundwater elevation data is collected at these sites, the data will be reviewed to determine if revisions to the undesirable results or sustainability management criteria should be revised.

7.6. Data Management System

SGMA requires development of a Data Management System (DMS). The DMS stores data relevant to development of a groundwater Basin's GSP as defined by the GSP Regulations (California Code of Regulations, Title 23, Division 2, Chapter 1.5, Subchapter 2). To comply with SGMA, the Basin DMS was developed in this GSP and will store data that is relevant to development and implementation of the GSP as well as for monitoring and reporting purposes. Appendix H describes the data management plan associated with the DMS.

7.7. Assessment and Improvement of Monitoring Network

The current assessment of the monitoring networks has identified data gaps that will be filled during the implementation phase of the GSP and prior to the first five-year assessment. These data gaps, consisting of six groundwater level monitoring sites and five surface water flow monitoring sites, are listed in Table 7-2 and Table 7-4 and shown in Figure 7-1 and Figure 7-3.

As previously mentioned, obtaining well construction information for all monitoring network wells is not an immediate necessity or a requirement for Basin management purposes, provided the lack of information does not affect the usefulness of the monitoring results toward Basin management. Over time, wells for which construction information is not known will be inspected with a video camera to document construction, either within the next five years or at the earliest practical opportunity, such as when the well pump is being serviced. The monitoring networks will be re-evaluated at each five-year assessment. If required, it may be necessary to install a group of paired piezometers with different screened intervals to confirm the HCM assessment that vertical hydraulic gradients between geologic formations are not significant to the Basin hydrogeologic system.

7.8. Annual Reports and Periodic Evaluation by the GSAs

Reporting requirements for the Annual Report and for periodic evaluation of the GSP are contained in Article 7 of the GSP regulations. The GSAs will submit an Annual Report that meets Article 7 regulations by April 1 of each year following adoption of the GSP, with the first Annual Report anticipated in 2022. Periodic evaluations of the GSP, including the monitoring networks, will be performed at least every five years and whenever the GSP is amended, with the first written evaluation anticipated no later than 2027.

8

GROUNDWATER SUSTAINABILITY PLAN

Sustainable Management Criteria (§354.22)

This chapter defines the conditions specified at each of the Representative Monitoring Sites (RMSs) that constitute Sustainable Management Criteria (SMCs), discusses the process by which the GSAs in the Basin will characterize undesirable results, and establishes minimum thresholds and measurable objectives for each Sustainability Indicator.

This chapter defines sustainability in the Basin for the purposes of managing groundwater in compliance with SGMA, and it addresses the regulatory requirements involved. The Measurable Objectives (MOs), Minimum Thresholds (MTs), and undesirable results presented in this chapter define the future sustainable conditions in the Basin and guide the GSAs in development of policies, implementation of projects, and promulgation of management actions that will achieve these future conditions.

IN THIS CHAPTER

8.1. Introduction

Defining Sustainable Management Criteria (SMC) requires technical analysis of historical data, and input from the affected stakeholders in the Basin. This chapter presents the data and methods used to develop the SMC and demonstrate how they influence beneficial uses and users. The SMCs presented in this chapter are based on currently available data and application of the best available science. As noted in this GSP, data gaps exist in the hydrogeologic conceptual model. Uncertainty caused by these data gaps was considered when developing the SMC. Due to uncertainty in the hydrogeologic conceptual model, these SMCs are considered initial criteria and will be reevaluated and potentially modified in the future as new data become available.

The discussion of SMC in this chapter is organized by Sustainability Indicators. The following Sustainability Indicators are applicable in the Basin:

- Chronic lowering of groundwater elevations
- Reduction in groundwater storage
- Degraded water quality
- Land subsidence
- Depletion of interconnected surface water

The sixth Sustainability Indicator, sea water intrusion, only applies to coastal basins, and is not applicable in the Basin.

To maintain an organized approach throughout the text, this chapter follows the same structure for each Sustainability Indicator. The description of each SMC contains all the information required by Section 354.22 et. seq of the SGMA regulations and outlined in the Sustainable Management Criteria BMP (DWR, 2017), including:

- How undesirable results were developed, including:
  - The criteria defining when and where the effects of the groundwater conditions that 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))
- How minimum thresholds were developed, 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))
- How measurable objectives were developed, including:
  - The methodology for setting measurable objectives (§354.30)
  - Interim milestones (§354.30 (a), §354.30 (e), §354.34 (g)(3))

The SGMA regulations address minimum thresholds before measurable objectives. This order was maintained for the discussion of all applicable Sustainability Indicators

8.2. Definitions (§351)

The SGMA legislation and regulations contain a number of new terms relevant to the SMCs. These terms are defined below using the definitions included in the SGMA regulations (§ 351, Article 2). Where appropriate, additional explanatory text is added in italics. This explanatory text is not part of the official definitions of these terms. To the extent possible, plain language, including limited use of overly technical terms and acronyms, was used so that a broad audience will understand the development process and implications of the SMCs.

1. Interconnected surface water (ISW) refers to surface water that is hydraulically connected at any point by a continuous saturated zone between the underlying aquifer and the overlying surface water. Interconnected surface waters are parts of streams, lakes, or wetlands where the groundwater table is at or near the ground surface and there is water in the lakes, streams, or wetlands.
2. Interim milestone (IM) refers to a target value representing measurable groundwater conditions, in increments of five years, set by an Agency as part of a Plan. Interim milestones are numeric targets such as groundwater elevations that will be achieved every five years to demonstrate progress towards sustainability.
3. Management area refers to an area within a basin for which the Plan may identify different minimum thresholds, measurable objectives, monitoring, or projects and management actions based on differences in water use sector, water source type, geology, aquifer characteristics, or other factors.
4. Measurable objectives (MOs) refer to specific, quantifiable goals for the maintenance or improvement of specified groundwater conditions that have been included in an adopted Plan to achieve the sustainability goal for the basin. Measurable objectives are goals that the GSP is designed to achieve.
5. Minimum thresholds (MTs) refer to numeric values for each Sustainability Indicator used to define undesirable results. Minimum thresholds are established at representative monitoring sites. Minimum thresholds are indicators of where an unreasonable condition might occur. For example, a particular groundwater elevation might be a minimum threshold if lower groundwater elevations would result in a significant and unreasonable reduction in groundwater storage.
6. Representative monitoring site (RMS) refers to a monitoring site within a broader network of sites that typifies one or more conditions within the basin or an area of the basin.
7. Sustainability Indicator refers to any of the effects caused by groundwater conditions occurring throughout the basin that, when significant and unreasonable, cause undesirable results, as described in Water Code Section 10721(x). The five Sustainability Indicators relevant to the Basin are listed in the introductory section of Chapter 8.
8. Uncertainty refers to a lack of understanding of the basin setting that significantly affects an Agency's ability to develop sustainable management criteria and appropriate projects and management actions in a Plan, or to evaluate the efficacy of Plan implementation, and therefore may limit the ability to assess whether a basin is being sustainably managed.
9. Undesirable Result Section 10721 of the Sustainable Groundwater Management Act states that Undesirable result means one or more of the following effects caused by groundwater conditions occurring throughout the basin:
   - Chronic lowering of groundwater levels indicating a significant and unreasonable depletion of supply if continued over the planning and implementation horizon. Overdraft during a period of drought is not sufficient to establish a chronic lowering of groundwater levels if extractions and groundwater recharge are managed as necessary to ensure that reductions in groundwater levels or storage during a period of drought are offset by increases in groundwater levels or storage during other periods.
   - Significant and unreasonable reduction of groundwater storage.
   - Significant and unreasonable seawater intrusion.

- Significant and unreasonable degraded water quality, including the migration of contaminant plumes that impair water supplies.
- Significant and unreasonable land subsidence that substantially interferes with surface land uses.
- Depletions of interconnected surface water that have significant and unreasonable adverse impacts on beneficial uses of the surface water.

10. Section 354.26 of the SGMA regulations states that “The criteria used to define when and where the effects of the groundwater conditions cause undesirable results shall be based on a quantitative description of the combination of minimum threshold exceedances that cause significant and unreasonable effects in the basin.”

8.3. Sustainability Goal (§354.24)

The sustainability goal for the Basin is a comprehensive statement that describes the important factors to be considered during the SGMA planning horizon. The sustainability goal was developed over a series of public meetings and public workshops with input from the City, County, and affected stakeholders. The June 10, 2020 Stakeholder Workshop, Groundwater Management Vision, was dedicated to obtaining information to be used to develop a sustainability goal for the Basin. In the workshop, stakeholders participated in an interactive visioning exercise where they helped populate a virtual white board to answer the question, ***“What is our shared vision of what a ‘sustainable SLO Basin’ means?”***

Stakeholders added ideas, perceptions, outcomes, and values onto the white board across the following categories:

- Available Groundwater Supply: What needs/uses does our groundwater supply always need to be able to serve?
- Available Groundwater Storage: What needs/uses does our stored groundwater need to serve or prepare us for?
- Groundwater Dependent Ecosystem Health: What outcomes do we want for surface water ecosystems and prevention of land subsidence?
- Cost to Users: If we achieve a “sustainable Basin,” how does it look to ratepayers?
- Groundwater Quality: What is the quality of groundwater we aim to sustain?

During the September 9, 2020 GSC meeting, the results of the interactive exercise from the June workshop were presented in an organized fashion to stakeholders. Significant concepts from the visioning exercise are incorporated into the Sustainability Goal presented herein and are represented as guiding principles that underpin the Basin sustainability goal. The SGMA regulations require the sustainability goal to culminate in the absence of undesirable results within 20 years of the applicable statutory deadline.

Per Section 354.24 of the SGMA regulations the Sustainability goal has three parts:

- Description of the sustainability goal
- A discussion of the measures that will be implemented to ensure the Basin will be operated within sustainable yield, and
- An explanation of how the sustainability goal is likely to be achieved.

8.3.1. Description of Sustainability Goal

The sustainability goal for the Basin is to manage the Basin to ensure beneficial uses and basin users have access to a safe and reliable groundwater supply that meets current and future demand without causing undesirable results.

Guiding principles of this goal are:

- Available groundwater supply supports diverse needs reliably and equitably.
- Stored groundwater equitably supports supply resilience and evolving needs.
- Groundwater levels support the sustained health of groundwater dependent ecosystems.
- Cost of maintaining sustainable groundwater levels is equitably distributed.
- Groundwater quality is maintained to a safe standard to meet diverse basin needs.

8.3.2. Sustainability Strategy

The sustainability strategy was developed and discussed at numerous public meetings of the GSC. Projects and management actions were developed collaboratively with GSA Staff, GSC members, and the public utilizing the guiding principles of the Sustainability Goal. A total of seven (7) projects are evaluated in Chapter 9 (Projects and Management Actions) and are centered around supplemental water sources that could be brought into the SLO Basin to mitigate the overdraft. In addition to the projects, three (3) management actions will be implemented. The implementation of a combination of projects and the management actions listed below will ensure that the SLO Basin will operate within the sustainable yield and achieve sustainability as described in the following sections of this Chapter.

- State Water Project for Edna Valley Agricultural Irrigation
- Stater Water Project Recharge Basin within the Edna Valley area.
- State Water Project to the Golden State Water Company
- State Water Project to the Edna and Varian Ranch Mutual Water Companies
- City of SLO Recycled Water for Edna Valley Agriculture
- Varian Ranch Mutual Water Company Arroyo Grande Subbasin Wells
- Price Canyon Discharge Relocation
- Expand Monitoring Network
- Develop and Implement Groundwater Extraction Metering Plan
- Develop Demand Management Plan

The projects and management actions will be implemented using an adaptive management strategy. Adaptive management allows the GSAs to react to the success or lack of success of actions and projects implemented in the Basin and to make management decisions to redirect efforts in the Basin to more effectively achieve sustainability goals. The implementation of the projects and management actions is described in additional detail in Chapter 10 (Implementation Plan).

8.4. Generalized Process for Establishing Sustainable Management Criteria (§354.22-30)

SMCs for the Basin were developed after technical analysis of hydrogeologic and geotechnical data by the consulting team, input from the GSC members, public input received in public meetings, written public comments in response to GSC meeting and workshop presentations, and meetings with GSA staff and GSC members. Public comments on alternative SMCs discussed during GSC meetings and responses to those comments are included in Appendix I. All presentations made at public meetings are available for review at the SLO Basin web site created for this GSP, www.slowaterbasin.com. The process further built on the Basin Groundwater Sustainability Agencies' history of involving interested parties – including the City, the County, environmental stakeholders, rural residents, agricultural stakeholders, water purveyors, and mutual water companies – in public meetings focused on groundwater resource planning.

The general process for establishing minimum thresholds and measurable objectives for the SMC and assessing significant and unreasonable conditions constituting undesirable results in the Basin was iterative and included the following:

- Evaluating historical data on groundwater elevations from wells monitored by the City and SLOCFCWCD.
- Evaluating water budget information presented in Chapter 6, including sustainable yield estimates and average deficits for the San Luis Valley and Edna Valley parts of the basin.
- Holding a series of public outreach meetings that outlined the GSP development process and introduced stakeholders to SMC, MOs, MTs, and other related information.
- Soliciting public comment and input on several alternative minimum threshold and measurable options based upon preliminary technical analysis presented at GSC meetings and the five guiding principles agreed upon.
- Evaluating public comment to assess what are significant and unreasonable effects relevant to SMC. Public comments from outreach meetings were analyzed to assess if different areas in the Basin had different perspectives for what constitutes an undesirable result in the Basin and how minimum thresholds and measurable objectives are established.
- Combining public comment, outreach efforts, hydrogeologic data and considering the interests of beneficial uses and groundwater users, land uses, and property interests in the Basin to describe undesirable results and setting preliminary conceptual MTs and MOs.
- Performing groundwater model simulations that incorporate projects and management actions discussed in Chapter 9 to assess if the SMC are achievable.
- Conducting public meetings to present recommended preliminary conceptual minimum thresholds and measurable objectives that are technically sound and reasonable, and receiving additional public input. Presentations and discussion of SMCs occurred at eleven meetings in the Basin between March 2020 and May 2021.
- Reviewing and considering public and GSC input on recommended preliminary SMCs with GSA staff.
- GSC recommended final SMCs to GSAs for approval.

A number of alternative options for both MTs and MOs were considered for each RMS after evaluation of the historical record of groundwater elevations at each well, assessment of trends of groundwater elevation decline (where applicable), and input from stakeholders regarding their desired conditions. Details regarding the specific SMCs for each Sustainability Indicator are included in the following sections of this chapter describing each indicator.

For all applicable Sustainability Indicators except for water quality (i.e., chronic lowering of groundwater levels, reduction of storage, land subsidence, and depletion of interconnected surface water), this GSP uses water levels as a proxy measurement metric to assess the SMCs for each indicator. Water levels are measured directly at each RMS. For the land subsidence Sustainability Indicator, direct measurement of changes in land surface elevation data (InSAR data) published by DWR define the SMCs, and water levels will be monitored in an RMS in the area of documented past subsidence to monitor groundwater conditions (SLV-09), and to manage such that water levels do not approach the levels observed in 1991-1992.

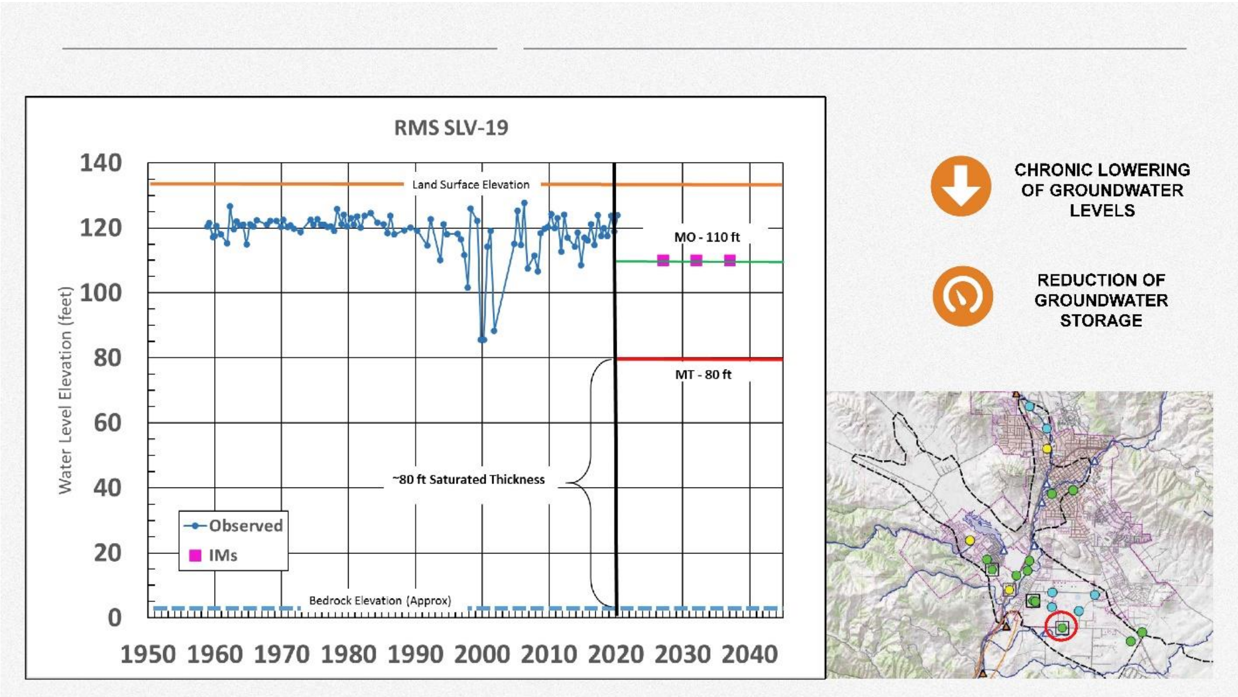


Figure 8-1. HYDROGRAPH, MINIMUM THRESHOLD (MT), MEASURABLE OBJECTIVE (MO), AND INTERIM MILESTONES (IM) FOR REPRESENTATIVE MONITORING SITE (RMS) SLV-19

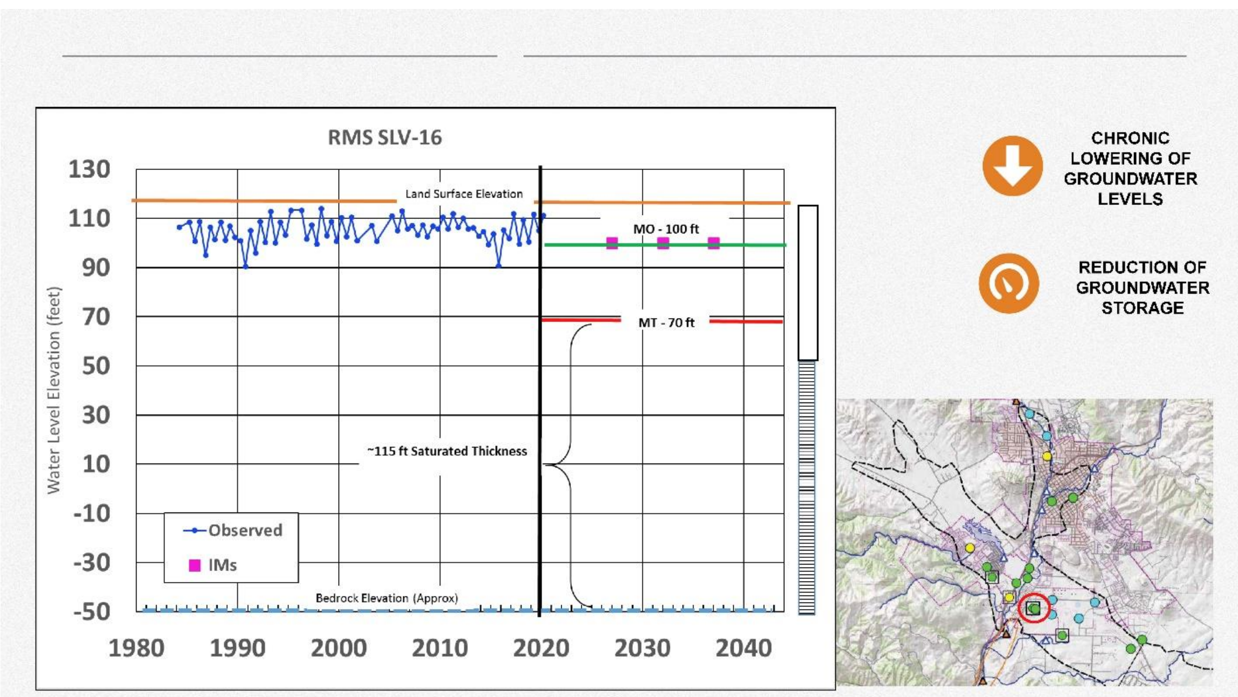


Figure 8-2. HYDROGRAPH, MINIMUM THRESHOLD (MT), MEASURABLE OBJECTIVE (MO), AND INTERIM MILESTONES (IM) FOR REPRESENTATIVE MONITORING SITE (RMS) SLV-16

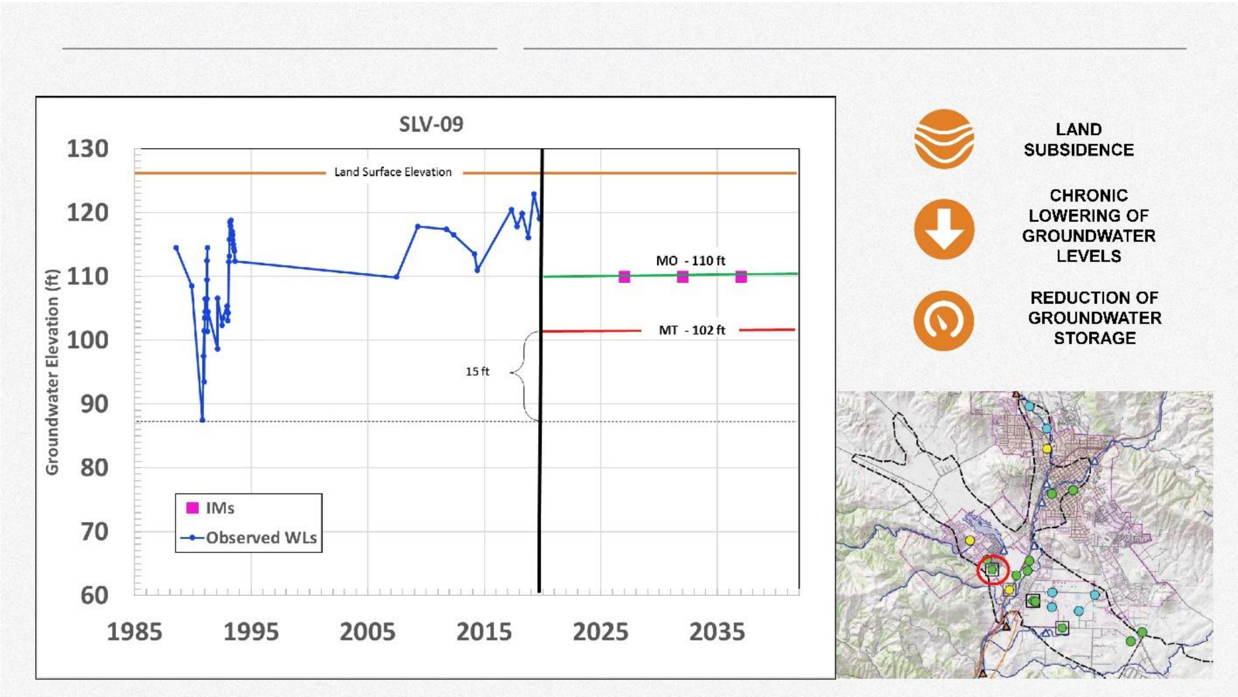


Figure 8-3. HYDROGRAPH, MINIMUM THRESHOLD (MT), MEASURABLE OBJECTIVE (MO), AND INTERIM MILESTONES (IM) FOR REPRESENTATIVE MONITORING SITE (RMS) SLV-09

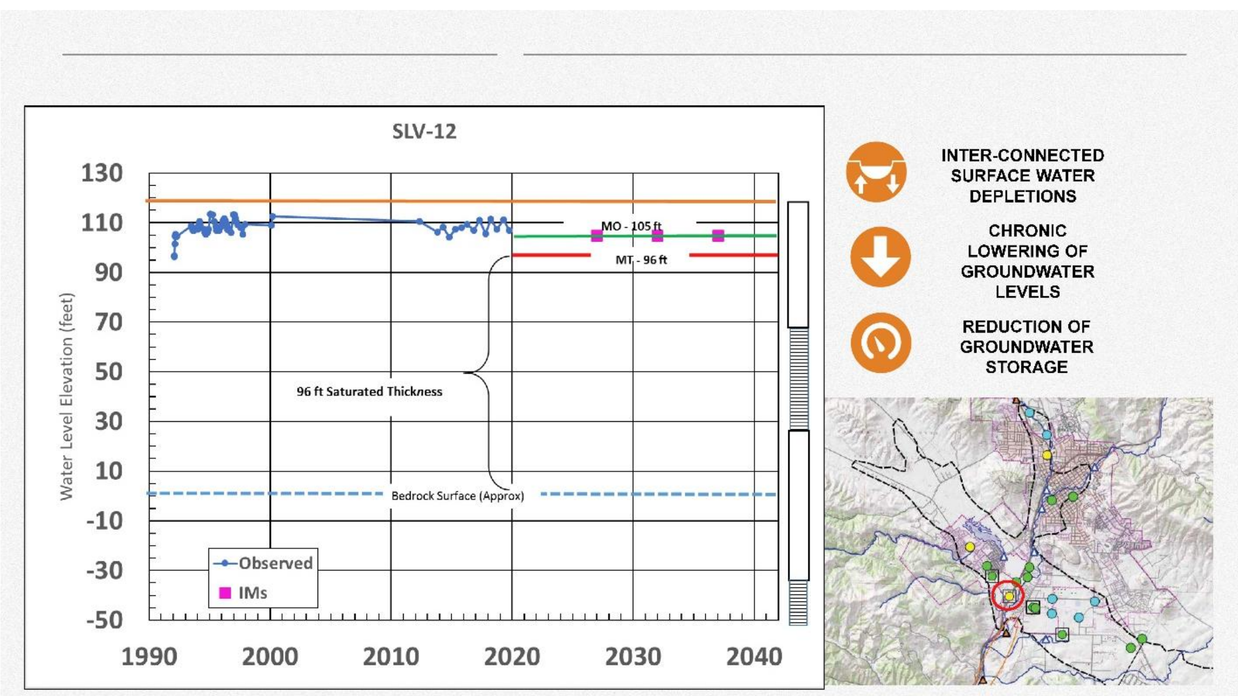


Figure 8-4. HYDROGRAPH, MINIMUM THRESHOLD (MT), MEASURABLE OBJECTIVE (MO), AND INTERIM MILESTONES (IM) FOR REPRESENTATIVE MONITORING SITE (RMS) SLV-12

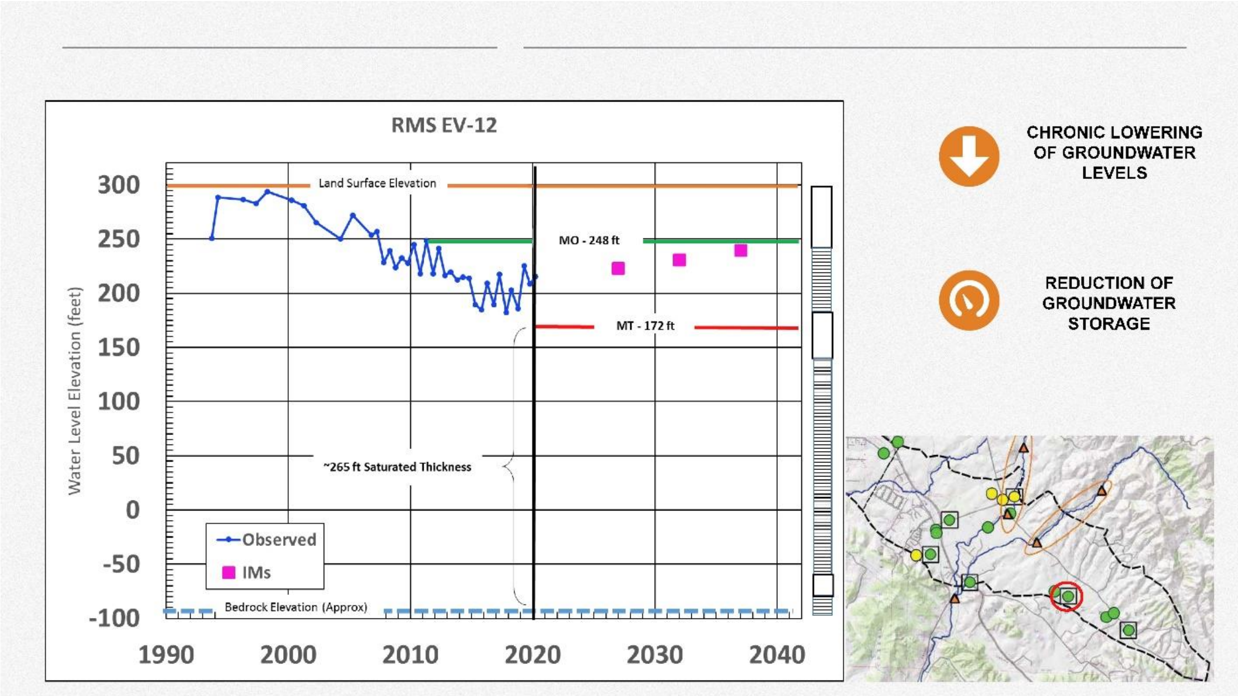


Figure 8-5. HYDROGRAPH, MINIMUM THRESHOLD (MT), MEASURABLE OBJECTIVE (MO), AND INTERIM MILESTONES (IM) FOR REPRESENTATIVE MONITORING SITE (RMS) EV-12

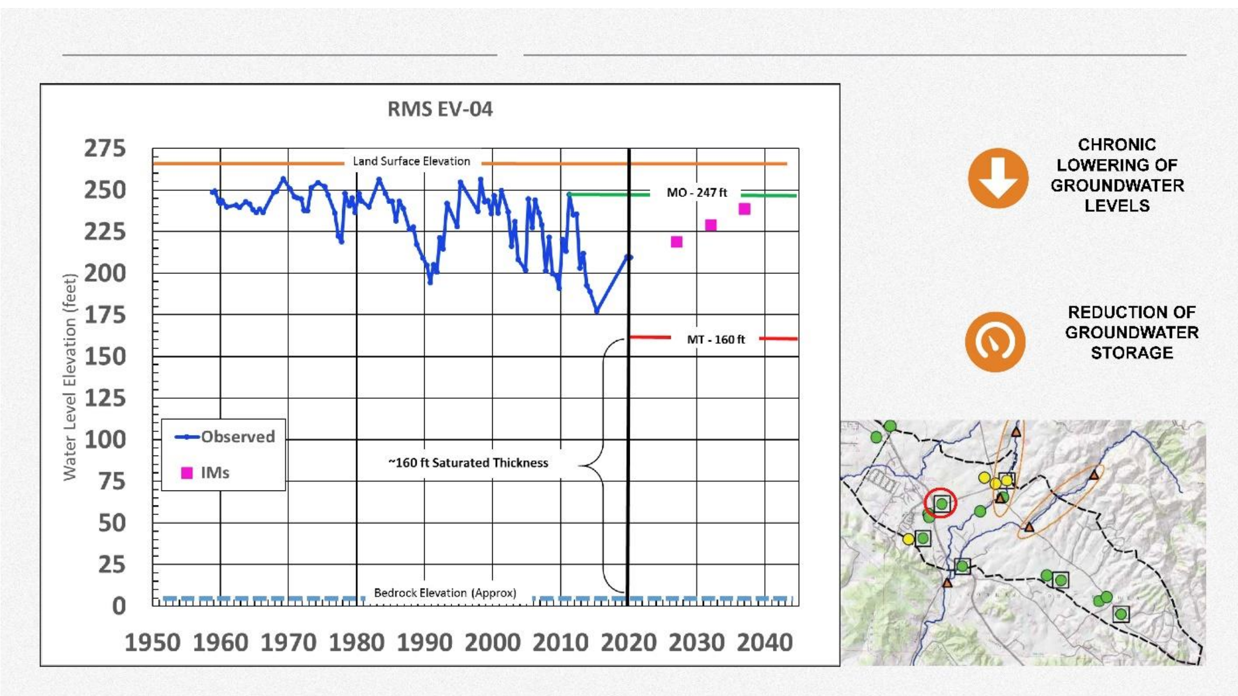


Figure 8-6. HYDROGRAPH, MINIMUM THRESHOLD (MT), MEASURABLE OBJECTIVE (MO), AND INTERIM MILESTONES (IM) FOR REPRESENTATIVE MONITORING SITE (RMS) EV-04

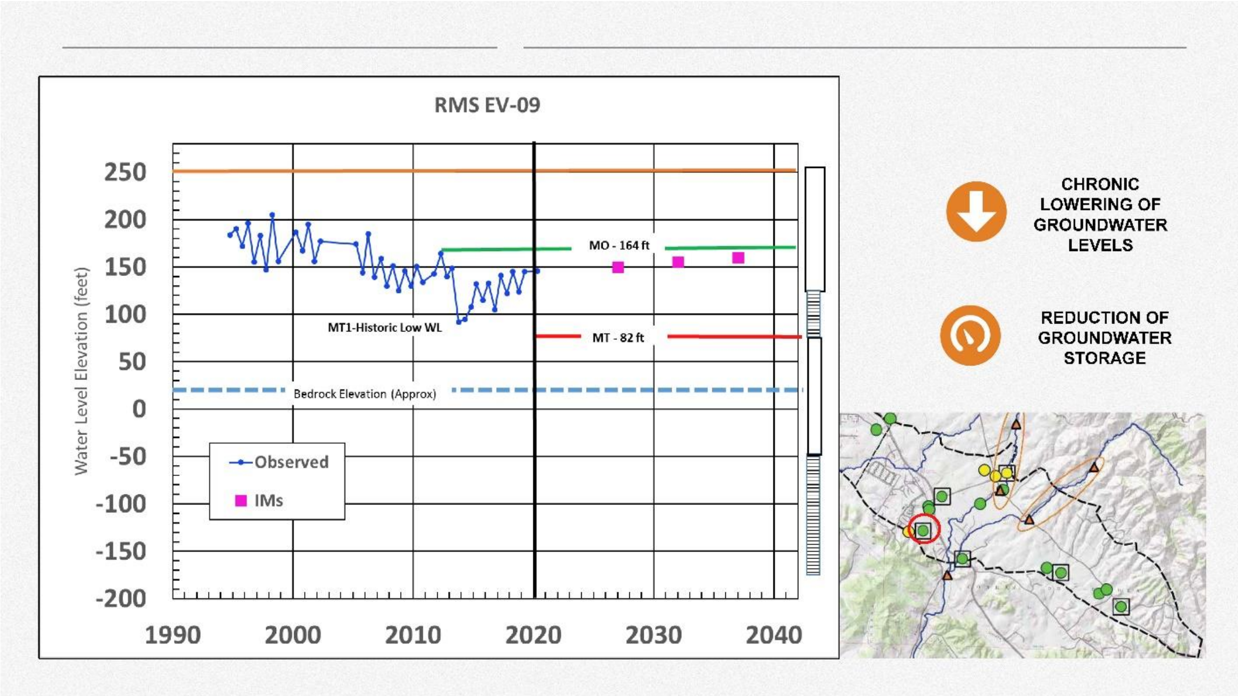


Figure 8-7. HYDROGRAPH, MINIMUM THRESHOLD (MT), MEASURABLE OBJECTIVE (MO), AND INTERIM MILESTONES (IM) FOR REPRESENTATIVE MONITORING SITE (RMS) EV-09

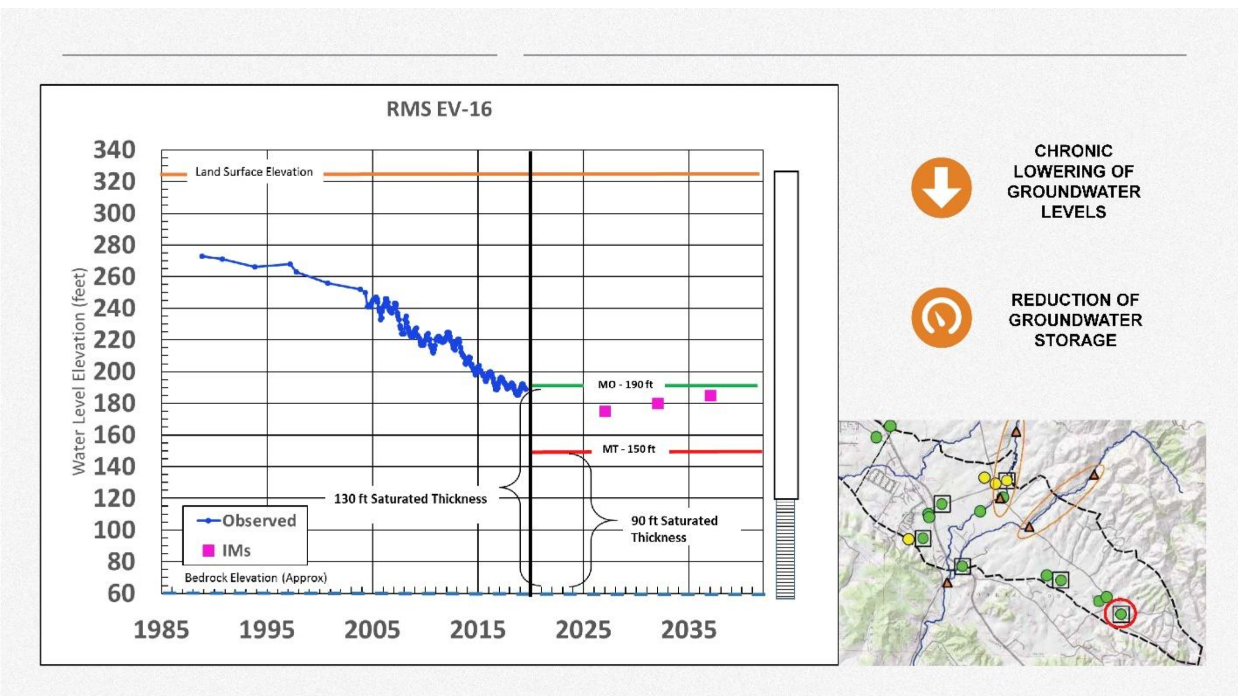


Figure 8-8. HYDROGRAPH, MINIMUM THRESHOLD (MT), MEASURABLE OBJECTIVE (MO), AND INTERIM MILESTONES (IM) FOR REPRESENTATIVE MONITORING SITE (RMS) EV-16

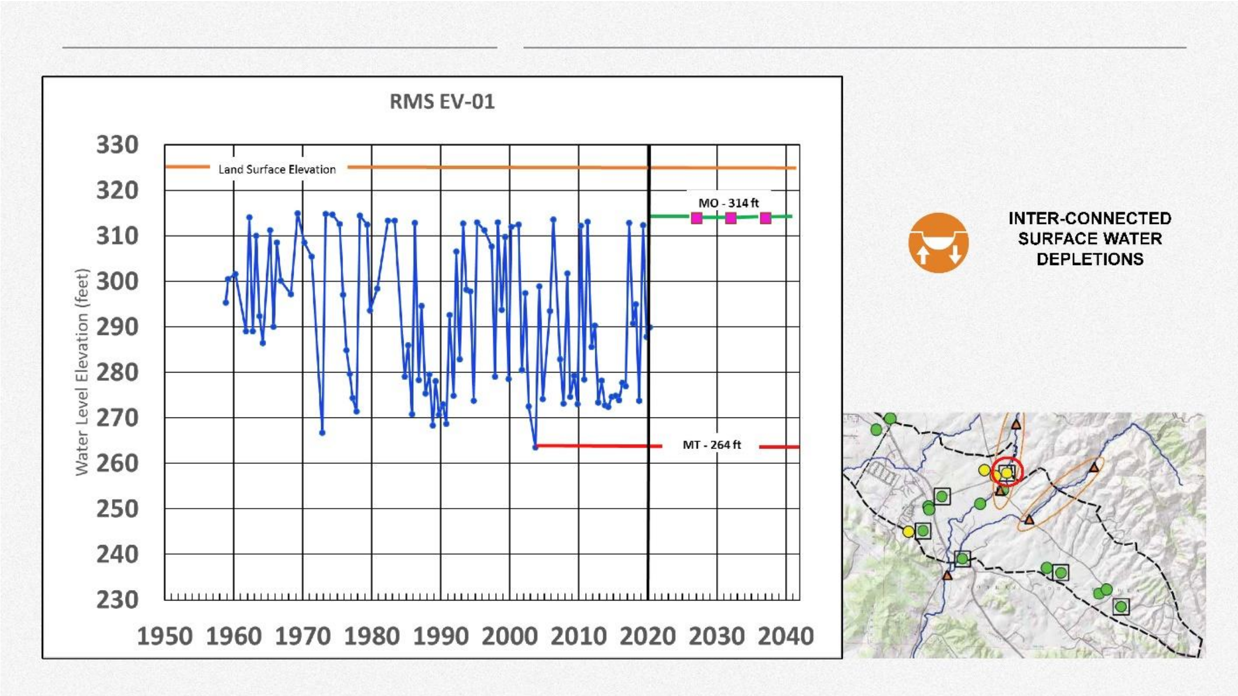


Figure 8-9. HYDROGRAPH, MINIMUM THRESHOLD (MT), MEASURABLE OBJECTIVE (MO), AND INTERIM MILESTONES (IM) FOR REPRESENTATIVE MONITORING SITE (RMS) EV-01

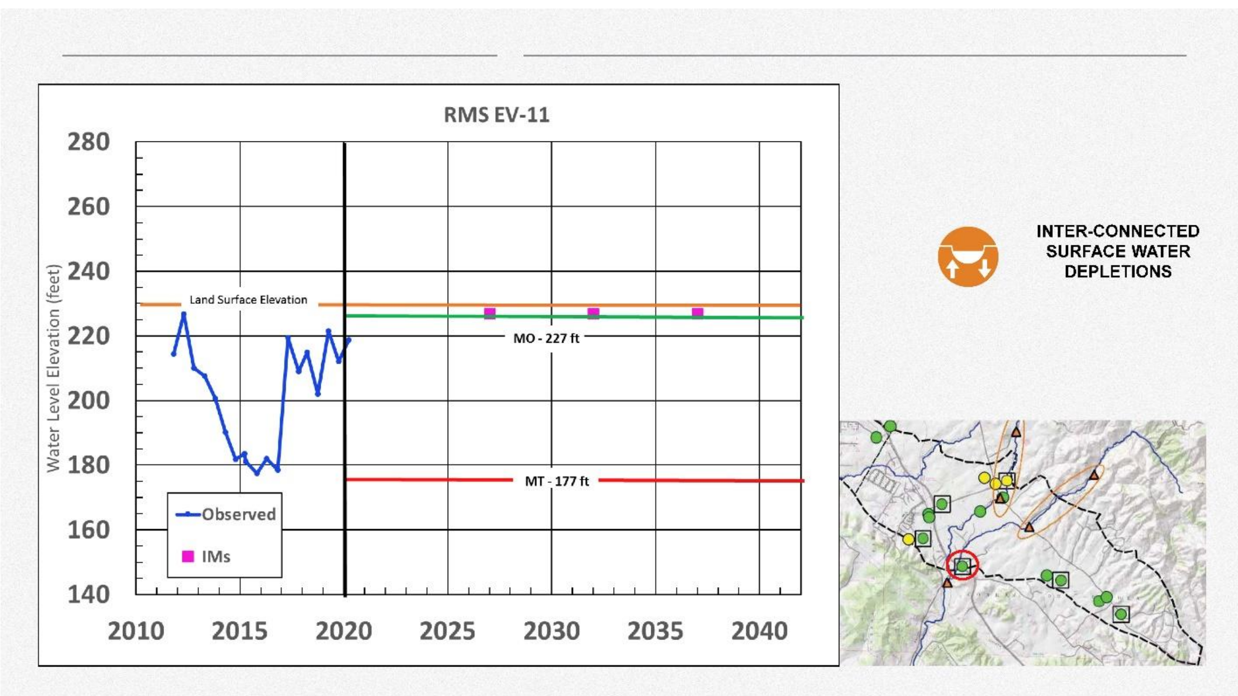


Figure 8-10. HYDROGRAPH, MINIMUM THRESHOLD (MT), MEASURABLE OBJECTIVE (MO), AND INTERIM MILESTONES (IM) FOR REPRESENTATIVE MONITORING SITE (RMS) EV-11

8.5. Chronic Lowering of Groundwater Levels Sustainability Indicator

This section of the GSP describes the SMC for the Chronic Lowering of Groundwater Levels Sustainability Indicator. The definition of Undesirable Results is presented, and MTs and MOs are presented for each RMS in the monitoring network.

8.5.1. Undesirable Results (§354.26)

The definition of undesirable results for the Chronic Lowering of Groundwater Indicator for the purposes of this GSP is as follows:

> ***The Basin will be considered to have undesirable results if two or more RMSs for water levels within a defined area of the Basin (i.e., San Luis Valley or Edna Valley) display exceedances of the minimum threshold groundwater elevation values for two consecutive fall measurements. Geographically isolated exceedances (i.e., conditions in a single well) will require investigation to determine if local or basin wide actions are required in response.***

Details addressing specific MTs and MOs are presented in the following sections. A summary of MTs and MOs used in the definition of Undesirable Conditions for the Chronic Lowering of Groundwater Sustainability Indicator are presented along with other indicators in Table 8-1.

Table 8-1. Summary of MTs, MOs, and IMs for SLO Basin RMSs

RMS	MT	MO	2020 WL	2027 IM	2032 IM	2037 IM	SUSTAINABILITY INDICATOR
SAN LUIS VALLEY							
SLV-09	102	110	119	110	110	110	Subsidence/Water Levels
SLV-16	70	100	111	100	100	100	Water Levels/Storage
SLV-19	80	110	123	110	110	110	Water Levels/Storage
SLV-12	96	105	105	105	105	105	SW-GW Interaction/Water Levels
EDNA VALLEY							
EV-09	82	164	146	150	155	160	Water Levels/Storage
EV-04	160	247	209	219	229	239	Water Levels/Storage
EV-13	172	248	215	223	231	238	Water Levels/Storage
EV-16	150	190	180	175	180	185	Water Levels/Storage
EV-01	263	314	290	314	314	314	SW-GW Interaction /Water levels
EV-11	177	227	219	227	227	227	SW-GW Interaction /Water levels

Note: All water level and interim milestone measurements refer to fall measurements.

8.5.1.1. Criteria for Establishing Undesirable Results (§354.26(b)(2))

Significant and unreasonable Chronic Lowering of Groundwater Levels in the Basin are those that:

- Reduce the ability of existing domestic wells of average depth to produce adequate water for domestic purposes (drought resilience).
- Cause significant financial burden to those who rely on the groundwater basin.
- Interfere with other SGMA Sustainability Indicators.

8.5.1.2. Possible Causes for Undesirable Results (§354.26(b)(1))

Conditions that could theoretically lead to an undesirable result include the following:

- Continuation of current levels of Edna Valley groundwater pumping without development of additional water supply projects, or development of additional municipal or agricultural pumping at significantly higher rates than are currently practiced. Maintenance of current or additional non-de minimis pumping may result in continued decline in groundwater elevations and exceedance of the proxy minimum threshold.
- Expansion of de minimis pumping. Adding domestic de minimis pumpers in the areas of the Basin administered by the County may result in lower groundwater elevations, and an exceedance of the proxy minimum threshold.
- Extensive, unanticipated drought. Minimum thresholds are established based on reasonable anticipated future climatic conditions. Extensive, unanticipated droughts more severe than those on record may lead to excessively low groundwater recharge and unanticipated high pumping rates that could cause an exceedance of the proxy minimum threshold.

8.5.1.3. Effects of Undesirable Results on Beneficial Users and Land Uses (§354.26(b)(3))

The primary effects on the beneficial users occurs from allowing multiple exceedances of the MTs in a small geographic area. Allowing two exceedances in a network of 10 RMS wells is reasonable if the exceedances are distributed throughout the Basin. If the exceedances are clustered in a limited area, it indicates that significant unreasonable effects are being experienced by a localized group of landowners. Any single exceedance will require investigation to determine the significance and causes of the observed conditions.

8.5.2. Minimum Thresholds (§354.28(c)(1))

Section 354.28(c)(1) of the SGMA 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”.

After the 10 RMS had been selected and discussed at public meetings, numerous alternative draft MTs were developed based on the evaluation of historical groundwater elevations over the available period of record (including consideration of average water levels over various time periods, long term trends, response to the recent drought, etc.), consideration of likely future use of groundwater, well construction data, assessment of remaining available saturated thickness, and public input from stakeholders. The following sections present details on the development of MTs for specific RMSs in the Basin.

8.5.2.1. Information and Methods Used for Establishing Chronic Lowering of Groundwater Level Minimum Thresholds (§354.28(b)(1))

The primary source of data that was evaluated for the Sustainability Indicator of chronic lowering of groundwater levels is historical groundwater elevation data collected by the SLOCFCWCD.

The information used for establishing the MOs and MTs for the chronic lowering of groundwater levels Sustainability Indicator included:

- Historical groundwater elevation data from wells monitored by the SLOCFCWCD.
- Depths and locations of existing wells.
- Maps of current and historical groundwater elevation data.

- Input from stakeholders regarding significant and unreasonable conditions and desired current and future groundwater elevations communicated during public meetings and solicitation of public comment on various options of MTs and MOs presented in the public forum.
- Results of modeling of various project scenarios of future groundwater level conditions.

It is observed that historical trends of water levels are significantly different in the San Luis Valley and the Edna Valley. For this reason, the approach for setting MTs is different in the San Luis Valley than in the Edna Valley.

San Luis Valley

In the San Luis Valley, there have been no long-term water level declines in any of the monitoring wells or RMS (Figure 5-11). All four of the RMS hydrographs in San Luis Valley (SLV-09, SLV-12, SLV-16, and SLV-19) display a significant temporary decline in water levels in the early 1990s. This corresponds to the period when the City and other groundwater users increased pumping from their wells during the drought of the late 1980s and early 1990s. After 1992-1993 groundwater pumping was reduced, and water levels have been in relative equilibrium since. While seasonal fluctuations continue as would be expected, year-to-year water levels have been essentially stable. In addition, the water budget analysis presented in Chapter 6 (Water Budget) documents that the San Luis Valley portion of the Basin is in surplus. City staff and City GSA participants have communicated their desire to maintain flexibility to develop groundwater in the future to potentially augment their water supply portfolio to supply the public with drinking water in their service area. Therefore, the City wishes to avoid the definition of MTs that would prevent future development of groundwater. For this reason, MTs for chronic lowering of groundwater levels at RMSs in the San Luis Valley that have not experienced any historical declines are set 10 to 20 feet lower than previously observed low water levels, to allow for potential future groundwater development by the City. (An exception to this approach is made for RMS SLV-12, due to its location proximate to Prefumo and San Luis Obispo Creeks, and its additional use as an RMS for depletion of interconnected surface water; the MT for this RMS is set at the historically observed lowest water level.) The GSAs will coordinate during GSP implementation to ensure such future development does not lead to undesirable results in the Basin. The GSAs considered historical groundwater elevations, available saturated thickness, proximity of nearby wells, and general hydrogeologic judgement when setting these MTs. Figure 7-1 displays the locations of RMSs for water levels and groundwater in storage in the Basin. MTs are presented in Table 8-1. Figure 8-1 through Figure 8-4 present historically observed water levels in the four RMS in the San Luis Valley portion of the basin, and the MTs set at these wells.

Edna Valley

In Edna Valley, by contrast, four wells show water level declines over the past 20-30 years (EV-04, EV-09, EV-13, and EV-16). Various alternative approaches were considered to establish MTs including designation of current water levels, water levels higher than current water levels, historical low water levels (usually those that occurred in 2015 at the end of the recent drought), and levels lower than the historical low. Not all of the Edna Valley hydrographs show the same trends. Evaluations were made allowing consideration for the human right to water by de minimis users in the Basin, as well as accommodations for agricultural stakeholders in the Basin. Each hydrograph has unique characteristics depending on the local hydrogeologic setting in the immediate vicinity of the well, and this leads to the consideration of different definitions of MTs for different wells, as discussed below.

RMS EV-13, EV-04, and EV-09 display declining water levels over the past 20-25 years, with historical low elevations occurring around Fall 2015 at the end of the recent drought, followed by some degree of recovery since then. The hydrographs for all three of these wells display recovery of water levels since then (Figure 8-5, Figure 8-6, Figure 8-7). Agricultural stakeholders in the Edna Valley communicated concern that setting the MT at the 2015 water levels in these wells would not provide them adequate operational flexibility to protect their long investments in the production of agriculture in the area. De minimis users communicated concern about lowered water levels affecting their ability to pump water for their domestic use. At the April 7, 2021 GSC meeting the agricultural stakeholders requested consideration of an MT for these three RMSs to be defined 10 feet lower than 2015 drought water level. They communicated their desire for a slightly greater factor of safety for their operations and investments in the event of another drought during the planning horizon of SGMA activities. Members of the GSC were polled, and a majority of the GSC members agreed that this was a reasonable request to protect the significant investments in vineyard agriculture in the valley and would not be considered an undesirable condition in this part of Edna Valley. Therefore, for these three wells, the MTs were defined to be 10 feet lower than the historical low groundwater elevation observed in 2015, at the height of the recent drought. (The measurement for EV-04 represents the Spring 2015 measurement; the Fall measurement was not collected. It is assumed that the Fall measurement would be lower than the Spring measurement, so the MT is set slightly lower than the Spring measurement.)

In order to assess the risk on private domestic well owners of having groundwater elevations lower than recent drought low levels, an analysis was performed to evaluate potential water level of MTs compared to the depths of private domestic wells identified in County data. The basin-wide Fall 2015 groundwater elevations were mapped and compared to the total depths of domestic wells in the County's well permitting database. Then the 2015 groundwater elevation arrays were reduced by 10 feet, 25 feet, and 50 feet, to project conditions of lowered water levels. These revised lowered groundwater elevations were then compared to the total depths of the identified domestic wells. If in any of these comparison evaluations, the water level was below the total depth of a domestic well, that well was marked as "dry" in the analysis and is summarized in Table 8-2 below. The objective of this analysis is to assess the level of impact to domestic wells associated with water level reduction of these magnitudes. This is not intended to be a definitive analysis, given that depth and location data of the domestic wells are imperfect (many wells in the database are placed on the same point location, an artifact of the practice of assigning locations to the center of a section if better information is not available.) However, it is intended to provide a general indication of how many additional domestic wells might be impacted if water levels were decreased.

For the analysis of 2015 water levels, the data indicated 15 wells as "dry", out of 155 wells in the database. (In reality, anecdotal information indicates local knowledge of three to four known wells that needed to be replaced or stopped being used during the recent drought in Edna Valley). For water levels 10 feet lower than 2015 water levels, no additional domestic wells in the County database were indicated as "dry", beyond those identified as dry using 2015 water levels. For water levels 25 feet lower than 2015 water levels, 29 wells were identified as "dry", an increase of 14 additional wells. For water levels 50 feet lower than 2015 water levels, 40 wells were identified as "dry", an increase of 25 additional wells. This evaluation was performed to give a relative idea as to the potential impact on domestic wells of lowered water levels. The conclusion of this analysis was that water levels 25 feet and 50 feet lower than the drought minimums would result in an unacceptable condition in which the number of domestic supply wells at risk of adverse operating conditions was too high. Therefore, the conclusion of this analysis is that lowering water levels 25 to 50 feet below 2015 conditions constitutes an unreasonable risk to domestic well owners, but that water levels 10 feet below the 2015 drought levels constitutes an acceptable level of risk for all stakeholders, and the definition of MTs for wells in this area 10 feet lower than 2015 levels does not constitute unreasonable or undesirable conditions.

Table 8-2. Groundwater Levels in Domestic Wells During the 2015 Drought (Edna Valley)

GROUNDWATER LEVEL CONDITION	TOTAL WELLS	NUMBER OF "DRY" WELLS
2015 Groundwater Levels	155	15
2015 Groundwater Levels -10 feet	155	15
2015 Groundwater Levels -25 feet	155	29
2015 Groundwater Levels -50 feet	155	40

RMS EV-16 displays a relatively steady decline in water levels of about 3.25 feet/year at the Varian Ranch Mutual Water Company (VRMWC) service area since the year 2000. The 2011-2015 drought is not apparent in this hydrograph as a period of historical low groundwater elevations. For this well, the MT was set at an elevation of 150 feet, which is lower than current groundwater elevations of about 180 feet, to allow for the various stakeholders (both agricultural interests and mutual water companies) in the area to implement projects to slow and stabilize the observed water level declines (Figure 8-10). Consideration of the recent rate of groundwater elevation decline, amount of available saturated thickness, and hydrogeologic judgement regarding the amount of time likely required to mitigate this trend, were used in defining the MTs at this well. (VRMWC owns property and wells in the adjacent Arroyo Grande sub-basin of the Santa Maria Valley Groundwater Basin, which may be useful in reversing this trend, and will be discussed in Chapter 9 (Projects and Management Actions)).

8.5.2.2. Relationship between Individual Minimum Thresholds and Relationship to Other Sustainability Indicators (§354.28(b)(2))

Section 354.28 of the SGMA regulations requires that the description of all MTs include a discussion of the relationship between the MTs for each Sustainability Indicator. In the SMC Best Management Practices document (DWR, 2017), DWR has clarified this requirement. First, the GSP must describe the relationship between each Sustainability Indicator's MT by describing why or how a water level MT set at a particular RMS is similar to or different to water level thresholds in a nearby RMS. Second, the GSP must describe the relationship between the selected MT and MTs for other Sustainability Indicators; in other words, describe how (for example) a water level minimum threshold would not trigger an undesirable result for land subsidence.

Groundwater elevation MTs are derived from examination of the historical record reflected in hydrographs at the RMS. They were tested for achievability through model simulations (as described in Chapter 9 (Projects and Management Actions). Because the MOs are largely based on observed historical groundwater conditions, the minimum thresholds derived from these objectives are not expected to conflict with each other. Groundwater elevation MTs can theoretically influence other Sustainability Indicators.

Examples are listed below:

1. **Change in groundwater storage.** Changes in groundwater elevations are directly correlated to changes in the amount of stored groundwater. Pumping at or less than the sustainable yield will maintain or raise average groundwater elevations in the Basin. The groundwater elevation MTs are set to establish a minimum elevation that will not lead to undesirable conditions, and that are acceptable to the stakeholders in the area. Therefore, if the groundwater elevation MTs are met, they will not result in long term significant or unreasonable changes in groundwater storage.
2. **Subsidence.** A significant and unreasonable condition for subsidence is permanent pumping-induced subsidence that substantially interferes with surface land use. One cause for subsidence is dewatering and compaction of clay-or peat-rich sediments in response to lowered groundwater levels. As discussed in Chapter 5 (Groundwater Conditions), significant subsidence was observed along Los Osos Valley Road in the early 1990s, which resulted in the City paying for significant

damage to affected local businesses. No observed subsidence has been reported in the Edna Valley. If MTs are maintained higher than the historically low water levels that were observed during the subsidence episode, this will minimize the risk of additional subsidence in the Basin. The groundwater elevation MT in RMS SLV-09 along Los Osos Valley Road is set 15 feet higher than the historically low groundwater elevation observed in the early 1990s. Therefore, if this MT is met, it should minimize the risk of further subsidence along Los Osos Valley Road. No subsidence MTs based on water levels are established in Edna Valley (the actual MTs for subsidence will be based on InSAR data provided annually by DWR and are discussed later in this chapter). Should new subsidence be observed due to lower groundwater elevations, the groundwater elevation MTs will be raised to mitigate this subsidence and avoid future subsidence.

3. **Degraded water quality.** Protecting groundwater quality is critically important to all groundwater users in the Basin, particularly for drinking water and agricultural uses. Maintaining groundwater levels protects against degradation of water quality or exceeding regulatory limits for constituents of concern in supply wells due to actions proposed in the GSP. Water quality in the Basin could theoretically be affected through two processes:
   - Low groundwater elevations in an area could theoretically cause deeper, poorer-quality groundwater to flow upward from bedrock into existing supply wells. Should groundwater quality degrade due to lowered groundwater elevations, the groundwater elevation MTs may be raised to avoid this degradation. However, since MTs are set to avoid significant declines of groundwater elevations below historically observed levels, and the historical low water levels did not result in water quality degradation, this is not expected to occur.
   - Changes in groundwater elevation due to actions implemented to achieve sustainability could change groundwater gradients, which could cause poor quality groundwater to flow towards supply wells that would not have otherwise been impacted. However, MTs are established so as not to change the basin patterns or gradients of groundwater flow, so this is not expected to occur in the Basin.
4. **Depletion of Interconnected Surface Water.** Groundwater levels measured at RMSs (SLV-12, EV-01, EV-11) will serve as a proxy for depletion of interconnected surface water. In addition, stream flow gages along SLO Creek will continue to measure surface water conditions in San Luis Valley, and proposed stream gages along Corral de Piedras Creek will serve to generate information on surface water inflow and outflow in Edna Valley, allowing for direct measurement of surface water gains and losses to the groundwater systems based on future hydrologic and pumping conditions in the Basin. However, MTs along the Creeks are defined at levels designed to avoid significant water declines in these areas, with the goal of minimizing any potential significant depletion of interconnected surface water flows.
5. **Seawater intrusion.** This Sustainability Indicator is not applicable to this Groundwater Basin.

8.5.2.3. Effect of Minimum Thresholds on Neighboring Basins (§354.28(b)(3))

Two neighboring groundwater basins share a boundary with the San Luis Obispo Basin; the Los Osos Basin to the northwest, and the Arroyo Grande Subbasin of the Santa Maria Valley Groundwater Basin to the southeast. The shared boundary with both of these basins is not extensive, and the Hydrogeologic Conceptual Model (HCM) posits that a groundwater divide separates the groundwater between those basins and the San Luis Obispo Basin. In the San Luis Valley, there have been no trends indicating groundwater declines that would affect the Los Osos Basin. In Edna Valley the areas with observed declines are over two miles downgradient from the Arroyo Grande Subbasin boundary. It is not anticipated that actions associated with the GSP will have any significant impact on either the Los Osos Basin or the Arroyo Grande Subbasin.

Additionally, the SLO Basin GSAs have developed a cooperative working relationship with both the Los Osos Groundwater Basin – Basin Management Committee and the GSAs working in the Arroyo Grande

Subbasin. Hydrogeologic conditions near the basin boundaries will be monitored, and any issues potentially affecting those basins will be communicated.

8.5.2.4. Effects of Minimum Thresholds on Beneficial Users and Land Uses (§354.28(b)(4))

Agricultural land uses and users

The agricultural stakeholders in the Edna Valley have maintained an active role during the development of this GSP. The groundwater elevation MTs place a practical limit on the acceptable lowering of groundwater levels in the Basin, thus conceptually restricting the current level of agriculture in the region without projects to supplement water supply to the Basin, or management actions to reduce current pumping. In the absence of other mitigating measures, this has been the practical effect of potentially limiting the amount of groundwater pumping in the Basin. Limiting the amount of groundwater pumping could limit the additional amount and type of crops that can be grown in the Basin, which could result in a reduction of economic viability for some properties. The groundwater elevation MTs could therefore limit the Basin's agricultural economy.

This could have various effects on beneficial users and land uses:

- There could be an economic impact to agricultural employees and suppliers of agricultural production products and materials, as well as the tourism industry supported by the wineries in the Basin. Many parts of the local economy rely on a vibrant agricultural industry, and they too will be hurt proportional to the losses imparted to agricultural businesses.
- Growth of city, county, and state tax rolls could be slowed or reduced due to the limitations imposed on agricultural growth and associated activities.

However, it should be noted that projects and management actions discussed in Chapter 9 will be pursued to allow for alternatives to reductions in agricultural pumping.

Urban land uses and users

The groundwater elevation MTs effectively limit the amount of groundwater pumping in the Basin. However, the MTs for the RMSs in the San Luis Valley are established below currently observed groundwater elevations to allow for reasonable future development of groundwater for potable supply to City residents. If groundwater elevations experience significant and sustained decline in the immediate vicinity of SLO Creek, this could potentially result in less groundwater discharge to the creek due to areas of interconnected groundwater and surface water. Impacts to stream flows will be monitored with the augmentation of current data collection programs in San Luis Valley, and the addition of new stream gauges in the Basin.

Domestic land uses and users

The groundwater elevation MTs are established to protect as many domestic wells as possible. Therefore, the MTs will likely have an overall beneficial effect on existing domestic land uses by protecting the ability to pump from domestic wells within the Edna Valley portion of the Basin. However, limited saturated thickness in some localized areas in the Basin of the shallowest domestic wells may require owners to drill deeper wells if water levels are decreased. Additionally, the groundwater elevation MTs may limit the increase of non-de minimis groundwater use in order to limit future declines in groundwater levels caused by non-de minimis domestic pumping.

Ecological land uses and users

Groundwater elevation MTs protect the groundwater resource and the existing ecological habitats that rely upon it because they are set to avoid significant and unreasonable declines in groundwater levels. As noted above, groundwater level MTs may limit increases in non-de minimis and agricultural groundwater uses. Ecological land uses and users may benefit by this reduction in non-de minimis and agricultural groundwater uses.

8.5.2.5. Relevant Federal, State, or Local Standards §354.28(b)(5)

No Federal, State, or local standards exist for chronic lowering of groundwater elevations.

8.5.2.6. Method for Quantitative Measurement of Minimum Thresholds §354.28(b)(6)

Conformance of Basin conditions to the established groundwater elevation MTs will be assessed through direct measurement of water levels from existing RMS. During planned 5-year revisions to this GSP, additional RMS may be stablished for the SMC evaluations, and direct water level measurements at these wells will be the method for quantitative measurement of MTs in the future. Groundwater level monitoring will be conducted in accordance with the monitoring plan outlined in Chapter 7 (Monitoring Network) and will comply with the requirements of the technical and reporting standards included in SGMA regulations.

As noted in Chapter 7 (Monitoring Network), the existing groundwater monitoring network in the Basin includes 12 wells. The GSP monitoring network developed in Chapter 7 increases the groundwater monitoring network to 40 wells to be used for water level measurements.

8.5.3. Measurable Objectives §354.30(a)(g)

The MOs for chronic lowering of groundwater levels represent target groundwater elevations that are established to achieve the sustainability goal by 2042. MOs are groundwater levels established at each RMS. MO groundwater levels are higher than MT groundwater levels and provide operational flexibility above MTs to ensure that the Basin be sustainably managed over a range of climate and hydrologic variability. MOs are subject to change by the GSAs after GSP adoption as new information and hydrologic data become available.

8.5.3.1. Information and Methods Used for Establishing Chronic Lowering of Groundwater Level Measurable Objectives §354.30(b)

Preliminary MOs were established based on historical groundwater level data, along with input and desired future groundwater levels from domestic groundwater users, agricultural interests, environmental interests, and other Basin stakeholders. The input and desired conditions were used to formulate a range of alternative MO options, which were discussed by the GSAs and the GSC. Final MOs were voted on by the GSC members to recommend to the GSAs for approval as part of the full GSP.

Preliminary MOs were established based on historical groundwater level data and input regarding desired future groundwater levels from domestic groundwater users, agricultural interests, environmental interests, and other public stakeholders. The input and desired conditions were used to formulate a range of conceptual MO scenarios. These scenarios were evaluated using the groundwater model developed during this GSP preparation to project the effects of future Basin operation and to select measurable objectives for the GSP.

As previously discussed in Chapter 5 (Groundwater Conditions) and Section 8.4.2, groundwater conditions in San Luis Valley and Edna Valley are significantly different. Therefore, as with the MTs, the approach to the MOs is different in the two valleys.

San Luis Valley

In San Luis Valley, definition of MOs within the historically observed range of groundwater elevations, but about 20 feet lower than fall 2020 water levels, was considered to preserve the City's desired flexibility to resume reasonable and managed groundwater use to augment its potable water supply portfolio to serve its customer base. MOs for SLV-09, SLV-16, SLV-19, and SLV-12 were set within the range of historical data, but lower than current water levels (Table 8-1) (Figure 8-1 through Figure 8-4).

Edna Valley

In Edna Valley, if recovery from drought levels is evident (EV-04, EV-09, EV-12), MOs were set at the high-water levels observed immediately prior to the drought (Spring 2011, in most cases) (Figure 8-5 through Figure 8-7). The rationale for this selection was that if the antecedent conditions before the recent drought are replicated, and no significant new groundwater pumping is occurring in the Basin, then the water level declines observed from 2012-2015 in the Basin will not be significantly exceeded in a similar drought. To the extent that groundwater elevations can recover to levels higher than the 2011 levels, the Basin will be more resilient to drought.

For the wells in Edna Valley to monitor surface water/groundwater conditions (EV-01, EV-11), MOs were set at approximately the average of seasonal high water levels over the period of record (Figure 8-8, Figure 8-9). RMS EV-01 shows that similar high water levels occur with regularity during wet periods, going back to the late 1950s. Therefore, this level was selected for the MOs for these wells because they are the naturally occurring water levels that have been observed for decades.

The MO for RMS EV-16, located in the southeast area of Tiffany Ranch Road near the upgradient extent of the Basin, was set slightly below current water levels (Figure 8-7). This approach is to try to prevent further significant reductions in water levels at this location, since it does not appear to have experienced any recovery of water levels since 2015 and needs to maintain sufficient saturated thickness to sustain production for the service area.

Since there is data uncertainty due to significant data gaps, MTs and MOs will be reviewed every 5 years during GSP updates throughout the twenty-year SGMA implementation horizon to assess if the RMSs and the assigned MOs and MTs remain protective of sustainable conditions in the Basin. MTs and MOs may be modified in the future as hydrogeologic conditions are monitored through the implementation phase of SGMA.

8.5.3.2. Interim Milestones §354.30(a)(e)

Interim milestones (IMs) are required to be included in the GSP. IMs at 5-year intervals for the MOs established at each RMS are included on Table 8-1.

Preliminary IMs were developed for the 10 RMS established for the basin. In San Luis Valley, because there have been no historic declines in water levels, IMs were simply defined as being numerically equivalent to the MO throughout the SGMA period. In Edna Valley, Interim milestones were generally selected to define a smooth linear increase in water levels between the observed groundwater elevation at the RMS in 2020, and the MO as presented in Table 8-1.

IMs may be adjusted at any time during the SGMA timeline. It is expected that they will be reconsidered at 5-year intervals when the Basin GSP is revised and updated. The monitoring of basin conditions during the initial 5-year period will provide good indicators on if the IMs are close to being met. Failure to meet IMs is not in and of itself an indication of undesired conditions but is meant to provide information determining whether the 20-year goals are on track to being achieved. Alternative projects and management actions may be considered or pursued if the IMs are not being met. Table 8-1 summarizes the interim milestones for the RMS.

8.6. Reduction of Groundwater Storage Sustainability Indicator §354.28(c)(2)

8.6.1. Undesirable Results

As per Section 354.26 of the SGMA regulations, locally defined significant and unreasonable conditions were assessed based on review of historical groundwater data and stakeholder input during numerous public meetings, analysis of available data, and discussions with GSA staff. It is recognized based on well-established hydrogeologic principles that the Reduction of Groundwater Storage Sustainability Indicator is directly correlated to the lowering of water level Sustainability Indicator.

Significant and unreasonable changes in groundwater storage in the Basin are those that:

- Lead to long-term reduction in groundwater storage.
- Interfere with other Sustainability Indicators.

Assessment of groundwater in storage will initially be evaluated with the same RMS and associated water level MTs and MOs as the chronic lowering of groundwater levels sustainability criteria. As additional data is collected in the monitoring network described in Chapter 7 (Monitoring Network), new RMS may be established, and appropriate SMCs determined by the GSAs.

For the purposes of this GSP, the definition of undesired conditions for the Reduction of Groundwater Storage Sustainability Indicator is as follows:

> ***The Basin will be considered to have undesirable results if two or more than two RMS for groundwater storage within a defined area of the Basin (I.e., San Luis Valley or Edna Valley) display exceedances of the MTs for two consecutive Fall measurements. Geographically isolated exceedances will require investigation to determine if local or basin wide actions are required in response***.

8.6.1.1. Criteria for Establishing Undesirable Results §354.2(b)(2)

Significant and unreasonable Reduction of Groundwater Storage in the Basin are those that:

- Reduce the ability of existing domestic wells of average depth to produce adequate water for domestic purposes (drought resilience).
- Cause significant financial burden to those who rely on the groundwater basin.
- Interfere with other SGMA Sustainability Indicators.

8.6.1.2. Potential Causes of Undesirable Results §354.2(b)(1)

Conditions that could theoretically lead to an undesirable result include the following:

- Continuation of current levels of Edna Valley pumpage without development of additional water supply projects, or development of additional municipal or agricultural pumping at significantly higher rates than are currently practiced. Maintenance of current or additional non-de minimis pumping may result in continued decline in groundwater elevations and exceedance of the proxy minimum threshold.
- Expansion of de minimis pumping. Adding domestic de minimis pumpers in the areas of the Basin administered by the County may result in lower groundwater elevations, and an exceedance of the proxy minimum threshold.
- Extensive, unanticipated drought. Minimum thresholds are established based on reasonable anticipated future climatic conditions. Extensive, unanticipated droughts more severe than those on record may lead to excessively low groundwater recharge and unanticipated high pumping rates that could cause an exceedance of the proxy minimum threshold.

8.6.1.3. Effects of Undesirable Results on Beneficial Users and Land Uses §354.2(b)(3)

The effects of these undesirable results on the beneficial users and uses are the same effects as those discussed for the Chronic Lowering of Groundwater Levels Sustainability Indicator.

The primary effects on the beneficial users (§354.26 (b)(3)) occurs from allowing multiple exceedances of the MTs in a small geographic are. Allowing a minimum of two exceedances in a network of 10 RMS wells is reasonable if the exceedances are distributed throughout the Basin. If the exceedances are clustered in a limited area, it indicates that significant unreasonable effects are being experienced by a localized group of landowners. Any exceedances will require investigation to determine the significance and causes of the observed conditions.

8.6.2. Minimum Thresholds §354.28(c)(2)

Section 354.28(c)(2) of the SGMA regulations states that “The minimum threshold for reduction of groundwater storage shall be a total volume of groundwater that can be withdrawn from the basin without causing conditions that may lead to undesirable results. Minimum thresholds for reduction of groundwater storage shall be supported by the sustainable yield of the basin, calculated based on historical trends, water year type, and projected water use in the basin.”

This GSP will monitor changes in groundwater level at the RMSs as a proxy for the change in groundwater storage metric. As allowed in Section 354.36(b)(1) of the SGMA regulations, groundwater elevation data at the RMS will be reported annually as a proxy to track changes in the amount of groundwater in storage.

Based on well-established hydrogeologic principles, stable groundwater elevations maintained above the MTs will limit depletion of groundwater from storage. Therefore, using groundwater elevations as a proxy, the MT is that the groundwater surface elevation averaged across all the wells in the groundwater level monitoring network will remain stable above the MT for chronic lowering of groundwater levels.

In accordance with the SGMA regulation cited above, GSAs have the option of defining the MT metric as a calculated volume of groundwater in storage. As discussed in Chapter 6 (Water Budget), separate estimates for total groundwater in storage were generated for the San Luis Valley and Edna Valley using methodology described in Chapter 6 (Water Budget) and shown in Figure 6-21. After the monitoring network described in Chapter 7 is established, and several years of water level data have been collected, a robust and repeatable method for directly quantifying groundwater in storage using the monitoring network may be developed and finalized. It is possible that in future versions of the GSP, the MT may be changed to be defined as the directly calculated amount of groundwater in storage. However, for the current 5-year implementation period, water levels at the RMS will be used as a proxy for the groundwater in storage Sustainability Indicator.

8.6.2.1. Information and Methods for Establishing Reduction of Storage Minimum Thresholds §354.28(b)(1)

As with the chronic reduction of groundwater levels Sustainability Indicator, the primary source of data that was evaluated for the Sustainability Indicator of reduction of groundwater storage is historical groundwater elevation data maintained by the County.

The information used for establishing the MOs and MTs for the chronic lowering of groundwater levels Sustainability Indicator included:

- Historical groundwater elevation data from wells monitored by the SLOCFCWCD.
- Depths and locations of existing wells.
- Maps of current and historical groundwater elevation data.

- Input from stakeholders regarding significant and unreasonable conditions and desired current and future groundwater elevations communicated during public meetings and solicitation of public comment on various options of MTs and MOs presented in the public forum.
- Results of modeling various project scenarios of future groundwater level conditions.

Storage MTs will be measured by collecting water level measurements at the RMS sites in the monitoring network. The monitoring network and protocols used to measure groundwater elevations at the RMS are presented in Chapter 7 (Monitoring Network). The Water Level Monitoring Network is presented in Figure 7-1. This data will be used to monitor groundwater elevations and assess changes in groundwater storage.

8.6.2.2. Relationship between Individual Minimum Thresholds and Other Sustainability Indicators §354.28(b)(2)

The MTs for reduction in groundwater storage is a single value of average groundwater elevation over the entire Basin. Therefore, the concept of potential conflict between MTs at different locations in the Basin is not applicable. The reduction in groundwater storage MT could influence other Sustainability Indicators.

The reduction in groundwater storage MT was selected to avoid undesirable results for other Sustainability Indicators, as outlined below:

- Chronic lowering of groundwater levels. Because groundwater elevations will be used as a proxy for estimating groundwater pumping and changes in groundwater storage, the reduction in groundwater storage would not cause undesirable results for this Sustainability Indicator.
- Seawater intrusion. This Sustainability Indicator is not applicable to this Basin.
- Degraded water quality. The minimum threshold proxy of stable groundwater levels is not expected to lead to a degradation of groundwater quality.
- Subsidence. Because future average groundwater levels will be stable, they will not induce any additional subsidence.
- Depletion of interconnected surface waters. Groundwater levels measured at representative monitoring wells (SLV-12, EV-01, EV-11) will serve as a proxy for depletion of interconnected surface water. In addition, stream flow gages along SLO Creek will continue to measure surface water conditions in San Luis Valley, and proposed stream gages along Corral de Piedras Creek will serve to generate information on surface water inflow and outflow in Edna Valley, allowing for direct measurement of surface water gains and losses to the groundwater systems based on future hydrologic and pumping conditions in the Basin. However, MTs along the creeks are defined to avoid significant water declines in these areas, with the goal of minimizing any potential significant depletion of interconnected surface water flows.

8.6.2.3. Effects of Minimum Thresholds on Neighboring Basins §354.28(b)(3)

Two neighboring groundwater basins share a boundary with the SLO Basin; the Los Osos Basin to the northwest, and the Arroyo Grande sub-basin of the Santa Maria Valley Groundwater Basin to the southeast. Neither of these shared boundaries are extensive, and the HCM posits that a groundwater divide separates the groundwater between them and the SLO Basin. In the San Luis Valley, there have been no trends indicating groundwater declines that would affect the Los Osos Basin. In Edna Valley the areas with observed declines are one to two miles from the Arroyo Grande Basin boundary in a downgradient direction. It is not anticipated that actions associated with the GSP will have any significant impact on either the Los Osos Basin or the Arroyo Grande Basin.

The SLO Basin GSAs have developed a cooperative working relationship with the Los Osos Groundwater Basin – Basin Management Committee and the GSAs working in the Arroyo Grande Subbasin. Groundwater conditions near the borders with these basins will be monitored and shared.

8.6.2.4. Effects of Minimum Thresholds on Beneficial Uses and Users §354.28(b)(4)

The MT for reduction in groundwater storage will maintain stable average groundwater elevations but may require a reduction in the amount of groundwater pumping in the Basin, or development of sources of supplemental water as discussed in Chapter 9 (Projects and Management Actions). Reducing pumping may impact the beneficial uses and users of groundwater in the Basin.

The practical effect of this GSP for protecting against the reduction in groundwater storage undesirable result is that it encourages minimal long-term net change in groundwater elevations and storage. Seasonal and drought cycle variations are expected, but during average conditions and over the long-term, beneficial users will have access to adequate volumes of water from the aquifer to service the needs of all water use sectors. The beneficial users of groundwater are protected from undesirable results.

Agricultural Land Uses and Users

The MT for reduction in groundwater storage may limit or reduce non-de minimis production in the Basin by reducing the amount of available water. The practical effect of these MTs on agricultural users is that current levels of agricultural pumping may not be sustainable without development of additional sources of water to the Basin. Owners of undeveloped agricultural lands that are currently not irrigated may be particularly impacted because the additional groundwater pumping needed to irrigate these lands could increase the Basin pumping beyond the sustainable yield, violating the MT. Existing agricultural operations may also be limited in their use of more water-intensive crops, expansion of existing irrigated lands, and by periods of extended drought that decrease the quantity of water naturally returning to the basin.

Urban Land Uses and Users

Potential future increases of groundwater pumping in the City of San Luis Obispo could decrease the cost of water for municipal users in the City, because groundwater may be the cheapest water supply alternative. However, in order to avoid undesirable results, the City is unlikely to pursue groundwater pumping in the quantity that it did during the 1980s-90s drought without the use of groundwater recharge.

Domestic Land Uses and Users

Existing domestic groundwater users may generally benefit from this MT. Many domestic groundwater users are de-minimis users whose pumping may not be restricted by the projects and management actions adopted in this GSP. By restricting the amount of groundwater that is pumped from the Basin, the de-minimis users would be protected from overdraft that could impact their ability to pump groundwater or require them to drill deeper wells.

Ecological Land Uses and Users

Groundwater dependent ecosystems would generally benefit from this MT. Maintaining groundwater levels close to current levels keeps groundwater supplies near present levels, which will continue to support groundwater dependent ecosystems.

8.6.2.5. Relation to State, Federal, or Local Standards §354.28(b)(5)

No federal, state, or local standards exist for reductions in groundwater storage.

8.6.2.6. Methods for Quantitative Measurement of Minimum Thresholds §354.28(b)(6)

The quantitative metric for assessing compliance with the reduction in groundwater storage MT is monitoring groundwater elevations. The approach for quantitatively evaluating compliance with the MT for reduction in groundwater storage will be based on evaluating groundwater elevations semi-annually. All groundwater elevations collected from the groundwater level monitoring network will be analyzed and averaged.

In the future, after the monitoring network is established and multiple years of data are available for analysis, a robust and repeatable method for calculating groundwater in storage utilizing the monitoring well network may be developed and finalized. At that time, the metric for defining the SMC of reduction of groundwater in storage may possibly be changed to direct calculation of groundwater in storage for the two areas of the basin, but this will be reviewed after additional data has been collected during the implementation phase of the GSP.

8.6.3. Measurable Objectives §354.30(a)(g)

The change in storage Sustainability Indicator uses groundwater levels as a proxy for direct calculation of groundwater in storage. The same MTs and MOs are used as are defined in the chronic lowering of groundwater level indicator to protect against significant and unreasonable reduction in groundwater storage.

8.6.3.1. Information and Methods Used for Establishing Reduction of Groundwater Storage Measurable Objectives §354.30(b)

Input from stakeholders suggested that they would prefer more groundwater in storage to maintain resiliency against future droughts. Therefore, the conservative approach of simply maintaining stable groundwater levels was adopted for the MO. MOs for the RMS are identical to the MOs for the chronic lowering of groundwater elevations MOs (Table 8-1).

8.6.3.2. Interim Milestones §354.30(a)(e)

Interim milestones for groundwater storage are the same as those established for chronic lowering of groundwater elevations. Achieving the groundwater elevation interim milestones will also eliminate long term reductions in groundwater in storage. Interim milestones are included on Table 8-1.

8.7. Seawater Intrusion Sustainability Indicator §354.28(c)(3)

This Sustainability Indicator does not apply to the Basin since the Basin is not a coastal basin.

8.8. Degradation of Groundwater Quality Sustainability Indicator §354.28(c)(4)

The purpose of the Degraded Water Quality Indicator in SGMA is to prevent any degradation in groundwater quality as a result of groundwater management under the GSP. SGMA is not intended to serve as impetus to improve water quality within the Basin. The Basin's current water quality is not considered degraded. For these reasons, the SMC in this section is set to maintain current conditions in the Basin, protecting from potential degradation as a result of groundwater management under this GSP.

8.8.1. Undesirable Results §354.26(a)(d)

Section 354.28(c)(2) of the SGMA 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."

By SGMA regulations, the Degraded Groundwater Quality undesirable result is a quantitative combination of groundwater quality minimum threshold exceedances. The undesirable results for the Degraded Water Quality Sustainability Indicator as defined for the purposes of this GSP are as follows:

> ***The Basin will be considered to have Undesirable Results if, for any 5-year GSP Update period, an increase in groundwater quality minimum threshold exceedances is observed at 20 percent or more of the RMSs in the Basin, as a result of groundwater management implemented as part of the GSP.***

The undesirable conditions for degraded water quality in the Basin are based on the goal of fewer than 20% of the RMSs for water quality exceedances that can occur as a result of GSP groundwater management activities over the next 5-year management period. Based on the current number of wells in the existing water quality monitoring network described in Chapter 7, the percentage defined equates to a maximum of two wells that can exceed the minimum thresholds.

Specifics regarding the definition of the MTs used in defining the Undesirable Results are detailed in the following sections. A summary of the MTs defined for the Degradation of Water Quality Sustainability Indicator are presented in Table 8-3.

Table 8-3. San Luis Obispo Valley Basin Groundwater Basin Water Quality Minimum Thresholds

ID	TDS MT (PPM)	NO3 MT (PPM)	ARSENIC MT (PPB)	TCE, PCE (PPB)
WQ-1	900	10	10	5
WQ-2	900	10	10	5
WQ-3	900	10	10	5
WQ-4	900	10	10	5
WQ-5	900	10	10	5
WQ-6	900	10	10	5
WQ-7	900	10	10	5
WQ-8	900	10	10	5
WQ-9	900	10	10	5

8.8.1.1. Criteria for Establishing Undesirable Results §354.26(b)(2)

Criteria used to establish the Undesirable Results for Degraded Water Quality Sustainability Indicator are observed water quality data and trends that:

- Reduce capacity of public water supply systems or unreasonably increase costs for public or private water supply.
- Reduce crop production.
- Result in constituent concentrations above regulatory primary drinking water standards at supply wells.
- Results in constituent concentrations above the RWQCB Basin Objectives for secondary standards (TDS).

8.8.1.2. Potential Causes for Undesirable Results §354.26(b)(1)

Conditions that may lead to an undesirable result include the following:

- **Changes to Basin Pumping:** If the location and rates of groundwater pumping change as a result of projects implemented under the GSP, these changes could cause movement of one of the constituents of concern towards a supply well at concentrations that exceed relevant water quality standards.
- **Groundwater Recharge:** Active recharge with imported water or captured runoff could cause movement of one of the constituents of concern towards a supply well in concentrations that exceed relevant water quality standards.
- **Recharge of Poor-Quality Water:** Recharging the Basin with water that exceeds a primary or secondary MCL or concentration that reduces crop production could lead to an undesirable result. However, permitting requirements generally preclude this circumstance.

8.8.1.3. Effects of Undesirable Results on Beneficial Users and Land Uses §354.26(b)(3)

As defined in this GSP, undesirable results are established to prevent degradation of water quality within the Basin prior to the implementation of any actions inherent in the management of groundwater in the Basin.

This limits the potential impacts of undesirable water quality on beneficial users in the Basin. However, potential effects of undesirable results include:

- Increased water treatment costs for public or private supply wells
- Reduced agricultural production

8.8.2. Minimum Thresholds §354.28(c)(4)

8.8.2.1. Effects of Undesirable Results on Beneficial Users and Land Uses §354.28(b)(1)

Locally defined significant and unreasonable conditions were assessed based on federal and state mandated drinking water and groundwater quality regulations, the Sustainable Management Criteria survey, public meetings, and discussions with GSA staff.

Significant and unreasonable changes in groundwater quality in the Basin are increases in a chemical constituent that either:

- Result in groundwater concentrations in a public supply well above an established primary or secondary MCL, or
- Lead to reduced crop production.

The information used for establishing the degraded groundwater quality minimum thresholds included:

- Historical groundwater quality data from production wells in the Basin
- Federal and state primary drinking water quality standards
- RWQCB Basin objectives for groundwater quality (2019) for TDS
- Feedback about significant and unreasonable conditions from GSC members, GSA staff members, and public stakeholders

The historical groundwater quality data used to evaluate groundwater quality minimum thresholds are presented in Chapter 5 (Groundwater Conditions) on Figure 5-19 through Figure 5-21.

As stated in Section 8.7.1, the SGMA regulations allow three options to develop an approach for setting degraded water quality minimum thresholds (number of wells, volume of water, or location of concentration isocontour). In the Basin, degraded water quality minimum thresholds are based on EPA-published water quality standards (EPA, 2018) for constituents of concern with a primary or secondary MCL to avoid degrading the existing water quality with respect to these constituents in the Basin. (Primary standards refer to chemical constituents in groundwater with a potential impact on human health; secondary standards refer to constituents that may affect taste or odor of drinking water.)

As noted in Section 354.28 (c)(4) of the SGMA regulations, minimum thresholds are based on a degradation of groundwater quality, not an improvement of groundwater quality. Therefore, this GSP was developed to avoid taking actions that may inadvertently move groundwater constituents that have already been identified in the Basin in such a way that they have a significant and unreasonable impact that would not otherwise occur.

Based on the review of groundwater quality in Chapter 5 (Groundwater Conditions), water quality in the basin is generally good. The primary constituents of concern that exist for both agricultural wells and public supply wells are:

- Total Dissolved Solids (TDS)
- Nitrate
- Arsenic
- Volatile Organic Compounds (PCE and TCE)

As noted in Section 5.6.3, based on available information there are two known groundwater contamination plumes in the Basin: The TCE plume along Buckley Road south of the airport, and a PCE plume within the City. Both of these cases are under active investigation with oversight by the RWQCB.

The MTs for the constituents of concern are presented in Table 8-3.

8.8.2.2. Relation of Minimum Thresholds to Other Sustainability Indicators §354.28(b)(2)

The groundwater quality minimum thresholds were set for each of four constituents previously discussed. These minimum thresholds were derived from existing data measured at individual wells and applicable regulatory criteria. There are no conflicts between the existing groundwater quality data. Because the underlying groundwater quality distribution is reasonable and realistic, there is no conflict that prevents the Basin from simultaneously achieving all minimum thresholds.

No actions regarding the MTs for Water Quality will directly influence other Sustainability Indicators. However, preventing migration of poor groundwater quality (for example, actions required to prevent additional migration of contaminant plumes) could theoretically limit activities needed to achieve minimum thresholds for other Sustainability Indicators, as discussed below:

- **Change in groundwater levels.** Groundwater quality minimum thresholds could influence groundwater level minimum thresholds by limiting the types of water that can be used for recharge to raise groundwater levels or locations where it could be recharged. Water used for recharge cannot exceed any of the groundwater quality minimum thresholds.
- **Change in groundwater storage.** Nothing in the groundwater quality minimum thresholds promotes pumping in excess of the sustainable yield. The groundwater quality minimum thresholds will not result in an exceedance of the groundwater storage minimum threshold.
- **Seawater intrusion.** This Sustainability Indicator is not applicable to this basin.
- **Subsidence.** Nothing in the groundwater quality minimum thresholds promotes a condition that will lead to additional subsidence and therefore, the groundwater quality minimum thresholds will not result in a significant or unreasonable level of subsidence.

- **Depletion of interconnected surface waters.** Nothing in the groundwater quality minimum thresholds promotes additional pumping or lower groundwater elevations in areas where interconnected surface waters may exist. Therefore, the groundwater quality minimum thresholds will not result in a significant or unreasonable depletion of interconnected surface waters.

8.8.2.3. Effects of Minimum Thresholds on Neighboring Basins §354.28(b)(3)

Because there is a groundwater divide between the SLO Basin and the adjacent Los Osos Basin and Arroyo Grande sub-basin, there is no anticipated effect of the degraded groundwater quality minimum thresholds on each of the two neighboring Basins.

8.8.2.4. Effects of Minimum Thresholds on Beneficial Users and Land Uses §354.28(b)(4)

The practical effect of the MTs for the Degraded Groundwater Quality Sustainability Indicator is that it deters any significant long-term changes to groundwater quality in the Basin. Therefore, Basin management that prevents the undesirable results from occurring will not constrain the use of groundwater, nor have a negative effect on the beneficial users and uses of groundwater.

Agricultural Land Uses and Users

The degraded groundwater quality minimum thresholds generally benefit the agricultural water users in the Basin by maintaining groundwater quality suitable for use in agriculture. For example, limiting the number of additional agricultural supply wells that may exceed constituent of concern concentrations (for example, TDS) that could reduce crop production ensures that a supply of usable groundwater will exist for beneficial agricultural use.

Urban Land Uses and Users

The degraded groundwater quality minimum thresholds generally benefit the urban water users in the Basin. Limiting the number of additional wells where constituents of concern could exceed primary or secondary MCLs ensures an adequate supply of quality groundwater for municipal use. Management of the Basin to prevent occurrences of these MTs may also result in lowered costs for water treatment. Existing State, Federal, Public Health or Municipal regulations may require that a well not be used if MCLs are exceeded and may supersede any actions related to SGMA-related MT exceedances. Wells in violation of federal, state, and local water quality regulations will have to comply with the specific regulations.

Domestic Land Uses and Users

The degraded groundwater quality minimum thresholds generally benefit the domestic water users in the Basin by maintaining current and acceptable water quality.

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 ecological water uses in the Basin. Preventing constituents of concern from migrating will prevent unwanted contaminants from impacting ecological groundwater supply.

8.8.2.5. Relevant Federal, State, or Local Standards §354.28(b)(5)

The Degraded Groundwater Quality minimum thresholds specifically incorporate federal and state drinking water standards.

8.8.2.6. Methods for Quantitative Measurement of Minimum Thresholds §354.28(b)(6)

The Degraded Groundwater Quality minimum thresholds will be directly measured using analytical laboratory results of sampling conducted at the RMSs of the Water Quality Monitoring Network presented in Chapter 7 (Monitoring Network). Groundwater quality will initially be measured using existing monitoring programs.

Exceedances of primary or secondary MCLs will be monitored by reviewing water quality reports submitted to the California Division of Drinking Water by municipalities and small water systems for the wells that are included in the Water Quality Monitoring Network.

8.8.3. Measurable Objectives §354.30(a)(g)

Groundwater quality should not be degraded due to actions taken under this GSP and, therefore, the measurable objectives are defined as zero exceedances as a result of groundwater management, in samples from the Water Quality Monitoring Network wells over the 20-year SGMA implementation horizon.

8.8.3.1. Information and Methods for Establishing Degradation of Water Quality Measurable Objectives §354.30(b)

Because protecting groundwater quality is important to the beneficial users and uses of the resource, the measurable objective for the Degradation of Water Quality Sustainability Indicator is defined as zero exceedances of the MTs over the 20-year SGMA implementation period. Any exceedance will be reviewed by the GSAs to determine its significance and potential responses.

8.8.3.2. Interim Milestones §354.30(a)(e)

Interim milestones show how the GSAs anticipate moving from current conditions to meeting the measurable objectives. For water quality, measurable objectives are set at the current number of water quality exceedances, which in this case is zero. Interim milestones are set for each five-year interval following GSP adoption. The interim milestones for degraded groundwater quality are defined as zero exceedances of the MT for each constituent of concern for 5, 10 and 15 years after GSP adoption.

8.9. Land Subsidence Sustainability Indicator §354.28(c)(5)

8.9.1. Undesirable Results §354.26(a)(d)

Locally defined significant and unreasonable conditions for the Land Subsidence Sustainability Indicator were assessed based on public meetings and discussions with GSA staff. Significant and unreasonable rates of land subsidence in the Basin are those that lead to a permanent subsidence of land surface elevations that impact infrastructure.

For clarity, this Sustainable Management Criterion references two related concepts:

- Land subsidence is a gradual settling of the land surface caused by, among other processes, compaction of subsurface materials due to lowering of groundwater elevations from groundwater pumping. Land subsidence from dewatering subsurface clay layers can be an inelastic process, and the potential decline in land surface could be permanent.
- Land surface fluctuation is the periodic or annual measurement of the ground surface elevation. Land surface may rise or fall in any one year. Declining land surface fluctuation may or may not indicate long-term permanent subsidence.

Subsidence was documented in the Los Osos Valley in the early 1990s. Currently, InSAR data provided by DWR shows that there has been a 0.01 to 0.02 foot gain in ground surface elevation along Los Osos Valley Road between June 2015 and October 2020. Therefore, there has been no recent significant land subsidence in the Basin.

By regulation, the ground surface Land Subsidence undesirable result is a quantitative combination of subsidence minimum threshold exceedances. For the Basin, no long-term subsidence that impacts infrastructure (including commercial buildings, homes, utility infrastructure, etc.) is acceptable. The Undesirable Results for the land subsidence Sustainability Indicator as defined for the purposes of this GSP are as follows:

> ***The Basin will be considered to have Undesirable Results if measured subsidence using InSAR data, between June of one year and June of the subsequent year is greater than 0.1 foot in any 1-year, or a cumulative 0.5 foot in any 5-year period, as a result of groundwater management under the GSP, or any long-term permanent subsidence is attributable to groundwater management.***

Should potential subsidence be observed, the GSAs will first assess whether the subsidence may be due to elastic processes. If the subsidence is not elastic, the GSAs will undertake a program to correlate the observed subsidence with measured groundwater levels, and ultimately implement changes to local groundwater management if the subsidence is judged to be the cause of the subsidence.

8.9.1.1. Criteria for Establishing Undesirable Results §354.26(b)(2)

Criteria used to establish the Undesirable Results for Land Subsidence Sustainability Indicator are satellite-measured subsidence data (InSAR data) collected by DWR.

8.9.1.2. Potential Causes of Undesirable Results §354.26(b)(1)

Conditions that may lead to an undesirable result include:

- A shift in pumping locations, which could lead to a substantial decline in groundwater levels.
- Shifting a significant amount of pumping and causing groundwater levels to fall in an area that is susceptible to subsidence, such as certain areas underlaying the City, could trigger subsidence in excess of the minimum threshold.

8.9.1.3. Effects of Undesirable Results on Beneficial Users and Land Uses §354.26(b)(3)

The effects of these undesirable results on the beneficial users and uses (§354.26 (b)(3)) include the damage of critical infrastructure, and the damage of private or commercial structures that would adversely affect their uses. Staying above the minimum threshold will avoid the subsidence undesirable conditions.

8.9.2. Minimum Thresholds §354.28(c)(5)

Section 354.28(c)(5) of the SGMA regulations states that “The minimum threshold for land subsidence shall be the rate and extent of subsidence that substantially interferes with surface land uses and may lead to undesirable results.”

Based on an analysis of potential errors in the InSAR data, as discussed in the following section, the subsidence minimum threshold is: The InSAR measured subsidence between June of one year and June of the subsequent year shall be no more than 0.1 foot in any single year and a cumulative 0.5 foot in any five-year period, resulting in no long-term permanent subsidence.

Although InSAR data is the official minimum threshold value for the land subsidence Sustainability Indicator, the GSAs have included one well to monitor for water levels as a proxy for potential subsidence. Regular data collection from this well could alert the GSAs to conditions that may lead to subsidence before InSAR data are available. RMS SLV-09 along Los Osos Valley Road is in the area of the basin that experienced significant subsidence in the early 1990s. Therefore, this well has been selected to monitor for conditions that could lead to subsidence. The minimum threshold for this well is set at 102 feet, 15 feet higher than the observed low water level in the early 1990s.

8.9.2.1. Information and Methods Used for Establishing Land Subsidence Minimum Thresholds §354.28(b)(1)

Minimum thresholds were established to protect groundwater supply, land uses and property interests from substantial subsidence that may lead to undesirable results. Changes in surface elevation are measured using InSAR data available from DWR. The general minimum threshold is the absence of long-term land subsidence due to pumping in the Basin.

The InSAR data provided by DWR, however, are subject to measurement error. DWR has stated that, on a statewide level, for the total vertical displacement measurements between June 2015 and June 2018, the errors are as follows (GSP, Paso Robles Basin, 2020):

1. The error between InSAR data and continuous GPS data is 16 mm (0.052 feet) with a 95% confidence level.
2. The measurement accuracy when converting from the raw InSAR data to the maps provided by DWR is 0.048 feet with 95% confidence level.

For the purposes of this GSP, the errors for InSAR data are considered the sum of errors 1 and 2, combined total error of 0.1 foot. Thus, measured land surface change of greater than 0.1 feet will be assessed as potential subsidence. As discussed previously, land surface elevations can fluctuate naturally. Therefore, subsidence will be monitored at the same time each year to reduce the effect of general fluctuations of elevation on observed data. Additionally, if subsidence is observed, a correlation to lowered groundwater elevations at RMS SLV-09 must exist for the minimum threshold to be exceeded.

Locally defined significant and unreasonable conditions are assessed based on historically observed water levels in areas of known past land subsidence, satellite-based measurements of land subsidence provided by DWR, public meetings, and discussions with GSA staff.

8.9.2.2. Relation of Minimum Thresholds to Other Sustainability Indicators §354.28(b)(2)

Land Subsidence minimum thresholds have little or no impact on other minimum thresholds, as described below:

- **Chronic lowering of groundwater elevations.** The Land Subsidence minimum thresholds will not result in significant or unreasonable groundwater elevations.
- **Change in groundwater storage.** The Land Subsidence minimum thresholds will not change the amount of pumping and will not result in a significant or unreasonable change in groundwater storage.
- **Seawater intrusion.** This Sustainability Indicator is not applicable in the Basin.
- **Degraded water quality.** The Land Subsidence minimum thresholds will not change the groundwater flow directions or rates, and therefore and will not result in a significant or unreasonable change in groundwater quality.
- **Depletion of interconnected surface waters.** The Land Subsidence minimum thresholds will not change the amount or location of pumping and will not result in a significant or unreasonable depletion of interconnected surface waters.

8.9.2.3. Effect of Minimum Thresholds on Neighboring Basins §354.28(b)(3)

The ground surface subsidence minimum thresholds are set to prevent any long-term subsidence that could harm infrastructure. Therefore, the subsidence minimum thresholds will not prevent the Los Osos Basin or the Arroyo Grande Basin from achieving sustainability.

8.9.2.4. Effect of Minimum Thresholds on Beneficial Users and Land Uses §354.28(b)(4)

The Land Subsidence minimum thresholds are set to prevent subsidence that could harm infrastructure. Available data indicate that there is currently no subsidence occurring in the Basin that affects infrastructure, and reductions in pumping are already required by the reduction in groundwater storage Sustainability Indicator. Therefore, the Land Subsidence minimum thresholds do not require any additional reductions in pumping. However, in general the amount of pumping in the Los Osos Valley Road area must be kept at levels significantly lower than implemented in the 1990s.

Staying above the minimum threshold will avoid the Land Subsidence undesirable result and protect the beneficial uses and users from impacts to infrastructure and interference with surface land uses.

8.9.2.5. Relevant Federal, State, or Local Standard §354.28(b)(5)

There are no federal, state, or local regulations related to subsidence.

8.9.2.6. Method for Quantitative Measurement of Minimum Thresholds §354.28(b)(6)

Minimum thresholds will be assessed using DWR-supplied InSAR data.

8.9.3. Measurable Objectives §354.30(a)(g)

The measurable objectives for subsidence represent target subsidence rates in the Basin. Long-term ground surface elevation data do not suggest the occurrence of permanent subsidence in the Basin. Therefore, the measurable objective for subsidence is maintenance of current ground surface elevations.

8.9.3.1. Information and Methods Used for Establishing Subsidence Measurable Objectives §354.30(b)

The measurable objectives are set based on maintaining current conditions and changes are measured by DWR-supplied InSAR data.

8.9.3.2. Interim Milestones §354.28(a)(e)

Interim milestones show how the GSAs anticipate moving from current conditions to meeting the measurable objectives. Interim milestones are set for each five-year interval following GSP adoption. Land Subsidence measurable objectives are set at current conditions of no long-term subsidence. There is no change between current conditions and sustainable conditions. Therefore, the interim milestones are identical to the minimum thresholds and measurable objectives.

8.10. Depletion of Interconnected Surface Water Sustainability Indicator §354.28(c)(6)

Natural hydraulic connections can exist between shallow groundwater systems and some surface water bodies. These surface water bodies can be gaining (receiving discharge from the alluvial aquifer) or losing (discharging water to the alluvial aquifer). These relationships may change in magnitude and direction across seasonal wet and dry cycles, longer term drought cycles, and in response to changes in surface water operations or groundwater management practices. The total volume or rate of streamflow in a creek is dependent upon many factors other than contributions from groundwater. Precipitation, temperature, evapotranspiration, and influent streamflow from the upper contributing watershed area each individually have a much greater influence on streamflow than groundwater pumping.

This GSP is designed as a groundwater management plan for the Basin. It is not within the scope or capability of this plan to mandate specific instream flow requirements deemed necessary for the recovery of native steelhead populations, such as minimum instream flows or minimum pool depths. Rather, it is the objective to plan for management of groundwater resources such that depletion of interconnected surface water is not significantly increased due to projects or management actions proposed in the plan.

Depletions of interconnected surface water occurs when there are decreased gains or increased losses in volumes of streamflow caused by lowered groundwater elevations associated with groundwater use. At certain levels, depletions may have adverse impacts on beneficial uses of the surface water and may lead to undesirable results.

Flux between a stream and the surrounding aquifer may be theoretically calculated using Darcy's Law:

Q = KIA, WHERE

Q = rate of the flux (ft^3/d)

K = Hydraulic conductivity of Aquifer (ft/day)

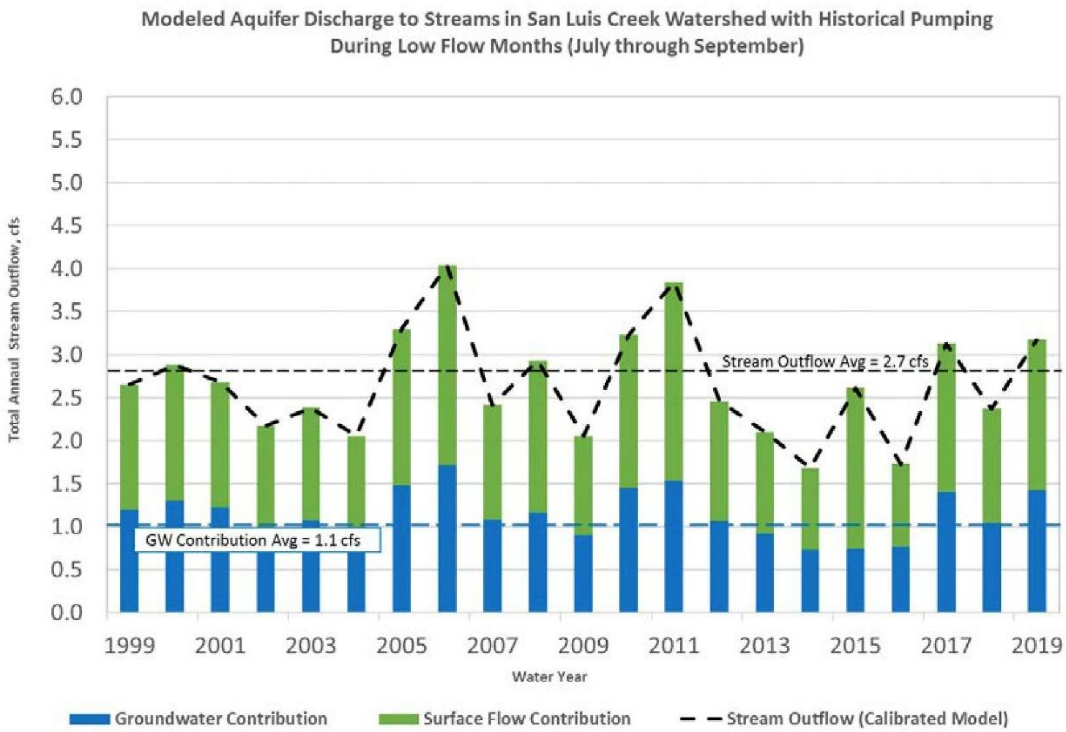
i = Hydraulic gradient between groundwater elevation and surface water elevations (ft/ft)

A = Cross Sectional Area of Groundwater Flow (ft^2)

Of the variables of Darcy's Law presented above, it is assumed that hydraulic conductivity and area of flow do not change with changing groundwater elevations; only the hydraulic gradient changes based on the groundwater elevation in the aquifer and the surface water elevation. A high groundwater elevation corresponds to a specific quantity of flux, while a lower groundwater elevation corresponds to a lesser flux quantity. So, although it is the quantity of flux that impacts GDEs, for the purposes of this GSP, this flux is defined and expressed in terms of the water level in the nearby alluvial sediments that results in the flux. If the groundwater elevation in the aquifer is greater than the elevation of the water surface in the stream, then the direction of flow is from the aquifer to the stream. If the water surface elevation of the stream is higher than the groundwater elevations, the direction of flow is from the stream to the surrounding aquifer. In order to accurately make this calculation, surveyed elevations of groundwater and surface water are necessary, as well as an estimate of hydraulic conductivity of the alluvial aquifer. If groundwater elevations in the vicinity of a stream are maintained such that the direction and magnitude of hydraulic gradient between the creek and the aquifer are not significantly changed, it follows that there will not be a significant or unreasonable depletion of Interconnected Surface Water flux between stream and aquifer. Therefore, groundwater levels in appropriate wells are judged to be a valid proxy for the quantification of depletion of interconnected surface water, and MTs defined in terms of groundwater elevations are a valid proxy for the corresponding amount of GW/SW flux.

Direct measurement of flux between an aquifer and an interconnected stream is not feasible using currently available data. A number of proposals to improve the collection of surface water and interconnected groundwater data are discussed in Chapter 7 (Monitoring Networks), and proposed details for these tasks are discussed in Chapter 10 (Implementation Plan). Among these recommendations is to accurately survey stream channel elevations and monitoring well measuring point elevations, so that the direction of flow may be characterized. In addition, monitoring wells used to assess the potential for depletion of surface water may be prioritized for installation of transducers for continuous monitoring of water levels to more accurately capture the temporal fluctuation of both stream water surface and groundwater elevations. Until such time as this data is available, this GSP uses water level measurements in representative wells located immediately adjacent to Basin creeks as the SMCs for the Depletion of Interconnected Surface Water Sustainability Indicator.

In an effort to demonstrate the relationship between streamflow and groundwater pumping (and associated water levels), the following modeling exercise is presented. The GSFLOW model is used to estimate streamflow depletion due to groundwater pumping in the San Luis Valley watershed over the past 20 years (all streams tributary to San Luis Creek are included in this exercise). The sensitivity of streamflow to pumping is evaluated as a comparison of two different model simulations. The first scenario is the historical calibration run, wherein Basin pumping was estimated as described in the water budget and applied to the historically calibrated model. This scenario was run, and model results were extracted for streamflow exiting the Basin during the months of July through September (critical low flow months important to steelhead habitat conditions), including both groundwater and surface water runoff contributions to streamflow. The results are presented in the top graph of Figure 8-11. Average streamflow during this time period was 2.7 cfs, with an average groundwater contribution to streamflow of 1.1 cfs. In the second scenario, all pumping in the Basin was eliminated, and the same model output was extracted. These results are presented in the bottom graph of Figure 8-11. Average streamflow increased to 4.1 cfs, with an average groundwater contribution of 1.6 cfs. So, these results indicate that streamflow depletion of 1.4 cfs, and a decrease of groundwater contribution to streamflow of 0.5 cfs, has occurred due to historical groundwater pumping in the Basin. It is important to acknowledge that this is a conceptual modeling exercise intended as a sensitivity analysis, and that streamflow in the Basin is not well documented or calibrated. As a result, there is a large amount of uncertainty in these results. Adding to the uncertainty is that the conditions of this scenario are outside the bounds of the conditions under which the model was calibrated (i.e., removing all pumping). As such, these results are intended to demonstrate an estimate of historical depletion, the results should not be used to inform any quantitative criteria at present, nor should any linear correlation between pumping volume and streamflow be inferred.



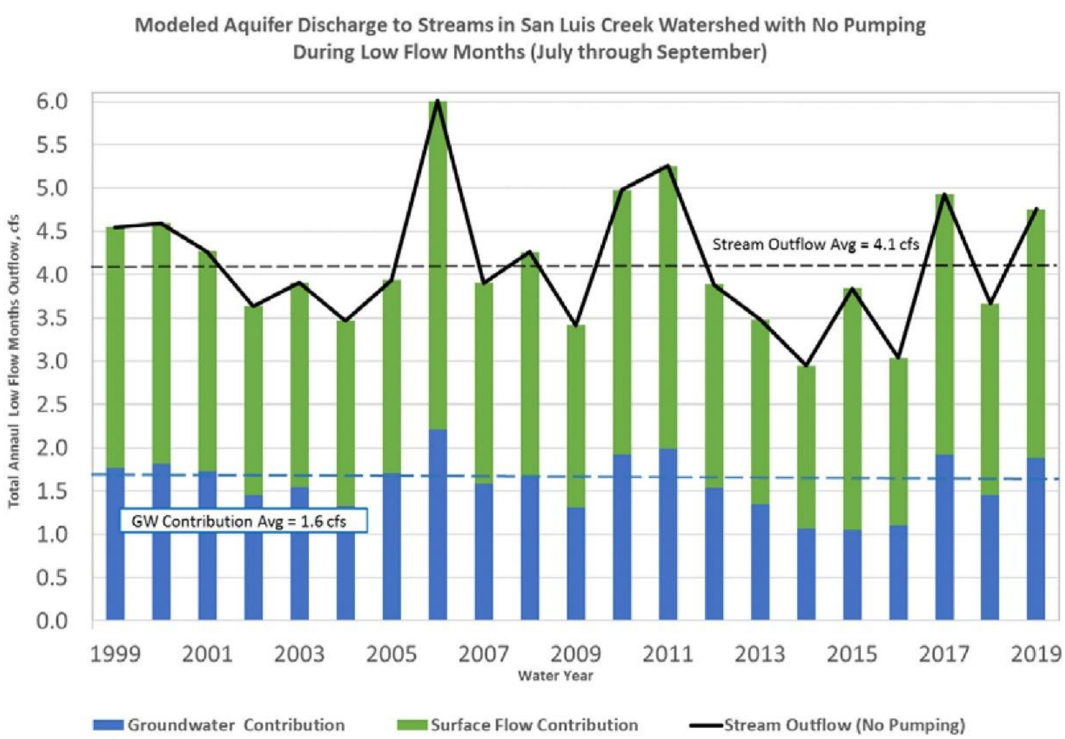


Figure 8-11. Comparison of Modeled Discharge to Streams in San Luis Creek Watershed During Low Flow Months (July through September) with Baseline and No Pumping Scenarios

8.10.1. Undesirable Results §354.26(a)(d)

The undesirable result for Depletions of Interconnected Surface Water is a significant and unreasonable depletion of interconnected surface water flows caused by groundwater management and pumping in the Basin. The metric for depletion of interconnected surface water is defined in SGMA as a volume or rate of surface water depletion. As discussed in Section 8.9, measurement of the fluxes between the aquifer and Basin creeks is not feasible with currently available data. SGMA regulations allow for the use of groundwater elevations as a proxy for the volume or rate of surface water depletion when defining MTs and MOs. To use groundwater elevation as a proxy, there must be significant correlation between groundwater elevation measurements and the sustainability indicator for which groundwater elevation measurements are to serve as a proxy. Significant correlation is difficult to prove due to the fact that streamflow due to groundwater pumping is so small compared to the other streamflow factors discussed above (rainfall, temperature, etc.). Theoretical correlation may be estimated using Darcy's Law as previously described; if groundwater elevations are prevented from excessive permanent declines near the streams, then the direction and magnitude of flux between the stream and the surrounding aquifer will not be substantially changed from the past 30-year period of record. Therefore, water level measurements at the RMSs designated for the Depletion of Interconnected Surface Water Sustainability Indicator will be used as the basis of MTs and Undesirable Results until better data becomes available under future monitoring activities. The statement defining undesirable results for the Depletion of Interconnected Surface Water for this GSP is as follows:

> ***The Basin will be considered to have undesirable results if any of the representative wells monitoring interconnected surface water display exceedances of the minimum threshold values for two consecutive Fall measurements.***

8.10.1.1. Criteria for Establishing Undesirable Results §354.26(b)(2)

Criteria used to define undesired conditions for this Sustainability Indicator are those that:

- Significantly or unreasonably reduce the groundwater levels in the vicinity of the creeks such that significant depletion of streamflow results.
- Impact the ability to provide surface water supplies to direct diverters
- Interfere with other SGMA Sustainability Indicators.

The information used for establishing the criteria for undesirable results for the Depletion of Interconnected Surface Water Sustainability Indicator is water levels data collected from three RMS wells (i.e., SLV-12 and EV-01, and EV-11) that are located immediately adjacent to San Luis Obispo and Corral de Piedras Creek systems. For the present, water levels in these wells will be used as a proxy indicator of undesirable results.

8.10.1.2. Potential Causes of Undesirable Results §354.26(b)(1)

Potential causes of undesirable results include increases in pumping in the proximity of a Basin creeks, or instream projects that could alter the natural flow regimes of the creeks.

8.10.1.3. Effects of Undesirable Results on Beneficial Users and Land Uses §354.26(b)(3)

If depletions of interconnected surface water were to reach undesirable results, adverse effects could include the reduced ability of the stream flows to meet instream flow requirements for local fisheries and critical habitat, or reduced ability to deliver surface water supplies to direct users of surface water in the Basin.

8.10.2. Minimum Thresholds §354.28(c)(6)

Section 354.28(c)(6) of the SGMA regulations states that "The minimum threshold for depletions of interconnected surface water shall be the rate or volume of surface water depletions caused by groundwater use that has adverse impacts on beneficial uses of the surface water and may lead to undesirable results."

Current data are insufficient to determine the rate or volume of surface water deletions in the creeks. Therefore, groundwater elevations in the RMSs intended to monitor surface water/groundwater interaction (SLV-12, EV-01, EV-11) are used as a proxy for the Depletion of Interconnected Surface Water Sustainability Indicator. Because there have been no historical groundwater level declines in the ISW RMS wells, the MTs are defined at these three RMSs as the lowest historically observed water level in the period of record. Minimum thresholds for these representative wells are presented in Table 8-1 and Figure 8-4, Figure 8-9, and Figure 8-10. If in the future, data from a more comprehensive monitoring program (as discussed in Chapter 7 (Monitoring Network) and Chapter 10 (Implementation Plan)) succeed in more robustly quantifying surface water depletions, those data may be used to re-define minimum thresholds for areas of interconnection.

RMS EV-01 is located along West Corral de Piedras Creek just where it enters the Basin, and EV-11 (Greengate) is located near the junction of East and West Corral de Piedras, near the outlet of the Basin. These wells are screened at least partially in the alluvial sediments associated with the creek, and therefore, reflect groundwater conditions in the alluvial sediments. Hydrographs for these wells display seasonal fluctuation of about 50 feet, which occur during wet and dry climatic periods. To avoid management conditions that allow for lower groundwater elevations than those historically observed, MTs for these wells were set at the historic low water levels indicated on the hydrographs, which occur with regularity during every extended dry period evident in the record (Figure 8-9, Figure 8-10).

San Luis Obispo Creek is a significant feature in the Basin. It is an unregulated (i.e., undammed) creek. Some reaches of San Luis Obispo Creek in the Basin have been observed to maintain flow year-round, and some reaches go dry in the summer. A more extensive description and quantification of the stream/aquifer interaction is included in Chapter 5 (Groundwater Conditions) and Chapter 6 (Water Budget). The water budget shows that flow conditions in the creek are highly variable depending on rainfall events and the hydrologic year type. In wetter years, when flows in the San Luis Obispo Creek are high there is greater amounts of discharge from the creek to the groundwater system. In drier years, when flows in the San Luis Obispo Creek are low, there is less stream recharge to the groundwater system. In both cases the amount of flux between the surface water and the groundwater system is small compared to the volume of water flowing down the creek. Inspection of hydrographs for RMS SLV-12, intended to monitor conditions along near San Luis Obispo Creek (Figure 8-4) do not indicate any significant declines of water levels since the drought of the early 1990s. Therefore, this data suggests that the mechanisms of surface water/groundwater interaction at this location have not been negatively impacted since the early 1990s.

East and West Corral de Piedras Creeks meet to form Pismo Creek just south of the basin boundary in Edna Valley. Corral de Piedras Creeks are significant features in the Edna Valley portion of the SLO Basin. West Corral de Piedras is affected by a private dam that impounds water at the Righetti Reservoir upstream from the basin. To the extent that captured flows impounded in Righetti Reservoir do not naturally flow downstream, the amount of stream flow is reduced and ancillary basin recharge via streamflow percolation is less than it would be under natural (I.e., undammed) conditions in the Edna Valley. East and West Corral de Piedras Creeks in the Basin are not observed to maintain flow year-round in most of the Basin. Inspection of hydrographs for RMS EV-01, intended to monitor conditions near West Corral de Piedras Creeks where it enters the Basin (Figure 8-9, Figure 8-10) indicate highly seasonal groundwater conditions which fluctuate between well-established high points near ground surface and low points significantly deeper than the assumed creek bed elevation, and do not reflect any significant long-term declines of water levels in the observed period of record dating back to the late 1950s. This hydrograph pattern indicates that surface water in Corral de Piedras

Creeks recharges the underlying aquifer when the creek is flowing and is disconnected from the underlying aquifer system when the creek is dry.

As described in Chapter 4 (Basin Setting) and Chapter 5 (Groundwater Conditions), there are insufficient data to quantitatively assess the extent of the connection between surface water and groundwater in the Basin. As described in Chapter 7 (Monitoring Networks), a more expansive monitoring network will be developed during GSP implementation to improve understanding of interconnection between surface water and groundwater in the Basin. Chapter 10 (Implementation Plan) addresses details of the plan to accumulate better data for this Sustainability Indicator. If in the future, better data are generated to quantify the connection between surface water and groundwater, undesirable results may be revised to reflect this data. For example, if pressure transducers are installed to generate continuous monitoring data, the definition of undesirable results, which is currently predicated on the assumption of only two water level measurements per year, will no longer be applicable, and may need to be revised. However, for this GSP, groundwater elevations in SLV-12, EV-01, and EV-11 will be used as a proxy for the Depletion of Interconnected Surface Water Sustainability Indicator.

8.10.2.1. Information and Methods Used for Establishing Depletion of Interconnected Surface Water Minimum Thresholds

As with the other Sustainability Indicators, the primary methods for development of SMCs for this Sustainability Indicator is monitoring of groundwater elevations in the three RMSs established for the purpose of monitoring hydrogeologic conditions in the adjacent creeks.

As with the chronic reduction of groundwater levels Sustainability Indicator, the primary source of data that was evaluated for the Depletion of Interconnected Surface Water Sustainability Indicator is historical groundwater elevation data maintained by the GSAs.

The information used for establishing the MOs and MTs for the chronic lowering of groundwater levels Sustainability Indicator included:

- Historical groundwater elevation data from wells monitored by the SLOCFCWCD.
- Construction details of RMS wells
- Long-term trends displayed in hydrographs of the RMS wells identified for this Sustainability Indicator.

The use of groundwater elevation as a proxy metric for the Depletion of Interconnected Surface Water Sustainability Indicator is adopted given the challenges and cost of direct monitoring of depletions of interconnected surface water. The depletion of interconnected surface water is driven by the gradient between water surface elevation in the surface water body and groundwater elevations in the connected, shallow groundwater system. By defining minimum thresholds in terms of groundwater elevations in shallow groundwater wells near surface water, the GSAs will monitor and manage this gradient, and in turn, manage potential changes in depletions of interconnected surface.

8.10.2.2. Relationship between Individual Minimum Thresholds and Other Sustainability Indicators

The MTs for the Depletion of Interconnected Surface Water Sustainability Indicator are defined as the lowest water levels observed in the period of record for each of the three RMSs. Therefore, the concept of potential conflict between MTs at different locations in the Basin is not applicable. The Depletion of Interconnected Surface Water Sustainability Indicator could influence other Sustainability Indicators.

The Depletion of Interconnected Surface Water Sustainability Indicator MTs was selected to avoid undesirable results for other Sustainability Indicators, as outlined below:

- **Chronic lowering of groundwater levels.** Because groundwater elevations will be used as a proxy for estimating Depletion of Interconnected Surface Water Sustainability Indicator, and the definitions of the MTs are set at historically observed conditions, the MTs will not cause undesirable results for this Sustainability Indicator.

- **Depletion of Groundwater Storage.** Because groundwater elevations will be used as a proxy for estimating Depletion of Interconnected Surface Water Sustainability Indicator, and the definitions of the MTs are set at historically observed conditions, the MTs will not cause undesirable results for this Sustainability Indicator.
- **Seawater intrusion.** This Sustainability Indicator is not applicable to this Basin.
- **Degraded water quality.** The minimum threshold proxy of stable groundwater levels is not expected to lead to a degradation of groundwater quality.
- **Subsidence.** Because future groundwater levels will be above historically observed conditions, they will not induce any additional subsidence.

8.10.2.3. Effects of Minimum Thresholds on Neighboring Basins

Two neighboring groundwater basins share a boundary with the SLO Basin; the Los Osos Basin to the northwest, and the Arroyo Grande Subbasin of the Santa Maria Valley Groundwater Basin to the southeast. Neither of these shared boundaries are extensive, and the HCM posits that a groundwater divide separates the groundwater between them and the SLO Basin. In addition, the Basin streams are relatively far from the Basin boundaries shared with the neighboring basins. In the San Luis Valley, there have been no trends indicating groundwater declines that would affect the Los Osos Basin. In Edna Valley the areas with observed declines are one to two miles from the Arroyo Grande Basin boundary in a downgradient direction. It is not anticipated that actions associated with the GSP will have any significant impact on either the Los Osos Basin or the Arroyo Grande Subbasin.

The SLO Basin GSAs have developed a cooperative working relationship with the Los Osos Groundwater Basin – Basin Management Committee and the GSAs working in the Arroyo Grande Subbasin. Groundwater conditions near the borders with these basins will be monitored and shared.

8.10.2.4. Effects of Minimum Thresholds on Beneficial Uses and Users

The MT for Depletion of Interconnected Surface Water is defined to maintain historically observed groundwater elevations.

The practical effect of this GSP for protecting against the Depletion of Interconnected Surface Water MTs is that it encourages minimal long-term net change in groundwater elevations in the vicinity of the Basin streams. Seasonal and drought cycle variations are expected, but during average conditions and over the long-term, beneficial users will have access to adequate volumes of water from the aquifer to service the needs of all water use sectors. The beneficial users of groundwater are protected from undesirable results.

Agricultural Land Uses and Users

The water levels set as MTs are within the historical range of data, implying that surface water/groundwater interaction will be within historical norms. Therefore, existing agricultural operations are not expected to be affected by the Depletion of Interconnected Surface Water MTs.

Urban Land Uses and Users

Development of real estate along streams and creeks is generally constrained by prohibiting development in mapped floodplains in the Basin. Therefore, the Depletion of Interconnected Surface Water MTs are not anticipated to affect urban land users in the Basin.

Domestic Land Uses and Users

Development of real estate along streams and creeks is generally constrained by prohibiting development in mapped floodplains in the Basin. Therefore, the Depletion of Interconnected Surface Water MTs are not anticipated to affect urban land users in the Basin.

Ecological Land Uses and Users

Groundwater dependent ecosystems would generally benefit from this MT. Maintaining groundwater levels close to within historically observed ranges will continue to support groundwater dependent ecosystems. More detailed mapping of GDEs, installation of gages in Edna Valley, and development of discharge rating curves for the San Luis Creek gages, all will clarify the effects of these MTs on ecological uses.

8.10.2.5. Relation to State, Federal, and Local Standards

Agreements with NOAA mandate a minimum delivery for environmental flows of 1.6 MGD of effluent flow from the City Wastewater Treatment Plant located along San Luis Obispo Creek near the outlet of the Basin in San Luis Valley.

SWRCB permit requirements with respect to outflow from Righetti Reservoir may impact flow conditions along West Corral de Piedras Creek.

8.10.2.6. Methods for Quantitative Measurement of Minimum Threshold

The quantitative metric for assessing compliance with the Depletion of Interconnected Surface Water MTs is monitoring groundwater elevations at the three RMSs designated for this Sustainability Indicator (SLV-12, EV-01, EV-11). The approach for quantitatively evaluating compliance with the MT for reduction in groundwater storage will be based on evaluating groundwater elevations semi-annually. All groundwater elevations collected from the groundwater level monitoring network will be analyzed and averaged.

8.10.3. Measurable Objectives

Similar to minimum thresholds, measurable objectives were defined using water level data based on the historical water level data observed in RMSs intended to monitor streamflow conditions. Measurable objectives for these wells are presented in Table 8-1and Figure 8-4, Figure 8-9, and Figure 8-10. If future data from a more comprehensive surface water monitoring program documents quantitative estimates of stream flow depletion, those data may be used to re-define the measurable objectives for areas of interconnection.

8.10.3.1. Method for Quantitative Measurement of Measurable Objectives

The measurable objectives are set based on maintaining current conditions of seasonal high water level elevations observed in the RMS wells during rainy periods. The quantitative method for assessing compliance with the MOs is monitoring of groundwater elevations at the selected RMSs.

8.10.3.2. Interim Milestones

Interim milestones show how the GSAs anticipate moving from current conditions to meeting the measurable objectives. Interim milestones are set for each five-year interval following GSP adoption. MOs for the Depletion of Interconnected Surface Water are set at historically observed conditions of high groundwater elevations during wet climatic periods. Therefore, the interim milestones are defined to be identical to the water levels associated with the MOs.

8.11. Management Areas

Management areas are not established in the Basin. The GSAs and GSC members did not find it necessary to sub-divide the Basin into smaller management areas with specific administrative requirements.

9

GROUNDWATER SUSTAINABILITY PLAN

Projects and Management Actions (§354.44)

This chapter describes the Projects, Management Actions, and Adaptive Management information that satisfies Sections 354.42 and 354.44 of the SGMA regulations.

These projects, actions, and their benefits are intended to help achieve the sustainable management goals in the Basin.

IN THIS CHAPTER

- Projects Overview
- Integrated Model Scenarios
- Management Actions
- Adaptive Management

9.1. Introduction

Under the Regulations, § 354.44, the Groundwater Sustainability Plan (GSP, Plan) is to include the following:

- Each Plan shall include a description of the projects and management actions the Agency has determined will achieve the sustainability goal for the basin, including projects and management actions to respond to changing conditions in the basin.
- Each Plan shall include a description of the projects and management actions that include the following:
  - A list of projects and management actions proposed in the Plan with a description of the measurable objective that is expected to benefit from the project or management action. The list shall include projects and management actions that may be utilized to meet interim milestones, the exceedance of minimum thresholds, or where undesirable results have occurred or are imminent. The Plan shall include the following:
    - A description of the circumstances under which projects or management actions shall be implemented, the criteria that would trigger implementation and termination of projects or management actions, and the process by which the Agency shall determine that conditions requiring the implementation of particular projects or management actions have occurred.
    - The process by which the Agency shall provide notice to the public and other agencies that the implementation of projects or management actions is being considered or has been implemented, including a description of the actions to be taken.
  - If overdraft conditions are identified through the analysis required by Section 354.18, the Plan shall describe projects or management actions, including a quantification of demand reduction or other methods, for the mitigation of overdraft.
  - A summary of the permitting and regulatory process required for each project and management action.
  - The status of each project and management action, including a timetable for expected initiation and completion, and the accrual of expected benefits.
  - An explanation of the benefits that are expected to be realized from the project or management action, and how those benefits will be evaluated.
  - An explanation of how the project or management action will be accomplished. If the projects or management actions rely on water from outside the jurisdiction of the Agency, an explanation of the source and reliability of that water shall be included.
  - A description of the legal authority required for each project and management action, and the basis for that authority within the Agency.
  - A description of the estimated cost for each project and management action and a description of how the Agency plans to meet those costs.
  - A description of the management of groundwater extractions and recharge to ensure that chronic lowering of groundwater levels or depletion of supply during periods of drought is offset by increases in groundwater levels or storage during other periods.
- Projects and management actions shall be supported by best available information and best available science.
- An Agency shall take into account the level of uncertainty associated with the basin setting when developing projects or management actions.

9.2. Overview of Potential Projects and Management Actions

9.2.1. Project and Management Actions Development

The projects and management actions concepts were developed over a series of working sessions with GSA staff, meetings with GSC members and in six public GSC meetings between December 9, 2020 and June 21, 2021. The projects and management actions are focused on the Edna Valley (Figure 9-1) where the overdraft was documented in Chapter 6 (Water Budget). The effectiveness of the projects and management actions will be assessed by the ability to mitigate undesirable results such as groundwater level declines in the Edna Valley Representative Monitoring Sites (RMS) described in Chapter 8 (Sustainable Management Criteria).

9.2.1.1. Screening and Ranking of Projects

An initial screening of the projects was performed using the evaluation criteria shown in Table 9-1. The Evaluation Criteria developed collaboratively with the GSC members were applied to the list of projects deliberated by the GSA Staff, GSC members, and the public. The scoring of each project was weighted to better represent the ease/likelihood of implementation and the impacts of the project on the sustainability goals described in Chapter 8 (Sustainable Management Criteria).

Two projects that were included in the initial project screening process were not selected for inclusion in the GSP for further evaluation. The projects that were not included were a project that considered the City San Luis Obispo delivering potable water to Golden State Water Company and a project for stormwater capture and recharge of East Corral de Piedra. The City of San Luis Obispo Potable Water to Golden State Water Company Project was removed after receiving comments from the City GSA during the public comment period for Chapters 9 and 10. The City GSA provided feedback at a public study session on July 20, 2021, designating that they were not supportive of this projecting being included within the GSP due to its infeasibility as it is in direct conflict with existing City General Plan policy that prohibits the delivery of potable water outside of City limits, as well as City Municipal Code that prohibits the sale of potable water outside of City limits. Due to this input from the City GSA, and acknowledgement that this project was infeasible from a policy basis, this project was removed from the GSP. The East Corral de Piedra Stormwater Capture and Recharge project was not selected for further evaluation due to the high unit cost ($6,000/AF) due to a small contributing watershed to East Coral de Piedras Creek, lack of ability to capture a significant amount of stormwater, and sensitivity to Steelhead passage. These technical limitations resulted in the project being removed from the GSP and deemed infeasible and impractical. The results of the screening and ranking of the final GSP projects are displayed in Table 9-2.

9.2.1.2. Summary of Projects

Table 9-3 provides a summary of the projects and management actions considered in this GSP. The table shows the status, timing for implementation (years), capital costs ($), annual Operations and Maintenance (O&M) ($/Year), quantity of water delivered (AFY), and the unit cost ($/AFY) for each project and management action. The projects discussed in this GSP are centered around supplemental water sources that could be brought into the SLO Basin to mitigate the overdraft. The projects considered supplemental water from three sources all of which have existing conveyance infrastructure within or in close proximity to the Basin; State Water Project, City of SLO recycled water, and Price Canyon discharge. The projects and management actions presented in this GSP are not an exhaustive list and during the implementation of the GSP additional projects or management actions may be developed and will be described in the annual and five-year evaluation reports.

The project costs included in this GSP were prepared in conformance with industry practice and, as planning level cost opinions, and ranked as a Class 4 Conceptual Opinion of Probable Construction Cost as developed by the Association for the Advancement of Cost Engineering (AACE) (Association for the Advancement of Cost Engineering, 2011). The AACE classification system is intended to classify the expected accuracy of planning level cost opinions and is not a reflection on the effort or accuracy of the actual cost opinions prepared for the GSP. According to AACE, a Class 4 Estimate is intended to provide a planning level conceptual effort with an accuracy that will range from -30% to +50% and includes an appropriate contingency for planning and feasibility studies. The conceptual nature of the projects and associated costs presented in this Chapter are based upon limited design information available at this current stage of the projects.

At this planning-level stage, two percentages were applied to the estimated construction costs, 30% for construction contingency and 25% for implementation costs (which incorporates anticipated Design, Construction Management, and Environmental and Construction Engineering costs). In order to estimate annual payments, a loan period of 30 years at a 5% interest rate was assumed. The $/AFY values were calculated using the total annual cost, which include capital repayment and operations and maintenance costs, divided by the estimated yield from each project, see Section 9.4 for further detail. It is important to note that the cost estimates shown in Table 9-3 do not include the cost of the water as the costs to purchase the water are subject to negotiation between the supplier and the purchasing party.

The projects were further evaluated with the integrated model to quantify the benefit of the projects respect to the SMCs in the Edna Valley. Model results are described in more detail in Section 9.4.

Table 9-1. Initial Project Screening Evaluation Criteria

CRITERIA	SCORING
Quantity of Water	1- <250 AFY 2- 250-500 AFY 3- 500-750 AFY 4- 750-1000 AFY 5- > 1,000 AFY
Capital Cost	1->$5M 3- $2.5 M -$ 5 M 5- $0 – 2.5M
Water Cost	1- >$4,000/AFY 2- $3,000 - $4,000/AFY 3- $2,000 - $3,000/AFY 4- $1,000 - $2,000/AFY 5- < $1,000/AFY
O&M Cost	1- >$2,000/AFY 2- $1,000 - $2,000/AFY 3- $500 - $1,000/AFY 4- $100 - $500/AFY 5- < $100/AFY
GW Water Quality Impact	1- Higher TDS to ambient groundwater 3- Equivalent TDS than ambient groundwater 5- Lower TDS than ambient groundwater
Reliability/Resiliency	1- Highly variable 3- Moderately reliable 5- Highly reliable
Timeline to Implement	1- > 10 years 2- 7 years 3- 5 years 4- 3 years 5- < 1 year
Feasibility/Complexity	1- Significant regulatory, environmental, political, or social challenges 3- Potential significant regulatory, environmental, political, or social challenges 5- Limited regulatory, environmental, political, or social challenges
Environmental Impacts	1- Detrimental Environmental impacts 3- Neutral Environmental impacts 5- Beneficial Environmental impacts
Socioeconomic Impacts	1- Detrimental Socioeconomic impacts 3- Neutral Socioeconomic impacts 5- Beneficial Socioeconomic impacts
Eligible for Grant Funding	1- Limited grant funding opportunities 3- Moderate grant funding opportunities 5- Significant grant funding opportunities
Groundwater Level Benefit	1- Minimal Effect on Groundwater Levels 3- Average Effect on Groundwater Levels 5- Highest Effect on Groundwater Levels

Table 9-2. Project Evaluation Scoring Results

PROJECTS	DESCRIPTION	QUANTITY OF WATER (AFY)	QUANTITY OF WATER	CAPITAL COST	WATER COST	O&M COST	GW WATER QUALITY BENEFITS	RELIABILITY/RESILIENCY	TIMELINE TO IMPLEMENT	FEASIBILITY/COMPLEXITY	ENVIRONMENTAL IMPACTS	SOCIOECONOMIC IMPACTS	ELIGIBILITY FOR GRANT FUNDS	GROUNDWATER LEVEL BENEFIT	TOTAL SCORE
		WEIGHTING FACTOR	3	2	2	2	1	1	1	2	1	1	1	4	
SWP to Ag Irrigation	Connection to SWP to offset Ag groundwater pumping through direct delivery of SWP Water	1000	5	2	3	4	5	3	3	3	3	4	4	3	73
SWP Recharge	Connection to SWP to provide water for groundwater recharge basin	500	3	2	3	4	5	3	3	3	3	4	4	4	71
City of SLO Recycled Water to Ag Irrigation	Connection to City of SLO Recycled Water System to offset Ag groundwater pumping through direct delivery	500-800	3	3	1	4	4	5	4	4	3	4	4	3	69
Price Canyon Discharge Relocation	Relocation of Sentinel Peak Produced Water Discharge location to upper Corral de Piedra Creek or direct delivery to agriculture	500	2	2	5	4	5	5	4	2	4	3	4	3	69
Varian Ranch MWC AG Subbasin Wells	Connection to Varian Ranch MWC wells in Arroyo Grande Subbasin to offset Varian Ranch groundwater pumping through direct delivery of imported groundwater	50	1	3	5	4	3	4	4	3	3	4	4	3	67
SWP to GSWC	Connection to SWP project to offset GSWC groundwater pumping through direct delivery of SWP Water	50	1	2	3	4	5	3	4	3	3	4	4	4	66
SWP to Mutual Water Companies	Connection to SWP to offset Edna and Varian Ranch MWC groundwater pumping through direct delivery of SWP Water	50	1	4	3	4	5	3	3	3	3	4	4	3	65

Table 9-3. Projects and Management Actions Strategies

PROJECTS AND MANAGEMENT ACTIONS	STATUS	IMPLEMENTATION TIMING	CAPITAL COST	ANNUAL CAPITAL PAYMENT	ANNUAL O&M	TOTAL ANNUAL PAYMENT	QUANTITY OF WATER (AF)	UNIT COST ($/AF)[1]
SWP to Ag Irrigation	Not begun yet	Feasibility study: 0 to 1 years Design/Construction: 1 to 5 years	$ 890,000	$ 58,000	$ 5,000	$ 63,000	1,000	$ 60
City of SLO Recycled Water to Ag Irrigation	Conceptually evaluated as part of the City of SLO Recycled Water Study (2017)	Feasibility study: 0 to 1 years Design/Construction: 1 to 3 years	$ 1,004,000	$ 65,000	$ 88,000	$153,000	600	$ 260
SWP Recharge	Not begun yet	Feasibility study: 0 to 1 years Design/Construction: 1 to 5 years	$ 3,624,000	$ 236,000	$ 101,000	$ 337,000	500	$ 670
SWP to GSWC	Not begun yet	Feasibility study: 0 to 1 years Design/Construction: 1 to 5 years	$ 2,685,000	$ 175,000	$ 17,000	$ 192,000	200	$ 960
Varian Ranch MWC AG Subbasin Wells	Not begun yet	Feasibility study: 0 to 1 years Design/Construction: 1 to 3 years	$ 2,701,000	$ 176,000	$ 34,000	$ 210,000	50	$ 4,200
SWP to Mutual Water Companies	Not begun yet	Feasibility study: 0 to 1 years Design/Construction: 1 to 5 years	$ 835,000	$ 54,000	$ 5,000	$ 59,000	50	$ 1,180
Price Canyon Discharge Relocation	Mitigated Negative Dec Completed in 2015	Feasibility study: 0 to 1 years Design/Construction: 1 to 3 years	$ 4,909,000	$ 319,000	$ 56,000	$ 375,000	500[2]	$ 750
Groundwater Extraction Metering Plan	Not begun yet	1 year						
Demand Management Strategies	Not begun yet	As needed						

1. Does not include the cost of the water.
2. Quantity of water at the discharge point.

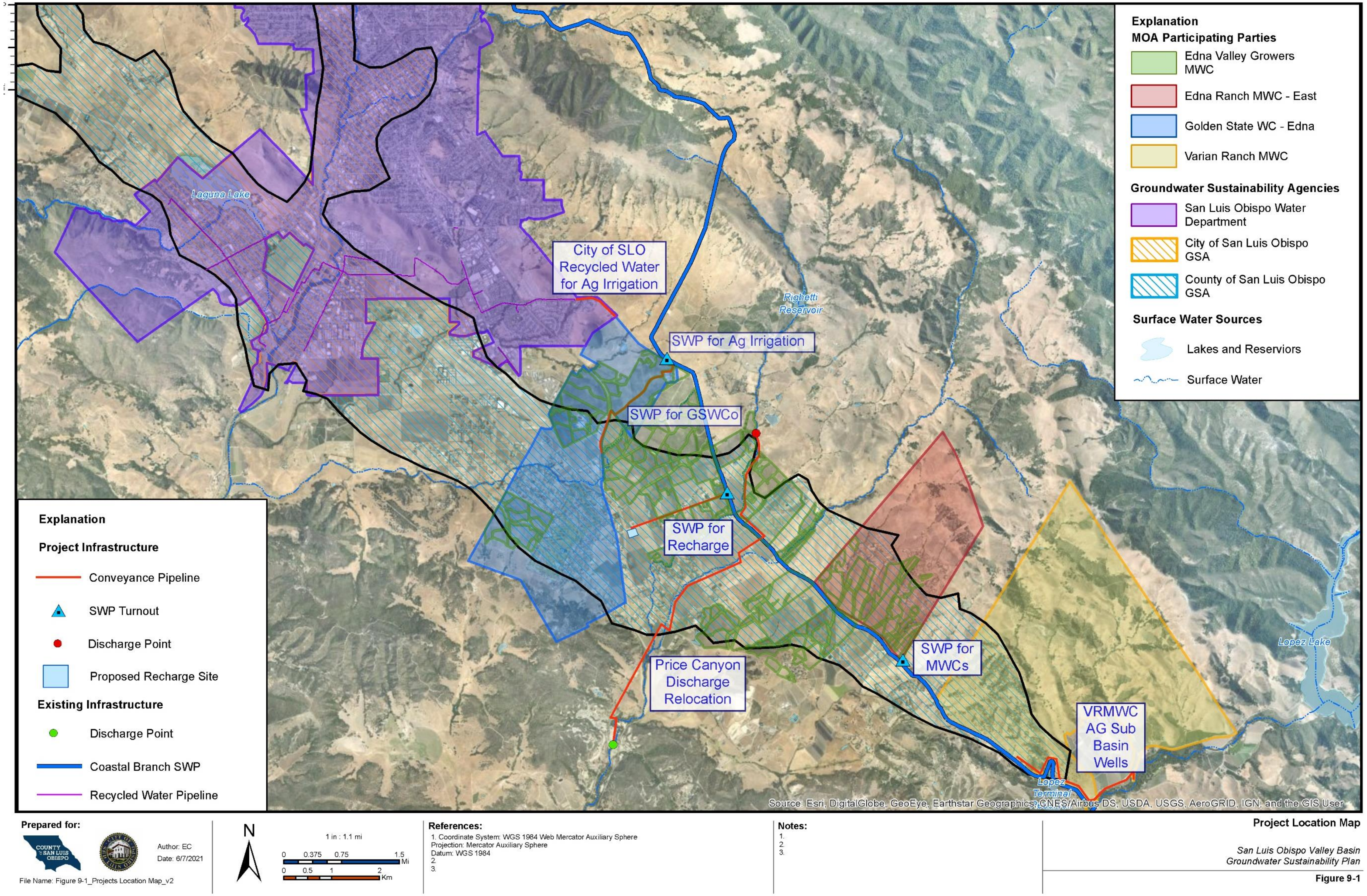


Figure 9-1. Project Location Map

9.2.2. Addressing Sustainability Indicators (§ 354.44 (1))

Table 9-4 shows the project and management action benefits and impacts on specific sustainability indicators and associated measurable objectives and minimum thresholds.

Table 9-4 Summary of Project and Management Action Benefits and Impacts on Sustainability Indicators.

Projects and Management Actions	Benefits	Measurable Objective	Exceedance of Minimum Thresholds
SWP to Ag Irrigation	Increases water levels in the Edna Valley to avoid minimum thresholds	Chronic Lowering of Groundwater Levels; Reduction of Groundwater Storage; Degradation of Groundwater Quality	Yes
City of SLO Recycled Water to Ag Irrigation	Increases water levels in the Edna Valley to avoid minimum thresholds Supplemental Water to Edna Valley	Chronic Lowering of Groundwater Levels; Reduction of Groundwater Storage	Yes
SWP Recharge	Increases water levels in the Edna Valley to avoid minimum thresholds	Chronic Lowering of Groundwater Levels; Reduction of Groundwater Storage; Degradation of Groundwater Quality	Yes
SWP to GSWC	Reduces localized groundwater production Supplemental Water to the Edna Valley	Chronic Lowering of Groundwater Levels; Reduction of Groundwater Storage; Degradation of Groundwater Quality	Yes
Varian Ranch MWC AG Subbasin Wells	Reduces localized groundwater production Supplemental Water to the Edna Valley	Chronic Lowering of Groundwater Levels; Reduction of Groundwater Storage	Yes
SWP to Mutual Water Companies	Reduces localized groundwater production Supplemental Water to the Edna Valley	Chronic Lowering of Groundwater Levels; Reduction of Groundwater Storage; Degradation of Groundwater Quality	Yes
Price Canyon Discharge Relocation	Increases recharge to the Edna Valley Increases streamflow in West Corral de Piedras for Steelhead	Depletion of Interconnected Surface Water; Chronic Lowering of Groundwater Levels; Reduction of Groundwater Storage	Yes
Groundwater Extraction Metering Plan	Improve understanding of the Basin Ability to manage the Basin		No
Voluntary Fallowing of Agricultural Land	Reduces groundwater production in the Edna Valley	Chronic Lowering of Groundwater Levels; Reduction of Groundwater Storage	Yes
Improved Irrigation Efficiency	Reduces groundwater production in the Edna Valley		Limited

Notes:

Chronic Lowering of Groundwater Levels

Reduction of Groundwater Storage

Depletion of Interconnected Surface Water

Degradation of Groundwater Quality

9.2.3. Overdraft Mitigation (§ 354.44 (2))

The proposed projects and management actions are intended to maintain groundwater levels above minimum thresholds through in-lieu pumping reductions or increased recharge. Overdraft is caused when pumping exceeds recharge and inflows in the Basin over a long period of time. Improving the management of groundwater in the Basin will help to mitigate overdraft.

9.3. Integrated Surface Water and Groundwater Modeling

As part of the development of this GSP, the GSAs incorporated the development of an integrated groundwater-surface water model of the Basin. A brief overview of the development and application of the model is presented herein. This discussion is not intended to be complete; more detailed documentation of the model is included in Appendix G, Surface Water/Groundwater Modeling Documentation.

The integrated model was developed using GSFLOW, a modeling code developed and maintained by the United States Geological Survey (USGS). GSFLOW incorporates two existing USGS modeling codes under a single structure. The first is the Precipitation Runoff Modeling System (PRMS), which models rainfall, plant uptake, evapotranspiration, and runoff to streams, using a water budget approach applied to a gridded domain of the model area. The second is MODFLOW, which simulates groundwater flow and surface water/groundwater interaction in the aquifers of the model area. GSFLOW operates by first running PRMS, using climatological input and daily time steps to calculate the movement of rainfall that falls onto the Basin area through plant canopy, root zone, runoff to streams, and deep percolation to the groundwater environment. GSFLOW then transmits necessary data to MODFLOW (e.g., streamflow, deep percolation, etc.) at times and locations significant to the simulation of groundwater flow for the completion of the GSFLOW run.

The areal model grid was established utilizing 500-foot square model grid cells that cover the entire contributing watershed of the Basin. The vertical grid was discretized into three layers to correspond to the three water bearing formations in the Basin (Alluvium, Paso Robles Formation, and Pismo Formation). The bedrock in the contributing watershed area was also discretized into three layers so that lateral hydraulic communication could be simulated between the bedrock and all three formations in the Basin.

A historical calibration period from water years 1987 through 2019 was selected to correspond to the period of the historical water budget analysis documented in Chapter 6 (Water Budget). The pumping estimates developed in the water budget analysis were used in the model calibration runs. Surface water flow data is unavailable for creeks in either the San Luis Valley or Edna Valley, but flow estimates were made for San Luis Obispo Creek based on flow stage or height data from the City's gages. The PRMS model was calibrated to achieve acceptable results for peak flow and flow volume on San Luis Obispo Creek. The MODFLOW model was calibrated to achieve acceptable results for groundwater elevations at wells in the Basin. The model calibration was found to meet industry criteria of a relative error of less than 10% (relative error is the mean error divided by the range of observed groundwater elevations). Therefore, the model was judged to be appropriate to perform predictive simulations to assess the impacts of proposed projects and management actions on water levels at RMS in the Basin.

The model was applied to evaluate the GSP projects and management actions using the following methodology. To maintain continuity of results between the historical calibration period (water years 1987 – 2019) and the predictive period (water years 2020-2044), each simulation was run continuously from the historical calibration period through the end of the predictive simulation period, from water years 1987 through 2044. The monthly 2019 pumping time series that was developed in the water budget analysis and used in the MODFLOW historical calibration was repeated for each year in the predictive simulation period. The climatological time series data from 1995-2019 used as input for PRMS historical calibration was repeated for the predictive simulation period. Thus, the pumping conditions reflect the most recent year for which data is available, and climatological conditions for the predictive simulations replicated the observed conditions from 1995-2019, including the recent drought period. It is assumed that there will be no significant increase in agricultural pumping or acreage during this time period.

In order to assess the effect that a simulated project would have on groundwater elevations in the Basin, the following methodology was used. A baseline scenario was simulated in which no projects or management actions occurred. Pumping was maintained at recent levels, and climate conditions were repeated for the recent time series as previously discussed. Then a project scenario was incorporated in which a specific project or management action was represented in the model, either through reduction of pumping or introduction of a new source of recharge, as appropriate. The modeled RMS hydrographs for the baseline scenario and the project scenario are then plotted on the same chart, so the effect of the project can be assessed by the difference in water levels between the baseline and project scenario over the predictive period of the project implementation. The projects discussed herein were represented with only the project under consideration represented in the model, in order to quantify the effect of the individual project discussed. So, each of the first four model simulations each represent a particular change in pumping or recharge specific to the project or projects being described. Then a final run was performed at the end that included all changes simultaneously. It is likely that more than one of these projects will be required to achieve sustainability, which will be discussed later in this chapter.

Five separate project scenarios were modeled (Table 9-5). However, some of these project model scenarios are intended to represent multiple projects as described in the following sections, but with different options for source water. It is assumed that the groundwater pumping reductions in the modeled project scenarios are offset by supplemental water supplies. For example, one of the project scenarios simulates a 1,000 AFY reduction in agricultural pumping. This reduction could conceivably be offset through import of State Water Project (SWP) water or short-term delivery of City of San Luis Obispo recycled water. So, this single model simulation could potentially represent the effects of more than one project, or a combination of projects, depending on the ultimate disposition and feasibility of obtaining the various possible sources of water or implementation of management actions. When this is the case, it will be noted in the text of the specific project descriptions. Additionally, a final project scenario was run in which four projects are represented simultaneously.

Table 9-5 Description of Modeled Scenarios

Scenario	Description	Applies to Projects
Baseline	2019 Production	No Projects
1	Reduce Agricultural pumping by 1,000 AFY	SWP for Ag Use City of SLO Recycled Water to Ag
2	500 AFY to Recharge Basin	SWP Recharge Basin
3	Reduce Golden State pumping by 200 AFY. Reduce ERMWC and VRMWC pumping by 50 AFY (combined).	SWP to GSWC, Varian Ranch MWC AG Subbasin Wells, SWP to Mutual Water Companies
4	Discharge 500 AFY as input into West Corral de Piedras Creek at its entrance to the SLO Basin	Price Canyon Discharge Relocation
5	Scenarios 1 through 4	All Projects Listed Above

9.4. Projects

9.4.1. State Water Project for Agricultural Irrigation

The Coastal Branch of the SWP conveys water from the California Aqueduct to San Luis Obispo and Santa Barbara Counties (Figure 9-1). The California Aqueduct is operated by the California Department of Water Resources (DWR). The Coastal Branch provides water to two SWP Contractors: the Santa Barbara County Flood Control and Water Conservation District (via the Central Coast Water Authority (CCWA), a Joint Powers Authority) and the SLOCFCWCD. The CCWA owns, operates, and maintains the Polonio Pass Water Treatment Plant (PPWTP) and operates the portion of the Coastal Branch that is downstream of Polonio Pass.

The Coastal Branch transects the Edna Valley subarea and runs along Orcutt Road as shown in Figure 9-1. This project includes the construction of a new turnout to the Coastal Branch along Orcutt Rd south of the Energy Dissipation Valve and 200 feet of 10-inch pipeline to connect to the existing Edna Valley Growers Mutual Water Company distribution system. The project would allow for approximately 1,000 AFY of SWP water based on the availability and cost of SWP water and will offset an equivalent amount of the irrigation demands currently met by groundwater. The SWP water is a treated water supply and may require dechlorination before being used for agricultural purposes.

SWP water for irrigation use to offset pumping could be purchased from 1) District subcontractors that receive their SWP water through Lopez and Chorro Valley Participants, 2) Santa Barbara County Participants or 3) a portion of the SLOCFCWCD's unsubscribed Table A amount (14,463 AFY). Any necessary agreements/terms would need to be identified, negotiated and developed amongst relevant parties, and environmental review would need to be conducted, to facilitate the transfers. The recent adoption of the Water Management Tools Amendment to the SWP Contracts by the SLOCFCWCD and the Santa Barbara County Flood Control and Water Conservation District (SBCWCFCD) presents new opportunities for obtaining SWP water supply and delivery capacity to Edna Valley.

9.4.1.1. Project Benefits (§ 354.44.5)

In order to assess this project's benefits to water levels in the aquifer and effect on sustainability of the Basin, a project scenario was simulated using the integrated GSFLOW model developed as part of the GSP efforts. A baseline simulation was performed in which agricultural pumping was kept constant at water year 2019 volumes, and climatological conditions for the predictive time period (water years 2020-2044 was defined as a repetition of the historical time series used for 1995-2019.

The model was run continuously for the time period from water years 1987 through 2044. This project simulation assumes that 1,000 AFY of SWP water is available for agriculture to offset irrigation supply currently supplied by groundwater.

For the predictive time period, agricultural pumping was reduced by 1,000 AFY in Edna Valley for the period starting in water year 2026 (these reductions were not applied to San Luis Valley, because no water level declines have been observed in that area). The 2026 starting period assumes it will take five years to implement the project or combination of projects required to make up the water for the pumping reduction. The 1,000 AFY in-lieu pumping reduction was distributed equally among all identified agricultural wells starting in 2026.

Figure 9-2 displays the baseline and Project Scenario 1 hydrographs for this project for the four Edna Valley wells identified as the RMS for the Chronic Lowering of Groundwater Levels Sustainability Indicator. Data from these hydrographs indicate that the increase in water levels over the baseline scenario in year 2042 at these wells ranges from 5 feet at EV-04 to 31 feet at EV-16. These results are summarized in Table 9-6.

It should be noted that it is recognized that some model results in the vicinity of RMS EV-04 seem anomalous; the well at this location is relatively insensitive to changes in pumping, and the magnitude of the seasonal and drought water level fluctuations is not fully captured. This was identified in the model documentation as an area where the model may be improved, but in general the model results are instructive.

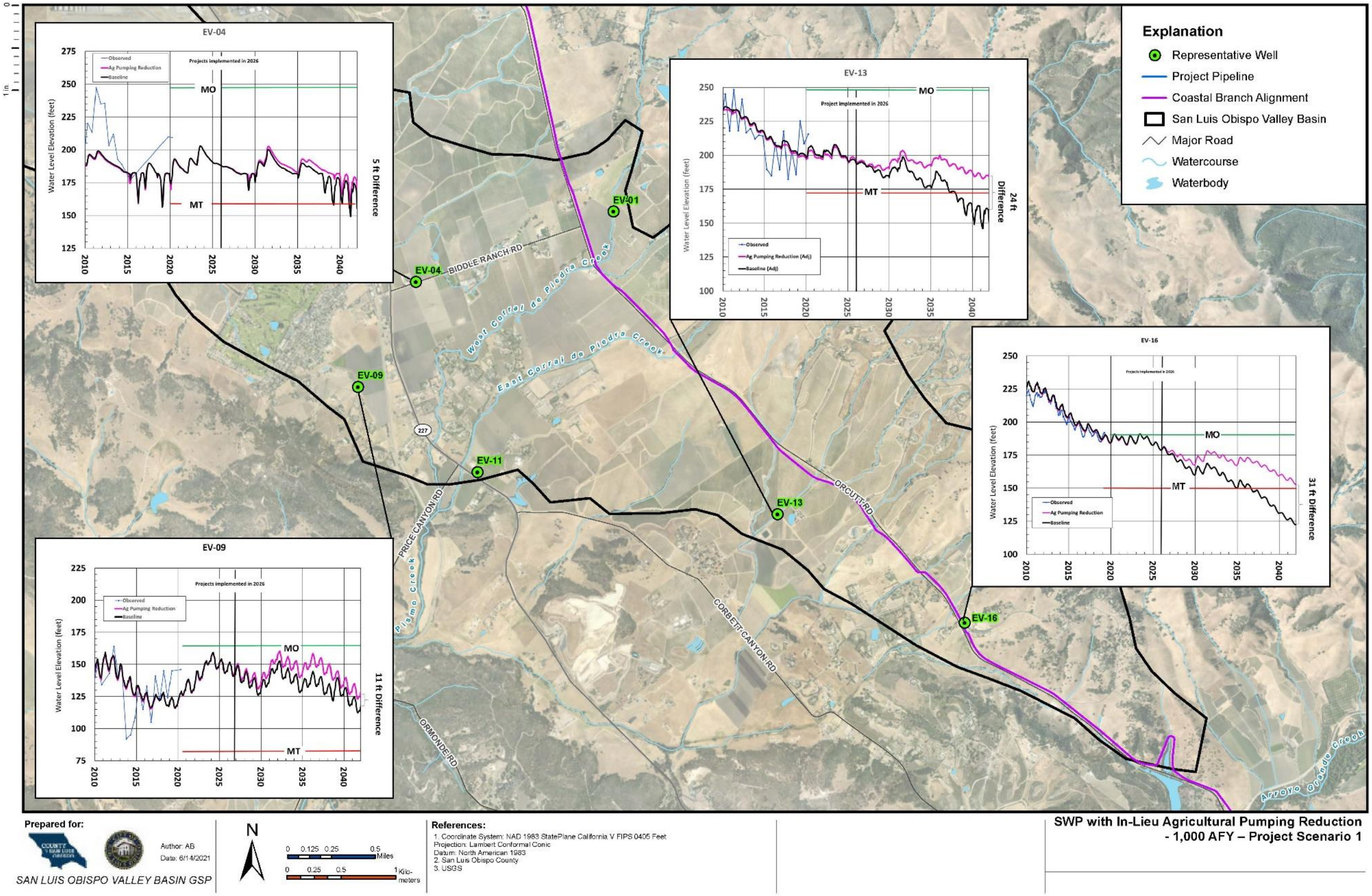


Figure 9-2. SWP with In-Lieu Agricultural Pumping Reduction - 1,000 AFY – Project Scenario 1

9.4.1.2. Supply Reliability (§ 354.44.6)

The latest estimates of anticipated SWP availability under future conditions are included in the Department of Water Resources 2019 SWP Delivery Capability Report (DCR) (DWR, 2019). The 2019 DCR anticipates approximately 58% of the SLOCFCWCD's and 59% of the SBCFCWCD's Table A and other contract amounts will be available on average under anticipated future conditions. These estimates are based on outputs from the CALSIM-2 Operations model (DWR, 2019). However, the availability of these SWP water supplies will be variable year by year based on hydrologic conditions. The historical delivery of Annual Allocation from the SWP ranges from 5% to 100% of the contracted amount. Because current demand for State Water in San Luis Obispo County is only 4,830 AFY out of the 25,000 AFY Table A amount, in many years there is unused State Water available.

Given the variable availability of SWP supplies, a project to deliver 1,000 AFY of SWP water to Edna Valley would likely need to be sized to accommodate greater than 1,000 AFY during wet years to balance out lower delivery amounts during dry years. Alternatively, contracts for the purchase of SWP could be structured to ensure a minimum delivery of 1,000 AFY of SWP water (e.g., purchasing extra water to serve as a drought buffer or more Table A Allocation or supply than delivery capacity) to provide a higher level of reliability for the SWP. However, to incorporate this enhanced reliability would likely increase the costs of the SWP supplies. For the purposes of the initial project level evaluation include in this GSP the capacity to deliver and availability of water were assumed to be a constant 1,000 AFY.

9.4.1.3. Project Costs (§ 354.44.8)

The estimated capital cost to construct a turnout off from the Coastal Branch Pipeline and infrastructure to connect to the existing Edna Valley Growers Mutual Water Company distribution system is approximately $890,000 equating to an annual payment of $63,000 and a unit cost of $60/AF. These costs do not include the cost to purchase SWP or the work required to negotiate a contract with the SLOCFCWCD or its subcontractors.

9.4.1.4. Project Implementation (§ 354.44.4)

Investigating the use of SWP as a supplemental water source would occur within the first year of implementation. Following the recommendations of the feasibility study, negotiations to acquire SWP from the identified sellers could take up to 5 years. The design and construction of the turnout and pipeline could occur concurrent with the negotiations and occur within 5 years.

9.4.1.5. Basin Uncertainty (§ 354.44.9d)

The benefits from the projects in terms of improved water levels in the Basin are evaluated using the integrated GSFLOW model. It should be understood that there is uncertainty that is inherent in the modeling process, including uncertainty with respect to parameters describing the subsurface environment, historical volumes of pumping, etc. The Integrated Model Calibration TM (Appendix E) identifies uncertainty and the need for additional data collection in the conceptual model, model parameters, and calibration.

9.4.1.6. Legal Authority (§ 354.44.7)

California Water Code Section 10726.2 provides GSAs the authority to purchase, among other things, land, water, and privileges. The GSAs have the legal authority to conduct a feasibility study into the use of SWP as a supplemental water supply for the SLO Basin. Following the recommendation from the feasibility study the project could be implemented by the GSAs, GSC members or other parties.

9.4.1.7. Permitting and Regulatory Processes (§ 354.44.3)

No permits or regulatory processes would be necessary for development of the feasibility study.

However, implementation of this project will likely require a California Environmental Quality Act (CEQA) environmental review process and may require an Environmental Impact Report or a Mitigated Negative Declaration (the review could also result in a Negative Declaration or Notice of Exemption). Additionally, permits from a variety of state and federal agencies may be necessary, and any project that coordinates with federal facilities or agencies may require National Environmental Policy Act (NEPA) documentation.

A new connection or turnout infrastructure requires coordination and agreements with the District, CCWA, and DWR.

9.4.1.8. Public Notice and Outreach (§ 354.44B)

The public notice and outreach associated with this project would occur through GSA, GSC and/or future governance structure public meetings. If CEQA is required, the project will follow the public noticing requirements required by CEQA.

9.4.2. City of SLO Recycled Water for Agricultural Irrigation

The City owns and operates a Water Resource Recovery Facility (WRRF) that treats municipal wastewater from the City, Cal Poly, and the San Luis Obispo County Airport. Tertiary treated and disinfected effluent is distributed for landscape irrigation and construction uses, or/and dechlorinated and discharged to San Luis Obispo Creek. The City is required to maintain a minimum daily average year-round discharge of 2.5 cubic feet per second (cfs) of treated effluent to San Luis Obispo Creek, which equals approximately 1.6 MGD or 1,800 AFY, for protection of downstream biological resources as required by the National Oceanic Atmospheric Administration, National Marine Fisheries Service (NOAA NMFS).

The City of San Luis Obispo has been utilizing recycled water as a component of its multi-source water supply since 2006. The City's goal is to use this water source to the highest and most beneficial use. The City is committed to the expansion of its non-potable recycled water programs and to the development of a potable reuse program to supplement groundwater and/or surface water supplies. The delivery of the City's recycled water to parties within the Edna Valley area has been identified as a potential short-term augmentation project to offset further lowering of groundwater levels within the Edna Valley.

With current in-City recycled water demands and influent into the WRRF, it is anticipated that the City could provide 500-700 acre-feet of recycled water annually with quantities decreasing as new in-City users come online, as indoor water conservation is increased as a result of statewide water efficiency mandates, and as the City develops potable reuse projects to supplement its water supplies. In-City groundwater basin augmentation efforts, new regulations, drought, additional in-City customers, and the like could reduce the quantity available to outside users by several hundred acre-feet per year in the foreseeable future.

The project includes the construction of 2,600 feet of 8-inch pipeline, a pumpstation, and a turnout to connect to the existing Edna Valley Growers Mutual Water Company distribution system. The project would allow for the delivery of approximately 100 AF/Month in the winter months with minimal amounts available during summer months and would replace some of the agricultural irrigation demands currently met by groundwater.

9.4.2.1. Project Benefits (§ 354.44.5)

This project is considered to be one of the various projects that may provide portions of the water supply needed to reduce Edna Valley agricultural pumping by 1,000 AFY. As such, it is considered conceptually to be part of the same model scenario (i.e., Project Scenario 1) as described in Section 9.4.1 State Project Water to Agriculture Irrigation. Because of the uncertainty of the supply, no model runs were dedicated specifically to this project. It is one of the sources that would provide benefits to Basin water levels as described in Section 9.4.1.1.

9.4.2.2. Supply Reliability (§ 354.44.6)

The quantity of recycled water available for use to City customers is dependent on the quantity of untreated wastewater flowing into the City's WRRF. Unlike most cities that experience relatively uniform recycled water availability throughout the year, the City of San Luis Obispo's recycled water availability is drastically impacted by the students from Cal Poly vacating the community during the summer months and thus decreasing the wastewater influent into the WRRF. This decrease in wastewater influent occurs during the summer months when the City's 50+ recycled water accounts increase irrigation to combat the warm, dry conditions. This decrease in availability, coupled with a substantial increase in demand, abnormally limits the recycled water available during the summer months.

Long-Term Versus Short-Term Availability

While there is currently surplus recycled water available year-round, with over 150 acre-feet per month available in some winter and spring months, it is anticipated that the City will not have a significant volume of recycled water supply available to sell to any outside-City users from June-October once the internal City demands increase to support new residential and commercial developments. Recycled water demands from Avila Ranch, San Luis Ranch, Righetti Ranch, and other future in-City developments are expected to result in increased recycled water demand of roughly 400-500 acre-feet per year with most of this demand occurring during the summer. These developments are currently being constructed with many of the Orcutt Area developments already receiving recycled water deliveries. The City continues to update its recycled delivery projections, as any amounts obligated for delivery beyond availability would need to be made up by use of City potable water supplies. This concern related to availability will continue to increase as both in-City and Cal Poly users continue to improve in their indoor water use efficiency in alignment with State regulations.

As the City continues to develop its groundwater pumping program, it has been identified that there is significant recharge potential (upwards of 400 acre-feet per year) within the City's portion of the SLO Basin adjacent to the WRRF. Recharge projects in other areas of the City have not yet been studied but are anticipated to increase the amount of water that could be recharged to the Basin. As the City resumes its groundwater pumping, additional capacity will likely be created within San Luis Valley subarea of the Basin, increasing the City's need for recycled water for recharge projects that may ultimately be to supplement the basin to ensure compliance with SGMA. As surface water supplies are adversely impacted by climate change, augmentation of the Basin will be the City's major water supply expansion strategy and will limit water availability for outside-City interests as augmentation projects come online. Potable reuse through storage in the Basin may also address the issues with seasonal availability by creating a prolonged time lag between highly treated wastewater injection/percolation and its withdrawal for use.

Physical Delivery Constraints

The City's recycled water storage and distribution system was designed to provide intermittent in-City deliveries within the southern half of the City. The City's storage tank, pumps, telemetry, and pipelines were not designed to provide recycled water to outside-City customers and may require upgrades in order to accommodate the continuous 24/7 delivery needed to deliver substantial volumes of water to the Edna Valley subarea. Additionally, the two potential pipeline alignments that could be utilized to deliver water to the Edna Valley area are sized for domestic irrigation delivery and limit the ability to deliver recycled water during the winter and spring months when it is most abundantly available. One pipeline located along Broad Street near the Airport is 6-inch diameter C900 pipe and the other, located along Tank Farm Road, is 8-inch diameter ductile iron pipe. It is estimated that the larger of the two pipelines could deliver approximately 100 acre-feet of recycled water per month if operated 24-hours per day for a full month. These undersized pipelines constrain the amount of water that could be delivered to outside City customers during the winter and spring months when it is available in its highest quantities.

9.4.2.3. Project Costs (§ 354.44.8)

The estimated capital cost to connect the City's recycled water distribution to the existing Edna Valley Growers Mutual Water Company distribution system is approximately $1,004,000 equating to an annual payment of $153,000 and a unit cost of $260/AF. These costs do not include the cost of the water that will be purchased from the City. The City's recycled water is approved to be sold within City limits for approximately $4,000/AF.

9.4.2.4. Project Implementation (§ 354.44.4)

The circumstance for implementation of this project is driven by the Basin overdraft conditions in the Edna Valley. The City and representatives from the Edna Valley have been discussing the feasibility of the project during the development of this GSP. It is estimated that the design and construction of the pipeline could occur within 1 to 3 years of the GSP Implementation.

9.4.2.5. Basin Uncertainty (§ 354.44.9d)

The addition of recycled water as a supplemental water supply source would help address the estimated overdraft described in Chapter 6 (Water Budget) in the Edna Valley portion of the Basin. The benefits from the project in terms of improved water levels in the Basin are evaluated using the integrated GSFLOW model. It should be understood that there is uncertainty that is inherent in the modeling process, including uncertainty with respect to parameters describing the subsurface environment, historical volumes of pumping, etc. The Integrated Model Calibration TM (Appendix E) identifies the uncertainties and the need for additional data collection in the conceptual model, model parameters, and calibration.

9.4.2.6. Legal Authority (§ 354.44.7)

California Water Code Section 10726.2 provides GSAs the authority to purchase, among other things, land, water rights, and privileges. The GSAs have the legal authority to conduct a feasibility study into the use of SWP as a supplemental water supply for the SLO Basin. Following the recommendation from the feasibility study the project could be implemented by the GSAs, GSC members or other parties. The City owns its recycled water and has the legal authority to sell its recycled water in alignment with its policies.

9.4.2.7. Permitting and Regulatory Processes (§ 354.44.3)

This project would require review and approval by the SLO City Council. The project may require a CEQA environmental review process and may require an Environmental Impact Report or a Mitigated Negative Declaration (the review could also result in a Negative Declaration or Notice of Exemption). Additionally, permits from a variety of state and federal agencies may be necessary, and any project that coordinates with federal facilities or agencies may require NEPA documentation.

Delivery of recycled water to the Edna Valley may require analysis to confirm that the large-scale, ongoing application of recycled water does not result in recycled water recharging the groundwater basin and thus constituting a potable reuse project. Direct application of recycled water at agronomic rates is allowable under the City's existing recycled water delivery permit.

While the City has policy language that allows for the sale of recycled water outside of City limits, specific findings must be made for this to be permitted. Examples of these findings include requirements for receiving properties to record a conservation, open space, Williamson Act, or other easement instrument to maintain the area being served in agriculture and open space, assurance that recycled water will not be used to increase development potential of the property being served, and that recycled water will not be further treated to make it potable. Contract negotiations related to the sale price of recycled water, term of delivery, etc. would require approval of the San Luis Obispo City Council.

9.4.2.8. Public Notice and Outreach (§ 354.44B)

The public notice and outreach associated with this project would occur through GSA, GSC and/or future governance structure public meetings. If CEQA is required, the project will follow the public noticing requirements required by CEQA.

9.4.3. State Water Project Recharge Basin

To enhance recharge in the Edna Valley, a groundwater recharge basin could be constructed to percolate SWP water. A groundwater recharge basin is a bermed basin structure designed for the purpose of efficiently allowing water collected in the basin to infiltrate through the ground surface, percolate through the vadose zone, and ultimately recharge the underlying aquifer. The concept of this project is to construct a recharge basin in the Edna Valley and supply it with water obtained from the SWP to recharge the aquifer.

The conceptual location selected for this project is near the southeast corner of Biddle Ranch Road and State Highway 227 (aka, Edna Road, Figure 9-3). This area is classified as having high recharge potential in the Stillwater Percolation zone Study discussed in Chapter 4 (Basin Setting). This land is currently utilized for agriculture, and it is assumed that a parcel of land adequate to build the recharge basin could be purchased. Water would be conveyed via a 6,000 foot 6-inch pipeline from the SWP pipeline, along Biddle Ranch Rd, to a newly constructed recharge basin on approximately 5 acres of land along Orcutt Road.

9.4.3.1. Project Benefits (§ 354.44.5)

In order to assess this project's benefits to the aquifer and effect on sustainability of the Basin in terms of expected water levels, Project Scenario 2 was simulated using the integrated GSFLOW model developed as part of the GSP effort. The project was defined to represent 500 AFY of supplemental water provided from the SWP made available to a newly constructed recharge basin to be located in Edna Valley. Benefits of recharge basins versus direct delivery to offset pumping include the potential to deliver water during seasonal periods when there is less demand for SWP water supplies and capacity in the SWP conveyance systems.

A baseline simulation was performed as previously described. The recharge basin is assumed to be less than 500 feet by 500 feet in area and is simulated in a single cell in the model. Recharge is input as a flux in MODFLOW (feet/day), so a flux rate equivalent to 500 AFY percolating into a 500 ft by 500 ft cell was input into model cell on a constant basis. The project was defined as beginning in 2026, allowing five years for project design and implementation.

Figure 9-3 displays the baseline and Project Scenario 2 hydrographs for this project for the four Edna Valley wells identified as RMS for the Chronic Lowering of Groundwater Levels Sustainability Indicator. Data indicate that the increase in water levels over the baseline scenario in year 2042 at these wells ranges from 2 feet at EV-16 to 52 feet at EV-04, which is the closest RMS to the recharge basin location. The water level increase in the SWP recharge basin scenario over baseline was 21 feet at EV-09, and 4 feet at EV-13. These results are summarized in Table 9-6.

9.4.3.2. Supply Reliability (§ 354.44.6)

The supply reliability of the SWP is discussed in detail in Section 9.4.1.2 and is applicable to this project. This project assumes a total of 500 AFY would be purchased and recharged in the Edna Valley. If both the SWP for Agricultural Irrigation and the SWP Recharge Basin projects were to be implemented the total capacity of SWP would be 1,500 AFY and contracts would need to be negotiated accordingly.

9.4.3.3. Project Costs (§ 354.44.8)

The estimated capital cost to construct a turnout off from the Coastal Branch Pipeline and infrastructure to connect to a newly constructed recharge basin is approximately $3,624,000 which equates to annual payment of $337,000 and a unit cost of $670/AF. If multiple SWP groundwater recharge projects are implemented, the cost of the turnout and other infrastructure can be shared. These costs do not include the cost to purchase SWP or the work required to negotiate a contract with the SLOCFCWCD or its subcontractors.

9.4.3.4. Project Implementation (§ 354.44.4)

The circumstance for implementation of this project is driven by the overdraft conditions in the Edna Valley. The feasibility study evaluation of the use of the SWP as a supplemental water source to recharge groundwater within the Edna Valley could occur within the first year of implementation. Following the recommendations of the feasibility study, negotiations to acquire SWP from the identified sellers could take up to 5 years. The design and construction of the turnout and pipeline could occur concurrent with the negotiations and be completed within 5 years.

9.4.3.5. Basin Uncertainty (§ 354.44.9d)

The addition of SWP as a supplemental water supply source would help address the uncertainty of the estimated overdraft described in Chapter 6 (Water Budget) in the Edna Valley portion of the Basin. The benefits from the projects in terms of improved water levels in the Basin are evaluated using the integrated GSFLOW model. It should be understood that there is uncertainty that is inherent in the modeling process, including uncertainty with respect to parameters describing the subsurface environment, historical volumes of pumping, etc. The Integrated Model Calibration TM (Appendix E) identifies uncertainty and the need for additional data collection in the conceptual model, model parameters, and calibration.

9.4.3.6. Legal Authority (§ 354.44.7)

California Water Code Section 10726.2 provides GSAs the authority to purchase, among other things, land, water, and privileges. The GSAs have the legal authority to conduct a feasibility study into the recharge of SWP as a supplemental water supply for the SLO Basin. Following the recommendation from the feasibility study the project could be implemented by the GSAs, GSC members or other parties.

9.4.3.7. Permitting and Regulatory Processes (§ 354.44.3)

No permits or regulatory processes would be necessary for development of the feasibility study.

However, implementation of this project will likely require a CEQA environmental review process and may require an Environmental Impact Report or a Mitigated Negative Declaration (the review could also result in a Negative Declaration or Notice of Exemption). Additionally, permits from a variety of state and federal agencies may be necessary, and any project that coordinates with federal facilities or agencies may require NEPA documentation.

A new connection or turnout infrastructure requires coordination and agreements with the District, CCWA, and DWR.

9.4.3.8. Public Notice and Outreach (§ 354.44B)

The public notice and outreach associated with this project would occur through GSA, GSC and/or future governance structure public meetings. If CEQA is required, the project will follow the public noticing requirements required by CEQA.

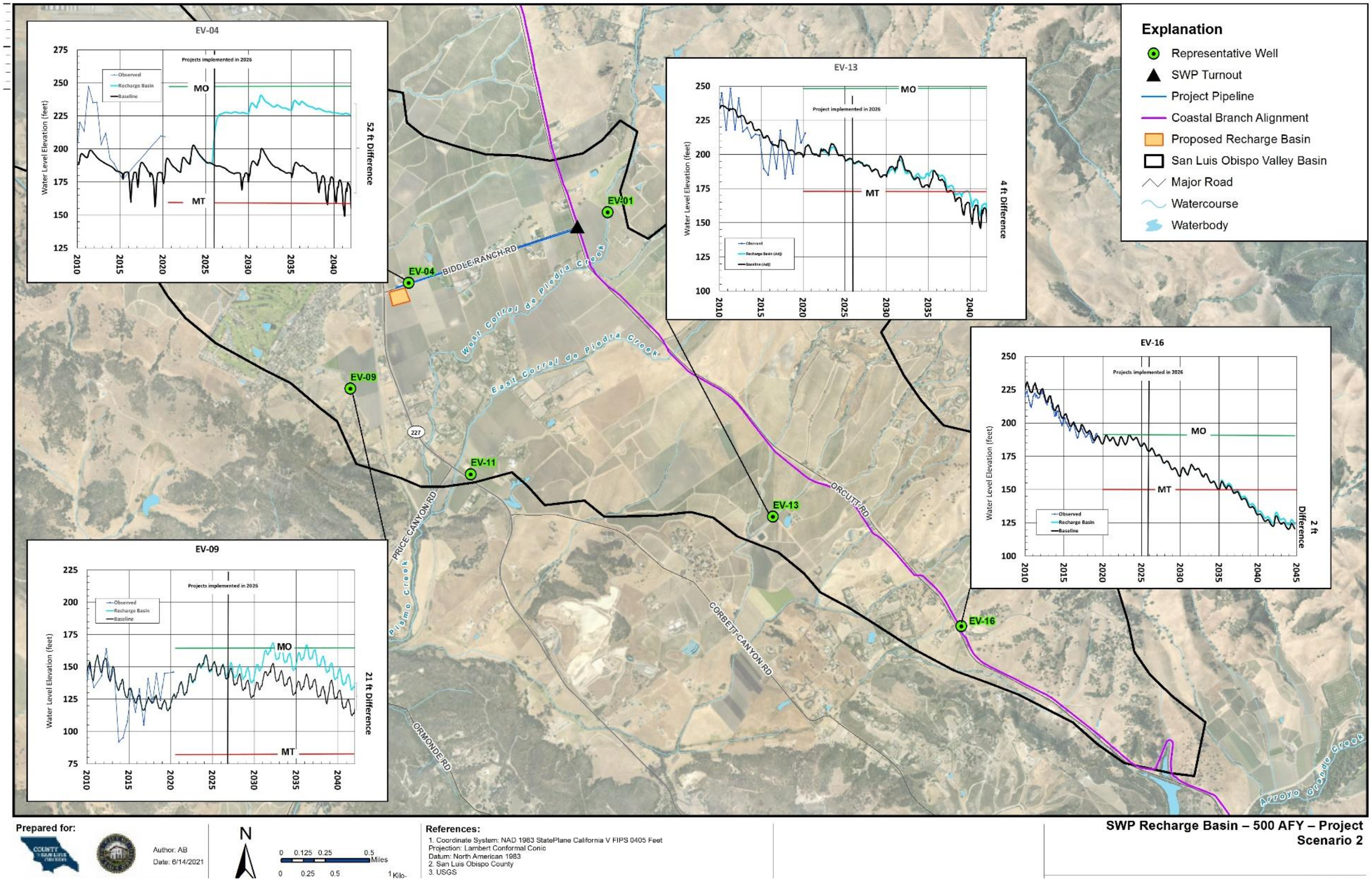


Figure 9-3. SWP Recharge Basin – 500 AFY – Project Scenario 2

9.4.4. State Water Project to Golden State Water Company

Golden State Water Company (GSWC) currently provides water to a small service area of County administered land in the central part of the Basin, near the boundary of Edna Valley and San Luis Valley. GSWC obtains its supply from groundwater wells within their service area. The recent drought resulted in significant constraints on GSWC's groundwater supplies. Because their service area is relatively small, their ability to site new wells to expand their source locations is limited. For this reason, the conceptual project of obtaining SWP water to augment GSWC's current supplies is evaluated.

This project assumes a SWP delivery of 200 AFY to GSWC, representing about 50% of its long-term demand. To implement this project, a turnout to the SWP pipeline along Orcutt Road will be required. From the corner of Orcutt Road and Biddle Ranch Road, approximately 8,000 feet of pipeline along Biddle Ranch Road will be required to convey the water from the SWP pipeline to the edge of the GSWC service area. Infrastructure improvements internal to GSWC's system are not included in this project evaluation.

9.4.4.1. Project Benefits (§ 354.44.5)

In order to assess this project's benefits to the aquifer and effect on sustainability of the Basin in terms of expected water levels, Project Scenario 3 was simulated using the integrated GSFLOW model developed as part of the GSP effort. This project assumes a 200 AFY reduction in pumping by GSWC. Edna Ranch MWC and Varian Ranch MWC pumping was also reduced, but these water companies are distant enough that results from one are not expected to have a significant impact on the other. As with the scenarios for agricultural pumping reduction, the water to offset this pumping reduction may come from this project or another source; in this case, additional water for GSWC may come from the SWP or/and City of SLO water (Section 9.4.5).

Modeled pumping for GSWC was reduced by 50% from recent annual pumping volumes at their operating wells. It is assumed that the remaining demand for GSWC's service area would be met through supplemental water from the SWP.

Figure 9-4 displays the baseline and project scenario hydrographs for this project for the four Edna Valley wells identified as RMS for the Chronic Lowering of Groundwater Levels Sustainability Indicator (EV-04, EV-09, EV-13, and EV-16). The data indicate that the increase in water levels over the baseline scenario in year 2042 at these wells ranges from 3 feet at EV-13 to 15 feet at EV-09, which is a GSWC well. These results are summarized in Table 9-6.

9.4.4.2. Supply Reliability (§ 354.44.6)

The supply reliability of the SWP is discussed in detail in Section 9.4.1.2 and is applicable to this project. This project assumes a total of 200 AFY would be purchased and delivered to GSWC.

9.4.4.3. Project Costs (§ 354.44.8)

The estimated capital cost to construct a turnout off from the Coastal Branch Pipeline, infrastructure to connect to the GSWC is approximately $2,685,000 which equates to annual payment of $192,000 and a unit cost of $960/AF. If multiple projects which require SWP water are implemented, the cost of the turnout and other infrastructure can be shared. These costs do not include the cost to purchase SWP or the work required to negotiate a contract with the SLOCFCWCD or its subcontractors.

9.4.4.4. Project Implementation (§ 354.44.4)

The circumstance for implementation of this project is driven by the overdraft conditions in the Edna Valley The feasibility study into the use of the SWP as a supplemental water source to GSWC would occur within the first year of implementation. Following the recommendations of the feasibility study, negotiations to acquire SWP from the identified sellers could take up to 5 years. The design and construction of the turnout and pipeline could occur concurrent with the negotiations and occur within 5 years.

9.4.4.5. Basin Uncertainty (§ 354.44.9d)

The addition of SWP as a supplemental water supply source to GSWC would help address the uncertainty of the estimated overdraft described in Chapter 6 (Water Budget) in the Edna Valley portion of the Basin. The benefits from the projects in terms of improved water levels in the Basin are evaluated using the integrated GSFLOW model. It should be understood that there is uncertainty that is inherent in the modeling process, including uncertainty with respect to parameters describing the subsurface environment, historical volumes of pumping, etc. The Integrated Model Calibration TM (Appendix E) identifies uncertainty and the need for additional data collection in the conceptual model, model parameters, and calibration.

9.4.4.6. Legal Authority (§ 354.44.7)

California Water Code Section 10726.2 provides GSAs the authority to purchase, among other things, land, water rights, and privileges. The GSAs have the legal authority to conduct a feasibility study into the obtaining SWP as a supplemental water supply for the SLO Basin. Following the recommendation from the feasibility study the project could be implemented by the GSAs, GSC members or other parties.

9.4.4.7. Permitting and Regulatory Processes (§ 354.44.3)

No permits or regulatory processes would be necessary for development of the feasibility study.

However, implementation of this project will likely require a CEQA environmental review process and may require an Environmental Impact Report or a Mitigated Negative Declaration (the review could also result in a Negative Declaration or Notice of Exemption). Additionally, permits from a variety of state and federal agencies may be necessary, and any project that coordinates with federal facilities or agencies may require NEPA documentation.

A new connection or turnout infrastructure requires coordination and agreements with the SLOCFCWCD, CCWA, and DWR.

9.4.4.8. Public Notice and Outreach (§ 354.44B)

The public notice and outreach associated with this project would occur through GSA, GSC and/or future governance structure public meetings. If CEQA is required, the project will follow the public noticing requirements required by CEQA.

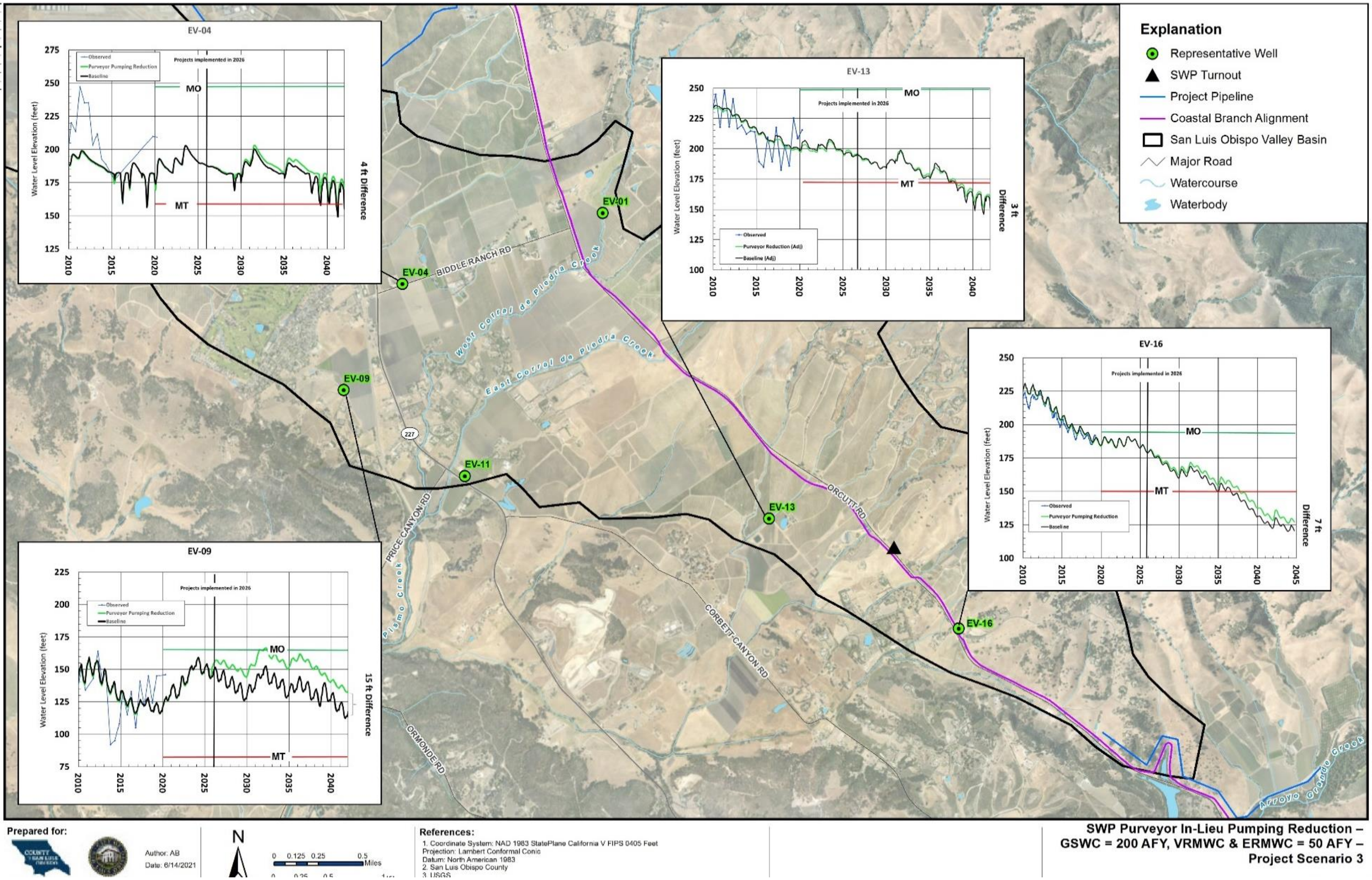


Figure 9-4. SWP Purveyor In-Lieu Pumping Reduction – GSWC = 200 AFY, VRMWC & ERMWC = 50 AFY – Project Scenario 3

9.4.5. Varian Ranch Mutual Water Company Arroyo Grande Subbasin Wells

The Varian Ranch MWC (VRMWC) is located in the southeastern extent of the Basin and currently supplies its service area from wells within the Basin. However, its service area extends into the neighboring Arroyo Grande Subbasin of the Santa Maria River Valley Groundwater Basin (SMRVGB). Twenty-two of their fifty-one parcels are located outside of the Basin in the adjacent Arroyo Grande Creek watershed. VRMWC owns an existing well, located on its property in the Arroyo Grande Subbasin that has been tested and found to be suitable for use as a domestic supply source for its service area.

The concept of this project is to build a conveyance pipeline to deliver approximately 50 AFY of water from the well that VRMWC owns in the Arroyo Grande Subbasin to an interconnection point within its current distribution system in the Basin. The project would also evaluate a connection with the adjacent Edna Ranch MWC (ERMWC). It is estimated that this pipeline will be 6 inches in diameter and approximately 10,850 feet long. The project also includes well pump and well site improvements. Utilization of this well to supply a portion of VRMWC and ERMWC's demand would reduce the pumping required of their wells in the Basin and would benefit water levels in the area.

9.4.5.1. Project Benefits (§ 354.44.5)

This project is considered to be one of the various projects that may provide supply to reduce pumping by the small water purveyors in Edna Valley. As such it is considered conceptually to be part of the same scenario as described in Section 9.4.4, SWP to GSWC.

Modeled pumping for both ERMWC and VRMWC wells in the Edna Valley were reduced by 50 AFY and is offset by groundwater pumped from the Arroyo Grande Subbasin.

Figure 9-4 displays the baseline and project scenario hydrographs for this project for the four Edna Valley wells identified as RMS for the Chronic Lowering of Groundwater Levels Sustainability Indicator (EV-04, EV-09, EV-13, and EV-16). The data indicate that the increase in water levels over the baseline scenario in year 2042 is about 7 feet at EV-16 (a MWC well).

9.4.5.2. Supply Reliability (§ 354.44.6)

The water source for this project is groundwater from the Arroyo Grande Subbasin. The County and City of Arroyo Grande are currently developing a GSP for the Arroyo Grande Subbasin and will be developing a detailed water budget which will provide information regarding the reliability of the groundwater source.

9.4.5.3. Project Costs (§ 354.44.8)

The estimated capital cost to convey groundwater from the Arroyo Grande Subbasin to the Varian Ranch distribution system is approximately $2,701,000 equating to an annual payment of $176,000 and a unit cost of $4,200/AF. These costs do not include any costs to purchase the water since the VRMWC currently owns the well.

9.4.5.4. Project Implementation (§ 354.44.4)

The circumstance for implementation of this project is driven by the overdraft conditions in the southeastern portion of Edna Valley. The feasibility study into the use of VRWMC wells in Arroyo Grande Subbasin as a supplemental water source to both VRMWC and ERMWC would occur within the first year of implementation. Following the recommendations of the feasibility study the design and construction of the turnout and pipeline could occur concurrent with the negotiations and occur within 3 years.

9.4.5.5. Basin Uncertainty (§ 354.44.9d)

The addition of the Arroyo Grande Varian Ranch MWC wells as a supplemental water supply source to VRMWC and Edna Ranch MWC would help address the uncertainty of the estimated overdraft described in Chapter 6 (Water Budget) in the Edna Valley portion of the Basin. The benefits from the projects in terms of improved water levels in the Basin are evaluated using the integrated GSFLOW model. It should be understood that there is uncertainty that is inherent in the modeling process, including uncertainty with respect to parameters describing the subsurface environment, historical volumes of pumping, etc. The Integrated Model Calibration TM (Appendix E) identifies uncertainty and the need for additional data collection in the conceptual model, model parameters, and calibration.

9.4.5.6. Legal Authority (§ 354.44.7)

California Water Code Section 10726.2 provides GSAs the authority to purchase, among other things, land, water rights, and privileges. The GSAs have the legal authority to conduct a feasibility study into the utilizing the Arroyo Grande Subbasin as a supplemental water supply for the southeastern portion of Edna Valley.

San Luis Obispo County Code Chapter 8.95 currently requires that a permit be obtained for any export of groundwater greater than 0.5 AFY from a Bulletin 118 defined groundwater basin within the County. The ordinance requires that the export permit only be approved if the Director of Public Works finds that the proposed export will not cause or contribute to significant detrimental impacts to groundwater resources, including such impacts to health, safety and welfare of overlying property owners.

9.4.5.7. Permitting and Regulatory Processes (§ 354.44.3)

This project may require a CEQA environmental review process and may require an Environmental Impact Report or a Mitigated Negative Declaration (the review could also result in a Negative Declaration or Notice of Exemption). Additionally, permits from a variety of state and federal agencies may be necessary, and any project that coordinates with federal facilities or agencies may require NEPA documentation.

9.4.5.8. Public Notice and Outreach (§ 354.44B)

The public notice and outreach associated with this project would occur through GSA, GSC and/or future governance structure public meetings. If CEQA is required, the project will follow the public noticing requirements required by CEQA.

9.4.6. State Water Project to the Mutual Water Companies

The VRMWC and ERMWC located in the southeastern extent of the Basin, currently provides water supply to their service areas from wells within the Basin. The recent drought resulted in significant constraints on their supplies.

To implement this project, a turnout to the SWP pipeline along Orcutt Road will be required. From the corner of Orcutt Road and Biddle Ranch Road, approximately 8,000 feet of pipeline along Biddle Ranch Road will be required to convey the water from the SWP pipeline to the edge of the ERMWC service area. Infrastructure internal to ERMWC and VRMWC's system is not included in this project evaluation.

9.4.6.1. Project Benefits (§ 354.44.5)

This project is considered to be one of the various projects that may provide water supply to reduce pumping by the water purveyors in Edna Valley. As such it is considered conceptually to be part of the same scenario as described in 9.4.4, SWP to GSWC. Because of the uncertainty of the supply, no model runs were dedicated specifically to this project. It is one of the sources that would provide the benefits to Basin water levels described in Section 9.4.4.

9.4.6.2. Supply Reliability (§ 354.44.6)

The supply reliability of the SWP is discussed in detail in Section 9.4.1.2 and is applicable to this project. This project assumes a total of 50 AFY would be purchased and served to ERMWC and VRMWC.

9.4.6.3. Project Costs (§ 354.44.8)

The estimated capital cost to construct a turnout off from the Coastal Branch Pipeline, infrastructure to connect to the ERMWC and VRMWC is approximately $835,000 which equates to annual payment of $59,000 and a unit cost of $1,180/AF. If multiple projects which require SWP water are implemented, the cost of the turnout and other infrastructure can be shared. These costs do not include the cost to purchase SWP or the work required to negotiate a contract with the SLOCFCWCD or its subcontractors.

9.4.6.4. Project Implementation (§ 354.44.4)

The circumstance for implementation of this project is driven by the overdraft conditions in the Edna Valley The feasibility study into the use of the SWP as a supplemental water source to ERMWC and VRMWC would occur within the first year of implementation. Following the recommendations of the feasibility study, negotiations to acquire SWP from the identified sellers could take up to 5 years. The design and construction of the turnout and pipeline could occur concurrent with the negotiations and occur within 5 years.

9.4.6.5. Basin Uncertainty (§ 354.44.9d)

The addition of SWP as a supplemental water supply source to ERMWC and VRMWC would help address the uncertainty of the estimated overdraft described in Chapter 6 (Water Budget) in the Edna Valley portion of the Basin. The benefits from the projects in terms of improved water levels in the Basin are evaluated using the integrated GSFLOW model. It should be understood that there is uncertainty that is inherent in the modeling process, including uncertainty with respect to parameters describing the subsurface environment, historical volumes of pumping, etc. The Integrated Model Calibration TM (Appendix E) identifies uncertainty and the need for additional data collection in the conceptual model, model parameters, and calibration.

9.4.6.6. Legal Authority (§ 354.44.7)

California Water Code Section10726.2 provides GSAs the authority to purchase, among other things, land, water rights, and privileges. The GSAs have the legal authority to conduct a feasibility study into the obtaining SWP as a supplemental water supply for the SLO Basin. Following the recommendation from the feasibility study the project could be implemented by the GSAs, GSC members or other parties.

9.4.6.7. Permitting and Regulatory Processes (§ 354.44.3)

No permits or regulatory processes would be necessary for development of the feasibility study.

However, implementation of this project will likely require a CEQA environmental review process and may require an Environmental Impact Report or a Mitigated Negative Declaration (the review could also result in a Negative Declaration or Notice of Exemption). Additionally, permits from a variety of state and federal agencies may be necessary, and any project that coordinates with federal facilities or agencies may require NEPA documentation.

A new connection or turnout infrastructure requires coordination and agreements with the SLOCFCWCD, CCWA, and DWR.

9.4.6.8. Public Notice and Outreach (§ 354.44.B)

The public notice and outreach associated with this project would occur through GSA, GSC and/or future governance structure public meetings. If CEQA is required, the project will follow the public noticing requirements required by CEQA.

9.4.7. Price Canyon Discharge Relocation

Sentinel Peak Resources LLC (Sentinel Peak) is an energy company that operates a well field that extracts petroleum hydrocarbons from an area approximately 1-2 miles southwest of Edna Valley in Price Canyon. Sentinel Peak owns and operates a water reclamation facility that treats water to (CSLRCD, 2014) tertiary standards and has an NPDES permit to discharge into Pismo Creek about 1 mile southwest of Highway 227 near Price Canyon Road. The discharge permit is primarily provided for increased flow in Pismo Creek and wildlife propagation with a secondary benefit to agriculture.

The proposed project would change the current point of discharge by about 3.5 miles to the upper portion of West Corral de Piedras Creek in the Edna Valley. The new discharge point would be approximately 1 mile east of Orcutt Road. The project would provide increased benefit to fisheries from increased streamflow, and also benefit Edna Valley agriculture by increasing streamflow percolation to the underlying aquifers. For the purpose of this analysis, it is assumed that 500 AFY of water will be available to deliver to the new discharge location, resulting in an average of 350 AFY of recharge to the Basin.

It is anticipated that a 6-inch diameter 17,760 foot long PVC pipeline would convey the water to the new discharge point. A booster pump would move the water through this pipeline to the new discharge location. The pipeline would cross approximately 6 agricultural properties, whose owners have already expressed their willingness to participate in the project, 4 creek crossings and 1 railroad crossing.

9.4.7.1. Project Benefits (§ 354.44.5)

In order to assess this project's benefits to the aquifer and effects on the sustainability of the Basin, Project Scenario 4 was simulated using the integrated GSFLOW model developed as part of the GSP efforts.

This project assumes a transfer of the 500 AFY of tertiary treated water that is currently discharged from Sentinel Peak's treatment plant to Pismo Creek downstream of the Basin to a new discharge point on West Corral de Piedra Creek near the northern edge of the Basin. Therefore, 500 AFY (0.7 cubic feet per second) was added as inflow to the MODFLOW Stream Flow Routing package in the first model cell representing West Corral de Piedras Creek that is in the Basin. It should be noted that adding this inflow to the stream segment is not equivalent to adding recharge directly to the aquifer. The additional streamflow from the project discharge will be routed downstream in the model and will ultimately result in an increased amount of streamflow percolation to the aquifer. However, this amount of additional streamflow percolation, which would be additional recharge to the aquifer that will benefit the groundwater users in the Basin, is not directly defined by the model user. It is calculated by the model based on the parameters defined in the SFR package. Evaluation of the model water budget results from the baseline and project scenarios indicates that an average of approximately 350 AFY of the 500 AFY project stream inflow associated with this project ultimately percolates to the aquifer to increase storage in the Basin.

Figure 9-5 displays the baseline and project scenario hydrographs for this project for the four Edna Valley wells identified as RMS for the Chronic Lowering of Groundwater Levels Sustainability Indicator (EV-04, EV-09, EV-13, and EV-16). The data indicate that the increase in water levels over the baseline scenario in year 2042 at these wells ranges from 6 feet at EV-16 and EV-13, to 8 feet at EV-04 and EV-09. Inspection of comparative water levels along West Corral de Piedras Creek indicate a water level increase of over 30 vertical feet along the creek itself.

9.4.7.2. Supply Reliability (§ 354.44.6)

The supply reliability of the Price Canyon discharge is tied to the operations related to the extraction of petroleum hydrocarbons from the Price Canyon and the associated permits. The long-term availability of this water source is uncertain.

9.4.7.3. Project Costs (§ 354.44.8)

The estimated capital cost to relocate the discharge point approximately 3.5 miles to West Corral de Piedras Creek is $4,909,000 equating to an annual payment of $375,000 and a unit cost of $750/AF. These costs do not include the cost of the water that will be purchased from Sentinel Peak.

9.4.7.4. Project Implementation (§ 354.44.4)

The circumstance for implementation of this project is driven by the overdraft conditions in the Edna Valley. A mitigated negative declaration/initial study was performed in July 2014 by the Coastal San Luis Resource Conservation District as the lead agency. The feasibility study into the relocation of the Price Canyon discharge point would occur within the first year of implementation. Negotiations between Sentinel Peak and representatives from the Edna Valley Growers MWC have been ongoing throughout the development of this GSP. The design and construction of the turnout and pipeline could occur concurrent with the negotiations and occur within 3 years.

9.4.7.5. Basin Uncertainty (§ 354.44.9d)

The increased recharge to the Edna Valley as the result of the relocation of the Price Canyon discharge point would help address the uncertainty of the estimated overdraft described in Chapter 6 (Water Budget) in the Edna Valley portion of the Basin. The benefits from the projects in terms of improved water levels in the Basin are evaluated using the integrated GSFLOW model. It should be understood that there is uncertainty that is inherent in the modeling process, including uncertainty with respect to parameters describing the subsurface environment, historical volumes of pumping, etc. The Integrated Model Calibration TM (Appendix E) identifies uncertainty and the need for additional data collection in the conceptual model, model parameters, and calibration.

9.4.7.6. Legal Authority (§ 354.44.7)

California Water Code Section10726.2 provides GSAs the authority to purchase, among other things, land, water rights, and privileges.

9.4.7.7. Permitting and Regulatory Processes (§ 354.44.3)

This project may require a CEQA environmental review process and an Environmental Impact Report or a Mitigated Negative Declaration (the review could also result in a Negative Declaration or Notice of Exemption). Additionally, permits from a variety of state and federal agencies may be necessary, and any project that coordinates with federal facilities or agencies may require NEPA documentation.

In addition, permits from the following government organizations that may be required to relocate the Price Canyon Discharge Point include:

- United States Army Corps of Engineers (USACE) – A Regional General Permit may be required if there are impacts to wetlands or connections to waters of the United States.
- California Department of Fish and Wildlife (CDFW) – A Standard Agreement is required if the project could impact a species of concern.
- Environmental Protection Agency (EPA) Region 9 – National Environmental Policy Act (NEPA) documentation must be submitted for any project that coordinates with federal facilities or agencies. Additional permits may be required if there is an outlet or connection to waters of the United States.
- National Marine Fisheries Service (NMFS) – A project may require authorization for incidental take, or another protected resources permit or authorization from NMFS.
- California Department of Transportation (Caltrans) – An Encroachment Permit is required if any state highway will be obstructed

9.4.7.8. Public Notice and Outreach (§ 354.44.B)

The public notice and outreach associated with this project would occur through GSA, GSC and/or future governance structure public meetings. If CEQA is required, the project will follow the public noticing requirements required by CEQA.

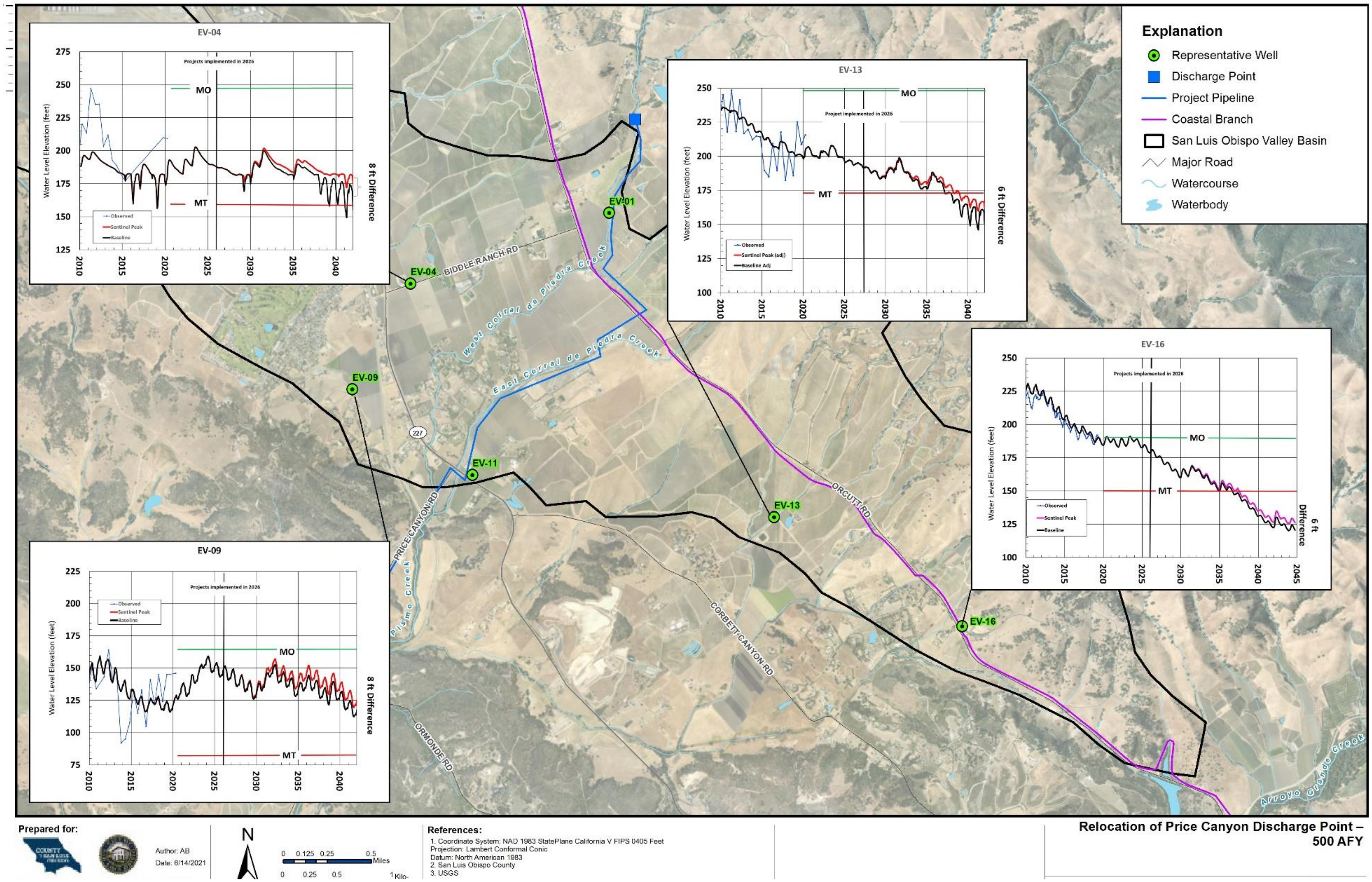


Figure 9-5. Relocation of Price Canyon Discharge Point – 500 AFY

9.4.8. Modeling of Multiple Projects

Basin groundwater modeling results for each of the projects previously discussed has represented the project described exclusively and does not model other projects concurrently. The model results indicate that it is unlikely that any single project presented will, by itself, maintain water levels above the defined MTs at the RMSs. Therefore, an additional model scenario was developed in which multiple projects were represented simultaneously, to demonstrate potential results of a multi-project approach. Technical details of each of the individual projects are presented in the original chapter sections and are not represented here.

The projects that are modeled in this multiple-projects scenario are:

- Reduction of agricultural pumping by 1,000 AFY (Sections 9.4.1, 9.4.2)
- Reduction of Edna Valley water purveyor pumping by 250 AFY (Sections 9.4.4, 9.4.5, 9.4.6, 9.4.7)
- State Water Project Recharge Basin – 500 AFY (Section 9.4.3)
- Relocation of Sentinel Peak WRF discharge –350AFY (Section 9.4.8)

As with the individual modeled project scenarios, all projects are represented as beginning in the year 2026.

Figure 9-6 displays the baseline and Project Scenario 5 hydrographs for the combined projects for the four Edna Valley wells identified as RMS for the Chronic Lowering of Groundwater Levels Sustainability Indicator (EV-04, EV-09, EV-13, and EV-16). The data indicate that the increase in water levels over the baseline scenario in year 2042 at these wells ranges from 39 feet at EV-16 to 63 feet at EV-EV-09. The projected water level increase over baseline was 46 feet at EV-16, and 62 feet at EV-04. These results are summarized in Table 9-6.

This scenario indicates that with all the projects presented incorporated into the management of the Basin, the benefit to water levels is more than required to achieve sustainability. So just as it has been stated previously that no one single project will likely bring the basin into sustainability, this scenario indicates that all of the projects presented are not required to achieve this goal.

Table 9-6 Summary Results of Modeled Scenarios

Scenario	Description	Increase Over Baseline Groundwater Elevations (ft) in 2042			
		EV-04	EV-09	EV-13	EV-16
1	Reduce Agricultural pumping by 1,000 AFY	5	11	24	31
2	500 AFY to Recharge Basin	52	21	4	2
3	Reduce Golden State pumping by 200 AFY. Reduce ERMWC and VRMWC pumping by 50 AFY (combined).	4	15	3	7
4	Discharge 500 AFY as input into West Corral de Piedras Creek at its entrance to the SLO Basin	8	8	6	6
5	Scenarios 1 through 4	62	63	39	46

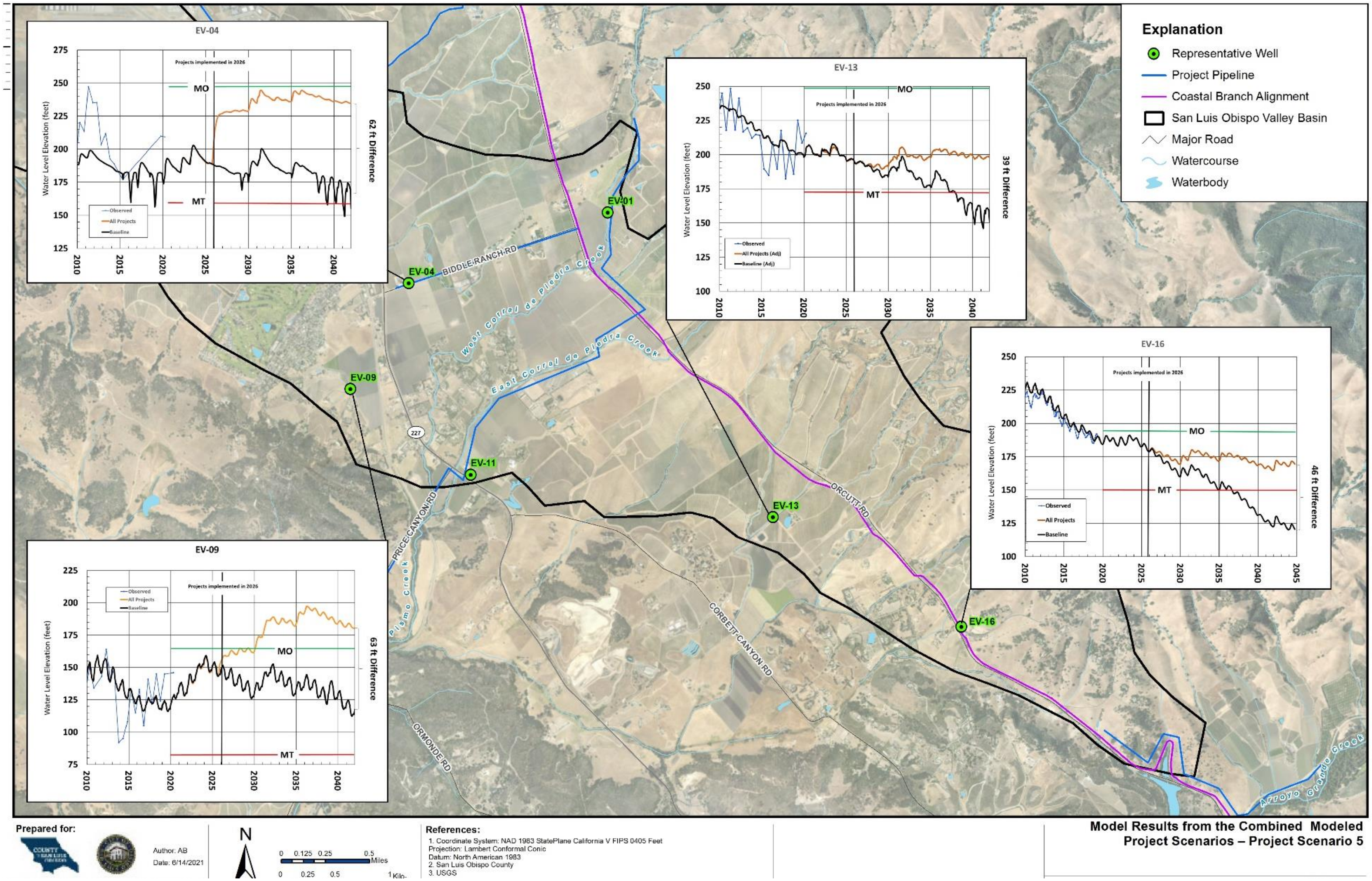


Figure 9-6. Model Results from the Combined Modeled Project Scenarios – Project Scenario 5

9.5. Management Actions

The management actions called for in this plan include the expansion of the monitoring network, development and implementation of a groundwater extraction metering and reporting plan, and the development of a demand management plan.

9.5.1. Expand Monitoring Network

This management action expands the monitoring network from the current SLOCFCWCD monitoring network of 12 wells to the new network of 40 monitoring wells as presented in Chapter 7 (Monitoring Network) within the first two years of the GSP implementation. Chapter 7 describes a proposed monitoring network that has adequate spatial resolution to properly monitor changes to groundwater and surface water conditions relative to SMCs within the Basin. The network will provide data with sufficient temporal resolution to demonstrate short-term, seasonal, and long-term trends in groundwater and related surface conditions. Included in Chapter 7 are recommendations for additional monitoring sites to better understand the groundwater and surface water interactions which include five surface water gages which will be paired with five monitoring wells.

9.5.2. Groundwater Extraction Metering and Reporting Plan

As described in Chapter 6 (Water Budget), groundwater extraction from wells is the primary component of outflow within the groundwater budget. Estimates for historical pumping were derived from various sources, including purveyor records, land use data and water duty factors, and daily soil-moisture budgets. The total estimated groundwater production in the SLO Basin during the water budget period of 2016 to 2019 was approximately 6,000 AFY. Of the 6,000 AFY, only about 5% or 300 AFY is metered. Groundwater purveyor meter records were provided by the City of San Luis Obispo, Golden State Water Company, Edna Ranch MWC, and Varian Ranch MWC. A groundwater extraction metering and reporting plan is a foundational component of the GSP that will facilitate the reporting of groundwater extraction data and the development of a groundwater accounting framework. The collection and reporting of this data will enable the GSAs to adaptively manage the groundwater resources. The location and quantity of agricultural pumping was identified as a significant data gap during the development of the water budget and integrated model. The collection of metered groundwater pumping data will provide a key metric to evaluate the effectiveness of the demand management strategies that will be included in the Demand Management Plan. It is anticipated that the Groundwater Extraction Metering and Reporting Plan will include two components: a de minimis self-certification and non de minimis extraction and reporting program.

SGMA provides the authority of a GSA to meter groundwater production:

- **10725.8. MEASUREMENT DEVICES AND REPORTING; INAPPLICABILITY OF SECTION TO DE MINIMIS EXTRACTORS**
  - *A groundwater sustainability agency may require through its groundwater sustainability plan that the use of every groundwater extraction facility within the management area of the groundwater sustainability agency be measured by a water-measuring device satisfactory to the groundwater sustainability agency*

Under California Water Code Section 10725.8(e) Measurement Devices and Reporting, SGMA exempts de minimis extractors from metering requirements.

9.5.2.1. De Minimis Self-Certification

De minimis extractor means a person who extracts, for domestic purposes, two acre-feet or less per year (CWC § 10721). The GSAs would consider developing an approach and process to allow de minimis extractors to self-certify that they extract two (2) acre-feet or less per year for domestic purposes.

> *§ 1030 g) "***Domestic purposes***" has the same meaning as "domestic uses" as defined in section 660 of Division 3 of Title 23 of the California Code of Regulations for the purposes of identifying if an extractor is a de minimis extractor*
>
> *§ 660. Domestic Uses. Domestic use means the use of water in homes, resorts, motels, organization camps, camp grounds, etc., including the incidental watering of domestic stock for family sustenance or enjoyment and the irrigation of not to exceed one-half acre in lawn, ornamental shrubbery, or gardens at any single establishments. The use of water at a camp ground or resort for human consumption, cooking or sanitary purposes is a domestic use.*

The GSP does not call for the regulation of de minimis extractors. However, growth of de minimis groundwater extractors could warrant regulated use in this GSP in the future. Growth will be monitored and reevaluated periodically. Estimated groundwater extractions from de-minimis users will be documented in the annual reports.

9.5.2.2. Non-De Minimis Extraction and Reporting Program

Water Code Section 10725.8 gives GSAs the power through their GSPs to require measurement of the use of groundwater extraction facilities by non-de minimis extractors. During the first five years of implementation, this GSP calls for the development of a Groundwater Extraction Metering and Reporting Plan for non-de minimis extractors to report extractions using metering devices or other suitable methods. It is anticipated that the Groundwater Extraction Metering and Reporting Plan developed pursuant to this GSP will provide for mandatory metering and reporting consistent with Water Code 10725.8 if, without limitation, there is insufficient voluntary participation and that such mandate would be implemented and enforced via a separately developed regulation. Such regulation could exclude a class of users beyond those that meet the statutory definition of a de minimis extractor if warranted and consistent with the objectives of this GSP.

9.5.3. Demand Management Plan

Water Code Section 10726.4 gives GSAs the power to control extractions by, among other things, regulating, limiting or suspending extractions subject to certain requirements or limitations. This GSP calls for the development of a Demand Management Plan that will include the documentation of water conservation measures taken by purveyors, irrigation efficiencies of the agricultural fields, water efficient crop conversion, and volunteer crop fallowing. The Demand Management Plan may also provide for mandatory pumping limitations consistent with Water Code Section 10726.4 which would be implemented and enforced via a separately developed regulation.

Such regulation would need to be based on the development of a defensible methodology under SGMA, and may be based on the development of a methodology for determining (1) baseline pumping in specific areas considering groundwater level trends in areas of decline, estimated available volume of water in those areas, and land uses and corresponding irrigation requirements; and (2) whose use must be limited and by how much considering, though not limited to, water rights, water conservation measures, and evaluation of anticipated benefits from projects bringing in supplemental water or other relevant actions individual extractors take.

9.5.3.1. Water Conservation Measures

The purveyors in SLO Basin have implemented significant water conservation measures during the most recent drought. The following sections summarize the water conservation measures that the metered purveyors (City of SLO, GSWC, VRMWC, ERMWC) have taken to reduce their water use and will be described in more detail in the demand management plan.

City of SLO

The City of San Luis Obispo has had a defined water conservation program since the 1970s. As an original signatory to the California Urban Water Conservation Council, the City has not maintained effective water conservation programs for several decades. In an effort to preserve groundwater supplies, the City has made significant investments in three surface water reservoirs and a recycled water program.

Today the City's per-capita water use is amongst the lowest in the state and is approximately half of what it was in the late 1980s. The City's current GPCD water demand is approximately 92 and has seen virtually no increase since the end of the 2012-2015 drought. City staff anticipate that GPCD water use within the City will continue to decrease as the State of California adopts enhanced conservation and water use efficiency mandates.

Mutual Water Companies

Edna Ranch East and Varian Ranch MWCs have implemented water conservation measures in response to Basin conditions and the drought since 2014.

The MWC's presented a technical memorandum at the December 9, 2020 GSC Meeting which documented the conservation measures taken by the MWC's and is summarized below (Wallace Group, 2020)**:**

- New monitoring technology, combined with conservation policies, have resulted in well water production of 35% compared to the 2013 baseline year, and 26% compared to the 10 year period of 2005 through 2014.
- The combined groundwater production of the MWC's (75 AFY on average over the last 5 years) and represents approximately 2% of the total production in the Edna Valley.

Golden State Water Company

In response to the Governor's Executive Order (B-29-15) the State Water Resources Control Board (Water Board) imposed restrictions to achieve a statewide 25% reduction in potable urban water usage through February 28, 2016.

These restrictions will require water consumers to reduce usage as compared to the amount they used in 2013. (GSWC, 2015)**. A Staged Mandatory Conservation and Ration Plan was developed and implemented in 2015. GSWC's Edna System is currently in Stage 2 which includes the following conservation measures:**

- Stage 1: Outdoor irrigation limited to two days per week, before 8 AM or after 7 PM; even addresses on Sunday and Wednesday, odd addresses on Tuesday and Saturday
- Stage 2: Irrigation restrictions from Stage 1; $2.50 emergency surcharge per CCF over allocation

GSWC has reduced the groundwater production from about 318 AFY in 2013 to approximately 210 AFY in 2019.

9.5.3.2. Irrigation Efficiency Improvements

Many of the agricultural users of groundwater in the Basin have implemented efficient irrigation methods and more is envisioned by agricultural operations to improve the irrigation efficiencies. There are potential irrigation efficiency benefits to the Basin that can be realized by changing the irrigation methods for some types of crops. Irrigation efficiency refers to the ratio of the amount of water consumed by the crop to the amount of water supplied through irrigation. Some irrigation water may be lost to evaporation, to surface runoff, or to deep percolation past the plant root zone. However, some of the deep percolation water may return to the underlying aquifer as illustrated later in this section. Irrigation methods vary in how efficient they utilize water, thus leaving an opportunity for modification in irrigation methods to result in reductions in water use. For example, flood irrigation is less efficient than spray irrigation, which is less efficient than drip irrigation applied at the surface, which is less efficient than drip irrigation applied directly to the root zone. Other on-farm water conservation measures may be implemented to improve irrigation efficiencies such as irrigation water management practices and measurement of pump flows. If a large enough area of agricultural fields converts to more efficient methods of irrigation, there may be a net benefit to the Basin that could offset needs for direct pumping reductions. A key component to understanding the net benefit (gain) in water savings is the concept of irrigation return flow, i,e, the amount of water that percolates past the root zone, to ultimately reach and recharge the underlying aquifer. The following analysis demonstrates an example of this concept.

Figure 9-7 uses data that are approximately representative of conditions in Edna Valley. If it is assumed that the consumptive demand of a specified area of crops is 3,520 AFY, the amount of required water and calculated irrigation return flow to the aquifer under varying assumptions of irrigation efficiency may be significantly different. Figure 9-7 presents a visual presentation of this analysis and documents how improvements to irrigation efficiency can result in recovery of groundwater levels.

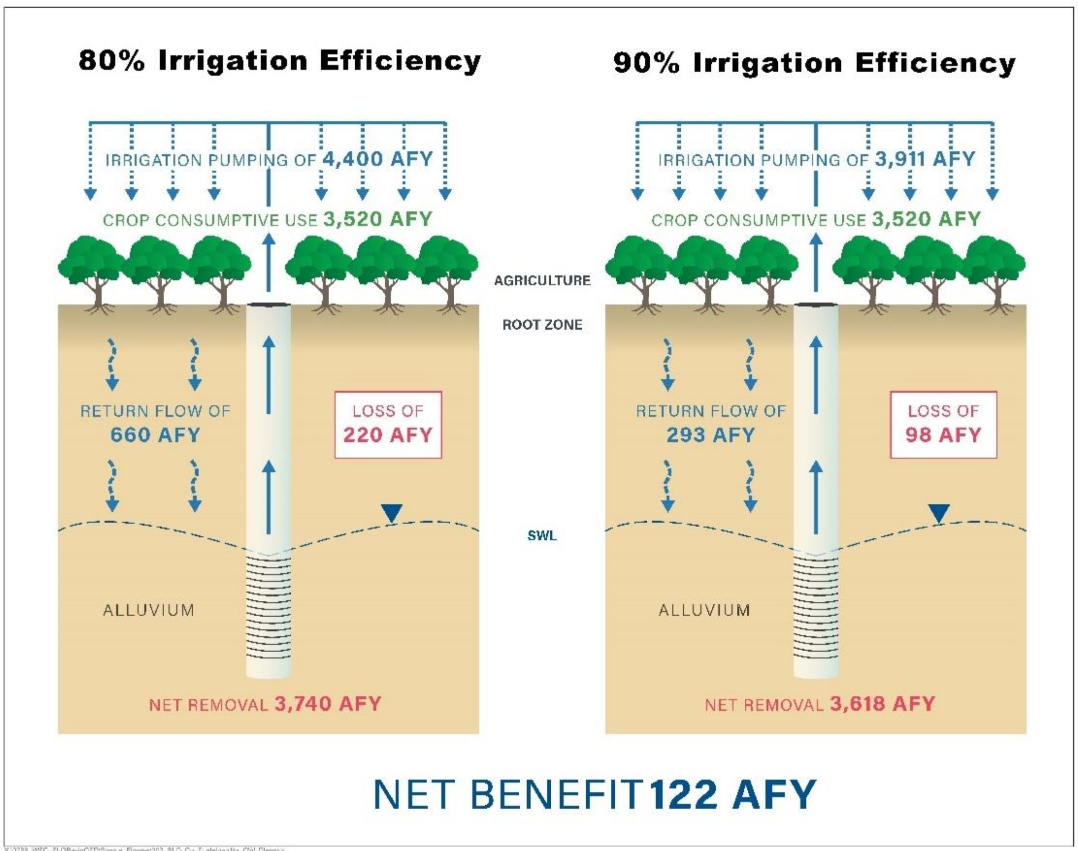


Figure 9-7. Irrigation Efficiency Comparison

Under the assumption of 80% irrigation efficiency, groundwater pumping of 4,400 AFY is required to provide the crop consumptive demand of 3,520 AFY (i.e., 3520/4400 = 80%). This results in 880 AFY of pumped water that is not directly up taken by the crop. For this analysis the assumption used in Chapter 6 (Water Budget) calculations is that 75% of the unused water reaches to the aquifer as return flow. (It is assumed the remainder is lost to evaporation or permanent entrapment in the vadose zone pore space). Therefore, 660 AFY reaches the aquifer as return flow. Thus, the net removal from the aquifer in this example is 3,740 AFY (4,400 AFY pumped reduced by 660 AFY of return flow).

If it is assumed that conversion to more efficient irrigation methods result in overall irrigation efficiency of 90%, groundwater pumping of 3,911 AFY is required to provide the crop consumptive demand of

3,520 AFY (i.e., 3520/3911= 90%). This results in 391 AFY of pumped water that is not directly up taken by the crop. Under the same assumptions as previously discussed, 293 AFY reaches the aquifer as return flow and 98 AFY is lost. Thus, the net removal from the aquifer in this example is 3,618 AFY (3,911 AFY pumped reduced by 293 AFY of return flow).

The difference in net removal from the aquifer under the assumptions of improved irrigation efficiency, displayed on Figure 9-7, is 122 AFY. This, then, is the net benefit to the aquifer of improving irrigation efficiency from 80% to 90%.

It is acknowledged that this example calculation is conceptual. Although groundwater pumping is easily measured, it is very difficult to accurately measure irrigation return flow, or the evaporative losses of applied irrigation. However, the hydrologic assumptions behind this analysis are well founded and commonly accepted in the industry. Therefore, this analysis demonstrates that conceptually there may be a net benefit to the aquifer if irrigation efficiency is improved basin wide. 122 AFY of water is approximately 10% of the Edna Valley overdraft calculated in Chapter 6 (Water Budget). This indicates that overall improved irrigation efficiency can be a significant contributor to bringing the Basin into sustainability.

With the implementation of the Groundwater Extraction and Metering Plan, the agricultural entities that implement improved irrigation methods will be able to document the improvements with reported meter readings.

9.5.3.3. Volunteer Water Efficient Crop Conversion

Chapter 6 (Water Budget) describes the applied water demand by crops within the SLO Basin. These crop types included citrus, deciduous (non-vineyard), pasture, vegetable, vineyard, and turfgrass. Estimates of per-acre annual water demand are shown in Table 9-7 below:

Table 9-7. Consumptive Use of Applied Water and Total Irrigated Acreage by Land Use/Land Cover Type

	ACRE-FEET PER ACRE PER YEAR			
LAND USE/ LAND COVER	LOW	MED	HIGH	ACREAGE 2018
Citrus	1.1	1.6	2.2	256
Deciduous	1.8	2.2	2.5	20
Pasture	2.6	3.1	3.7	41
Vegetables[1]	1.4	1.6	2	768
Vineyard	0.5	0.6	0.8	2410
Turfgrass[2]	2	2.6	4.1	164

[1]60 percent of ET applied water to account for fallow fields

[2]Turfgrass represents irrigated turf i.e. lawns, golf courses, etc

As shown above, crop types use different quantities of water per year and the conversion from a less efficient crop would reduce the overall groundwater demand. This voluntary water efficient crop conversion program may be included in the Demand Management Plan.

9.5.3.4. Volunteer Land Fallowing

The Voluntary Fallowing Program will create a process to convert high water use irrigated agricultural lands to low water use open space or other less water intensive land use on a voluntary basis. The program would be similar to the volunteer water efficient crop conversion program and the resulting benefit would depend on the initial crop type. This voluntary fallowing program may be included in the Demand Management Plan.

9.5.3.5. Pumping Limitations

The projects and management actions described above are developed to maintain groundwater levels above minimum thresholds through in-lieu pumping limitations or increased recharge. As a result, it is anticipated that the Demand Management Plan will prioritize the development of water conservation measures, irrigation efficiencies, volunteer water efficient crop conversion and the volunteer fallowing of crops to avoid direct mandatory pumping limitations. Mandatory pumping limitations may be required if the criteria for undesirable results for the sustainability indicators as described in Chapter 8 (Sustainable Management Criteria) are met.

Any mandatory pumping limitations would be implemented and enforced via a separately developed and adopted regulation. Such regulation would need to be based on the development of a defensible methodology under SGMA, and may be based on the development of a methodology for determining (1) baseline pumping in specific areas considering groundwater level trends in areas of decline, estimated available volume of water in those areas, and land uses and corresponding irrigation requirements, and (2) whose use must be limited and by how much considering, though not limited to, water rights, implementation of water conservation measures and other management actions, and evaluation of anticipated benefits from projects bringing in supplemental water or other relevant actions individual extractors take. It is anticipated that any such regulation would exclude de minimis extractors as defined in SGMA and may also exclude other classes of extractors that don't meet the statutory definition if such exclusion is warranted (e.g., based on certain conditions such as conservation efforts) and compatible with the objectives of this GSP.

Supplemental water projects that are implemented for existing residential or irrigated agriculture uses are likely to require proactive demand management, especially with reference to the planting of new irrigated crops, the replacement of existing crops with those of higher demand, or the implementation of other related land uses that require additional basin production. Otherwise, the benefits of a supplemental water supply will be reduced or eliminated by offsetting increases in demand from new planting or residential uses. Residential or agricultural demand management measures are expected to be documented in the Demand Management Plan, in collaboration with the residential or agricultural stakeholders funding the related supplemental water projects.

9.6. Adaptive Management (§ 354.44A)

Adaptive management allows the GSAs to react to the success or lack of success of actions and projects implemented in the Basin and to make management decisions to redirect efforts in the Basin to more effectively achieve sustainability goals. The GSP process under SGMA requires annual reporting and updates to the GSP at minimum every 5 years. These requirements provide opportunities for the GSAs to evaluate progress towards meeting its sustainability goals and avoiding undesirable results.

Adaptive management triggers are thresholds that, if reached, initiate the process for considering implementation of adaptive management actions or projects. For SLO Bain, the trigger for adaptive management is the following:

- If analytical or modeled projections anticipate that future conditions will exceed the undesirable result thresholds, then the preparation for implementation of additional projects and management actions would begin.
- If actual conditions exceed the undesirable result thresholds, then additional projects and management actions will be implemented

10

GROUNDWATER SUSTAINABILITY PLAN

Implementation Plan

This chapter is intended to serve as a conceptual roadmap for each Groundwater Sustainability Agency (GSA) to start implementing the Groundwater Sustainability Plan (GSP) over the first five years and discusses implementation effects in accordance with the Sustainable Groundwater Management Act (SGMA) regulations sections 354.8(f)(2) and (3).

IN THIS CHAPTER

- GSP Implementation Schedule and Costs
- Funding
- Reporting

A general schedule showing the major tasks and estimated timeline for the GSP implementation is provided in Figure 10-1.

The implementation plan provided in this chapter is based on current understanding of Basin conditions and includes consideration of the projects and management actions included in Chapter 9, as well as other actions that are needed to successfully implement the GSP including the following:

- GSP implementation, administration, and management
- Funding
- Reporting, including annual reports and 5-year evaluations and updates

10.1. GSP Implementation, Administration, and Management

10.1.1. Administrative Approach/Governance Structure

The City and County (GSAs) and the participating parties will continue to operate under the existing MOA, including the existing governance structure, until actions are taken amending/revising the existing MOA or developing new agreements (e.g., joint power agreement). The existing MOA is included in Appendix A and will automatically terminate upon DWR's approval of the GSP for the Basin. During DWR's GSP review process, the GSAs intend to revisit the governance structure before the GSP is approved to better serve the implementation of the GSP. For example, the updated governance structure could be established through a new agreement between the GSAs that supersedes the existing MOA. The agreement would outline details and responsibilities for GSP administration and implementation among the participating entities and may include provisions to establish other advisory bodies to advise the GSAs on GSP implementation, updates, etc.

10.1.2. Implementation Schedule

Figure 10-1 illustrates the GSP implementation schedule. Included in the chart are activities necessary for ongoing GSP monitoring and updates, as well as tentative schedules for the development of projects and management actions. Additional details about the activities included in the schedule are provided in these activities' respective sections of this GSP. Adaptive management and mandatory demand management would only be implemented if triggering events are reached, as described in Chapter 9 (Projects and Management Actions) and are shown as ongoing in the schedule.

10.1.3. Implementation Costs

Implementation of this GSP is estimated to cost approximately $965,000 per year for the first five years of implementation, excluding the planning and development of the specific projects listed in Chapter 9. Costs related to the various activities anticipated for the first five years are shown in Table 10-1. Estimates of future annual implementation costs (Years 6 through 20) will be developed during future updates of the GSP, which will include the development of the various anticipated projects. The costs of specific projects and management actions will like vary year by year, based in part on needed adaptive management activities.

10.1.3.1. Administration and Finance

The Administration and Finance implementation activities include the following: GSP Administration Development, Ongoing GSP Implementation, Fee Study, Funding Mechanism Implementation, Demand Management Plan. The total estimated cost during the initial five years of the GSP implementation is approximately $2,850,000 and is shown in Table 10-1. It is anticipated that the Administrative and Finance Costs will be paid for by regulatory fees and will be analyzed as part of the fee study as described in Section 10.2.2.

ID	Task Name	Duration	Start
1	**San Luis Basin GSP Implementation**	**5208 days**	**Mon 1/31/22**
2	**GSP Approval**	**480 days**	**Mon 1/31/22**
3	Plan Submittal to DWR	0 days	Mon 1/31/22
4	DWR Review and Approval	24 mons	Mon 1/31/22
5	**Administration and Finance**	**5200 days**	**Mon 1/31/22**
6	Administrative Approach/Governance Structure	12 mons	Mon 1/31/22
7	**Financing Plan**	**5200 days**	**Mon 1/31/22**
8	Fee Study	12 mons	Mon 1/31/22
9	Funding Mechanism Implementation	12 mons	Mon 1/2/23
10	Fee Collection	236 mons	Mon 12/4/23
11	Public Coordination and Outreach	248 mons	Mon 1/2/23
12	Adaptive Management	260 mons	Mon 1/31/22
13	**Management Action Implementation**	**5200 days**	**Mon 1/31/22**
14	Demand Mangement Plan	24 mons	Mon 1/31/22
15	Demand Management Implementation	236 mons	Mon 12/4/23
16	**Monitoring Network Implementation**	**5200 days**	**Mon 1/31/22**
17	Groundwater Metering and Reporting Plan	12 mons	Mon 1/31/22
18	Develop Monitoring Program	12 mons	Mon 1/31/22
19	Monitoring Program	248 mons	Mon 1/2/23
20	**Project Implementation**	**5200 days**	**Mon 1/31/22**
21	Supplemental Water Feasibility Study	12 mons	Mon 1/31/22
22	Agreement Negotiation	6 mons	Mon 1/2/23
23	Planning/Design	12 mons	Mon 6/19/23
24	Construction	12 mons	Mon 5/20/24
25	Operation	218 mons	Mon 4/21/25
26	**Reporting**	**5208 days**	**Mon 1/31/22**
27	**Annual Reports**	**4956 days**	**Fri 4/1/22**
48	**5-Yr GSP Evaluation/Update**	**5208 days**	**Mon 1/31/22**
49	Evaluate/Refine SMCs	260 mons	Mon 1/31/22
50	Update Integrated Model	260 mons	Mon 1/31/22
51	5-Yr Report/GSP Evaluation/Integrated Model Update 1	0 days	Thu 4/1/27
52	5-Yr Report/GSP Evaluation/Integrated Model Update 2	0 days	Thu 4/1/32
53	5-Yr Report/GSP Evaluation/Integrated Model Update 3	0 days	Wed 4/1/37
54	GSP Updates (if needed)	193 mons	Thu 4/1/27

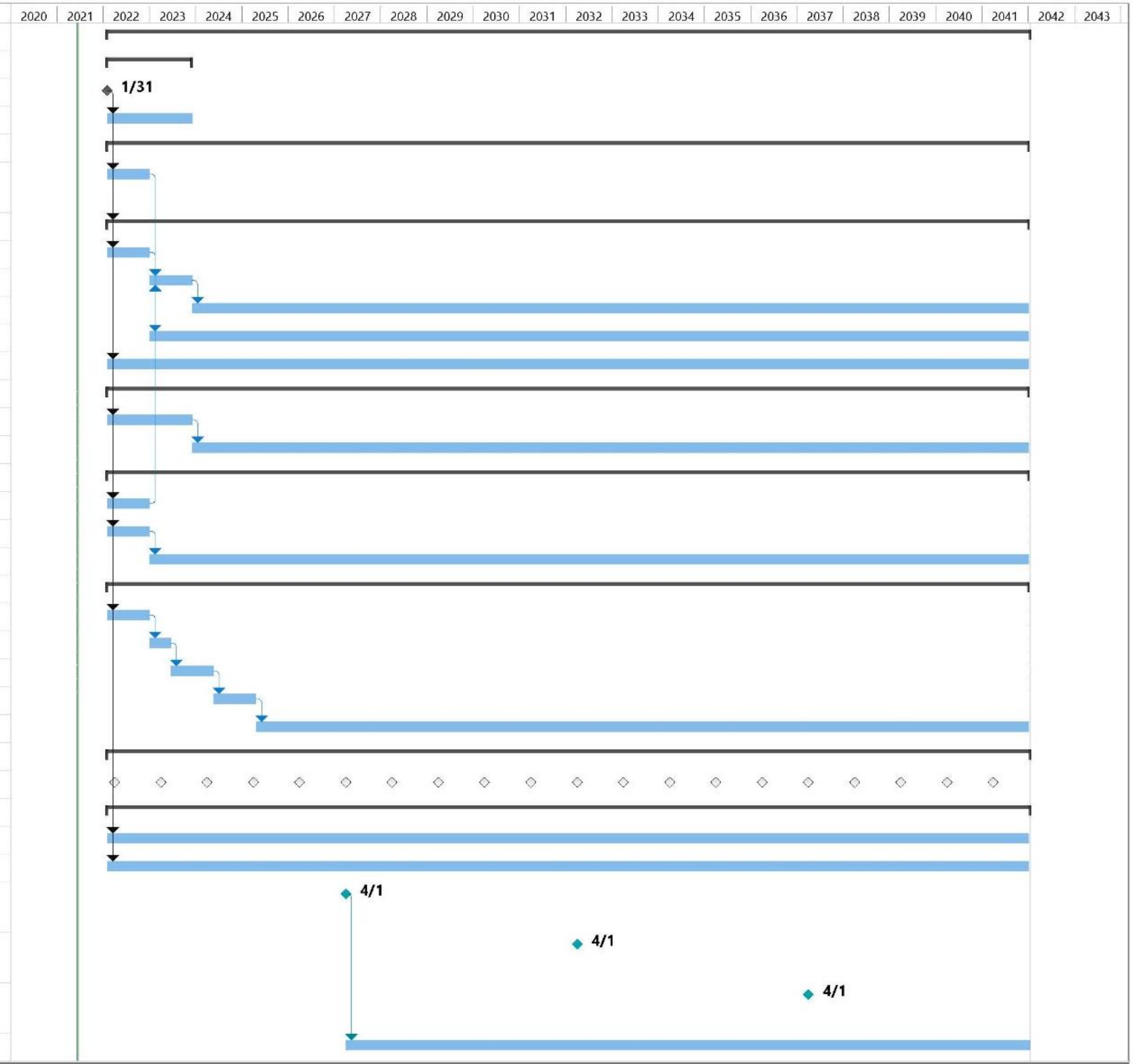


Figure 10-1. SLO Basin GSP Implementation Schedule

10.1.3.2. Monitoring Network Implementation

The Monitoring Network Implementation includes the development of a groundwater metering and reporting plan via regulation, development and implementation of a monitoring program, and conducting annual monitoring. The Groundwater Metering and Reporting Plan is described in detail in Section 9.5 Management Actions and will provide a key metric to evaluate the effectiveness of the demand management strategies and enable the GSAs to adaptively manage the Basin. The monitoring program is described in detail in Chapter 7 (Monitoring Network) and the development and implementation of the monitoring network is targeted to monitor changes to groundwater and surface water conditions relative to SMCs within the Basin. The annual monitoring is the execution of the data collection required to complete the Annual Reports. The total estimated cost during the initial five years of the GSP implementation is approximately $875,000 as shown in Table 10-1. It is anticipated that the Monitoring Network Implementation will be paid for by regulatory fees and will be analyzed as part of the fee study as described in Section 10.2.2.

10.1.3.3. Project Implementation

Project implementation is anticipated to include the following steps: Supplemental Water Feasibility Study; Planning and Design; Construction and Operation. The initial step for project implementation is anticipated to include completion a Supplemental Water Feasibility Study to further evaluate the different supplemental water supply options (e.g., SWP, Recycled Water, Price Canyon Discharge Water, etc.) described in Chapter 9 (Projects and Management Actions). This evaluation will include a more granular analysis of the parameters associated with each of the different supplemental supply options available to address the overdraft in the basin, including assessment of seasonal supply availability and demand patterns, hydraulic capacity, costs of supplemental water, environmental/permitting requirements, and updated infrastructure and operation & maintenance costs. The feasibility study will also include additional groundwater model scenario analysis to further determine beneficiaries of the individual projects to assist in developing equitable project cost sharing mechanisms.

The findings from the Supplemental Water Feasibility Study will be utilized to inform agreement negotiations and planning/design of the preferred supplemental water supply projects for the basin. It is anticipated that the Projects will be paid for by project proponents/beneficiaries and costs associated with project implementation is not included in the GSP Implementation Budget estimate shown in Table 10-1. Specific details regarding the cost share mechanisms are anticipated to be determined after the preferred supplemental water projects are identified and further defined. Additionally, it is anticipated that grant funding would be available to assist with project implementation, see Section 10.2.3.

10.1.3.4. Reporting

SGMA regulations require the GSAs to submit annual reports to DWR on the status of GSP implementation. The reporting requirements are presented in Section 10.3.1. SGMA regulations require the GSAs to evaluate the GSP at least every 5 years and whenever the Plan is amended. The reporting requirements for the periodic evaluation are presented in Section 10.3.2. The initial 5-year GSP evaluation is due for submission to DWR in April 2027. The estimated cost to prepare an annual report is $100,000/year and the cost for the initial Five Year GSP update is estimated to be $500,000, equating to a total of $1,000,000 over the initial five years of the GSP implementation. It is anticipated that the Reporting Costs will be paid for by regulatory fees and will be analyzed as part of the fee study as described in Section 10.2.2.

10.1.4. Outreach and Communication

To meet the requirements of SGMA, implementation of the GSP will require additional communication and outreach efforts and coordination among the City and County GSAs and stakeholder groups. The GSP calls for GSAs to routinely provide information to the public about GSP implementation and ongoing sustainable management of the Basin. The GSP calls for a website to be maintained as a communication tool for posting data, reports, and meeting information. The website may also include forms for on-line reporting of information needed by the GSAs (e.g., annual pumping amounts) and an interactive mapping function for viewing Basin features and monitoring information.

10.2. Funding

The budget information included in Section 10.1.3 will be used to conduct a fee study which could include development of funding mechanisms to cover the costs of implementing the regulatory programs described in the GSP. This fee could include costs related to monitoring and reporting, hydrogeologic studies, pumping reduction or limitations enforcement (if necessary), public outreach, and other related costs. Project implementation costs are anticipated to be covered by the project proponents and the associated beneficiaries. Project implementation costs may be evaluated as part of the Supplemental Water Feasibility Study.

10.2.1. GSP Implementation Funds

Development of this GSP was partially funded through a Proposition 1 Sustainable Groundwater Planning Grant from DWR, along with in-kind contributions from the GSAs and GSC members. Although ongoing implementation of the GSP could include contributions from its member agencies, which are ultimately funded through customer fees or other public funds, additional funding would be required to implement the GSP. Included in the GSP implementation is a Fee Study that will evaluate multiple approaches for funding the ongoing administration and implementation of the GSP.

10.2.2. Fee Study

The GSAs plan to perform a fee study to evaluate and provide recommendations for developing GSP implementation funding mechanisms. This study may include focused public outreach and meetings to educate and solicit input on the potential fee structures/funding mechanisms (i.e., pumping fees, assessments, or a combination of both). California Water Code Sections 10730 and 10730.2 provide GSAs with the authority to impose certain fees, including fees on groundwater pumping. Any imposition of fees, taxes or other charges would need to follow the applicable protocols outlined in the above referenced water code sections and all applicable Constitutional requirements based on the nature of the levy. It is anticipated that the fee study will cover the costs associated with the Administrative and Finance, Monitoring Network Implementation, and Reporting. The Fee Study is not anticipated to cover the costs associated with project implementation.

10.2.3. Grant/Low Interest Financing

The GSAs may pursue grants and low-interest financing to help pay for GSP implementation costs to the extent possible. If grants or low-interest financing is obtained for GSP implementation it could be utilized to offset costs for the GSAs and basin pumpers. However, as mentioned previously external funding/financing may only be eligible for project and management action implementation and not ongoing GSP administrative expenses.

10.3. Reporting

As part of GSP implementation, SGMA Regulation Section 356.2 requires the GSAs to develop annual reports and more detailed five-year evaluations, which could lead to updates of the GSP. The following sections describe the reporting requirements for both the annual reports and five-year evaluations.

10.3.1. Annual Reports

Annual reports will be developed to address current needs in the Basin and the legal requirements of SGMA. As defined by DWR, annual reports must be submitted for DWR review by April 1st of each year following the GSP adoption, except in years when five-year or periodic assessments are submitted. Annual reports are anticipated to include three key sections: General Information, Basin Conditions, and Implementation Progress. The GSAs will compile information relevant to annual reports and the Basin Point of Contact will coordinate collection of information and submit a single annual report for the Basin to DWR.

10.3.1.1. General Information

The General Information section will include an executive summary that highlights the key content of the annual report. This section will include a map of the Basin, a description of the sustainability goals, a description of GSP projects and their progress, as well as an annual update to the GSP implementation schedule.

10.3.1.2. Basin Conditions

Basin conditions will describe the current groundwater conditions and monitoring results in the Basin. This section will include an evaluation of how conditions have changed over the previous year and will compare groundwater data for the water year to historical groundwater data.

Pumping data, effects of project implementation (if applicable), surface water deliveries, total water use, and groundwater storage data will be included. Key required components include:

- Groundwater level data from the monitoring network, including contour maps of seasonal high and seasonal low water level maps
- Hydrographs of groundwater elevation data at RMS
- Groundwater extraction data by water use sector
- Groundwater Quality at RMS
- Surface water supply availability and use data by water use sector and source
- Streamflow
- Total water use data
- Change in groundwater in storage, including maps for the aquifer
- Subsidence rates and associated survey data

10.3.1.3. Implementation Progress

Progress toward GSP implementation will be included in the annual report.

This section of the annual report will describe the progress made toward achieving interim milestones as well as implementation of projects and management actions. Key required components include:

- GSP implementation progress, including proposed changes to the GSP

- Progress toward achieving the Basin sustainability goals

Development of an annual report will begin following the end of the water year, September 30, and will include an assessment of the previous water year. The annual report will be submitted to DWR before April 1st of the following year. The 2021 annual report covering water year 2021 will be submitted by the GSAs by April 1, 2022. Five annual reports for the Basin will be submitted to DWR between 2022 and 2026, prior to the first five-year assessment of this GSP, which is to be submitted to DWR in January 2027.

10.3.2. Five-Year Evaluation Reports

As required by SGMA regulations, an evaluation of the GSP and the progress toward meeting the approved sustainable management criteria and the sustainability goal will occur at least every five years and with every amendment to the GSP. A written five-year evaluation report (or periodic evaluation report) will be prepared and submitted to DWR. The information to be included in the evaluation reports is provided in the sections below.

10.3.2.1. Sustainability Evaluation

A Sustainability Evaluation will contain a description of current groundwater conditions for each applicable sustainability indicator and will include a discussion of overall sustainability in the Basin. Progress toward achieving interim milestones and measurable objectives will be included, along with an evaluation of status relative to minimum thresholds. If any of the adaptive management triggers are found to be met during this evaluation, a plan for implementing adaptive management as described in Section 9.6 of this GSP will be included.

10.3.2.2. Plan Implementation Progress

A Plan Implementation Progress section will describe the current status of project and management action implementation and whether any adaptive management actions have been implemented since the previous report. An updated project implementation schedule will be included, along with any new projects identified that support the sustainability goals of the GSP and a description of any projects that are no longer included in the GSP. The benefits of projects and management actions that have been implemented will be described and updates on projects and management actions that are underway at the time of the report will be documented.

10.3.2.3. Reconsideration of GSP Elements

As additional monitoring data are collected, land uses and community characteristics change, and GSP projects and management actions are implemented, it may become necessary to reconsider elements of this GSP and revise the GSP as appropriate. GSP elements to be reassessed may include basin setting, management areas, undesirable results, minimum thresholds, and measurable objectives. If appropriate, a revised GSP, completed at the end of the five-year assessment period, will include revisions informed by findings from the monitoring program and changes in the Basin, including changes to groundwater uses, demands, or supplies, and results of project and management action implementation.

10.3.2.4. Monitoring Network Description

A description of the monitoring network will be provided. An assessment of the monitoring network's function will be included, along with an analysis of data collected to date. If data gaps are identified, the GSP will be revised to include a method for addressing these data gaps, along with an implementation schedule for addressing gaps and a description of how the GSA will incorporate updated data into the GSP.

Table 10-1. GSP Implementation Costs (2022-2027)

GSP IMPLEMENTATION ACTIVITY	DESCRIPTION	ESTIMATED COST	UNIT	ANTICIPATED TIMEFRAME	ESTIMATED COSTS (2022 -2027)
Administrative and Finance					
GSP Administration Development	Develop Administrative Approach/Governance Structure for GSP Implementation	$100,000	Lump Sum	Q1-4, 2022	$100,000
Ongoing GSP Implementation	Routine GSP Administration (including staffing, overhead expenses, equipment, outreach and communication, etc.)	$500,000	Annual	2021 - 2025	$2,500,000
Fee Study	Prepare a fee study to evaluate and provide recommendations for GSP implementation funding mechanisms	$150,000	Lump Sum	Q1-4, 2022	$150,000
Funding Mechanism Implementation	Implement and begin collecting GSP Implementation fees	$100,000	Lump Sum	Q1-4, 2023	$100,000
Demand Management Plan	The demand management plan will include the documentation of water conservation measures, and develop programs for volunteer water efficient crop conversion, volunteer fallowing of crops, and pumping reductions, etc. in a stakeholder driven process.	$100,000	Lump Sum	2022 - 2023	$100,000
Monitoring Network Implementation					
Groundwater Metering and Reporting Plan	Develop a plan to establish and maintain a groundwater pumping, metering, and reporting plan (does not include meters and installation)	$150,000	Lump Sum	Q1-4, 2022	$150,000
Monitoring Program	Conduct survey of proposed monitoring well network to verify locations and elevations, and video logging if applicable	$100,000	Lump Sum	Q1-4, 2022	$100,000
	Construction of 5 new monitoring wells and 5 surface water gages for GW/SW interaction, transducers and surveying	$500,000	Lump Sum	Q1-4, 2022	$500,000
Annual Monitoring	Complete annual monitoring (Field work)	$25,000	Annual	Q1-4, 2022	$125,000
Project Implementation					
Supplemental Water Feasibility Study		Costs estimates for the Supplemental Water Feasibility Study, Planning/Design and Construction of Supplemental Water Projects not included in the initial 5-Yr budget.			
Planning/Design					
Construction					
Reporting					
Annual Reports	Compile data and prepare GSP Annual Report	$100,000	Annual	2021 - 2025	$500,000
5-Yr GSP Updates	Compile data and prepare 5-yr GSP Updates, including Integrated Model updates	$500,000	Lump Sum	Q2, 2026 - Q1, 2027	$500,000
				TOTAL ESTIMATED COSTS (2022 - 2027)	**$4,825,000**
				AVERAGE ANNUAL ESTIMATED COST (2022 - 2027)	**$965,000**

10.3.2.5. New Information

New information available since the last five-year evaluation or GSP amendment will be described and evaluated. If the new information should warrant a change to the GSP, this will also be included, as described previously in Reconsideration of GSP Elements.

10.3.2.6. Regulations or Ordinances

A summary of the regulations or ordinances related to the GSP that have been implemented by DWR or others since the previous report will be provided. The report will include a discussion of any required updates to the GSP.

10.3.2.7. Legal or Enforcement Actions

Legal or enforcement actions taken by the GSA in relation to the GSP will be summarized, including an explanation of how such actions support sustainability in the Basin.

10.3.2.8. Plan Amendments

A description of amendments to the GSP will be provided in the five-year evaluation report, including adopted amendments, recommended amendments for future updates, and amendments that are underway.

10.3.2.9. Coordination

Ongoing coordination will be required among the GSA, members of the GSC, and the public. The five-year evaluation report will describe coordination activities between these entities such as meetings, joint projects, data collection and sharing, and groundwater modeling efforts.

10.3.2.10. Reporting to Stakeholders and the Public

Outreach activities associated with the GSP implementation, assessment, and GSP updates will be documented in the five-year evaluation report.

11

GROUNDWATER SUSTAINABILITY PLAN

References

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Article 5.			Plan Contents for San Luis Obispo Valley Basin	GSP Document References				
				Page Numbers of Plan	Or Section Numbers	Or Figure Numbers	Or Table Numbers	Notes
§ 354.			**Introduction to Plan Contents**					
			This Article describes the required contents of Plans submitted to the Department for evaluation, including administrative information, a description of the basin setting, sustainable management criteria, description of the monitoring network, and projects and management actions.					
			Note: Authority cited: Section 10733.2, Water Code.					
			Reference: Section 10733.2, Water Code.					
SubArticle 1.			**Administrative Information**					
§ 354.2.			**Introduction to Administrative Information**					
			This Subarticle describes information in the Plan relating to administrative and other general information about the Agency that has adopted the Plan and the area covered by the Plan.					
			Note: Authority cited: Section 10733.2, Water Code.					
			Reference: Section 10733.2, Water Code.					
§ 354.4.			**General Information**					
			Each Plan shall include the following general information:					
(a)			An executive summary written in plain language that provides an overview of the Plan and description of groundwater conditions in the basin.					Executive Summary is included in the GSP.
(b)			A list of references and technical studies relied upon by the Agency in developing the Plan. Each Agency shall provide to the Department electronic copies of reports and other documents and materials cited as references that are not generally available to the public.		11			Section 11 is a Reference List
			Note: Authority cited: Section 10733.2, Water Code.					
			Reference: Sections 10733.2 and 10733.4, Water Code.					
§ 354.6.			**Agency Information**					
			When submitting an adopted Plan to the Department, the Agency shall include a copy of the information provided pursuant to Water Code Section 10723.8, with any updates, if necessary, along with the following information:					
(a)			The name and mailing address of the Agency.		2.1			
(b)			The organization and management structure of the Agency, identifying persons with management authority for implementation of the Plan.		2.2	2-2		
(c)			The name and contact information, including the phone number, mailing address and electronic mail address, of the plan manager.		2.4			
(d)			The legal authority of the Agency, with specific reference to citations setting forth the duties, powers, and responsibilities of the Agency, demonstrating that the Agency has the legal authority to implement the Plan.		2.3			
(e)			An estimate of the cost of implementing the Plan and a general description of how the Agency plans to meet those costs.		10.1.3,10.2.2, 10,2,3		10-1	
			Note: Authority cited: Section 10733.2, Water Code.					
			Reference: Sections 10723.8, 10727.2, and 10733.2, Water Code.					
§ 354.8.			**Description of Plan Area**					

Article 5.			Plan Contents for San Luis Obispo Valley Basin	GSP Document References				
				Page Numbers of Plan	Or Section Numbers	Or Figure Numbers	Or Table Numbers	Notes
			Each Plan shall include a description of the geographic areas covered, including the following information:					
(a)			One or more maps of the basin that depict the following, as applicable:					
	(1)		The area covered by the Plan, delineating areas managed by the Agency as an exclusive Agency and any areas for which the Agency is not an exclusive Agency, and the name and location of any adjacent basins.		3.1			
	(2)		Adjudicated areas, other Agencies within the basin, and areas covered by an Alternative.		3.2			
	(3)		Jurisdictional boundaries of federal or state land (including the identity of the agency with jurisdiction over that land), tribal land, cities, counties, agencies with water management responsibilities, and areas covered by relevant general plans.		3.3			
	(4)		Existing land use designations and the identification of water use sector and water source type.		3.4			
	(5)		The density of wells per square mile, by dasymetric or similar mapping techniques, showing the general distribution of agricultural, industrial, and domestic water supply wells in the basin, including de minimis extractors, and the location and extent of communities dependent upon groundwater, utilizing data provided by the Department, as specified in Section 353.2, or the best available information.		3.5			
(b)			A written description of the Plan area, including a summary of the jurisdictional areas and other features depicted on the map.		3.1	3-2		
(c)			Identification of existing water resource monitoring and management programs, and description of any such programs the Agency plans to incorporate in its monitoring network or in development of its Plan. The Agency may coordinate with existing water resource monitoring and management programs to incorporate and adopt that program as part of the Plan.		3.6			
(d)			A description of how existing water resource monitoring or management programs may limit operational flexibility in the basin, and how the Plan has been developed to adapt to those limits.	N/A				No water resource monitoring or management programs will limit the operation flexibility of SLO Basin.
(e)			A description of conjunctive use programs in the basin.		3.7			No active conjuctive use programs crurrently operating in SLO Basin.
(f)			A plain language description of the land use elements or topic categories of applicable general plans that includes the following:					
	(1)		A summary of general plans and other land use plans governing the basin.		3.8			
	(2)		A general description of how implementation of existing land use plans may change water demands within the basin or affect the ability of the Agency to achieve sustainable groundwater management over the planning and implementation horizon, and how the Plan addresses those potential effects					The exiisting land use plans will not affect the sustainable groundwater management in the SLO Basin.
	(3)		A general description of how implementation of the Plan may affect the water supply assumptions of relevant land use plans over the planning and implementation horizon.	NA				

Article 5.			Plan Contents for San Luis Obispo Valley Basin	GSP Document References				
				Page Numbers of Plan	Or Section Numbers	Or Figure Numbers	Or Table Numbers	Notes
	(4)		A summary of the process for permitting new or replacement wells in the basin, including adopted standards in local well ordinances, zoning codes, and policies contained in adopted land use plans.		3.6.3.6, 3.6.3.7			
	(5)		To the extent known, the Agency may include information regarding the implementation of land use plans outside the basin that could affect the ability of the Agency to achieve sustainable groundwater management.	NA				Land Use Plans outside the SLO Basin won't affect the ability of the GSAs to achieve sustainable groundwater management.
(g)			A description of any of the additional Plan elements included in Water Code Section 10727.4 that the Agency determines to be appropriate.	NA				None
			Note: Authority cited: Section 10733.2, Water Code.					
			Reference: Sections 10720.3, 10727.2, 10727.4, 10733, and 10733.2, Water Code.					
§ 354.10.			**Notice and Communication**					
			Each Plan shall include a summary of information relating to notification and communication by the Agency with other agencies and interested parties including the following:					
(a)			A description of the beneficial uses and users of groundwater in the basin, including the land uses and property interests potentially affected by the use of groundwater in the basin, the types of parties representing those interests, and the nature of consultation with those parties.		App E			The Communication and Engagement Plan describes the beneficial uses and users in the basin.
(b)			A list of public meetings at which the Plan was discussed or considered by the Agency.				2-1	
(c)			Comments regarding the Plan received by the Agency and a summary of any responses by the Agency.		App K			
(d)			A communication section of the Plan that includes the following:					
	(1)		An explanation of the Agency's decision-making process.		App E			
	(2)		Identification of opportunities for public engagement and a discussion of how public input and response will be used.		App E			
	(3)		A description of how the Agency encourages the active involvement of diverse social, cultural, and economic elements of the population within the basin.		App E			
	(4)		The method the Agency shall follow to inform the public about progress implementing the Plan, including the status of projects and actions.		10.1.4			
			Note: Authority cited: Section 10733.2, Water Code.					
			Reference: Sections 10723.2, 10727.8, 10728.4, and 10733.2, Water Code					
SubArticle 2.			**Basin Setting**					
§ 354.12.			**Introduction to Basin Setting**					

				GSP Document References				
				Page Numbers of Plan	Or Section Numbers	Or Figure Numbers	Or Table Numbers	Notes
			This Subarticle describes the information about the physical setting and characteristics of the basin and current conditions of the basin that shall be part of each Plan, including the identification of data gaps and levels of uncertainty, which comprise the basin setting that serves as the basis for defining and assessing reasonable sustainable management criteria and projects and management actions. Information provided pursuant to this Subarticle shall be prepared by or under the direction of a professional geologist or professional engineer.					
			Note: Authority cited: Section 10733.2, Water Code.					
			Reference: Section 10733.2, Water Code.					
§ 354.14.			**Hydrogeologic Conceptual Model**					
(a)			Each Plan shall include a descriptive hydrogeologic conceptual model of the basin based on technical studies and qualified maps that characterizes the physical components and interaction of the surface water and groundwater systems in the basin.		4.1:4.8,5.7			
(b)			The hydrogeologic conceptual model shall be summarized in a written description that includes the following:					
	(1)		The regional geologic and structural setting of the basin including the immediate surrounding area, as necessary for geologic consistency.		4.5			
	(2)		Lateral basin boundaries, including major geologic features that significantly affect groundwater flow.		4.5.1			
	(3)		The definable bottom of the basin.			4-4		
	(4)		Principal aquifers and aquitards, including the following information:					
		(A)	Formation names, if defined.		4.5.2			
		(B)	Physical properties of aquifers and aquitards, including the vertical and lateral extent, hydraulic conductivity, and storativity, which may be based on existing technical studies or other best available information.		4.6			
		(C)	Structural properties of the basin that restrict groundwater flow within the principal aquifers, including information regarding stratigraphic changes, truncation of units, or other features.		4.5.1			
		(D)	General water quality of the principal aquifers, which may be based on information derived from existing technical studies or regulatory programs.		5.9			
		(E)	Identification of the primary use or uses of each aquifer, such as domestic, irrigation, or municipal water supply.		4.5.2			
	(5)		Identification of data gaps and uncertainty within the hydrogeologic conceptual model					The HCM for the SLO Basin is well defined.
(c)			The hydrogeologic conceptual model shall be represented graphically by at least two scaled cross-sections that display the information required by this section and are sufficient to depict major stratigraphic and structural features in the basin.		4.6.1	4-9:4-21		

Article 5.			Plan Contents for San Luis Obispo Valley Basin	GSP Document References				
				Page Numbers of Plan	**Or Section Numbers**	**Or Figure Numbers**	**Or Table Numbers**	**Notes**
(d)			Physical characteristics of the basin shall be represented on one or more maps that depict the following:					
	(1)		Topographic information derived from the U.S. Geological Survey or another reliable source.		4.2	4-1		
	(2)		Surficial geology derived from a qualified map including the locations of cross-sections required by this Section.			4-8		
	(3)		Soil characteristics as described by the appropriate Natural Resources Conservation Service soil survey or other applicable studies.			4-6		
	(4)		Delineation of existing recharge areas that substantially contribute to the replenishment of the basin, potential recharge areas, and discharge areas, including significant active springs, seeps, and wetlands within or adjacent to the basin.		5.3	5-12:5-15		
	(5)		Surface water bodies that are significant to the management of the basin.		4.7			
	(6)		The source and point of delivery for imported water supplies.			3-3		
			Note: Authority cited: Section 10733.2, Water Code.					
			Reference: Sections 10727.2, 10733, and 10733.2, Water Code.					
§ 354.16.			**Groundwater Conditions**					
			Each Plan shall provide a description of current and historical groundwater conditions in the basin, including data from January 1, 2015, to current conditions, based on the best available information that includes the following:					
(a)			Groundwater elevation data demonstrating flow directions, lateral and vertical gradients, and regional pumping patterns, including:					
	(1)		Groundwater elevation contour maps depicting the groundwater table or potentiometric surface associated with the current seasonal high and seasonal low for each principal aquifer within the basin.			5-1:5-7		
	(2)		Hydrographs depicting long-term groundwater elevations, historical highs and lows, and hydraulic gradients between principal aquifers.			5-11		
(b)			A graph depicting estimates of the change in groundwater in storage, based on data, demonstrating the annual and cumulative change in the volume of groundwater in storage between seasonal high groundwater conditions, including the annual groundwater use and water year type.			5-9,5-10		
(c)			Seawater intrusion conditions in the basin, including maps and cross-sections of the seawater intrusion front for each principal aquifer.	NA				The SLO Basin is not adjacent to a coastline.
(d)			Groundwater quality issues that may affect the supply and beneficial uses of groundwater, including a description and map of the location of known groundwater contamination sites and plumes.		5.9	5-19	5-1	
(e)			The extent, cumulative total, and annual rate of land subsidence, including maps depicting total subsidence, utilizing data available from the Department, as specified in Section 353.2, or the best available information.		5.6			

Article 5.			Plan Contents for San Luis Obispo Valley Basin	GSP Document References				
				Page Numbers of Plan	Or Section Numbers	Or Figure Numbers	Or Table Numbers	Notes
(f)			Identification of interconnected surface water systems within the basin and an estimate of the quantity and timing of depletions of those systems, utilizing data available from the Department, as specified in Section 353.2, or the best available information.		5.7			
(g)			Identification of groundwater dependent ecosystems within the basin, utilizing data available from the Department, as specified in Section 353.2, or the best available information.		5.8, App F, 7.3.6			
			Note: Authority cited: Section 10733.2, Water Code.					
			Reference: Sections 10723.2, 10727.2, 10727.4, and 10733.2, Water Code.					
§ 354.18.			**Water Budget**					
(a)			Each Plan shall include a water budget for the basin that provides an accounting and assessment of the total annual volume of groundwater and surface water entering and leaving the basin, including historical, current and projected water budget conditions, and the change in the volume of water stored. Water budget information shall be reported in tabular and graphical form.		6			Chapter 6 is the Water Budget Chapter.
(b)			The water budget shall quantify the following, either through direct measurements or estimates based on data:					
	(1)		Total surface water entering and leaving a basin by water source type.			6-4:6-6	6-1:6-3	
	(2)		Inflow to the groundwater system by water source type, including subsurface groundwater inflow and infiltration of precipitation, applied water, and surface water systems, such as lakes, streams, rivers, canals, springs and conveyance systems.			6-7:6-9	6-1:6-3	
	(3)		Outflows from the groundwater system by water use sector, including evapotranspiration, groundwater extraction, groundwater discharge to surface water sources, and subsurface groundwater outflow.			6-7:6-9	6-1:6-3	
	(4)		The change in the annual volume of groundwater in storage between seasonal high conditions.		6.4.7			
	(5)		If overdraft conditions occur, as defined in Bulletin 118, the water budget shall include a quantification of overdraft over a period of years during which water year and water supply conditions approximate average conditions.		6.4.9			
	(6)		The water year type associated with the annual supply, demand, and change in groundwater stored.				6-1:6-3	
	(7)		An estimate of sustainable yield for the basin.		6.4.8			
(c)			Each Plan shall quantify the current, historical, and projected water budget for the basin as follows:					
	(1)		Current water budget information shall quantify current inflows and outflows for the basin using the most recent hydrology, water supply, water demand, and land use information.		6.4	6-7:6-9	6-1:6-3	The historical and current water budget coponents are presented together.

				GSP Document References				
				Page Numbers of Plan	Or Section Numbers	Or Figure Numbers	Or Table Numbers	Notes
	(2)		Historical water budget information shall be used to evaluate availability or reliability of past surface water supply deliveries and aquifer response to water supply and demand trends relative to water year type. The historical water budget shall include the following:					
		(A)	A quantitative evaluation of the availability or reliability of historical surface water supply deliveries as a function of the historical planned versus actual annual surface water deliveries, by surface water source and water year type, and based on the most recent ten years of surface water supply information.		6.4.3	6-7:6-9	6-1:6-3	
		(B)	A quantitative assessment of the historical water budget, starting with the most recently available information and extending back a minimum of 10 years, or as is sufficient to calibrate and reduce the uncertainty of the tools and methods used to estimate and project future water budget information and future aquifer response to proposed sustainable groundwater management practices over the planning and implementation horizon.		6.4	6-7:6-9	6-1:6-3	
		(C)	A description of how historical conditions concerning hydrology, water demand, and surface water supply availability or reliability have impacted the ability of the Agency to operate the basin within sustainable yield. Basin hydrology may be characterized and evaluated using water year type.		6-2,	6-7:6-9	6-1:6-3	
	(3)		Projected water budgets shall be used to estimate future baseline conditions of supply, demand, and aquifer response to Plan implementation, and to identify the uncertainties of these projected water budget components. The projected water budget shall utilize the following methodologies and assumptions to estimate future baseline conditions concerning hydrology, water demand and surface water supply availability or reliability over the planning and implementation horizon:					
		(A)	Projected hydrology shall utilize 50 years of historical precipitation, evapotranspiration, and streamflow information as the baseline condition for estimating future hydrology. The projected hydrology information shall also be applied as the baseline condition used to evaluate future scenarios of hydrologic uncertainty associated with projections of climate change and sea level rise.		6.6			
		(B)	Projected water demand shall utilize the most recent land use, evapotranspiration, and crop coefficient information as the baseline condition for estimating future water demand. The projected water demand information shall also be applied as the baseline condition used to evaluate future scenarios of water demand uncertainty associated with projected changes in local land use planning, population growth, and climate.		6.6			

Article 5.			Plan Contents for San Luis Obispo Valley Basin	GSP Document References				
				Page Numbers of Plan	Or Section Numbers	Or Figure Numbers	Or Table Numbers	Notes
		(C)	Projected surface water supply shall utilize the most recent water supply information as the baseline condition for estimating future surface water supply. The projected surface water supply shall also be applied as the baseline condition used to evaluate future scenarios of surface water supply availability and reliability as a function of the historical surface water supply identified in Section 354.18(c)(2)(A), and the projected changes in local land use planning, population growth, and climate.		6.6			
(d)			The Agency shall utilize the following information provided, as available, by the Department pursuant to Section 353.2, or other data of comparable quality, to develop the water budget:					
	(1)		Historical water budget information for mean annual temperature, mean annual precipitation, water year type, and land use.		6.4	6-10	6-1:6-3	
	(2)		Current water budget information for temperature, water year type, evapotranspiration, and land use.			6-10	6-1:6-3	
	(3)		Projected water budget information for population, population growth, climate change, and sea level rise.		6.6			
(e)			Each Plan shall rely on the best available information and best available science to quantify the water budget for the basin in order to provide an understanding of historical and projected hydrology, water demand, water supply, land use, population, climate change, sea level rise, groundwater and surface water interaction, and subsurface groundwater flow. If a numerical groundwater and surface water model is not used to quantify and evaluate the projected water budget conditions and the potential impacts to beneficial uses and users of groundwater, the Plan shall identify and describe an equally effective method, tool, or analytical model to evaluate projected water budget conditions.		6			Chapter 6 relies on the best available information and best available science to quantify the water budget. The model was being developed as part of the GSP and was not avaiable at the time the historical water budget was charachterzed. The inputs for the historical water budget informed the model and the model was used to develop the projected water budget.
(f)			The Department shall provide the California Central Valley Groundwater-Surface Water Simulation Model (C2VSIM) and the Integrated Water Flow Model (IWFM) for use by Agencies in developing the water budget. Each Agency may choose to use a different groundwater and surface water model, pursuant to Section 352.4.	NA				A GSFLOW model was deloped as part of this GSP and is documented in Appendix F.
			Note: Authority cited: Section 10733.2, Water Code.					
			Reference: Sections 10721, 10723.2, 10727.2, 10727.6, 10729, and 10733.2, Water Code.					
§ 354.20.			**Management Areas**					
(a)			Each Agency may define one or more management areas within a basin if the Agency has determined that creation of management areas will facilitate implementation of the Plan. Management areas may define different minimum thresholds and be operated to different measurable objectives than the basin at large, provided that undesirable results are defined consistently throughout the basin.	NA				The SLO Basin does not have management areas.
(b)			A basin that includes one or more management areas shall describe the following in the Plan:					

Article 5.			Plan Contents for San Luis Obispo Valley Basin	GSP Document References				
				Page Numbers of Plan	Or Section Numbers	Or Figure Numbers	Or Table Numbers	Notes
	(1)		The reason for the creation of each management area.	NA				The SLO Basin does not have management areas.
	(2)		The minimum thresholds and measurable objectives established for each management area, and an explanation of the rationale for selecting those values, if different from the basin at large.	NA				The SLO Basin does not have management areas.
	(3)		The level of monitoring and analysis appropriate for each management area.	NA				The SLO Basin does not have management areas.
	(4)		An explanation of how the management area can operate under different minimum thresholds and measurable objectives without causing undesirable results outside the management area, if applicable.	NA				The SLO Basin does not have management areas.
(c)			If a Plan includes one or more management areas, the Plan shall include descriptions, maps, and other information required by this Subarticle sufficient to describe conditions in those areas.	NA				The SLO Basin does not have management areas.
			Note: Authority cited: Section 10733.2, Water Code.					
			Reference: Sections 10733.2 and 10733.4, Water Code.					
SubArticle 3.			**Sustainable Management Criteria**					
§ 354.22.			**Introduction to Sustainable Management Criteria**					
			This Subarticle describes criteria by which an Agency defines conditions in its Plan that constitute sustainable groundwater management for the basin, including the process by which the Agency shall characterize undesirable results, and establish minimum thresholds and measurable objectives for each applicable sustainability indicator.					
			Note: Authority cited: Section 10733.2, Water Code.					
			Reference: Section 10733.2, Water Code.					
§ 354.24.			**Sustainability Goal**					
			Each Agency shall establish in its Plan a sustainability goal for the basin that culminates in the absence of undesirable results within 20 years of the applicable statutory deadline. The Plan shall include a description of the sustainability goal, including information from the basin setting used to establish the sustainability goal, a discussion of the measures that will be implemented to ensure that the basin will be operated within its sustainable yield, and an explanation of how the sustainability goal is likely to be achieved within 20 years of Plan implementation and is likely to be maintained through the planning and implementation horizon.		8.3.1			
			Note: Authority cited: Section 10733.2, Water Code.					
			Reference: Sections 10721, 10727, 10727.2, 10733.2, and 10733.8, Water Code.					
§ 354.26.			**Undesirable Results**					

Article 5.			Plan Contents for San Luis Obispo Valley Basin	GSP Document References				
				Page Numbers of Plan	Or Section Numbers	Or Figure Numbers	Or Table Numbers	Notes
(a)			Each Agency shall describe in its Plan the processes and criteria relied upon to define undesirable results applicable to the basin. Undesirable results occur when significant and unreasonable effects for any of the sustainability indicators are caused by groundwater conditions occurring throughout the basin.		8.5.1, 8.6.1, 8.8.1, 8.9.1, 8.10.1			
(b)			The description of undesirable results shall include the following:					
	(1)		The cause of groundwater conditions occurring throughout the basin that would lead to or has led to undesirable results based on information described in the basin setting, and other data or models as appropriate.		8.5.1.2, 8.6.1.2, 8.8.1.2, 8.9.1.2, 8.10.1.2			
	(2)		The criteria used to define when and where the effects of the groundwater conditions cause undesirable results for each applicable sustainability indicator. The criteria shall be based on a quantitative description of the combination of minimum threshold exceedances that cause significant and unreasonable effects in the basin.		8.5.1.1			
	(3)		Potential effects on the beneficial uses and users of groundwater, on land uses and property interests, and other potential effects that may occur or are occurring from undesirable results.		8.5.2.4, 8.6.2.4, 8.7.2.4, 8.9.2.4, 8.10.2.4			
(c)			The Agency may need to evaluate multiple minimum thresholds to determine whether an undesirable result is occurring in the basin. The determination that undesirable results are occurring may depend upon measurements from multiple monitoring sites, rather than a single monitoring site.		8.5.1			
(d)			An Agency that is able to demonstrate that undesirable results related to one or more sustainability indicators are not present and are not likely to occur in a basin shall not be required to establish criteria for undesirable results related to those sustainability indicators.		8.5.2.2			
			Note: Authority cited: Section 10733.2, Water Code.					
			Reference: Sections 10721, 10723.2, 10727.2, 10733.2, and 10733.8, Water Code.					
§ 354.28.			**Minimum Thresholds**					
(a)			Each Agency in its Plan shall establish minimum thresholds that quantify groundwater conditions for each applicable sustainability indicator at each monitoring site or representative monitoring site established pursuant to Section 354.36. The numeric value used to define minimum thresholds shall represent a point in the basin that, if exceeded, may cause undesirable results as described in Section 354.26.		8.5.2, 8.6.2, 8.8.2, 8.9.2, 8.10.2			
(b)			The description of minimum thresholds shall include the following:					

Article 5.			Plan Contents for San Luis Obispo Valley Basin	GSP Document References				
				Page Numbers of Plan	Or Section Numbers	Or Figure Numbers	Or Table Numbers	Notes
	(1)		The information and criteria relied upon to establish and justify the minimum thresholds for each sustainability indicator. The justification for the minimum threshold shall be supported by information provided in the basin setting, and other data or models as appropriate, and qualified by uncertainty in the understanding of the basin setting.		8.4.2.1			
	(2)		The relationship between the minimum thresholds for each sustainability indicator, including an explanation of how the Agency has determined that basin conditions at each minimum threshold will avoid undesirable results for each of the sustainability indicators.		8.5.2.2, 8.6.2.2, 8.8.2.2, 8.9.2.2, 8.10.2.2			
	(3)		How minimum thresholds have been selected to avoid causing undesirable results in adjacent basins or affecting the ability of adjacent basins to achieve sustainability goals.		8.5.2.3, 8.6.2.3, 8.8.2.3, 8.9.2.3, 8.10.2.3			The SLO Basin is not connected to adjacent groundwater basins.
	(4)		How minimum thresholds may affect the interests of beneficial uses and users of groundwater or land uses and property interests.		8.5.2.4, 8.6.2.4, 8.8.2.4, 8.9.2.4, 8.10.2.4			
	(5)		How state, federal, or local standards relate to the relevant sustainability indicator. If the minimum threshold differs from other regulatory standards, the Agency shall explain the nature of and basis for the difference.		8.5.2.5, 8.6.2.5, 8.8.2.5, 8.9.2.5, 8.10.2.5			
	(6)		How each minimum threshold will be quantitatively measured, consistent with the monitoring network requirements described in Subarticle 4.		8.5.2.5, 8.6.2.5, 8.8.2.5, 8.9.2.5, 8.10.2.5			
(c)			Minimum thresholds for each sustainability indicator shall be defined as follows:					
	(1)		Chronic Lowering of Groundwater Levels. The minimum threshold for chronic lowering of groundwater levels shall be the groundwater elevation indicating a depletion of supply at a given location that may lead to undesirable results. Minimum thresholds for chronic lowering of groundwater levels shall be supported by the following:					
		(A)	The rate of groundwater elevation decline based on historical trends, water year type, and projected water use in the basin.		8.4.2.1			
		(B)	Potential effects on other sustainability indicators.		8.4.2.2			

Article 5.			Plan Contents for San Luis Obispo Valley Basin	GSP Document References				
				Page Numbers of Plan	Or Section Numbers	Or Figure Numbers	Or Table Numbers	Notes
	(2)		Reduction of Groundwater Storage. The minimum threshold for reduction of groundwater storage shall be a total volume of groundwater that can be withdrawn from the basin without causing conditions that may lead to undesirable results. Minimum thresholds for reduction of groundwater storage shall be supported by the sustainable yield of the basin, calculated based on historical trends, water year type, and projected water use in the basin.		8.5.1			The Reduction of Groundwater Storage MT is evaluated with the same RMS and associated water level MTs and MOs as the chronic lowering of groundwater levels sustainability criteria.
	(3)		Seawater Intrusion. The minimum threshold for seawater intrusion shall be defined by a chloride concentration isocontour for each principal aquifer where seawater intrusion may lead to undesirable results. Minimum thresholds for seawater intrusion shall be supported by the following:					
		(A)	Maps and cross-sections of the chloride concentration isocontour that defines the minimum threshold and measurable objective for each principal aquifer.	NA				This Sustainability Indicator does not apply to the Basin since the Basin is not a coastal basin
		(B)	A description of how the seawater intrusion minimum threshold considers the effects of current and projected sea levels.	NA				This Sustainability Indicator does not apply to the Basin since the Basin is not a coastal basin
	(4)		Degraded Water Quality. The minimum threshold for degraded water quality shall be the degradation of water quality, including the migration of contaminant plumes that impair water supplies or other indicator of water quality as determined by the Agency that may lead to undesirable results. The minimum threshold shall be based on the number of supply wells, a volume of water, or a location of an isocontour that exceeds concentrations of constituents determined by the Agency to be of concern for the basin. In setting minimum thresholds for degraded water quality, the Agency shall consider local, state, and federal water quality standards applicable to the basin.	NA				This Sustainability Indicator does not apply to the Basin since the Basin is not a coastal basin
	(5)		Land Subsidence. The minimum threshold for land subsidence shall be the rate and extent of subsidence that substantially interferes with surface land uses and may lead to undesirable results. Minimum thresholds for land subsidence shall be supported by the following:					
		(A)	Identification of land uses and property interests that have been affected or are likely to be affected by land subsidence in the basin, including an explanation of how the Agency has determined and considered those uses and interests, and the Agency's rationale for establishing minimum thresholds in light of those effects.		8.8.2.4			
		(B)	Maps and graphs showing the extent and rate of land subsidence in the basin that defines the minimum threshold and measurable objectives.		4.8,5.6,	4-23		
	(6)		Depletions of Interconnected Surface Water. The minimum threshold for depletions of interconnected surface water shall be the rate or volume of surface water depletions caused by groundwater use that has adverse impacts on beneficial uses of the surface water and may lead to undesirable results. The minimum threshold established for depletions of interconnected surface water shall be supported by the following:					
		(A)	The location, quantity, and timing of depletions of interconnected surface water.		8.9			

				GSP Document References				
				Page Numbers of Plan	Or Section Numbers	Or Figure Numbers	Or Table Numbers	Notes
		(B)	A description of the groundwater and surface water model used to quantify surface water depletion. If a numerical groundwater and surface water model is not used to quantify surface water depletion, the Plan shall identify and describe an equally effective method, tool, or analytical model to accomplish the requirements of this Paragraph.		App G, 8.9			
(d)			An Agency may establish a representative minimum threshold for groundwater elevation to serve as the value for multiple sustainability indicators, where the Agency can demonstrate that the representative value is a reasonable proxy for multiple individual minimum thresholds as supported by adequate evidence.		8.9.2			
(e)			An Agency that has demonstrated that undesirable results related to one or more sustainability indicators are not present and are not likely to occur in a basin, as described in Section 354.26, shall not be required to establish minimum thresholds related to those sustainability indicators.		8.9.2.2			
			Note: Authority cited: Section 10733.2, Water Code.					
			Reference: Sections 10723.2, 10727.2, 10733, 10733.2, and 10733.8, Water Code.					
§ 354.30.			**Measurable Objectives**					
(a)			Each Agency shall establish measurable objectives, including interim milestones in increments of five years, to achieve the sustainability goal for the basin within 20 years of Plan implementation and to continue to sustainably manage the groundwater basin over the planning and implementation horizon.		8.5.3, 8.6.3, 8.8.3, 8.9.3, 8.10.3			
(b)			Measurable objectives shall be established for each sustainability indicator, based on quantitative values using the same metrics and monitoring sites as are used to define the minimum thresholds.		8.5.3, 8.6.3, 8.8.3, 8.9.3, 8.10.3			
(c)			Measurable objectives shall provide a reasonable margin of operational flexibility under adverse conditions which shall take into consideration components such as historical water budgets, seasonal and long-term trends, and periods of drought, and be commensurate with levels of uncertainty.		8.5.2.1			
(d)			An Agency may establish a representative measurable objective for groundwater elevation to serve as the value for multiple sustainability indicators where the Agency can demonstrate that the representative value is a reasonable proxy for multiple individual measurable objectives as supported by adequate evidence.		8.6, 8.8, 8.10	8-2 thru 8-11		
(e)			Each Plan shall describe a reasonable path to achieve the sustainability goal for the basin within 20 years of Plan implementation, including a description of interim milestones for each relevant sustainability indicator, using the same metric as the measurable objective, in increments of five years. The description shall explain how the Plan is likely to maintain sustainable groundwater management over the planning and implementation horizon.		Chapter 10			Chapter 10 is the Implementation Plan.

Article 5.			Plan Contents for San Luis Obispo Valley Basin	GSP Document References				
				Page Numbers of Plan	Or Section Numbers	Or Figure Numbers	Or Table Numbers	Notes
(f)			Each Plan may include measurable objectives and interim milestones for additional Plan elements described in Water Code Section 10727.4 where the Agency determines such measures are appropriate for sustainable groundwater management in the basin.		NA			
(g)			An Agency may establish measurable objectives that exceed the reasonable margin of operational flexibility for the purpose of improving overall conditions in the basin, but failure to achieve those objectives shall not be grounds for a finding of inadequacy of the Plan.		NA			
			Note: Authority cited: Section 10733.2, Water Code.					
			Reference: Sections 10727.2, 10727.4, and 10733.2, Water Code.					
SubArticle 4.			**Monitoring Networks**					
§ 354.32.			**Introduction to Monitoring Networks**					
			This Subarticle describes the monitoring network that shall be developed for each basin, including monitoring objectives, monitoring protocols, and data reporting requirements. The monitoring network shall promote the collection of data of sufficient quality, frequency, and distribution to characterize groundwater and related surface water conditions in the basin and evaluate changing conditions that occur through implementation of the Plan.					
			Note: Authority cited: Section 10733.2, Water Code.					
			Reference: Section 10733.2, Water Code.					
§ 354.34.			**Monitoring Network**					
(a)			Each Agency shall develop a monitoring network capable of collecting sufficient data to demonstrate short-term, seasonal, and long-term trends in groundwater and related surface conditions, and yield representative information about groundwater conditions as necessary to evaluate Plan implementation.		7			Chapter 7 is the Monitoring Netork.
(b)			Each Plan shall include a description of the monitoring network objectives for the basin, including an explanation of how the network will be developed and implemented to monitor groundwater and related surface conditions, and the interconnection of surface water and groundwater, with sufficient temporal frequency and spatial density to evaluate the affects and effectiveness of Plan implementation. The monitoring network objectives shall be implemented to accomplish the following:					
	(1)		Demonstrate progress toward achieving measurable objectives described in the Plan.		7.2			
	(2)		Monitor impacts to the beneficial uses or users of groundwater.		7.2			
	(3)		Monitor changes in groundwater conditions relative to measurable objectives and minimum thresholds.		7.2			
	(4)		Quantify annual changes in water budget components.		7.2			
(c)			Each monitoring network shall be designed to accomplish the following for each sustainability indicator:					

				GSP Document References				
				Page Numbers of Plan	Or Section Numbers	Or Figure Numbers	Or Table Numbers	Notes
	(1)		Chronic Lowering of Groundwater Levels. Demonstrate groundwater occurrence, flow directions, and hydraulic gradients between principal aquifers and surface water features by the following methods:					
		(A)	A sufficient density of monitoring wells to collect representative measurements through depth-discrete perforated intervals to characterize the groundwater table or potentiometric surface for each principal aquifer.		7.3.1.1			
		(B)	Static groundwater elevation measurements shall be collected at least two times per year, to represent seasonal low and seasonal high groundwater conditions.		7.3.1			
	(2)		Reduction of Groundwater Storage. Provide an estimate of the change in annual groundwater in storage.		7.3.1,7.4.2			
	(3)		Seawater Intrusion. Monitor seawater intrusion using chloride concentrations, or other measurements convertible to chloride concentrations, so that the current and projected rate and extent of seawater intrusion for each applicable principal aquifer may be calculated.	NA				The Basin is not susceptible to seawater intrusion and will not be monitored for that indicator.
	(4)		Degraded Water Quality. Collect sufficient spatial and temporal data from each applicable principal aquifer to determine groundwater quality trends for water quality indicators, as determined by the Agency, to address known water quality issues.		7.4.4			
	(5)		Land Subsidence. Identify the rate and extent of land subsidence, which may be measured by extensometers, surveying, remote sensing technology, or other appropriate method.		7.4.5			
	(6)		Depletions of Interconnected Surface Water. Monitor surface water and groundwater, where interconnected surface water conditions exist, to characterize the spatial and temporal exchanges between surface water and groundwater, and to calibrate and apply the tools and methods necessary to calculate depletions of surface water caused by groundwater extractions. The monitoring network shall be able to characterize the following:					
		(A)	Flow conditions including surface water discharge, surface water head, and baseflow contribution.		7.4.6			
		(B)	Identifying the approximate date and location where ephemeral or intermittent flowing streams and rivers cease to flow, if applicable.		7.4.6, App F			
		(C)	Temporal change in conditions due to variations in stream discharge and regional groundwater extraction.		7.4.6, App F			
		(D)	Other factors that may be necessary to identify adverse impacts on beneficial uses of the surface water.		7.4.6, App F			
(d)			The monitoring network shall be designed to ensure adequate coverage of sustainability indicators. If management areas are established, the quantity and density of monitoring sites in those areas shall be sufficient to evaluate conditions of the basin setting and sustainable management criteria specific to that area.		7.4.6			

Article 5.			Plan Contents for San Luis Obispo Valley Basin	GSP Document References				
				Page Numbers of Plan	Or Section Numbers	Or Figure Numbers	Or Table Numbers	Notes
(e)			A Plan may utilize site information and monitoring data from existing sources as part of the monitoring network.		7.2.4			
(f)			The Agency shall determine the density of monitoring sites and frequency of measurements required to demonstrate short-term, seasonal, and long-term trends based upon the following factors:					
	(1)		Amount of current and projected groundwater use.		7.2			
	(2)		Aquifer characteristics, including confined or unconfined aquifer conditions, or other physical characteristics that affect groundwater flow.		7.2			Discussed throughout Chapter 7 and Chapter 8.
	(3)		Impacts to beneficial uses and users of groundwater and land uses and property interests affected by groundwater production, and adjacent basins that could affect the ability of that basin to meet the sustainability goal.		7.2			Discussed throughout Chapter 7 and Chapter 8.
	(4)		Whether the Agency has adequate long-term existing monitoring results or other technical information to demonstrate an understanding of aquifer response.		7.2			Discussed throughout Chapter 7 and Chapter 8. Specifically in the Interconnected GW/SW components of the plan.
(g)			Each Plan shall describe the following information about the monitoring network:					
	(1)		Scientific rationale for the monitoring site selection process.		7.2.3			
	(2)		Consistency with data and reporting standards described in Section 352.4. If a site is not consistent with those standards, the Plan shall explain the necessity of the site to the monitoring network, and how any variation from the standards will not affect the usefulness of the results obtained.		7.5			
	(3)		For each sustainability indicator, the quantitative values for the minimum threshold, measurable objective, and interim milestones that will be measured at each monitoring site or representative monitoring sites established pursuant to Section 354.36.		7.4			
(h)			The location and type of each monitoring site within the basin displayed on a map, and reported in tabular format, including information regarding the monitoring site type, frequency of measurement, and the purposes for which the monitoring site is being used.			7-1, 7-2, 7-3	7-1:7-5	
(i)			The monitoring protocols developed by each Agency shall include a description of technical standards, data collection methods, and other procedures or protocols pursuant to Water Code Section 10727.2(f) for monitoring sites or other data collection facilities to ensure that the monitoring network utilizes comparable data and methodologies.		App H			
(j)			An Agency that has demonstrated that undesirable results related to one or more sustainability indicators are not present and are not likely to occur in a basin, as described in Section 354.26, shall not be required to establish a monitoring network related to those sustainability indicators.		7.4.3			
			Note: Authority cited: Section 10733.2, Water Code.					
			Reference: Sections 10723.2, 10727.2, 10727.4, 10728, 10733, 10733.2, and 10733.8, Water Code					

Article 5.			Plan Contents for San Luis Obispo Valley Basin	GSP Document References				
				Page Numbers of Plan	Or Section Numbers	Or Figure Numbers	Or Table Numbers	Notes
§ 354.36.			**Representative Monitoring**					
			Each Agency may designate a subset of monitoring sites as representative of conditions in the basin or an area of the basin, as follows:					
(a)			Representative monitoring sites may be designated by the Agency as the point at which sustainability indicators are monitored, and for which quantitative values for minimum thresholds, measurable objectives, and interim milestones are defined.		7.2.2			
(b)			(b) Groundwater elevations may be used as a proxy for monitoring other sustainability indicators if the Agency demonstrates the following:					
	(1)		Significant correlation exists between groundwater elevations and the sustainability indicators for which groundwater elevation measurements serve as a proxy.		7.3.1			
	(2)		Measurable objectives established for groundwater elevation shall include a reasonable margin of operational flexibility taking into consideration the basin setting to avoid undesirable results for the sustainability indicators for which groundwater elevation measurements serve as a proxy.		8.4,8.6,8.10			
(c)			The designation of a representative monitoring site shall be supported by adequate evidence demonstrating that the site reflects general conditions in the area.		8.4			
			Note: Authority cited: Section 10733.2, Water Code.					
			Reference: Sections 10727.2 and 10733.2, Water Code					
§ 354.38.			**Assessment and Improvement of Monitoring Network**					
(a)			Each Agency shall review the monitoring network and include an evaluation in the Plan and each five-year assessment, including a determination of uncertainty and whether there are data gaps that could affect the ability of the Plan to achieve the sustainability goal for the basin.		7.7,7.8			
(b)			Each Agency shall identify data gaps wherever the basin does not contain a sufficient number of monitoring sites, does not monitor sites at a sufficient frequency, or utilizes monitoring sites that are unreliable, including those that do not satisfy minimum standards of the monitoring network adopted by the Agency.		7.3.1.1,7.3.2.1,7.4.2.1			
(c)			If the monitoring network contains data gaps, the Plan shall include a description of the following:					
	(1)		The location and reason for data gaps in the monitoring network.		7.3.1.1,7.3.2.1,7.4.2.1			
	(2)		Local issues and circumstances that limit or prevent monitoring.	NA				
(d)			Each Agency shall describe steps that will be taken to fill data gaps before the next five-year assessment, including the location and purpose of newly added or installed monitoring sites.		7.3.1.1,7.3.2.1,7.4.2.1			

Article 5.			Plan Contents for San Luis Obispo Valley Basin	GSP Document References				
				Page Numbers of Plan	Or Section Numbers	Or Figure Numbers	Or Table Numbers	Notes
(e)			Each Agency shall adjust the monitoring frequency and density of monitoring sites to provide an adequate level of detail about site-specific surface water and groundwater conditions and to assess the effectiveness of management actions under circumstances that include the following:					
	(1)		Minimum threshold exceedances.		7.5.4			
	(2)		Highly variable spatial or temporal conditions.		7.5.4			
	(3)		Adverse impacts to beneficial uses and users of groundwater.		7.5.4			
	(4)		The potential to adversely affect the ability of an adjacent basin to implement its Plan or impede achievement of sustainability goals in an adjacent basin.		7.5.4			
			Note: Authority cited: Section 10733.2, Water Code.					
			Reference: Sections 10723.2, 10727.2, 10728.2, 10733, 10733.2, and 10733.8, Water Code					
§ 354.40.			**Reporting Monitoring Data to the Department**					
			Monitoring data shall be stored in the data management system developed pursuant to Section 352.6. A copy of the monitoring data shall be included in the Annual Report and submitted electronically on forms provided by the Department.					
			Note: Authority cited: Section 10733.2, Water Code.					
			Reference: Sections 10728, 10728.2, 10733.2, and 10733.8, Water Code.					
SubArticle 5.			**Projects and Management Actions**					
§ 354.42.			**Introduction to Projects and Management Actions**					
			This Subarticle describes the criteria for projects and management actions to be included in a Plan to meet the sustainability goal for the basin in a manner that can be maintained over the planning and implementation horizon.					
			Note: Authority cited: Section 10733.2, Water Code.					
			Reference: Section 10733.2, Water Code.					
§ 354.44.			**Projects and Management Actions**					
(a)			Each Plan shall include a description of the projects and management actions the Agency has determined will achieve the sustainability goal for the basin, including projects and management actions to respond to changing conditions in the basin.		9			
(b)			Each Plan shall include a description of the projects and management actions that include the following:					
	(1)		A list of projects and management actions proposed in the Plan with a description of the measurable objective that is expected to benefit from the project or management action. The list shall include projects and management actions that may be utilized to meet interim milestones, the exceedance of minimum thresholds, or where undesirable results have occurred or are imminent. The Plan shall include the following:					

Article 5.			Plan Contents for San Luis Obispo Valley Basin	GSP Document References				
				Page Numbers of Plan	Or Section Numbers	Or Figure Numbers	Or Table Numbers	Notes
		(A)	A description of the circumstances under which projects or management actions shall be implemented, the criteria that would trigger implementation and termination of projects or management actions, and the process by which the Agency shall determine that conditions requiring the implementation of particular projects or management actions have occurred.		9.6			A
		(B)	The process by which the Agency shall provide notice to the public and other agencies that the implementation of projects or management actions is being considered or has been implemented, including a description of the actions to be taken.		9.4.1.8			
	(2)		If overdraft conditions are identified through the analysis required by Section 354.18, the Plan shall describe projects or management actions, including a quantification of demand reduction or other methods, for the mitigation of overdraft.		9.2.3			
	(3)		A summary of the permitting and regulatory process required for each project and management action.		9.4.1.7			
	(4)		The status of each project and management action, including a time-table for expected initiation and completion, and the accrual of expected benefits.		9.4.1			
	(5)		An explanation of the benefits that are expected to be realized from the project or management action, and how those benefits will be evaluated.		9.4.1.1			
	(6)		An explanation of how the project or management action will be accomplished. If the projects or management actions rely on water from outside the jurisdiction of the Agency, an explanation of the source and reliability of that water shall be included.		9.4.1.2			
	(7)		A description of the legal authority required for each project and management action, and the basis for that authority within the Agency.		9.4.1.6			
	(8)		A description of the estimated cost for each project and management action and a description of how the Agency plans to meet those costs.		9.4.1.3,10.1.3			
	(9)		A description of the management of groundwater extractions and recharge to ensure that chronic lowering of groundwater levels or depletion of supply during periods of drought is offset by increases in groundwater levels or storage during other periods.		9.4.8			
(c)			Projects and management actions shall be supported by best available information and best available science.		9.4.1			
(d)			An Agency shall take into account the level of uncertainty associated with the basin setting when developing projects or management actions.		9.4.1.5			
			Note: Authority cited: Section 10733.2, Water Code.					
			Reference: Sections 10727.2, 10727.4, and 10733.2, Water Code.					

B

City of San Luis Obispo Resolution to Form GSA

RESOLUTION NO. 10796 (2017 SERIES)

A RESOLUTION OF THE CITY COUNCIL OF THE CITY OF SAN LUIS OBISPO, CALIFORNIA, AUTHORIZING THE CITY TO BECOME A GROUNDWATER SUSTAINABILITY AGENCY FOR THE SAN LUIS OBISPO VALLEY GROUNDWATER BASIN FOR THE AREA THAT LIES BENEATH AND WITHIN THE JURISDICTIONAL BOUNDARIES OF THE CITY OF SAN LUIS OBISPO

WHEREAS, in 2014 the California Legislature and the Governor passed into law the Sustainable Groundwater Management Act (SGMA) for local management of groundwater resources in California through the formation of Groundwater Sustainability Agencies (GSAs) and through preparation and implementation of Groundwater Sustainability Plans (GSPs); and

WHEREAS, the City overlies a portion of the San Luis Obispo Valley Groundwater Basin (SLOVGB), which is subject to SGMA, and thus one or more GSAs must be formed for the SLOVGB by June 30, 2017, or the SLOVGB may be subject to regulation by the State Water Resources Control Board; and

WHEREAS, the City is a "local agency" as that term is defined by SGMA, and as such is authorized to form a GSA to manage groundwater resources in the SLOVGB and within the City's jurisdictional boundaries in accordance with SGMA and other applicable laws and authorities; and

WHEREAS, the City desires to form a GSA to manage groundwater resources in the SLOVGB beneath and within the City's jurisdictional boundaries; and

WHEREAS, the City intends that its GSA will work cooperatively with the other GSAs that have formed or will be formed in the SLOVGB to prepare one or more GSPs by January 31, 2022, so that groundwater resources in the SLOVGB will be properly managed and sustainable in accordance with the provisions of SGMA; and

WHEREAS, it is essential that the City form this GSA because SGMA grants GSAs substantial additional powers and authorities to ensure sustainable groundwater management. Acting as the GSA within the City's jurisdictional boundaries will, among other things, confirm the City's role as the local groundwater management agency, ensure access to SGMA authorities, and preserve access to grant funding and other opportunities that may be available to GSAs; and

WHEREAS, pursuant to the requirements of SGMA, the City held a public hearing on this date after publication of notice pursuant to California Government Code section 6066 to consider adoption of this Resolution.

NOW, THEREFORE, BE IT RESOLVED by the Council of the City of San Luis Obispo as follows:

SECTION 1. All of the above recitals are true and correct and incorporated herein by reference.

SECTION 2. The City of San Luis Obispo hereby elects to become the Groundwater Sustainability Agency in accordance with the Sustainable Groundwater Management Act over the portion of the San Luis Obispo Valley Groundwater Basin which lies under and within the jurisdictional boundaries of the City of San Luis Obispo.

SECTION 3. The City Manager is authorized and directed to submit a notice of this Resolution along with all other required information to the California Department of Water Resources in accordance with the Sustainable Groundwater Management Act.

SECTION 4. The City Groundwater Sustainability Agency shall consider the interests of all beneficial uses and users of the groundwater within the jurisdictional boundaries of the City and will develop an outreach program for all such stakeholders. The City Groundwater Sustainability Agency will continue to coordinate with other local agencies and stakeholders that overlie the San Luis Obispo Valley Groundwater Basin in order to manage groundwater resources.

SECTION 5. The City Groundwater Sustainability Agency shall establish and maintain a list of persons interested in receiving notices regarding the City's involvement in the preparation of one or more Groundwater Sustainability Plans in the San Luis Obispo Valley Groundwater Basin, where any person may request in writing to be placed on the City's list of interested persons.

SECTION 6. Resolution Number 10777 (2017 Series) is hereby repealed.

Upon motion of Council Member Pease, seconded by Council Member Christianson, and on the following roll call vote:

AYES:	Council Members Christianson, Gomez, and Pease Vice Mayor Rivoire and Mayor Harmon
NOES:	None
ABSENT:	None

The foregoing resolution was adopted this 16th day of May, 2017.

Mayor Heidi Harmon

ATTEST:

Carrie Gallagher
City Clerk

APPROVED AS TO FORM:

J. Christine Dietrick
City Attorney

IN WITNESS WHEREOF, I have hereunto set my hand and affixed the official seal of the City of San Luis Obispo, California, this 24th day of May, 2017.

Carrie Gallagher
City Clerk

C

County of San Luis Obispo Resolution to Form GSA

IN THE BOARD OF SUPERVISORS

County of San Luis Obispo, State of California

Tuesday, May 23, 2017

PRESENT: Supervisors Bruce S. Gibson, Adam Hill, Lynn Compton, Debbie Arnold, and Chairperson John Peschong

ABSENT: None

RESOLUTION NO. 2017-146

RESOLUTION FORMING THE SAN LUIS OBISPO VALLEY BASIN – COUNTY OF SAN LUIS OBISPO GROUNDWATER SUSTAINABILITY AGENCY AND FINDING THAT THE PROJECT IS EXEMPT FROM SECTION 21000 ET SEQ. OF THE CALIFORNIA PUBLIC RESOURCES CODE (CEQA)

The following Resolution is hereby offered and read:

WHEREAS, in 2014, the California Legislature adopted, and the Governor signed into law, three bills (SB 1168, AB 1739, and SB 1319) collectively referred to as the Sustainable Groundwater Management Act (SGMA) (Water Code §§ 10720 *et seq.*), that became effective on January 1, 2015, and that have been subsequently amended; and

WHEREAS, the intent of SGMA, as set forth in Water Code Section 10720.1, is to provide for the sustainable management of groundwater basins at a local level by providing local groundwater agencies with the authority, and technical and financial assistance necessary, to sustainably manage groundwater; and

WHEREAS, SGMA requires the formation of Groundwater Sustainability Agencies (GSAs) for the purpose of achieving groundwater sustainability through the adoption and implementation of Groundwater Sustainability Plans (GSPs) for all medium and high priority basins as designated by the California Department of Water Resources (DWR); and

WHEREAS, SGMA requires that a local agency or collection of agencies decide to become a GSA for all medium and high priority basins on or before June 30, 2017 and that the GSA or GSAs for basins DWR has not designated as "subject to critical conditions of overdraft" develop a GSP or coordinated GSPs on or before January 31, 2022; and

WHEREAS, the San Luis Obispo Valley Groundwater Basin (Basin) has been designated by DWR as a medium priority basin, but not subject to critical conditions of overdraft; and

WHEREAS, the County of San Luis Obispo and the City of San Luis Obispo are each a "local agency" within the Basin as defined in Water Code Section 10721(n) and thus are eligible to form GSAs; and

WHEREAS, it is anticipated that the City of San Luis Obispo will form a GSA for the portion of the Basin within the City boundary; and

WHEREAS, the County of San Luis Obispo intends to form a GSA to cover all other portions of the Basin; and

WHEREAS, SGMA authorizes certain entities, specifically water corporations regulated by the Public Utilities Commission and mutual water companies, to participate in a GSA through a memorandum of agreement or other legal agreement; and

WHEREAS, a number of such entities overlie the Basin, including the Edna Valley Growers Mutual Water Company, the Edna Ranch Mutual Water Company, the Varian Ranch Mutual Water Company and the Golden State Water Company, and it is anticipated that such entities will desire to enter into a memorandum of agreement with the County and City of San Luis Obispo establishing a process by which such entities will participate in the preparation of the GSP for the Basin; and

WHEREAS, the County of San Luis Obispo published a notice of public hearing consistent with the requirements contained within Water Code Section 10723(b); and

WHEREAS, the Board of Supervisors conducted such a public hearing on May 23, 2017; and

WHEREAS, the County of San Luis Obispo is committed to the sustainable management of groundwater within the Basin and intends to consider the interests of all beneficial users and uses of groundwater within the Basin through, among other things, coordination with the City of San Luis Obispo and the entities eligible to participate in SGMA as described above.

NOW, THEREFORE, BE IT RESOLVED AND ORDERED by the Board of Supervisors of the County of San Luis Obispo, State of California, that:

Section 1: The foregoing recitals are true and correct and are incorporated herein by reference.

Section 2: The County of San Luis Obispo hereby decides to become the GSA for, and undertake sustainable groundwater management within, the Basin, with the exception of the portions of the Basin located within the City of San Luis Obispo ("GSA Boundary"). The GSA shall be known as the San Luis Obispo Valley Basin – County of San Luis Obispo Groundwater Sustainability Agency, and a map of the GSA Boundary is attached hereto as Exhibit A and incorporated herein.

Section 3: The Director of Public Works of the County of San Luis Obispo, or designee, is hereby authorized and directed to submit notice of adoption of this Resolution in addition to all other information required by SGMA, including but not limited to, all information required by Water Code Section 10723.8, to DWR, and to develop and maintain an interested persons list as described in Water Code Section 10723.4 and a list of interested parties as described in Water Code Section 10723.8(a)(4).

Section 4: The Director of Public Works of the County of San Luis Obispo, or designee, is hereby authorized and directed to take such other and further actions as may be necessary or appropriate to implement the intent and purposes of this Resolution.

Section 5: The Board of Supervisors finds that the adoption of this Resolution is exempt from the requirements of the California Environmental Quality Act (Public Resources Code §§ 21000 et seq.) (CEQA) pursuant to Section 15061(b)(3) of the CEQA Guidelines.

Section 6: The Environmental Coordinator of the County of San Luis Obispo is hereby directed to file a Notice of Exemption in accordance with the provisions of CEQA.

Upon motion of Supervisor Hill, seconded by Supervisor Gibson, and on the following roll call vote, to wit:

AYES: Supervisors Hill, Gibson, Compton, Arnold and Chairperson Peschong

NOES: None

ABSENT: None

ABSTAINING: None

the foregoing resolution is hereby adopted on the 23rd day of May, 2017.

John Peschong
Chairperson of the Board of Supervisors

ATTEST:

TOMMY GONG
Clerk of the Board of Supervisors

By: Annette Ramirez
Deputy Clerk
[SEAL]

APPROVED AS TO FORM AND LEGAL EFFECT:

RITA L. NEAL
County Counsel

By: /s/ Erica Stuckey
Deputy County Counsel

Dated: May 1, 2017

L:\Water Resources\2017\May\BOS\San Luis Obispo Valley Basin GSA\SLO Valley Basin rsl.docx CB:jb

STATE OF CALIFORNIA,)
) **ss.**
COUNTY OF SAN LUIS OBISPO)

I, Tommy Gong, County Clerk and ex-officio Clerk of the Board of Supervisors, in and for the County of San Luis Obispo, State of California, do hereby certify the foregoing to be a full, true and correct copy of an order made by the Board of Supervisors, as the same appears spread upon their minute book.

WITNESS my hand and the seal of said Board of Supervisors, affixed this 23rd day of May, 2017.

Tommy Gong
County Clerk and Ex-Officio Clerk
of the Board of Supervisors

(SEAL)

By: [signature]
Deputy Clerk

D

Memorandum of Agreement – Preparation of GSP

DICK 1.

MEMORANDUM OF AGREEMENT REGARDING PREPARATION OF A GROUNDWATER SUSTAINABILITY PLAN FOR THE SAN LUIS OBISPO VALLEY GROUNDWATER BASIN

This Memorandum of Agreement ("MOA") is entered into by and between the City of San Luis Obispo ("City"), the County of San Luis Obispo ("County"), the Edna Valley Growers Mutual Water Company ("EVGMWC"), the Varian Ranch Mutual Water Company ("VRMWC"), the Edna Ranch Mutual Water Company ("ERMWC") and the Golden State Water Company ("GSWC") (each referred to individually as a "Party" and collectively as the "Parties") for purposes of coordinating preparation of a single groundwater sustainability plan for the San Luis Obispo Valley Groundwater Basin.

Recitals

WHEREAS, on September 16, 2014, Governor Jerry Brown signed into law Senate Bills 1168 and 1319 and Assembly Bill 1739, known collectively as the Sustainable Groundwater Management Act ("SGMA"), which became effective on January 1, 2015 and which have been and may continue to be amended from time to time; and

WHEREAS, SGMA requires the establishment of a groundwater sustainability agency ("GSA") or agencies for all basins designated as medium- or high-priority by the Department of Water Resources ("DWR") on or before June 30, 2017; and

WHEREAS, SGMA further requires the adoption of a groundwater sustainability plan ("GSP") or coordinated GSPs for all basins designated by DWR as medium- or high-priority and not subject to critical conditions of overdraft on or before January 31, 2022; and

WHEREAS, DWR has designated the San Luis Obispo Valley Groundwater Basin (Basin No. 3-9) ("Basin") as a medium-priority basin not subject to critical conditions of overdraft; and

WHEREAS, the County and the City have each decided to become the GSA within their respective service areas overlying the Basin and have informed DWR of their decision and intent to undertake sustainable groundwater management therein; and

WHEREAS, the County and the City desire to collectively develop a single GSP to sustainably manage the Basin; and

WHEREAS, the County and the City further desire to include the other Parties to this MOA who each constitute entities eligible to participate in a GSA (sometimes referred to individually as a "Participating Party" or collectively as the "Participating Parties") in the development of the GSP through the creation of the Groundwater Sustainability Commission.

NOW, THEREFORE, it is mutually understood and agreed as follows:

Section 1
Purpose

This MOA is entered into by the Parties for the purpose of establishing the manner in which the City and the County, with input from the Participating Parties, will coordinate in the development of a single GSP for the Basin that will be considered for adoption by the City Council and the County Board of Supervisors and subsequently submitted to DWR for approval. This MOA may also serve as the basis for continued cooperation among the City and the County in the management of the Basin during the period between adoption of the GSP by the City Council and the County Board of Supervisors and approval of the GSP by DWR. As more specifically set forth in Section 10.3 below, this MOA shall automatically terminate upon DWR's approval of the GSP for the Basin.

Section 2
Term

This MOA shall become effective on the date that the last of the six (6) Parties signs ("Effective Date") and shall remain in effect until terminated in accordance with Section 9.2 or Section 10.3 below.

Section 3
City and County Roles and Responsibilities

3.1 The City and the County shall work jointly to meet the objectives of this MOA.

3.2 The City and the County shall retain the services of a consultant(s) to meet the objectives of this MOA, including, but not limited to, preparation of a GSP for the Basin in accordance with the provisions set forth in Section 7 below.

3.3 The City and the County shall each designate a staff person(s) to participate in the development of the GSP and related technical studies through, without limitation, the provision of guidance and available data, in coordination with the consultant(s), and to administer the Groundwater Sustainability Commission (e.g. to, among other things, timely publish all agendas and take minutes).

3.4 The City and the County shall each be responsible for adopting the GSP and implementing the GSP within their respective service areas. Notwithstanding the foregoing, nothing contained in this MOA shall be construed as obligating either the City Council or the County Board of Supervisors to adopt the GSP developed pursuant to this MOA or as preventing either the City Council or the County Board of Supervisors from adopting the GSP developed under this MOA in the event that the other elects not to adopt it or in the event that the Groundwater Sustainability Commission fails to recommend approval.

3.5 The City and the County may lead certain Basin-wide public outreach and stakeholder involvement to improve development of the GSP.

3.6 The City shall be responsible for taking all legally required actions associated with its appointment of the member and alternate member to the Groundwater Sustainability Commission representing the City as set forth in Section 4.5, including, without limitation, all applicable requirements under the Maddy Act (Government Code §§ 54970 et seq.) and the County shall be responsible for taking all such actions associated with its appointment of the member and alternate member to the Groundwater Sustainability Commission representing the County and its confirmation of the members and alternate members to the Groundwater Sustainability Commission representing the Participating Parties as set forth in Section 4.4 and Section 4.3, respectively.

Section 4
Establishment of the Groundwater Sustainability Commission

4.1 The City and the County hereby establish the Groundwater Sustainability Commission to serve as an advisory committee to the City Council and the County Board of Supervisors in connection with preparation of the GSP and interim Basin management actions subject to each Participating Party making its required contributions under Section 6(B).

4.2 The Groundwater Sustainability Commission shall be composed of five (5) members: one (1) member representing the City, one (1) member representing the County, one (1) member representing EVGMWC, one (1) member collectively representing VRMWC and ERMWC and one (1) member representing GSWC.

4.3 Each of the Participating Parties shall nominate a member and an alternate member to represent it on the Groundwater Sustainability Commission subject to confirmation by the County Board of Supervisors with the exception that VRMWC and ERMWC shall jointly nominate a member and an alternate member to represent them subject to confirmation by the County Board of Supervisors. Said members shall serve at the pleasure of the County Board of Supervisors and may be removed at any time provided that the County Board of Supervisors shall have no authority to replace a removed member with an individual who has not been nominated by the relevant Participating Party or collection of Participating Parties.

4.4 The County Board of Supervisors shall appoint the member and alternate member representing the County and said members shall serve at the pleasure of the County Board of Supervisors.

4.5 The City Council shall appoint the member and alternate member representing the City and said members shall serve at the pleasure of the City Council.

4.6 All meetings of the Groundwater Sustainability Commission shall be conducted in accordance with the Ralph M. Brown Act (Government Code §§ 54950 et seq.).

4.7 A majority of the members of the Groundwater Sustainability Commission shall constitute a quorum for purposes of transacting business, except that less than a quorum may vote to adjourn the meeting.

4.8 Each member of the Groundwater Sustainability Commission shall be entitled to one (1) vote on any matter under consideration by the Groundwater Sustainability Commission.

4.9 All advisory opinions submitted by the Groundwater Sustainability Commission to the City Council and the County Board of Supervisors shall be supported by a majority of the members, except for the recommendation to adopt the GSP or any amendments thereto which shall be supported by at least four (4) of the members.

4.10 The County Board of Supervisors and the City Council may approve or reject any advisory opinion submitted by the Groundwater Sustainability Commission provided that in every case that the County Board of Supervisors or City Council rejects an advisory opinion of the Groundwater Sustainability Commission related to the contents or adoption of the GSP it shall do so only after holding a public hearing, at which time the members of the Groundwater Sustainability Commission shall have the right to appear and address the City Council and the County Board of Supervisors.

4.11 None of the members or alternate members shall be entitled to any compensation from the County or the City for their service on the Groundwater Sustainability Commission.

Section 5
Establishment of Additional Advisory Committees

The City Council and the County Board of Supervisors may from time to time jointly establish one or more additional advisory committees or establish standing or ad hoc committees to assist in carrying out the purposes and objectives of this MOA. Without limiting the foregoing, it is anticipated that the City Council and the County Board of Supervisors will establish a stakeholder advisory committee to the Groundwater Sustainability Commission to consider the interests of beneficial uses and users not already represented on the Groundwater Sustainability Commission consistent with Water Code Section 10723.2.

Section 6
Funding

The City and the County agree to jointly fund the costs associated with implementation of this MOA in accordance with and subject to the following:

A. Within sixty (60) days of the Effective Date and prior to each anniversary of the Effective Date, City and County staff shall prepare an annual budget for the GSAs to implement this MOA for approval by the City Council and the County Board of Supervisors.

B. Each of the Participating Parties shall be responsible for contributing the following funds to help defray the costs of the Groundwater Sustainability Commission and in consideration for their participation thereon within thirty (30) days of the Effective Date and within thirty (30) days of each anniversary of the Effective Date:

EVGMWC	$28,200
VRMWC	$4,550
ERMWC	$4,550
GSWC	$12,700

C. Subject to City Council and County Board of Supervisor approval of the annual budget, the City and County agree to fund the annual budget (less the contributions set forth in Section 6(B)) in accordance with the percentage allocations set forth below. Notwithstanding the foregoing and Section 10.1, the City Council and the County Board of Supervisors may amend said percentage allocations without the agreement of the Participating Parties.

County	70%
City	30%

D. It is anticipated that the vast majority of budgeted costs to be paid by the City and the County will involve costs for consultant services. Consequently, most City and County contributions will be paid in the manner described in Section 7 below.

Section 7
Retention of Consultants

7.1 The County agrees to act as the contracting agent to retain the services of a consultant(s) as described in Section 3.2 above.

7.2 Notwithstanding the foregoing, the County agrees that the City and one (1) member of the Groundwater Sustainability Commission not representing the City or the County designated by the Groundwater Sustainability Commission shall be included in the selection of any consultant retained by the County pursuant to this MOA. More specifically, a staff representative from the City and the designated member of the Groundwater Sustainability Commission shall be given an opportunity to review and approve all requests for proposals prior to their release and to participate in the various stages of the selection process, including, but not limited to, review of proposals and participation on interview panels.

7.3 All consultant contracts entered into by the County pursuant to this MOA shall include the following: (1) a provision requiring that the consultant name the City as an additional insured, (2) an expected spend plan estimating the amount of the not to exceed contract amount that the consultant expects to invoice each month, and (3) a provision requiring that the consultant calculate both the County and City's share of each invoice consistent with Section 6(C) and send monthly invoices to both the County and the City showing the foregoing calculation.

7.4 Both the City and the County shall be responsible for remitting payment of their share of each monthly invoice directly to the consultant within thirty (30) days of receipt or within the time frame otherwise set forth in the consultant contract.

Section 8
Notice

8.1 To provide for consistent and effective communication among the Parties, each Party shall designate a representative as its central point of contact on matters relating to this MOA.

8.2 All notices, statements, or payments related to this MOA shall be deemed to have been duly given if in writing and delivered electronically, personally or mailed by first-class, registered or certified mail to the Parties at the addresses set forth in Exhibit A. The Parties may update Exhibit A from time to time without formal amendment to this MOA.

Section 9
Withdrawal and Termination

9.1 Any Participating Party may unilaterally withdrawal from this MOA without causing or requiring termination of this MOA. Withdrawal shall become effective upon thirty (30) days written notice to the remaining Parties' designated addresses as listed in Exhibit A. A Participating Party that has withdrawn from this MOA shall remain obligated to pay its allocation of the current annual budget. If a Participating Party withdraws, the Groundwater Sustainability Commission shall automatically be reconstituted to no longer include a member or alternate member representing the withdrawing Participating Party. In addition, the withdrawing Participating Party's annual contribution as set forth in Section 6(B) for all subsequent years shall be allocated among the remaining Participating Parties on a pro rata basis.

9.2 This MOA may be terminated by either the City or the County upon thirty (30) days written notice to all Parties' designated addresses as listed in Exhibit A. Upon termination, any unused portion of the cost contributions described in Section 6(B) and Section 6(C) as of the effective date of termination shall be returned to each Party on a pro rata basis. If the City terminates this MOA, it shall remain obligated to pay its cost share obligation under any existing consultant contract entered into by the County pursuant to this MOA.

Section 10
Miscellaneous

10.1 Subject to the exception set forth in Section 6(C), this MOA may be amended only by unanimous written consent of all current Parties.

10.2 This MOA may be executed in counterparts.

10.3 This MOA shall automatically terminate upon DWR's approval of the adopted GSP. Depending on the content of the GSP, the Parties may decide to enter into a new agreement to coordinate GSP implementation.

10.4 This MOA is made in the State of California, under the Constitution and laws of said State and is to be so construed.

10.5 If any provision of this MOA is determined to be invalid or unenforceable, the remaining provisions shall remain in full force and unaffected to the fullest extent permitted by law and regulation.

10.6 This MOA constitutes the sole, entire, integrated and exclusive agreement between the Parties regarding the contents herein. Any other contracts, agreements, terms, understandings, promises or representations not expressly set forth or referenced in this writing are null and void and of no force and effect.

10.7 The Parties agree and acknowledge that this MOA has been developed through negotiation, and that each Party has had a full and fair opportunity to revise the terms of this MOA. Consequently, the normal rule of construction that any ambiguities are to be resolved against the drafting party shall not apply in construing or interpreting this MOA.

[signatures to follow on next page]

IN WITNESS WHEREOF, the Parties have executed this MOA by authorized officials thereof on the dates indicated below.

CITY OF SAN LUIS OBISPO

By: ____________________

Its: ____________________

Date: ____________________

APPROVED AS TO FORM AND LEGAL EFFECT:

By: ____________________

Its: ____________________

Date: ____________________

COUNTY OF SAN LUIS OBISPO

B

Its

Date

APPROVED AS TO FORM AND LEGAL EFFECT:

By: ____________________

Its: Deputy County Counsel

Date: Nov. 6, 2017

EDNA VALLEY GROWERS MUTUAL WATER COMPANY

By: ____________________

Its: ____________________

Date: ____________________

VARIAN RANCH MUTUAL WATER COMPANY

By: ____________________

Its: ____________________

Date: ____________________

EDNA RANCH MUTUAL WATER COMPANY

By: ____________________

Its: ____________________

Date: ____________________

GOLDEN STATE WATER COMPANY

By: ____________________

Its: ____________________

Date: ____________________

IN WITNESS WHEREOF, the Parties have executed this MOA by authorized officials thereof on the dates indicated below.

CITY OF SAN LUIS OBISPO

By: ____________________

Its: ____________________

Date: ____________________

APPROVED AS TO FORM AND LEGAL EFFECT:

By: ____________________

Its: ____________________

Date: ____________________

COUNTY OF SAN LUIS OBISPO

By: JOHN PESCHONG

Its: Chairperson, Board of Supervisors, County of San Luis Obispo, State of California

Date: January 9, 2018

APPROVED AS TO FORM AND LEGAL EFFECT:

By: ____________________

Its: ____________________

Date: ____________________

ATTEST:

Tommy Gong, County Clerk-Recorder and Ex-Officio Clerk of the Board of Supervisors

By, SANDY CURRENS

Deputy Clerk

EDNA VALLEY GROWERS MUTUAL WATER COMPANY

By: [signature]

Its: President

Date: 11/2/17

VARIAN RANCH MUTUAL WATER COMPANY

By: ____________________

Its: ____________________

Date: ____________________

EDNA RANCH MUTUAL WATER COMPANY

By: ____________________

Its: ____________________

Date: ____________________

GOLDEN STATE WATER COMPANY

By: ____________________

Its: ____________________

Date: ____________________

IN WITNESS WHEREOF, the Parties have executed this MOA by authorized officials thereof on the dates indicated below.

CITY OF SAN LUIS OBISPO

By: ____________________

Its: Mayor

Date: 1/26/18

APPROVED AS TO FORM AND LEGAL EFFECT:

By: ____________________

Its: Asst. City Attorney

Date: 1/25/18

COUNTY OF SAN LUIS OBISPO

By: ____________________

Its: ____________________

Date: ____________________

APPROVED AS TO FORM AND LEGAL EFFECT:

By: ____________________

Its: Deputy County Counsel

Date: Nov. 6, 2017

EDNA VALLEY GROWERS MUTUAL WATER COMPANY

By: ____________________

Its: ____________________

Date: ____________________

VARIAN RANCH MUTUAL WATER COMPANY

By: ____________________

Its: ____________________

Date: ____________________

EDNA RANCH MUTUAL WATER COMPANY

By: ____________________

Its: ____________________

Date: ____________________

GOLDEN STATE WATER COMPANY

By: ____________________

Its: ____________________

Date: ____________________

EXHIBIT A

PARTY ADDRESS LIST

County of San Luis Obispo
County Government Center, Room 206
San Luis Obispo, CA 93408
Attention: Wade Horton, Public Works Director

City of San Luis Obispo
Utilities Department
879 Morro Street
San Luis Obispo, CA 93401-2710
Attention: Carrie Mattingly, Utilities Director

Edna Valley Growers Mutual Water Company
4910 Edna Road
San Luis Obispo, CA 93401
Attention: Bob Schiebelhut, President

Varian Ranch Mutual Water Company
2060 Varian Circle
Arroyo Grande, CA 93420
Attention: James Lokey

Edna Ranch Mutual Water Company
5665 Edna Ranch Circle
San Luis Obispo, CA 93401
Attention: Andy Mangano

Golden State Water Company
2330 A Street, Suite A
Santa Maria, CA 93455
Attention: General Manager, Coastal District

EXHIBIT A
PARTY ADDRESS LIST

County of San Luis Obispo
County Government Center, Room 206
San Luis Obispo, CA 93408
Attention: Wade Horton, Public Works Director

City of San Luis Obispo
Utilities Department
879 Morro Street
San Luis Obispo, CA 93401-2710
Attention: Carrie Mattingly, Utilities Director

Edna Valley Growers Mutual Water Company
4910 Edna Road
San Luis Obispo, CA 93401
Attention: Bob Schiebelhut, President

Varian Ranch Mutual Water Company
2060 Varian Circle
Arroyo Grande, CA 93420
Attention: James Lokey

Edna Ranch Mutual Water Company
5665 Edna Ranch Circle
San Luis Obispo, CA 93401
Attention: Andy Mangano

Golden State Water Company
2330 A Street, Suite A
Santa Maria, CA 93455
Attention: General Manager, Coastal District

IN WITNESS WHEREOF, the Parties have executed this MOA by authorized officials thereof on the dates indicated below.

CITY OF SAN LUIS OBISPO

By: ____________________

Its: ____________________

Date: ____________________

APPROVED AS TO FORM AND LEGAL EFFECT:

By: ____________________

Its: ____________________

Date: ____________________

COUNTY OF SAN LUIS OBISPO

By: ____________________

Its: ____________________

Date: ____________________

APPROVED AS TO FORM AND LEGAL EFFECT:

By: ____________________

Its: ____________________

Date: ____________________

EDNA VALLEY GROWERS MUTUAL WATER COMPANY

By: ____________________

Its: ____________________

Date: ____________________

VARIAN RANCH MUTUAL WATER COMPANY

By: [signature]

Its: President

Date: 10/31/2017

EDNA RANCH MUTUAL WATER COMPANY

By: ____________________

Its: ____________________

Date: ____________________

GOLDEN STATE WATER COMPANY

By: ____________________

Its: ____________________

Date: ____________________

IN WITNESS WHEREOF, the Parties have executed this MOA by authorized officials thereof on the dates indicated below.

CITY OF SAN LUIS OBISPO

By: ____________________

Its: ____________________

Date: ____________________

APPROVED AS TO FORM AND LEGAL EFFECT:

By: ____________________

Its: ____________________

Date: ____________________

COUNTY OF SAN LUIS OBISPO

By: ____________________

Its: ____________________

Date: ____________________

APPROVED AS TO FORM AND LEGAL EFFECT:

By: ____________________

Its: ____________________

Date: ____________________

EDNA VALLEY GROWERS MUTUAL WATER COMPANY

By: ____________________

Its: ____________________

Date: ____________________

VARIAN RANCH MUTUAL WATER COMPANY

By: ____________________

Its: ____________________

Date: ____________________

EDNA RANCH MUTUAL WATER COMPANY

By: [signature]

Its: PRESIDENT

Date: 11/14/17

GOLDEN STATE WATER COMPANY

By: ____________________

Its: ____________________

Date: ____________________

IN WITNESS WHEREOF, the Parties have executed this MOA by authorized officials thereof on the dates indicated below.

CITY OF SAN LUIS OBISPO

By: ____________________

Its: ____________________

Date: ____________________

APPROVED AS TO FORM AND LEGAL EFFECT:

By: ____________________

Its: ____________________

Date: ____________________

COUNTY OF SAN LUIS OBISPO

By: ____________________

Its: ____________________

Date: ____________________

APPROVED AS TO FORM AND LEGAL EFFECT:

By: ____________________

Its: ____________________

Date: ____________________

EDNA VALLEY GROWERS MUTUAL WATER COMPANY

By: ____________________

Its: ____________________

Date: ____________________

VARIAN RANCH MUTUAL WATER COMPANY

By: ____________________

Its: ____________________

Date: ____________________

EDNA RANCH MUTUAL WATER COMPANY

By: ____________________

Its: ____________________

Date: ____________________

GOLDEN STATE WATER COMPANY

By: Denise Kruger

Its: Sr. Vice President

Date: November 3, 2017

E

Notice and Communication

Communication and Engagement Plan

C&E Plan Implementation Workshop

DRAFT

Communication and Engagement Plan

for Groundwater Sustainability Plan Development in the San Luis Obispo Valley Groundwater Basin

Prepared for San Luis Obispo County

June 5, 2019

Table of Contents

The Sustainable Groundwater Management Act (SGMA) requires local governments and water agencies in California's high- and medium-priority groundwater basins, as defined by the California Department of Water Resources (DWR), to form Groundwater Sustainability Agencies (GSAs) and operate under a Groundwater Sustainability Plan (GSP) by the year 2022. Basins subject to critical conditions of overdraft must begin to manage groundwater under a GSP sooner – by January 31, 2020.

This Communication and Engagement Plan (C&E Plan) describes the planned activities for engaging interested parties in SGMA implementation efforts in the San Luis Obispo Valley Basin. It is designed to meet the stakeholder engagement requirements of SGMA and the GSP Regulations. The ultimate purpose of the document is to facilitate effective communication and engagement with the multiple and varied stakeholders in the San Luis Obispo Valley Basin.

Structure of this C&E Plan

DWR defines the purpose of its Stakeholder *Communication and Engagement Guidance Document* (C&E Guidance Document) to:

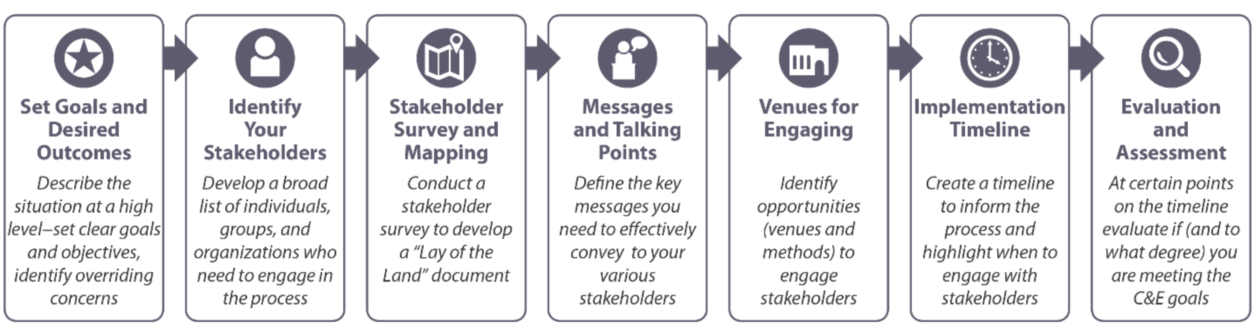
- Demonstrate how a GSA can effectively communicate and engage with multiple and varied stakeholders
- Identify the methods and tools to support communication and engagement
- Identify how a GSA can conduct meaningful engagement to develop a GSP

The C&E Guidance Document describes DWR's seven-step process for communication and engagement:

1. ***Set Goals and Desired Outcomes***
2. ***Identify Your Stakeholders***
3. ***Stakeholder Survey and Mapping***
4. ***Messages and Talking Points***
5. ***Venues for Engaging***
6. ***Implementation Timeline***
7. ***Evaluation and Assessment***

This C&E Plan is organized to follow the steps suggested above and shown in **Figure 1**.

***Figure 1**. Engagement Steps from DWR GSP Stakeholder and Engagement Guidance Document*



1. Introduction to the San Luis Obispo Valley Basin

The San Luis Obispo Valley Basin (Groundwater Basin 3-009[1]) is situated in the San Luis and Edna Valleys in central to southwest San Luis Obispo County. The basin overlies an area of approximately 12,700 acres and is part of the Central Coast Watershed. It is bound on the northeast by the Santa Lucia Range, on the southwest by the San Luis Range, and on all other sides by contact with impermeable Miocene and Franciscan Group rocks. A rise in bedrock south of the San Luis Obispo Airport has created two separate subsurface drainage systems known as the San Luis Valley subbasin and the Edna Valley subbasin. The Edna Valley subbasin covers approximately 4,700 acres and is entirely within the unincorporated San Luis Obispo County (County). The San Luis Valley subbasin spans approximately 8,000 acres and includes both the unincorporated county and city of San Luis Obispo (City).

- **City of San Luis Obispo.** The City of San Luis Obispo is located near the intersection of Highway 101 and Hwy 1. A portion of the City is located within the basin. The City's land uses consist primarily of commercial and residential areas.
- **San Luis Obispo County.** San Luis Obispo County is located in the southern region of California between approximately San Miguel and Santa Maria. The entire basin is located within the County. The County's land uses consist of commercial, agricultural, residential, and undeveloped lands.

The primary sources of water supply for uses in the basin include groundwater from the San Luis Obispo Valley Basin and surface water from the Whale Rock Reservoir, Salinas Reservoir, the Nacimiento Water Project, and recycled water through the City's Water Recycling Program.[2]

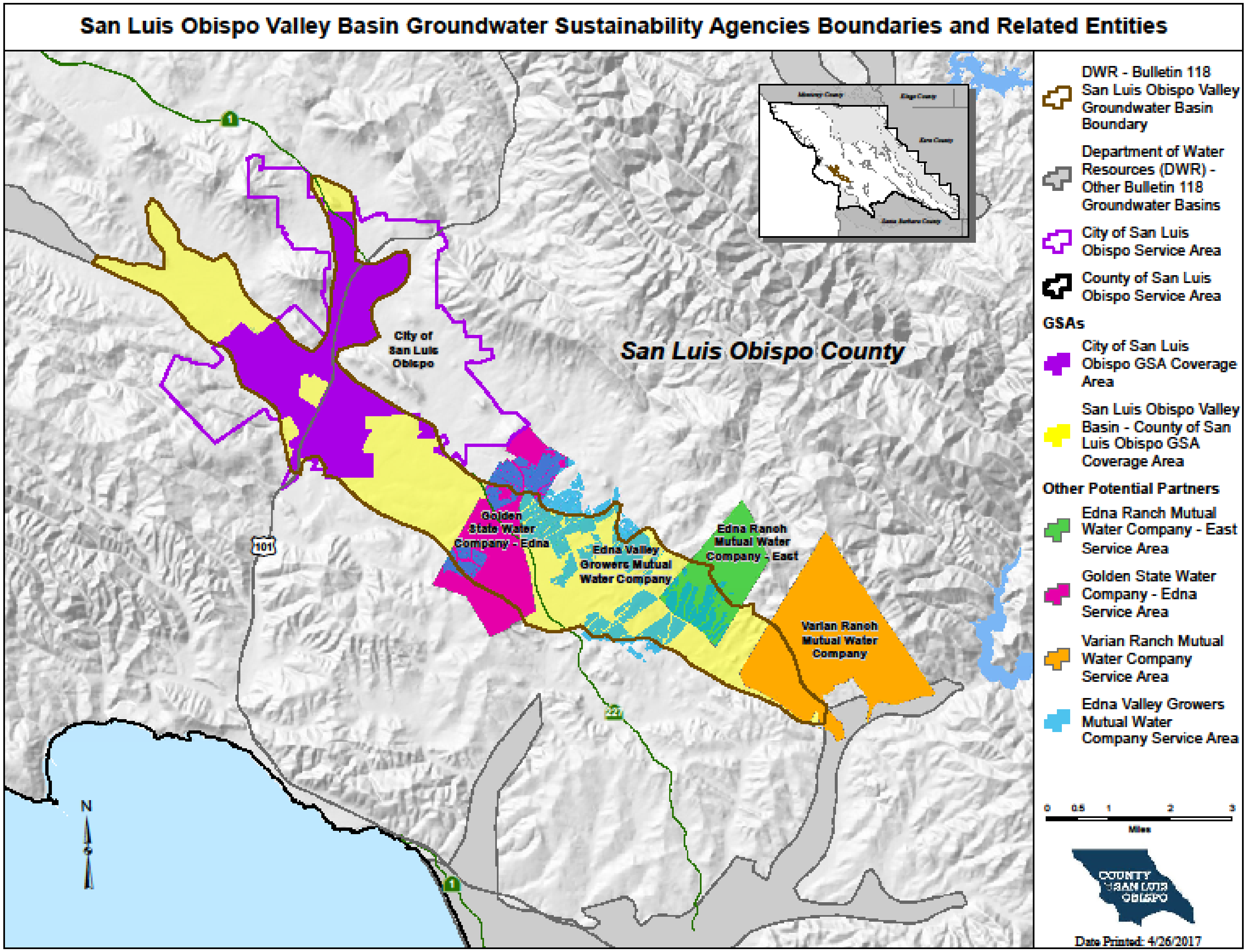
Water users in the basin include municipalities, communities, rural domestic residences, and industrial, environmental, and agricultural users. The major water purveyors are the Edna Valley Growers Mutual Water Company, Varian Ranch Mutual Water Company, Edna Ranch Mutual Water Company, and Golden State Water Company.

Figure 2 shows the location of the San Luis Obispo Valley Basin and the GSA boundaries.

[1] As identified and delineated in California Department of Water Resources Bulletin 118 https://water.ca.gov/Programs/Groundwater-Management/Bulletin-118

[2] https://www.slocity.org/government/department-directory/utilities-department/water/water-sources/recycled-water

Figure 2*. San Luis Obispo Valley Basin Groundwater Sustainability Agency Boundary*



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2. Goals and Desired Outcomes

The goal of this C&E Plan is to describe the planned activities for engaging interested parties in SGMA implementation efforts in the San Luis Obispo Valley Basin and to provide opportunities for interested parties to participate in GSP development. This plan serves as a roadmap to support achieving the desired outcomes identified below.

- **Educate the public about the importance of the GSP and the value of their input.** Stakeholder input is a critical part of the GSP development process. Basin stakeholders define the values of the local community and priorities for groundwater management. This valuable input identifies the unique concerns of the stakeholders and guides decision-making and development of projects and management actions. The C&E Plan is designed to encourage stakeholder participation and to disseminate information about GSP development.
- **Engage a diverse group of stakeholders.** The C&E Plan is developed with thoughtful consideration about how to engage the diverse array of stakeholders in the basin. One size does not fit all when it comes to stakeholder engagement. The C&E Plan outlines multiple venues for communication with varied audiences.
- **Make stakeholder participation easy and accessible.** One way to increase engagement is to make participation easy for the stakeholders. The opportunities for stakeholders to engage in GSP development should be clear and easily accessible. The C&E Plan provides methods to make engagement easy for stakeholders.
- **Allow interested parties the opportunity to provide meaningful input.** Aligning the engagement schedule with the GSP development schedule allows stakeholders to engage at key decision points in the GSP development process. Public meetings will inform interested parties about what decisions need to be made, provide relevant technical information, and request feedback.
- **Provide a roadmap for GSA leadership.** The C&E Plan provides a clear roadmap and schedule for GSA leaders to follow, keeping engagement efforts consistent among stakeholders and on track throughout the duration of the project.

The goal and desired outcomes listed above are the drivers for this planning document. They inform and shape the remainder of this C&E Plan.

3. GSP Participants and the Decision-Making Process

Everyone in the basin has a role to play in GSP development. Generally, participants fall into one of the following groups.

- GSA Leadership
- Technical Experts
- Interested Parties

Each of these groups provide a unique contribution to the GSP.

GSA Leadership

To comply with SGMA, two GSAs were formed to manage the groundwater resources of the San Luis Obispo Valley Basin in a sustainable manner as directed under a GSP that must be prepared by 2022 and implemented for the next 40 years

- City of San Luis Obispo Groundwater Sustainability Agency
- San Luis Obispo Valley Basin - County of San Luis Obispo Groundwater Sustainability Agency

In January 2018, the City and the County entered into a Memorandum of Agreement (MOA) with the Edna Valley Growers Mutual Water Company, Varian Ranch Mutual Water Company, Edna Ranch Mutual Water Company, and Golden State Water Company to prepare a single GSP for the San Luis Obispo Valley Basin, establishing the Groundwater Sustainability Commission (GSC or Commission). The GSC serves as an advisory committee to the San Luis Obispo City Council and County of San Luis Obispo Board of Supervisors.

The GSC has five members as shown in **Table 1**.

Table 1. Commission Membership

San Luis Obispo Valley Groundwater Sustainability Commission Members
• One member representing the City • One member representing the County • One member representing Edna Valley Growers Mutual Water Company • One member collectively representing Varian Ranch Mutual Water Company and Edna Ranch Mutual Water Company • One member representing Golden State Water Company

All meetings of the Commission are open to the public and interested parties are encouraged to attend. The Commission will make recommendations to the City Council and County Board of Supervisors regarding GSP development (e.g., recommendation to adopt). A public Notice of Intent to adopt the GSP and a public hearing will be held prior to adoption of the GSP. The final decision-making power to adopt the GSP will be executed separately by the City Council and County Board of Supervisors.

Technical Experts

Technical experts are there to provide subject matter expertise on highly complex issues about the basin and surrounding basins and to inform the Commission and interested parties about the benefits and consequences of potential projects and management actions identified in GSP development. Technical experts may include outside consultants or staff of agencies that are signatories to the MOA. Section 3.2 of the MOA outlines how the City and County will retain consultant services.

Interested Parties

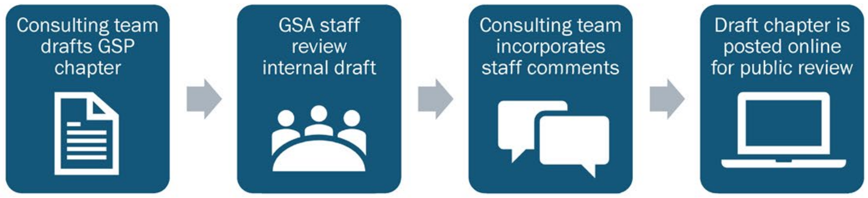
Interested parties consist of beneficial users of groundwater, stakeholders, and anyone affected/impacted by groundwater in and around basin. The interested parties may represent environmental interests, Native American tribes, agricultural interests, urban groundwater users, etc. *GSA Leadership* and *Technical Experts* provide information to interested parties through the engagement venues and tools described in this plan. The interested parties provide input regarding the priorities and values of the community and the likelihood of the success of proposed project concepts and the hurdles that must be overcome to achieve groundwater sustainability. Interested parties may also include agencies, such as the U.S. Department of Fish and Wildlife, with an interest in sustainable groundwater management in the basin. Interested parties can participate in the GSP development process by attending public meetings, commenting on draft documents, and participating in workshops. More information on interested parties is included in **Section 4. Stakeholder Groups**.

GSP Chapter Review Process

The San Luis Obispo Valley Basin GSAs formulated a process for reviewing draft GSP chapters, as illustrated in ***Figure 3***. GSA leadership, technical experts, and interested parties have an opportunity to provide feedback on each chapter of the GSP at varying stages of the review process.

The individual chapters will be prepared by the consulting team with input from GSA staff. After the draft chapters have been approved by the Commission they will be posted on the Portal to begin a minimum 30-day comment period. Specific dates will be provided for each draft document to allow for adequate review. Public comments will be submitted through the Portal and all comments received will be available for review. The comments will be reviewed by the technical experts and be considered for inclusion in the draft GSP.

Figure 3. *GSP Chapter Review Process*



	Consulting team drafts GSP chapter	GSA staff review internal draft	Consulting team incorporates staff comments	Draft chapter is posted online for public review
Technical Specialist				
Consultant	X		X	
GSA Staff		X		
GSA Leadership				
GSC (the Commission)				X
Interest Parties				X
GSA				

GSP Review Process

Comments collected during public review of draft chapters will be considered when revising the chapters for the Draft GSP. After the draft GSP has been approved by the Commission it will be posted on the Portal to begin an additional minimum 30-day comment period. The roles of the GSP participants in preparation of the Final Draft GSP will follow the steps shown in Figure 4.

Figure 4. *GSP Review Process*

	Consulting team drafts GSP	GSA staff review internal draft GSP	Consulting team incorporates staff comments	Draft GSP is posted online for public review
Technical Specialist				
Consultant	X		X	
GSA Staff		X		
GSA Leadership				
GSC (the Commission)				X
Interest Parties				X
GSA				

GSP Adoption Process

Once the GSP has been finalized, the Commission will make a recommendation to the GSAs to adopt the GSP. The City of San Luis Obispo City Council and San Luis Obispo County Board of Supervisors will then consider adoption of the GSP. The GSP participants with responsibilities in this phase are shown in Figure 5.

Figure 5. *GSP Adoption Process*

	Final GSP posted	GSAs adopt GSP
Technical Specialist		
Consultant		
GSA Staff		
GSA Leadership		
GSC (the Commission)	X	
Interest Parties		
GSA		X

4. Stakeholder Groups

Pursuant to California Water Code sections 10723.8 and 10723.2, the San Luis Obispo Valley Basin GSAs will consider throughout the project the interests of all beneficial uses and users of groundwater, as well as those that are responsible for implementing the actions developed within the basin's GSP. The San Luis Obispo Valley Basin GSAs are committed to an open public review and feedback process, including active and open discussions with all interested parties during the GSP development process. ***Appendix A*** includes the initial list of interested parties submitted to the California Department of Water Resources at the time of the GSA's formation. The list includes parties grouped by the categories below.

- Agencies
- Water corporations regulated by PUC or a Mutual Water Company
- Agricultural users
- Domestic well owners
- Municipal well operators
- Public water systems
- Local land use planning agencies
- Environmental users of groundwater
- Surface water users
- Federal government
- California Native American tribes
- Disadvantaged Communities

Stakeholder Group Identification

The stakeholder list provided in ***Appendix A*** was used to form the Basin's initial interested parties list. The interested parties list was expanded by adding information collected via the SGMA interest e-mail list hosted on the County's website.[3] The SGMA interest e-mail list has been online for more than one year and over 280 parties have indicated interest in being added to the Basin's mailing list.

Once signed up for the interest list, parties are contacted via email when events related to GSP development are scheduled for the San Luis Obispo Valley Basin. The interested parties list will continue to expand as people answer the stakeholder survey (**Section 5**) and are encouraged to sign up for communications via the Groundwater Communication Portal described below.

Groundwater Communication Portal

A web-based outreach tool called the San Luis Obispo Valley Basin Groundwater Communication Portal (Portal) electronically notifies interested parties when the GSAs host events regarding groundwater management. The Portal is used to grow and maintain the interested parties list described above. Interested parties can add themselves to the interest list and access draft chapters for review at any time by registering for portal access at [to be added once domain name has been purchased].

[3] https://www.slocounty.ca.gov/Departments/Public-Works/Committees-Programs/Sustainable-Groundwater-Management-Act-(SGMA)/San-Luis-Obispo-Valley-Groundwater-Basin.aspx

The Portal will track outreach engagements such as Commission meetings and communications with individuals or groups of stakeholders involved in the development of the GSP and store the information in a database for GSA retrieval. The database will include meeting dates, locations, times, and documents such as meeting agendas. A description of the Portal and its functions is provided in ***Appendix B*.**

5. Stakeholder Survey

DWR created a stakeholder survey template hosted at the Communication and Engagement Digital Toolkit[4] webpage. The survey is designed to learn about stakeholder interests, issues, and challenges. The survey may include the following questions:

- Are you familiar with SGMA regulations?
- Are you currently engaged in activity or discussions regarding groundwater management in this region?
- Do you own or manage land in this region?
- Do you manage water resources? If yes, what is your role?
- What is your primary interest in land or water resources management?
- Do you have concerns about groundwater management? If so, what are they?
- Do you have recommendations regarding groundwater management? If so, what are they?
- What else do you want us to know?
- Who else should we listen to?

The survey has been customized for San Luis Obispo Valley Basin GSP development and is included as ***Appendix C***. The survey is scheduled to be distributed to interested parties in Summer 2019. The results of the survey will be used to inform this plan and will be included in the Final C&E Plan submitted with the Final GSP.

[4] https://water.ca.gov/Programs/Groundwater-Management/Assistance-and-Engagement

6. Venues and Tools: Opportunities for Engagement

The San Luis Obispo Valley GSAs aim to encourage stakeholders with diverse social, cultural, and economic backgrounds to be actively involved in the GSP development. To achieve this goal, *focused engagement* and thoughtfully selected *venues and tools* should be employed.

Focused Engagement

The initial list of interested parties that was imported into the Portal from the County's SGMA email interest list included 290 entries. To support the diversity of elements and ensure we engage with potentially underrepresented communities on the list, the groups below will be given focused attention when choosing venues and tools for engagement.

- **Disadvantaged Communities.** The City is recognized as a Disadvantaged Community (DAC).[5] Meetings will be held in proximity to this area to allow easy access for interested parties. Information about GSP development and meeting dates/times will be posted in areas that the City has found to be successful in reaching underrepresented populations in previous outreach efforts. These areas include public events such as the Farmer's Market, City kiosks at City facilities such as the finance office where utility bills are paid, the parks and recreation department where after-school programs are coordinated, and other City facilities such as the Senior Citizens Center.
- **Bilingual Residents.** The GSAs will gather information regarding the languages spoken in the communities within the basin and provide translation services for the languages as appropriate per the Dymally-Alatorre Bilingual Service Act.
- **Tribal Governments.** Per SGMA §10720.3(c), any federally recognized Indian tribe may voluntarily agree to participate in the planning, financing, and management of groundwater basins. There are no federally recognized Native American tribes within the geographic boundaries of the San Luis Obispo Valley Basin. However, the Northern Chumash Tribal Council community encompasses the County area. Therefore, the San Luis Obispo Valley GSAs will refer to DWR's Engagement with Tribal Governments Guidance Document and will contact the tribal representative to invite participation in GSP development.

Stakeholder Workshops

Stakeholder workshops are designed to create opportunities for stakeholders and other interested parties to provide meaningful input during GSP chapter development. The workshop schedule is aligned with the GSP development schedule (***Appendix D***) for this purpose. The workshops will be led by technical experts such as consultants or GSA staff. Workshop dates will vary based on when input is deemed most useful. Suggestions for optimizing the benefit of the workshops are listed below.

- Choose workshop venues, dates, and times to maximize stakeholder participation.
- Use the Portal to inform interested parties about workshops during GSP development.

[5] Per DWR Disadvantaged Communities Mapping Tool at https://gis.water.ca.gov/app/dacs/; accessed May 28, 2019

- Announce the Portal at stakeholder workshops and encourage attendees to sign up.

Groundwater Sustainability Commission Meetings

Regular meetings of the Groundwater Sustainability Commission provide an opportunity for City and County staff, participating parties, and their consultants to present updates on the status of GSP development. Meetings are scheduled every three months (quarterly). See the GSP development schedule (***Appendix D***) for planned dates. An interested party may sign up on the emailing list using the Portal to receive updates on meeting dates and times. Meetings of the Groundwater Sustainability Commission are subject to the Brown Act and are open to the public.

Public Notices and Hearings

Meeting notices will be sent in advance of stakeholder workshops and Commission meetings. SGMA requires a publicly noticed hearing at three distinct points in GSP development:

- At GSA formation §10723(b) – this process is complete
- When a GSP is adopted or amended (§10728.4)
- Before imposing or increasing fees

Public Draft GSP Documents

When draft GSP component documents (e.g., chapters) are released by the Commission, they will also be posted to the Portal and will be open for public comment. A comment form will be available on the Portal to submit comments on draft documents by chapter and section. These comments will be considered when revising the public draft documents and finalizing the Final Draft GSP chapters.

Tools for Communication

Initially, the GSAs anticipate producing the informational materials listed below.

GSA Website

The County has a webpage dedicated to SGMA implementation in the San Luis Obispo Valley Basin. Both the City and County websites point to this page[6] to share information on GSP development. The site will be supplemented by the Portal as discussed below.

Groundwater Communication Portal (Portal)

The GSAs will use the San Luis Obispo Valley Basin Portal as a tool to communicate with interested parties. The Portal will store interested party information and distribute e-mail invitations for events posted to the calendar, these events may include GSC meetings, workshops, and other outreach events. There are additional tools within the Portal that will be used to enhance communication. These tools include the following:

- **E-Blast.** E-mails will be sent to interested parties for those who sign up for email notifications on the Portal using the e-blast tool. E-blasts will be effective for sending reminders of upcoming deadlines, such as the close of a survey or comment period.
- **Public Comment Form.** During public comment periods, a form will be available on the Portal for interested parties to submit comments on draft GSP documents. The form allows comments

[6] https://www.slocounty.ca.gov/Departments/Public-Works/Committees-Programs/Sustainable-Groundwater-Management-Act-(SGMA)/San-Luis-Obispo-Valley-Groundwater-Basin.aspx

by chapter and automatically stores the information for GSA review, reducing the risk of misplaced comments.

Direct Mailing

Communications about GSP development will be sent only in digital format. For those who don't have access online or prefer to receive direct postal mailings, the agenda and agenda packet will be mailed to those who request it. There may be times when a direct postal mailing is appropriate. The County sent a mailer in May 2019 to provide information about the next two Commission meetings. The mailer also includes a request form for the recipient to fill out and return to the County if he/she desires to receive notification of future events via postal mail. A copy of the mailer is provided as ***Appendix E***.

Outreach Materials

Given previous outreach efforts within City limits, the City does not believe a direct mail piece would be effective in reaching community members or the DAC population. To reach these community members, the City plans to direct outreach efforts for SGMA meetings to online resources, public events such as a Farmer's Market, and with outreach at several City kiosks at City facilities including the finance office where utility bills are paid, the parks and recreation department where after-school programs are coordinated, and at other City facilities such as the Senior Citizens Center.

FAQ

A frequently asked questions (FAQ) document will be created and updated periodically throughout the GSP development. The FAQ will address questions about SGMA, San Luis Obispo Valley Basin GSAs, and the development of the GSP. Updates to the FAQ will be posted on the Portal and on the County and City websites.

7. Evaluation and Assessment

The activities identified in this C&E Plan are designed to meet the goals and objectives identified in **Section 2**. Below, **Table 3** lists tasks compiled from the contents of this C&E Plan. This is a working list that will be modified and updated as needed throughout GSP development.

Table 3. Outreach Tasks

C&E Plan Section	Task	Description
4	Launch Groundwater Communication Portal (GCP)	Link to Portal from existing website, announce URL at Commission meeting, post future meetings to calendar, send invitations
5	Conduct Stakeholder Survey	Modify DWR's stakeholder survey for this basin, collect stakeholder feedback via custom survey (***Appendix C***)
6	Assess need for translation services	Document the GSA determination of what constitutes a substantial number of non-English speaking people per the Dymally-Alatorre Bilingual Service Act and the level to which translation services will be provided
6	Public Postings	Post information about GSP development and meetings in public spaces within the City limits such as Farmer's Market and City facilities
6	Conduct Stakeholder Workshops	Conduct stakeholder workshops per the GSP Development Schedule (***Appendix D***)
6	Public Notices	Send meeting notices in advance of stakeholder meetings, including Commission meetings
6	Direct Mailing	Send direct mail to land owners in unincorporated areas of the basin to announce GSP development and Commission meetings. Stakeholders who request it may have the agenda and agenda packet sent to them
6	Hold a public hearing for GSP adoption	Per SGMA § 10728.4, give 60-day notice and hold a public hearing to adopt the final GSP before submitting to DWR
6	Include GCP URL on printed materials	Educate public about where they can find information and updates related to groundwater management in the basin
6	Announce GCP at public meetings	Educate public about where they can find information and updates related to groundwater management in the basin (GCP)

Like the list above, this C&E Plan is a living document to be updated as needed throughout GSP development. Successful use and implementation of the task list and C&E Plan will indicate success.

8. Appendices

Appendix A. **Stakeholder lists submitted at time of GSA formations**
Appendix B. **Groundwater Communication Portal (GCP)**
Appendix C. **San Luis Obispo Valley Basin Stakeholder Survey**
Appendix D. **GSP Development Schedule**
Appendix E. **Postal Mailer: Groundwater Sustainability Plan Update**
Appendix F. **References**

Appendix A.

Stakeholder lists submitted at time of GSA formations

GSA Formation **Exhibit D: List of Beneficial Users**

Initial List of Interested Parties within the San Luis Obispo Valley Basin

Pursuant to the California Water Code Section 10723.2, the San Luis Obispo Valley Basin – County of San Luis Obispo Groundwater Sustainability Agency, in coordination with other GSAs within the San Luis Obispo Valley Groundwater Basin (Basin), will consider the interest of all beneficial uses and users, as well as those responsible for implementing a Groundwater Sustainability Plan (GSP). The County of San Luis Obispo has developed a list of interested parties and will revise the list as needed throughout the development of the GSP. An initial list of stakeholders and interested parties within the proposed San Luis Obispo Valley Basin – County of San Luis Obispo GSA service area, as defined in the water code, follows.

Agency:
County of San Luis Obispo
San Luis Obispo County Flood Control & Water Conservation District
City of San Luis Obispo
Coastal San Luis Resource Conservation District

Water Corporations Regulated by PUC or a Mutual Water Company:
Edna Ranch Mutual Water Company - East
Golden State Water Company - Edna
Varian Ranch Mutual Water Company
Edna Valley Growers Mutual Water Company
Maxwellton Mutual Water

Agricultural users:
Individual agricultural landowners
Farm Bureau
Coastal San Luis Obispo Resource Conservation District
UC Cooperative Extension
USDA Conservation Service
USDA Farm Service Agency
Grower-Shipper Association
SLO Wine Country Association

Domestic well owners:
Individual rural residential/suburban landowners
Tiffany Ranch
O'Conner Way

Municipal well operators:
Covered in other categories

Public water systems:
(per EHS records)
141 Suburban Road Water Supply
200 Suburban Road Water Supply
Bear Valley Water Company

GSA Formation **Exhibit D: List of Beneficial Users**

Initial List of Interested Parties within the San Luis Obispo Valley Basin

Buttonwood Industrial Park- Inactive
CB&I Constructors Inc
Chevron - Tank Farm
Congregation Beth David
Copeland S Investments
East Airport Fiero Lane Water Company
Edna Valley Vineyard
Elks Lodge #322
Ernie Ball Inc
Fiero Lane Water Company
Hidden Hills Mobilodge
Higuera Apartments
Holdgrafter & Associates
Horizon Lane Water Supply
Irish Hills
J M Sims Water Supply
Jespersen Ranch
Laureate Water Company
Madonna Inn Water Company
Noll Properties Industrial Park
Paragon Triangle Water Supply
Poly Ranch
R. Howard Strabaugh Inc
San Luis Business Park
San Luis Sourdough - Inactive
San Luis Water & Power
SLO County Farm Bureau
SLO Partners
Sunset Drive-In Snack Bar
Tank Farm Business Park
Tank Farm Industrial Plaza
Tiger Water Supply
Toyota San Luis Obispo
Vachell Water System
Wallace Water Systems
Whitson Industrial Park
Williams Water Company
Edna Ranch West (not in basin)

Local land use planning agencies:
City of San Luis Obispo
County of San Luis Obispo
San Luis Obispo Council of Government (SLO COG)

GSA Formation **Exhibit D: List of Beneficial Users**

Initial List of Interested Parties within the San Luis Obispo Valley Basin

Environmental users of groundwater:
Central Coast Salmon Enhancement
The Nature Conservancy

Surface water users:
Individual agricultural landowners
City of San Luis Obispo
Central Coast Salmon Enhancement

Federal government:
U.S. Fish & Wildlife

California Native American tribes:
Chumash – no specific water uses in area

Disadvantaged communities:
Covered under other categories

Appendix B.

Groundwater Communication Portal (Portal)

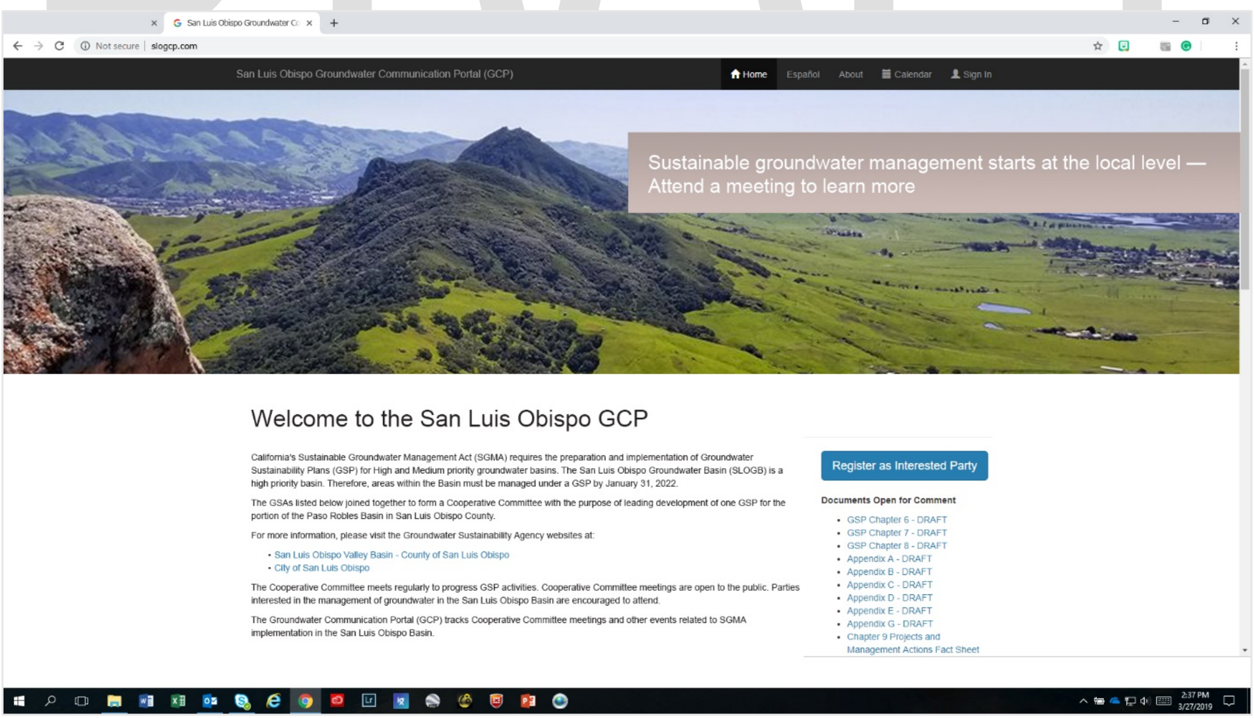
San Luis Obispo Valley Basin Groundwater Communication Portal (Portal)

GEI Consultants developed a tool to help our clients with their SGMA outreach efforts. The tool, referred to as the Groundwater Communication Portal (Portal), can be customized for any groundwater basin to track engagement efforts. The GCP is a web-based tool where you can post events and automatically inform interested parties with the click of a button. Interested parties can register with the GCP to stay informed about events related to GSP development and register for individual events to receive updates.

The GCP serves as a repository for all information about GSA meetings and interested parties. Storing all stakeholder engagement information in one place will be beneficial both for creating the communications section of the GSP and for continued tracking of outreach efforts moving forward to GSP 5-year updates and implementation. The Portal's administrative functions include report generation, so you can easily generate your list of interested parties or details about events (e.g., who was notified). Administrators may also add attachments to the events, including items such as meeting agendas, minutes, and sign-in sheets.

Portal Features

- Maintain the GSAs' list of interested parties
- Allow interested parties to self-register
- Post meeting details and documents
- Automatically notify interested parties with the click of a button
- Track who was notified and who replied to your invitation
- View a calendar of events
- Send e-mail blasts
- Track outreach efforts with a communication log
- Upload project documents and collect public comments



Draft design for the San Luis Obispo Valley GCP

Appendix C.

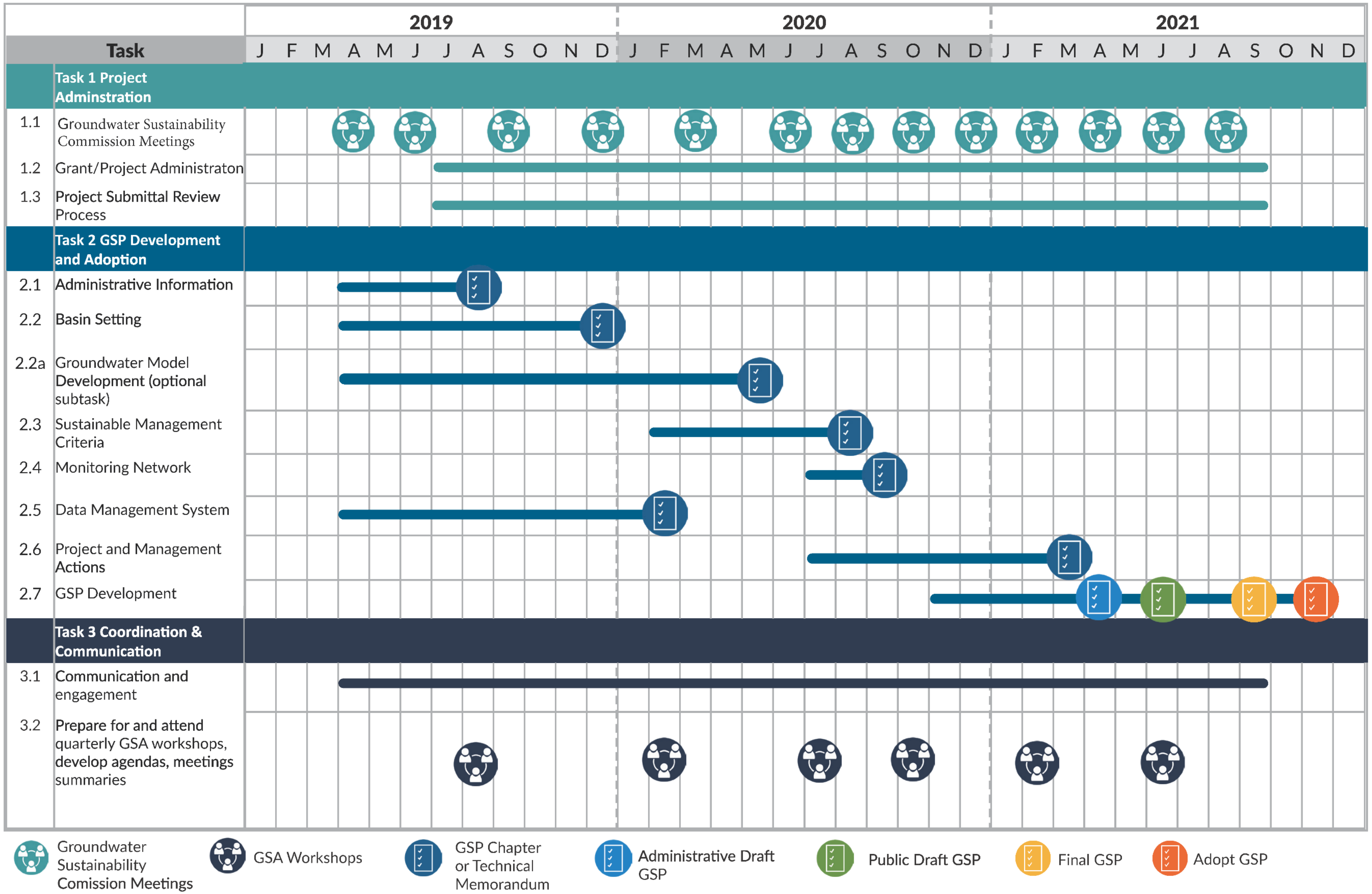
San Luis Obispo Valley Basin Stakeholder Survey

(not included in this draft)

Appendix D.

GSP Development Schedule

PROJECT SCHEDULE



Appendix E.

Postal Mailer: Groundwater Sustainability Plan Update

SLO Basin Groundwater Sustainability Plan Update

The Groundwater Sustainability Commission (GSC) for the San Luis Obispo Valley Groundwater Basin (SLO Basin) is preparing a Groundwater Sustainability Plan (GSP). The purpose of the GSP is to sustainably manage our groundwater resources and meet the requirements of the Sustainable Groundwater Management Act (SGMA). All interested stakeholders and members of the public are encouraged to participate to help guide the GSP development process.

The GSC held a meeting on April 4, 2019 to initiate and provide an overview of the GSP process. The SLO Basin's pathway to sustainability through the development of a GSP is described below.

Upcoming Meetings

JUNE 2019

» **Wednesday, June 12 || 3:30pm**
Groundwater Sustainability Commission Meeting
- *Draft Communication and Engagement Plan*
- *Groundwater Communications Portal Debut*
- *Integrated Groundwater-Surface Water Model*

AUGUST 2019

» **Date and Time: TBD**
Groundwater Sustainability Agency Workshop

June 12 meeting located at:

SLO City/County Library
995 Palm Street
San Luis Obispo, CA 93401

If you would like to receive email notification, please sign up for the SGMA Email List at: **www.slocounty.ca.gov/slobasin**

At this website you can also find out information about progress to-date and all posted agendas and meeting materials.

Postal Mailing List Request Form *San Luis Obispo Valley Basin - County of San Luis Obispo Groundwater Sustainability Agency*

If you wish to receive meeting notification and printed meeting materials by postal mail, please provide your contact information below: (please check one)

☐ Agenda

☐ Agenda Packet (a fee may be applied)
(includes the agenda)

Name ______________________________

Company ______________________________

Address ______________________________

City, State, Zip ______________________________

Please tear along the dotted line and return this Postal Mailing List Request Form to:

Dick Tzou
San Luis Obispo County Public Works Department
County Government Center, Room 206
San Luis Obispo, CA 93408

Email: dtzou@co.slo.ca.us | Phone: (805) 781-4473

Appendix F.

References

Stakeholder Communication and Engagement Guidance Document for Groundwater Sustainability Plan, Department of Water Resources, January 2018

Engagement with Tribal Governments Guidance Document for Sustainable Management of Groundwater, Department of Water Resources, June 2017

COMMUNICATIONS & ENGAGEMENT
IMPLEMENTATION WORKPLAN

for SLO Basin Groundwater Sustainability Plan (GSP) Development

LAST UPDATED: AUGUST 2019

PREPARED BY WATER SYSTEMS CONSULTING

HOW TO USE THIS WORKPLAN

The enclosed workplan is intended to supplement the San Luis Obispo Groundwater Sustainability Communications and Engagement Plan (C&E Plan) and serve as the primary, day-to-day tool for managing its effective implementation.

This workplan was developed by Water Systems Consulting. Monthly updates will be provided to the full GSA team, namely with updated detail on the "Implementation Priorities" slide, on page 8.

CONTENTS

01

TARGET STAKEHOLDER AUDIENCES

TARGET STAKEHOLDER CATEGORIES, detail

GENERAL PUBLIC. Citizen groups, community leaders

LAND USE. GSC Agencies (City of San Luis Obispo Mayor and City Council; County of San Luis Obispo Dept. of Planning and Building staff); **US Forest Service; Land Use Commission**

PRIVATE / RURAL GROUNDWATER USERS. Private pumpers, domestic users (townhome and mobile home communities, campgrounds, private homeowners)

AGRICULTURAL WATER USERS.
All GSC Agencies; water agencies + irrigation districts (Golden State Water Company, Mutual Water Company; **Farm bureaus** (San Luis Obispo County Farm Bureau; individual agriculture land owners; Cal Poly; A Lab)

URBAN / INDUSTRIAL USERS. Commercial and industrial users (Airvol Block)

INTEGRATED WATER MANAGEMENT.
SLO County Flood and Water Conservation District, IRWMG Group; Water Resource Advisory Committee; Zone 9 Flood Control District; DWR

ENVIRONMENTAL AND CONSERVATION ORGS.
Federal and state agencies (US Fish and Wildlife);
Environmental groups (Central Coast Salmon Enhancement / Creek Lands; The Nature Conservancy; Sierra Club; NOAA; National Marine Fisheries);
Conservation groups (Save Our Water; Water Use It Wisely; San Luis Obispo Master Gardeners; SLO County Land Conservancy; CA Conservation Corp);
Resource conservation districts (San Luis Obispo County Flood and Water Conservation District; Coastal San Luis Resource Conservation District; Central Coast Water Conservation; Regional Water Quality Control Board, State Division of Drinking Water).

ECONOMIC DEVELOPMENT. SLO Economic Development Corp; Hourglass Project; wine association; **Elected officials** (San Luis Obispo County Board of Supervisors; Senators Bill Monning, Dianne Feinstein, Kamala Harris; Congressman Salud Carbajal; Assemblyman Jordan Cunningham).

HUMAN RIGHT TO WATER. Disadvantaged communities; Rural Community Assistance Corp

TRIBES. The Chumash people

PRIORITY STAKEHOLDERS CATEGORIES,

July-December 2019

While outreach to all stakeholders audiences will take place continuously, priority attention will be given to the groups below over the next few months. This is based an analysis of these group's proximity to the need for a sustainable groundwater plan—namely in either their ability to influence this outcome and/or how the plan will impact then; as well as their level of interest in participating in plan development.

LAND USE. GSC Agencies (City of San Luis Obispo Mayor and City Council; County of San Luis Obispo Dept. of Planning and Building staff); **US Forest Service; Land Use Commission**

AGRICULTURAL WATER USERS.
All GSC Agencies; water agencies + irrigation districts (Golden State Water Company, Mutual Water Company; **Farm bureaus** (San Luis Obispo County Farm Bureau; individual agriculture land owners; Cal Poly; A Lab)

ENVIRONMENTAL AND CONSERVATION ORGS.
Federal and state agencies (US Fish and Wildlife); **Environmental groups** (Central Coast Salmon Enhancement / Creek Lands; The Nature Conservancy; Sierra Club; NOAA; National Marine Fisheries); **Conservation groups** (Save Our Water; Water Use It Wisely; San Luis Obispo Master Gardeners; SLO County Land Conservancy; CA Conservation Corp); **Resource conservation districts** (San Luis Obispo County Flood and Water Conservation District; Coastal San Luis Resource Conservation District; Central Coast Water Conservation; Regional Water Quality Control Board, State Division of Drinking Water).

02

GOALS AND EVALUATION METRICS

OUTREACH GOALS

- Create an inclusive, transparent participation experience that builds public trust in the Groundwater Model and GSP and optimizes participation among all those impacted.
- Employ outreach methods that facilitate shared understanding of the importance of sustainable groundwater and its impact on stakeholders.
- Communicate “early and often,” and actively identify and eliminate barriers to participation.
- Develop a cost-effective, stakeholder-informed GSP supported by best-in-class technical data.

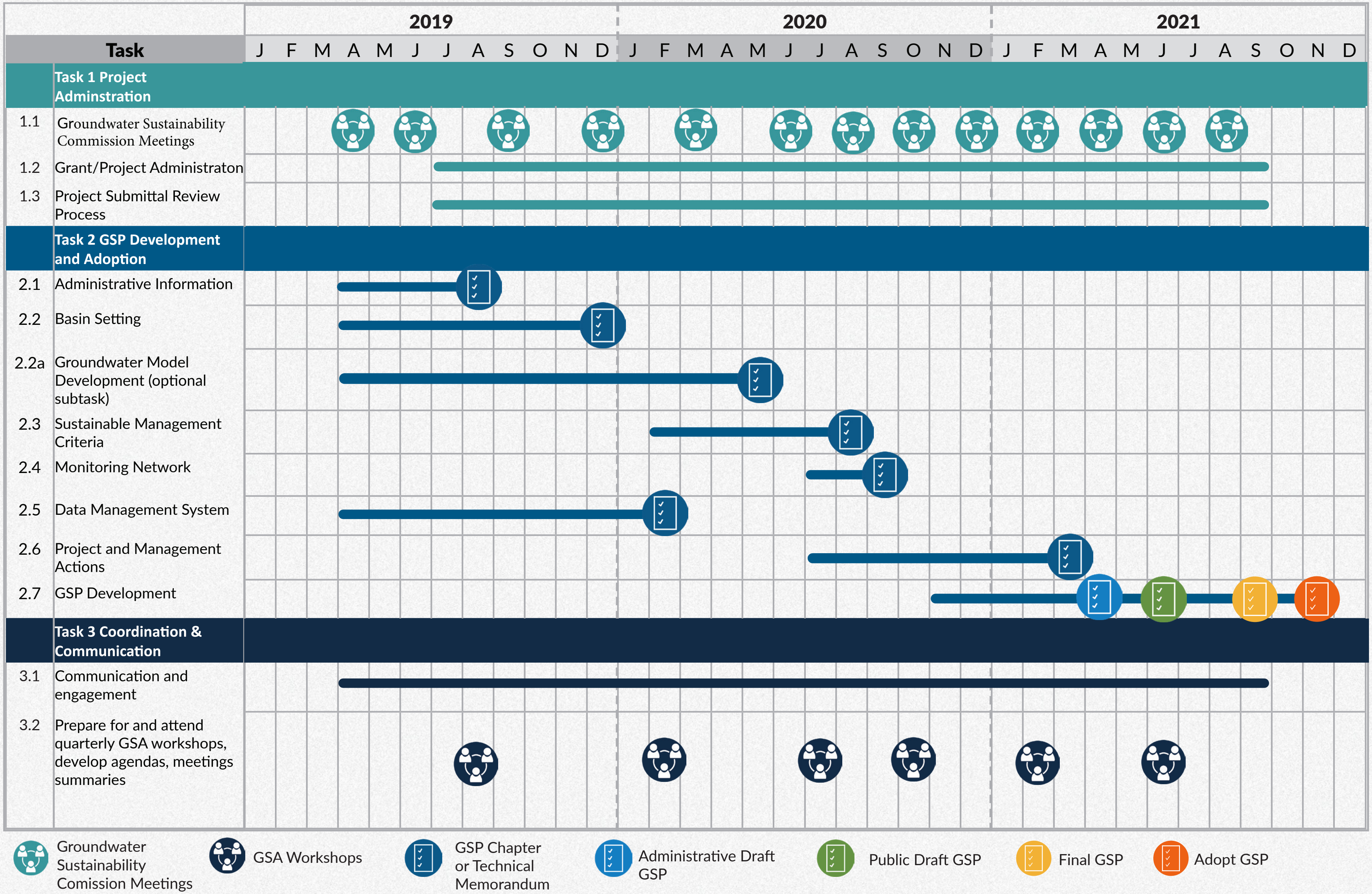
EVALUATION METRICS

- Rate and representative diversity of Portal subscribes / unsubscribes relevant to our target stakeholder categories
- Rate and representative diversity of public comment at key project milestones, compared to our target stakeholder categories
- Representative diversity of GSC Meeting attendance over time, compared to our target stakeholder categories
- Representative diversity of Stakeholder Workshop attendance over time, compared to our target stakeholder categories

03

WORKPLAN AND TIMELINE

PROJECT SCHEDULE



COMMUNICATION PRIORITIES, Jul-Nov 2019

	JUL	AUG	SEP	OCT	NOV
GSP DEVELOPMENT	• Develop Intro and Admin Info Chapter • Develop Basin Setting Chapter • Develop Groundwater Model • Develop Data Management System	• **Develop Intro and Admin Info Chapter—COMPLETE** • Develop Basin Setting Chapter • Develop Groundwater Model • Develop Data Management System	• Develop Basin Setting Chapter • Develop Groundwater Model • Develop Data Management System	• Develop Basin Setting Chapter • Develop Groundwater Model • Develop Data Management System	• Develop Basin Setting Chapter • Develop Groundwater Model • Develop Data Management System
C&E PLAN DEVELOPMENT	• C&E Plan, respond to public comment • Add outreach materials to portal • Finalize, distribute survey; synthesize results	------	------	------	------
GSC QUARTERLY MEETINGS	------	• Plan Sep meeting agenda/ content • Create presentation deck	• Finalize presentation deck/graphics • **Facilitate meeting—SEP 11**	------	• Plan Dec meeting agenda/content • Create presentation deck
STAKEHOLDER WORKSHOPS	• Workshop #1 planning • Develop presentation and workshop materials	**FACILITATE WORKSHOP #1**	------	------	• Set workshop #2 date/time/ location
STAKEHOLDER OUTREACH	• Monthly workplan to team • Develop master messaging • Develop FAQs • Develop trifold brochure, table tents, posters, mini presentation deck, flyer • RECRUIT: Send outreach materials to stakeholder orgs to distribute • ENGAGE/INVITE: **Send eblast and snail mail Workshop #1 invite Print all materials** • INFORM: **JUL 15—Send quarterly ebulletin and snail mail bulletin** • INFORM: Post news/content to Communications Portal	• Monthly workplan to team • Adapt messaging, outreach materials, and approach as needed following Workshop #1 • RECRUIT: Send outreach materials to stakeholder orgs to distribute • RECRUIT: Present intro deck at target stakeholder orgs; distribute materials • INVITE: **2 weeks prior to workshop, send eblast Workshop #1 invite reminder.** • INFORM: Post news/content to Communications Portal	• Monthly workplan to team • Adapt messaging, outreach materials, and approach as needed following Workshop #1 • RECRUIT: Recruit stakeholders to subscribe to portal, emphasize priority segments, ACTION TBD • INFORM: Draft quarterly bulletin content • INFORM: Post news/content to Communications Portal	• Monthly workplan to team • RECRUIT: Recruit stakeholders to subscribe to portal, emphasize priority segments, ACTION TBD • INFORM: **OCT 15—Send quarterly ebulletin and snail mail bulletin** • INFORM: Post news/content to Communications Portal	• Monthly workplan to team • RECRUIT: Recruit stakeholders to subscribe to portal, emphasize priority segments, ACTION TBD • INFORM: Post news/content to Communications Portal

04

OUTREACH TOOLS AND MATERIALS

WEBSITES

The following materials will be used in regular cadence to keep the public informed of project progress, including invitations to four quarterly workshops and to make public comment in line with project milestones and drafting of plan chapters.

A. WEBSITE AND COMMUNICATIONS PORTAL—The central hub for project information, engagement, and public comment. FAQs will be housed here; the stakeholder list is managed here; and email communications are distributed from here to subscribed stakeholders.

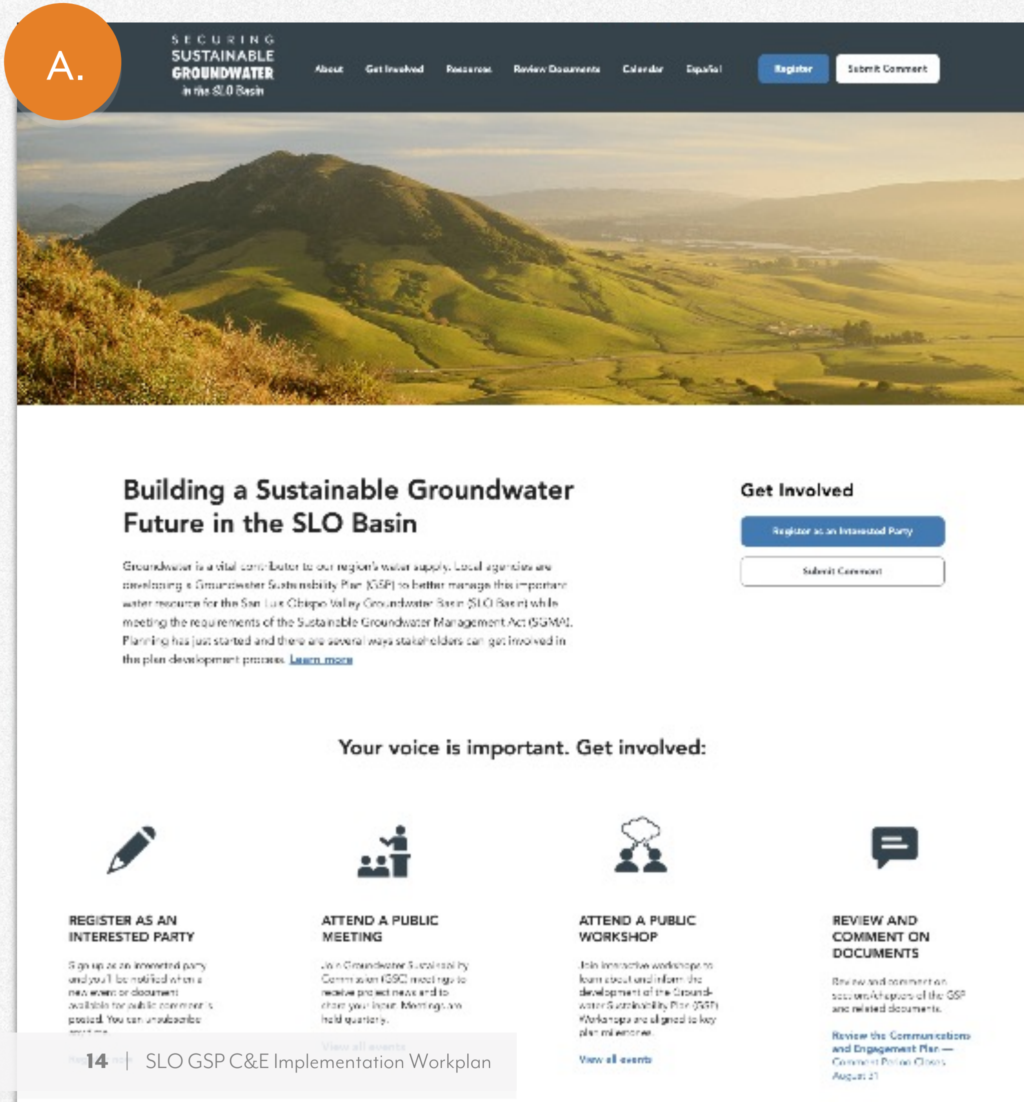
SLOWaterBasin.com

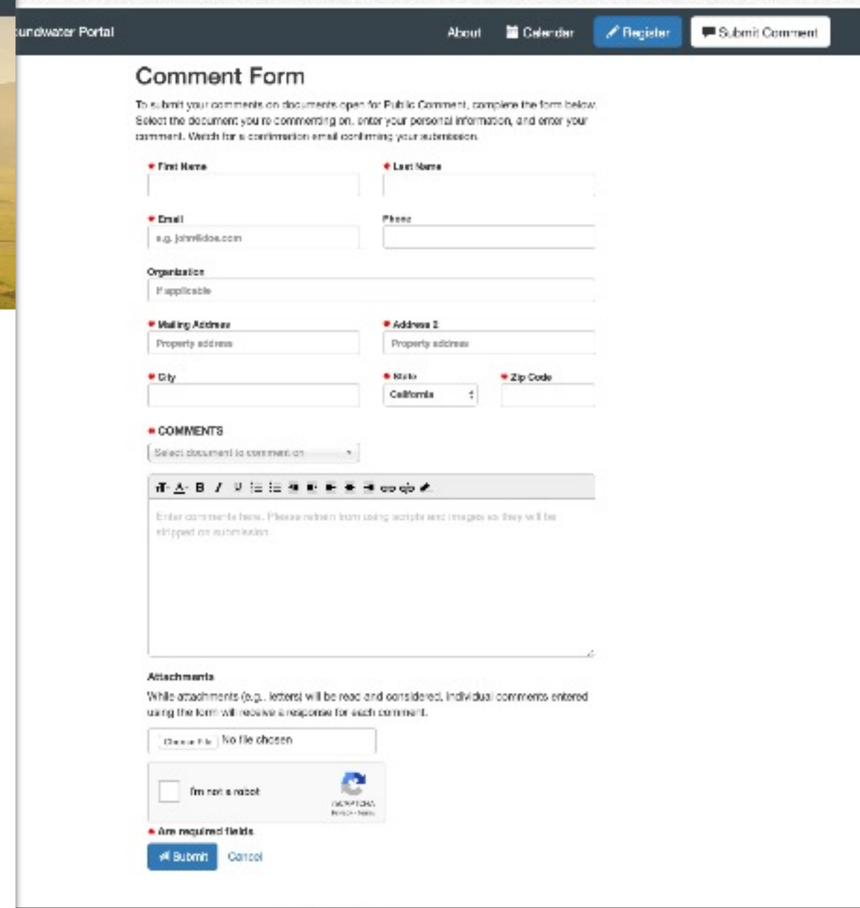
B. CITY OF SAN LUIS OBISPO WEB PAGE WITH FAQS, LINK TO PORTAL, ETC. —Stakeholders can access the full basin characterization report here, as well as an interactive map of the SLO Basin.

WEBSITES

A. GROUNDWATER COMMUNICATIONS PORTAL

B. CITY OF SAN LUIS OBISPO WEB PAGE





WEBSITES

A. GROUNDWATER COMMUNICATIONS PORTAL

B. CITY OF SAN LUIS OBISPO WEB PAGE

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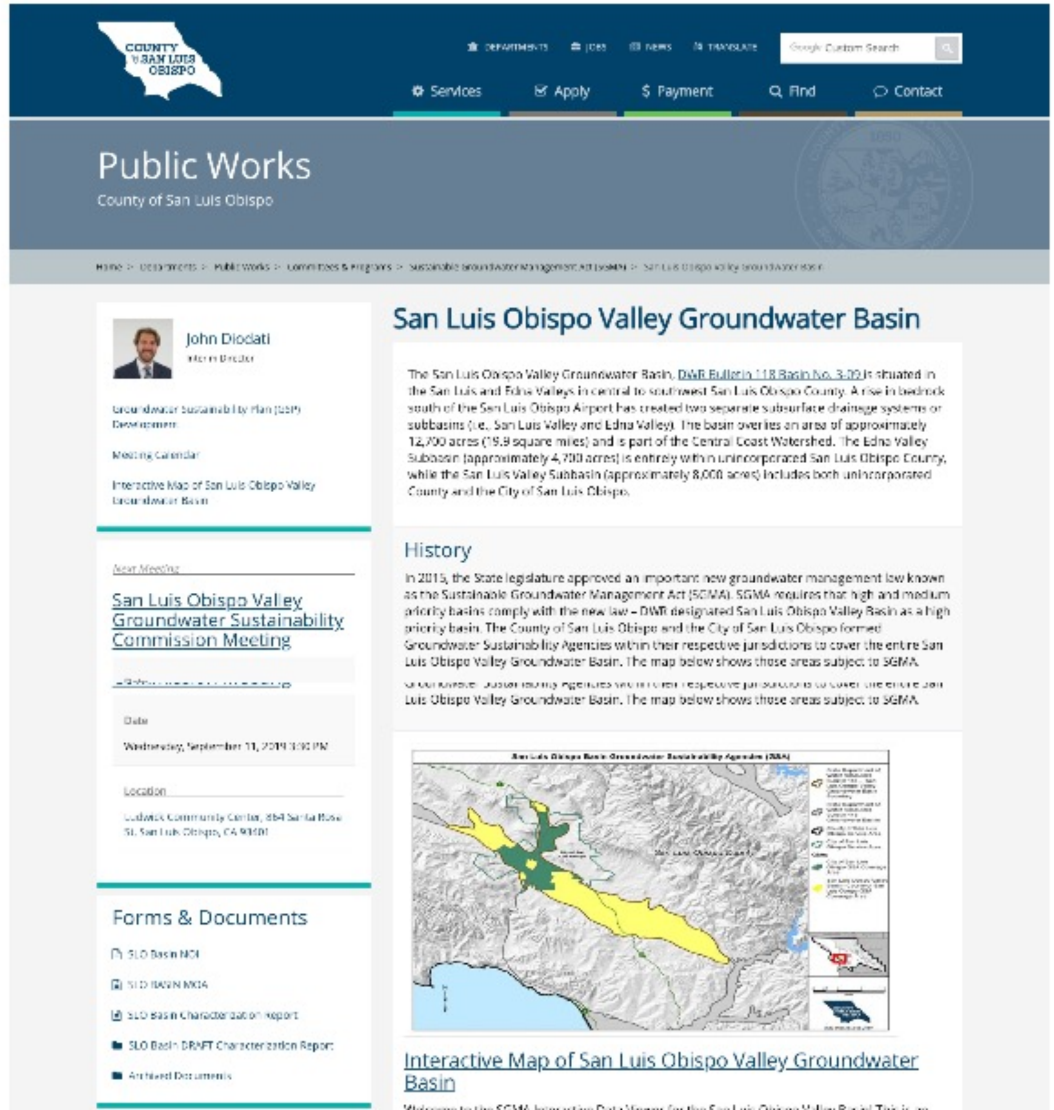

STAKEHOLDER RECRUITMENT MATERIALS

Inclusive and diverse representation of affected stakeholders in the GSP process is critical to creating an effective GSP. These materials will be used to continually recruit participation among target stakeholder audiences, including focused recruitment for audiences that are continually underrepresented in GSC meetings and workshops.

A. PHYSICAL MAILER

B. RACK CARD

C. TABLE TENTS

D. FLYER

STAKEHOLDER RECRUITMENT MATERIALS

PHYSICAL MAILER

SLO Basin Groundwater Sustainability Plan Update

The Groundwater Sustainability Commission (GSC) for the San Luis Obispo Valley Groundwater Basin (SLO Basin) is preparing a Groundwater Sustainability Plan (GSP). The purpose of the GSP is to sustainably manage our groundwater resources and meet the requirements of the Sustainable Groundwater Management Act (SGMA). All interested stakeholders and members of the public are encouraged to participate to help guide the GSP development process.

The GSC held a meeting on April 4, 2019 to initiate and provide an overview of the GSP process. The SLO Basin's pathway to sustainability through the development of a GSP is described below.

PHASE 1
FACT REPORTING AND EDUCATION
- GSP Kickoff
- Communications and Engagement Plan
- Plan Area and Basin Setting: Hydrogeologic Conceptual Model, Current Historical Groundwater Conditions, and Water Budget
- Groundwater Model Development
- Data Management System

MARCH 2019 – AUGUST 2020

PHASE 2
SUSTAINABLE GOAL SETTING
- Sustainable Management Criteria: Management Areas
- Sustainability Goal, Measurable Objectives, Minimum Threshold, and Undesired Results

JANUARY 2020 – JULY 2020

PHASE 3
PLAN TO SUSTAINABILITY
- Projects and Management Actions to Achieve Sustainability
- Plan Implementation: Estimate Costs and Schedule

JUNE 2020 – FEBRUARY 2021

PHASE 4
GSP DOCUMENTATION
- Administrative Draft GSP
- Final GSP

OCTOBER 2020 – AUGUST 2021

SGMA-COMPLIANT PLAN

Upcoming Meetings

JUNE 2019

» **Wednesday, June 12 || 3:30pm**
Groundwater Sustainability Commission Meeting
- *Draft Communication and Engagement Plan*
- *Groundwater Communications Portal Debut*
- *Integrated Groundwater-Surface Water Model*

AUGUST 2019

» **Date and Time: TBD**
Groundwater Sustainability Agency Workshop

June 12 meeting located at:

SLO City/County Library
995 Palm Street
San Luis Obispo, CA 93401

If you would like to receive email notification, please sign up for the SGMA Email List at: **www.slocounty.ca.gov/slobasin**

At this website you can also find out information about progress to-date and all posted agendas and meeting materials.

Postal Mailing List Request Form

San Luis Obispo Valley Basin - County of San Luis Obispo Groundwater Sustainability Agency

If you do not have access to email and wish to receive meeting notification and printed meeting materials by postal mail, please provide your contact information below: (please check one)

☐ Agenda

☐ Agenda Packet (a fee may be applied)
(includes the agenda)

Name ______________________

Company ______________________

Address ______________________

City, State, Zip ______________________

Please tear along the dotted line and return this Postal Mailing List Request Form to:

Dick Tzou
San Luis Obispo County Public Works Department
County Government Center, Room 206
San Luis Obispo, CA 93408

Email: dtzou@co.slo.ca.us | Phone: (805) 781-4473

COUNTY OF SAN LUIS OBISPO

STAKEHOLDER RECRUITMENT MATERIALS

RACK CARD

SECURING
SUSTAINABLE GROUNDWATER
in the SLO Basin

Groundwater is a vital part of our region's water supply. Local agencies are developing a Groundwater Sustainability Plan (GSP) to sustainably manage this important water resource for the San Luis Obispo Valley Groundwater Basin (SLO Basin) while meeting the requirements of the Sustainable Groundwater Management Act (SGMA).

PLANNING HAS JUST STARTED.

Visit **SLOWaterBasin.com** to learn how you can participate.

SLOWaterBasin.com
GET INVOLVED NOW

PROJECT TIMELINE

- ADMIN INFO & BASIN SETTING — 2019
- SUSTAINABLE GOAL SETTING — 2020
- PLAN TO SUSTAINABILITY
- FINAL PLAN DEVELOPMENT — 2021
- 2022

Your voice is important. Get involved:

GET INVOLVED

MEETINGS. Join Groundwater Sustainability Commission (GSC) meetings to receive project news and to share your input. **MEETINGS ARE HELD QUARTERLY.**

WORKSHOPS. Join interactive workshops to learn about and inform the development of the GSP. **WORKSHOPS ARE ALIGNED WITH PLAN MILESTONES.**

REVIEW AND COMMENT. Review and comment on sections/chapters of the GSP. **FIND DOCUMENTS OPEN FOR COMMENT ON THE WEBSITE.**

ESPAÑOL? Si necesita solicitar alojamiento para asistir a un evento, incluidos los servicios de traducción al español, comuníquese con Dick Tzou a dtzou@co.slo.ca.us o al 805-781-4473.

SLOWaterBasin.com

Sign up as an interested party for alerts of meetings and opportunities to comment.

STAKEHOLDER RECRUITMENT MATERIALS

FLYER

SECURING
SUSTAINABLE
GROUNDWATER
in the SLO Basin

Groundwater is a vital part of our region's water supply. Local agencies are developing a Groundwater Sustainability Plan (GSP) to sustainably manage this important water resource for the San Luis Obispo Valley Groundwater Basin (SLO Basin) while meeting the requirements of the Sustainable Groundwater Management Act (SGMA).

PLANNING HAS JUST STARTED. Visit **SLOWaterBasin.com** to learn how you can participate.

ESPAÑOL?

Si necesita solicitar alojamiento para asistir a un evento, incluidos los servicios de traducción al español, comuníquese con Dick Tzou a dtzou@co.slo.ca.us o al 805-781-4473.

THE SLO BASIN

SAN LUIS VALLEY

CITY OF SAN LUIS OBISPO

EDNA VALLEY

1

101

227

Your voice is important. Here's how to get involved:

MEETINGS. Join Groundwater Sustainability Commission (GSC) meetings to receive project news and to share your input. MEETINGS ARE HELD QUARTERLY.

WORKSHOPS. Join interactive workshops to learn about and inform the development of the GSP. WORKSHOPS ARE ALIGNED WITH PLAN MILESTONES.

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SLOWaterBasin.com — GET INVOLVED NOW

STAKEHOLDER RECRUITMENT MATERIALS

TABLE TENT

STAKEHOLDER COMMUNICATION MATERIALS

These materials will be used in regular cadence to keep subscribed stakeholders and the visitors to the Portal informed of project progress, including participation to four quarterly workshops and to make public comment.

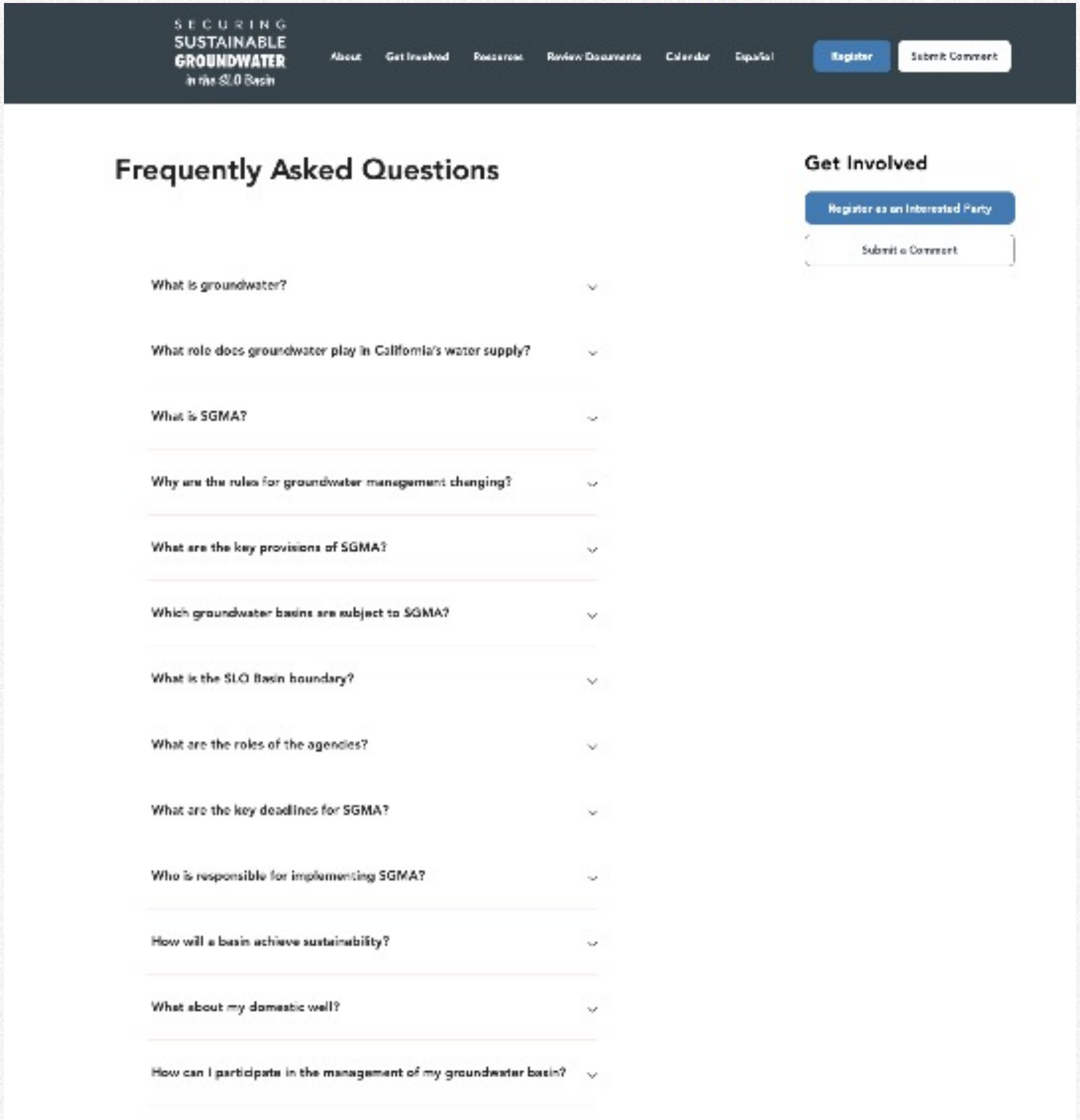
A. FAQS — Housed at SLOWaterBasin.com

B. QUARTERLY NEWSLETTER — Sent to to subscribed stakeholders (email and snail mail); includes notices/news of opportunities to participate, upcoming meetings and workshops, and a summary of the quarterly GSC meetings and past workshops.

C. GSP PORTAL SUBSCRIBER EBLASTS

STAKEHOLDER COMMUNICATION MATERIALS

FAQS



STAKEHOLDER COMMUNICATION MATERIALS

NEWSLETTER

A QUARTERLY UPDATE OF THE SLO BASIN GROUNDWATER SUSTAINABILITY PLAN DEVELOPMENT
VOLUME 1 | JULY 2019

Building a Sustainable Groundwater Future in the SLO Basin

During a normal year, nearly 40 percent of California's agricultural and urban water demand is met by the use of groundwater, which has resulted in declining groundwater levels in some groundwater basins throughout California. In an effort to ensure the sustainable use of California's groundwater and a water-secure future for the State, the Sustainable Groundwater Management Act (SGMA) was signed into law in 2014. The California Department of Water Resources (DWR) prioritized 515 groundwater basins in California into one of four categories; high, medium, low or very low priority based on a set of criteria.

SGMA is a State law that requires local governments and water agencies that overlie high and medium priority basins to form Groundwater Sustainability Agencies (GSAs) for the purpose of sustainably managing the groundwater basins. Locally, the San Luis Obispo Valley Groundwater Basin (SLO Basin) has been identified as a high priority basin by the State. Therefore, to meet SGMA requirements, the County of San Luis Obispo (County) and the City of San Luis Obispo (City) each formed a GSA. These two GSAs are the governmental entities tasked with developing and implementing the SLO Basin's Groundwater Sustainability Plan (GSP).

Although the GSAs were formed by the two local public agencies, representatives of the Golden State Water Company, Edna Ranch Mutual Water Company, Varian Ranch Mutual Water Company, and Edna Valley Growers Mutual Water Company were engaged in developing a governance structure. In addition to the formation of the two GSAs, a Groundwater Sustainability Commission (GSC) — an advisory body to the GSAs — was established through a Memorandum of Agreement (MOA) between the GSAs and the above participating parties, and the terms under which the City GSA and County GSA will jointly develop a single GSP in coordination with the GSC.

GSP development recently began and will continue through January 2022. All interested stakeholders and members of the public are encouraged to participate to help guide the GSP development process. Visit SLOWaterBasin.com for details on how you can participate in this important process.

In this issue

Why am I receiving this?

- You live or work in the SLO Basin
- You may be affected by the SLO Basin's groundwater use
- You subscribed to receive updates about SGMA or GSP development

Through the duration of the SLO Basin GSP development, this newsletter will be distributed quarterly to all subscribers of the SLOWaterBasin.com Portal and made available at GSC meetings and stakeholder workshops. To stop receiving these newsletters, go to SLOWaterBasin.com, scroll to the bottom of the page and click "unsubscribe."

SLOWaterBasin.com — GET INVOLVED NOW

STAKEHOLDER COMMUNICATION MATERIALS

EBLASTS

Quarterly Update: SLO Groundwater Sustainability Plan (July 2019)

SV

SLO Valley Groundwater Communication Portal (GCP) <no-reply-slogcp@geiconsult...

Tiffany Meyer

Tuesday, August 20, 2019 at 11:31 AM

Show Details

WHY AM I RECEIVING THIS EMAIL? You are receiving this email because you subscribed to receive updates about SGMA or GSP development. To unsubscribe, visit http://SLOWaterBasin.com, scroll to the bottom, and click "unsubscribe." The Groundwater Sustainability Agencies for the San Luis Obispo Valley Groundwater Basin (SLO Basin) are currently developing a new Groundwater Communication Portal (Portal) at http://SLOWaterBasin.com. The Portal will be the online communication hub for public participation in the GSP development process, including reviewing and submitting public comments on GSP chapters/sections.

Building a Sustainable Groundwater Future in the SLO Basin

A quarterly update of the SLO Basin Groundwater Sustainability Plan development

Volume 1 | July 2019

DOWNLOAD THE FULL ISSUE HERE: http://slowaterbasin.com/service/document/download/40

ISSUE SUMMARY:

SGMA and Groundwater Sustainability Plan Overview— During a normal year, nearly 40 percent of California's agricultural and urban water demand is met by the use of groundwater, which has resulted in declining groundwater levels in some groundwater basins throughout California. In an effort to ensure the sustainable use of California's groundwater and a water-secure future for the State, the Sustainable Groundwater Management Act (SGMA) was signed into law in 2014 …

April 10, 2019 GSC Meeting Summary — On April 9, 2019 the County Board of Supervisors approved a contract with Water System Consulting (WSC) to develop a GSP for the SLO Basin. Following this selection, the GSC held a kick-off meeting on April 10, 2019 to initiate the development of a Groundwater Sustainability Plan (GSP) …

June 12, 2019 GSC Meeting Summary —The Groundwater Communications Portal (Portal) at SLOWaterBasin.com was previewed by the consulting team. The Portal will be the online communication hub for public participation in the GSP development process, including reviewing and submitting public comments on GSP chapters/sections. The best way to stay apprised of project news and opportunities to participate and engage is to register on the Portal as an "interested party" …

Project Milestones and Opportunities to Participate —The Groundwater Sustainability Plan (GSP) will be developed in phases through the end of 2021 to meet the required completion deadline of January 31, 2022. There will be ample opportunity for the public to participate in the plan development process, including participation in quarterly public GSC meetings, interactive workshops, and review and comment for each GSP chapter … NEXT WORKSHOP on SGMA and Groundwater 101: August 14, 2019.

Future GSC Chapter/Section Review Opportunities — Download the full PDF for details on all future opportunities to participate in the GSP development …

F

Groundwater Dependent Ecosystems in the San Luis Obispo Valley Groundwater Basin

Stillwater Sciences
895 Napa Ave., Suite B-4, Morro Bay, CA 93442
phone 805-570-7499

TECHNICAL MEMORANDUM

DATE:	October 19, 2020
TO:	WSC and Cleath-Harris Geologists
FROM:	Aleksandra Wydzga and Ethan Bell (Stillwater Sciences)
SUBJECT:	Groundwater-Dependent Ecosystems in the San Luis Obispo Valley Groundwater Basin

The purpose of this memo is to summarize known information about surface water hydrology relevant to Groundwater Dependent Ecosystems (GDEs) in the San Luis Obispo (SLO) Valley Groundwater Basin (Section 1), identify GDEs overlying and dependent upon the SLO Valley Groundwater Basin (Section 2), identify sustainable GDE indicators (Section 3) for the SLO Valley Groundwater Basin, and propose a hydrologic monitoring network to track these indicators over time (Section 4). GDEs are defined in California's Sustainable Groundwater Management Act (SGMA) as "ecological communities of species that depend on groundwater emerging from aquifers or on groundwater occurring near the ground surface" (23 CCR § 351(m)).

1 EXISTING SURFACE WATER HYDROLOGY

1.1 Overview of GDE Relevant Surface and Groundwater Hydrology

The Basin is overlain by two watersheds: San Luis Obispo (SLO) and Pismo (Figure 1). Flows in SLO and Pismo Creeks can be divided into wet season flows, typically occurring from January to April, and dry season flows, typically from June to October. Short transitional periods occur between the wet and dry seasons. Wet season instream flows originate from a range of sources including precipitation-driven surface runoff events, water draining from surface depressions or wetlands, shallow subsurface flows (e.g., soil), and groundwater. Dry season instream flows, however, if present, are fed primarily by groundwater. As groundwater levels fall over the dry season, so do the corresponding instream flows. If groundwater elevations remain above instream water elevations, groundwater discharges into the stream and surface flows continue through the entire dry season (creating perennial conditions). If groundwater elevations fall below the streambed elevation, the stream can go dry. Streams that typically flow in the wet season and dry up in the dry season are termed intermittent. Due to climactic changes or groundwater pumping, over time streams can transition from historically perennial to intermittent conditions (Barlow and Leake 2012). Dry season flows supported by groundwater in the SLO and Pismo Creeks are critical for the survival of various special-status species, including but not limited to the federally threatened California red-legged frog (CRLF) *(Rana draytonii)* and Steelhead (*Oncorhynchus mykiss)*.

SLO Creek and Pismo Creek are underlain by numerous aquifers. These aquifers are connected to one another, and to surface waters, but the degree of connection varies spatially. Aquifers can include confined aquifers, unconfined aquifers, and perched aquifers (see Chapter 4 of the Draft

Groundwater Sustainability Plan). Aquifers may be hydrologically linked with ponds, lakes, wetlands, and creeks. In the SLO Valley Groundwater Basin, few data exist to characterize the connection between surface water and groundwater.

The SLO Valley Groundwater Basin is divided into two sub-basins: the SLO Valley sub-basin and the Edna Valley sub-basin. While the groundwater in these basins is hydraulically connected, a shallow subsurface bedrock divide between the two sub-basins partially isolates the deeper portions of the two aquifers (Appendix A). Groundwater in the Edna sub-basin flows both towards the SLO Valley sub-basin in the northwest portion of the basin and towards Price Canyon in the southwest portion of the basin. Groundwater flowing towards Price Canyon rises to the surface as it approaches the bedrock constriction of Price Canyon and the Edna fault system. A 1954 DWR map (Appendix B) best illustrates the groundwater flow from the Edna Valley sub-basin both towards SLO and into Price Canyon. As groundwater from the Edna sub-basin flows towards Price Canyon and rises to the surface, it creates a perennial reach of Pismo Creek that flows through Price Canyon and supports year-round critical habitat for threatened steelhead.

1.2 Losing and Gaining Reaches

Streams are often subdivided into losing and gaining reaches to describe their connection to groundwater. In a losing reach water flows from the stream to the groundwater while in a gaining reach water flows from the groundwater into the stream. The connection between losing reaches to the regional aquifer may be unclear as water can be trapped in perched aquifers above the regional water table. Figure 1 shows the likely extent of known gaining and losing reaches in SLO and Pismo Creeks during typical late spring and dry season conditions. This map is compiled from various data sources, including a field survey of wet and dry reaches of SLO Creek (Bennett 2015), field surveys and flow measurements of Pismo Creek (Balance Hydrologics 2008), an instream flow study of Pismo Creek (Stillwater Sciences 2012), a regional instream flow assessment that included SLO and Pismo Creeks (Stillwater Sciences 2014), spring and summer low flow measurements in SLO and Pismo Creeks (2015–2018) (Creek Lands Conservation 2019), and consideration of the effects of local geologic features such as bedrock outcrops and faults, both of which can force deeper groundwater to the surface. The effect of faults and bedrock outcrops can be localized or extend for some distance downstream. Portions of the SLO and Pismo Creeks and their tributaries for which no data exist are left unhighlighted in Figure 1. In general, the extent of losing or gaining reaches can vary by water year type or pumping conditions. For example, East Corral de Piedra and West Corral de Piedra on the north-east side of the basin can be dry in the spring and summer during drier years but be flowing in wetter years (Creek Lands Conservation 2019). In contrast, gaining reaches shown on SLO Creek appear fairly consistent across water year types (Bennett 2015, Creek Lands Conservation 2019). Figure 1 is based on limited data sources and improved mapping of losing and gaining reaches is recommended (Section 4).

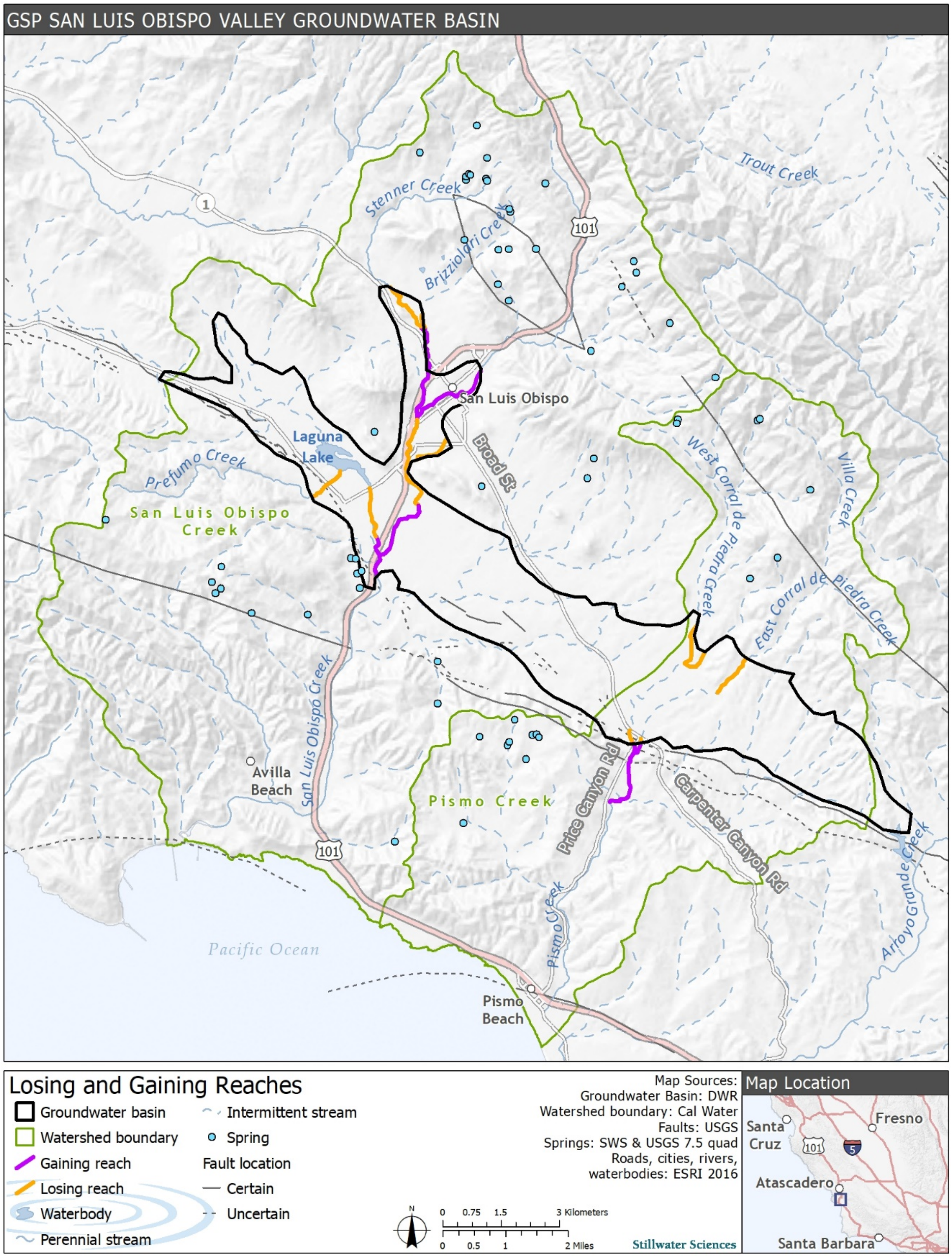


Figure 1. Typical late spring and dry season losing and gaining reaches in the basin. Portions of the SLO and Pismo Creeks and their tributaries for which no data exist are left unhighlighted.

1.3 Relevance to GDEs

Depending on location and time of year, GDEs that overly the SLO Valley Groundwater Basin can be supported by a range of water sources including direct precipitation, surface runoff, shallow subsurface flow, and groundwater. Shallow subsurface flow can vary from short-term precipitation driven flow (e.g. macro-pores filled during a precipitation event that drain on the order of days to weeks) to flow that is directly connected to groundwater (e.g. groundwater discharge into streams during the dry season). In the wet season, GDEs overlying the SLO Groundwater Basin are supported by a wider range of surface and groundwater hydrological sources than in the dry season. In the dry season, the primary water source supporting the GDEs is groundwater, although in some reaches irrigation return flow may be present. Irrigation return flow can have surface water sources from outside the basin (e.g. City of SLO parcels) or local groundwater (e.g. Edna Valley). Groundwater supporting GDEs overlying the SLO Valley Groundwater Basin can originate outside of the groundwater basin or within the groundwater basin. Both our proposed our strategy to identify sustainable GDE indicators (Section 3) and our proposed monitoring network (Section 4) take advantage of and integrate these hydrologic realities to focus on the assessment and monitoring of GDEs in locations and during seasons that are reliant on groundwater originating in the SLO Groundwater Basin.

2 POTENTIAL GROUNDWATER DEPENDENT ECOSYSTEMS (GDES) AND ASSOCIATED FLORA AND FAUNA

2.1 Distribution of Potential GDEs Based on Best Available Vegetation and Wetland Data

Groundwater dependent ecosystems (GDEs) are defined in California's Sustainable Groundwater Management Act (SGMA) as "ecological communities of species that depend on groundwater emerging from aquifers or on groundwater occurring near the ground surface" (23 CCR § 351(m)). As described in The Nature Conservancy's guidance for GDE analysis (Rohde et al. 2018), a GDE's dependence on groundwater refers to reliance of GDE species and/or communities on groundwater for all or a portion of their water needs. The Department of Water Resources (DWR) compiled a statewide Natural Communities Commonly Associated with Groundwater database (DWR 2019). This database identifies potentially groundwater dependent ecosystems based on the best available vegetation and wetland data (Klausmeyer et al. 2018). DWR (2019) identifies potentially groundwater dependent wetland areas using National Wetland Inventory (NWI) wetland data (USFWS 2018). These data were evaluated and assessed to accurately capture wetland and riverine features. In the SLO Valley Groundwater Basin, the best available vegetation mapping dataset (FVEG) was from the California Fire and Resource Assessment Program Vegetation (California Department of Forestry and Fire Protection 2015). FVEG is a remotely sensed dataset that classifies vegetation to coarse types (i.e., the California Wildlife Habitat Relationship System). Given the limitations of this dataset to accurately capture and identify vegetation using a precise classification system, it was deemed inappropriate for use in determining potential GDEs in the SLO Groundwater Basin. Instead, a manual assessment of vegetation with potential groundwater dependence was conducted using National Agricultural Imagery Program 2018 color aerial imagery (NAIP 2018). Vegetation communities identified as potentially groundwater dependent included riparian trees and shrubs, and oak woodlands. Oak woodlands were considered potentially groundwater dependent, particularly coast live oak riparian woodlands, because coast live oak (*Quercus agrifolia*) is known to make use of groundwater at depths of up to 36 ft (see Steinberg 2002 and references cited therein). Some other species of California oak, particularly blue oak (*Q. douglasii*) are known to develop deeper roots that can access deeper groundwater in fractured bedrock on hillslopes (up to 70 feet [Lewis and Burgy 1964]), however such landscape positions are substantially different from what would be expected for GDEs occurring within a recognized groundwater basin on valley bottom or floodplain alluvial deposits. Therefore, we rely on the species-specific rooting and groundwater depth data for coast live oak cited by Steinberg (2002).

Potential vegetation and wetland GDEs were retained if the underlying depth to water in 2019 was inferred to be 30 feet or shallower based on the existing well network (Figure 2). Depth to groundwater was interpolated from seventeen wells for which groundwater level data was available in the spring of 2019 (WSC in progress). The depth to groundwater shown in Figure 2 is assumed to represent regional groundwater levels; however, the screening depth is known for only 6 of the 17 of the wells. Wells where the screened depth is unknown may be measuring groundwater levels for deeper aquifers that are unconnected to the shallow groundwater system, and thus groundwater deeper than 30 ft for a given well may not reflect the absence of shallow groundwater, but instead reflects the absence of data. To determine the hydraulic connectivity between potential perched aquifers to the regional aquifer, additional monitoring with nested piezometers could be utilized.

For the purposes of differentiating between potential and unlikely GDEs, different assumptions were made for the SLO versus Edna Valley sub-basins in areas of no groundwater data. In the SLO sub-basin (underlying SLO Creek), it was assumed that the depth to regional groundwater was less than 30 feet because the limited available data indicate that groundwater in this sub-basin is generally relatively shallow. In the Edna Valley (underlying Pismo Creek), it was assumed that the depth to regional groundwater was more than 30 feet because the limited available data indicate that the groundwater in this sub-basin is generally deeper. One exception to this assumption was made on upper East Corral de Piedra where the conditions were assumed to be similar to those on upper West Corral de Piedra where early dry season wet conditions have been observed by Stillwater Sciences and Balance Hydrologics (2008). The 30-foot depth criterion is consistent with guidance provided by The Nature Conservancy (Rohde et al. 2019) for identifying GDEs.

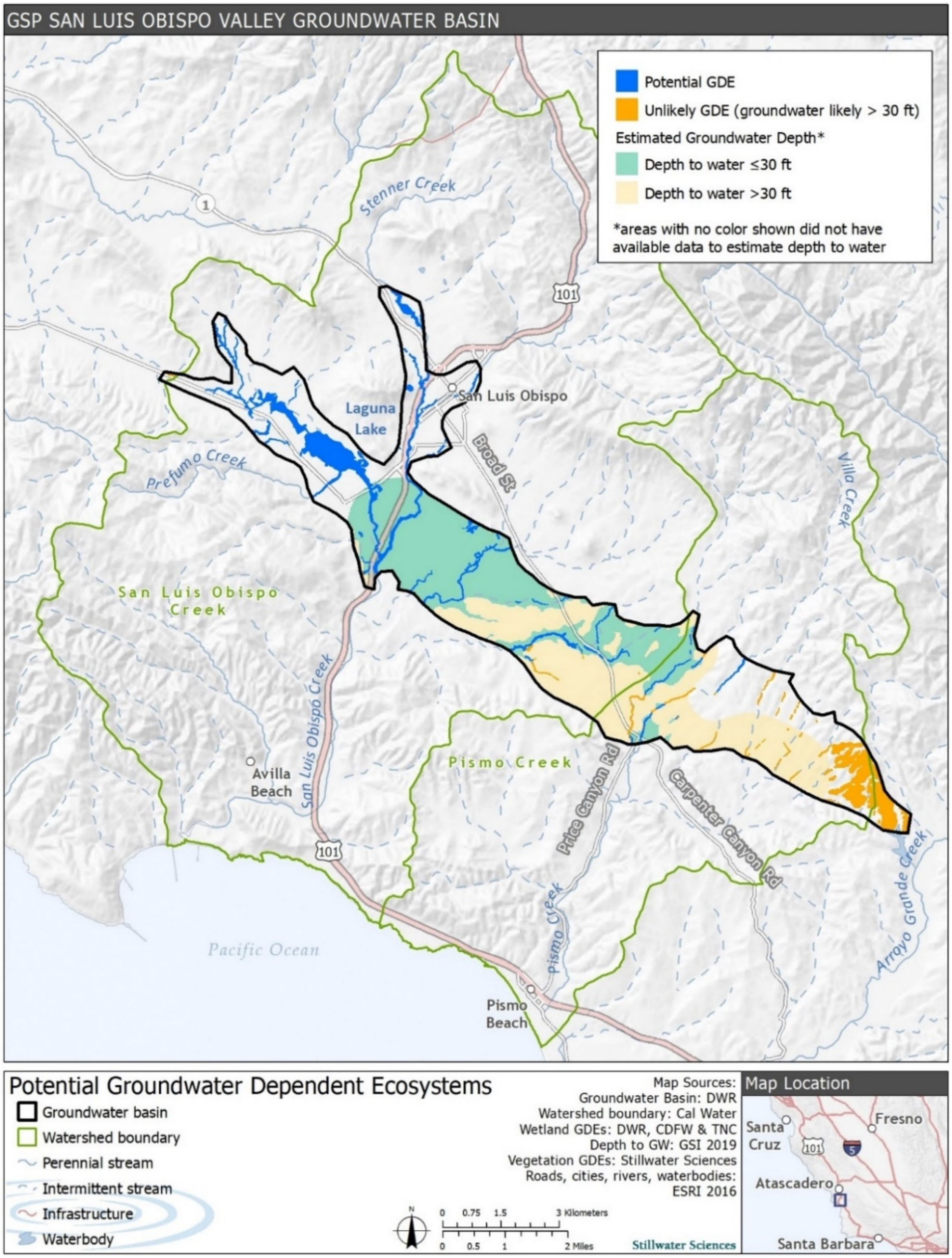


Figure 2. Potential Groundwater Dependent Ecosystems.

2.2 Special-Status Species and Sensitive Natural Communities Associated with GDEs

For the purposes of this memorandum, special-status species are defined as those:

- listed, proposed, or under review as endangered or threatened under the federal Endangered Species Act (ESA) or the California Endangered Species Act (CESA);
- designated by California Department of Fish and Wildlife (CDFW) as a Species of Special Concern;
- designated by CDFW as Fully Protected under the California Fish and Game Code (Sections 3511, 4700, 5050, and 5515);
- designated as rare under the California Native Plant Protection Act (CNPPA); and/or
- included on CDFW's most recent *Special Vascular Plants, Bryophytes, and Lichens List* (CDFW 2020) with a California Rare Plant Rank (CRPR) of 1, 2, 3, or 4.

In addition, sensitive natural communities are defined as:

- vegetation communities identified as critically imperiled (S1), imperiled (S2), or vulnerable (S3) on the most recent California Sensitive Natural Communities List (CDFW 2020).

To determine the terrestrial and aquatic special-status species that may utilize potential GDE units overlying the SLO Valley Groundwater Basin, Stillwater ecologists queried existing databases on regional and local occurrences and distributions of special-status species. Databases accessed include the California Natural Diversity Database (CNDDB) (CDFW 2019b), eBird (2019), and TNC freshwater species list (TNC 2019). Spatial database queries were centered on the potential GDEs plus a 1-mile buffer. Stillwater's ecologists reviewed the database query results and identified special-status species and sensitive natural communities with the potential to occur within and to be associated with the vegetation and aquatic communities in or immediately adjacent to the potential GDEs. Table 1 summarizes these special-status species and sensitive natural communities, describes their habitat preferences and potential dependence on GDEs, and identifies known nearby occurrences (Table 1). Wildlife species were evaluated for potential groundwater dependence using the Critical Species Lookbook (Rohde et al. 2019).

The SLO Valley Groundwater Basin supports steelhead belonging to the South-Central California Coast Distinct Population Segment (DPS) which is federally listed as threatened. Within this DPS, the population of steelhead within the SLO Creek, and Pismo Creek portions of the groundwater basin have both been identified as Core 1 populations which means they have the highest priority for recovery actions, have a known ability or potential to support viable populations, and have the capacity to respond to recovery actions (NMFS 2013). One critical recovery action listed by the National Marine Fisheries Service (NMFS) includes the implementation of operating criteria to ensure instream flows allow for essential steelhead habitat functions (NMFS 2013).

The SLO Valley Groundwater Basin was determined to have **high ecological value** because: (1) the known occurrence and presence of suitable habitat for several special-status species including the Core 1 population status of South-Central California Coast Steelhead DPS and several special-status plants and animals that are directly or indirectly dependent on groundwater (Table 1); and (2) the vulnerability of these species and their habitat to changes in groundwater levels (Rohde et al. 2018).

Table 1. Special-status species and sensitive natural communities documented in the vicinity of the San Luis Obispo (SLO) Valley Groundwater Basin with a potential GDE association.

Common name *Scientific name*	Status[1] Federal/ State/CRPR	Potential to occur	Query source	GDE association[2]	Habitat association and occurrence
Birds					
Bank swallow *Riparia*	–/ST/–	Some potential	eBird	Indirect	Nests in vertical bluffs or banks, usually adjacent to water (i.e., rivers, streams, ocean coasts, and reservoirs), where the soil consists of sand or sandy loam. This species relies on surface water that may be supported by groundwater (Rohde et al 2019). eBird occurrences in SLO Valley including Laguna Lake.
Least bittern *Ixobrychus exilis*	–/SSC/–	Some potential	eBird	Direct	Freshwater and brackish marshes with dense aquatic or semiaquatic vegetation interspersed with clumps of woody vegetation and open water. eBird occurrences in SLO Valley including Laguna Lake.
Loggerhead shrike *Lanius ludovicianus*	–/SSC/–	Likely	CNDDB, eBird	Indirect	Open shrubland or woodlands with short vegetation and and/or bare ground for hunting; some tall shrubs, trees, fences, or power lines for perching; typically nest in isolated trees or large shrubs. CNDDB occurrences in SLO Valley.
Northern harrier *Circus hudsonius*	–/SSC/–	Some potential	eBird	Indirect	Nests, forages, and roosts in wetlands or along rivers or lakes, but also in grasslands, meadows, or grain fields. eBird occurrences in SLO Valley including Laguna Lake.
Peregrine falcon *Falco peregrinus*	–/SFP/–	Some potential	eBird	Indirect	Wetlands, woodlands, cities, agricultural lands, and coastal area with cliffs (and rarely broken-top, predominant trees) for nesting; often forages near water. eBird occurrences in SLO Valley including Laguna Lake.
Redhead *Aythya americana*	–/SSC/–	Some potential	eBird	Direct	Freshwater emergent wetlands with dense stands of cattails (*Typha* spp.) and bulrush (*Schoenoplectus* spp.) interspersed with areas of deep, open water; forage and rest on large, deep bodies of water. Summer resident in southern California. eBird occurrences in SLO Valley including Laguna Lake along SLO Creek.

Common name ***Scientific name***	**Status[1] Federal/ State/CRPR**	**Potential to occur**	**Query source**	**GDE association[2]**	**Habitat association and occurrence**
Tricolored blackbird *Agelaius tricolor*	–/ST/–	Likely	CNDDB, eBird	Direct	Feeds in grasslands and agriculture fields; nesting habitat components include open accessible water with dense tall emergent vegetation, a protected nesting substrate (including flooded or thorny vegetation), and a suitable nearby foraging space with adequate insect prey. Relies on groundwater dependent ecosystems for breeding and roosting (Rohde et al 2019). CNDDB occurrence in Edna Valley and eBird occurrence in SLO Valley including Laguna Lake, Pismo Creek, and Stenner Creek.
White-tailed kite *Elanus leucurus*	–/SFP/–	Likely	CNDDB, eBird	Indirect	Lowland grasslands and wetlands with open areas; nests in trees near open foraging area. CNDDB and eBird occurrences in SLO Valley including Laguna Lake.
Mammals					
Pallid bat *Antrozous pallidas*	–/SSC/–	Likely	CNDDB	Potential Indirect	Roosts in rock crevices, tree hollows, mines, caves, and a variety of vacant and occupied buildings; feeds in a variety of open woodland habitats. CNDDB occurrence in SLO Valley.
Amphibians and reptiles					
California red-legged frog *Rana draytonii*	FT/SSC/–	Likely	CNDDB	Direct	Breeds in still or slow-moving water with emergent and overhanging vegetation, including wetlands, wet meadows, ponds, lakes, and low-gradient, slow moving stream reaches with permanent pools; uses adjacent uplands for dispersal and summer retreat. Relies on surface water that may be supported by groundwater (Rohde et al. 2019). Critical habitat is within the SLO watershed. CNDDB occurrences include SLO Creek and tributaries.
Coast Range newt *Taricha torosa*	–/SSC/–	Likely	CNDDB	Direct	Chaparral, oak woodland, and grasslands. Relies on surface water that may be supported by groundwater for breeding. CNDDB occurrences are in SLO Creek and Brizziolari Creek.
Foothill yellow-legged frog *Rana boylii*	–/SE/–	Unlikely	CNDDB	Direct	Shallow tributaries and mainstems of perennial streams and rivers, typically associated with cobble or boulder substrate; occasionally found in isolated pools, vegetated backwaters, and deep, shaded, spring-fed pools. All CNDDB occurrences are historical (1958) in Arroyo Grande Creek and population is possibly extirpated.

Common name *Scientific name*	Status[1] Federal/ State/CRPR	Potential to occur	Query source	GDE association[2]	Habitat association and occurrence
Northern California legless lizard *Anniella pulchra*	–/SSC/–	Likely	CNDDB	Indirect	Chaparral, pine-oak woodlands, desert scrub, sandy washes, and stream terraces with sycamores, cottonwoods, or oaks. Occurs in moist warm loose soil with plant cover. CNDDB occurrences in Edna Valley.
Western pond turtle *Emys marmorata*	–/SSC/–	Likely	CNDDB	Direct	Ponds, lakes, rivers, streams, creeks, marshes, and irrigation ditches with basking sites. Relies on surface water that may be supported by groundwater. CNDDB occurrences include SLO and Edna Valley, as well as, Pismo Creek, Miossi Creek, Prefumo Creek, and Mainstem and East Fork of SLO Creek
Fish					
Steelhead, South Central California DPS *Oncorhynchus mykiss*	FT/–/–	Likely	CNDDB	Direct	Rivers and streams with cold water, clean gravel of appropriate size for spawning, and suitable rearing habitat; typically rear in fresh water for one or more years before migrating to the ocean. Suitable habitat present (migration, rearing); species known to occur in SLO and Pismo Creek and their tributaries (i.e., West Corral de Piedra Creek).
Plants and Sensitive Natural Communities					
San Luis Obispo sedge *Carex obispoensis*	–/–/1B.2	Likely	CNDDB	Direct	Seeps, often with serpentine and sometimes gabbro soils or clay soils in closed-cone coniferous forest, chaparral, coastal prairie, coastal scrub, and valley and foothill grassland (CNPS 2020); all CNDDB observations are along Prefumo Creek and Froom Creek outside of the groundwater basin
Congdon's tarplant *Centromadia parryi* subsp. *congdonii*	–/–/1B.1	Likely	CNDDB	Direct	Valley and foothill grassland (CNPS 2020); all CNDDB observations are within the SLO Creek watershed including around Laguna Lake and East Fork of SLO Creek
Chorro Creek bog thistle *Cirsium fontinale* var. *obispoense*	FE/SE/1B.2	Likely	CNDDB	Direct	Serpentine seeps and drainages in chaparral, cismontane woodlands, coastal scrub, and valley and foothill grassland (CNPS 2020); CNDDB observations are limited to the SLO Creek watershed and are associated with seeps and springs,
Adobe sanicle *Sanicula maritima*	–/CR/1B.1	Likely	CNDDB	Direct	Clay and serpentine soils in chaparral, coastal prairie, meadows and seeps, and valley and foothill grassland (CNPS 2020); multiple CNDDB occurrences in open grassy area of Laguna Lake Park, along Laguna Creek, and South Hills

Common name ***Scientific name***	**Status[1] Federal/ State/CRPR**	**Potential to occur**	**Query source**	**GDE association[2]**	**Habitat association and occurrence**
Saline clover *Trifolium hydrophilum*	–/–/1B.2	Likely	CNDDB	Direct	Marshes and swamps, mesic and alkaline soils in valley and foothill grassland, and vernal pools (CNPS 2020); one CNDDB occurrence, located in Laguna Lake Park
Coastal and Valley Freshwater Marsh	–/S2.1/–	Likely	CNDDB	Direct	Dominated by perennial, emergent monocots including tules (*Schoenoplectus* spp.) and cattails (*Typha* spp.). May form completely closed canopies (Holland 1986). CNDDB observations around Laguna Lake.

[1] **Status codes:**

Federal

FE = Federally listed endangered

FT= Listed as threatened under the federal Endangered Species Act

– No federal status

State Rank

SE = Listed as Endangered under the California Endangered Species Act

ST = Listed as Threatened under the California Endangered Species Act

SFP = CDFW Fully Protected species

SSC = CDFW species of special concern

CR = California State listed as rare

S2.1 = CDFW imperiled and threatened species

– No state status

California Rare Plant Rank (CRPR)

1B = Plants rare, threatened, or endangered in California and elsewhere

CRPR Threat Ranks

0.1 Seriously threatened in California (high degree/immediacy of threat)

0.2 Fairly threatened in California (moderate degree/immediacy of threat)

– No CRPR status

[2] **Groundwater Association**

Direct: Species directly dependent on groundwater for some or all of its water needs (e.g., cottonwood with roots in groundwater, juvenile steelhead in dry season)

Indirect: Species dependent upon other species that rely on groundwater for some or all of their water needs (e.g., riparian birds)

3 GDE EVALUATION AND SUSTAINABLE INDICATORS

In Section 2 we identified potential GDEs distributed throughout the SLO Valley Groundwater Basin. In Section 3 we identify specific GDE types that are likely or have potential to occur in the SLO Valley Groundwater Basin. Each GDE type has a different requirement to sustainably function. For each GDE type we then identify sustainable GDE indicators and target values. Sustainable GDE indictors are metrics that can be monitored to determine if undesirable impacts are occurring. The target values are set based on the best available data for each GDE type. These values are determined by the needs of special-status species, sensitive natural communities, or keystone species associated with each GDE type. As more data becomes available, the indicator type or target value may be refined. Furthermore, sustainable GDE indicator target values may not be met due to management activities (e.g., pumping) or due to climate (e.g., extended drought conditions). Thus if sustainable indicator target values are not met, additional studies or assessments to determine the cause may be required.

3.1 GDE Types

Eight distinct likely or uncertain types of GDEs have been identified in the SLO Valley Groundwater Basin. Likely GDE types include riverine (fast moving), riverine (slow moving), riparian, lacustrine, and wetland/marsh. Three uncertain GDE types include seasonal wetlands/wet meadows, springs and seeps, and oak woodlands. Seasonal wetlands are uncertain because their dependence of surface water versus groundwater is unknown and may be site specific. Spring and seeps are uncertain because they may be dependent on recharge from fractured bedrock in the surrounding hills rather than SLO Valley Groundwater Basin water. Oak woodlands are uncertain because groundwater elevation data from areas they are present (e.g. the eastern Edna Valley) are unavailable. Additional studies for these GDE types are recommended in Section 3.2.

The diversity of GDEs overlying the SLO Valley Groundwater Basin is due to the unique hydrogeomorphology of the basin, whereas the groundwater basin is oriented perpendicular to the general direction of surface water flow (Figure 2). A description of each GDE type along with associated special-status species, natural sensitive communities, and/or keystone species are listed in Table 2. Keystone species are defined as species that serve as indicators of GDEs sustainability. If the sustainable indicator target value is met for a GDE type with a keystone species, all habitats and species associated with that GDE type are assumed to be protected.

While a complete list of special-status species with known occurrence or presence of suitable habitat in potential GDE units overlying or within 1 mile of the SLO Valley Groundwater Basin are listed in Table 1, only those species that have a direct association with GDEs are included in Table 2. Examples of species omitted from Table 2 include species that are believed to have be extirpated from this area (e.g., foothill yellow-legged frog) or have an indirect association with GDEs (e.g., loggerhead shrike). Species that have an indirect association are assumed to be protected if the GDE indicators listed above are met. For example, the loggerhead shrike is known to occur within the SLO Valley Groundwater Basin. It lives in shrublands or woodlands with short vegetation and/or bare ground for hunting, uses tall shrubs and trees for perching, and typically nests in isolated trees. Some trees or shrubs used for perching or nesting may be part of a GDE; which is assumed to be protected if GDE indicators that are developed for each GDE type (Table 2) are met.

Table 2. Summary of Groundwater Dependent Ecosystem (GDE) types known to occur in the San Luis Obispo (SLO) Valley Groundwater Basin.

GDE type	GDE habitat description	Associated special-status species[A], sensitive natural communities[B], or keystone species[C]	Key life stages primarily dependent on groundwater	Sustainable GDE indicator	Monitoring period[D]	Location and target value
Riverine (Fast moving)	Fast moving, flowing water	Steelhead, South Central California DPS[C] *Oncorhynchus mykiss*	Juvenile steelhead	Flow rate (cfs)	Late spring (May-June) and dry season (July–Oct)	1) Stenner Creek at Nipomo St = 0.85 cfs (late spring); 0.33 cfs (dry season) (SWS 2014) 2) SLO Creek at Marsh St = 1.20 cfs (late spring); 0.90 cfs (late summer) (SWS 2014)
					Late spring (May–June) and dry season (July–Oct)	Pismo Creek at Railroad crossing = 1.50 cfs (late spring)/; 0.50 cfs (dry season) (Stillwater 2016)
Riverine (Slow moving)	Slow moving or still water; interspersed or interconnected with wetlands, marshes, or grasslands	California red-legged frog[C] *Rana draytonii*	Larval development and metamorphosis	Water depth (ft)	Late spring (May–June) and dry season (July–Oct)	East Fork of SLO Creek at Jespersen Road = 2.3 ft
		Coast Range newt *Taricha torosa*	Larval development and metamorphosis			
		Western pond turtle *Emys marmorata*	Foraging adults and juveniles			
Lacustrine/ Lacustrine Connected	Open water. Interspersed or interconnected with wetlands, marshes, tributaries, or grasslands	Least bittern *Ixobrychus exilis*	All life stages	TBD[E]	TBD	Laguna Lake Target values TBD
		Redhead *Aythya americana*	Adults; potential for limited resident breeding			
		Tricolored blackbird *Agelaius tricolor*	All life stages			

GDE type	GDE habitat description	Associated special-status species[A], sensitive natural communities[B], or keystone species[C]	Key life stages primarily dependent on groundwater	Sustainable GDE indicator	Monitoring period[D]	Location and target value
Wetland/ Marsh	Dominated by perennial, emergent monocots including tules (*Schoenoplectus* spp.) and cattails (*Typha* spp.). May form completely closed canopies (Holland 1986)	Coastal and Valley Freshwater Marsh	Adult plants	TBD	TBD	Tank Farm wetlands Target value TBD
Riparian	Dominated by mature woody vegetation including cottonwoods, sycamores, and willows	California Sycamore Woodland; Fremont Cottonwood Forest and Woodland and/or Black Cottonwood Forest and Woodland	Adult trees	Depth to groundwater (ft) and/or rate of groundwater elevation change[F]	TBD	See Figure 3 and Table 3 for all proposed locations Target values TBD
Seasonal wetland/wet meadow	An area that is inundated by water seasonally (i.e., present during the growing season but absent by the end of the growing season in most years) (FGDC 2013)	Adobe sanicle *Sanicula maritima* Congdon's tarplant *Centromadia parryi* ssp. *congdonii,* Saline clover *Trifolium hydrophilum*	Adult plants	TBD	TBD	TBD
Springs and seeps	A location where water from the ground rises to the surface, commonly with saturated soil, standing, or flowing water year-round.	Chorro Creek bog thistle *Cirsium fontinale* var. *obispoense* SLO sedge *Carex obispoensis*	Adult plants	TBD	TBD	TBD

GDE type	GDE habitat description	Associated special-status species[A], sensitive natural communities[B], or keystone species[C]	Key life stages primarily dependent on groundwater	Sustainable GDE indicator	Monitoring period[D]	Location and target value
Oak woodlands	Coast live oak riparian woodlands	Coast live oak[C] *Quercus agrifolia*; Pallid bat *Antrozous pallidas*[G]	Adult trees	Depth to groundwater (ft) and/or rate of groundwater elevation change	TBD	TBD

[A] A list of special-status species with known occurrence or presence of suitable habitat in potential GDE units overlying the or within 1 mile of the SLO Valley Groundwater Basin are listed in Table 1. Of those species, only those species that are likely or have some potential to occur and that have a direct association with potential GDEs are listed in Table 2.
[B] Sensitive natural communities as defined as vegetation communities that are critically imperiled, imperiled, or vulnerable on the most recent California Sensitive Natural Communities List (CDFW 2020) or by CNPS 2020.
[C] Keystone species.
[D] Monitoring is proposed only for those time periods for which each GDE type is anticipated to be primarily dependent upon groundwater originating in the SLO Valley groundwater Basin (see Section 4 for discussion).
[E] TBD = To be determined
[F] Depth to groundwater or the rate of groundwater elevation change in the dry season is anticipated to be the sustainable indicator for mature woody riparian vegetation and oak woodland based on research by Amlin, N. M., and S. B. Rood. 2002; Mahoney, J. M., and S. B. Rood. 1998; Rood, S. B., and J. M. Mahoney. 1990; Segelquist, C. A., M. L. Scott, and G. T. Auble. 1993; Shafroth, P. B., J. C. Stromberg, and D. T. Patten. 2002; and Vaghti, M. G., and S. E. Greco. 2007.
[G] Pallid bats utilize oak savannahs, black oaks, oak grasslands, and open oak woodlands (Pierson and Rainey 2002). Oak savannahs are usually characterized by valley oak, blue oak, interior live oak, or coast live oak, with the specific composition dependent on latitude and elevation. Pallid bats typically roost in caves, crevices, bridges, buildings and occasionally tree hollows.

3.2 Evaluation of Potential GDEs and GDE Types

The potential GDEs and GDE types identified herein were based on the best available but limited groundwater data, wetland data and low-resolution vegetation data. These potential GDEs and GDE types require ground-truthing to determine the dominant vegetation types and quality, habitat types and quality, existing hydrologic conditions and their spatial extent to improve our understanding of their distribution and groundwater dependence. Ground-truthing should include reconnaissance level field-survey of a sub-set of accessible areas mapped as potential GDEs. At each site, field biologists could assess the following: (1) vegetation data (e.g., dominant vegetation types and plant species, indications of the proportion of live vs. senescent canopy, and vegetation density); (2) qualitative observations of hydrologic conditions (e.g. flowing or standing water); and, (3) habitat conditions for special-status or keystone species by comparing each species' habitat preferences (e.g., large trees, open water or herbaceous cover, etc.) to conditions present at the site. Based on this field data, GDE distribution, GDE type, and habitat for associated special-status species could be refined. Habitat assessments should be focused on federally or state threatened or endangered flora or fauna with direct groundwater association including the state threatened species Tricolored blackbird *(Agelaius tricolor),* the federally threatened California red-legged frog (*R. draytonii*), the federally threatened Steelhead trout (*O. mykiss*), and the federally endangered Chorro Creek bog thistle (*Cirsium fontinale* var. *Obispoense)*.

Furthermore, seven of the eight GDE types (Table 2) may require additional assessment/analysis to either determine the extent to which the GDE type is groundwater dependent, the timing of groundwater dependence, and/or to refine the sustainable GDE indicator or target values. To this extent the following are proposed for consideration:

Oak tree along East Corral de Piedra Creek

1. **Riverine (fast moving).** Conduct an instream flow study of mainstem SLO and Stenner Creeks to identify flows required by juvenile steelhead in the late spring and summer/early fall dry season, as well as, an assessment of the quality of steelhead habitat in the East Fork of SLO Creek and Davenport Creek.
2. **Lacustrine.** Conduct a study of Laguna Lake to determine the magnitude, timing and duration of the dependence of the Lake on groundwater originating from the SLO Valley Groundwater Basin (e.g. a surface-groundwater assessment/model). Based on the results of the study and associated special-status species habitat assessments, develop sustainable GDE indicator(s), timing of groundwater dependence, and indicator target values.
3. **Wetland/Marsh.** Conduct an assessment of wetlands and marshes found within the SLO Valley Groundwater Basin that support special-status species or sensitive natural communities; determine the magnitude, timing and duration of their dependence on groundwater originating from the SLO Valley Groundwater Basin; and develop sustainable GDE indicator(s) and associated information.

4. **Riparian.** Install groundwater monitoring wells at proposed locations (Table 3), collect and analyze data. Refine GDE indicator(s) and develop site specific target values for the depth to groundwater below the surface (ft) that will sustain the GDE at each location.
5. **Seasonal wetlands.** Conduct an assessment of seasonal wetlands and wet meadows found within the SLO Valley Groundwater Basin, especially those that support groundwater dependent special-status species including Adobe sanicle, Congdon's tarplant, and Saline clover. While these plants need soil saturation or inundation for seed germination, establishment and growth, the dependence on groundwater versus surface water is unknown and may be site specific. If seasonal wetlands primarily dependent on groundwater originating in the SLO Groundwater Basin are indentified, develop sustainable GDE indicator(s) and associated information.
6. **Springs and seeps.** Conduct an assessment of springs and seeps within the SLO Valley Groundwater Basin to identify their locations and to determine their dependence on groundwater originating from the SLO Valley Groundwater Basin. The study could include measurements of the magnitude and timing of flow rates and/or an isotopic analysis to identify water sources. It is anticipated that many springs and seeps will be dependent on recharge from fractured bedrock in the surrounding hills rather than SLO Valley Groundwater Basin water. Springs and seeps within the basin that are known to occur include but are not limited to the base of the South Hills, Irish Hills, and hills surrounding Laguna Lake. If appropriate, develop a sustainable groundwater indicator and associated information.
7. **Oak woodlands.** Conduct an assessment of oak woodlands within the SLO Valley Groundwater Basin to determine the oak species composition and distribution, with a particular focus on coast live oak riparian woodlands. Utilize existing wells or install new monitoring wells to monitor depth to groundwater. Utilizing the assessment and monitoring data determine if oak woodlands (e.g. Eastern Edna Valley) (Figure 2) are groundwater dependent. For example, coast live oak may have several deep main roots that tap groundwater if present within approximately 36 feet of the soil surface (Canadell et al 1996; Cooper 1922; Plumb 1980). If the oak woodlands are determined to be groundwater dependent, conduct an assessment of Pallid bat habitat distribution within oak woodlands and develop sustainable GDE indicators and associated data.

3.3 Identification of Sustainable GDE Indicators

Each type of GDE (Table 2) has a different suite of fauna and flora associated with it. For some GDE types, we also identified associated sensitive natural communities (as identified by CDFW 2020 or CNPS 2020) or keystone species. Keystone species are defined as species that serve as indicators of GDEs sustainability. To develop indicators for each GDE type the requirements of sensitive or keystone species were considered. To this extent the life histories and habitat requirements of key faunal species are discussed in the following section, along with an explanation of the development of GDE indicators dependent on faunal species.

3.4 Life Histories and Habitat Requirements of Key Faunal Species

3.4.1 Key aquatic species

Steelhead

Steelhead have one of the most complex life histories of any salmonid species, exhibiting both anadromous and freshwater resident life histories. Freshwater residents are typically referred to as rainbow trout, and those exhibiting an anadromous life history are called steelhead (NMFS 1998).

Steelhead exhibit highly variable life history patterns throughout their range but are broadly categorized into winter and summer reproductive ecotypes. Winter steelhead, the most widespread reproductive ecotype and the only type currently present in Central California Coast streams, become sexually mature in the ocean, enter spawning streams in summer, fall or winter, and spawn a few months later in winter or late spring (Meehan and Bjornn 1991; Behnke 1992).The timing of upstream migration is correlated with higher flow events, such as freshets or sand bar breaches, and seasonal decline of associated lower water temperatures in winter (NMFS 2006)

Spawning occurs primarily from January through March but may begin as early as late December and may extend through April (Hallock 1987). Individual steelhead may spawn more than once, returning to the ocean between each spawning migration. Steelhead may spawn more than one season before dying (iteroparity), in contrast to other species of the *Oncorhynchus* genus. Upon emerging from the gravel, fry rear in edgewater habitats and move gradually into pools and riffles as they grow larger. Cover is an important habitat component for juvenile steelhead, both as velocity refuge and as a means of avoiding predation (Shirvell 1990, Meehan and Bjornn 1991). Steelhead, however, tend to use riffles and other habitats not strongly associated with cover during summer rearing more than other salmonids. In winter, they become inactive and hide in any available cover, including gravel, cobbles, or woody debris. Juvenile steelhead rear a minimum of one and typically two or more years in fresh water before migrating to the ocean during smoltification (the process of physiological change that allows ocean survival). Juvenile migration to the ocean generally occurs from December through August.

Although various steelhead life stages occur in aquatic habitats that overly the SLO Groundwater Basin, these aquatic habitats are supported by a range of surface and groundwater sources (see Section 1 for discussion). However, during the late spring and dry season, the primary source supporting steelhead in GDEs overlying the SLO Valley Groundwater Basin is groundwater. Thus the dependence of steelhead on groundwater is greatest during the late spring and the summer-fall dry season and it is for these times of the year that target values for sustainable GDE indicators are proposed (Table 2). Target values are based on the best available data.

In 2014 Stillwater Sciences completed a county-wide instream flow study for steelhead trout during their two most flow sensitive periods for minimum instream flows: late spring (May and June) and late summer (August and September) (Stillwater 2014). All available hydrologic and physical terrain data and instream flow assessments were reviewed and analyzed to explore appropriate watershed stratification and to assess the ability to extrapolate existing instream flow analyses throughout all watersheds of the County. A predictive model, based on watershed area, was developed to estimate minimum instream flows during these time periods. The purpose of the Stillwater (2014) study analysis was to provide a preliminary estimate of the magnitude and timing of instream flows that would support steelhead in creeks of SLO County and was not intended to provide sufficient precision or detail from which to establish regulatory limits. However, due to an absence of a detailed instream flow study in SLO Creek, this study is utilized to set preliminary target flow values herein. Two sites were selected for monitoring: Stenner Creek at the Nipomo Street Bridge and Mainstem SLO Creek at the Marsh Street Bridge (Table 2, Figure 3). These locations were selected because in the dry season these are in hydrologically gaining reaches, indicating that at the proposed locations the instream flows are primarily supported by SLO Valley Groundwater Basin groundwater. In Stenner Creek at Nipomo Street the sustainable flow target is set at 0.85 cfs for the late spring (May-June) and 0.33 cfs for the dry season (July-Oct) (SWS 2014) and at SLO Creek at the Marsh Street bridge the target is set at 1.20 cfs (late spring) and 0.90 cfs (dry season) (SWS 2014). To evaluate the approximate streamflow values proposed herein, a detailed instream flow study for SLO Creek for SLO and Stenner Creeks is recommended.

In 2016 Stillwater Sciences completed an instream flow study on Pismo Creek (Stillwater 2016). Based on this study, the streamflow target values recommended for mainstem Pismo Creek at the railroad crossing are set at 2.50 cfs in May, 1.50 cfs in June, and 0.50 cfs from July through the end of October. Similar to the approach used for SLO Creek, this location was selected for monitoring because it is located in a hydrologically a gaining reach and is likely supported by groundwater originating in the SLO Valley Groundwater Basin during the dry season.

California Red-legged Frog (CRLF)

CRLF is a federally listed as threatened and is a CDFW species of special concern. The species' range occurs from south of Elk Creek in Mendocino County to Baja California, with isolated remnant populations occurring in the Sierra foothills, from sea level to approximately 8,000 ft (Stebbins 1985, Shaffer et al. 2004). Most California red-legged frog populations are currently largely restricted to coastal drainages on the central coast of California.

CRLF habitat includes wetlands, wet meadows, ponds, lakes, and low-gradient, slow-moving stream reaches. Breeding habitats are generally characterized by still or slow-moving water with deep pools (usually at least 2.3 ft deep, although frogs have been known to breed in shallower pools) with emergent and overhanging vegetation (Jennings and Hayes 1994). Breeding sites can be ephemeral or permanent; if ephemeral, inundation is usually necessary into the summer months (through July or August) for successful metamorphosis. Although some adults may remain resident year-round at favorable breeding sites, others may disperse overland up to a mile or more (Fellers and Kleeman 2007). Movements may be along riparian corridors, but many individuals move directly from one site to another without apparent regard for topography or watershed corridors (Bulger et al. 2003). CRLFs sometimes enter a dormant state during summer or in dry weather (aestivation), finding cover in small mammal burrows, moist leaf litter, root wads, or cracks in the soil. However, CRLFs in coastal areas are typically active year-round because temperatures are generally moderate (USFWS 2002, Bulger et al. 2003).

The breeding (i.e., mating and egg-laying) season begins as early as late November and lasts though as late as April (Jennings and Hayes 1994). Females lay egg masses containing approximately 2,000–6,000 eggs (USFWS 2002). Eggs hatch within 6–14 days and tadpoles require approximately 11–20 weeks to metamorphose, generally from May to September (USFWS 2002), although overwintering by CRLFs has been documented at non-forested breeding sites (Fellers et al. 2001). CRLFs become reproductively mature frogs at 2 to 4 years, with females taking longer to develop (Jennings and Hayes 1994).

Pools with water depths greater than 2.3 feet deep are optimal, though not required, to support a majority of the breeding and larval development periods. This water depth is used to set the sustainable GDE target value. Although CRLF begin to breed as early as late November, and tadpole growth and development continues through as late as September, the aquatic habitats utilized by CRLF are supported by a range of surface and groundwater sources throughout the year. However, during the late spring and dry season, the primary source supporting CRLF in GDEs overlying the SLO Valley Groundwater Basin is groundwater. For the slow moving riverine GDE type, the target values for sustainable GDE indicators are proposed based on CRLF requirements for the late spring and summer (Table 2). We propose that CRLF is a keystone species for the slow moving riverine GDE type, and if the proposed sustainable indicator criterion is met for the late spring and summer, it assumed that sufficient groundwater will be available year-round for all habitats and species associated with this GDE type, including newts and western pond turtles.

Coast Range Newt

Coast Range newts occur commonly in the Coast Ranges from central Mendocino County south to northern San Diego County. Populations south of the Salinas River in Monterey County are considered by CDFW as a Species of Special Concern. Coast Range newts breed in ponds, reservoirs, and streams. Habitats are often in or near streams in valley-foothill hardwood and hardwood-conifer areas (Morey 1988); in southern California, suitable habitats include a generally drier zone of chaparral, oak woodland, or grassland. Stream-breeding newts in southern California commonly lay eggs in deep, slow pools, occasionally in runs, and almost never in riffles (Gamradt and Kats 1997, as cited in AmphibiaWeb 2020). Egg masses may be attached to aquatic vegetation, branches, and the outer surfaces of rocks; in southern California, egg masses are usually laid under rocks in quiet stream pools (AmphibiaWeb 2020) After metamorphosis, California newts disperse from aquatic habitats to terrestrial uplands. Deep leaf litter and animal burrows may be used as summer aestivation sites. During or after winter/spring rains, Coast Range newts return to their breeding site to mate, often migrating large distances and in large numbers. During a study by Trenham (1988), newts were recaptured up to 3,200 m (nearly two miles) away from the breeding pond where they were originally captured and marked.

Migration from aestivation sites to breeding sites generally begins anywhere from late December to February, depending on the amount of rainfall, though populations that breed in stream pools migrate later, typically in March and April after stream flooding has subsided (Nafis 2020). Egg incubation to hatching times may vary at different locations, ranging from two weeks to two and a half months depending on water temperature, and the larval period lasts several months (Nafis 2020, AmphibiaWeb 2020). Larvae transform and begin to live on land at the end of the summer or in early fall, until as late as October (Nafis 2020). In summary stream-breeding Coast Range newts require quiet stream pools from March through October.

Western Pond Turtle

Western pond turtle is a CDFW species of special concern. Western pond turtles inhabit fresh or brackish water characterized by areas of deep water, low flow velocities, moderate amounts of riparian vegetation, warm water and/or ample basking sites, and underwater cover elements, such as large woody debris and rocks (Jennings and Hayes 1994). Along major rivers, western pond turtles are often concentrated in side-channel and backwater areas. Turtles may move to off-channel habitats, such as oxbows, during periods of high instream flows (Holland 1994). Although adults are habitat generalists, hatchlings and juveniles require specialized habitat for survival through their first few years. Hatchlings spend much of their time feeding in shallow water with dense submerged or short emergent vegetation (Jennings and Hayes 1994). Although an aquatic reptile, western pond turtles require upland habitats for basking, overwintering, and nesting, typically within 0.6 mi from aquatic habitats (Holland 1994). Reese and Welsh (1998) recorded frequent and prolonged year-round use of terrestrial habitat up to 0.3 mi (500 m) from the Trinity River for both nesting and overwintering activities.

Western pond turtle eggs are typically laid in June and July, though they may be laid throughout the year (Holland 1994, Reese 1996); local climatic and water level variations can alter the timing of nesting in this species (Crump 2001). Egg-laying sites vary from sandy shorelines to various forest soil types, although they are generally located in grassy meadows, away from trees and shrubs (Holland 1994), with canopy cover commonly less than about 10% (Reese 1996). Incubating eggs are extremely sensitive to increased soil moisture, which can cause high mortality (Bettelheim 2005, Shaffer 2005, Ashton et al. 1997). Young hatch in late fall and emerge either immediately or overwinter in the nest and emerge in early spring. Low fecundity, low hatchling and juvenile survivorships, high adult survivorship, and potentially long lifespans are characteristic of this species (Jennings et al. 1992). Western pond turtles have temperature-dependent sex determination, where the temperature of the egg during incubation determines the sex (Spinks et al. 2003). In summary, while pond turtles nest sites occur only in upland habitats, aquatic habitat is used year-round by foraging adults and juveniles, particularly deep pools with low flow.

3.4.2 Key birds

Least Bittern

Least bittern is a CDFW species of special concern. The smallest of the ardeids, they are cryptic marsh associates that are seldom seen. Because of their secretive nature, there are significant knowledge gaps regarding breeding behavior and interannual movement patterns.

Breeding populations exist in small patches throughout the state but are concentrated in the Central Valley and along the Southern Coast (Sterling 2008; Poole et al. 2020), with some documented breeding populations in the eastern Sierra (Kirk 1995) and Klamath basin (Poole et al. 2020). SLO County is within the known breeding range (Sterling 2008).
Least bittern are known to breed in both freshwater and brackish marshes (Sterling 2008, Poole et al. 2020), where they build nests atop platforms secured to the stalks of emergent vegetation (usually *Typha* or *Scirpus* spp., but occasionally *Phragmites* spp.) (Weller 1961, Poole et al. 2020). Nests are built up to 75 centimeters above the water surface where water depth is between eight centimeters and one meter. Least bittern show a preference for habitat that includes dense stands of emergent vegetation with adjacent pockets of open water. (Weller 1961, Poole et al. 2020). Breeding usually begins in late April and lasts through August (Kirk 1995, Sterling 2008, Poole et al. 2020). Population abundances decrease outside of the breeding season, which suggests seasonal migration, though some birds are likely winter residents. While foraging, least bittern stalk prey beneath the water surface by perching on the stalks of emergent vegetation (Weller 1961). Important food resources include small fish, terrestrial and aquatic invertebrates, amphibians, and occasionally small mammals (Weller 1961, Poole et al. 2020).

Flooded stands of emergent vegetation are a critical requirement for successful breeding (minimum depth of 8 cm) and foraging. Maintaining stable water levels in Laguna Lake such that emergent vegetation on the lake margins remains inundated throughout the nest selection and breeding season (April–August) is the most important consideration for least bittern in the SLO watershed. However, the role of groundwater in maintaining these water elevations is unclear.

Redhead

A CDFW species of special concern, redheads are medium-bodied freshwater diving ducks (pochards) that occur throughout the United States. Pacific flyway redheads breed predominantly in Alaska, Canada, and the midwestern United States (Bellrose 1980, Beedy and Deuel 2008, Baldassarre 2014, Woodin and Michot 2020), however, resident populations occur year-round in California and breed in limited numbers from April through August (Gibbs et al. 1992 as cited in Beedy and Deuel 2008). 2019 CDFW breeding waterfowl surveys estimated 5,051 breeding individuals in the state, with a long-term average of 3,958 breeding individuals (Skalos and Weaver 2019). Seasonal migrants winter throughout California between September and April (Beedy and Deuel 2008, Baldassarre 2014). Resident breeding populations occur mostly in the Central Valley and the northeastern region of the state (in Siskiyou and Modoc County, and the Klamath Basin) (Bellrose 1980, Beedy and Deuel 2008). However, breeding occurrences have been documented outside of the “typical” range in Alameda, Monterey, and Ventura counties

(Beedy and Deuel 2008), so breeding could occur within the SLO watershed if habitat requirements for successful nesting are met.

Redheads tend to build nests in dense stands of emergent vegetation (typically *Typha* and *Scirpus* spp.) over shallow water, though they have been recorded building ground nests in dense cover (Bellrose 1980, Baldassarre 2014, Beedy and Deuel 2008). Proximity to open water is a key requirement for successful breeding, as hens lead broods to water approximately one day after hatching (Bellrose 1980, Yerkes 2000, Baldassarre 2014). Redheads exhibit flexibility in foraging behavior, diving for submerged aquatic vegetation in water up to one meter deep, and tipping up or dabbling in shallower water (Bellrose 1980, Baldassarre 2014, Woodin and Michot 2020). Wigeon grass (*Rupia* spp.), duckweed (*Lemna* spp.), pond weed (*Potamogeton* and *Stuckenia* spp.), and both terrestrial and aquatic invertebrates are important food resources (Bellrose 1980, Baldassarre 2014, Woodin and Michot 2020). Most breeding pairs documented in California occupied permanent or semipermanent wetlands containing ponds with water deeper than one meter (CDFG and USFWS unpubl. data as cited in Beedy and Deuel 2008). Research in other geographic areas has tied reproductive success to water permanence, depth of water beneath nest sites, and overland distance from nest locations to foraging water (Bellrose 1980, Yerkes 2000). Other than maintaining a hydrologic regime conducive to the growth of critical forage plants and nesting substrate, the maintenance of permanent open water approximately one meter deep is the most important consideration for this species in the SLO watershed.

For redheads, maintaining a depth of one meter in open water would be a good target for the breeding season for reproduction and year-round for wintering birds. However, the role of groundwater in maintaining open water is unclear.

Tricolored blackbird

Tricolored blackbird is listed as threatened by the state of California. Tricolored blackbirds are the most prodigious colonially nesting bird in North America (Cook and Toft 2005, Beedy et al. 2020). Endemic to California, their breeding range includes most of the Central Valley and parts of the Central and Southern California Coast (Beedy 2008, Beedy et al. 2020). SLO County is within the known breeding range (Beedy 2008), however in 2017 only three birds were observed breeding in the County during annual surveys (Meese 2017).

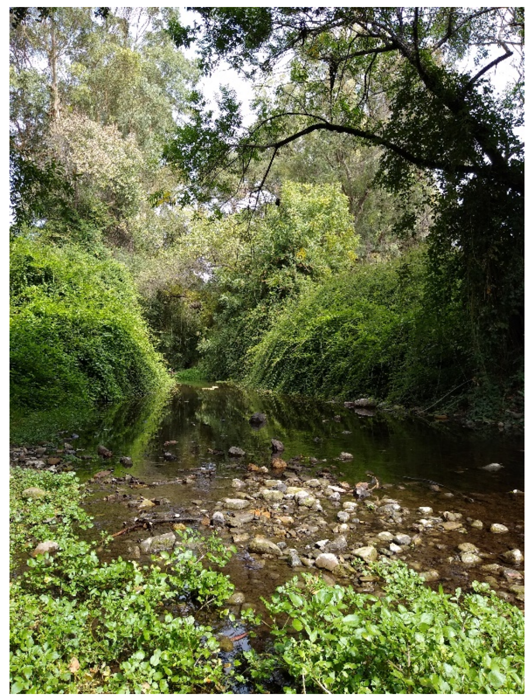
Nest initiation begins in late March with breeding lasting through August (Beedy 2008, Wilson et al. 2016, Beedy et al. 2020). Historically, tricolored blackbird colonies nested in flooded stands of vegetation (particularly *Typha* spp. and *Schoenoplectus* spp.) (Cook and Toft 2005, Wilson et al. 2016, Beedy et al. 2020). However, since the arrival of Europeans in California, there has been an observable shift in behavior, with tricolored blackbirds often utilizing protective stands of non-native upland vegetation such as Himalayan blackberry (*Rubus armeniacus*). It is thought that this switch has resulted from the widespread degradation or outright disappearance of historic Central Valley wetlands. Colonies occupying non-native upland habitat exhibit increased reproductive success when compared to colonies that nest in native flooded vegetation (Cook and Toft 2005).

Successful reproduction for tricolored blackbirds requires a combination of access to open water, appropriate nesting substrate, and proximity to high-quality foraging habitat (Beedy and Hamilton 1997). This species primarily feeds on terrestrial arthropods, including Coleoptera, Orthoptera, Diptera, Hemiptera, Arachnids, and Lepidoptera (Beedy and Hamilton 1997, Crase and DeHaven 1977). Colonies are usually located within a few kilometers of productive grassland, shrubland, forest, or agricultural land (Beedy and Hamilton 1997, Wilson et al. 2016).

Maintaining open water in proximity to suitable nesting habitat (whether emergent vegetation or substantial stands of armored upland vegetation) during the nesting season would be a good target for this species. However, the role of groundwater in maintaining open water in proximity to nesting habitat is unclear.

4 PROPOSED SURFACE WATER MONITORING NETWORK

Depending on location and time of year, GDEs that overly the SLO Valley Groundwater Basin can be supported by a range of water sources including direct precipitation, surface runoff, shallow subsurface flow, and groundwater. Shallow subsurface flow can vary from short-term precipitation driven flow (e.g. macro-pores filled during a precipitation event that drain on the order of days to weeks) to flow that is directly connected to groundwater (e.g. groundwater discharge into streams during the dry season). Because GDEs overlying the SLO Groundwater Basin are supported by a wider range of surface and groundwater hydrological processes in the wet season, we propose to focus monitoring of GDEs in the late spring baseflow period and summer/early fall dry season. During the late spring and summer/early fall dry season, the primary sources supporting these GDEs are likely groundwater, although in some reaches irrigation return flow may also be a factor. Irrigation return flow could have surface water sources from outside the basin (e.g. City of SLO parcels) or be dependent on local groundwater (e.g. Edna Valley). Base flows and groundwater levels during the late spring and summer/early fall dry seasons are also critical to ensure sustainable ecological conditions for many groundwater dependent species. Groundwater supporting GDEs overlying the SLO Valley Groundwater Basin can originate outside of the groundwater basin or within the groundwater basin. Our proposed monitoring network accounts for these two sources of groundwater by selecting locations that are likely primarily dependent of groundwater originating in the SLO Groundwater Basin. For example, proposed monitoring locations for instream flows (Table 3, Figure 4) are located in reaches that are likely hydrologically gaining in the late spring and dry season (Figure 1). Herein we assume that if the GDE indicators are met in the late spring and dry season, then sufficient groundwater would also be available in the wet season to sustain GDEs. However, we recommend that as more data becomes available, this assumption be revisited.



Mainstem SLO Creek several hundred feet upstream of the Marsh St Bridge, September 2020

4.1 Proposed Monitoring Network

There are six existing County stage gages within or adjacent to the SLO Valley Groundwater Basin (Figure 3, Table 3). An additional three stage gages are proposed. These proposed stream gage locations may be modified as future work is completed in the basin. Rating curves, which correlate stage with stream flows, should be developed for all nine sites. In addition, we propose that groundwater be monitored at all of these nine sites plus five additional sites (Figure 3, Table 3) for riparian and wetland/marsh GDE types.

In addition to the above stage, stream flow, and groundwater monitoring, we recommend that streamflow is spatially mapped across a range of seasons and water year types to identify losing and gaining reaches with the SLO Groundwater Basin. Identifying losing and gaining reaches is fundamental to understanding surface-groundwater connectivity. This type of data collection is conducted by measuring instream flow in multiple locations along a reach of creek in a short period of time and examining the loss or gain of stream flow rates along the length of the stream channel. An example of this type of data collection on Stenner Creek is provided in Appendix C.

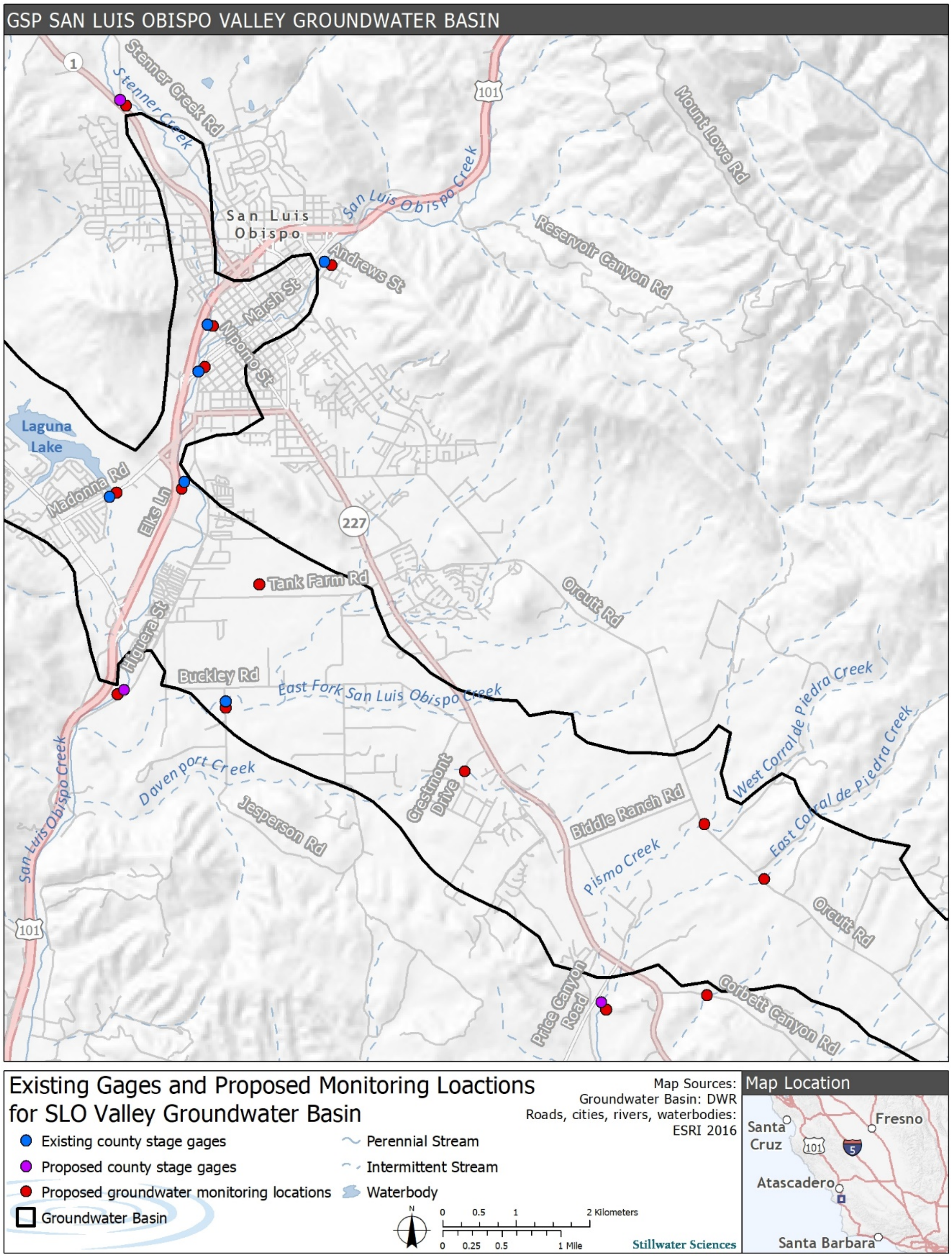


Figure 3. Existing and proposed monitoring locations for Groundwater Dependent Ecosystems.

Table 3. Summary of proposed hydrologic monitoring for the SLO Valley Groundwater Basin.

Water Body	Location	Proposed monitoring parameters	Purpose	Sustainable GDE indicators	Sustainable GDE indicator target values
Existing county stage gage and proposed groundwater monitoring locations					
1) Stenner Creek	Nipomo Street	1) Stage (ft) 2) Flow rate (ft/sec) 3) Groundwater elevation (ft)	1) Water budget 2) Surface-groundwater connectivity 3) Sustainable GDE indicators	Flow rate (cfs)	0.85 cfs (late spring); 0.33 cfs (dry season)[A]
				Depth to groundwater below ground surface (ft)	TBD
2) Mainstem SLO Creek	Andrews Street	1) Stage (ft) 2) Flow rate (ft/sec)	1) Flow into the basin for water budget 2) Surface-groundwater connectivity 3) Sustainable GDE indicator	Depth to groundwater below ground surface (ft)	TBD
3) Mainstem SLO Creek	Marsh Street	1) Stage (ft) 2) Flow rate (ft/sec) 3) Groundwater elevation (ft)	1) Water budget 2) Surface-groundwater connectivity 3) Sustainable GDE indicators	Flow rate (cfs)	1.20 cfs (late spring); 0.90 cfs (dry season)[A]
				Depth to groundwater below ground surface (ft)	TBD
T4) Mainstem SLO Creek	Elks Lane	1) Stage (ft) 2) Flow rate (ft/sec) 3) Groundwater elevation (ft)	1) Water budget 2) Surface-groundwater connectivity 3) Sustainable GDE indicator	Depth to groundwater below ground surface (ft)	TBD
5) East Fork SLO Creek	Jespersen Road	1) Stage (ft) 2) Flow rate (ft/sec) 3) Groundwater elevation (ft)	1) Water budget 2) Surface-groundwater connectivity 3) Sustainable GDE Indicators	Water depth (ft)	2.3 feet[B] (late spring and dry season)
				Depth to groundwater below ground surface (ft)	TBD
6) Prefumo Creek	Madonna Road	1) Stage (ft) 2) Flow rate (ft/sec) 3) Groundwater elevation (ft)	1) Water budget 2) Surface-groundwater connectivity 3) Laguna Lake study 4) Sustainable GDE indicator	Depth to groundwater below ground surface (ft)	TBD

Water Body	Location	Proposed monitoring parameters	Purpose	Sustainable GDE indicators	Sustainable GDE indicator target values
New proposed stage gage and groundwater monitoring locations					
7) Stenner Creek	Stenner Creek Road	1) Stage (ft) 2) Flow rate (ft/sec) 3) Groundwater elevation (ft)	1) Flow into the basin for water budget 2) Surface-groundwater connectivity 3) Sustainable GDE indicator	Depth to groundwater below ground surface (ft)	TBD
8) Mainstem SLO Creek	Old bridge, near Higuera Street	1) Stage (ft) 2) Flow rate (ft/sec) 3) Groundwater elevation (ft)	1) Flow out of the basin for water budget 2) Surface-groundwater connectivity 3) Sustainable GDE indicator	Depth to groundwater below ground surface (ft)	TBD
9) Pismo Creek	Railroad Crossing	1) Stage (ft) 2) Flow rate (ft/sec) 3) Groundwater elevation (ft)	1) Water budget 2) Surface-groundwater connectivity 3) Sustainable GDE indicators	Flow rate (cfs)	1.50 cfs (late spring)/; 0.50 cfs (dry season) (Stillwater 2016)
				Depth to groundwater below ground surface (ft)	TBD
New proposed groundwater monitoring locations					
10) Tank Farm Wetlands	Near Tank Farm Rd	Groundwater elevation (ft)	GDE indicator	Groundwater depth below surface (ft)	TBD
11) Davenport Creek	Crestmont Road	Groundwater elevation (ft)	GDE indicator	Groundwater depth below surface (ft)	TBD
12) East Corral de Piedra	Orcutt Road	Groundwater elevation (ft)	GDE indicator	Groundwater depth below surface (ft)	TBD
13) West Corral de Piedra	Orcutt Road	Groundwater elevation (ft)	GDE indicator	Groundwater depth below surface (ft)	TBD
14) Canada de Verde	Corbett Canyon Rd	Groundwater elevation (ft)	GDE indicator	Groundwater depth below surface (ft)	TBD

[A] In 2014 Stillwater Sciences completed a county-wide instream flow study for steelhead trout during their two most flow sensitive periods for minimum instream flows (late spring and later summer). A predictive model, based on watershed area, was developed to estimate minimum instream flows during these time periods. Values reported here are based on this model assuming that Stenner Creek at the Nipomo Street bridge has a watershed area of 11.0 square miles and SLO Creek at the Marsh Street Bridge has a 24.5 square mile watershed area
[B] Jennings and Hayes 1994
[C] Stillwater Sciences 2016

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Appendices

Appendix A

Basin Sediment Thickness Map
(GSI 2017)

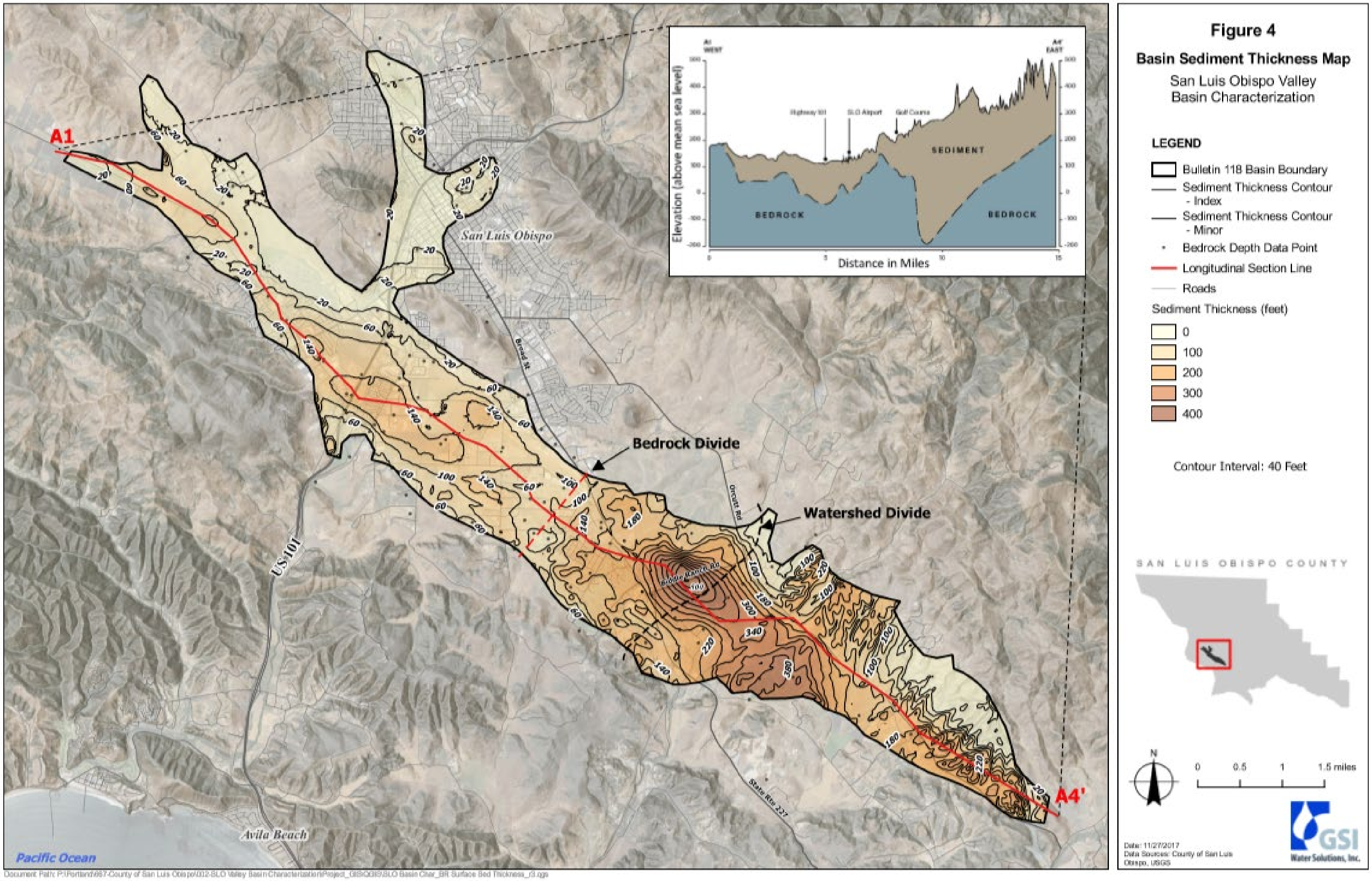

Figure A-1. SLO Groundwater Valley Basin Sediment Thickness Map (GSI 2017).

Appendix B

Fall 1954 Water Level Map (GSI 2017)

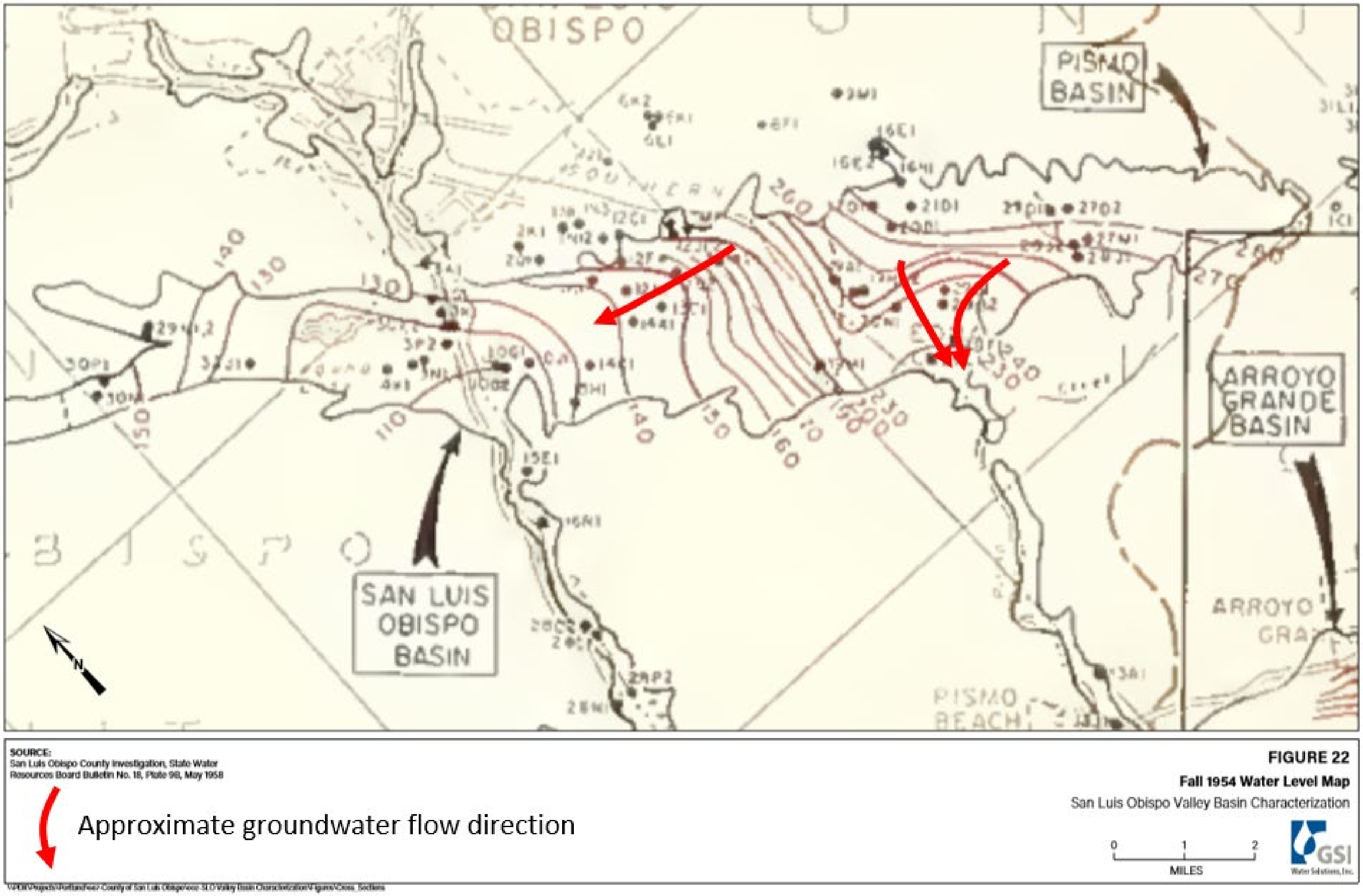

Figure B-1. SLO Groundwater Valley Basin 1954 Water Level Map (Data from DWR, Figure from GSI 2017; direction of groundwater flow (red arrows) added by Stillwater Sciences)

Appendix C

Map of Gaining and Losing Instream Flow Conditions, Stenner Creek, September 2020 (Creek Lands Conservation, unpublished data)

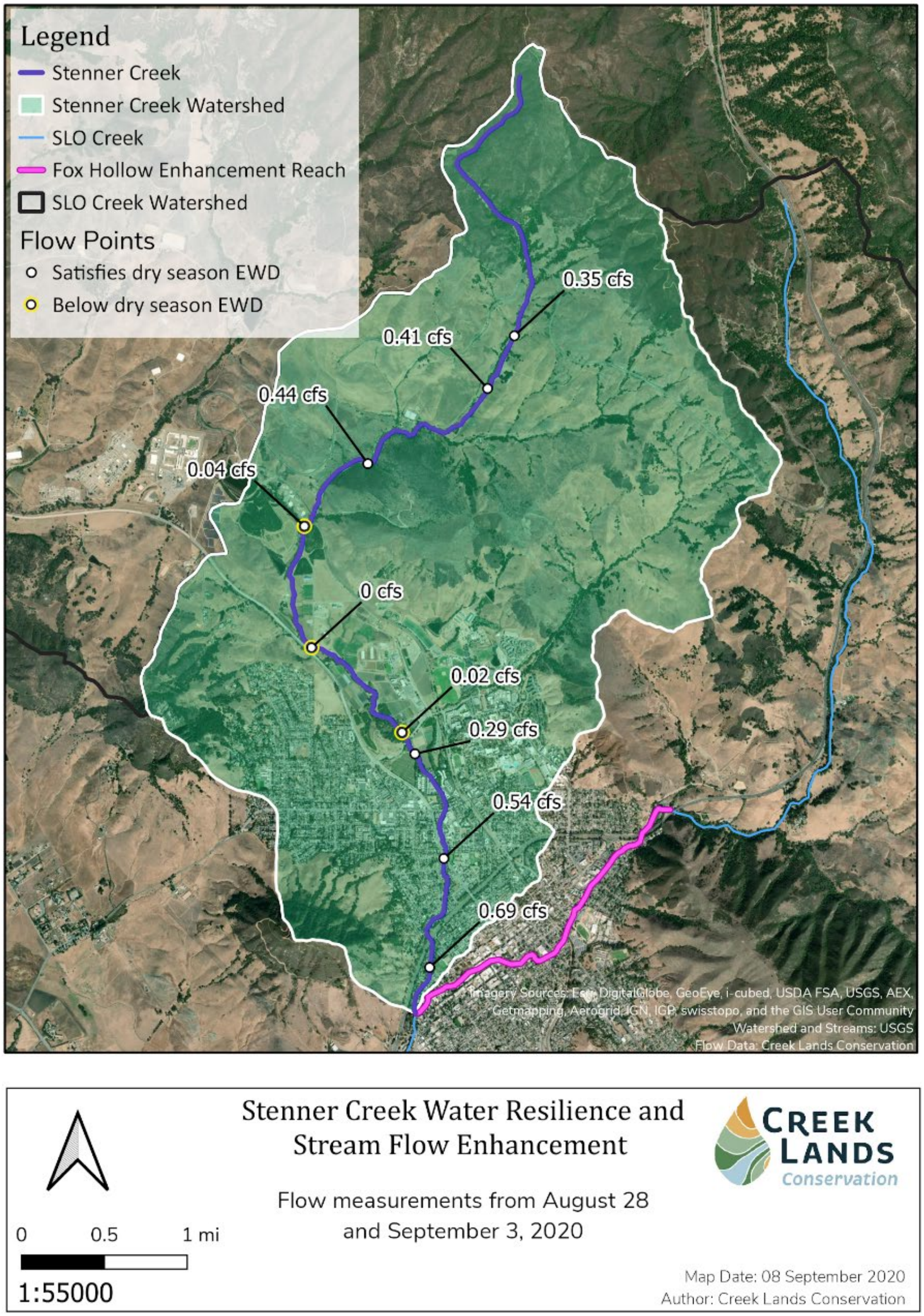

Figure C-1. Stenner Creek flow rate (cfs) as measured by Creek Lands Conservation (CLC) in late August/early September 2020 showing losing and gaining hydrologic conditions. Flow is also compared to environmental water demand (EWD) as defined by Stillwater Sciences (2014). (Figure by CLC)

Surface Water / Groundwater Modeling Documentation

Selection of appropriate modeling software for development of SLO Basin integrated SW/GW model

Surface Water/Groundwater Modeling Approach Technical Memorandum (Modeling TM No.1)

Surface Water/Groundwater Modeling Calibration Technical Memorandum (Modeling TM No.2

Geophysical Survey TM

GSI Water Solutions, Inc.

DRAFT Technical Memorandum

To: Michael Cruikshank
Water Systems Consulting, Inc.

and

Dick Tzou, San Luis Obispo County Project Manager.
Mychal Boerman, City of San Luis Obispo Project Manager

From: Dave O'Rourke (GSI)

Date: May 31, 2019

Re: Selection of appropriate modeling software for development of SLO Basin integrated SW/GW model

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1.0 Introduction

This Technical Memo (TM) was developed by the consultant team supporting the San Luis Obispo Valley Groundwater Basin (SLOVGB, or SLO Basin) Groundwater Sustainability Commission (GSC). The GSC consists of representatives of two distinct Groundwater Sustainability Agencies (GSAs), representing the City and County of San Luis Obispo. The SLOVGB has been identified as a high priority basin according to the DWR basin prioritization. Under the terms of the Sustainable Groundwater Management Act (SGMA), high-priority basins must complete a Groundwater Sustainability Plan (GSP) by January 31, 2022, and must achieve sustainability by 2042. A numerical model is recommended for support the GSP development.

1.1 Background

Previous hydrogeologic investigations (DWR 1958, Boyle 1992, DWR 1997) have concluded that infiltration from streams in the basin represent a significant portion of the water budget. Because of this factor, the GSC has opted for development of an integrated groundwater surface water model to support the development of the GSP. Several modeling alternatives are available. This document discusses the approach that will be taken to develop an integrated groundwater-surface water model that will be used to assist the GSC during their development of a Groundwater Sustainability Plan (GSP).

1.2 Objective

The objective of this TM is to discuss the differences in the available modeling platform alternatives, and document the supporting information that led to the selection of the most appropriate modeling platform.

1.3 Model Selection Criteria

The consulting team performing the technical work for the SLO Basin GSP has been tasked with the development of an integrated groundwater/surface water flow model for use in supporting the GSP development. The model will be used to estimate future groundwater levels in the basin, and to demonstrate the effect that various proposed management actions will have on the goal of achieving sustainability by 2042.

Available modeling methods have been researched and evaluated for their ability to meet project needs. It is important that the modeling approach meet DWR Sustainable Groundwater Management Act (SGMA) public domain requirements, so any models not meeting this requirement were not considered.

There are several alternatives available for consideration of the model selection, which will be discussed in Section 2 of this memo. Model alternatives will be evaluated based on the following criteria.

- Capability to realistically model essential groundwater – surface water interactions, including rainfall-runoff relationships, streamflow accumulation, surface-water hydrology, variable groundwater elevations, perennial and seasonal groundwater interaction between surface water and groundwater, and irrigation-related return flows to the aquifer
- Perceived credibility, as demonstrated by citation in the peer-reviewed literature
- Meets DWR SGMA public domain requirements
- Ability to model recharge from irrigation and septic systems
- Ability to meet project requirements within the defined scope and budget
- Longevity of model, availability of support/updates
- Transparency
- Degree of leveraging information developed during development of previous models and investigations.
- Proven use for similar applications

2.0 Overview of Alternative Model Options

The following alternative modeling approaches and software packages were considered and documented in this technical memo:

- MODFLOW + HSPF (Coupled Model)
- GSFLOW
- MODFLOW-OWHM
- DWR Integrated flow model (IWFM)

2.1 Overview of MODFLOW + HSPF (Coupled model)

One approach that has been used successfully over the past 20+ years is the construction of separate models for groundwater and surface water, and tailored development of computer code to allow the two models to communicate data at points of intersection (for example, at the location where a stream from the surrounding watershed enters the basin). Because hydrologic response in the groundwater environment is much slower than that of the surface water environment, groundwater models generally utilize much longer stress periods (typically monthly, seasonal, or annual) than surface water models (typically daily or hourly). MODFLOW models are "distributed" or spatially discretized into small cells (typically from 100 ft^2 to 1 mi^2), whereas surface water models usually are discretized into irregular shaped sub-watershed scales on the order of tens to hundreds of square miles, with the advantage of much shorter surface water model computational time on the order of minutes. The only distributed surface water model with gridded cells is PRMS, which is used in GSFLOW. This section will present independent summaries of MODFLOW and HSPF, followed by a brief discussion of the requirements to couple the two models.

2.1.1 MODFLOW

With the exception of IWFM (which will be discussed separately), the groundwater modeling alternatives discussed in this memo all utilize some version of MODFLOW. MODFLOW is a publicly available groundwater modeling code developed by the USGS. It is the most commonly used groundwater modeling code in the world, and is considered an industry standard. In essence, MODFLOW discretizes the active model area into a grid of rectangles, assigns hydrogeologic parameters and initial conditions to each cell, and solves the groundwater flow equation for each cell in the model area. The USGS is continually updating MODFLOW and releasing new versions. In 2011, they released MODFLOW-NWT, a version of MODFLOW that significantly improved the capability of MODFLOW to solve for conditions in unconfined aquifers subject to drying and re-wetting during seasonal climatic fluctuations. In 2013, MODFLOW-USG (Un-Structured Grid) was released, a version that overcame previous constraints on geometric representation of girds, and thus significantly improved the ability of the model to represent complex geologic settings, as well as providing a much more efficient solver for numerical computations. MODFLOW-USG cannot be used with GSFLOW or MODFLOW-OWHM. In 2019, a new object-oriented program and underlying framework called MODFLOW 6 was developed to provide a platform for supporting multiple models and multiple types of models within the same simulation. Each version of MODFLOW has its own individual constraints and advantages when considered in coupling with a surface water model; these will be discussed in more detail later in this TM. Within the MODFLOW 6 framework, a regional-scale groundwater model may be coupled with multiple local-scale groundwater models. Or, a surface-water flow model could be coupled to multiple groundwater flow models. MODFLOW 6 is not compatible with GSFLOW or MODFLOW-OWHM.

2.1.2 HSPF

HSPF is a continuous simulation hydrologic model that grew out of a number of EPA models, including the NPS model, ARM, and the Stanford Watershed Model. A continuous simulation model simulates the inter-storm periods are modeled through a series of soil-moisture routines. Once the model has simulated the hydrologic cycle on the land surface, water (and pollutants) can be routed through a drainage network of many sub-watersheds within the HSPF model.

HSPF has routines to model rainfall and the water budget of land surface processes, including interception, evaporation, transpiration, surface runoff, interflow, groundwater baseflow, surface and subsurface detention storages, the root-zone soil moisture balance, and overland and river routing of storm water runoff. The pathway of water from precipitation to the watershed outlet is through canopy interception, infiltration or runoff, where infiltrated water moves through a series of underground storages (including root-zone storage) and surface runoff is routed down the river network.

Water that does not infiltrate becomes surface runoff which either flows into surface storage or becomes storm flow, which is routed by a modified Chezy-Manning equation over the land surface and to the river network. The Chezy-Manning equation accounts for the runoff delayed response of the watershed due to friction and watershed shape. The infiltrated water, however, follows a more complicated path.

There are basically three possible fates in the subsurface: interflow, baseflow, or root-zone storage. The infiltrated water is first partitioned between interflow and active ground-water recharge in a similar way to how surface water is partitioned between surface runoff and infiltration. Interflow storage is subsequently routed to the stream through a simple linear reservoir. Active groundwater recharge is partitioned between baseflow storage and root-zone storage and is a function of the soil moisture in the model. Root-zone storage terminates in evapotranspiration; baseflow storage is routed either to the stream through another simple linear reservoir with a longer residence time than for interflow, or ultimately to deep percolation to recharge the underlying aquifer.

2.1.3 Coupled Model

In a coupled model, custom computer code needs to be developed at points of intersection between the HSPF model and the MODFLOW model. Both HSPF and MODFLOW are written using the computer language Fortran. To appropriately couple the groundwater and surface models, detailed tracking of the calibrated HSPF model output is necessary. HSPF output such as streamflow must be stored in a separate file, routed to the input files for the MODFLOW simulations. HSPF calculated deep percolation of surface water is tracked in HSPF model for each sub watershed and must be distributed over the MODFLOW cells that lie within each sub-watershed. The distribution of HSPF calculated deep percolation over MODFLOW grid cells, as input to the MODFLOW recharge input files, is done externally to both HSPF and MODFLOW models using a Geographical Information System (GIS).

As discussed previously, HSPF frequently operates with stress periods of days (or shorter), while MODFLOW typically is applied using monthly, seasonal, or annual stress periods. Therefore, any output from HSPF will likely require additional processing to generate average values consistent with the stress period setup of the MODFLOW model.

In summary, because MODFLOW and HSPF are designed to simulate the groundwater and surface water environments independently, they are well-suited to model the watershed and aquifer processes of SLO Basin. The end results should be a calibrated HSPF surface water model and a calibrated MODFLOW groundwater model. A potential disadvantage is that models are independent and a few iterations may be required when the calibrated HSPF calculated deep percolation does not provide the recharge needed to calibrate the groundwater model. The advantage of this method is that both the most versatile and industry standard surface water and groundwater models are used and allows the modeler to use familiar and well-supported graphical user interfaces and software packages for pre- and post-processing. Also, each model can be independently updated and used for when smaller surface water or groundwater projects that have no great impact on surface water groundwater interaction need to be assessed without having to deal with a more complicated fully integrated model.

2.2 Overview of GSFLOW

GSFLOW is a fully integrated watershed-groundwater model (Markstrom et al., 2008) that has been widely used throughout the United States by the USGS and other hydrologic professionals to model surface water and groundwater conditions in various geologic settings. GSFLOW is a coupled groundwater and watershed flow model based on integration of the USGS Precipitation-Runoff Modeling System (PRMS) and MODFLOW. The PRMS and MODFLOW models are compiled, calibrated, and run separately before calibrating and running the combined model (GSFLOW) to complete the model development process. Normally coupled model simulations have run times that are much longer than uncoupled groundwater or surface-water models and in many cases, forward model run times can become limiting for practical calibration. However, GSFLOW simulates these processes in a computationally efficient manner such that GSFLOW can be applied to watershed-scale problems ranging from a few square kilometers to several thousand kilometers and for time periods that range from months to several decades using a daily timestep (Markstrom et al., 2008).

GSFLOW was developed to simulate coupled groundwater – surface water flow in one or more watersheds by simultaneously simulating flow across the land surface, within subsurface saturated and unsaturated materials, and within streams and lakes (Markstrom et al., 2008; Regan et al., 2016). GSFLOW can be conceptualized as three regions with exchanges of flow between them. GSFLOW uses physically based processes and empirical methods with user inputs of air temperature and precipitation (snow/rain) to simulate the distribution of precipitation into runoff, evapotranspiration, infiltration, groundwater flow, and surface-water flow.

GSFLOW also provides other advantages over other models that may be used. Watershed scale data is available online through several public data providers that contain data for many watersheds throughout the country. These data are standardized and GSFLOW was designed to readily incorporate the data available online by using semi-automated tools that are available for use and are relatively simple to use. Gardner et al. (2018) introduces the use of these tools that rely on ArcGIS using ArcPy. ArcPy allows control of ArcGIS using Python, a widely used and well documented programming language, to perform GIS related tasks in a semi-automated way. These tools take all the required data needed for PRMS and GSFLOW models and can generate the input files required to run each model, respectively. At this time, these tools do not generate input files for the MODFLOW model so this part of the development of the model is still required to be done manually.

GSFLOW does not have a common or well-supported GUI to assist with pre- and post-processing of well files and output. EarthFX, a Canadian company, has recently released a software package designed to assist with GSFLOW modeling, but company representatives communicated that the product is not a comprehensive pre- and post- processor.

2.3 Overview of MODFLOW-OWHM

MODFLOW-OWHM (OWHM) includes the Farm Process package for MODFLOW for simulating the use and movement of water across irrigated and other landscapes. OWHM also incorporates several additional MODFLOW capabilities from various independent versions of MODFLOW such as the subsidence and seawater-intrusion packages and local-grid refinement capability that are not currently available in GSFLOW. The core concept of the Farm Process is to internally calculate crop irrigation requirements (crop demands) and to then allocate surface-water and groundwater irrigation supplies to meet those demands that cannot be met by precipitation or root uptake from groundwater.

Through the Farm Process, OWHM provides several specialized capabilities to represent and manage the surface-water and groundwater deliveries to farms that extend beyond the core water-withdrawal and irrigation-application capabilities of MODFLOW, MODFLOW-NWT, and GSFLOW. OWHM also provides options for simulating the effects of land subsidence on coupled groundwater and surface-water systems with irrigated agriculture. However, if these capabilities are not needed, the Water Mission Area of the USGS recommends use of GSFLOW for most projects requiring hydrologic simulation and analysis of coupled groundwater/surface-water/watershed systems.

OWHM: OWHM was first released in 2014 (Hanson and others, 2014a). OWHM includes the Farm Process for MODFLOW-2005 for simulating the use and movement of water across irrigated and other landscapes. OWHM also incorporates and enhances many capabilities from various independent versions of MODFLOW. These include MODFLOW's Local Grid Refinement capability (MODFLOW-LGR; Mehl and Hill, 2007, 2013), MODFLOW-NWT (Niswonger and others, 2011), Surface-Water Routing Process (SWR; Hughes and others, 2012), and the Riparian Evapotranspiration Package (Maddock and others, 2012).

The core concept of the Farm Process is based on a farm irrigation water budget (Schmid and Hanson, 2007; Hanson and others, 2010). The Farm Process estimates farm crop demands and irrigation requirements within user specified water-balance subregions and then determines available water supplies from precipitation, surface-water and groundwater deliveries, and root uptake from groundwater to meet those demands. A key feature of the Farm Process is the internal calculation of this residual irrigation demand, and automatic activation of user specified wells to meet that demand. Water from precipitation and irrigation in excess of consumptive use is either directed as overland runoff (return flow) to the stream network or to the underlying saturated or unsaturated zones as deep percolation. The Farm Process provides several options that allow the user to constrain surface-water and groundwater supplies and to conjunctively manage surface-water and groundwater allocations. OWHM also uses the time-step and stress-period concepts of MODFLOW, and can be run with or without the Farm Process active.

2.4 Overview of IWFM

The DWR- developed Integrated Water Flow Model (IWFM) is a computer program developed and maintained by DWR, and used for water resources management and planning within a basin. It is capable of calculating groundwater flows, soil moisture movement in the topsoil, stream flows, land surface flows and flow exchange between the groundwater, streams and land surface as generated by rainfall, agricultural irrigation, and municipal and industrial water use. In addition, IWFM can calculate agricultural water demands based on crop type and acreage, soil types, irrigation methods, and rainfall rates, so it can be used to evaluate management actions associated with changes in agriculture. Municipal and industrial water demands can be estimated based on population and per-capita water use rates, so these may be varied to simulate management actions in these water use sectors. IWFM is a tool that can help understand the movement of the surface and subsurface water flows within a basin, and to plan the use of groundwater and surface water to meet future agricultural, municipal and industrial water demands.

DWR maintains IWFM, and has made IWFM available to Groundwater Sustainable Agencies (GSAs) to develop their Groundwater Sustainability Plans (GSPs) as a tool that can be used for sustainable groundwater management. There is at present no GUI for this model, although one is in development.

3.0 Comparisons of Significant Features of Modeling Alternatives

There are many technical differences in the details of the various presented modeling alternatives, too many for a comprehensive discussion of all of them. This section will present brief comparisons on the most significant differences between the alternatives presented as they impact the decision of which modeling alternative to select for support of the GSP.

All four modeling alternatives presented will provide simulation both of watershed processes outside of the Basin and groundwater processes within the Basin. The factors that differentiate between alternatives and dictate the selection will likely be the teams judgement of some of the technical details.

The coupled model approach using MODFLOW + HSPF allows the modeler to utilize MODFLOW-USG, which has advantages with respect to layer geometry and solver capabilities. GSFLOW and OWHM do not support MODFLOW-USG. Independent development of separate MODFLOW and HSPF models allows the modeler access to well supported GUI software, which can be a time saver during model development and post-processing. However, the project requirements associated with the necessity for custom coding required to link two independent models may be a significant portion of the work effort. In addition, this would not result in a single integrated model, but in two independent models that communicate. The necessity for custom coding introduces a "black box" element that may not be easily understood by the stakeholders, and the custom coding may complicate legacy uses of the models by future users. Although MODFLOW and HSPF are industry standard models, the coupling of the two models is a significant feature, and the lack of established standard methods may be problematic for the public process aspects of SGMA. California Water Code 23 CCR §352.4(f)(3) states that "Groundwater and surface water models developed in support of a Plan after the effective date of these regulations shall consist of public domain open-source software". The original source code required for coupling of two models could be interpreted to violate this requirement.

GSFLOW has a comparable modeling approach to the coupled model approach, but it is contained within a single modeling package supported by the USGS. As such, the documentation of the linkage between the surface water and groundwater processes is more robust than would be the case in the coupled model approach. GSFLOW is better than OWHM for headwaters to basin simulations and consideration of generation of overland runoff, soil zone processes, and streamflow generation. As such it is appropriate for application to environmental flows, streamflow water budget analysis, and watershed issues.

MODFLOW-OWHM is more appropriate for consideration of areas with intense irrigation, like the Central Valley. Its internal functions that calculate crop demand make changes in water demands under different crop types easier to implement. OWHM has the Local Grid Refinement capability, not available in GSFLOW. Allocation of crop demand between surface water and groundwater sources is more explicitly considered, and ability to simulate transient land uses is easier to effect. Calculation of runoff from headwater watershed areas is not performed. The primary purpose of OWHM is to evaluate conjunctive use of groundwater and surface water supplies in agricultural areas. OWHM provides specialized capabilities to represent the SW and GW deliveries to farms that extend beyond the typical water withdrawal and irrigation application capabilities of MODFLOW and GSFLOW. OWHM supports the subsidence and sea water intrusion packages. However, we do not anticipate using these packages.

Both codes use the time-step and stress-period concepts of MODFLOW, but GSFLOW uses daily time steps and internal daily stress periods for certain budget items; OWHM uses longer time steps of several days to weeks within each stress period. This has implications for file size and run times. A traditional

MODFLOW groundwater model might typically be run with annual, seasonal, or monthly stress periods, with several variable length time-steps per stress period. In this instance, long-term calibration runs of 50-75 years are feasible. With daily stress periods, the run time and file size of such long runs can become problematic.

IWFM has some aspects of both GSFLOW and OWHM. It can generate runoff estimates at the basin boundary, but is more focused on agriculture-related simulations and management actions. It has no software package to assist with pre- and post-processing. Because it was developed by a California state agency, it's applications have been largely limited to California, and so does not have the degree of public use and documentation as the USGS models, which are applied nationwide.

4.0 Recommendation

All four options would meet the technical requirements of an integrated groundwater surface water model to support the GSP development in the Basin. However:

- The coupled model approach could potentially be problematic with respect to the requirement that models "…shall consist of open domain public source software…", due to the necessity for custom code implementation to link the two independent models;
- The OWHM model does not develop estimates for watershed runoff in headlands areas upstream of the basin;
- IWFM has no dedicated pre- and post- processors available for input development of output data presentation, and is less widely applied than the USGS-developed models.
- GSFLOW offers the representation of the Basin watershed from the headlands to the outflow from the Basin, development of streamflow estimates for ungaged streams, and an appropriate level of detail to simulate different management actions.

For these and other reasons discussed in the body of this TM, the team recommends that the GSC endorse the use of GSFLOW for use in the development of an integrated groundwater/surface water model for use in support the GSP development.

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Project: SLO Basin Groundwater Sustainability Plan

Subject: **Draft** Surface Water/Groundwater Modeling Approach Technical Memorandum (Modeling TM No.1)

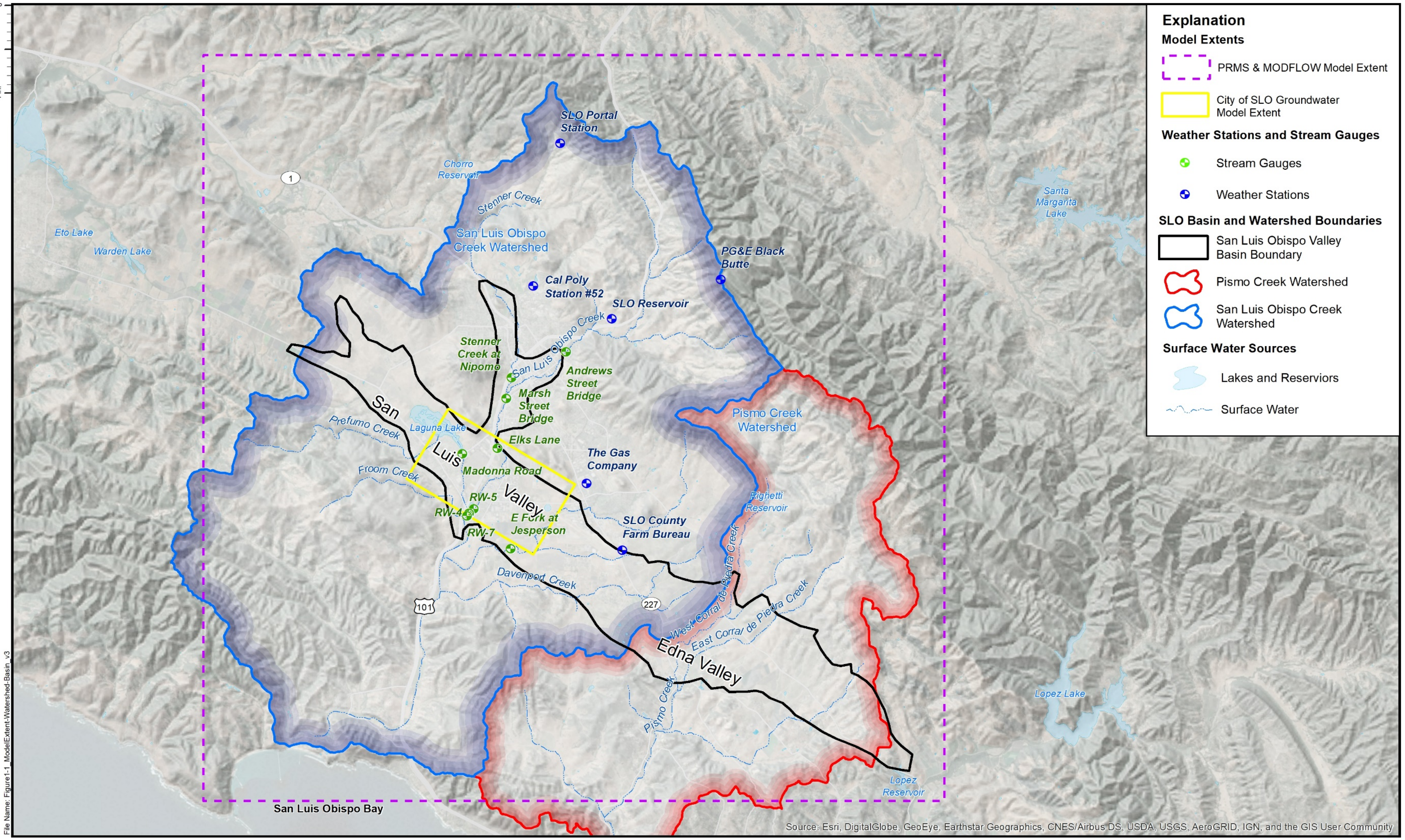
Section 1. Introduction

This draft Technical Memo (TM No.1) is prepared by Water Systems Consulting, Inc. (WSC) and GSI Water Solutions, Inc. (GSI), for the San Luis Obispo (SLO) County Groundwater Sustainability Agency (GSA) and the City of SLO GSA. As part of the Groundwater Sustainability Plan (GSP) for the SLO Valley Groundwater Basin (Basin), the consultant team is developing an integrated surface water-groundwater numerical model for the objective of evaluating the potential impacts of proposed projects and management actions associated with the GSP. The objective of this TM is to document the modeling approach and hydrogeologic conceptual model (HCM) associated with the construction of the integrated numerical model of the SLO Basin.

The Basin covers approximately 20 square miles in central San Luis Obispo County (County). The Basin extents are defined as the contact of water-bearing sediments with the non-water-bearing formations of the Santa Lucia Range to the northeast, and the San Luis Range and the Edna Fault Zone to the southwest. Annual average precipitation in the Basin is approximately 18 to 22 inches (GSI Water Solutions, Inc., 2018). The Basin is commonly divided into two sub-areas: the San Luis Valley and the Edna Valley. The San Luis Valley occupies approximately the northwestern half of the Basin; it includes the City of San Luis Obispo (City), and the primary land uses are municipal and industrial. Most water supply in the San Luis Valley is from both in-basin groundwater sources and imported surface water sources (Whale Rock Reservoir, Salinas Reservoir, and Nacimiento Reservoir). The Edna Valley occupies the southeastern half of the Basin. The primary land use is agriculture, with wine grapes as the dominant crop type. Groundwater is the major source of water supply in the Edna Valley.

To date, a watershed scale groundwater or integrated surface water-groundwater model has not been published for the entire Basin. In 1997, the California Department of Water Resources (DWR) performed initial work on a basin groundwater model, but the model was never published. A groundwater model was developed within a portion of the Basin that encompasses the San Luis Valley (the City of SLO model)(Cleath-Harris Geologists, 2018) and a surface water hydraulic model has been developed for the San Luis Obispo Creek watershed (Questa Engineering Corp., 2007). Figure 1-1 shows the watershed and Basin boundaries, and the proposed model extent for both PRMS and MODFLOW.

GSI developed a TM to evaluate multiple integrated surface water-groundwater modeling systems and identified the best modeling system to achieve compliance and project objectives for the SLO GSP (GSI Water Solutions, Inc., 2019). GSFLOW, a fully integrated hydrologic model (IHM) developed by the United States Geological Survey (USGS) (Markstrom, Niswonger, Regan, Prudic, & Barlow, 2008), was recommended to the GSP Groundwater Sustainability Commission (GSC) to be selected as the model system to be used for the GSP. IHM models like GSFLOW can provide important information about water resources and are often used as decision support tools for resource management (Laniak, et al., 2013). GSFLOW integrates the Precipitation-Runoff Modeling System (PRMS) watershed model code with the MODFLOW groundwater model code.



Prepared for:

SAN LUIS OBISPO VALLEY BASIN GSP

Author: EC
Date: 2/18/2020

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References:
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Model Extents, Watershed, and Basin Overview

Figure 1-1

Section 2. Hydrogeologic Conceptual Model

This section of the TM summarizes the HCM for the San Luis Obispo Valley Groundwater Basin (Basin) (DWR Basin 3-09), including summary discussion of both geologic formations and hydrogeologic conditions significant to the development of the numerical model. These subjects are evaluated in greater detail in the Basin Characterization Report (GSI Water Solutions, Inc., 2018), and the reader is directed to that report for a more comprehensive discussion of relevant topics.

2.1. Geologic Formations and Water Bearing Properties

For the purpose of the GSP, the rocks in the Basin vicinity may be considered as two basic groups; the water-bearing sediments of the SLO Basin, and the consolidated bedrock of the surrounding hills and watershed. Compared to the saturated sediments that comprise the Basin aquifers, the consolidated bedrock formations are not considered to be water-bearing. Although bedding plane and/or structural fractures in these rocks may yield small amounts of water to wells, they do not represent a significant portion of the pumping in the area. In fact, the DWR Bulletin 118 delineation of the Basin boundaries is defined both laterally and vertically by the contacts of the Basin sediments with the surrounding and underlying consolidated bedrock formations.

Figure 2-1 displays a stratigraphic column of the significant local geologic units. Figure 2-2 presents a geologic map of the Basin vicinity (assembled from a mosaic of the Dibblee maps from the San Luis Obispo, Pismo Beach, Lopez Mountain, and Arroyo Grande NE quadrangles) showing where the various formations crop out at the surface.

Figure 2-2 also displays the Basin boundaries defined in DWR Bulletin 118. Inspection of Figure 2-2 indicates that the existing DWR GIS shapefiles for the Basin boundary do not match up precisely with the mapped extent of the water-bearing formations. This is likely an artifact of previous mapping being performed at a larger statewide scale.

The water-bearing sedimentary formations and the non-water-bearing bedrock formations are briefly described below, from the youngest to the oldest.

2.1.1. Basin Sedimentary Formations

Recent Alluvium

The Recent and Older Alluvium is the mapped geologic unit composed of unconsolidated sediments of gravel, sand, silt, and clay, deposited by fluvial processes along the courses of San Luis Obispo Creek, Davenport Creek, East and West Corral de Piedras Creeks, and their tributaries. Lenses of sand and gravel are the productive strata within the Alluvium. There is no significant difference in hydrogeologic properties between Recent and Older Alluvium. These strata have no significant lateral continuity across large areas of subsurface within the Basin. Thickness of Alluvium may range from just a few feet to greater than 50 feet.

Paso Robles Formation

The Paso Robles Formation underlies the Recent Alluvium throughout most of the Basin and overlies the Pismo Formation where present. It is composed of poorly sorted, unconsolidated to mildly consolidated sandstone, siltstone, and claystone, with thin beds of volcanic tuff in some areas. The Paso Robles Formation is exposed at the surface through much of the Edna Valley, except in areas where existing streams have deposited Recent Alluvium on top of it. Wells that screen both the Recent Alluvium and Paso Robles Formation have reported yields from less than 100 to over 500 gallons per minute (gpm). There is no laterally extensive fine-grained confining unit separating the Paso Robles formation from the Recent Alluvium in the Basin.

Pismo Formation

The oldest geologic water-bearing unit with significance to the hydrogeology of the Basin is the Pismo Formation. The Pismo Formation is a Pliocene-aged sequence of unconsolidated to loosely consolidated marine deposited sedimentary units composed of claystone, siltstone, sandstone, and conglomerate. There are five recognized members of the Pismo Formation (Figure 2-1). While all are part of the Pismo Formation, the distinct members reflect different depositional environments, and the variations in geology may affect the hydrogeologic characteristics of the strata. From the bottom (oldest) up, these are:

- The Edna Member, which lies unconformably atop the Monterey Formation, and is locally bituminous (hydrocarbon-bearing)
- The Miguelito Member, primarily composed of thinly bedded grey or brown siltstones and claystones
- The Gragg Member, usually described as a medium-grained sandstone
- The Bellview Member, composed of interbedded fine-grained sandstones and claystones
- The Squire Member, generally described as a medium- to coarse-grained fossiliferous sandstone of white to grey sands.

Previous reports have identified the significant thicknesses of sand at depth beneath the Paso Robles Formation in the Edna Valley as the Squire Member of the Pismo Formation. However, ambiguities exist in the identification of the individual Pismo Formation members, so for the purposes of this report, these sediments will be referred to more generally as the Pismo Formation. The Pismo Formation is extensive below the Paso Robles Formation in the Edna Valley. There is no laterally extensive fine-grained confining layer separating the Pismo Formation from the Paso Robles Formation in the Basin. Thicknesses of Pismo Formation up to 400 feet are reported or observed in well completion reports.

Wells that are completed in both the Paso Robles and Pismo Formations are reported to yield from less than 100 gpm to approximately 700 gpm.

2.1.2. Bedrock Formations

Monterey Formation

The Monterey Formation is a thinly bedded siliceous shale, with layers of chert in some locations. In other areas of the County outside of the Basin, the Monterey Formation is the source of significant oil production. While fractures in consolidated rock may yield small quantities of water to wells, the Monterey Formation is not considered to be a Basin aquifer for the purposes of this Study. Some wells in the Basin screen both Basin sediments and the upper portion of the Monterey Formation. Of the bedrock formations discussed here, the Monterey Formation is the one most often used for water supply in the Basin. There are no paired wells that provide specific data comparing water levels in wells screening the Monterey Formation and the Basin sediments. However, the Monterey Formation is assumed to receive rainfall recharge in the mountains at higher elevations than the Basin. For this reason it is assumed that an upward vertical flow gradient exists between the Monterey Formation and the overlying Basin sediments. Because the Monterey formation is significantly less productive than the Basin sediments, the rate of this flux is not expected to be significant.

Obispo Formation

The Obispo Formation and associated Tertiary volcanics are composed of materials associated with volcanic activity along tectonic plate margins approximately 20 to 25 million years ago. Although fractures in consolidated volcanic rock may yield small quantities of water to wells, the Obispo Formation is not considered to be an aquifer for the purposes of this Study.

Franciscan Assemblage

The Franciscan Assemblage contains the oldest rocks in the Basin area, ranging in age from late Jurassic through Cretaceous (150 to 66 million years ago). The rocks include a heterogeneous collection of basalts, which have been altered through high-pressure metamorphosis associated with subduction of the oceanic crust beneath the North American Plate before the creation of the San Andreas Fault. Although fractures may yield small quantities of water to wells, the Franciscan Assemblage is not considered to be an aquifer for the purposes of this Study.

2.2. Geologic Structure

The primary geologic structures of significance to the hydrogeology of the Basin are the Edna Fault Zone and the adjacent Los Osos Fault Zone, which together form the southwestern boundary of the Basin through the uplift of the Franciscan and Monterey strata southwest of the faults. The Edna Fault is identified as a normal fault, extending from southeast of the Edna Valley to the vicinity of the town of Edna (Figure 2-2). There are some disconnected and unnamed fault splays mapped in the area south of the San Luis Obispo County Regional Airport. The Los Osos Fault Zone is mapped along the southwest edge of the Los Osos Valley. Movement along the Edna and Los Osos Valley Fault Zones has brought the water-bearing sediments of the Basin into contact with the bedrock formations of the San Luis Range. No available water level or other data indicate that the faults have any significant effect on the movement or quality of groundwater in the Basin.

2.3. Lithologic Data

All readily available lithologic data were obtained for the preparation of the Characterization Report (GSI Water Solutions, Inc., 2018) and updated for this TM. Sources of data included Well Completion Reports on file with the County and DWR, boring logs documented in published government reports or private consultant reports, geophysical boring logs, and various other sources. In all, 405 data points with lithologic information were collected for use in the GSP. (The reader is referred to the Characterization Report to evaluate the details of twelve cross sections generated in the Basin, which will not be duplicated herein.) Lithologic data were assigned spatial coordinates based on available mapping, and descriptions of geologic materials were recorded in a database for reference in future Sustainable Groundwater Management Act management activities. Lithologic data point locations are presented in Figure 2-3.

Available lithologic data, cross sections, and land surface elevation data were evaluated to identify probable contacts between geologic formations. Based on these data, GSI developed a map of total thickness of combined Basin sediments (Alluvium, Paso Robles Formation, and Pismo Formation), presented in Figure 2-4. This figure indicates that the Basin sediments are significantly thicker in the Edna Valley than in the San Luis Valley. Lithologic data were reviewed to identify contacts between the Recent Alluvium, Paso Robles Formation, and Pismo Formation. Based on these contacts, twelve cross sections were developed and presented in the Characterization Report (GSI Water Solutions, Inc., 2018); the reader is directed to that report to review details of the cross sections. Based on this data, a 3-D lithologic model of the SLO Basin sediments was developed using the software package Leapfrog©. Leapfrog 3D is a geologic modeling platform that incorporates and processes data from multiple sources including boreholes, GIS, grids, mesh/surface information, and historical cross section data. The Leapfrog model can be used as a basis to develop a numerical groundwater model grid and/or for 3D visualization and presentation purposes (Figure 2-5).

2.4. Hydrogeologic Setting

This section of the TM presents a summary discussion of hydrogeologic conditions in the SLO Basin as they pertain to the integrated model development. These subjects are evaluated in greater detail in the Basin Characterization Report (GSI Water Solutions, Inc., 2018), and the reader is directed to that report for a more comprehensive discussion of relevant topics. This TM will present an overview of the hydrogeology but will not duplicate the level of detail provided in the Characterization Report.

2.4.1. Hydrogeologic Units

Although there are significant intervals of clay evident in boring logs throughout the Basin, the clay lenses are not consistent across large areas. There is no evidence of laterally extensive impermeable strata that vertically isolates the geologic formations from one another. As a result, it appears that in the San Luis Valley, the Recent Alluvium and the Paso Robles Formation function as a single hydrogeologic unit. Work performed for the City indicates that alluvial deposits have a significantly higher hydraulic conductivity than the Paso Robles Formation and the Pismo Formation (Cleath, 2019). It does not appear that wells in the San Luis Valley are screened exclusively in either the Recent Alluvium or the Paso Robles Formation. Similarly, in the Edna Valley, there is no laterally extensive impermeable strata separating the Paso Robles and Pismo Formations. Frequently, the sand of one formation is in contact with the sands of the other formation. Therefore, it appears that in the Edna Valley, the Paso Robles Formation and the Pismo Formation function as a single hydrogeologic unit. Therefore, the modeling approach will be to represent each of the geologic units separately in the model, but no discrete barriers to vertical flow between the units will be simulated.

2.4.2. Recharge

The primary mechanisms for recharge in the Basin occur via infiltration of rainfall, percolation of seasonal streamflow from the alluvial sediments to underlying formations, deep percolation of applied irrigation water, and mountain front recharge. Mountain front recharge has not been specifically discussed or quantified in previous studies.

DWR (Department of Water Resources, 1958) estimated that average recharge to the Basin was 2,250 acre-feet per year (AFY). Working with data from a longer period of record, Boyle (Boyle Engineering Corp., 1991) estimated total recharge to the Basin from 1978-1990 was 3,650 AFY (1,510 acre-feet from irrigation percolation, 1,450 acre-feet from rainfall, 430 acre-feet from stream seepage losses, 300 acre-feet from reclaimed wastewater). In its draft report, DWR (Department of Water Resources , 1997), using a groundwater model approach, estimated combined recharge from precipitation, agriculture return flows, and incidental urban recharge, to average 4,560 AFY and range from 2,300 AFY in a drought year to 9,590 AFY in a wet year (As discussed previously, the groundwater model was never published). It should be noted that DWR (Department of Water Resources , 1997) estimates aquifer recharge from stream seepage only during dry years; in wet years, DWR estimated that the aquifer discharges to streams.

Cleath-Harris Geologists (CHG), a member of the consultant team developing the SLO Basin GSP, is preparing estimates of a historical water budget simultaneously with the development of the Basin numerical model. Estimates for each of the components of recharge discussed herein will be utilized during the calibration of the model.

2.4.3. Groundwater Pumping

Patterns and quantities of groundwater use in the Basin have varied depending on the period of record. The City of San Luis Obispo did not begin using groundwater until the late 1980s. In the 1990s, the City relied on significant groundwater use, particularly during the drought of the early 1990s. Today, by contrast, the City's potable water wells are used only for emergency standby due to groundwater contamination. The City does have plans to utilize groundwater as a drinking water supply in the future.

Agricultural groundwater use in the Edna Valley has changed in recent decades in response to market drivers, with the total irrigated acreage expanding significantly, and the crop types changing. Currently, wine grapes are the dominant crop type. No continuous estimates of groundwater pumpage in the Basin are available. Agricultural wells have not been metered in the past, and methods to estimate agricultural pumpage indirectly may vary. However, various published estimates have been presented in past reports and are briefly discussed below.

DWR (Department of Water Resources, 1958) estimates that 1,900 acre-feet of groundwater was pumped at that time. No details on this estimate are evident in the report text.

Boyle (Boyle Engineering Corp., 1991) reports an estimate of agricultural groundwater pumpage of 5,200 AFY, based on evaluation of irrigated acreage of various crop types, unit water use for each crop type, and irrigation efficiency. It is noteworthy that there is no reported irrigated vineyard acreage reported for their study period (1978-1990). Municipal and industrial pumpage is estimated to average 600 to 800 AFY during that period but was reported to be as high as 2,600 AFY during the drought year of 1990. Resultant total groundwater pumpage estimates for the Basin range from 5,690 to 7,810 AFY.

In its draft report, DWR (Department of Water Resources , 1997) presents some estimates for groundwater pumpage in the Basin. For years ranging from 1970 to 1995, groundwater pumpage estimates for all water user groups from the San Luis Valley range from 1,900 to 3,300 AFY, with the maximum estimate in the drought year of 1990. Pumpage estimates from the Edna Valley range from 2,330 to 4,340 AFY. Resultant total groundwater pumpage estimates for the Basin range from 4,380 to 7,640 AFY.

CHG is developing estimates of historical pumping as part of the water budget analysis. The results of that analysis will be incorporated into the historical calibration of the groundwater model.

2.4.4. Evapotranspiration

Evapotranspiration refers to the process by which water is transferred from the land to the atmosphere by evaporation from the soil and other surfaces and by transpiration from plants. This mechanism for outflow from the Basin may be significant in areas where the water table is near the land surface, such as along the stream corridors in the Basin. Transpiration of applied irrigation water to agricultural crops is also a significant process in the hydrology of the Basin. The details of the evapotranspiration processes will be represented in the integrated model.

2.4.5. Surface Water/Groundwater Interaction

Surface water/groundwater interactions represent a significant portion of the water budget of SLO Basin. In the Basin, these interactions occur primarily at streams and lakes.

Laguna Lake is the only lake in the Basin. The downstream outlet of the lake is dammed to artificially impound water to maintain water elevation in the lake to preserve and enhance the wildlife habitat and recreational purposes. The water in the lake is partially supplied by seasonal flow in Prefumo Creek, which flows into Laguna Lake. During dry periods, the lake may remain at least partially full, although it may dry up during extended drought. This appears to indicate that in addition to surface water inflow, the water in the lake is at least partially supplied by subsurface groundwater inflow.

Groundwater interaction with streams in the Basin is not well quantified, but it is recognized as an important component of recharge in the water budget. During the dry season when many streams have no flow, the groundwater elevation is below the streambed. Therefore, it is generally understood that San Luis Obispo Creek discharges to the underlying aquifer, at least in the first part of the wet-weather flow season. If there is constant seasonal surface water flow, it is possible that groundwater elevations may rise to the point that they are higher than the stream elevation, and the creek may become a seasonally gaining stream, but there are no data to corroborate this. It may remain a losing stream throughout most or all years.

The amount of flow in surface water/groundwater interaction is difficult to quantify. Boyle (Boyle Engineering Corp., 1991) assumed that 10 percent of the measured surface water flow coming into the Basin in San Luis Obispo Creek and Stenner Creek was recharged to the aquifer and at an average rate of 430 AFY. In its draft report, DWR (Department of Water Resources , 1997) reports model-generated estimates ranging from streams gaining 2,700 AFY from the aquifer, to streams losing 680 AFY to the aquifer.

The County, through its Water Resources Division coordination with Zone 9 and the City, maintains a network of five stream gages in the San Luis Valley of the Basin to record heights of flow throughout the year for flood warning purposes. The gages were constructed in November 2001 and have periods of record from 2005 to the present. Continuous monitoring of the height of flow at the gages is recorded, but equivalent discharge (e.g. cubic feet per second) is not recorded. Partial rating curves have recently been developed for some of the gages based on field measurements of discharge for observed flows. Additionally, estimated theoretical rating curves for each gage based on hydraulic modeling using HEC-RAS have been developed (Questa Engineering Corp., 2007).

2.4.6. Groundwater Flow Patterns

Groundwater flow in the Basin is predominantly from the Edna Valley toward the San Luis Obispo Creek alluvium, at which point the flow direction leaves the Basin through the alluvium. Groundwater in the northwestern areas of the Basin near the City boundary and Los Osos Valley Road flows southeastward toward the San Luis Obispo Creek alluvium. In the Edna Valley, there are also local areas of flow leaving the Basin along the Corral de Piedras Creek and alluvium of other smaller tributaries, in the southeastern portion of the Basin.

DWR (Department of Water Resources, 1958) published a series of maps depicting groundwater elevation maps for the various parts of its study area, including groundwater elevations in the Basin for Fall 1954. This map displays dominant groundwater flow direction from higher elevations in the Edna Valley (over 280 feet relative to mean sea level [msl]) to lower elevations (less than 110 feet msl) where San Luis Obispo Creek exits the Basin (GSI Water Solutions, Inc., 2018).

Boyle (Boyle Engineering Corp., 1991) presents water level elevation contour maps for the spring of 1986 and 1990. Contours for spring of 1990 display a pattern of groundwater flow in the Basin very similar to that exhibited in the DWR map. Contours for the spring of 1986 are not presented in this report, but 1986 represents wetter conditions than the 1990 map, and it is noted in Boyle (Boyle Engineering Corp., 1991) that there is a difference of approximately 10 feet of elevation between the two maps, representing the variation in water levels that may be observed between wet and dry weather cycles (GSI Water Solutions, Inc., 2018).

In its draft report, DWR (Department of Water Resources , 1997) used a computer groundwater model developed for its study to generate a series of modeled water level maps representing wet, dry, and average conditions. The model results are not re-presented in this Study, but the maps display the same general flow patterns as the DWR (Department of Water Resources, 1958) and Boyle (Boyle Engineering Corp., 1991) maps based on field data. Water level elevations in what DWR defines as the San Luis sub-basin in wet years were approximately 10 to 20 feet higher than in dry years. In what DWR defines as the Edna sub-basin, the difference in groundwater elevations between wet and dry years was approximately 20 to 30 feet.

Recent groundwater level data collected as a part of the District’s voluntary monitoring network were obtained and used to generate a water table map to evaluate more recent conditions. Figure 2-6 presents the contours generated from the data for the October 2019 monitoring event. Because there are no significant or extensive aquitards separating the Alluvium, Paso Robles Formation, and Pismo Formation, the water level maps assume that all three formations function as a single hydrogeologic unit. This map confirms the previously estimated primary direction of groundwater flow from the Edna Valley to the San Luis Valley, but several new features are apparent. First, a pronounced mound is evident at the location where Corral de Piedras Creek enters the Basin in Edna Valley, near the corner of Biddle Ranch Road and Orcutt Road. This indicates that this is a groundwater recharge area, and that the recent rains of 2016-2017 have elevated water levels in this area. Secondly, a depression in the water table surface is evident in the area near Edna Road and Biddle Ranch Road, likely due to agricultural pumping in the area in recent years. The southeast and northwest extents of the Basin had no wells monitored during this event to calculate water levels in these areas.

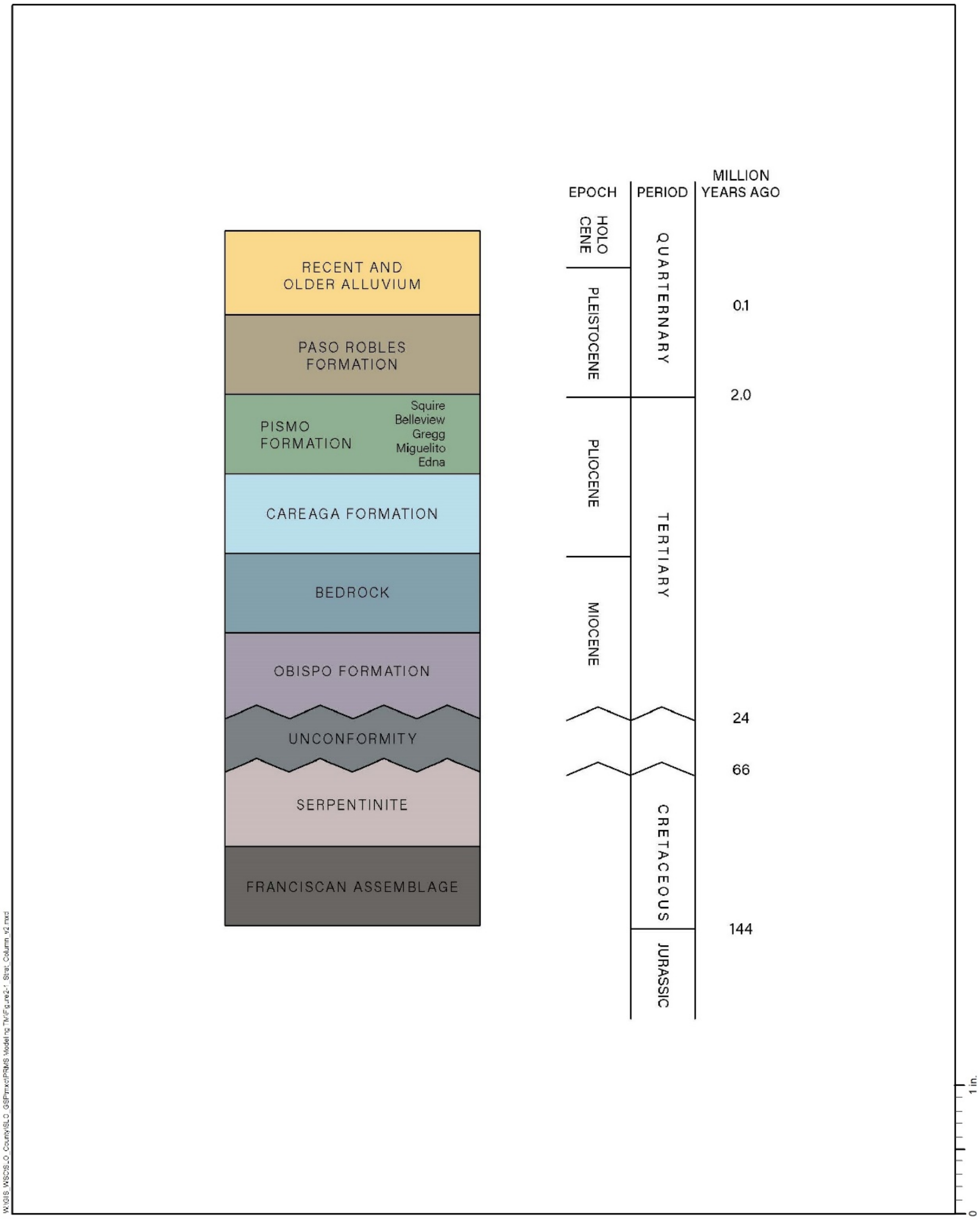
The San Luis Valley and the Edna Valley are characterized by different patterns of groundwater use. In the San Luis Valley, groundwater use has been dominated by municipal and industrial use. In the Edna Valley, groundwater use is dominated by agricultural use. During the past 20 to 25 years, vineyards have supplanted other crop types as the dominant agricultural use. Available water level data were reviewed, and data from wells with the longest period of record are presented here.

Figure 2-7 presents long-term groundwater elevation hydrographs for ten wells throughout the Basin. Three main patterns of water level change are evident in these hydrographs. The hydrographs for the wells in the San Luis Valley indicate that water levels in these wells, although somewhat variable in response to seasonal weather and water use fluctuations and longer-term drought cycles, are essentially stable. There are no long-term trends indicating steadily declining water levels in this area. By contrast, several wells in the Edna Valley display steadily declining water levels during the past 20 to 25 years.

Two wells in close proximity to the groundwater recharge area in Edna Valley where Corral de Piedras Creek enters the Basin display much greater volatility in response to drought cycle fluctuations than the wells in San Luis Valley but appear to rebound to pre-drought levels when the drought cycle ends; water levels in these wells do not display a long-term decline of water levels.

2.4.7. Hydraulic Properties

During the preparation of the Basin Characterization Report (GSI, 2018), all available data on constant rate aquifer tests and specific capacity tests in the Basin were collected, reviewed, and presented in the report. Seventy-seven well locations in the Basin were identified that had an estimate of aquifer hydraulic parameters, indicating reasonable data density in the Basin. Wells screened in the Alluvium and Paso Robles Formation have reported transmissivities ranging from about 5,000 to 158,000 gallons per day per foot (gpd/ft), and averaging over 42,000 gpd/ft. Wells screened in Paso Robles and Pismo Formations have transmissivities ranging from less than 1,000 to about 40,000 gpd/ft, and average about 10,000 gpd/ft. These data are presented in a summary table in Chapter 4 of the GSP.



Prepared for:

COUNTY OF SAN LUIS OBISPO

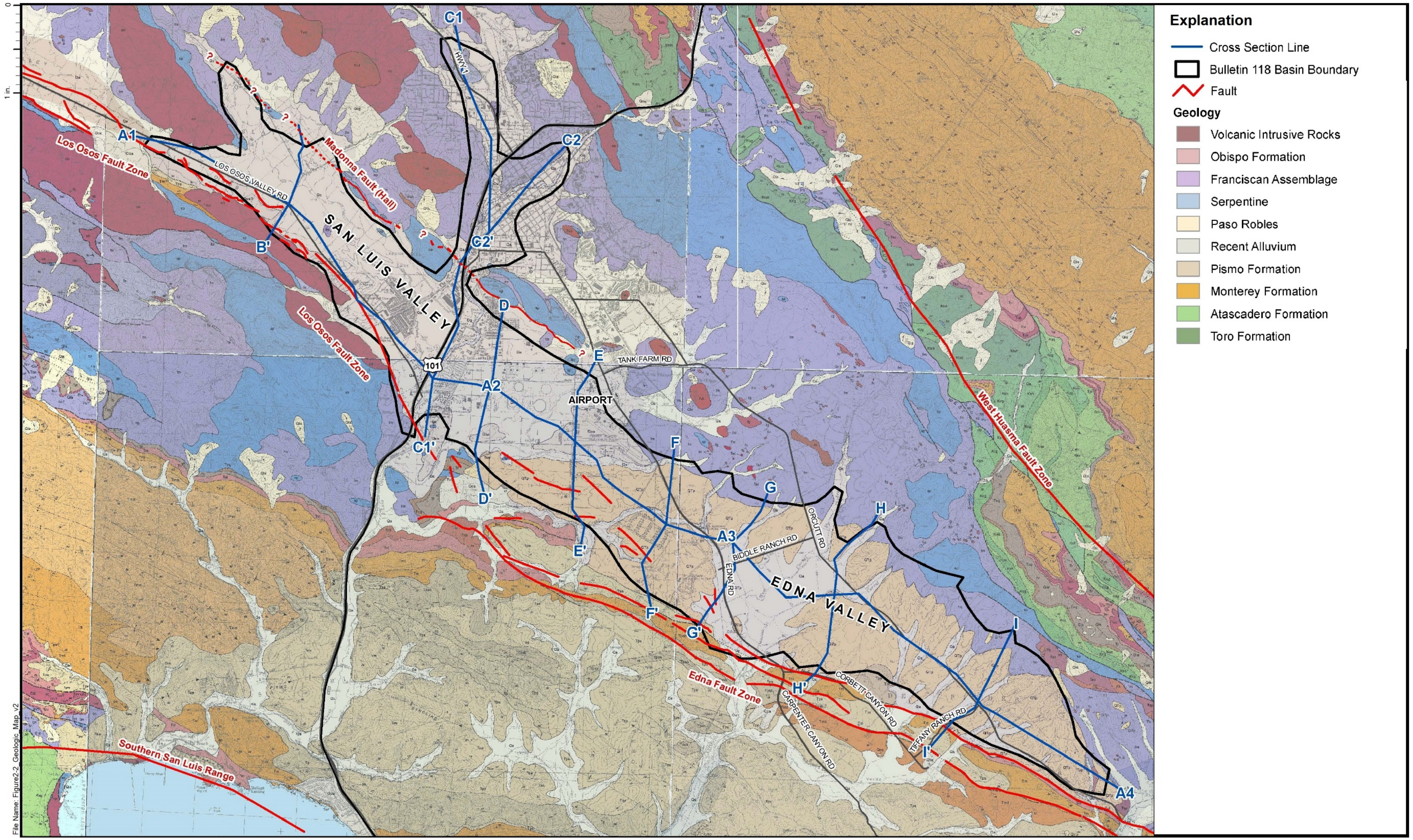
Author: EC
Date: 1/13/2020

SAN LUIS OBISPO VALLEY BASIN GSP

Notes:
1.
2.
3.

Local Geologic Stratigraphic Column

Figure 2-1



Prepared for:

Author: EC
Date: 1/13/2020

SAN LUIS OBISPO VALLEY BASIN GSP

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1 in : 1.5 mi
0 0.5 1 2 Mi
0 0.75 1.5 3 Km

References:
1. Coordinate System: NAD 1983 StatePlane California V FIPS 0405 Feet
Projection: Lambert Conformal Conic
Datum: North American 1983
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Notes:
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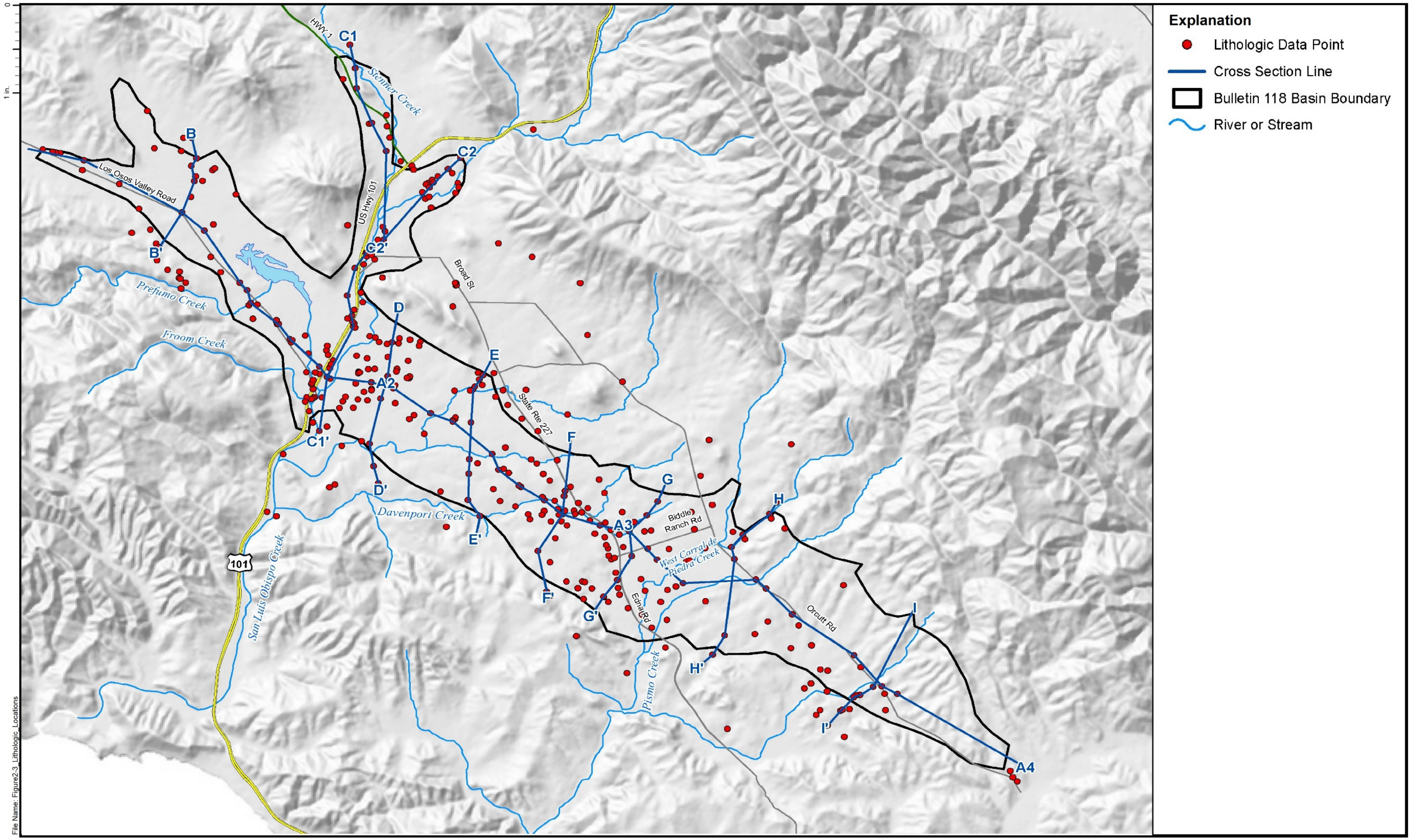
San Luis Obispo Valley Basin Geologic Map

Figure 2-2



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COUNTY OF SAN LUIS OBISPO

Author: EC
Date: 10/15/2019

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1. Coordinate System: NAD 1983 StatePlane California V FIPS 0405 Feet
Projection: Lambert Conformal Conic
Datum: North American 1983
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Notes:
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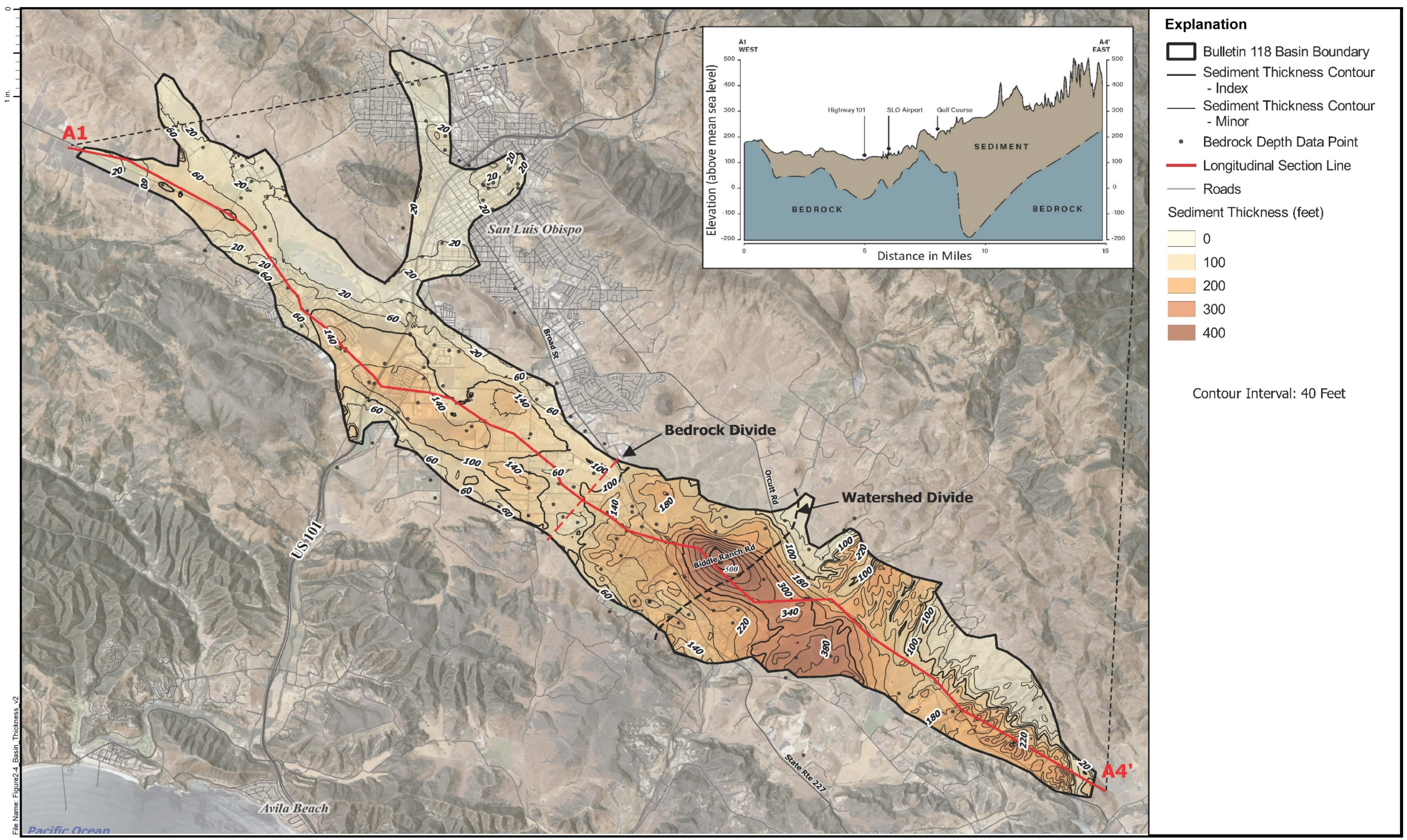
San Luis Obispo Valley Basin Cross Section Lines and Lithologic Data Points

Figure 2-3



Prepared for:

SAN LUIS OBISPO VALLEY BASIN GSP

Author: EC
Date: 1/13/2020

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0 0.75 1.5 3 Km

References:
1. Coordinate System: NAD 1983 StatePlane California V FIPS 0405 Feet
Projection: Lambert Conformal Conic
Datum: North American 1983
2.
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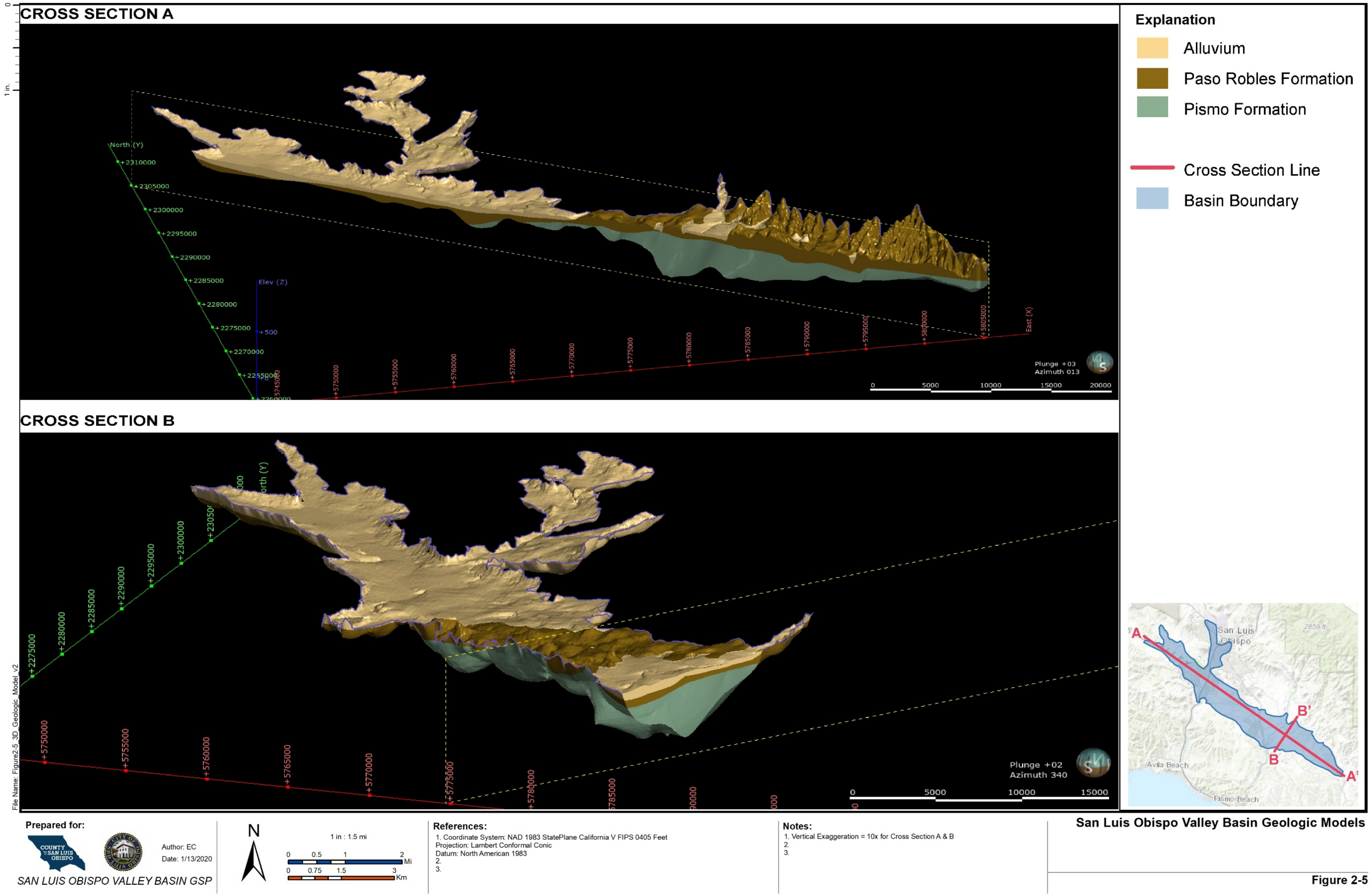
Notes:
1. Vertical Exaggeration = 57x for inset cross section
2.
3.

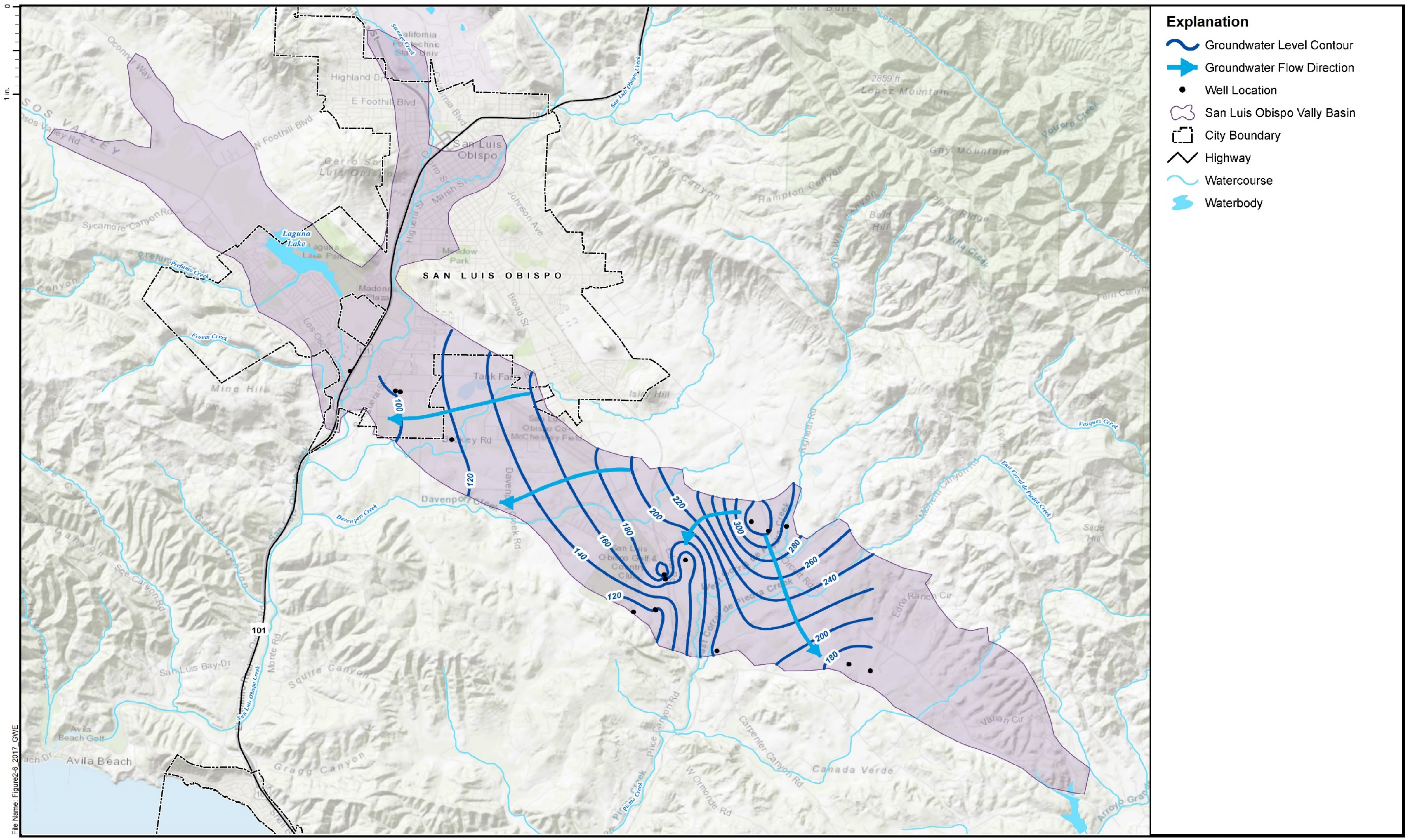
San Luis Obispo Valley Basin Sediment Thickness

Figure 2-4



San Luis Obispo Valley Basin Geologic Models

Figure 2-5



Prepared for:

Author: EC
Date: 10/14/2019

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1. Coordinate System: NAD 1983 StatePlane California V FIPS 0405 Feet
Projection: Lambert Conformal Conic
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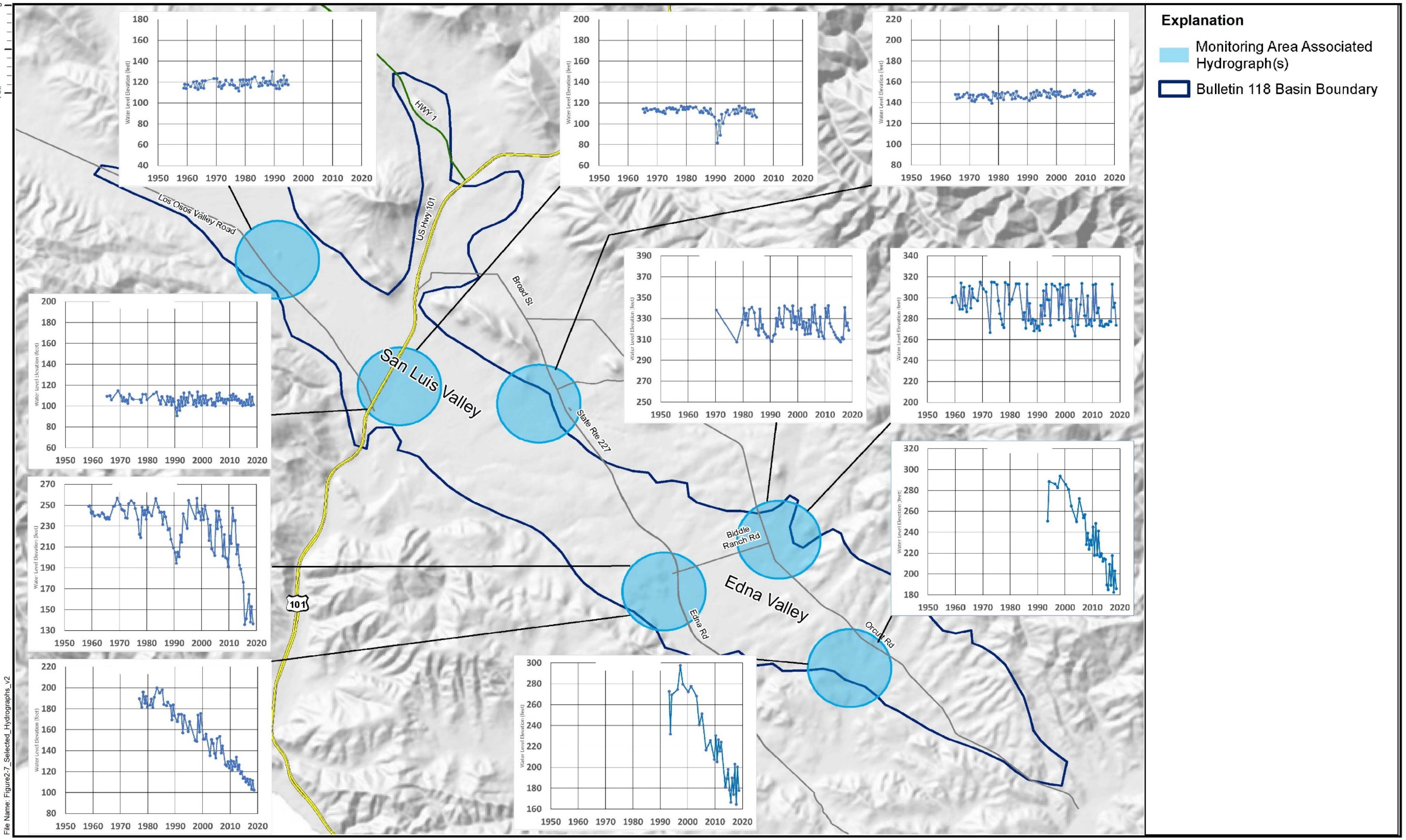
October 2017 Groundwater Elevations

Figure 2-6



Prepared for:

Author: EC
Date: 1/13/2020

SAN LUIS OBISPO VALLEY BASIN GSP

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References:
1. Coordinate System: NAD 1983 StatePlane California V FIPS 0405 Feet
Projection: Lambert Conformal Conic
Datum: North American 1983
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Selected Hydrographs in San Luis Obispo Valley Basin

Figure 2-7

Section 3. Modeling Approach

The GSA expressed a preference for an integrated surface water-groundwater model to be used to support the GSP, rather than a traditional groundwater model limited to the extents of the Basin. An integrated model simulates surface water processes in the contributing watershed as well as groundwater flow within the basin and incorporates results of the surface water simulation as input into the groundwater flow model. There are numerous approaches and available modeling codes capable of achieving this objective. GSI and WSC evaluated four options for development of an integrated numerical model and documented the results in a TM prepared for GSA staff (GSI Water Solutions, Inc., 2019), and presented the results to the GSC in a public meeting. The four options considered were:

- MODFLOW + HSPF (coupled model)
- MODFLOW-One Water (OWHM)
- IWFM – DWR Integrated Flow Model
- GSFLOW

For reasons documented in the supporting TM (GSI Water Solutions, Inc., 2019), the decision was made to use GSFLOW as a platform for the integrated model.

GSFLOW is a fully integrated watershed-groundwater model (Markstrom et al., 2008) that has been used throughout the United States by the USGS and other hydrologic professionals to model surface water and groundwater conditions in various geologic settings. GSFLOW is a coupled groundwater and watershed flow model based on integration of the USGS watershed model PRMS and groundwater model MODFLOW. The PRMS and MODFLOW models can be developed separately, with initial parameter estimation performed in the two models separately, before integrating the two component models. Then the integrated model is calibrated and run using GSFLOW to complete the model development process.

GSFLOW was developed to simulate coupled groundwater – surface water flow in one or more watersheds by simultaneously simulating flow across the land surface, within subsurface saturated and unsaturated materials, and within streams and lakes (Markstrom et al., 2008). GSFLOW uses physically based processes and empirical methods with user inputs of air temperature and precipitation (i.e., snow/rain) to simulate the distribution of precipitation into runoff, evapotranspiration, infiltration, groundwater flow, and surface-water flow.

Details of the modeling approach for PRMS and MODFLOW are presented in the following sections.

Section 4. PRMS: Surface Water-Component Model

The modeling software that will be used to simulate the watershed-scale surface water component of the integrated model is PRMS version 5.0.0. PRMS is a deterministic, distributed-parameter, physical-process hydrologic model used to simulate and evaluate the watershed response of various combinations of climate and land use (Markstrom, et al., PRMS-IV, the Precipitation-Runoff Modeling System, Version 4, 2015).

In the PRMS model, climate data, including precipitation and temperature, are applied to simulate hydrologic water budgets based on spatially defined watershed-component model parameters such as plant canopy and soil zone properties. Surface and subsurface flow is calculated through the cascading of rain-generated runoff. When run in PRMS-only simulations, runoff that infiltrates into the soil zone is distributed to the subsurface reservoir and groundwater reservoir where it can interflow to streams or lakes. When run in a coupled GSFLOW simulation, groundwater flow routing is simulated in MODFLOW rather than PRMS. Initial parameter estimation of the PRMS model will be performed in PRMS-only mode prior to integration into GSFLOW and final calibration of the integrated model.

4.1. Model Discretization

Model discretization is performed using Gsflow-Arcpy (Gardner, Morton, Huntington, Niswonger, & Henson, 2018), a toolkit of ArcGIS Python codes. Gsflow-Arcpy consists of a series of python scripts that, when run in succession, produce model-ready PRMS parameter files and a parameter shapefile for visual representation of all inputs.

Prior to performing the model discretization, the watershed boundary, or model domain, for PRMS and GSLFOW was delineated. The model domain was defined by all land area that drains surface runoff into the San Luis Obispo Valley Groundwater Basin. The two primary watersheds that make up this area are the San Luis Obispo Creek and Pismo Creek watersheds. The two pre-delineated watersheds were trimmed at the south-west boundary of the Basin. A topographic analysis was then performed along the south-west boundary to capture all sub-watersheds that drain to the Basin, including the Prefumo Creek and Froom Creek sub-watersheds. Figure 4-1 presents the PRMS model domain.

4.1.1. Hydrologic Response Unit Discretization

The first step in preparation of the PRMS model is the spatial discretization of the watershed into individual hydrologic response units (HRU). This is performed to allow for spatial variability in model inputs (elevation, slope, vegetation type, etc.) and reporting of the simulation results, as a water balance and energy balance are computed at each timestep at each HRU. A grid-based approach, which entails the delineation of the watershed into square grid-cell HRUs, was selected for both the PRMS and MODFLOW models. Various grid cell sizes were evaluated, ranging from 250-foot (ft) to 1,000-ft. Sample grids at differing cell sizes were overlaid onto aerials and base maps to evaluate grid cell density. GSI and WSC performed a brief literature review to assess what grid cell size has been used in comparison to the entire modeled area for other GSFLOW modeling studies documented in the state. The ratios of cell size to watershed size were assessed in comparison to other GSFLOW models, including the Santa Rosa Plain Model (Woolfenden & Nishikawa, 2014) and the Santa Cruz Mid-County Basin Model prepared by HydroMetrics Water Resources, Inc. (Huntington, King, & Tana, 2016). This comparison indicated that 500-foot grid cells for the model yielded a grid cell to model area ratio within the bounds of those from other documented GSFLOW modeling studies. Therefore, a uniform grid cell size of 500 ft x 500 ft, totaling 21,462 cells, was adopted for the initial model development.

The delineation of the watershed into HRUs for the PRMS model was performed using the Gsflow-Arcpy toolkit. Limitations of the ArcInfo grid format is that it will only perform raster-based calculations on vertical-horizontal oriented grid cells (Environmental Systems Research Institute (ESRI), 2013). Additionally, GSFLOW requires that the grid cells in PRMS output files match those in the MODFLOW files or if the PRMS and MODFLOW grid cells orientation and total model extents differ, HRU's assigned in PRMS and their associated gravity reservoirs are reassigned proportionally to each MODFLOW grid cell. To resolve this limitation, the vertical oriented PRMS grid and its populated input data fields will be used for PRMS calibration. Once PRMS and MODFLOW have been initially run separately, PRMS HRU's and their associated gravity reservoirs will be reassigned to the MODFLOW grid. This combined grid will create the final grid to be used for GSFLOW calibration and multiple model runs assessing various scenarios. This approach will maintain the integrity of the developed PRMS input files and allows for simplified integration between PRMS and MODFLOW into GSFLOW that does not require custom code integration and use of additional data files.

Once the HRU grid cells are generated, the next step in the discretization is the designation of cells as one of four types: land, lake, swale, or inactive. Two water bodies within the watershed, Laguna Lake and the Righetti Reservoir, were designated in the model input. Swales, which represent a sink without an outlet, were not identified within the watershed and therefore were excluded from the designation in the model input. Inactive cells represent those outside the watershed boundary that are not included in the model simulation.

The last step to the HRU discretization is the designation of sub-basins. Sub-basins were delineated based on the locations of the various stream gages (see Section 4.2.2), the outlet of Righetti Reservoir, and the model outlet points. Figure 4-1 presents the results of HRU discretization and Figure 4-2 presents the locations of model sub-basin points and model outlet points.

4.1.2. Stream Segments

Another spatial unit that is defined as part of the model discretization is the delineation of stream segments throughout the watershed. In PRMS, lateral flows, inflow and outflow are calculated at each stream segment. Delineation of the stream segments began with first assigning mean surface elevations to each HRU grid cell within the watershed using a 10-meter resolution digital elevation model (DEM) from the National Elevation Dataset (National Elevation Dataset, 2019). The mean elevations are then used by the Gsflow-Arcpy script to designate the stream segments locations by creating continuously down-sloping HRUs. Generated stream segments were viewed in comparison to USGS National Hydrography Dataset (NHD) streams in ArcMap (National Hydrography Dataset, 2002 - 2016) and recent satellite imagery from Google Earth to evaluate the accuracy of the stream delineation. Stream segment alignments were iteratively adjusted by manually altering the mean elevation of HRUs and rerunning the Gsflow-Arcpy script. The level of detail with regards to stream order was optimized to be representative of the main branches and the primary tributaries. Figure 4-3 presents the stream segments generated for the PRMS model.

4.2. Model Inputs and Calibration Data

Like the model discretization, Gsflow-Arcpy (Gardner, Morton, Huntington, Niswonger, & Henson, 2018) was used to assign input parameters to the HRUs such that they are formatted and structured for direct use by the PRMS model software.

4.2.1. Climate Input

PRMS requires a variety of climatic data for use throughout the various stages of modeling, including pre-processing of input data (mean monthly precipitation, maximum temperature, and minimum temperature), simulation runs (daily precipitation, maximum temperature, and minimum temperature), and calibration (solar radiation and evapotranspiration). Climatic data, dating back to 1870, was obtained from the Cal Poly Weather Station through the help of the Irrigation Training & Research Center (ITRC). The Cal Poly Weather Station houses not only the ITRC owned gages but also the California Irrigation Management Information System (CIMIS) and National Oceanic and Atmospheric Administration (NOAA) weather stations. While there are other County and privately-owned climate stations throughout the watershed, the Cal Poly Weather Station is the only station that has extensive records spanning the duration of the anticipated calibration period. Furthermore, the ITRC has performed thorough quality control reviews on the data collected from the Cal Poly Weather Station.

As part of the pre-processing and generation of input data, mean monthly precipitation was spatially distributed to each HRU within the model domain using 30-year normal baseline datasets, spanning from 1981 to 2010, from the Parameter-Regression on Independent Slopes Model (PRISM) (NACSE, 2019). Monthly precipitation scaling factors, that act as multipliers to account for changes in elevation, were then calculated for each HRU based on a ratio between the PRISM data and 1870-2018 mean monthly observed precipitation data from the Cal Poly Weather Station. Figure 4-4 and Figure 4-5 show the mean annual precipitation PRISM dataset and mean annual precipitation scaling factors derived from the PRISM and the Cal Poly Weather Station datasets. During PRMS simulations, the HRU precipitation scaling factors will be multiplied by the daily precipitation measurements from the Cal Poly Weather Station to calculate daily precipitation at each HRU. This will be performed using the precip_1sta module, as discussed further in Section 4.3. The accuracy of the precipitation scaling factors will be assessed by comparing the measured precipitation at the three County rain gages (SLO Portal, SLO Reservoir, and The Gas Company) to the modeled rainfall at each respective HRU.

Mean monthly minimum and maximum temperature values were assigned to each HRU using the 30-year normal PRISM dataset, as done with precipitation. Daily minimum and maximum temperature will be calculated at each HRU during PRMS simulations using daily observed maximum and minimum temperature data from the Cal Poly Weather Station and monthly PRISM data assigned to each HRU. PRMS simulations will use the temp_sta module to perform temperature calculations, as discussed further in Section 4.3. The accuracy of the modeled temperature will be assessed by comparing the modeled minimum and maximum temperatures to the measured values at the two nearby weather stations (PG&E Black Butte and SLO County Farm Bureau) with data available on Weather Element (Weather Element, 2014).

4.2.2. Streamflow Data

The County of San Luis Obispo owns and operates five real-time data monitoring stream gages along San Luis Obispo Creek, within the model domain. Each gage station records creek stage (depth) on fifteen-minute intervals. Available stage data at each station dates to 2005. Of the five County stream gages, three have stage-discharge relationships, or rating curves, that were approximated by Central Coast Salmon Enhancement (CCSE) based on recorded stage data and measured flows between 2017 and 2019. These stream gages include the Andrews Street Bridge, Stenner Creek at Nipomo, and Elks Lane (Figure 1-1). The rating curves generated for these gauge stations are considered the best available information for use in converting stage data to flow rate, and therefore are anticipated to be the primary datasets for use in calibrating the PRMS model. As previously mentioned, Questa Engineering Corps also estimated theoretical rating curves for each of the five County gages using a HEC-RAS model (Questa Engineering Corp., 2007). However, preliminary application of these rating curves to the stream gage data resulted in abnormal daily mean hydrographs in comparison to the hydrographs generated using the CCSE rating curves. The Questa rating curves may be used as a secondary dataset for comparison of modeled to observed flows at the Jesperesen and Madonna Road gage stations, where no CCSE rating curves exist.

In addition to the County owned gages, the City of San Luis Obispo collects weekly measurements of stage and flow within San Luis Obispo Creek at the outfall of the Water Resources Recovery Facility (WRRF) during the months of April to September as part of the National Pollutant Discharge Elimination System (NPDES) permitting program. It is not anticipated that this data will be used for calibration purposes given the apparent daily and monthly data gaps.

Lastly, monthly diversion data, dating back to 2010, is available for the 500-acre-foot Righetti Reservoir located along West Corral De Piedra Creek. A sub-basin, or sub-watershed, was designated at this reservoir in the model so that simulated flows can potentially be calibrated to observed monthly data. The efficacy of calibration at this location will be dependent on the capabilities of the PRMS routing modules and the limited information available on the day-to-day operations of the reservoir. At the very least, the Righetti Reservoir diversion data may be used to incorporate future diversion flows into modeling scenarios.

4.2.3. Additional Parameters

Vegetation, soil, and impervious land cover surfaces play important roles in routing and distributing runoff throughout PRMS. Vegetation is used by relating vegetation type to root depth and evapotranspiration to model water balances within the soil zone, and vegetation's various roles in runoff processes. Vegetation data was retrieved from the LANDFIRE datasets available through the United States Department of Agriculture, Forest Service (LANDFIRE, 2019). The vegetation parameters are calculated and populated before the soil parameters in order to establish root depths for each vegetation type. Soil data from SSURGO and STATSGO (Soil Survey Staff, 2019) are used to extract available water content (AWC), saturated hydraulic conductivity (Ksat), soil type, and percentages of sand, silt, and clay values throughout the watershed. These values are then assigned to various soil parameters used in PRMS to model flux's between vegetation and the soil-root zone. Impervious land cover surfaces are used to model surface runoff in areas that have no infiltration or in areas with different infiltration rates then can be expected from certain vegetated areas or soil types. The National Land Cover Database (Homer, Fry, & Barnes, 2012) data is used to derive these areas within each HRU grid cell represented as percentages. Figure 4-6 shows the National Land Cover Database data showing land cover types in the Basin derived from the impervious Arcpy script.

4.3. PRMS Modules

PRMS simulates the hydrologic cycle through various processes, each with one or more modules available for use. Table 4-1 presents the modules that have been selected for use in this model.

Table 4-1. PRMS Modules to Be Used

Module Name	Process	Description[1]
basin	Basin Definition	Defines shared watershed wide and HRU physical parameters and variables.
cascade	Cascading Flow	Determines computational order of the HRUs and groundwater reservoirs for routing flow downslope.
soltab	Solar Table	Computes potential solar radiation and sunlight hours for each HRU for each day of the year.
obs	Time Series Data	Reads and stores observed data from all specified measurement stations.
temp_sta	Temperature Distribution	Distributes maximum and minimum temperatures to each HRU by using temperature data measured at one station.
precip_1sta	Precipitation Distribution	Determines the form of precipitation and distributes it from one or more station to each HRU by using monthly correction factors to account for differences in altitude, spatial variation, topography, topography, and measurement gage efficiency.
ddsolrad	Solar Radiation Distribution	Distributes solar radiation to each HRU and estimates missing solar radiation data using a maximum temperature per degree-day relation.
transp_tindex	Transpiration Period	Determines whether the current time step is in a period of active transpiration by the temperature index method.
potent_jh	Potential Evapotranspiration	Computes the potential evapotranspiration by using the Jensen-Haise formulation (Jensen & Haise, 1963)
intcp	Canopy Interception	Computes volume of intercepted precipitation, evaporation from intercepted precipitation, and throughfall that reaches the soil.
srunoff_smidx	Surface Runoff	Computes surface runoff and infiltration for each HRU by using a nonlinear variable-source-area method allowing for cascading flow.
soilzone	Soil-Zone	Computes inflows to and outflows from soil zone of each HRU and includes inflows from infiltration, groundwater, and upslope HRUs, and outflows to gravity drainage, interflow, and surface runoff to down-slope HRUs.
gwflow	Groundwater	Sums inflow to and outflow from PRMS groundwater reservoirs. Used in the PRMS-only model, not the integrated GSFLOW model.
strmflow	Streamflow	Computes flow in the stream network using the Muskingum routing method and flow and storage in on-channel lake using several methods. Used in the PRMS-only model, not the integrated GSFLOW model.

[1] (Markstrom, et al., PRMS-IV, the Precipitation -Runoff Modeling System, Version 4: Updated Tables from Version 4.0.3 to Version 5.0.0, 2019; Markstrom, Niswonger, Regan, Prudic, & Barlow, 2008)

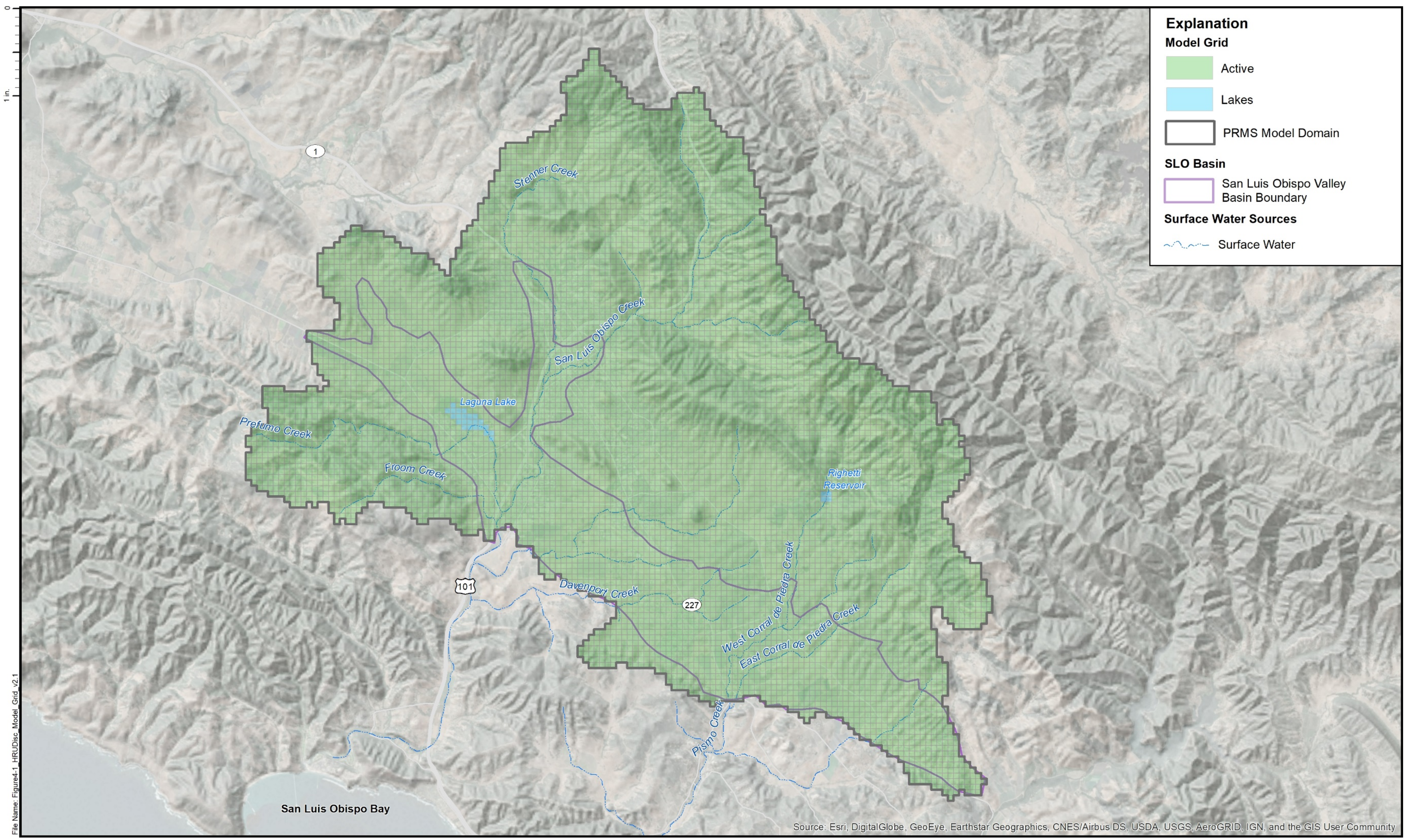
4.4. Calibration Approach

The PRMS model will be calibrated using the USGS Luca software (Hay & Umemoto, 2007) and a step-wise approach that includes the optimization of the following data sets: mean monthly solar radiation, mean monthly potential evapotranspiration, streamflow volume (annual mean, mean monthly, and monthly mean), and streamflow timing (daily and monthly mean). Simulated values and model outputs will be compared to calibration data sets generated from measured data. Data sets for solar radiation and potential evapotranspiration will be derived from measurements recorded at the Cal Poly CIMIS Weather Station 52. Calibration data sets for streamflow volume and timing will be derived from the CCSE and Questa Engineering Corps rating curves and measured stage data at the five County stream gages, as discussed in Section 4.2.2. The Madonna Road stream gage will be used for calibration of the integrated GSFLOW model but not for initial calibration of the PRMS model, as it is located downstream of Laguna Lake which will be modeled in MODFLOW using the Lake Package. The PRMS calibration simulation period will be based on the available stream gage data, which spans from July 2006 to August 2019.

Modeled and measured streamflow will be evaluated in the integrated model via comparison of daily and mean monthly hydrographs as well as using goodness-of-fit statistics. Goodness-of-fit statistics that will be considered for use include the percent-average-estimation-error (PAEE), the absolute-average-estimation-error (AAEE), and the Nash-Sutcliffe model efficiency (NSME). Table 4-2 presents the range of goodness-of-fit criteria as outlined for the Santa Rosa Plain Model (Woolfenden & Nishikawa, 2014). The optimal goal is to achieve calibration results within the "Very Good" or "Excellent" range, however, this may not be feasible at each stream gage location due to limitations associated with the accuracy of the rating curves and stream gage stage data.

Table 4-2. Goodness-of-fit Statistics

Goodness-of-fit Category	PAEE (%)	AAEE (%)	NSME
Excellent	-5 to 5	≤0.5	≥0.95
Very Good	-10 to -5 or 5 to 10	0.5 to 1.0	0.85 to 0.94
Good	-10 to -5 or 5 to 10	10 to 15	0.75 to 0.84
Fair	-10 to -5 or 5 to 10	15 to 25	0.6 to 0.74



Prepared for:

SAN LUIS OBISPO VALLEY BASIN GSP

Author: EC
Date: 12/18/2019

N

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0 0.75 1.5 3 Km

References:
1. Coordinate System: NAD 1983 StatePlane California V FIPS 0405 Feet
Projection: Lambert Conformal Conic
Datum: North American 1983
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Notes:
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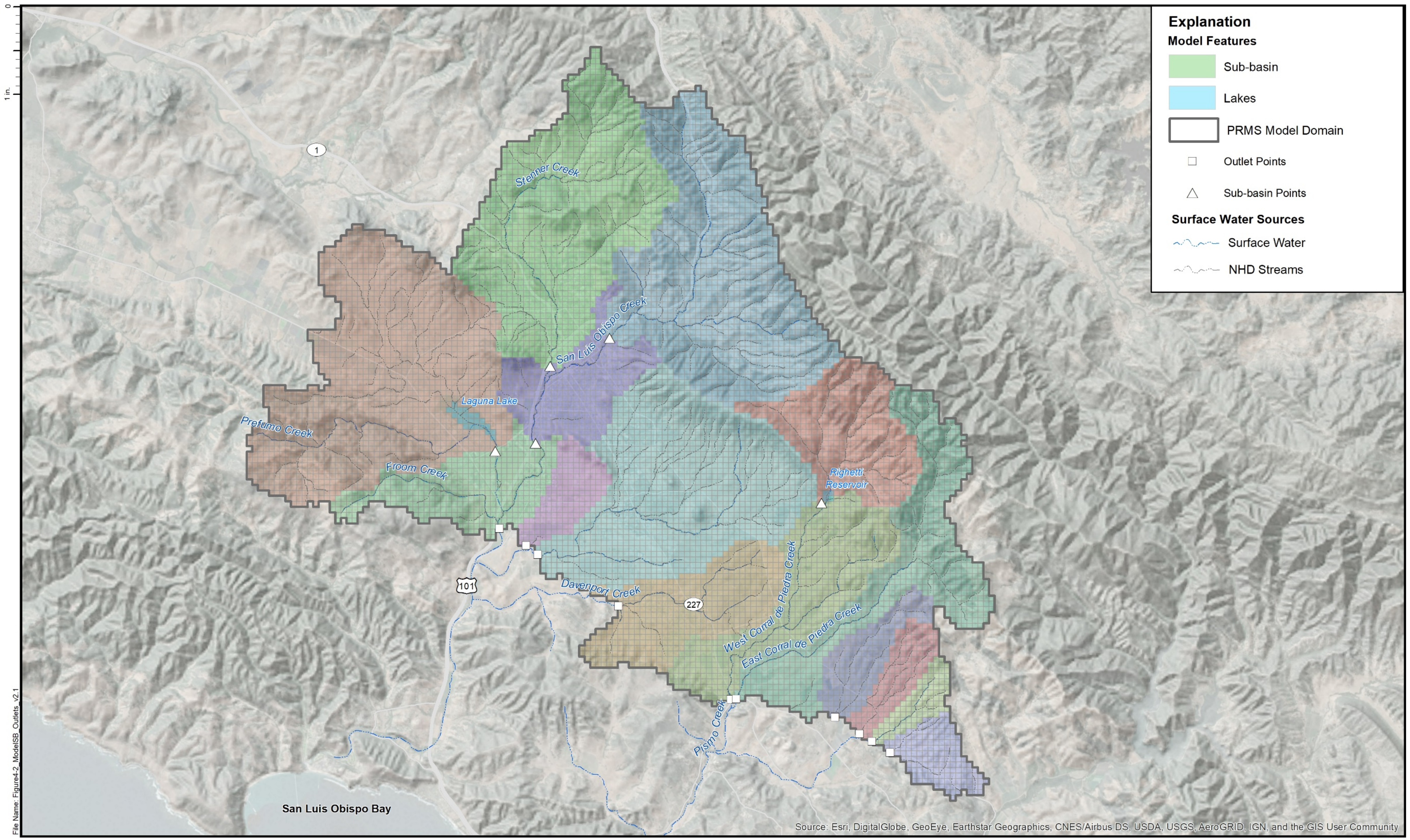
3.

HRU Discretization of Model Grid

Figure 4-1



Prepared for:

SAN LUIS OBISPO VALLEY BASIN GSP

Author: EC
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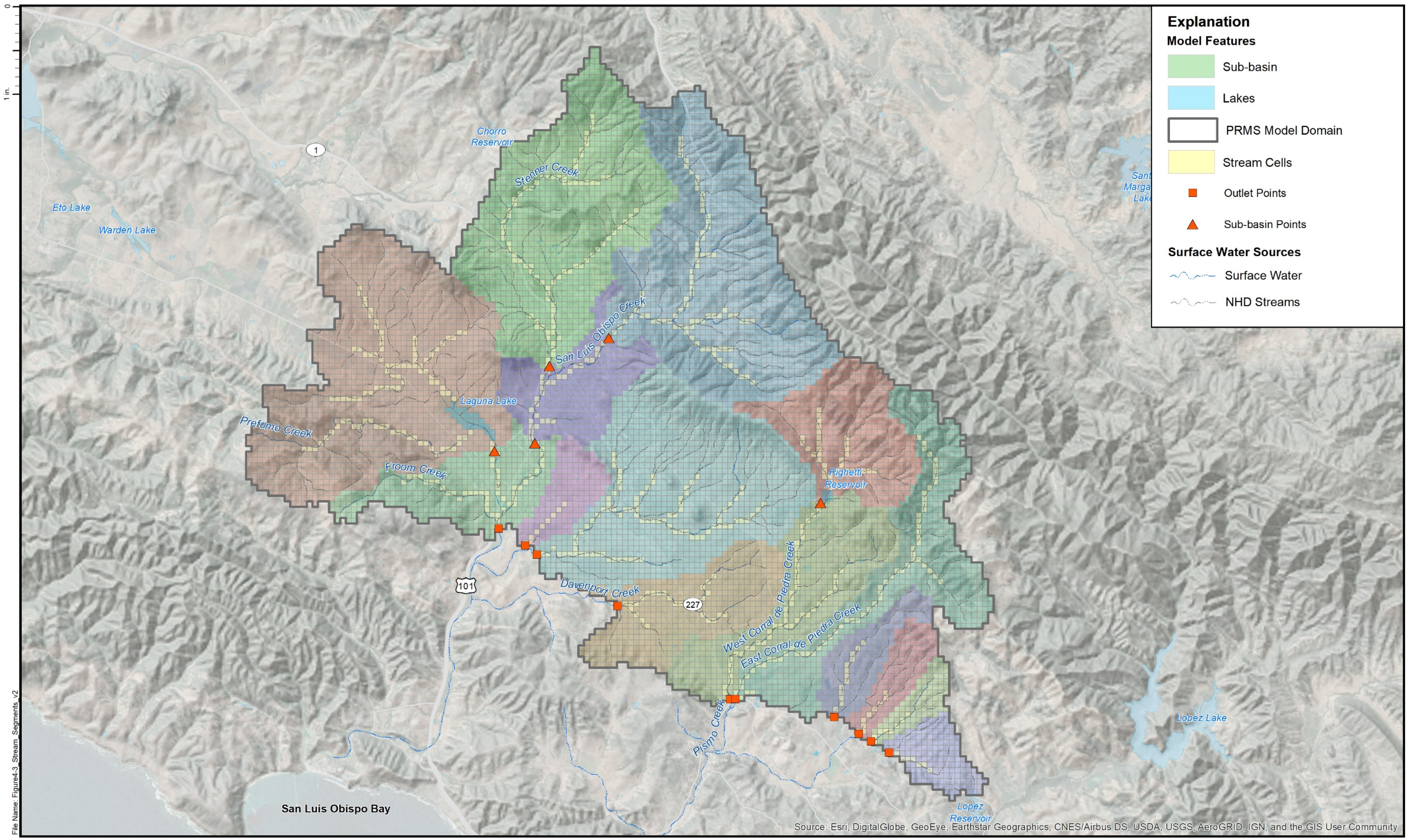
Model Sub-basins and Outlets

Figure 4-2



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1 in : 1.5 mi

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Datum: North American 1983
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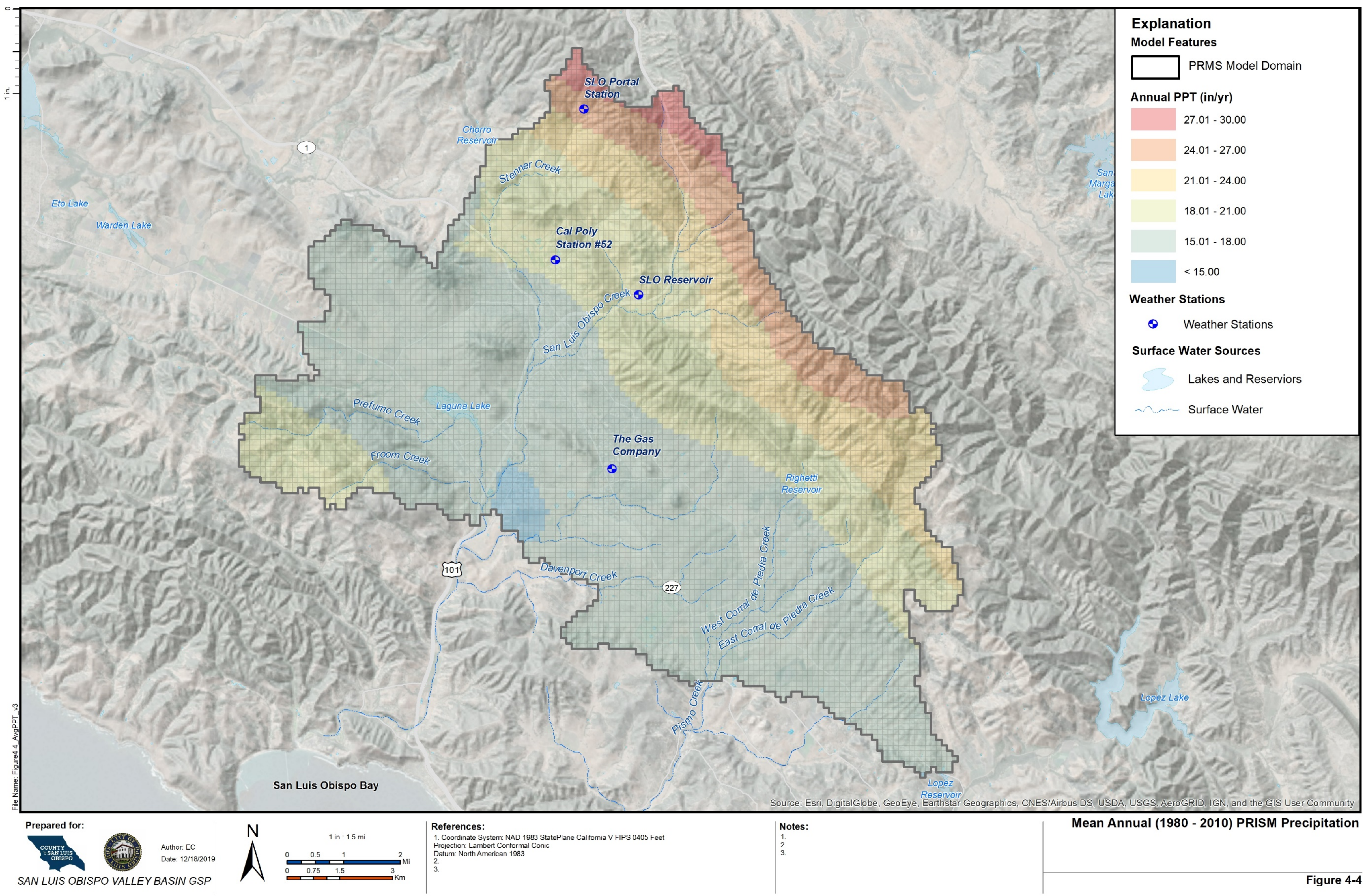
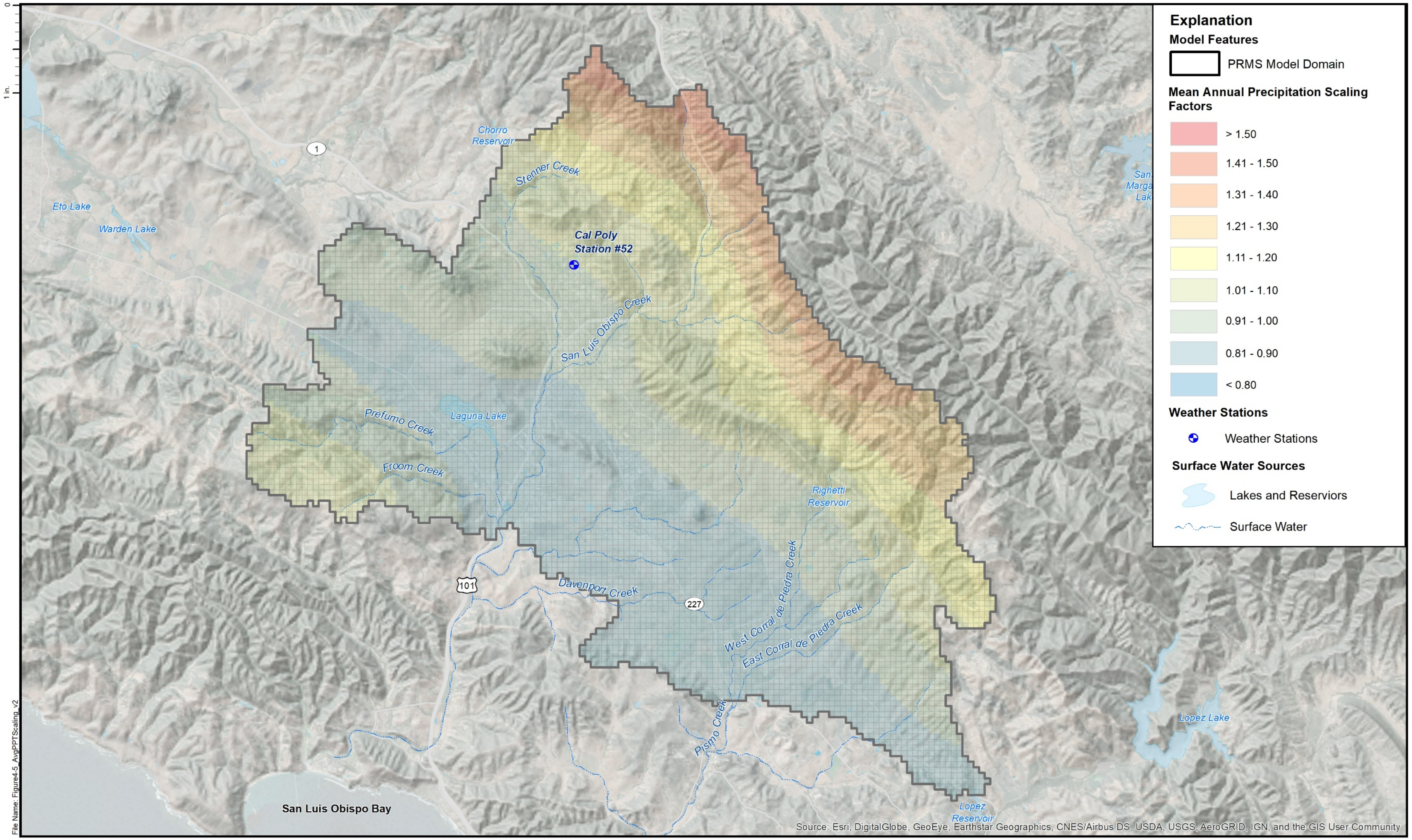
Model Stream Segments and Sub-basins

Figure 4-3



Mean Annual (1980 - 2010) PRISM Precipitation

Figure 4-4



Prepared for:

Author: EC
Date: 10/10/2019

SAN LUIS OBISPO VALLEY BASIN GSP

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References:
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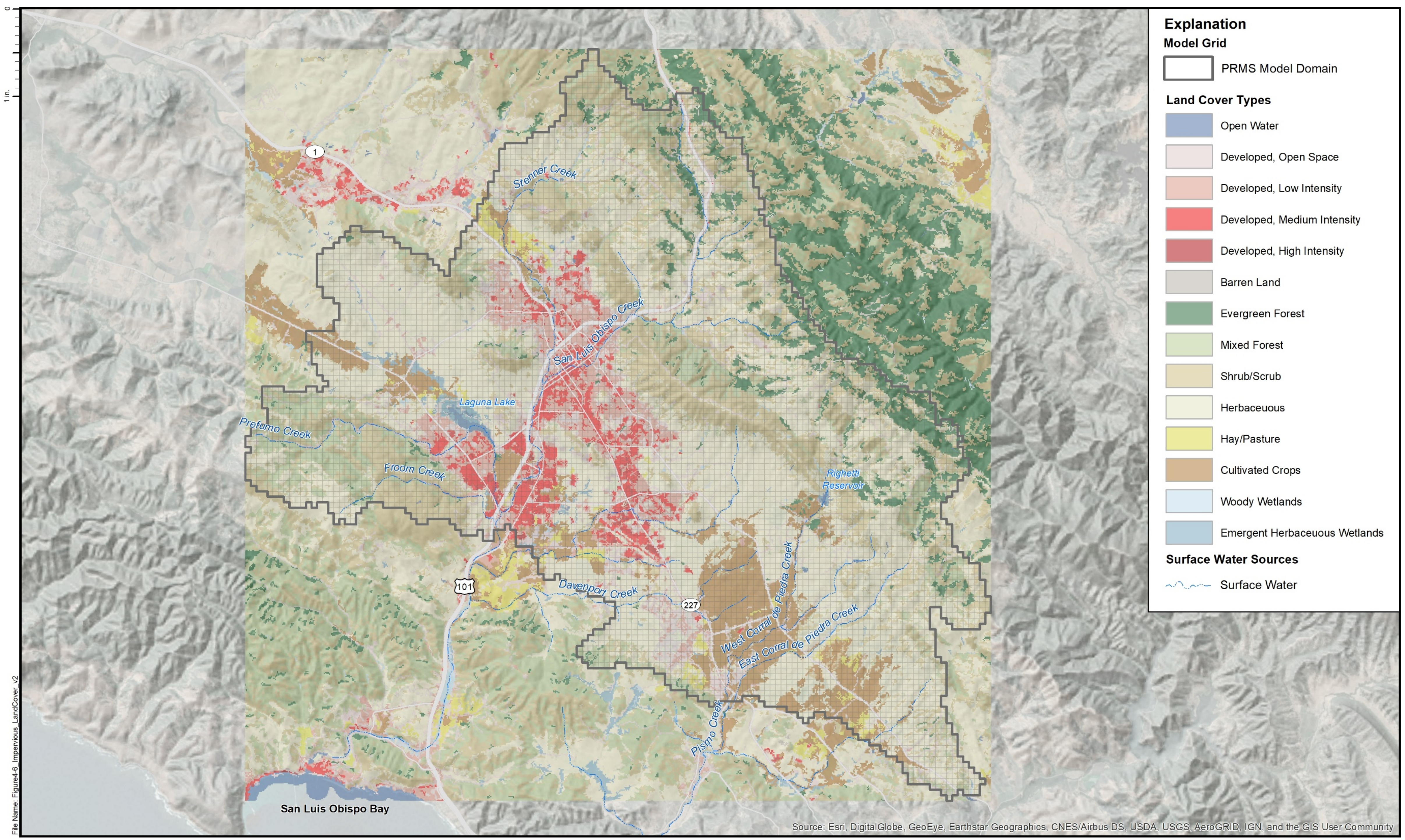
Mean Annual Precipitation Scaling Factors

Figure 4-5



Prepared for:

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Author: EC
Date: 12/18/2019

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References:
1. Coordinate System: NAD 1983 StatePlane California V FIPS 0405 Feet
Projection: Lambert Conformal Conic
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Land Cover Types

Figure 4-6

Section 5. MODFLOW: Groundwater Flow Model

MODFLOW is a publicly available groundwater modeling code developed by the USGS. It is the most used groundwater modeling code in the world and is considered an industry standard. MODFLOW-NWT is the most recent version of MODFLOW that is compatible with GSFLOW; this is the version of MODFLOW that is being implemented. This section of the TM summarizes the modeling approach for the MODFLOW portion of the GSFLOW model.

5.1. Model Discretization

Model grid discretization for the areas represented by both PRMS and MODFLOW were discussed in the previous discussion of PRMS model approach. A uniform grid cell size of 500 feet by 500 feet was adopted for model development.

Vertical discretization of the model (i.e., model layering) will be implemented based on the dominant geologic formations in the Basin (Figure 5-1). One layer each will be assigned to the Recent Alluvium, Paso Robles Formation, and Pismo Formation. In addition, because there are wells identified within the Basin that draw from both the Basin sediments and the underlying Monterey Formation bedrock, a fourth model layer will be added to represent undifferentiated bedrock (i.e., both Franciscan and Monterey Formation represented with a single layer) beneath the Basin, and extending up to the watershed boundaries.

5.1.1. Lateral Boundaries

Groundwater elevations at the northwest extent of the Basin where it bounds with the Los Osos Valley Basin, and at the southeast extent of the Basin where it bounds with the Arroyo Grande sub-basin, are assumed to be coincident with divides in the groundwater surface between the adjacent basins. These lateral boundaries of the Basin will be represented with Constant Head Boundaries (CHBs) with elevations assigned using the most accurate estimate of groundwater elevations in these areas that can be developed from available data.

5.1.2. Mountain Front Recharge

Groundwater elevations in the bedrock formations of the mountains surrounding the Basin are higher than the groundwater elevations within the Basin. Since groundwater flows from areas of higher head to areas with lower head, it is assumed that some amount of inflow to the Basin sediments occurs through the mechanism of mountain front recharge. Subsurface inflow to the Basin through mountain front recharge will be estimated as part of CHG's water budget analysis. It is not expected that this will comprise a significant portion of the Basin water budget. The estimates that will be generated for this component of inflow to the Basin will be represented using General Head Boundaries (GHBs) along the lateral boundaries of the Basin.

5.1.3. Recharge

In a traditional MODFLOW model, various components of recharge to the aquifer such as infiltration of precipitation, irrigation and municipal return flow, etc., are estimated and implemented into the model via the MODFLOW Recharge Package. With the integrated modeling approach provided by GSFLOW, these components of recharge are explicitly simulated using the physically-based processes simulated in PRMS, and the results are transmitted for use by MODFLOW in the groundwater flow simulations. Initial estimates of these recharge components will be made based on water budget analysis and calibration of the MODFLOW model to observed historical water levels. Refinement and revision of these estimates will occur during the combined calibration process using both PRMS and MODFLOW.

5.1.4. Infiltration of Streamflow

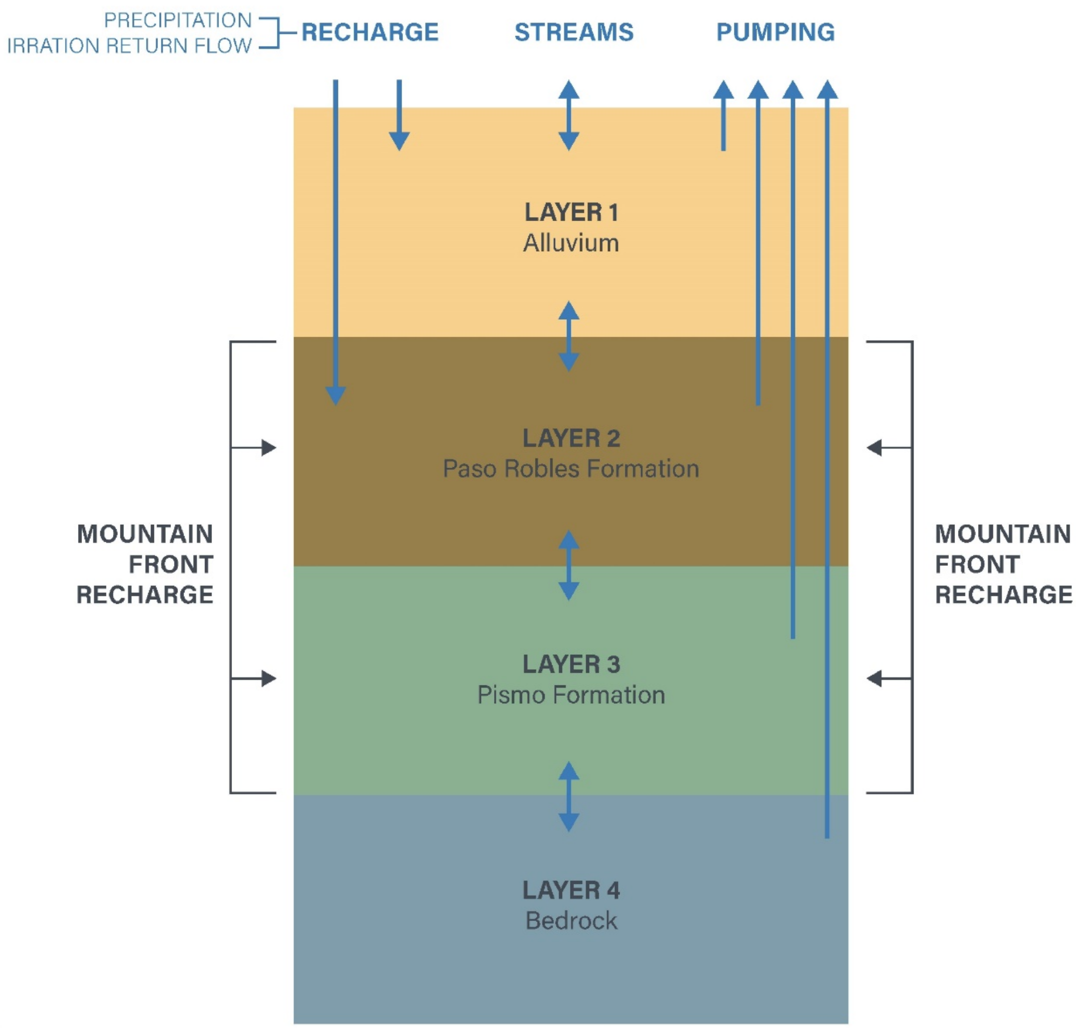
As discussed previously, seasonal infiltration of streamflow to the underlying aquifers is a significant component of the Basin water budget. Streamflow processes within the Basin will be represented using the Streamflow Routing packages available in MODFLOW (SFR and SFR2). Estimates of streamflow infiltration into the underlying aquifers in the Basin provided by the CHG water budget analysis and by previous studies will be used as general guides during historical calibration. Parameters of the SFR package will be adjusted until the quantities of flux between the streams and the aquifers are consistent with the available data.

5.1.5. Well Pumpage

CHG estimates of historical well pumpage developed for the water budget analysis will be incorporated into the historical calibration of the groundwater model. Municipal pumpage by the City will be represented in the specific wells owned and operated by the City. For representation of agricultural pumpage in MODFLOW, there is often not adequate information on well location or pumpage amounts to attempt to explicitly represent pumpage from individual wells. A common approach is to spread estimated agricultural pumping amounts over the entire area of irrigated fields. GSI anticipates that given the amount of data available on well locations in the irrigated areas of the Basin and estimates of historical agricultural pumpage generated by CHG's water budget analysis, it may be feasible to apply irrigation pumpage to specific wells located within the irrigated field areas. Pumpage from de minimis well owners will be estimated based on County data and spread across the areas where the wells are located; no effort to identify specific de minimis wells will be made.

5.2. Calibration Approach

As discussed previously, PRMS and MODFLOW may be run separately during the early stages of model development. It is anticipated that GSI will conduct initial parameter estimation using a long-term historical simulation in MODFLOW-only mode, prior to and separate from the PRMS initial calibration. Because PRMS must be run using daily time steps, it is not necessarily the most efficient tool to perform a long-term simulation to generate initial parameter estimates. Evaluation of the hydrographs in Figure 2-7 indicate that water levels were in approximate equilibrium prior to 1980. The drought of the late 1980s and early 1990s is clear in the hydrographs of some of these wells. In addition, water level declines in Edna Valley wells beginning in the 1990s is evident. In order to capture these significant trends in water levels over the years, the initial parameter estimation of the MODFLOW model will be performed to simulate the 40-year period from 1980 to 2019 using quarterly or monthly stress periods, before the MODFLOW and PRMS models are combined for the integrated model. Annual values provided by the CHG water budget analysis will be used to guide model inputs for such model parameters as pumping and recharge. Aquifer hydraulic properties such as transmissivity and storativity will be varied within ranges indicated by available data (GSI 2018). After the initial parameter estimates of the groundwater flow model are complete, the MODFLOW model will be combined with the PRMS model to perform a joint calibration in which the points of contact between the surface water model and the groundwater flow model are adjusted over the calibration period. All the hydrographs displayed in Figure 2-7 will be used as calibration targets for the MODFLOW model. A commonly referenced metric for groundwater model calibration is to achieve a scaled root mean square error less than 10% for water level calibration targets. GSI and WSC will attempt to meet this calibration standard for modeled groundwater elevations.



Prepared for:

SAN LUIS OBISPO VALLEY BASIN GSP

Author: EC
Date: 10/15/2019

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Model Layering and Hydrologic Conceptual Model

Figure 5-1

Section 6. Summary and Next Steps

This TM has presented the data summary, HCM, and anticipated modeling approach for the development of an integrated surface water-groundwater model of the SLO Basin and its contributing watersheds. After approval by the GSA staff, the next step is to perform calibration of the model, discussed in Section 5.2. After separate initial runs of PRMS and MODFLOW are completed, the two models will be joined in GSFLOW, and a combined calibration will be implemented in which parameters of both models will be adjusted to achieve a good fit between observed and modeled water levels, stream flow, and other water budget components.

After calibration of the integrated model is completed, a sensitivity analysis will be performed. The purpose of a sensitivity analysis to identify parameters or boundary conditions to which model forecasts are particularly sensitive. Sensitivity analysis provides a measure of the influence of parameter uncertainty on model predictions. During the sensitivity analysis, key model input parameters and boundaries (such as pumping, recharge, transmissivity, etc.) are systematically varied on the calibrated model simulation, and the resulting impact on the modeled heads are quantified. Calibration and sensitivity analyses will be documented in a separate Technical Memo.

After the completion of the sensitivity analysis, if the model is judged to be adequate for the purposes of the GSP, it will be used to run predictive scenarios simulating projects and management actions to be specified by the GSAs. When the predictive scenarios are complete, an uncertainty analysis will be performed. The purpose of the uncertainty analysis is to identify the impact of parameter uncertainty on the use of the model's ability to effectively support management decisions. This can inform the interpretation of the model results to identify high priority locations for recharge projects, expansion of monitoring networks, and other management actions. The uncertainty analysis is like the sensitivity analysis in that key model parameters are systematically varied and resultant impacts on modeled heads are quantified. However, the uncertainty analysis is performed on the predictive scenario runs rather than the calibration simulation.

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Reviewed by: Michael Cruikshank, PG, CHG

Project: SLO Basin Groundwater Sustainability Plan

Subject: **Draft** Surface Water/Groundwater Modeling Calibration Technical Memorandum (Modeling TM No.2)

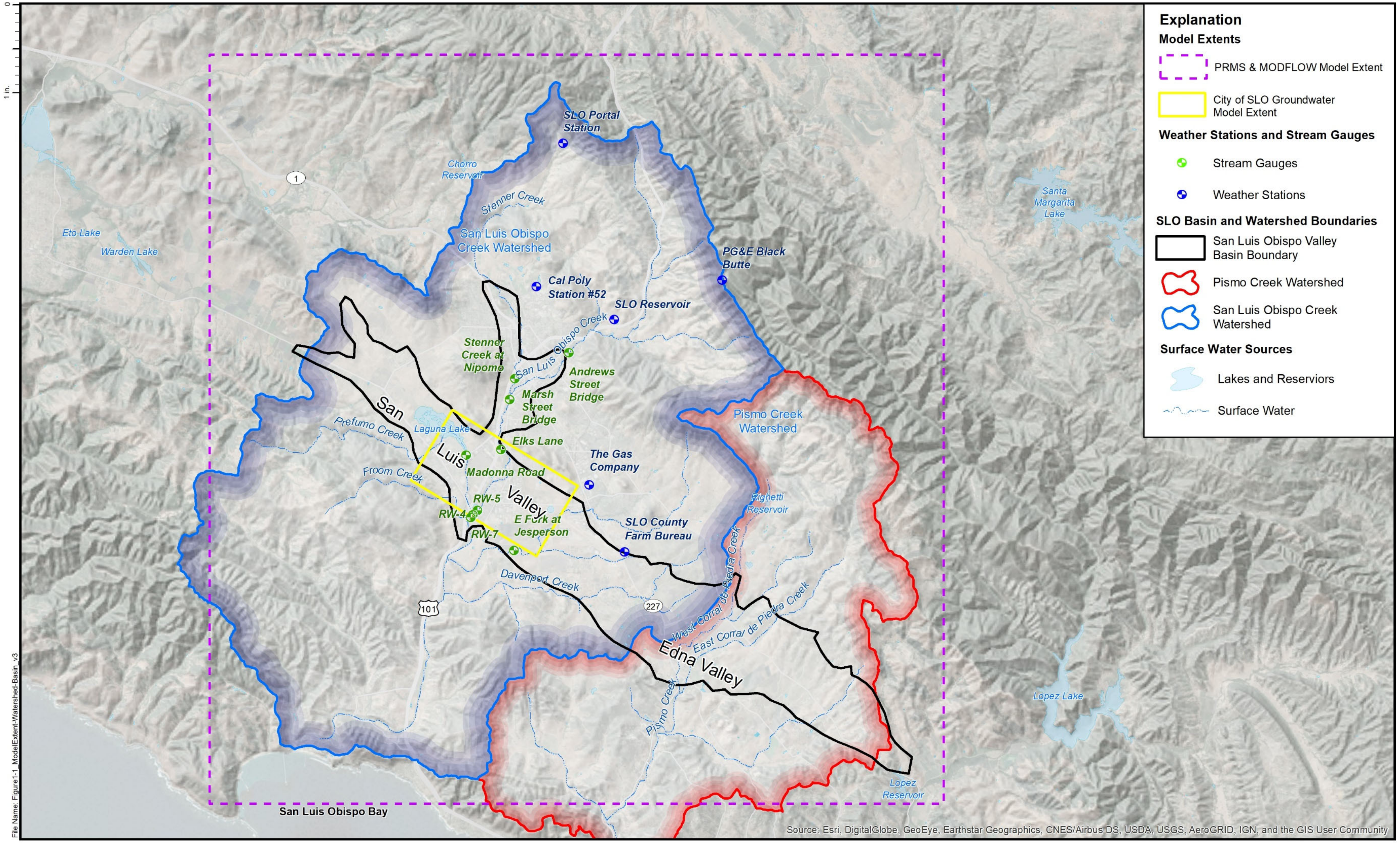
Section 1. Introduction

This draft Technical Memo (TM No.2) is prepared by Water Systems Consulting, Inc. (WSC) and GSI Water Solutions, Inc. (GSI), for the San Luis Obispo (SLO) County Groundwater Sustainability Agency (GSA) and the City of SLO GSA. As part of the Groundwater Sustainability Plan (GSP) for the SLO Valley Groundwater Basin (Basin), the consultant team is developing an integrated surface water-groundwater numerical model for the objective of evaluating the potential impacts of proposed projects and management actions associated with the GSP. The objective of this TM is to document the modeling calibration associated with the construction of the integrated numerical model of the Basin.

The Basin covers approximately 20 square miles in central San Luis Obispo County (County). The Basin extents are defined as the contact of water-bearing sediments with the non-water-bearing Formations of the Santa Lucia Range to the northeast, and the San Luis Range and the Edna Fault Zone to the southwest. Annual average precipitation in the Basin is approximately 18 to 22 inches (GSI Water Solutions, Inc., 2018). The Basin is commonly divided into two sub-areas: the San Luis Valley and the Edna Valley. The San Luis Valley occupies approximately the northwestern half of the Basin; it includes the City of San Luis Obispo (City), and the primary land uses are municipal and industrial. Most water supply in the San Luis Valley is from both in-basin groundwater sources and imported surface water sources (Whale Rock Reservoir, Salinas Reservoir, and Nacimiento Reservoir). The Edna Valley occupies the southeastern half of the Basin. The primary land use is agriculture, with wine grapes as the dominant crop type. Groundwater is the major source of water supply in the Edna Valley.

To date, a watershed scale groundwater or integrated surface water-groundwater model has not been published for the entire Basin. In 1997, the California Department of Water Resources (DWR) performed initial work on a basin groundwater model, but the model was never published. A groundwater model was developed within a portion of the Basin that encompasses the San Luis Valley (the City of SLO model) (Cleath-Harris Geologists, 2018) and a surface water hydraulic model has been developed for the San Luis Obispo Creek watershed (Questa Engineering Corp., 2007). Figure 1-1 shows the watershed and Basin boundaries, and the integrated model grid.

GSI developed a TM to evaluate multiple integrated surface water-groundwater modeling systems and identified the best modeling system to achieve compliance and project objectives for the SLO GSP (GSI Water Solutions, Inc., 2019). GSFLOW, a fully integrated hydrologic model (IHM) developed by the United States Geological Survey (USGS) (Markstrom, Niswonger, Regan, Prudic, & Barlow, 2008), was recommended to the GSP Groundwater Sustainability Commission (GSC) to be selected as the model system to be used for the GSP. In this TM, we will present the calibration process and results for the surface water model (PRMS) and groundwater model component (MODFLOW) that were completed separately before being coupled in the GSFLOW integrated model. Preliminary calibration and results from the GSFLOW calibration are also discussed. This TM will conclude with next steps to be completed that includes GSFLOW sensitivity analysis describing the most sensitive parameters that influence results of the GSFLOW model and if any data is needed to be improved upon and model validation runs will be completed at the end of 2025 as part of the 5-year GSP update.



Prepared for:

SAN LUIS OBISPO VALLEY BASIN GSP

Author: EC
Date: 2/18/2020

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References:
1. Coordinate System: NAD 1983 StatePlane California V FIPS 0405 Feet
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Model Extents, Watershed, and Basin Overview

Figure 1-1

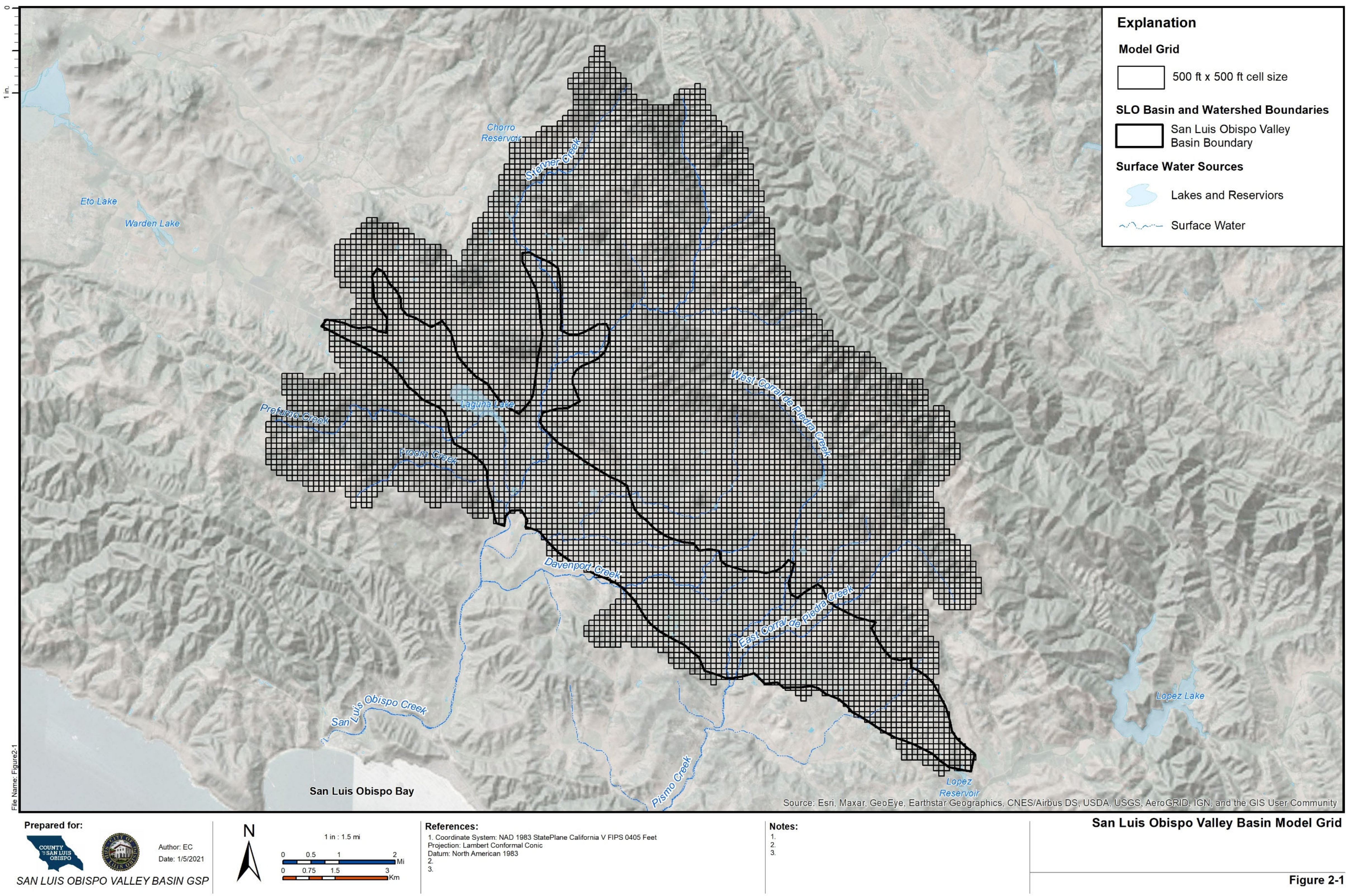
Section 2. Surface Water Model Development

The Basin surface water model was developed using the Precipitation-Runoff Modeling System (PRMS) version 5.0.0 which simulates the watershed-scale surface water component of the GSFLOW integrated model. PRMS is a deterministic, distributed-parameter, physical-process hydrologic model used to simulate and evaluate the watershed response of various combinations of climate and land use (Markstrom, et al., PRMS-IV, the Precipitation-Runoff Modeling System, Version 4, 2015).

In the PRMS model, climate data, including precipitation, temperature, and solar radiation, are applied to simulate hydrologic water budgets based on spatially defined watershed-component model parameters such as plant canopy and soil zone properties. Surface and subsurface flow is calculated through the cascading of rain-generated runoff. When run in PRMS-only mode, runoff that infiltrates into the soil zone is distributed to the subsurface reservoir and groundwater reservoir where it can interflow to streams or lakes. When run in a coupled GSFLOW simulation, groundwater flow routing is simulated in MODFLOW rather than PRMS. Initial parameter estimation of the PRMS model was performed in PRMS-only mode prior to integration into GSFLOW and final calibration of the integrated model for water year (WY) 1985 - 2019. The calibration period for the surface water model was WY 2006 – 2019 based on the available surface water data sets.

2.1. Model Grid

The surface water model was developed to cover the entire Basin watershed. The model grid cell was determined by evaluating various grid cell sizes ranging from 250-ft to 1,000-ft. The ratios of cell size to watershed size were assessed in comparison to other GSFLOW models, including the Santa Rosa Plain Model (Woolfenden & Nishikawa, 2014) and the Santa Cruz Mid-County Basin Model prepared by HydroMetrics Water Resources, Inc. (Huntington, King, & Tana, 2016). It was determined that 500-ft by 500-ft model grid would be an appropriate grid cell size to discretize the model over the watershed area (Figure 2-1).



San Luis Obispo Valley Basin Model Grid

Figure 2-1

2.2. Datasets and Sources

The data used in the surface water model to develop and calibrate PRMS are described in the following sections.

2.2.1. Climate Data

The climate data sources within the Basin include two weather stations, Cal Poly #52 and SLO Reservoir[1](shown in Figure 1-1) and Parameter-Regression on Independent Slopes Model (PRISM) data (Table 2-1) were used in the surface water model calibration.

Table 2-1: Climate data used for surface water model.

Climate Data Source	Date Range	Precipitation (in)[A]	Date Range	Temperature (F)[B]	Date Range	Evapotranspiration (in)[C]	Date Range	Solar Radiation (Ly/day)[C]
Cal Poly #52*	1870 - 2019	YES	1906 - 2019	YES	1986 - 2019	YES	1986 - 2019	YES
SLO Reservoir	2005 - 2019	YES	-	-	-	-	-	-
PRISM	1981 - 2010	YES	1981 – 2010	YES	-	-	-	-

* - Weather station contains sensors from ITRC, CIMIS, and NOAA

A - Daily precipitation record starts 2/1/1893
B - Daily temperature record starts 4/1/1906
C - Daily evaporation and solar radiation record starts 4/2/1986

PRISM data spatially distributes precipitation and temperature to account for orographic effects due to elevation change. The 800m mean monthly precipitation and minimum and maximum temperature values from 1981 to 2010 from the Parameter-Regression on Independent Slopes Model (PRISM) (NACSE, 2019) were used in the surface water model. Monthly precipitation scaling factors and daily minimum and maximum temperature were calculated at each HRU using GSFLOW-ArcPy scripts developed by Gardner

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[1] The Irrigation Training & Research Center (ITRC) noted in a technical memorandum dated April 22nd, 2014 that the data recorded between 2006 – 2010 was not correct due to maintenance issues and corrections are recommended using the SLO Reservoir weather station precipitation values. Precipitation and temperature data records were corrected by the consultant using their professional judgement according to this recommendation by the ITRC to produce a consistent measures climate dataset for use in the surface water model.

et al., 2018. The precip_1sta and temp_sta modules were used to perform precipitation and temperature calculations as described above.

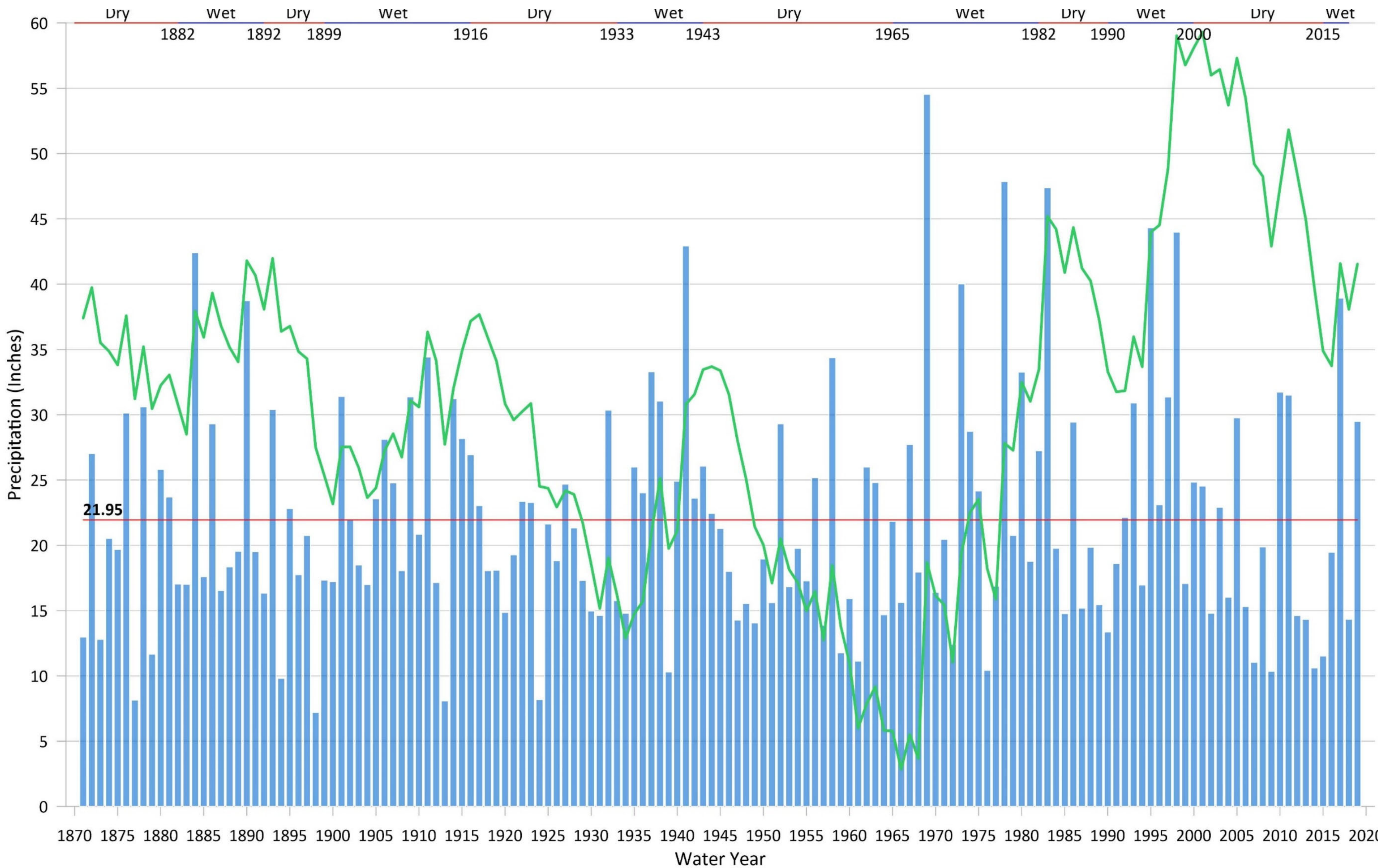
Figure 2-2 shows the measured Cal Poly #52 precipitation data from1870 to 2018 as well the approximated wet-dry years as interpreted from the calculated cumulative departure from the mean (CDFM) line.

2.2.2. Potential Evapotranspiration Data

Potential evapotranspiration (PET) for natural vegetation and irrigated crops was computed by the PRMS model based on air temperature, solar radiation, and two Jensen-Haise formula coefficients using the Jensen-Haise method (Jensen and Haise, 1963). Annual PET data for reference crops are available from CIMIS and specific evapotranspiration data for different crop types within the Basin are available from DWR. The actual evapotranspiration was calculated in the model from the PET data while also considering land use, vegetation type, soil type, and available soil moisture.

2.2.3. Topography

A 10-m USGS digital elevation model (DEM) was used to determine the slopes, connectivity, and elevations within the watershed area. The DEM was processed using the GSFLOW-ArcPy scripts (Gardner et al., 2018) that utilize the USGS Cascade Routing Tool (Henson et al., 2013) to define the cascading surfaces and subsurface flow paths for the grid-based domain. As part of the CRT calculation, unintentional swales (low-lying areas) are smoothed to provide continuous down-sloping HRUs. After these calculations have been completed, we found not all unintentional swales were adequately smoothed and, in these areas, manual modifications were made to provide continuous down-sloping HRUs. Figure 2-3 presents the 10-m DEM used for the surface water model.



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01/18/2021

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Legend

Precipitation (Annual)

CDFM

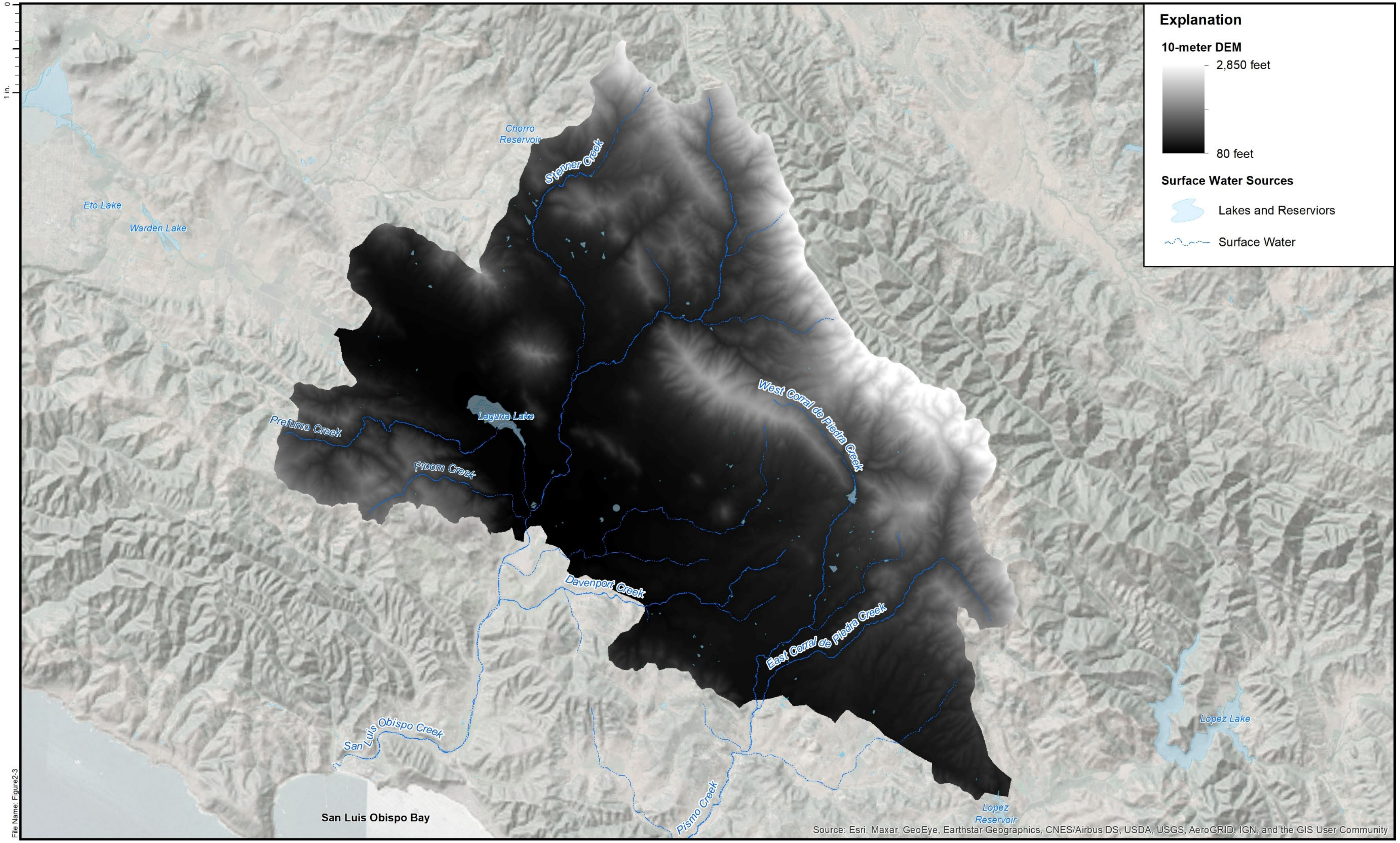
Historical Average Precipitation

Notes:

1. Data Source: Cal Poly State University, Cal Poly/NOAA Station

San Luis Obispo Historical Annual Precipitation and CDFM

Figure 2-2



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Date: 1/18/2021

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Notes:
1. 10-meter DEM obtained from USGS Seamless Dataset
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San Luis Obispo Valley Basin Watershed 10-meter Digital Elevation Model (DEM)

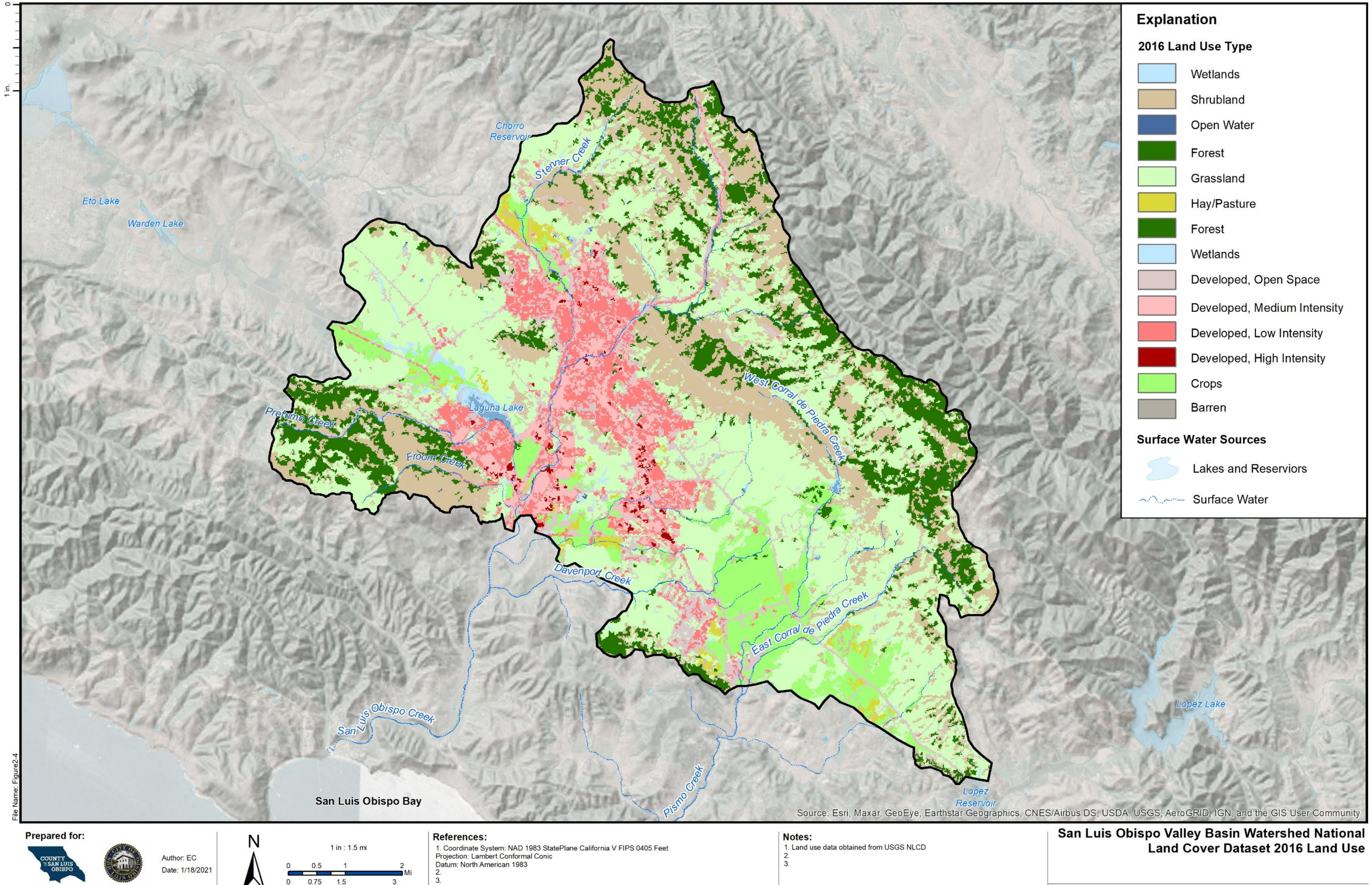
Figure 2-3

2.2.4. Land Use

Soil attributes based on the National Resources Conservation Service (NRCS) soil survey data (SSURGO and STATSGO) are assigned to HRUs and are used by various soil parameters in PRMS to model flux's between vegetation and the soil-root zone. SSURGO data didn't fully extend across the entire watershed and STATSGO data was used in the northeast portion of the watershed in the Santa Lucia Mountains to provide full soil data coverage.

Land use was fixed in the PRMS baseline model to provide a starting point for comparison for future model scenarios. The National Land Cover Dataset (Homer, Fry, & Barnes, 2012) is a grid-based representation of land uses in the watershed and was used as a base land use layer. DWR spatial crop data from 2014 and U.S. Forest Service (USFS) Landfire dataset were used in conjunction with the NLCD dataset to provide a more detailed characterization of land cover and use. The land cover percentages are assigned to each HRU and is used to model flux's between vegetation and the soil root-zone and in the case of impervious land cover areas, no infiltration that would lead to surface runoff. Figure 2-4 through 2-7 presents the NLCD land use, DWR crop, and Landfire vegetation datasets used for the surface water model.

Imperviousness of each grid was determined from the NLCD 2016 dataset (Figure 2-8). Visual comparisons between NLCD 2001 and NLCD 2016 data indicate minimal changes in the watershed. The average imperviousness of the watershed in 2001 was 31.6% and shifted slightly to 34% in 2016. Imperviousness as a percentage of the total watershed area in 2001 was 16.4% and shifted slightly to 17.1% in 2016. As such, use of the 2016 data was determined to be representative of the modeling period.



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1. Coordinate System: NAD 1983 StatePlane California V FIPS 0405 Feet
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1. Land use data obtained from USGS NLCD
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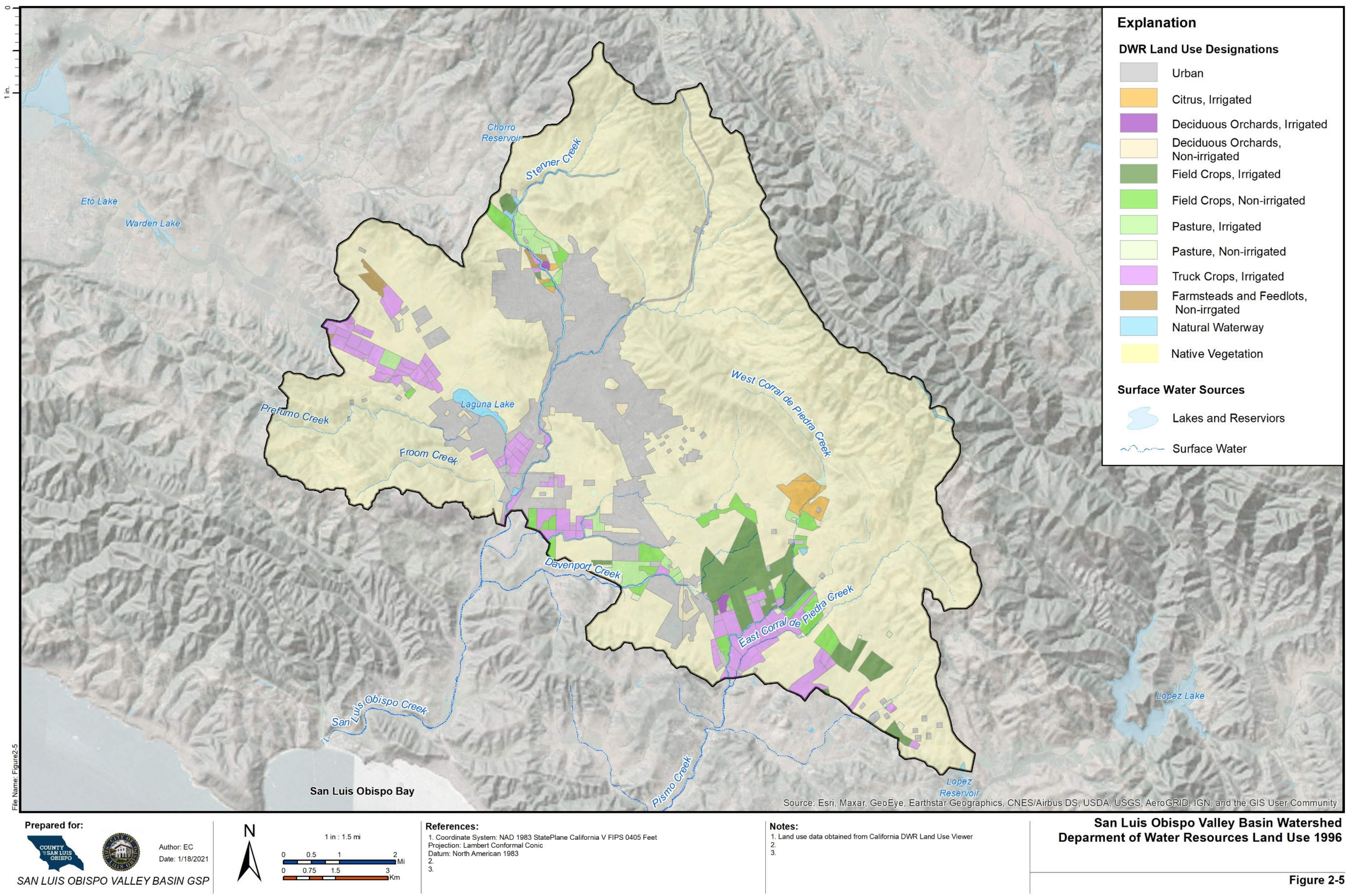
San Luis Obispo Valley Basin Watershed National Land Cover Dataset 2016 Land Use

Figure 2-4


Explanation
DWR Land Use Designations
Urban
Citrus, Irrigated
Deciduous Orchards, Irrigated
Deciduous Orchards, Non-irrigated
Field Crops, Irrigated
Field Crops, Non-irrigated
Pasture, Irrigated
Pasture, Non-irrigated
Truck Crops, Irrigated
Farmsteads and Feedlots, Non-irrgated
Natural Waterway
Native Vegetation
Surface Water Sources
Lakes and Reserviors
Surface Water
Chorro Reservoir
Stenner Creek
Eto Lake
Warden Lake
Laguna Lake
Prefumo Creek
Froom Creek
West Corral de Piedra Creek
Davenport Creek
East Corral de Piedra Creek
San Luis Obispo Creek
Pismo Creek
Lopez Lake
Lopez Reservoir
San Luis Obispo Bay
Source: Esri, Maxar, GeoEye, Earthstar Geographics, CNES/Airbus DS, USDA, USGS, AeroGRID, IGN, and the GIS User Community
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Author: EC
Date: 1/18/2021
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Notes:
1. Land use data obtained from California DWR Land Use Viewer
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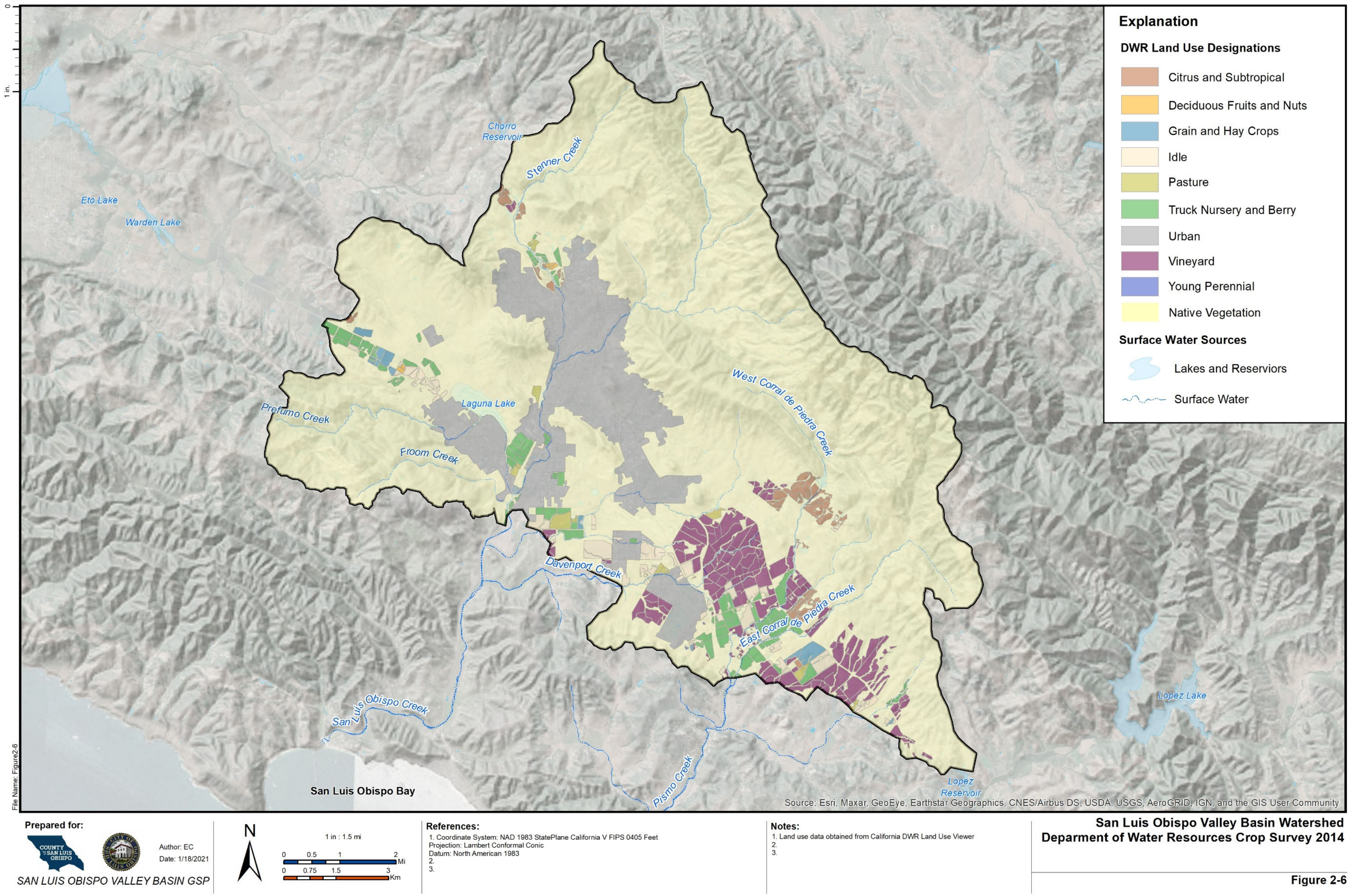
San Luis Obispo Valley Basin Watershed
Deparment of Water Resources Land Use 1996
Figure 2-5



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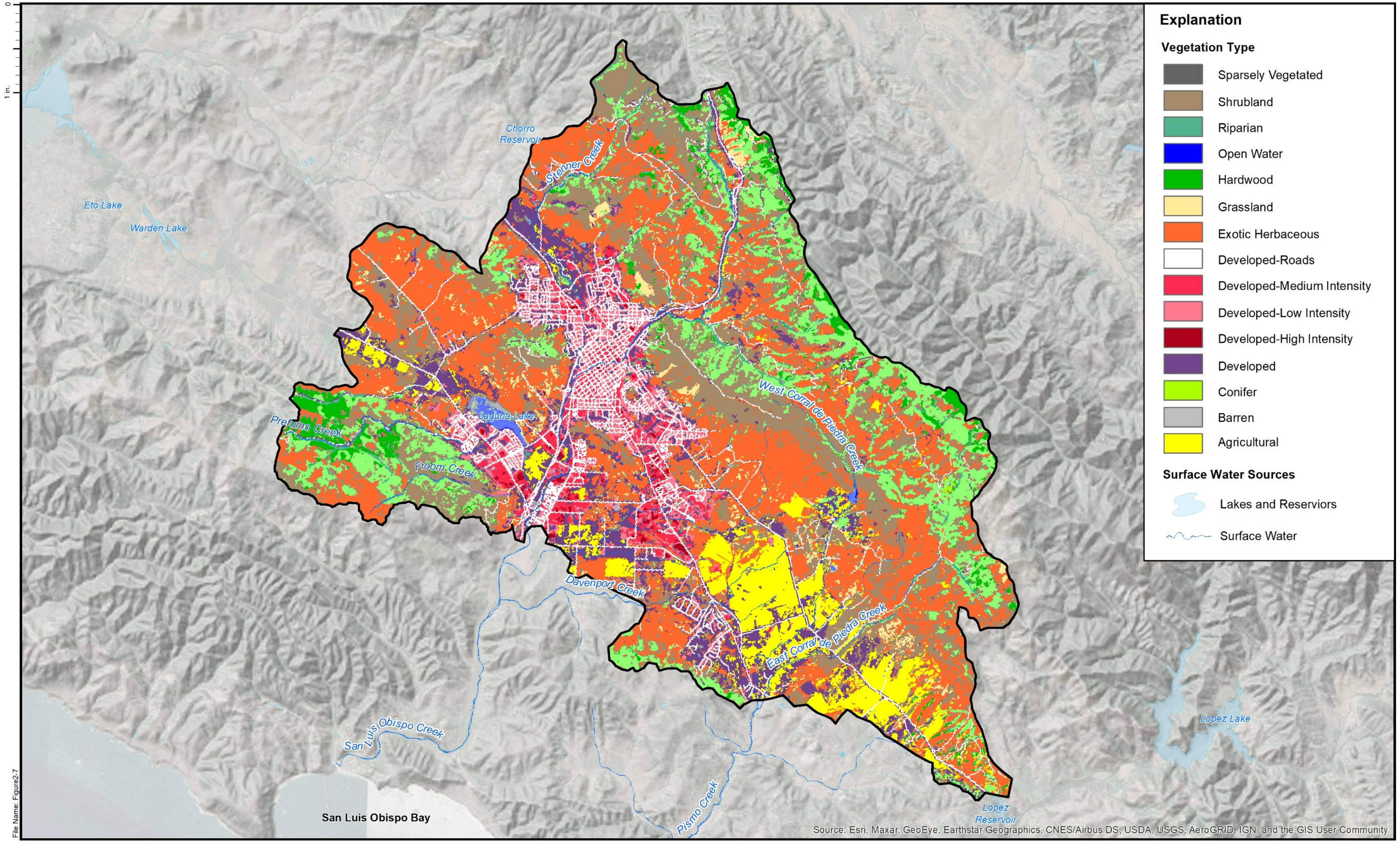
San Luis Obispo Valley Basin Watershed
Deparment of Water Resources Crop Survey 2014

Figure 2-6



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Date: 1/18/2021

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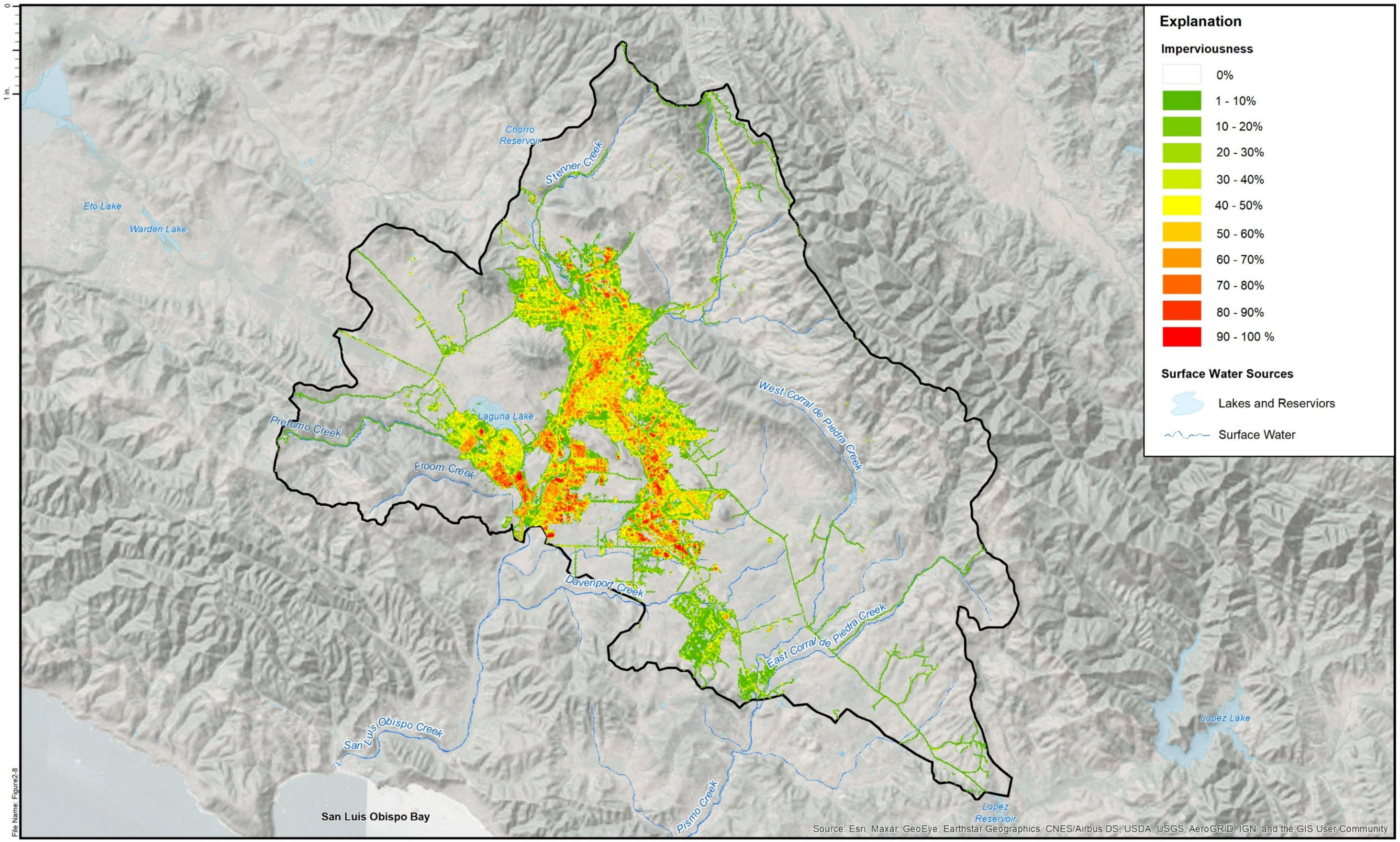
0 0.75 1.5 3 Km

References:
1. Coordinate System: NAD 1983 StatePlane California V FIPS 0405 Feet
Projection: Lambert Conformal Conic
Datum: North American 1983
2.
3.

Notes:
1. Vegetation type data retrieved from 2016 USFS LANDFIRE dataset
2.
3.

San Luis Obispo Valley Basin U.S. Forest Service 2016 LANDFIRE

Figure 2-7



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Author: EC
Date: 1/18/2021

SAN LUIS OBISPO VALLEY BASIN GSP

N

1 in : 1.5 mi

0 0.5 1 2 Mi
0 0.75 1.5 3 Km

References:

1. Coordinate System: NAD 1983 StatePlane California V FIPS 0405 Feet
Projection: Lambert Conformal Conic
Datum: North American 1983
2.
3.

Notes:

1. Imperviousness data obtained from USGS NLCD
2.
3.

San Luis Obispo Valley Basin National Land Cover Dataset 2016 Imperviousness

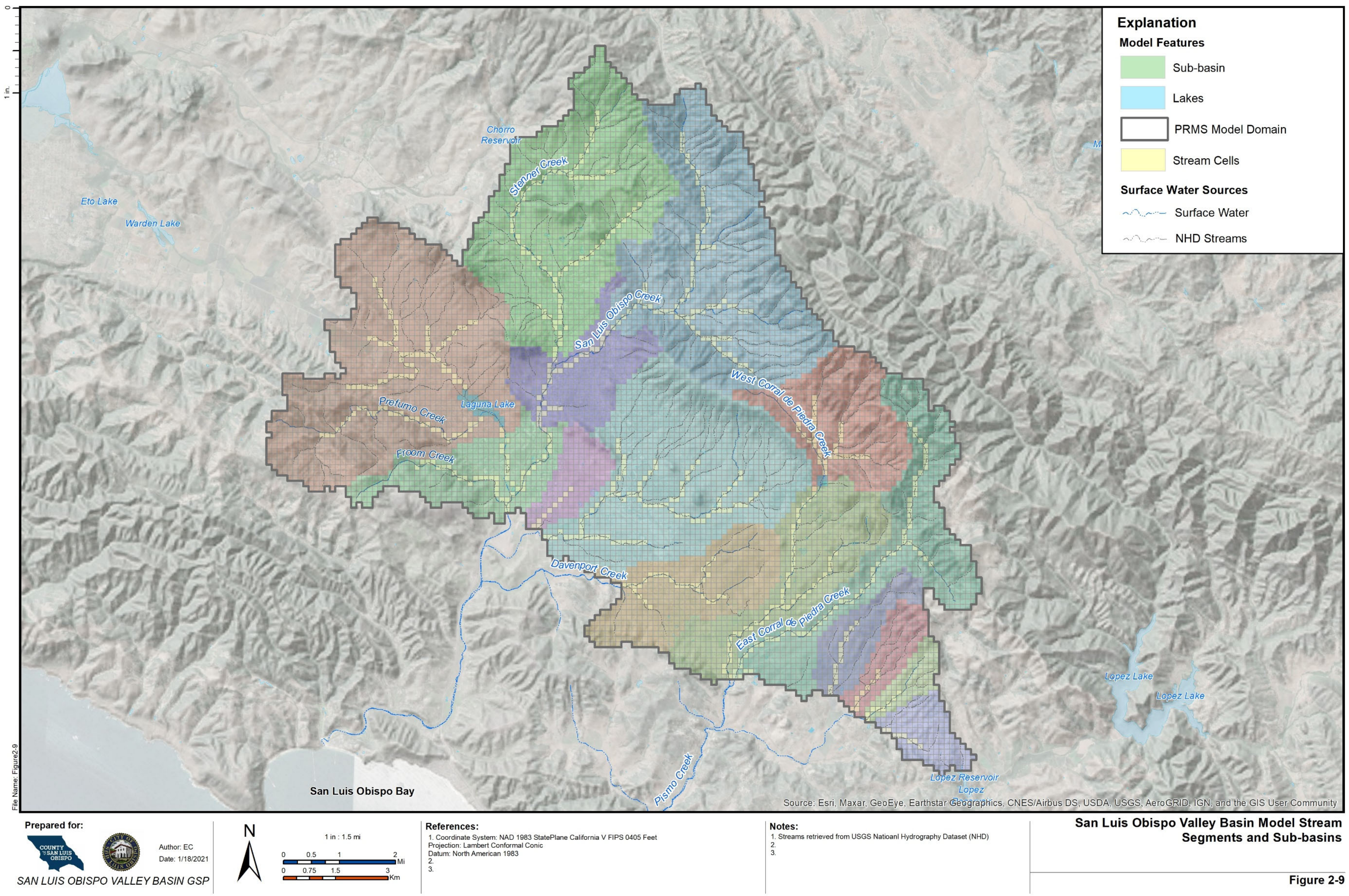
Figure 2-8

2.2.5. Irrigation

Irrigation within the Basin wasn't directly incorporated into the PRMS model. Changes in irrigation will be evaluated and incorporated in the GSFLOW model as part of the calibration process to provide the water budget fluxes necessary for modeled scenario evaluations.

2.2.6. Stream Network

Streamflow and routing are handled in MODFLOW using the SFR package once PRMS is coupled in MODFLOW. Before integrating in GSFLOW, PRMS requires streamflow routing to be completed. The PRMS stream network is delineated by assigning mean surface elevations to each HRU grid cell within the watershed using the watershed 10-m DEM as described in *Topography* from the National Elevation Dataset (National Elevation Dataset, 2019).The mean elevations are then used by the GSFLOW-ArcPy scripts to designate the stream segments locations by creating continuously down-sloping HRUs. Generated stream segments were viewed in comparison to USGS National Hydrography Dataset (NHD) streams in ArcMap (National Hydrography Dataset, 2002 - 2016) and recent satellite imagery from Google Earth to evaluate the accuracy of the stream delineation. Stream segment alignments were iteratively adjusted by manually altering the mean elevation of HRUs and rerunning the GSFLOW-ArcPy scripts. The level of detail with regards to stream order was optimized to be representative of the main branches and the primary tributaries. Figure 2-9 presents the stream segments generated for the PRMS model.



San Luis Obispo Valley Basin Model Stream Segments and Sub-basins

Figure 2-9

2.2.7. Streamflow Gages

The County of San Luis Obispo owns and operates five real-time data monitoring stream gages along San Luis Obispo Creek and its tributaries, within the model domain (Figure 2-10). Table 2-2 provides a summary of the streamflow data available for each stream gage. Each gage station records creek stage (depth or elevation) on fifteen-minute intervals. Available stage data at each station dates to back to 2005 apart from the Andrews Street Bridge gage. Of the five County stream gages, three have stage-discharge relationships, or rating curves, that were approximated by Central Coast Salmon Enhancement (CCSE) based on recorded stage data and measured flows between 2017 and 2019 (CCSE, 2019). These stream gages include the Andrews Street Bridge, Stenner Creek at Nipomo, and Elks Lane. Rating curves generated for these gauge stations (Figures 2-11 through 2-13) are considered the best available information for use in converting stage data to flow rate, and therefore were the primary data for used in calibrating the PRMS model.

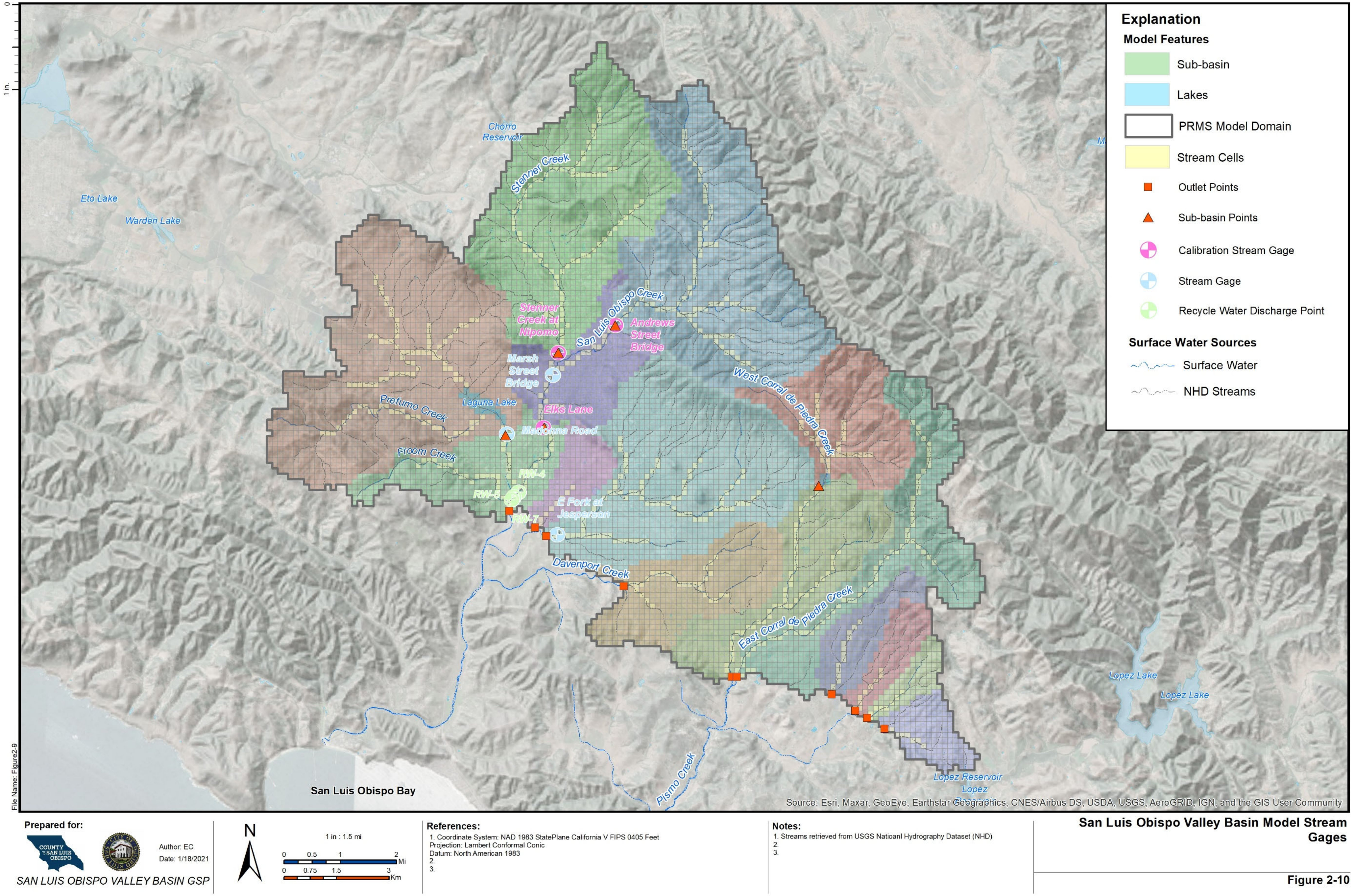
Questa Engineering Corps also estimated theoretical rating curves for each of the five County gages using a HEC-RAS model (Questa Engineering Corp., 2007). However, preliminary application of these rating curves to the stream gage data resulted in abnormal daily mean hydrographs in comparison to the hydrographs generated using the CCSE rating curves. The Questa rating curves was used as a secondary dataset for comparison of modeled to observed flows at the Jespersen and Madonna Road gage stations, where no CCSE rating curves exist (Figures 2-14 & 2-15).

In addition to the County owned gages, the City of San Luis Obispo collects weekly measurements of stage and flow within San Luis Obispo Creek at the outfall of the Water Resources Recovery Facility (WRRF) during the months of April to September as part of the National Pollutant Discharge Elimination System (NPDES) permitting program. This data was not included in PRMS and instead will be included in the SFR package of MODFLOW and will be evaluated in GSFLOW.

Table 2-2: Stream gage data for the Basin.

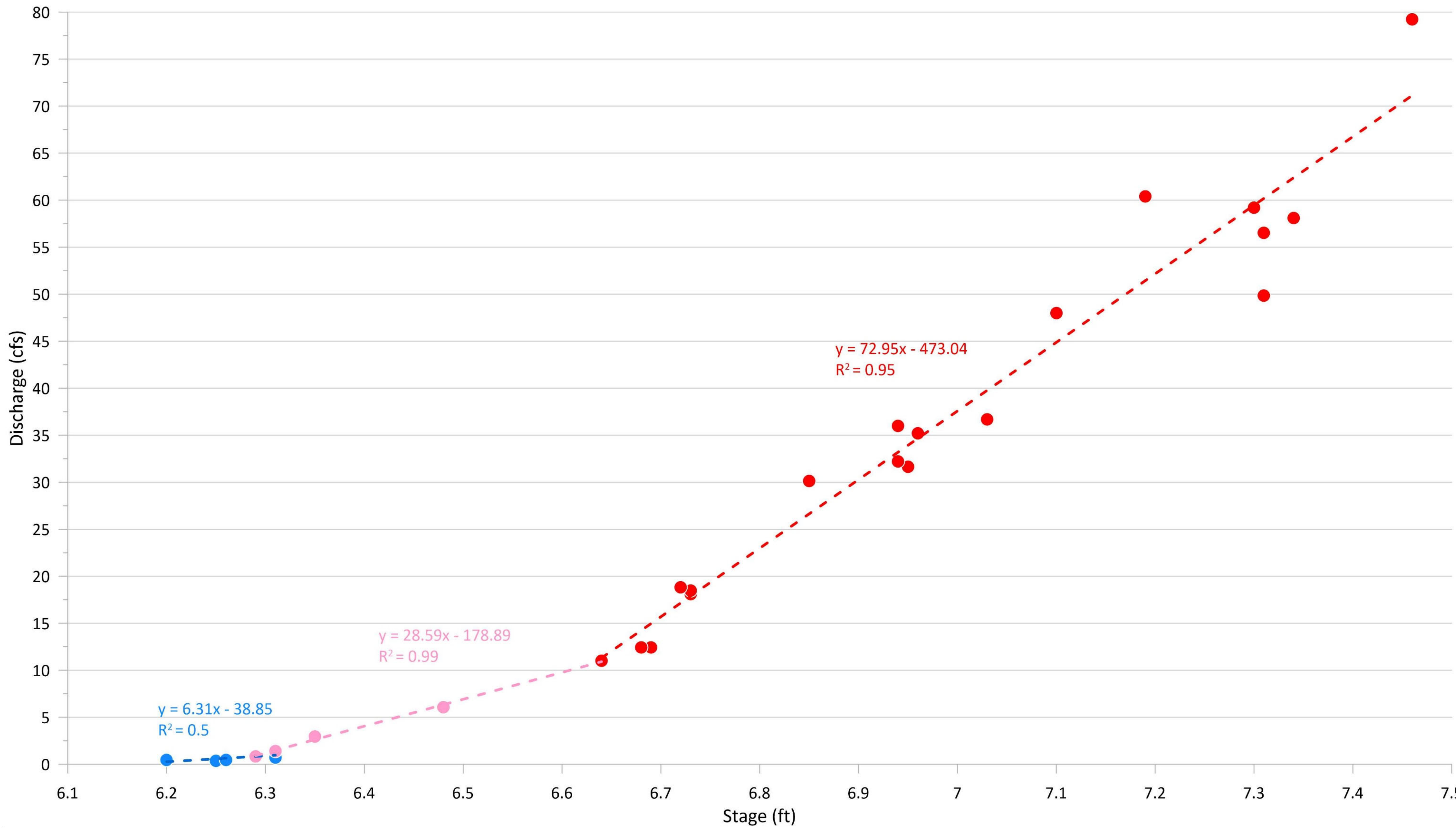
Stream Gage	Source/Station No.	Data Recorded	Data Interval	Data Range	Datum[1]
Andrews St Bridge	SLO County (745)	Stage	15 Minutes	8/26/2006 - 8/31/2019	NAVD 88
Stenner Creek at Nipomo	SLO County (781)	Stage	15 Minutes	5/23/2005 - 8/31/2019	NAVD 88
Elks Ln	SLO County (740)	Stage	15 Minutes	5/20/2005 - 8/31/2019	NAVD 88
Madonna Rd	SLO County (778)	Stage	15 Minutes	5/20/2005 - 8/31/2019	NAVD 88
E. Fork at Jespersen Rd	SLO County (783)	Stage	15 Minutes	5/20/2005 - 8/31/2019	NAVD 88
RW-4	City of SLO	Depth, Flow	Weekly	2005 - 2019	-
RW-5	City of SLO	Depth, Flow	Weekly	2005 - 2019	-
RW-7	City of SLO	Depth, Flow	Weekly	2005 - 2019	-

[1]Prior to 5/23/2017 County data was recorded on NGVD 29 datum. Conversion is 2.86 feet.



San Luis Obispo Valley Basin Model Stream Gages

Figure 2-10



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SAN LUIS OBISPO VALLEY BASIN GSP

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Legend

Low Flow

Medium Flow

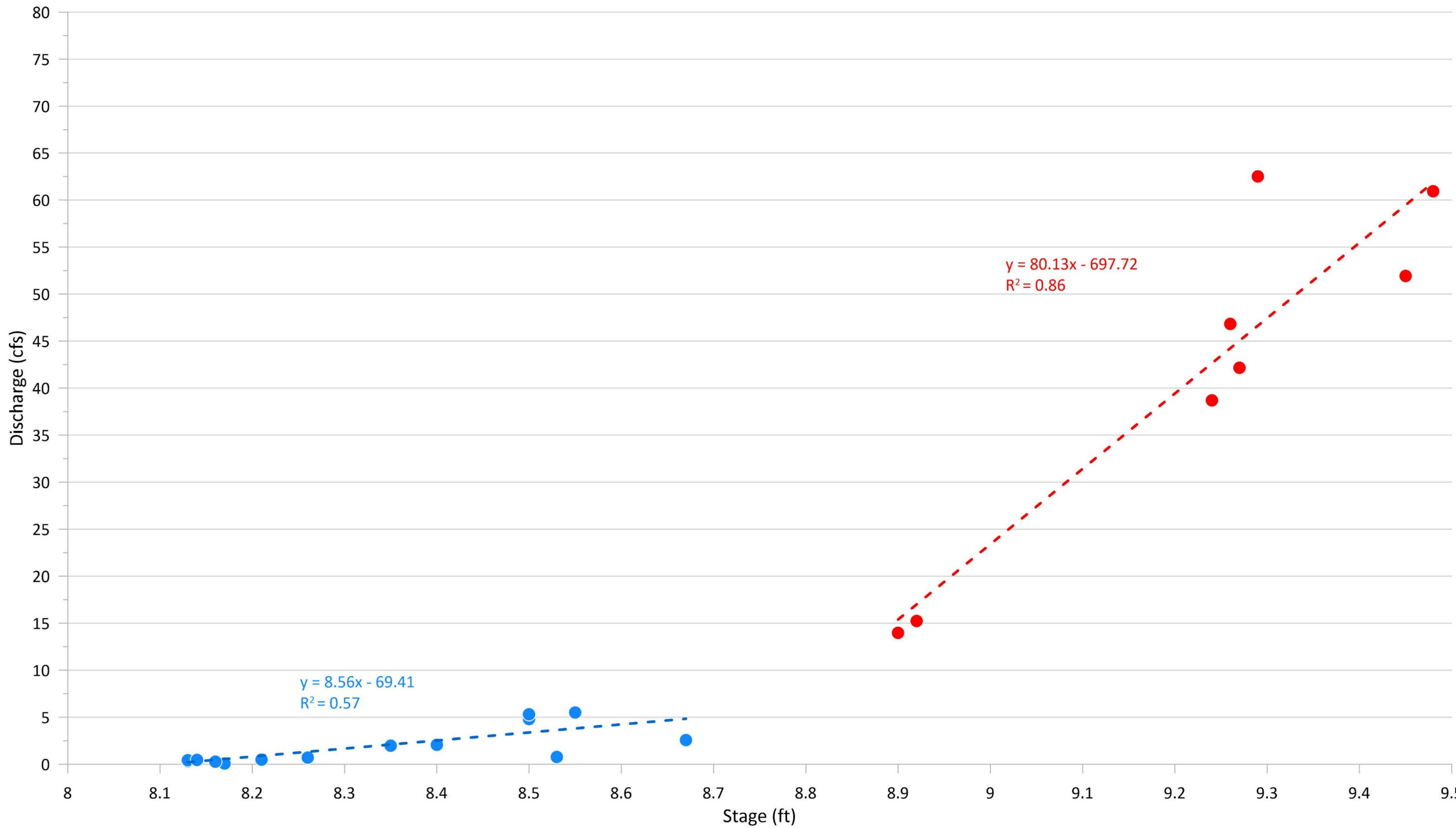
High Flow

Notes:

1. Data Source: Central Coast Salmon Enhancement (CCSE)

CCSE Rating Curve for Andrews St Bridge

Figure 2-11



Prepared for:

Author: EC

01/13/2021

SAN LUIS OBISPO VALLEY BASIN GSP

Legend

Low Flow

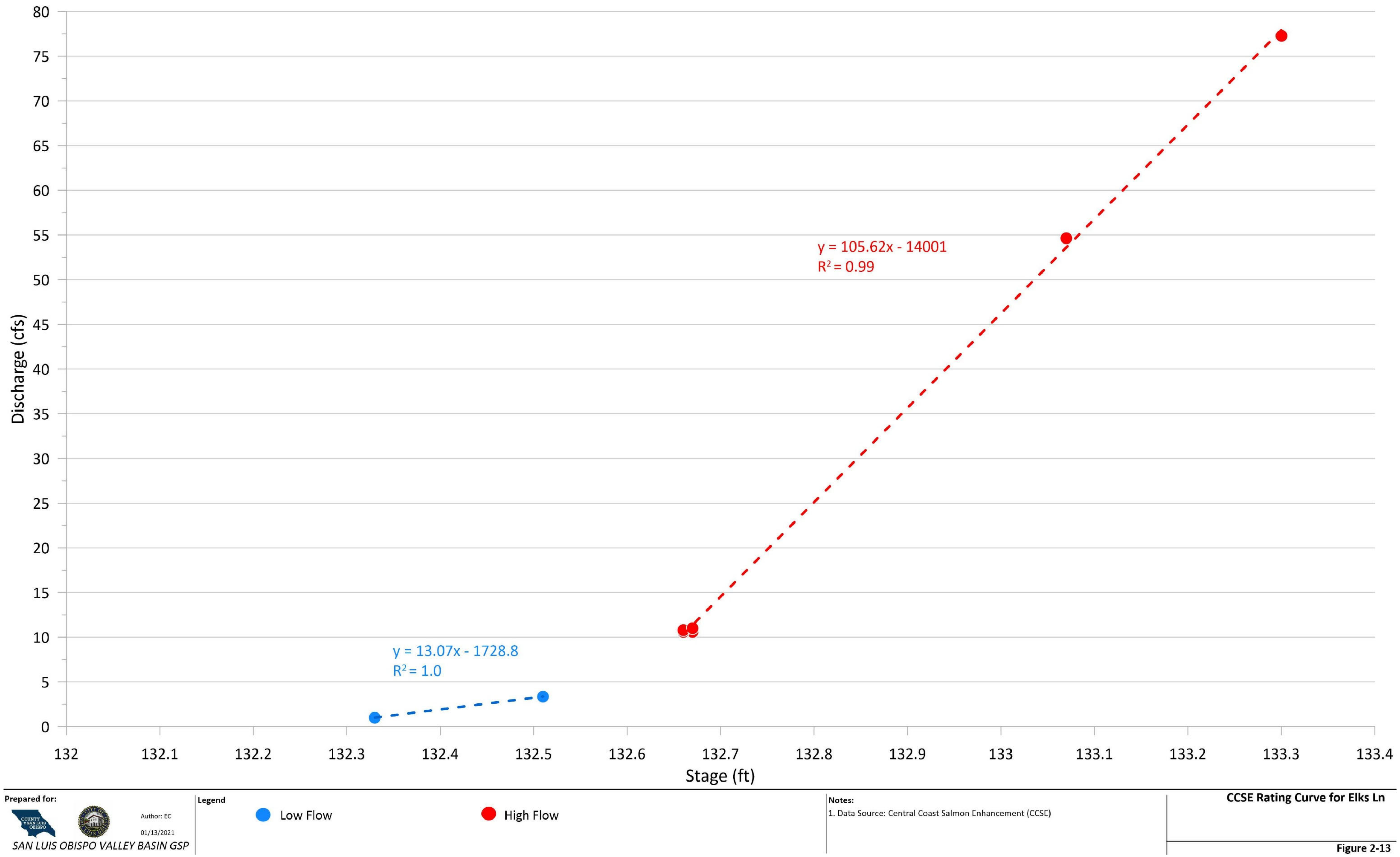
High Flow

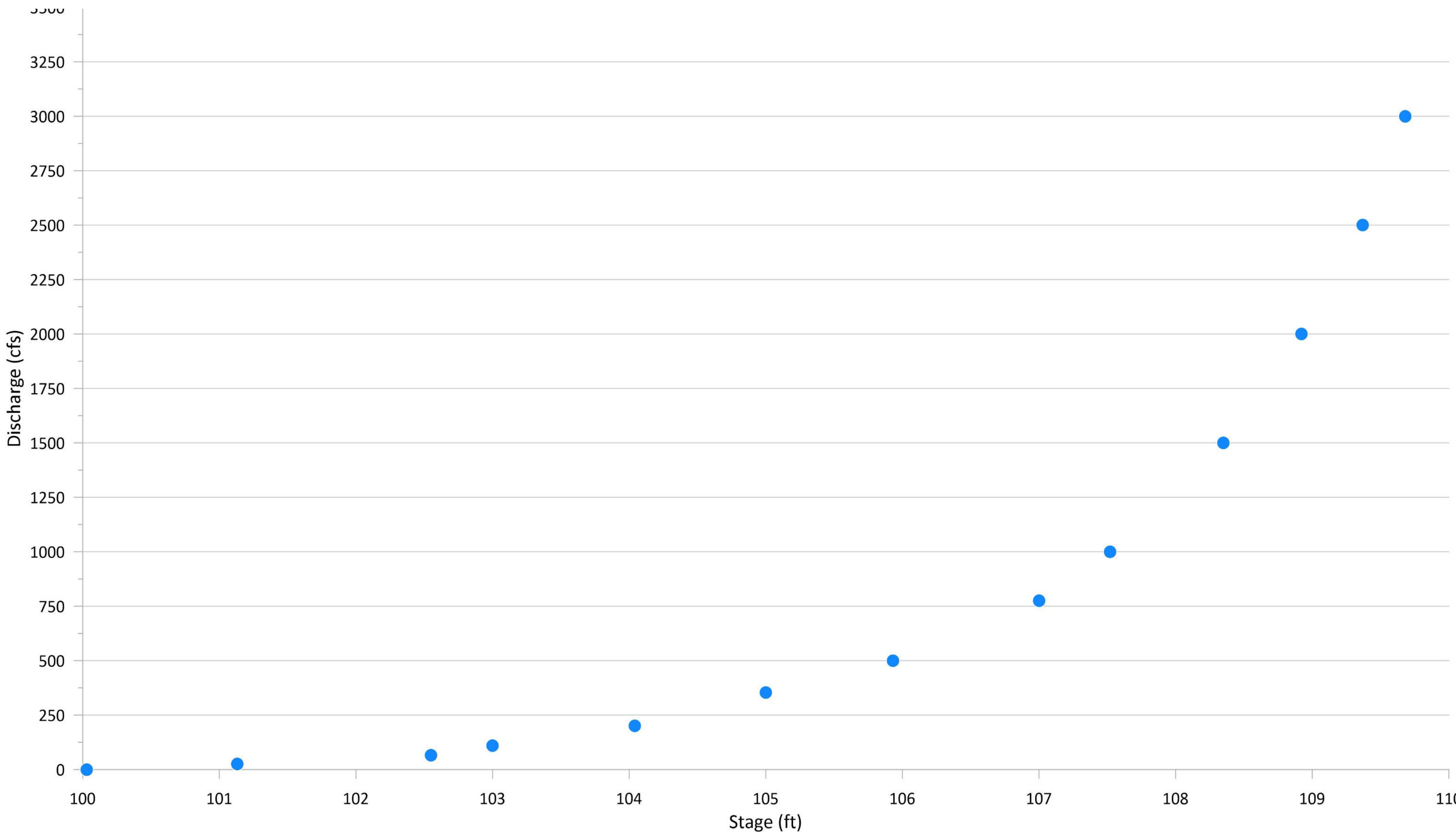
Notes:

1. Data Source: Central Coast Salmon Enhancement (CCSE)

CCSE Rating Curve for Stenner

Figure 2-12


Discharge (cfs)
Stage (ft)
y = 105.62x - 14001
R² = 0.99
y = 13.07x - 1728.8
R² = 1.0
0
5
10
15
20
25
30
35
40
45
50
55
60
65
70
75
80
132
132.1
132.2
132.3
132.4
132.5
132.6
132.7
132.8
132.9
133
133.1
133.2
133.3
133.4
Prepared for:
Author: EC
01/13/2021
SAN LUIS OBISPO VALLEY BASIN GSP
Legend
Low Flow
High Flow
Notes:
1. Data Source: Central Coast Salmon Enhancement (CCSE)
CCSE Rating Curve for Elks Ln
Figure 2-13



Prepared for:

Author: EC

01/13/2021

SAN LUIS OBISPO VALLEY BASIN GSP

Legend

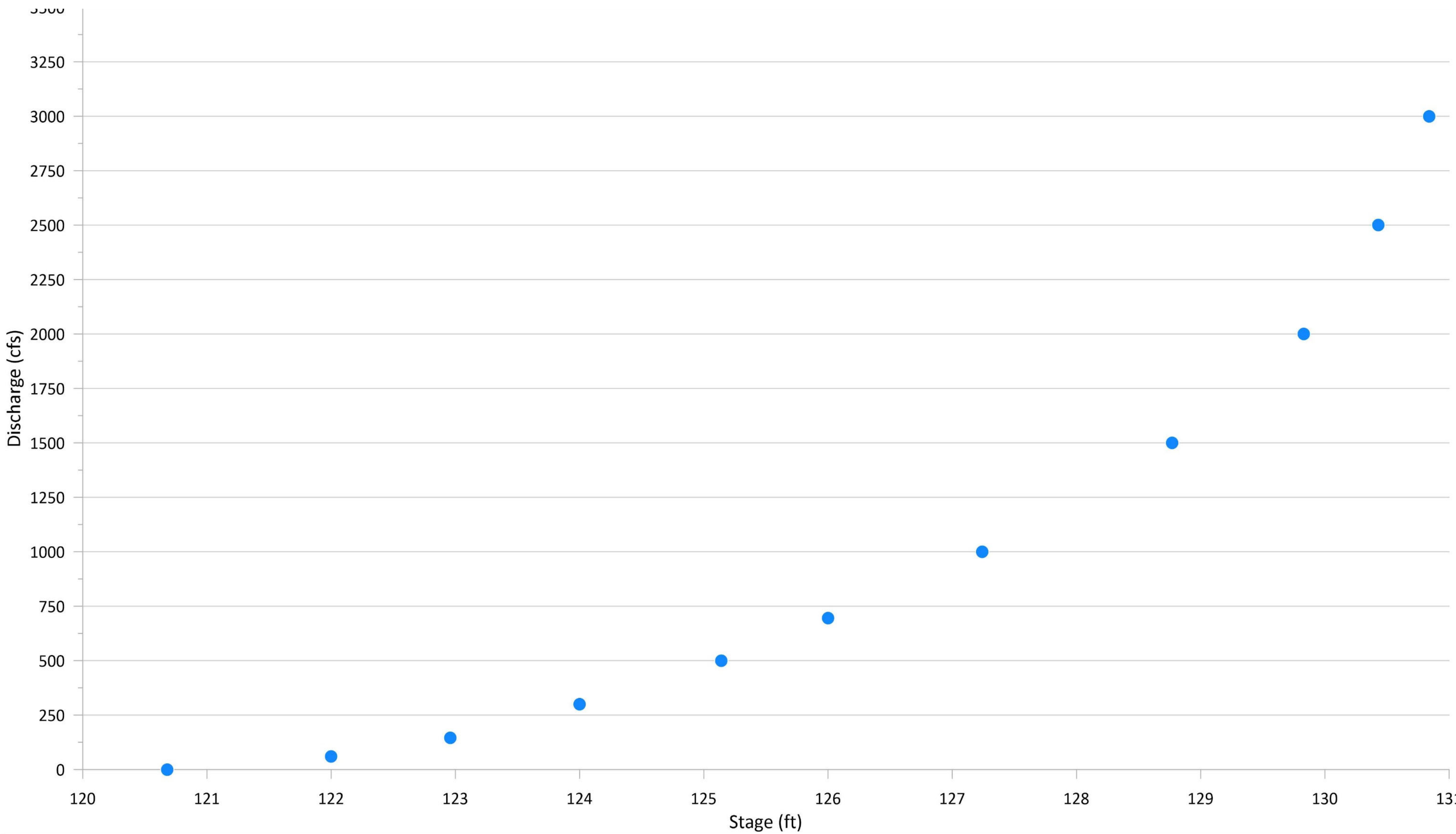
Flow

Notes:

1. Data Source: Questa Engineering Corporation

Questa Rating Curve for Jespersen

Figure 2-14



Prepared for:

Author: EC

01/13/2021

SAN LUIS OBISPO VALLEY BASIN GSP

Legend

Flow

Notes:

1. Data Source: Questa Engineering Corporation

Questa Rating Curve for Madonna

Figure 2-15

2.3. PRMS Modules Used

PRMS simulates the hydrologic cycle through various processes, each with one or more modules available for use. Table 2-3 presents the modules that were selected for use in the surface water model.

Table 2-3: Selected modules used in PRMS model.

Module Name	Process	Description[1]
basin	Basin Definition	Defines shared watershed wide and HRU physical parameters and variables.
cascade	Cascading Flow	Determines computational order of the HRUs and groundwater reservoirs for routing flow downslope.
soltab	Solar Table	Computes potential solar radiation and sunlight hours for each HRU for each day of the year.
obs	Time Series Data	Reads and stores observed data from all specified measurement stations.
temp_sta	Temperature Distribution	Distributes maximum and minimum temperatures to each HRU by using temperature data measured at one station.
precip_1sta	Precipitation Distribution	Determines the form of precipitation and distributes it from one or more station to each HRU by using monthly correction factors to account for differences in altitude, spatial variation, topography, topography, and measurement gage efficiency.
ddsolrad	Solar Radiation Distribution	Distributes solar radiation to each HRU and estimates missing solar radiation data using a maximum temperature per degree-day relation.
transp_tindex	Transpiration Period	Determines whether the current time step is in a period of active transpiration by the temperature index method.
potent_jh	Potential Evapotranspiration	Computes the potential evapotranspiration by using the Jensen-Haise formulation (Jensen & Haise, 1963)
intcp	Canopy Interception	Computes volume of intercepted precipitation, evaporation from intercepted precipitation, and throughfall that reaches the soil.
srunoff_smidx	Surface Runoff	Computes surface runoff and infiltration for each HRU by using a nonlinear variable-source-area method allowing for cascading flow.
soilzone	Soil-Zone	Computes inflows to and outflows from soil zone of each HRU and includes inflows from infiltration, groundwater, and upslope HRUs, and outflows to gravity drainage, interflow, and surface runoff to down-slope HRUs.
gwflow	Groundwater	Sums inflow to and outflow from PRMS groundwater reservoirs. Used in the PRMS-only model, not the integrated GSFLOW model.
strmflow	Streamflow	Computes flow in the stream network using the Muskingum routing method and flow and storage in on-channel lake using several methods. Used in the PRMS-only model, not the integrated GSFLOW model.

[1] (Markstrom, et al., PRMS-IV, the Precipitation -Runoff Modeling System, Version 4: Updated Tables from Version 4.0.3 to Version 5.0.0, 2019; Markstrom, Niswonger, Regan, Prudic, & Barlow, 2008)

2.4. PRMS Calibration Approach and Parameters

The PRMS model was calibrated using the USGS Luca software (Hay & Umemoto, 2007) in a step-wise approach that includes the optimization of solar radiation, PET, and streamflow. The PRMS calibration period was based on available stream gage data, which spans from July 2006 to August 2019. Simulated values and model outputs were compared to calibration data sets generated from measured data. Data sets for solar radiation and potential evapotranspiration were derived from measurements recorded at the Cal Poly #52 weather station. Calibration data sets for streamflow were derived from the CCSE rating curves and measured stage data at Andrews Street Bridge, Stenner Creek at Nipomo, and Elks Lane. The Questa Engineering rating curves at these streamflow gages were not used for comparison due to their documented issues and possible over estimation of streamflow (Questa Engineering Corp., 2007).

2.4.1. Potential Evapotranspiration and Solar Radiation

PRMS solar radiation (SR) and PET parameters were first calibrated to measured SR and calculated PET at the Cal Poly weather station. PRMS calculates solar radiation using the ddsolrad module where the parameters are slope and intercept of the maximum temperature per degree day linear relationship. Monthly parameters (dday_intcp and dday_slope) are calibrated (Table 2-4) to monthly averages of solar radiation (Figure 2-16). Based on calibrated air temperature and solar radiation, monthly coefficients (jh_coef) for the Jensen-Haise equation are adjusted to calibrate simulated potential evapotranspiration to average potential evapotranspiration at the stations (Table 2-4). The Jensen-Haise equation requires air temperature and solar radiation so average monthly air temperature and solar radiation from the Cal Poly weather station was used.

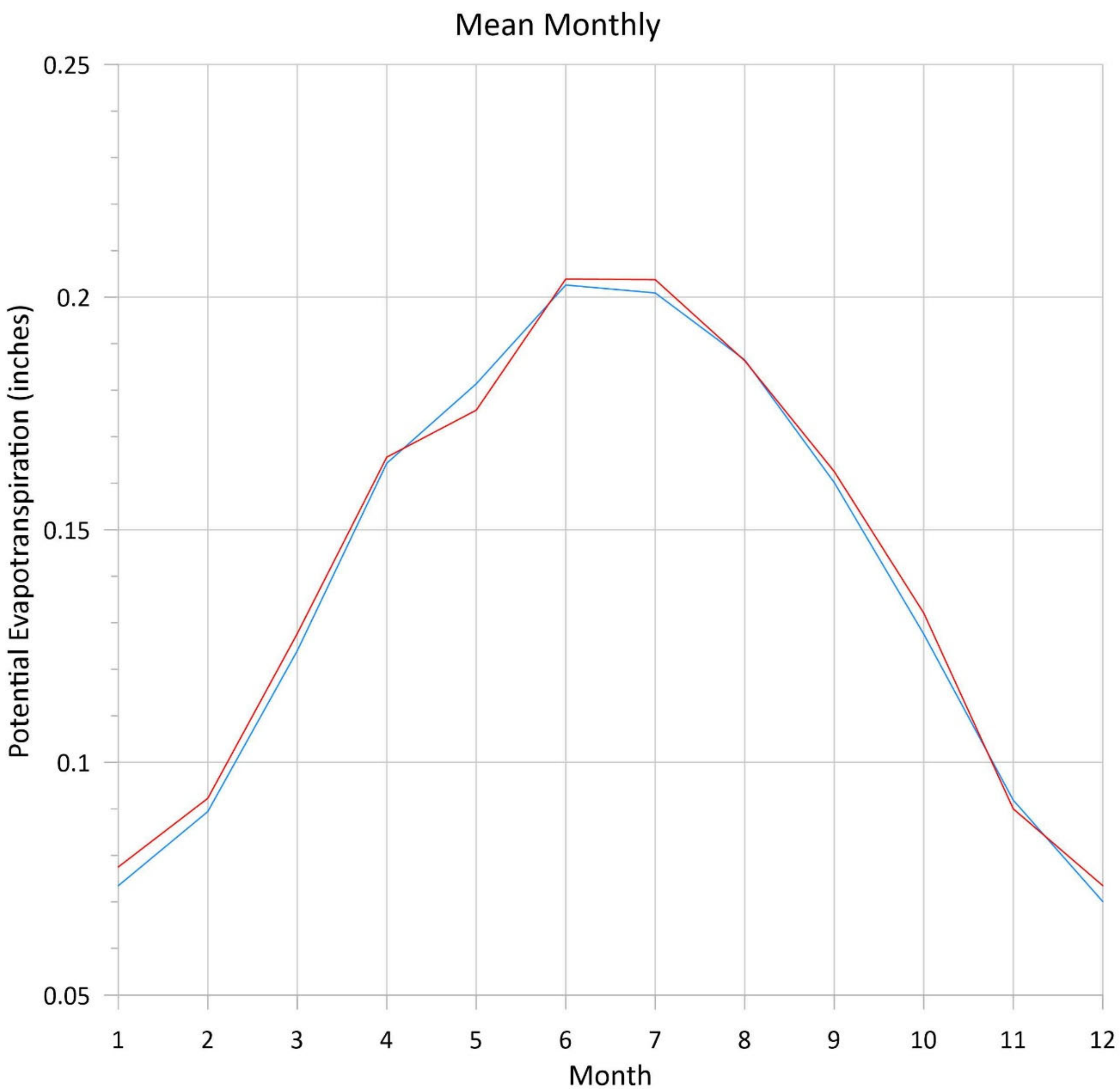
Table 2-4: Solar radiation and potential evapotranspiration monthly calibration parameters.

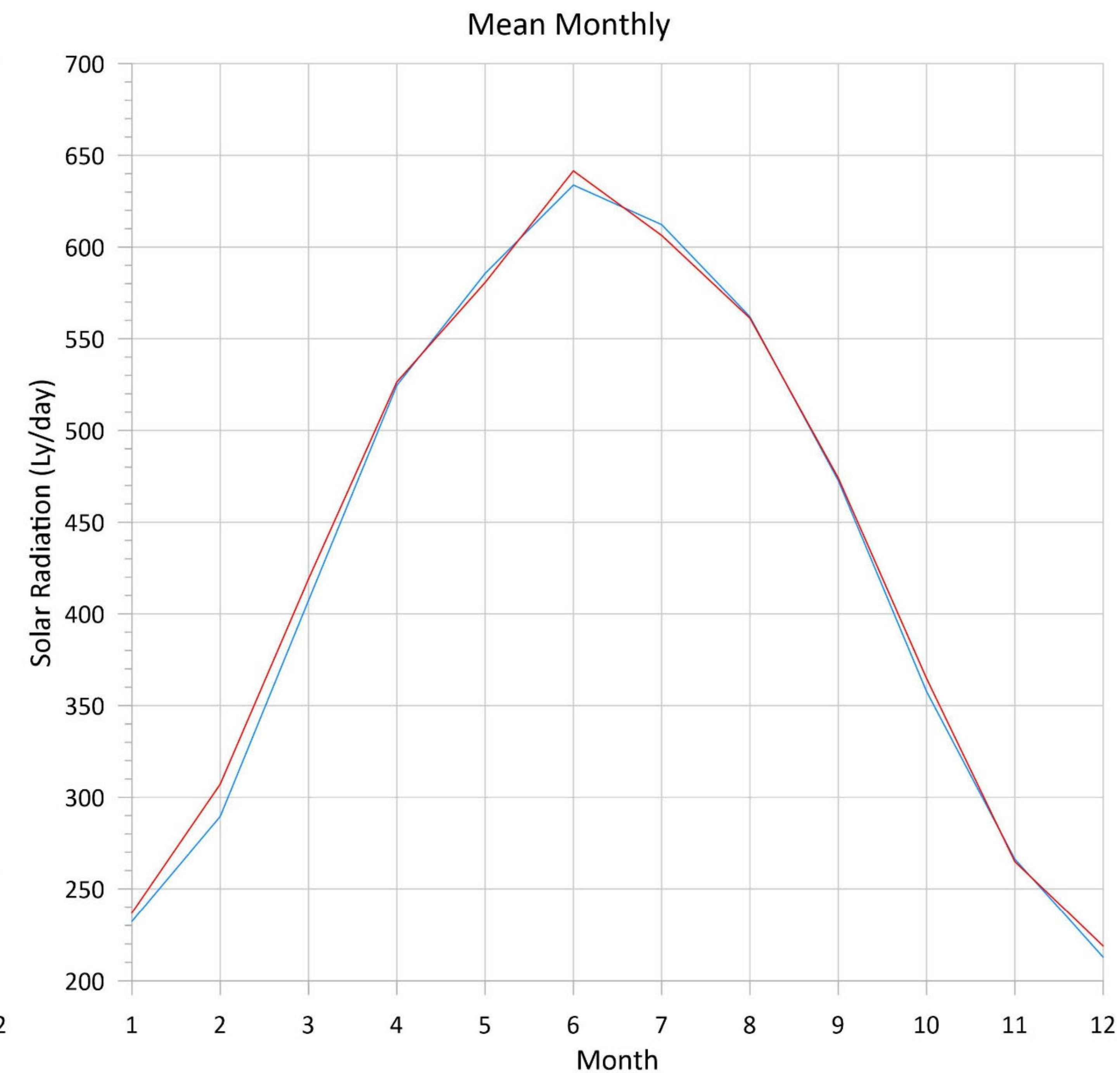
Parameter	dday_inctp[A]	dday_slope[B]	jh_coef[C]
January	-9	0.19	0.013951
February	-9	0.21	0.013001
March	-9	0.208	0.012301
April	-7.8	0.2	0.012401
May	-10	0.225	0.011559
June	-22	0.39	0.011049
July	-38	0.57	0.010966
August	-36	0.54	0.010735
September	-15	0.255	0.01105
October	-15	0.26	0.012034
November	-15	0.265	0.012719
December	-10	0.21	0.01492

A - intercept in temperature degree-day relation

B - slope in temperature degree-day relation

C - monthly adjustment factor using in Jensen-Haise PET calculations





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01/14/2021

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Legend

Weather Station
PRMS Output

Notes:
1. Data Source: Cal Poly Weather Station 52

ET and Solar Radiation Calibration

Figure 2-16

2.4.2. Surface Water Parameters

Calibration of the surface water component consisted of adjusting various watershed parameters for the entire Basin for Andrews Street Bridge, Stenner Creek, and Elks Lane stream gages. Each of these gages are in the SLO Valley portion of the Basin. Some parameters represent the soil zone reservoir volumes and other parameters represent coefficients for empirical equations describing flows to and from soil zone reservoirs. Table 2-5 shows the watershed parameters and provides their calculated values.

The capillary zone capacities soil_moist_max and soil_rechr_max have spatial variation within each HRU based on calculations using the SSURGO/STATSGO soils datasets. In general, parameters representing flows from the soil zone are on the low end of the expected range while parameters representing soil moisture capacities (sat_threshold, soil_moist_max, and soil_rechr_max_frac) are relatively high. Soil moisture capacity variables were the most sensitive in influencing surface water flow outputs in the model.

Table 2-5: Surface water model watershed parameters.

Parameter Name	Parameter Description	Associated flow	Min	Max	Average
Carea_max	Maximum possible area contributing to surface runoff as proportion of HRU	Hortonian Surface Flow	0	0.0083	0.0003
fastcoef_lin	Linear coefficient to route preferential-flow storage down slope	Fast interflow	0.63	0.63	0.63
fastcoaf_sq	Non-linear coefficient to route preferential flow down slope	Fast interflow	0.899	0.899	0.899
gwflow_coef	Groundwater routing coefficient	Groundwater flow	0.0023	0.0023	0.0023
gwsink_coef	Groundwater sink coefficient	Groundwater flow	0	0	0
imperv_stor_max	Maximum impervious area retention storage for each HRU	Hortonian Surface Flow	0.05	0.05	0.05
pref_flow_den	Preferential-flow pore density	Preferential flow	0.2	0.2	0.2
sat_treshold	Soil saturation threshold, above field-capacity threshold	gravity and preferential flow	4.6	13.6	6.2
slowcoef_lin	Linear coefficient to route gravity-flow storage down slope	Slow interflow	0.0266	0.0276	0.0266
slowcoef_sq	Non-linear coefficient to route gravity-flow storage down slope	Slow interflow	0.0107	0.0582	0.0108
smidx_coef	Coefficient in non-linear contributing area algorithm for each HRU	Hortonian Surface Flow	0.36	0.36	0.36
smidx_exp	Exponent in non-linear contributing area algorithm for each HRU	Hortonian Surface Flow	0.21	0.21	0.21
soil_moist_max	Maximum available water holding capacity of soil profile. Soil profile is surface to bottom of rooting zone.	NA	1.007	16.392	4.236
soil_rechr_max_frac	Fraction of capillary reservoir capillary reservoir water-holding capacity where losses occur as evaporation and transpiration	NA	0	1	0.3479
soil2gw_max	Maximum amount of capillary reservoir excess that is routed directly to the groundwater reservoir	Direct recharge	0	0	0
ssr2gw_rate	Coefficient in equation used to route water from subsurface reservoirs to the groundwater reservoirs	Gravity drainage	0.0084	35.64	0.032
ssr2gw_exp	Coefficient in equation used to route water from the subsurface reservoirs to the groundwater reservoirs	Gravity drainage	1.2	1.2	1.2

2.4.3. Surface Water Calibration Results

The surface water evaluation of the PRMS model consists of a 'weight of the evidence' approach (Donigian, 2002) where both qualitative graphical comparisons and quantitative statistical comparisons are made. Graphical comparisons generally include visual evaluation of timeseries plots comparing the measured and simulated flow rates at calibrated stream gages, while quantitative comparisons may include calculating a range of standard statistical measures.

For our purposes, the model was evaluated to verify the model accuracy does not exceed the accuracy or uncertainty associated with the data used to develop and calibrate the model. Since the surface water data measured at Andrews Street Bridge, Stenner Creek at Nipomo, and Elks Lane using the CSSE dataset has known inherent data uncertainty due to inconsistent stage measurements and rating curves for each gage, it's expected that the calibration may not achieve the best desirable relative calibration goals and we shouldn't expect to achieve exceptional calibration goals at each gage.

Relative calibration goals are proposed based on guidance from USGS (Woolfenden and Nishikawa, 2014 and Helsel et al., 2020) specific to PRMS and GSFLOW application. Simulated and measured streamflow was evaluated in the integrated model via comparison of daily mean, mean monthly, monthly mean, and annual mean hydrographs as well as using goodness-of-fit statistics. Goodness-of-fit statistics that were used include the reduced major axis regression (RMA) R^2, percent-average-estimation-error (PAEE), the absolute-average-estimation-error (AAEE), and the Nash-Sutcliffe model efficiency (NSME).

Reduced major axis (RMA; type II) linear regression analysis was chosen to calculate the R^2 for measured monthly mean streamflow versus simulated monthly mean streamflow to investigate the linear relationship between measured and simulated streamflow used in the calibrated model. RMA regression was used since there was relatively significant unexplained error in our predictor variable (measured monthly mean streamflow) that ordinary least squares (OLS) regression cannot adjust for (OLS assumes no error in predictor variable) resulting in a biased regression model which in our case, would provide erroneous results. RMA regression makes no assumptions about dependence (Friedman et al., 2013) and minimizes the sum of triangular areas between data points and the best fit line (Carr, 2012).

The RMA R^2 measures the linear goodness-of-fit and assumes estimation error in both simulated and measured data. The PAEE and AAEE measure the model bias, or systematic error, but cannot provide a definitive measure of goodness of fit alone. The NSME provides a measure of the mean square error, similar to the normalized root-mean-square error (RMSE) and can be a good indicator of the goodness of fit, but can still have substantial estimation bias. Therefore, the combination of these statistics is used to represent goodness of fit. A model that exactly matches observed results would have RMA R^2 value of 1.0, PAEE and AAEE values of 0, and an NSME value of 1.0 (Woolfenden and Nishikawa, 2014; Helsel et al., 2020).

Table 2-6 presents the range of goodness-of-fit criteria as outlined for the Santa Rosa Plain Model (Woolfenden & Nishikawa, 2014) and includes the RMA R^2 categories to further evaluate model fit. The optimal goal is to achieve calibration results within the "Very Good" or "Excellent" range, however, this may not be feasible at each stream gage location due to the following limitations:

- Accuracy of the stage data and rating curves from CSSE and Questa Engineering datasets.
- Limited model calibration period (WY 2006 – 2019) in relation to the full model run period (WY 1985 – 2019).
- Stream gages used for calibration are not spatially distributed throughout the model domain (i.e. no stream gages exist within Edna Valley to be used for calibration purposes).
- Precipitation data from 2006 – 2010 was corrected from documented measurement error at the primary rain gage used for calibration.

Table 2-6: Surface water model goodness-of-fit statistics calibration goals.

Goodness-of-fit Category	RMA R^2	PAEE (%)	AAEE (%)	NSME
Excellent	0.9	-5 to 5	≤0.5	≥0.95
Very Good	0.8	-10 to -5 or 5 to 10	0.5 to 1.0	0.85 to 0.94
Good	0.7	-15 to -10 or 10 to 15	10 to 15	0.75 to 0.84
Fair	0.6	-25 to -15 or 15 to 25	15 to 25	0.6 to 0.74

It's also well documented that in practice a wide range of goodness-of-fit categories may be achieved at stream gages that were used in the model calibration and it's rare to obtain "Excellent" or "Very good" classifications for more than one stream gage (Hunt et al., 2013, Woolfenden & Nishikawa, 2014).

Daily mean, mean monthly, annual mean, and monthly mean hydrographs of modeled and measured streamflow were evaluated at the Andrews Street Bridge, Stenner Creek at Nipomo, and Elks Lane stream gages (i.e. calibration gages) to determine if measured streamflow's were reasonably simulated at the stream gages.

As seen in Figures 2-17 – 2-19 showing the daily mean streamflow for each stream gage, there is one notable rainfall event that produced greatly outsized simulated flow versus measured flow. This rainfall event took place on October 13, 2009 and according to NOAA, it was a very wet and windy storm front that resulted in up to 15-inches of rain in the Santa Lucia Mountains along California's central coast (NOAA, 2020). The measured rainfall at the Cal Poly Station used in the model on this day was 6.22 inches which is the wettest day in the calibration period and almost two times greater than the next wettest day in the calibration period. Table 2-7 presents the flow at each stream gage for the top five wettest days and precipitation in the calibration period which take place in seasonally wetter months between October and March. Considering the substantially higher rainfall on October 13, 2009 compared to the other four wettest days in the calibration period, it would be expected for the measured data to reflect substantially higher flows for such a substantial rainfall event, but that is not the case. Before the development of this model, it was known that there may be varying degrees of measurement error in the stream gage stage data and how relevant the rating curves developed by Questa and CCSE (CCSE 2019, Questa Engineering Corp., 2007) will prove to be and the data may have a strong influence on the quality of model results. The discrepancy between the measured flow and simulated flow during this rainfall event relative to the other wettest days of the calibration period showcases the limitations of the available streamflow data in the Basin and may introduce increased model error into the model beyond natural variation inherently present in surface water processes. With improved data collection and recalibration of the model in the future, the model results may be improved.

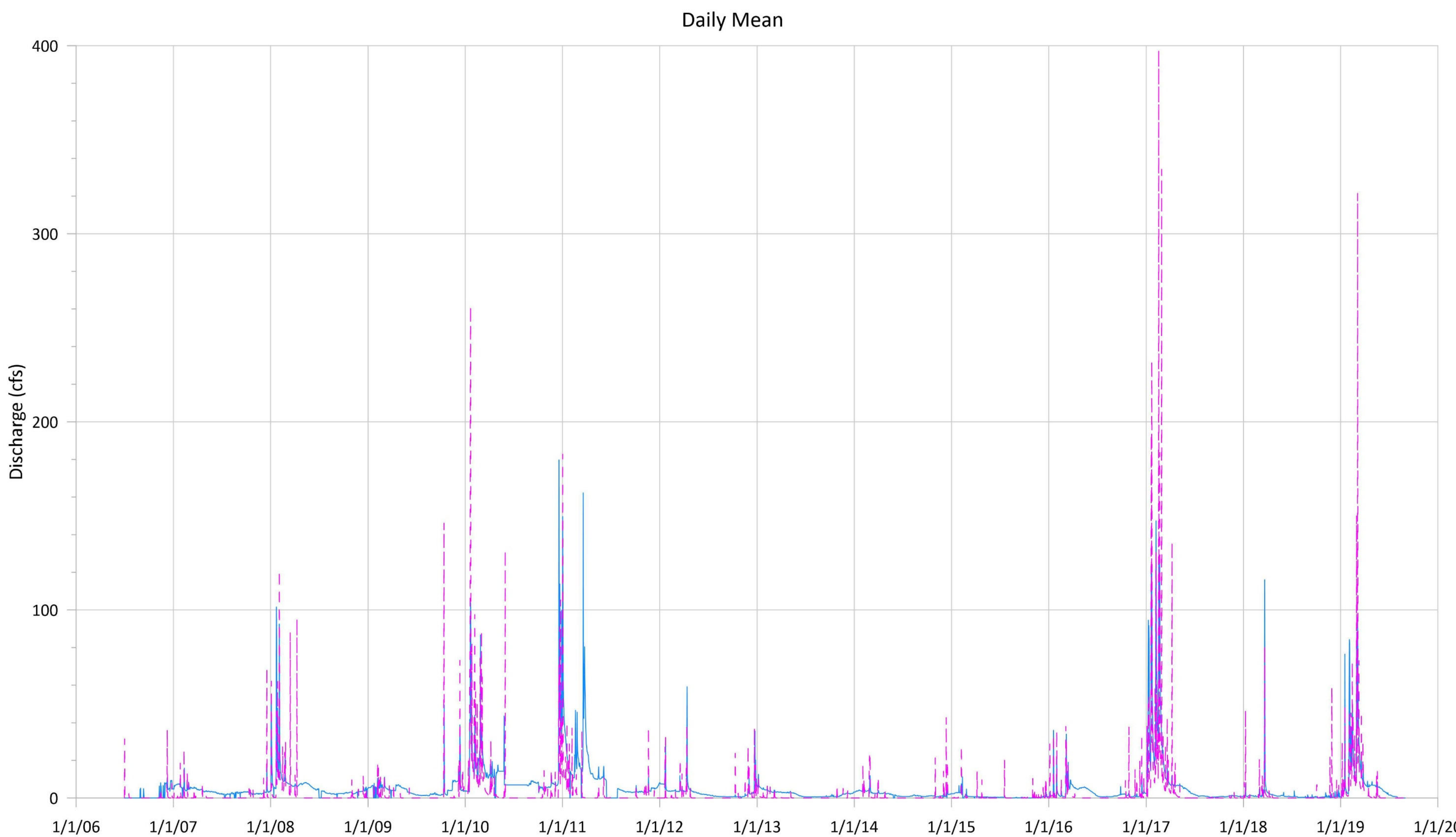
Table 2-7: Measured flow at each rain gage and precipitation for the five wettest days in the calibration period.

Date	Elks Ln - CCSE	Stenner - CCSE	Andrew - CCSE	Elks Ln - PRMS Output	Stenner - PRMS Output	Andrew - PRMS Output	Precipitation (in)
10/13/2009	109.576	65.187	12.455	500.698	208.717	161.02	6.220
12/18/2007	112.930	40.110	17.297	227.893	98.621	72.429	3.465
3/22/2018	309.108	176.052	116.027	298.599	131.353	81.099	3.250
1/4/2008	158.501	79.552	51.835	233.301	100.386	68.252	3.189
12/19/2010	442.437	222.541	179.727	402.626	161.086	133.622	3.071

Despite the limitations of the streamflow data available in the Basin that was used in the model, the calibration resulted in a reasonable fit of the calculated mean monthly, annual mean, and monthly mean data as shown in Figures 2-20 – 2-22. In addition, the model produced anticipated goodness-of-fit statistics for the RMA R^2, NSME, PAEE, and AAEE as shown in Figures 2-23 – 2-25. The RMA R^2 for monthly mean streamflow values for all three gages were above 0.75 indicating a strong, positive relationship between measured and simulated streamflow which was expected. Stenner Creek had one-year in the beginning of the calibration period with a NSME values below 0 and a strongly negative PAEE value indicating the model provided insignificant predictive value at Stenner Creek at the beginning of the calibration period. Andrews Street Bridge had consistently high NSME values for most of the calibration period, but was positively biased indicating simulated streamflow at Andrews Street Bridge were on average higher than observed values. For Elks Lane and Stenner Creek, the PAEE and AAEE were within a similar range, however, Andrews Street Bridge had a very high PAEE and AAEE. Simulated flows at Elks Lane provided the most predictive value and is the southmost stream gage in the model domain. Table 2-8 summarizes the goodness-of-fit statistics for each calibration gage and the assigned goodness-of-fit determination. Overall, the model fit the mean of the measured data and generally estimates high and low streamflow events reasonably well and the calibrated input parameters for PRMS should be adequate for use in evaluating model scenarios based on daily, monthly, and annual changes when fully coupled into GSFLOW.

Table 2-8: Streamflow calibration goodness-of-fit statistics for monthly mean data.

Calibrated Stream Gage	RMA R^2	PAEE (%)	AAEE (%)	NSME	Goodness-of-fit Determination
Andrews Street Bridge	0.76	50.36%	50.36%	0.68	Poor
Stenner Creek	0.81	1.37%	1.37%	0.33	Good
Elks Lane	0.85	9.02%	9.02%	0.75	Very Good



Prepared for:

Author: EC

07/26/2021

SAN LUIS OBISPO VALLEY BASIN GSP

Legend

CCSE Discharge

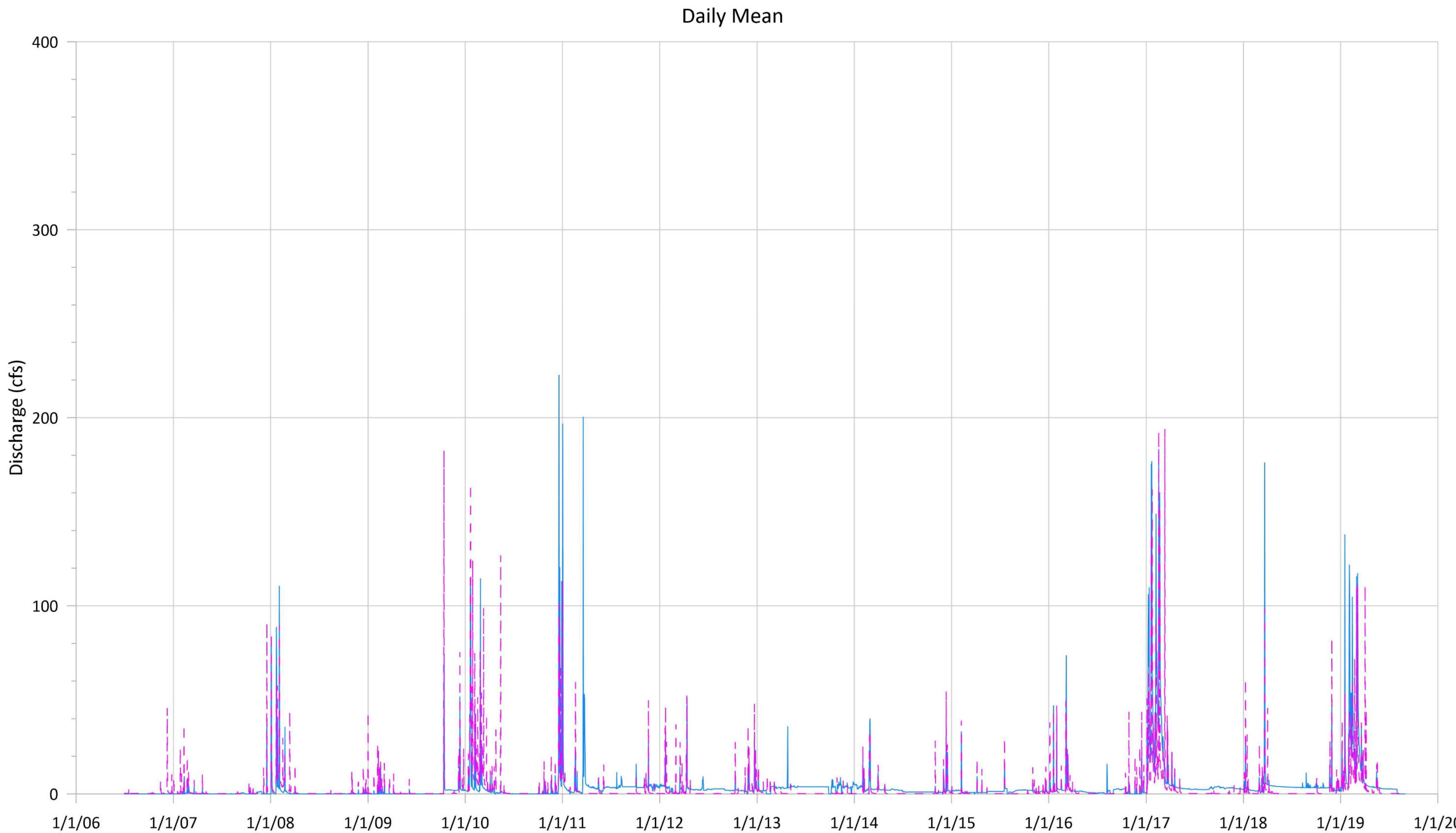
PRMS Dicharge

Notes:

1. Data Source: Central Coast Salmon Enhancement (CCSE)

Andrews Street Bridge Stream Gage Hydrograph

Figure 2-17



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Author: EC

07/26/2021

SAN LUIS OBISPO VALLEY BASIN GSP

Legend

CCSE Discharge

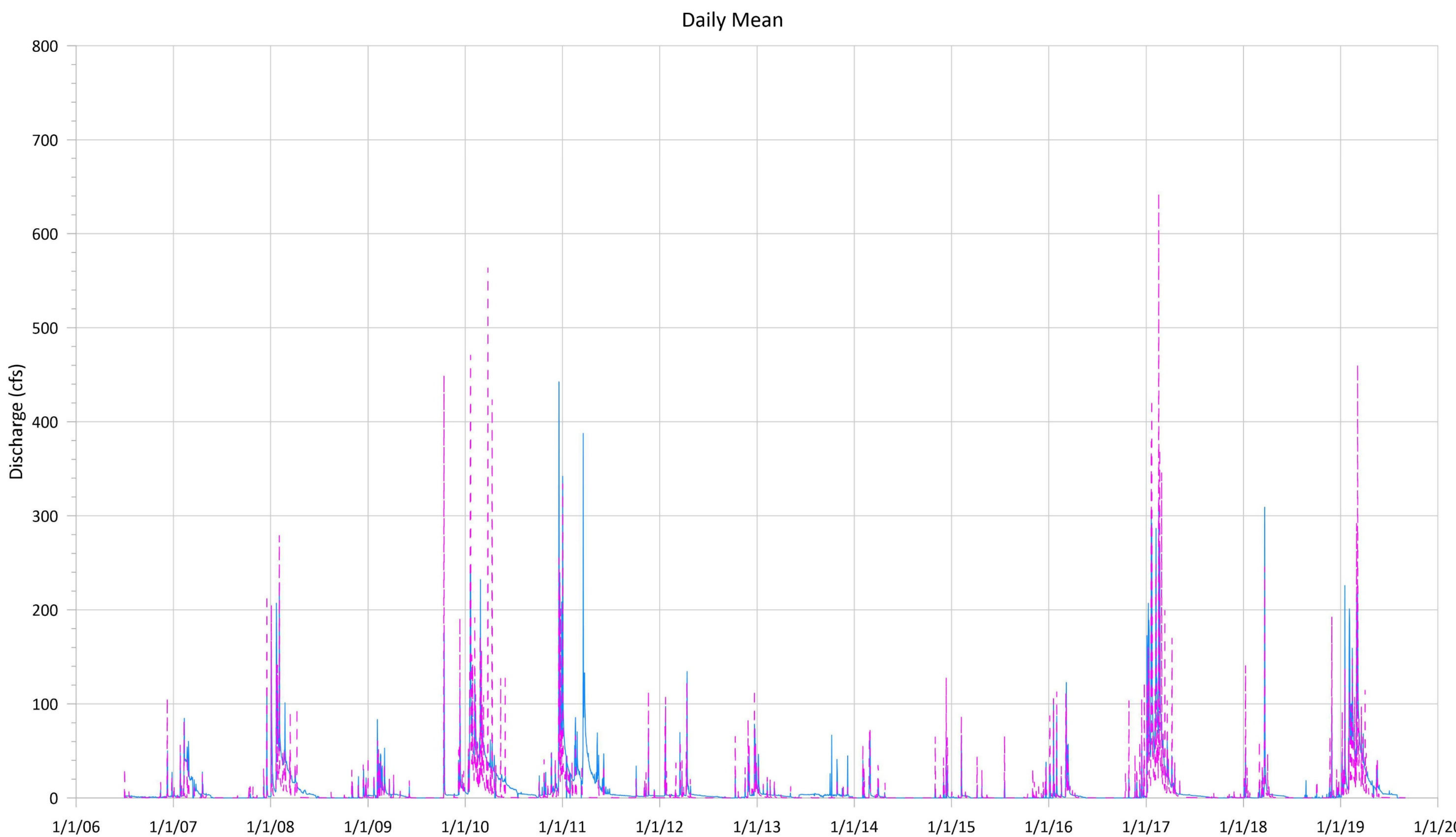
PRMS Dicharge

Notes:

1. Data Source: Central Coast Salmon Enhancement (CCSE)

Stenner Creek Stream Gage Hydrograph

Figure 2-18



Prepared for:

Author: EC

07/26/2021

SAN LUIS OBISPO VALLEY BASIN GSP

Legend

CCSE Discharge

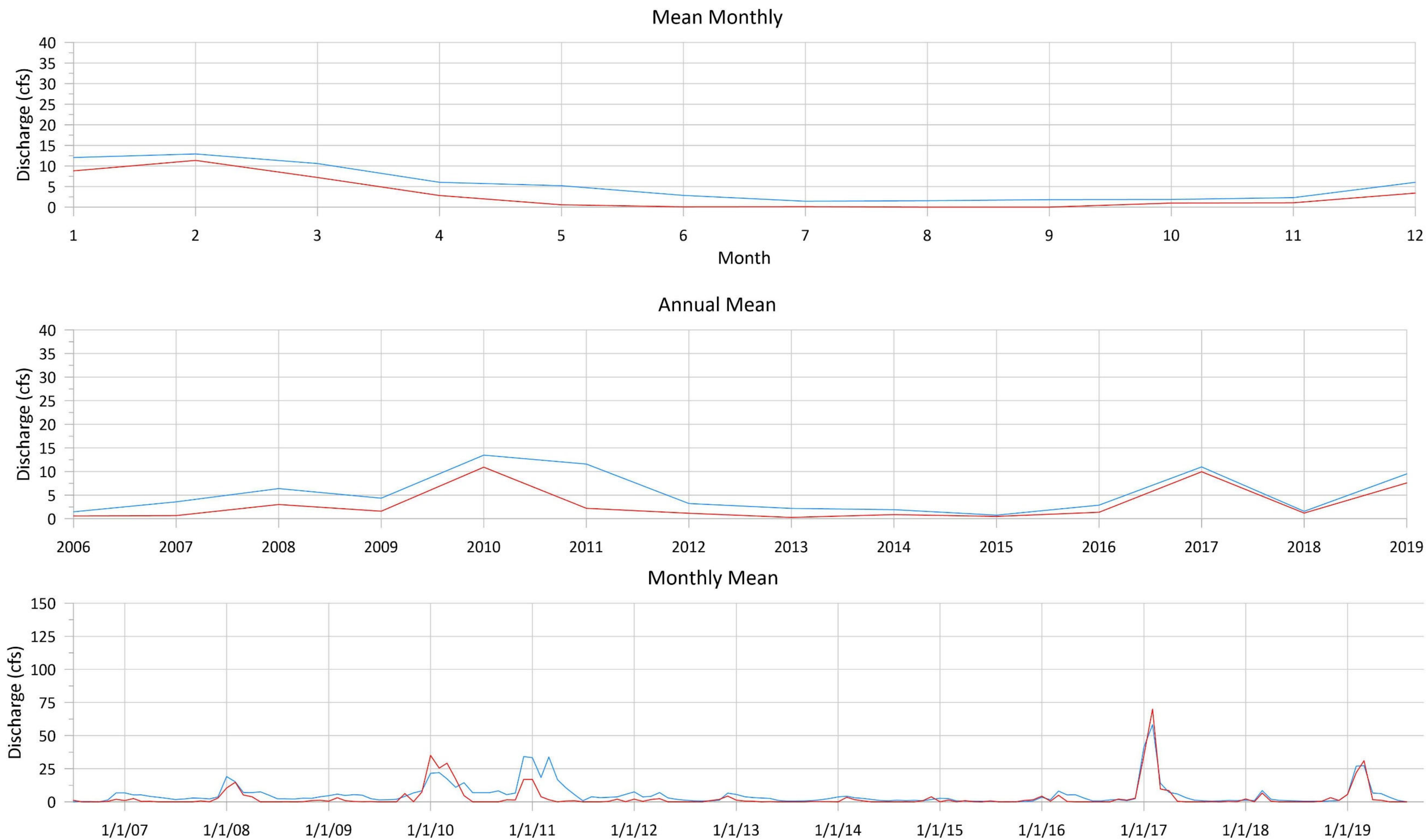
PRMS Dicharge

Notes:

1. Data Source: Central Coast Salmon Enhancement (CCSE)

Elks Lane Stream Gage Hydrograph

Figure 2-19



Prepared for:

Author: EC

07/27/2021

SAN LUIS OBISPO VALLEY BASIN GSP

Legend

CCSE Discharge

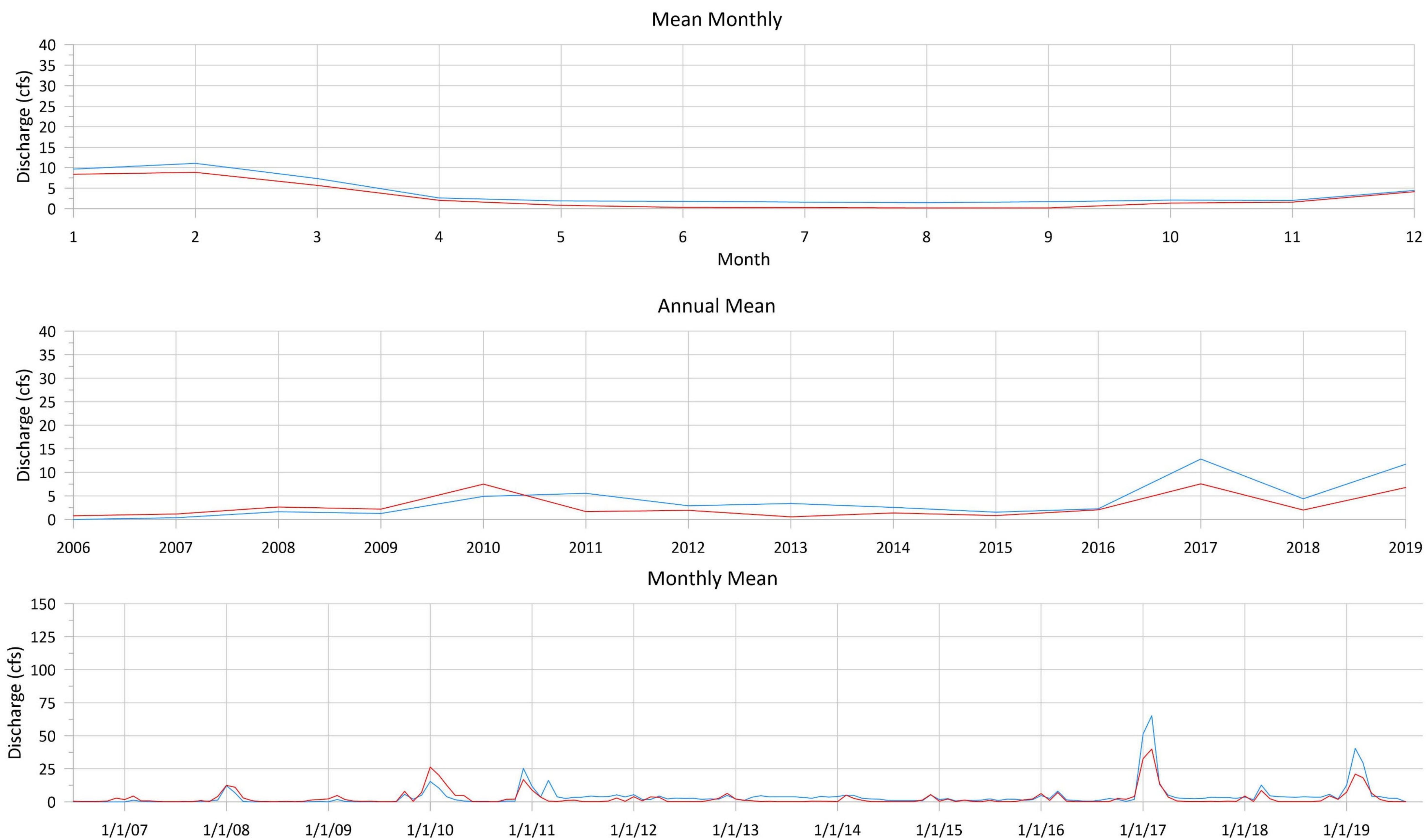
PRMS Discharge

Notes:

1. Data Source: Central Coast Salmon Enhancement (CCSE)

Andrews Street Bridge Stream Gage Calibration

Figure 2-20



Prepared for:

Author: EC

07/27/2021

SAN LUIS OBISPO VALLEY BASIN GSP

Legend

CCSE Discharge

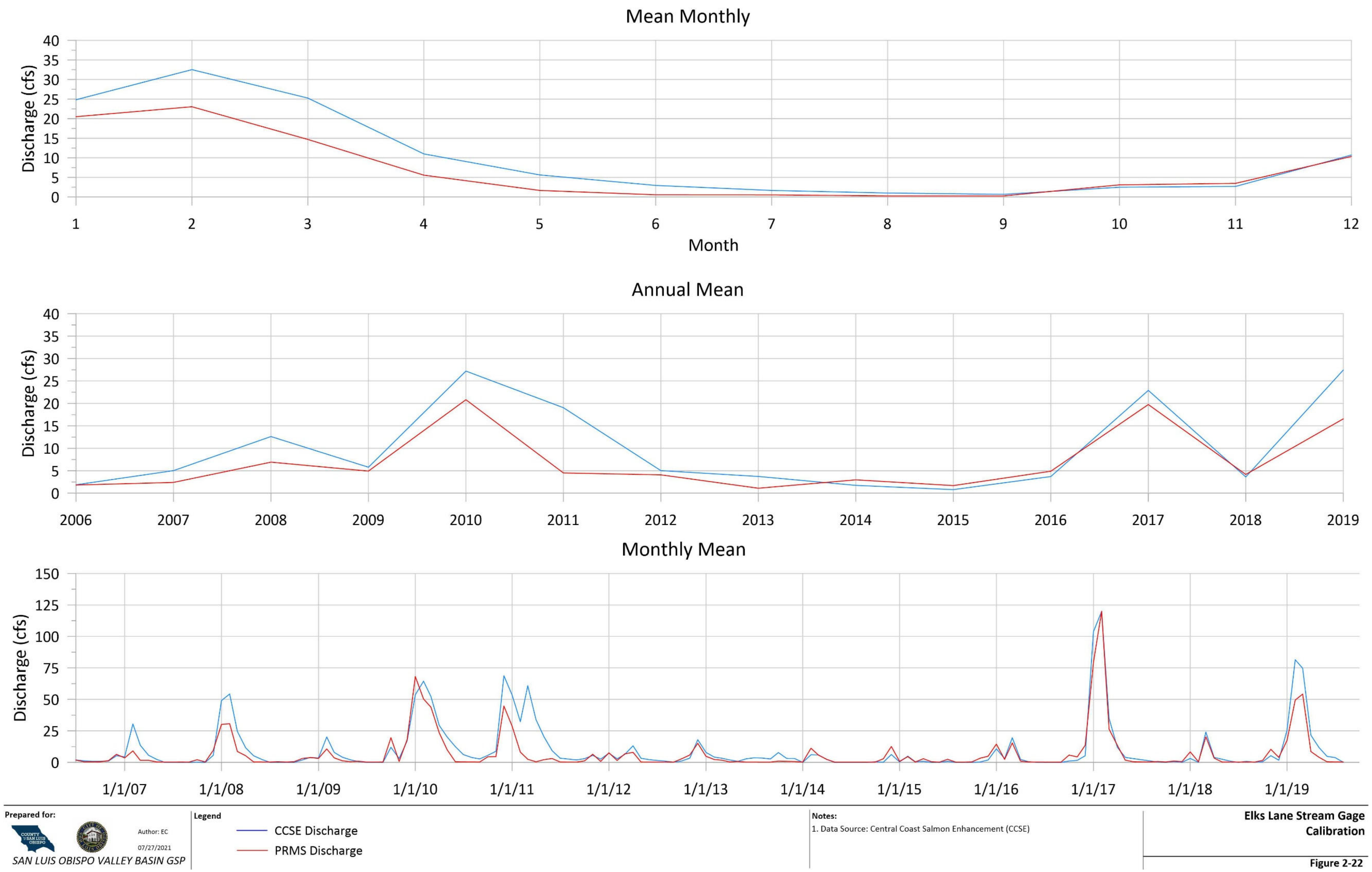
PRMS Discharge

Notes:

1. Data Source: Central Coast Salmon Enhancement (CCSE)

Stenner Creek Stream Gage Calibration

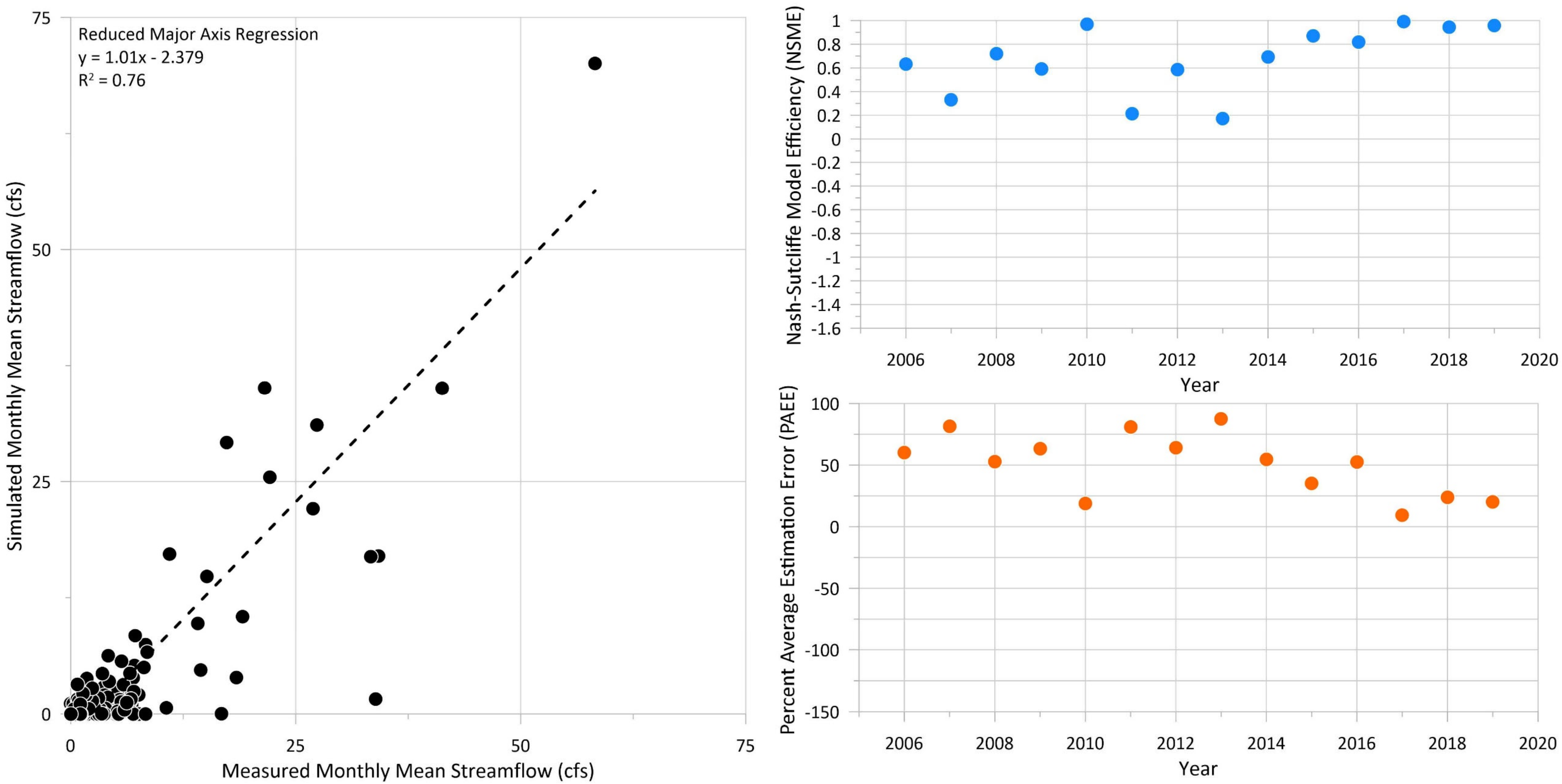
Figure 2-21



Elks Lane Stream Gage Calibration

Figure 2-22

Goodness-of-fit Statistics



Prepared for:

Author: EC

07/27/2021

SAN LUIS OBISPO VALLEY BASIN GSP

Legend

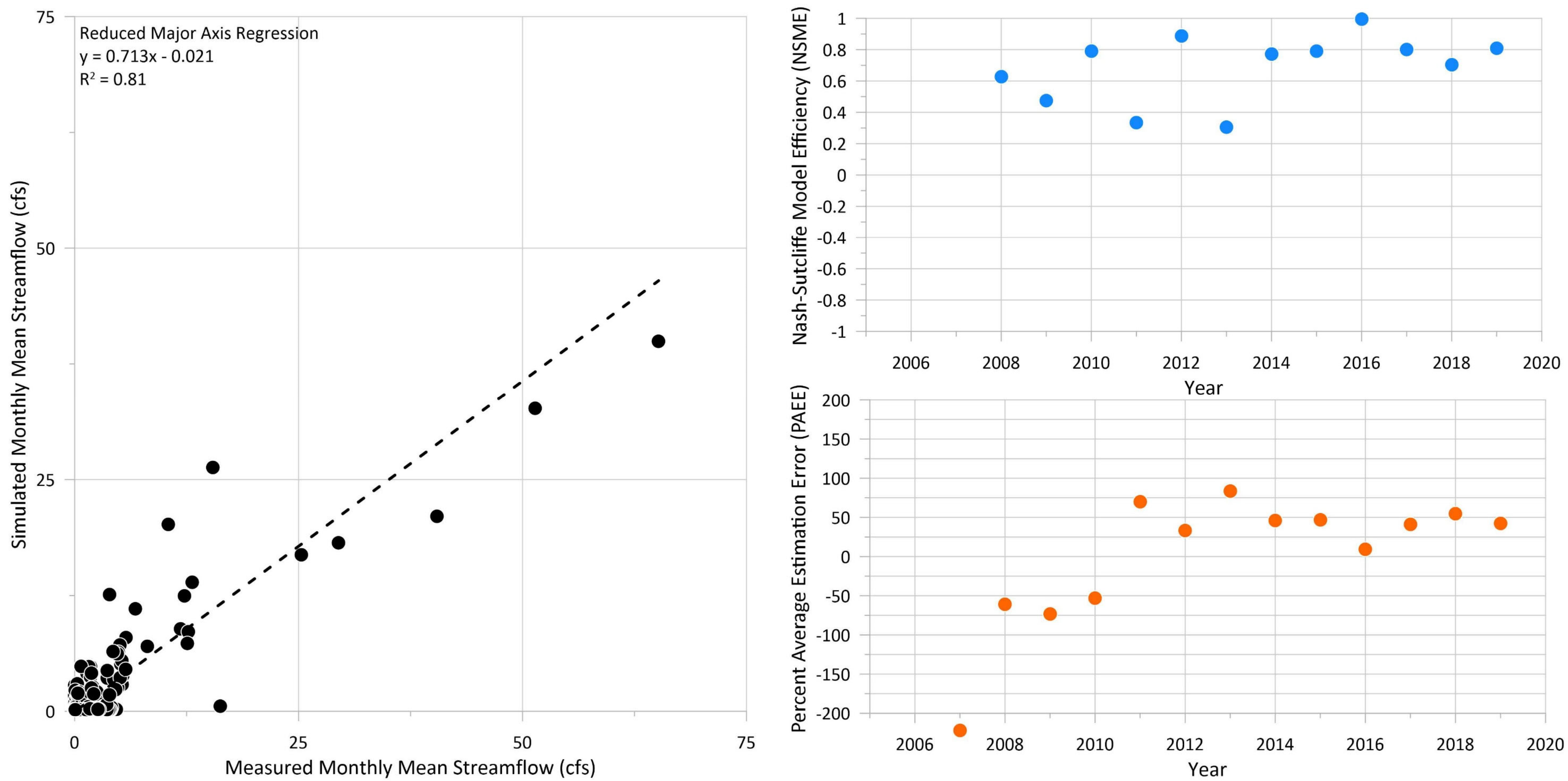
- Streamflow Data
- NSME
- PAEE

Notes:
1. Data Source: Central Coast Salmon Enhancement (CCSE)

Andrews Street Bridge
Model Calibration Statistics

Figure 2-23

Goodness-of-fit Statistics



Prepared for:

Author: EC

07/27/2021

SAN LUIS OBISPO VALLEY BASIN GSP

Legend

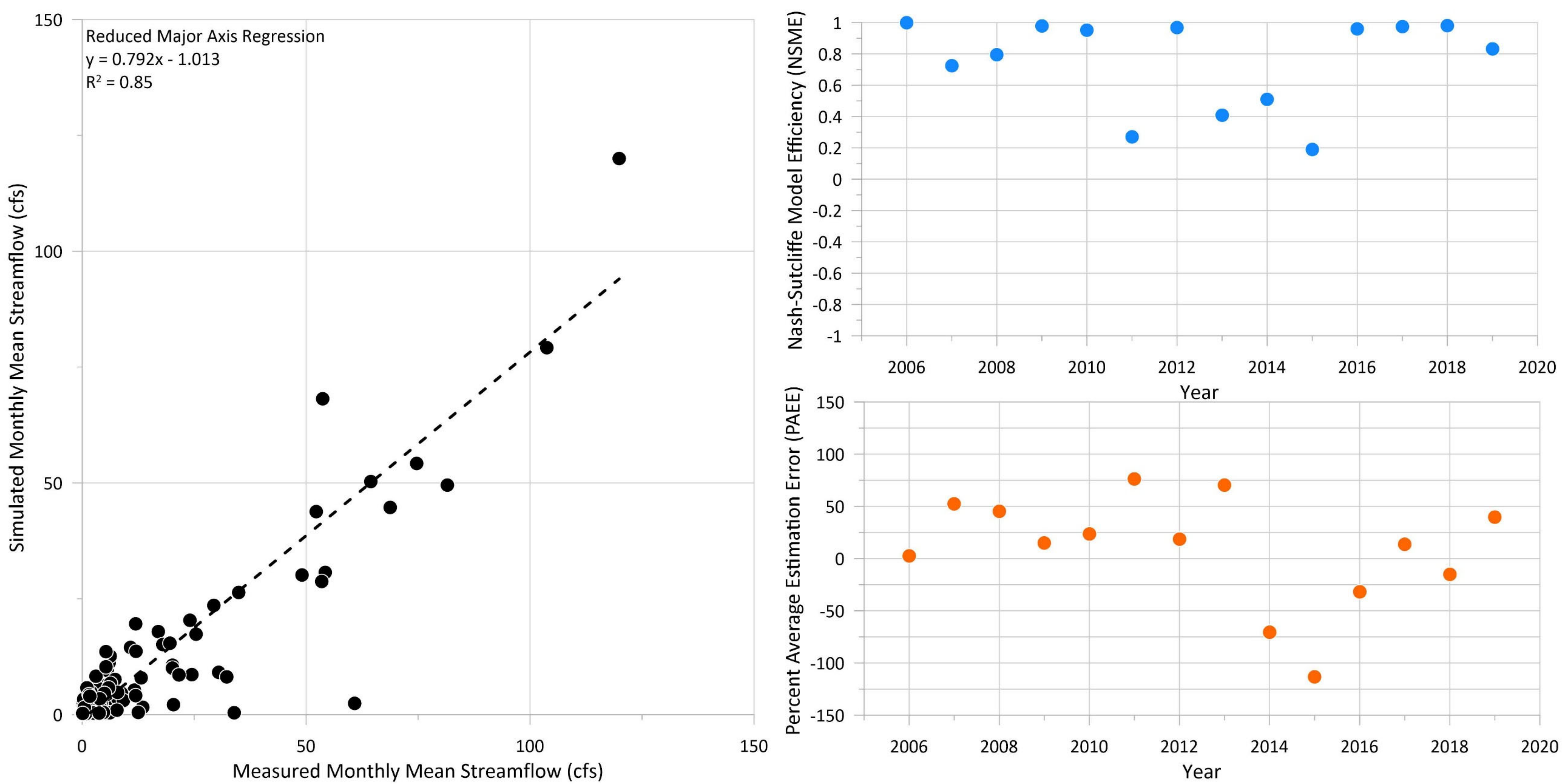
- Streamflow Data
- NSME
- PAEE

Notes:
1. Data Source: Central Coast Salmon Enhancement (CCSE)
2. 2006 NSME and PAEE
3. 2007 NSME and PAEE -3.97 and -222.27, respectively, and are not displayed on chart due to scale

Stenner Creek Model Calibration Statistics

Figure 2-24

Goodness-of-fit Statistics



Prepared for:

Author: EC
07/27/2021
SAN LUIS OBISPO VALLEY BASIN GSP

Legend
- Streamflow Data
- NSME
- PAEE

Notes:
1. Data Source: Central Coast Salmon Enhancement (CCSE)

Elks Lane Model
Calibration Statistics

Figure 2-25

Section 3. Groundwater Model Development

Groundwater model development was performed using MODFLOW, a public domain groundwater modeling code developed and maintained by the U.S. Geological Survey, and Groundwater Vistas, a proprietary software package used for pre-processing and post-processing of groundwater model data developed and maintained by James Rumbaugh of Environmental Systems International.

Although it was originally considered for the PRMS model and the MODFLOW model to have different grids, additional research with the authors of GSFLOW Groundwater vistas determined that there would likely be no significant advantage, and numerous disadvantages, in setting up the groundwater model this way. Ultimately, it was agreed that the most efficient approach would be for the PRMS model and the MODFLOW model to have coincident model grids. Thus, the MODFLOW model maintains the same 500-foot square grid size with a north-south orientation as that previously described for the PRMS model (Figure 2-1).

The original hydrogeologic conceptual model (HCM) developed for the model was to have four layers. From the top down, Layer 1 will represent the Recent Alluvium. Layer 2 is to represent the Paso Robles Formation, which underlies the Alluvium. Layer 3 represents the Pismo Formation, which underlies the Paso Robles Formation in the Edna Valley, but does not occur over significant areas in SLO Valley. Layer 4 represents the undifferentiated bedrock which underlies the Basin, and crops out in the contributing watershed areas north and south of the Basin. Layer 4 represents the Franciscan Assemblage, the Monterey Formation, and in some areas the Obispo Formation. This HCM was maintained until the final calibration of the integrated model in GSFLOW, as will be discussed in Section 4.

3.1. Datasets and Sources

The layering of the model is complex due to variable depositional environments in different parts of the model domain. In the area of SLO Valley near downtown San Luis Obispo north of the main body of the Basin (colloquially referred to as the “Antlers” due to its shape), the Alluvium directly overlies bedrock; no Paso Robles Formation or Pismo Formation is present. In the main body of the Basin in the SLO Valley where Alluvium and Paso Robles Formation overlie bedrock; there is no significant Pismo Formation present. In the northwestern portion of the Edna Valley, no Alluvium is present, and the Paso Robles Formation crops out at the surface, underlain by the Pismo Formation. There is a pod of Alluvium that crops out at the surface associated with East and West Corral de Piedras Creeks. In the southeast extent of the Basin, the Paso Robles Formation crops out at the surface, underlain by the Pismo Formation. In the contributing watershed area, none of the sedimentary layers of the Basin exist and none of the three Formations that comprise the Basin sediments occurs over the entire model area.

The variable depositional environments made for challenging grid geometry, since MODFLOW-2005 requires all layers to extend throughout the entire model domain. To address this issue, in areas where a particular layer does not exist, the model used “dummy” grid cells of 1-foot thickness to maintain layer continuity, and assigned hydraulic characteristics appropriate to either the layer above or below the dummy cell.

To evaluate the extent and thickness of each Formation in the Basin, and the associated thickness and extent of the model layers, GSI reviewed all Well Completion Reports (WCRs) available from the County Department of Environmental Health, the County Agency that oversees well permit applications in the County. For each available WCR, the lithologic descriptions were reviewed, and geologic contacts between the Formations comprising the Basin sediments were assigned. Geologic cross sections were generated based on evaluation of this data. Cross sections are presented in Chapter 4 of the Groundwater Sustainability Plan, and in the Basin Characterization report previously published (GSI, 2017). These data were then processed using the software Leapfrog, to generate a 3-dimensional geologic model representing the Basin. The Leapfrog stratigraphic model was then imported into Groundwater Vistas to create the 3-dimensional groundwater in MODFLOW using Groundwater Vistas.

During the preparation of the Basin characterization Report (GSI, 2017), a comprehensive summary of available data of hydraulic characteristics of the Basin Formations (hydraulic conductivity, transmissivity, specific capacity, storativity) were documented and compiled. These data were referenced to assign initial parameter estimates for aquifer hydraulic properties to the model, which were then adjusted during the calibration process.

Water level data were obtained from the county's water level monitoring program. Additional water level data was obtained from various other reports compiled as part of this project. A review of Well Completion Reports for wells in the Basin indicates that because most wells are screened to the bottom of permeable sediments, very few wells are screened in only one of the geologic Formations. In the San Luis Obispo Valley, wells are commonly screened across both Alluvium and Paso Robles Formation. In the Edna Valley, wells are commonly screened across both the Paso Robles Formation and the Pismo Formation. Because of this, wells used for calibration targets were generally assigned to the deepest model layer at the target location, unless specific data indicated otherwise. (For example, some wells are clearly indicated as alluvial wells).

3.2. MODFLOW Modules Used

The following MODFLOW modules were used in the development of the groundwater model:

- Basic package – Used to define time discretization and identify active flow areas and no flow cells.
- Solver package - Used to define numerical parameters associated with selected numerical solution alternative.
- Well package - Used to represent pumping from Basin.
- General Head Boundary package - Used during MODFLOW-only initial runs to represent mountain front recharge.
- Recharge package - Used during MODFLOW-only initial runs to represent aerially distributed precipitation-sourced aquifer recharge.
- Evapotranspiration Package - Used during MODFLOW-only initial runs to represent evapotranspiration from shallow aquifer.

- Horizontal Flow Boundary package - Used represent the Edna fault system along the southern boundary of the Basin.
- Constant head package - Used during MODFLOW-only initial runs to represent heads along the boundaries of adjacent basin, Los Osos Basin to the northwest, and Arroyo Grande sub-basin to the southeast.
- Layer Property Flow package- Used to define layer thickness and aquifer hydraulic properties in the model.
- Discretization package - Used to define grid size and transient time steps.
- Lake Package - Used to represent Laguna Lake and Righetti Reservoir.
- Streamflow Routing Package - Used to simulate streamflow and surface water/groundwater interaction.
- Unsaturated Zone Flow package - Used in GSFLOW combined model to simulate temporary storage in the vadose zone.

3.3. MODFLOW Calibration Approach and Parameters

The following general approach was used during the calibration of the MODFLOW groundwater model.

3.3.1. Steady-State Model

Once the Basin water budget was delivered as Chapter 6 of the GSP, the annual estimates of pumping were available for direct application in transient model tuns. Some of the primary water budget components described in the water budget, such as precipitation-based recharge and stream flow into and out of the aquifer, were available for use as estimates for initial inputs into the model. A steady-state version of the model (I.e., a single stress period, with no time variation of aquifer inflows and outflows) representing pre-development conditions (I.e., no groundwater pumping) was developed in which long term average values for these values were input into the model. A series of runs were then commenced in which key parameters from each layer (horizontal and vertical hydraulic conductivity, GHB head assignments, streamflow conductance, evapotranspiration parameters) were varied. Mass balance output from each layer of the model were exported and evaluated to assess the direction and quantity of vertical flow between the model layers. The goal of this portion of the calibration process was to reach a steady state version of the model in which water levels were reasonable, and direction and quantity of vertical flow between the model layers was consistent with the hydrogeologic conceptual model (HCM) presented in the modeling approach Technical Memo. In addition, vertical flow between the layers prior to the commencement of pumping in the Basin would be upward from layer 4 to layer 1 in the main body of the Basin. Estimates of aquifer discharge to streams or inflow from streams was targeted at values in the vicinity of the estimates developed during the water budget and presented in Chapter 6 of the GSP. After each run, mass balance information for each model layer was exported individually, and imported into a visual representation of the model layers to assess direction of vertical flow and the amounts in acre-feet per year. The primary parameters that were varied during this effort were horizontal and vertical hydraulic conductivity, assigned to appropriate zones in each layer, and streambed conductance in the SFR package (The water budget information did not assess the flow between layers). Additionally, dry cells in the groundwater model were a persistent problem, and model parameters were adjusted to attempt to minimize or eliminate dry cells in the model domain.

Repeated model runs were simulated and analyzed manually to achieve an acceptable steady-state version of the model. Once it was judged that the steady-state model yielded reasonable water levels and mass balance output, and dry cells were reduced to a manageable amount, the model was converted to perform transient simulations.

3.3.2. Transient Model – Annual Stress Periods

When the steady-state version of the model had reached a level of acceptability in which the vertical flow between model layers was judged to conform to the HCM, and water levels appeared to replicate the flow patterns and groundwater elevations exhibited in the earliest available water level maps (1954, presented in Chapter 5), and dry cells were at a minimum, then a transient version of the model was prepared in which 35 annual stress periods representing water years 1985 through 2019 were simulated. This version of the model does not have the required time step discretization to integrate with PRMS under GSFLOW; therefore, this version of the model was considered an interim step to the ultimately calibrated GSFLOW model.

Municipal pumping was applied at the documented locations of the municipal pumping wells, with annual pumping volumes included as compiled by Cleath-Harris Geologists (CHG) during the preparation of the Basin water budget. Agricultural pumping was distributed equally to well locations assigned by GSI throughout the areas identified as having agricultural land use, with total agricultural pumping volumes as determined by CHG.

Annually variable water budget volumes for precipitation-based recharge, were distributed equally to all cells in the model.

Streamflow into the Basin was taken from the CHG water budget, distributed among the streams which flow into the SLO Valley and the Edna Valley from the contributing bedrock watershed area, and input into the model as stream inflow in the SFR package average to stream cells that enter the Basin.

Evapotranspiration parameters were left unchanged from the steady-state version of the model.

A similar exercise as previously described was employed for the transient model. Layer-specific mass balance results from the model run were exported and assessed. Transient water level data from all well data judged to be with the agricultural pumping in Edna Valley placed in layer 3 (Pismo Formation). It was observed that vertical flow from layer 3 to the upper layers reversed direction, from upward to downward in response to declining water levels inlayer 3, and streamflow into the Basin.

3.3.3. PEST Application

After the version of the model with 35 annual stress periods was running smoothly and within expected parameters, GSI utilized the software package PEST to refine hydraulic parameter estimation in the model to achieve a better calibration. PEST refers to a software package and associated suite of utility programs which support it. PEST employs mathematical optimization routines to adjust model parameters within constraints defined by the modeler. PEST sets up routines wherein the model is run many times (hundreds to thousands of times), while parameters chosen by the modeler are varied within constraints defined by the modeler. Calibration statistics such as the sum squared of residuals are tracked after each run, and parameter estimates are varied from one run to the next in a manner intended to drive the calibrations statistics downward with successive simulations.

Because PEST may run the MODFLOW model hundreds to thousands of times during the optimization, the run time for the MODFLOW model cannot be too long. When the MODFLOW model is ultimately run in conjunction with PRMS under GSFLOW, the MODFLOW model must have daily time steps (though not necessarily daily stress periods), to match the time steps employed by PRMS. The version of the model with 35 annual time steps took approximately 3 to 4 minutes to run. This run time is quick enough that PEST appeared to be feasible to use. If we had set up a version of the model with monthly stress periods and daily time steps, it was estimated that the MODFLOW model would take multiple hours to run, thus making the time involved with a PEST analysis infeasible.

The model parameters selected to vary during the successive PEST runs of the MODFLOW model were horizontal and vertical hydraulic conductivity. Inflows and outflows to the groundwater model such as recharge, streamflow, and pumping have been defined in the water budget. Therefore, it was judged that the hydraulic parameters of the aquifer were the most appropriate model variables to adjust during the PEST runs.

A table of compiled aquifer hydraulic parameter estimates (transmissivity, hydraulic conductivity, specific capacity, and storativity) generated in the Basin over the years was previously compiled by GSI during the preparation of the Basin Characterization Report (included as Appendix A to this TM). These values were used to define the minimum and maximum values of horizontal hydraulic conductivity used in the MODFLOW model during the PEST simulations. Vertical hydraulic conductivity is very rarely measured in the field, so there are no direct measurements for this parameter. However, it is commonly acknowledged that the vertical hydraulic conductivity of an aquifer is lower than the horizontal hydraulic conductivity. Therefore, the PEST constraints for vertical hydraulic conductivity were defined such that they were allowed to vary between 0.1 ft/day and 0.00001 ft/day. This range of variability is considered reasonable because vertical hydraulic conductivity of clays is very low, and significant amounts of clay in an area can significantly impede vertical movement of groundwater.

Separate zones of hydraulic conductivity were defined for each model layer within the Basin, and separate layers within each layer were defined for the areas of Edna Valley and San Luis Obispo Valley (within SLO Valley, separate zones were defined for the main part of the Basin and the “Antlers” area.

3.3.4. PEST Run Summary

The calibration statistics from the optimal PEST run are provided in Table 3-1. A residual (also referred to as error) is defined as the difference between the modeled head and the observed head at a particular calibration target location. Most modelers promulgate a calibration standard that considers both the numerical value of the residual, as well as the range of heads across the model domain. For example if the range of water levels across a model is 10 feet, an average residual of 10 feet is not adequate. But if the range of water levels across a model domain is 250 feet, then an average residual of 10 feet will likely be more than adequate. Several sources propose a standard that the Scaled Root Mean Square Error (that is, the root mean square of all residuals in the model divided by the range of heads observed in the calibration data), referred to hereafter as the Relative Error, be maintained at a level lower than 10% (ESI, 1999; Spitz and Moreno, 1996; ASTM, 2020). The results of this PEST run of the model using annual time steps meet the ASTM standards for groundwater model calibration. Because this model employed annual stress periods, the results did not capture the seasonal variability of water levels inherent in the calibration target data. Wells in the county water level program are monitored twice a year, in spring and summer, and so have to different measurements for each year. This version of the model only generates one water level per year.

Table 3-1: PEST-Generated Calibration Statistics for 35 Annual Stress Period Model

Residual Mean	3.35
Absolute Residual Mean	15.02
Residual Std. Deviation	20.26
RMS Error	20.54
Min. Residual	-122.31
Max. Residual	56.31
Number of Observations	1781
Range in Observations	235.25
Scaled Residual Std. Deviation	8.6%
Scaled Absolute Residual Mean	6.4%
Scaled RMS Error	8.7%
Scaled Residual Mean	0.014

The transient model with annual time steps just described was considered an interim version of the model whose primary purpose was to define an appropriate initial distribution of aquifer hydraulic conductivity for the Basin. Final calibration in the combined GSFLOW model was expected to change significantly, because many of the primary inflows such as recharge, streamflow, and mountain front recharge, which were directly defined in the MODFLOW-only model, would necessarily be generated by PRMS in the GSFLOW simulations and transmitted to MODFLOW for use in the simulations. This is a significant difference. Basic water budget terms needed to be re-assessed in terms of the PRMS-MODFLOW interface in GSFLOW. In addition, the daily time step/monthly stress period time discretization utilized in MODLFOW for the purposes of the integrated GSFLOW simulations creates significantly more detail and variability than the MODFLOW-only simulations.

Section 4. GSFLOW Model Development, Calibration, and Validation

The GSFLOW model is developed by integrating the PRMS and MODFLOW models described in Sections 2 and 3, respectively. The GSFLOW platform is designed to integrate PRMS and MODFLOW models and includes scripts for facilitating this integration. The GSFLOW model grid maintains the same 500-foot grid cells developed for PRMS and MODFLOW.

Model calibration of a groundwater model generally consists of matching simulated groundwater levels to historic water level measurements from wells in the Basin and of matching simulated surface water flows to historic streamflow gage data. This section describes the calibration process, including the modeling period, calibration approach and parameters, and specific calibration goals. In addition to the calibration goals listed below, the model output was evaluated to achieve a model mass-balance error that is within acceptable limits, defined as less than 1 percent based on USGS guidance (Reilly and Harbaugh, 2004).

4.1. Modeling Period

The GSFLOW modeling period will comprise a total of 35 years from Water Years 1985 through 2019. The first two years are considered a “windup” period wherein the model equilibrates prior to the formal calibration period beginning in Water Year 1987, which corresponds to the analytical water budget period. This period enables leveraging of the existing climate data and groundwater data that is available in the Basin. The model was run on daily time steps for the PRMS and GSFLOW and monthly groundwater modeling stress periods with daily time steps in MODFLOW.

4.2. Calibration Approach and Parameters

Calibration of the integrated GSFLOW model will consist of adjustment of specific parameters that govern the surface water and groundwater portions of the model domain. The model calibration approach and parameters that will be adjusted for the surface water and groundwater portions of the model are summarized in the following sections. While the individual calibration of the surface water and groundwater models are discussed in previous separate sections, the individual model calibrations will be confirmed in the coupled GSFLOW model and if further calibration adjustments were needed then parameters in PRMS, MODFLOW were altered

4.2.1. Surface Water

The surface water portion of the GSFLOW model was initially run in PRMS-only mode and then calibrated by comparing model-predicted flows to historic wet season streamflow gage data (Section 4.3.7). Calibrating the model for wet-weather flows in advance of integrating the models will aid the calibration of the groundwater portion of the model in GSFLOW by providing a well-defined spatial representation of groundwater recharge from rain events (Allander et al., 2014). The dry-weather surface water flows will be calibrated within the integrated GSFLOW model (i.e., in conjunction with the groundwater calibration described in Section 6.2.2), due to the inherent dependence of the low flows on the groundwater model. The calibration of dry-weather flows will be based upon comparison to historic streamflow gages, manual streamflow measurements, and wet-dry maps across different seasons and years (Section 4.3.8).

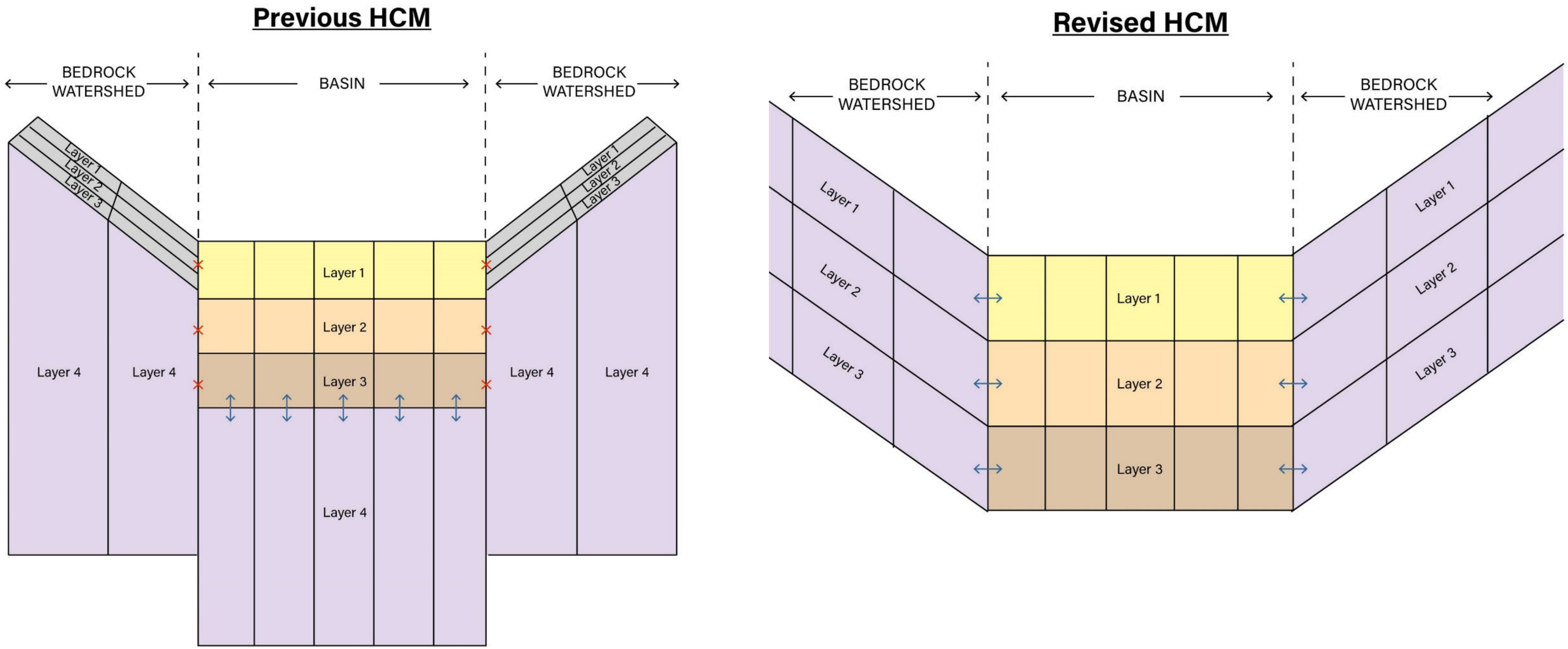
4.2.2. Groundwater

When the combined PRMS-MODFLOW integrated model was initially run in GSFLOW, the transient MODFLOW model was re-discretized temporally to simulate monthly stress periods with daily time step, as required in order to be consistent with the PRMS model. In addition, the Unsaturated Zone Flow Package was added to the MODFLOW model, which is a requirement of GSFLOW and provides the connection between surface and groundwater water from direct precipitation on land surface. After this, the integrated model was run in GSFLOW, and the results were evaluated to ascertain what changes were necessary to achieve a groundwater model calibration that meets the ASTM standards discussed previously.

Modeling problems were encountered with the integrated model that stemmed from the representation of Layer 4 (combined bedrock layer) that crops out in the contributing watershed area and underlies the Basin. These geologic formations are not part of the groundwater basin, and are not really aquifers in the usual sense of the word; they do not readily yield groundwater usable in economic quantities. However, because of the requirements of GSFLOW, it is necessary to include these formations in the groundwater model because the watershed area is an important part of the surface water model.

The primary function of the contributing bedrock watershed area to the groundwater model is to receive output from PRMS, to generate and deliver streamflow to the SFR cells and ultimately to the main area of the basin, some recharge to the fractured bedrock, and flux between the bedrock and the basin sediments. In the original conceptual model developed for this project, the combined bedrock of Franciscan Assemblage, Monterey Formation, and Obispo Formation was to be represented as a single layer, with appropriate parameter estimates assigned for hydraulic characteristics such as hydraulic conductivity, transmissivity, and storativity. Problems arose due to the relatively large area of the bedrock layer as a single layer, with unreasonable quantities of storage needed to be accepted into the layer, and transmitting unreasonable quantities of flux through the bottom of Layer 3 to achieve model calibration. In addition, there was no flux between the bedrock layer and the margins of the Basin, since Layers 1, 2, and 3 pinch out at the margins. Thus, the water budget component of mountain front recharge, as conceptualized in the HCM, was not properly being simulated in the model runs with the original single Layer 4 to represent the bedrock.

Ultimately, it was decided to revise the HCM in order to more realistically represent hydrologic processes in the bedrock layer. Instead of a single monolithic model layer representing the bedrock in the contributing watersheds, the model was changed so that the bedrock was represented by 3 layers. These layers would be analogous to, and in direct contact with Layers 1, 2, and 3 in the Basin, and would not extend beneath the Basin sediments in the main part of the Basin. This conceptualization, displayed in Figure 4-1, allows the model to more readily transmit hydrologic fluxes across the Basin margins and achieve calibration with water derived from the watershed areas without having to resort to an unrealistic upward flux from the original Layer 4. Because the adjusted HCM can now transmit water as mountain block recharge directly to Layer 1, 2 and 3 the original HCM Layer 4 is not needed and was removed to reduce the model run time. Additionally, the streamflow model cells that used to be in Layer 4 were move to Layer 1 with extended thickness below and near the streamflow cell to represent some streamflow infiltration into the fractured bedrock system.



Prepared for:

Author: EC

01/25/2021

SAN LUIS OBISPO VALLEY BASIN GSP

Legend

Notes:

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Groundwater Hydrogeologic Conceptual Model

Figure 4-1

4.3. Calibration Goals

The model calibration goals for the surface water and groundwater portions of the model are presented in the following sections. While the surface water and groundwater calibration goals are discussed in separate sections, the final calibrations were performed in the coupled GSFLOW model.

4.3.1. Surface Water

The surface water evaluation of the GSFLOW model consists of a 'weight of the evidence' approach (Donigian, 2002) where both qualitative graphical comparisons and quantitative statistical comparisons are made. Graphical comparisons generally include visual evaluation of timeseries plots comparing the measured and simulated flow rates at calibrated stream gages, while quantitative comparisons may include calculating a range of standard statistical measures. This approach is nearly identical to the approach taken to evaluate the surface water model calibrated in PRMS-only mode as described in 2.4.3.

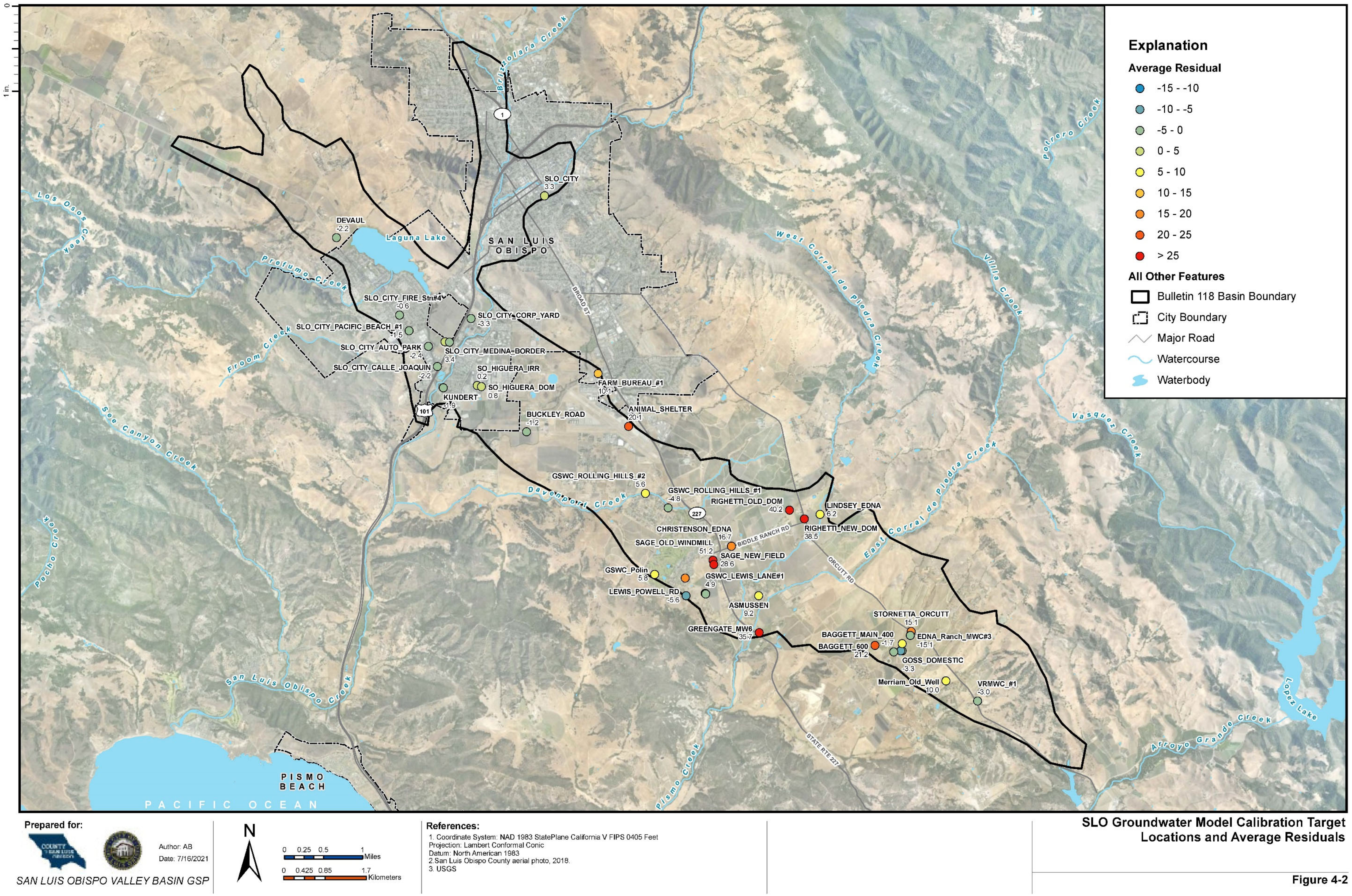
Table 4-1- presents the range of goodness-of-fit criteria as outlined for the Santa Rosa Plain Model (Woolfenden & Nishikawa, 2014) and includes the RMA R^2 categories to further evaluate model fit. The optimal goal is to achieve calibration results within the "Very Good" or "Excellent" range, however, as described in 2.4.3 this may not be feasible.

Table 4-1: Surface water model goodness-of-fit statistics calibration goals.

Goodness-of-fit Category	RMA R^2	PAEE (%)	AAEE (%)	NSME
Excellent	0.9	-5 to 5	≤0.5	≥0.95
Very Good	0.8	-10 to -5 or 5 to 10	0.5 to 1.0	0.85 to 0.94
Good	0.7	-15 to -10 or 10 to 15	10 to 15	0.75 to 0.84
Fair	0.6	-25 to -15 or 15 to 25	15 to 25	0.6 to 0.74

4.3.2. Groundwater

The groundwater model is evaluated primarily on the statistical evaluation of residuals in modeled head (groundwater surface elevation) across the model domain. As previously discussed, the primary goal is to achieve a relative error of less than 10% (ESI, Spitz and Moreno, ASTM). Additional analysis includes scatter plots of observed versus modeled residuals to identify any particular areas that are problematic in the model, and graphs of residuals versus time is presented to identify any model-wide change in residual with time, and to identify if the model has a bias toward positive or negative residuals. Groundwater elevation hydrographs for calibration targets are considered in this statistical evaluation, and are presented in Appendix B. A map displaying the locations of groundwater calibration targets, and the average residual for each target location, is presented as Figure 4-2.



SLO Groundwater Model Calibration Target Locations and Average Residuals

Figure 4-2

After the model-wide calibration goals were achieved, iterative additional simulations continued to be run to attempt to achieve a better fit between modeled and observed data at the specific wells identified as representative wells. In particular, the representation of surface water/groundwater interaction along Corral de Piedras Creeks in the Edna Valley, as expressed in transient groundwater elevations in alluvial wells along the stream course, will continue to be evaluated and a better fit for these alluvial wells will be attempted. The final output of calibration statistics for the GSFLOW model is presented in Table 4-2.

Table 4-2: Integrated GSFLOW Groundwater Model Statistics

Residual Mean	5.6
Absolute Residual Mean	12.8
Residual Std. Deviation	17.4
RMS Error	18.3
Min. Residual	-66.7
Max. Residual	79.5
Number of Observations	2563
Range in Observations	239
Scaled Residual Std. Deviation	7.3%
Scaled RMS Error (Relative Error)	7.6%
Scaled Absolute Mean	5.3%

Summaries of calibration statistics for the Representative Wells identified in Chapters 7 and 8 of the GSP in San Luis Valley, Edna Valley area, and for the combined basin area are presented are presented in Table 4-3. The calibration statistics for the Representative Wells are better than for the model overall.

Calibration figures are presented in Appendix B. Scatter plots of observed versus modeled residuals for the entire model area are presented in Figure B-1. This plot corresponds to the calibration statistics is presented in Table 4-2. Distribution of residuals with time for the entire model area are presented in Figure B-2; these results do not indicate any temporal bias in residuals in the model. Scatter plots and graphs of residuals with time for the SLO Valley representative wells and Edna Valley representative wells are presented in Figures B-3 through B-6.

Final calibrated hydrographs for 42 wells used as calibration targets are included in Appendix B. Hydrographs for wells in San Luis Valley are included as figures B-7 through B-21. Hydrographs for wells located in Edna Valley are presented in Figures B-22 through B-48. Inspection of all 42 hydrographs indicates that the model results approximate observed water levels adequately for the model to be used to assess projects and management actions in this GSP.

Table 4-3 GSFLOW Groundwater Calibration Statistics for Subsets of Model Domain

Calibration Target Subset	Mean Residual (ft)	Residual Standard Deviation (ft)	Relative Error	Well Count
San Luis Valley Representative Wells	2.2	10.8	6.1%	5
Edna Valley Representative Wells	0.4	14.3	6.1%	5
All Representative Wells	0.9	13.6	5.8%	10

The response of the basin aquifer to various stresses observed in the period of record are accurately captured in the model results. Long-term trends of declining water levels in Edna Valley, and the response to pumping and drought conditions in the San Luis Valley in the early 1990s, are reflected in the model results. It is acknowledged that some wells do not display modeled groundwater levels that accurately capture the seasonal fluctuation observed in the field data. This is an area for improvement that will be discussed further at the end of this TM.

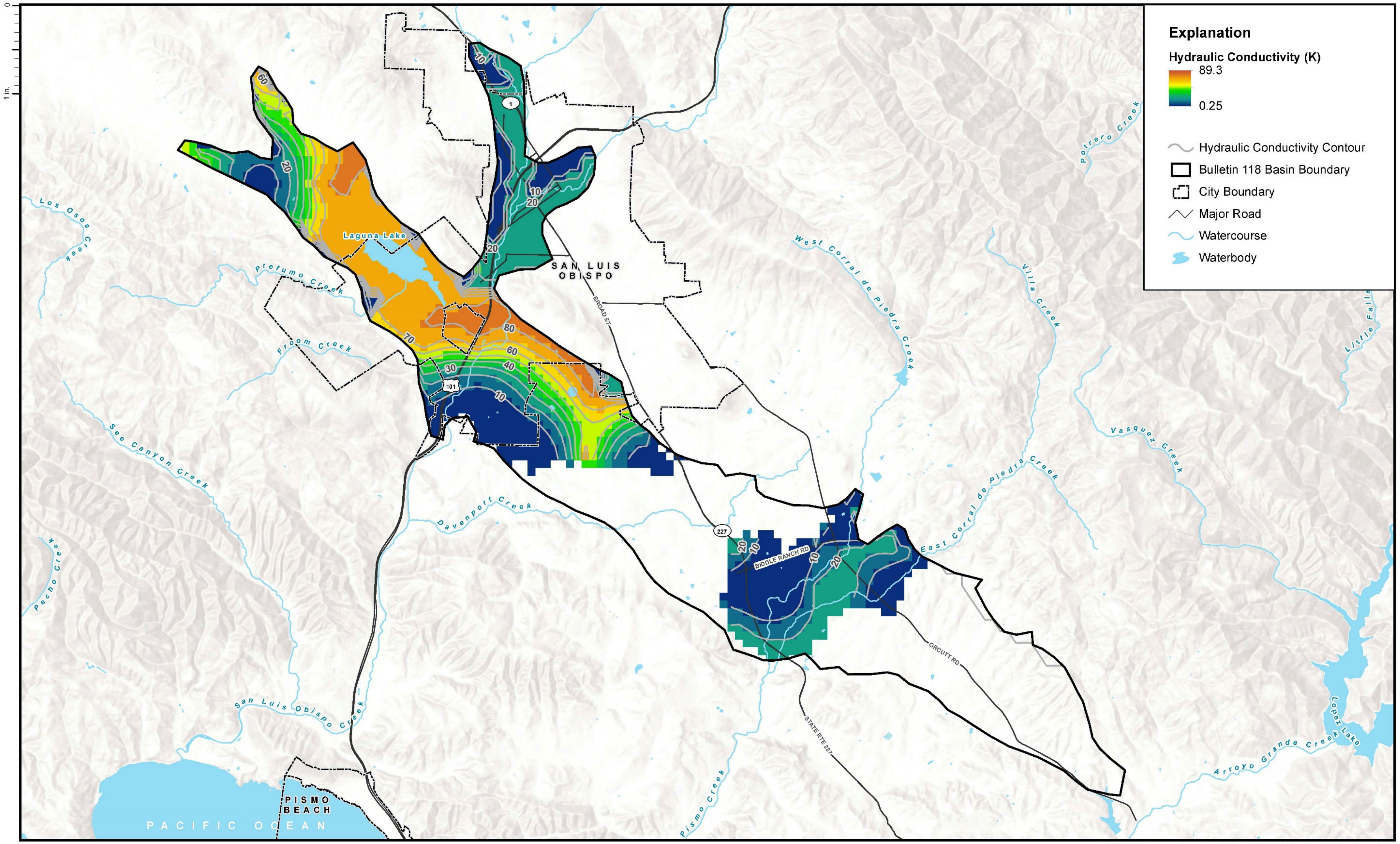
The primary model parameters that affect modeled groundwater elevations are hydraulic conductivity and storativity. Figures 4-3 through 4-5 display the calibrated hydraulic conductivity fields for model Layers 1 (Alluvium), 2 (Paso Robles Formation), and 3 (Pismo Formation). Table 4-3 presents the range and average hydraulic conductivity values for each model layer.

Figures 4-6 through 4-8 present the final calibrated model distribution of specific storage for the model. (Specific storage is multiplied by aquifer thickness to calculate aquifer storativity; specific storage is the parameter required by MODFLOW to define storage in the model.) Table 4-4 presents the range and average values of specific storage for each of the model layers.

Table 4-4 Calibrated GSFLOW Groundwater Model Parameters

Model Layer	Hydraulic Conductivity (ft/day)			Specific Storage (1) (unitless)			Streambed Conductance (ft2/day)		
	Average	Max	Min	Average	Max	Min	Average	Max	Min
1	34.2	89.3	0.25	4.2E-4	9.8E-3	1E-6	1.4	10	0.1
2	14.2	31.2	0.1	9.3E-5	1.5E-3	1E-6	na (2)	na	na
3	8.9	50.0	0.1	1.0E-4	1.5E-3	1E-6	na	na	na

Notes: 1. Specific Yield was set at 0.05 for all layers.
2. na = not applicable. (Streams only represented in Layer 1).



Prepared for:

Author: AB
Date: 7/6/2021

SAN LUIS OBISPO VALLEY BASIN GSP

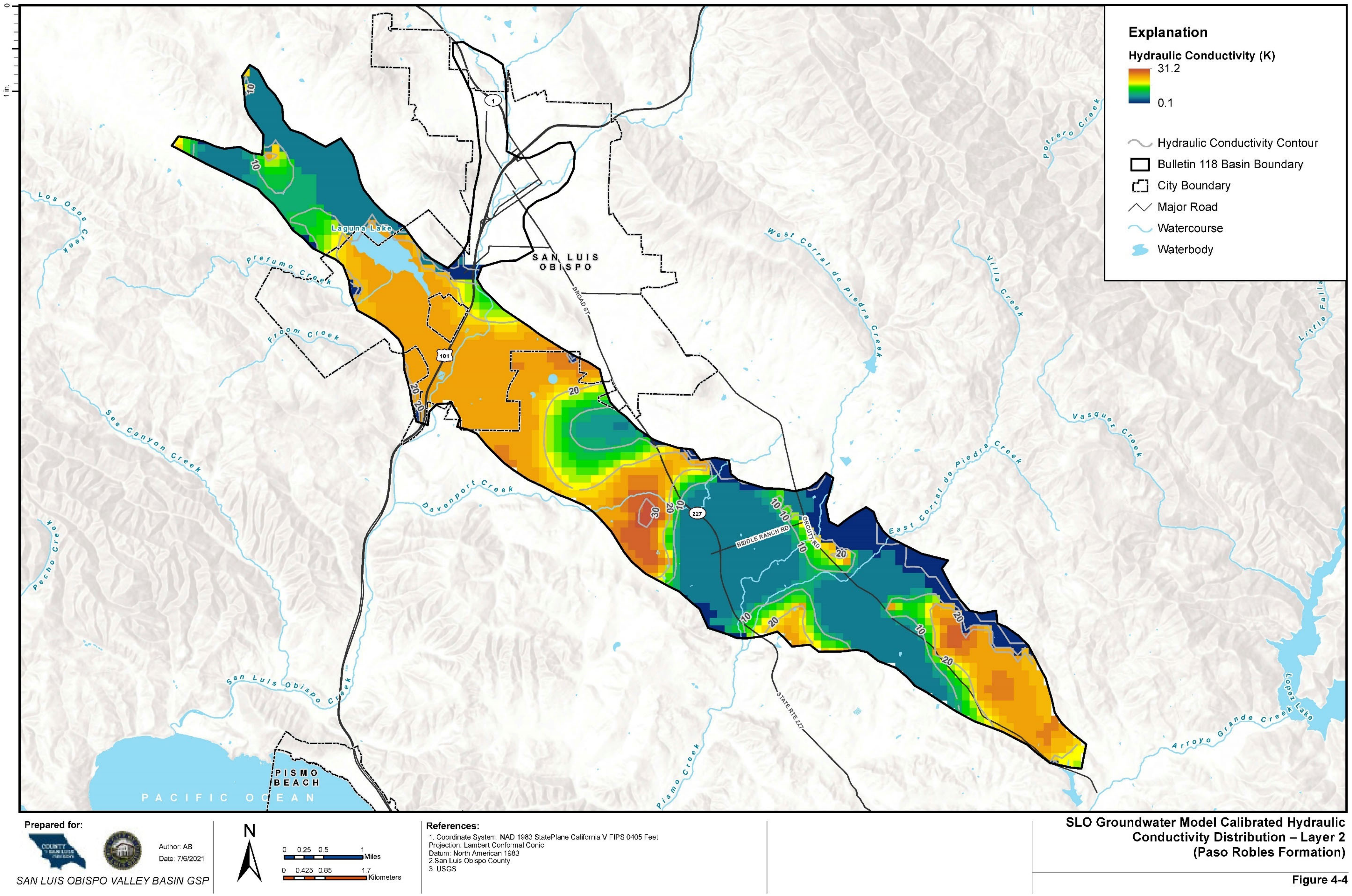
N

0 0.25 0.5 1 Miles
0 0.425 0.85 1.7 Kilometers

References:
1. Coordinate System: NAD 1983 StatePlane California V FIPS 0405 Feet
Projection: Lambert Conformal Conic
Datum: North American 1983
2. San Luis Obispo County
3. USGS

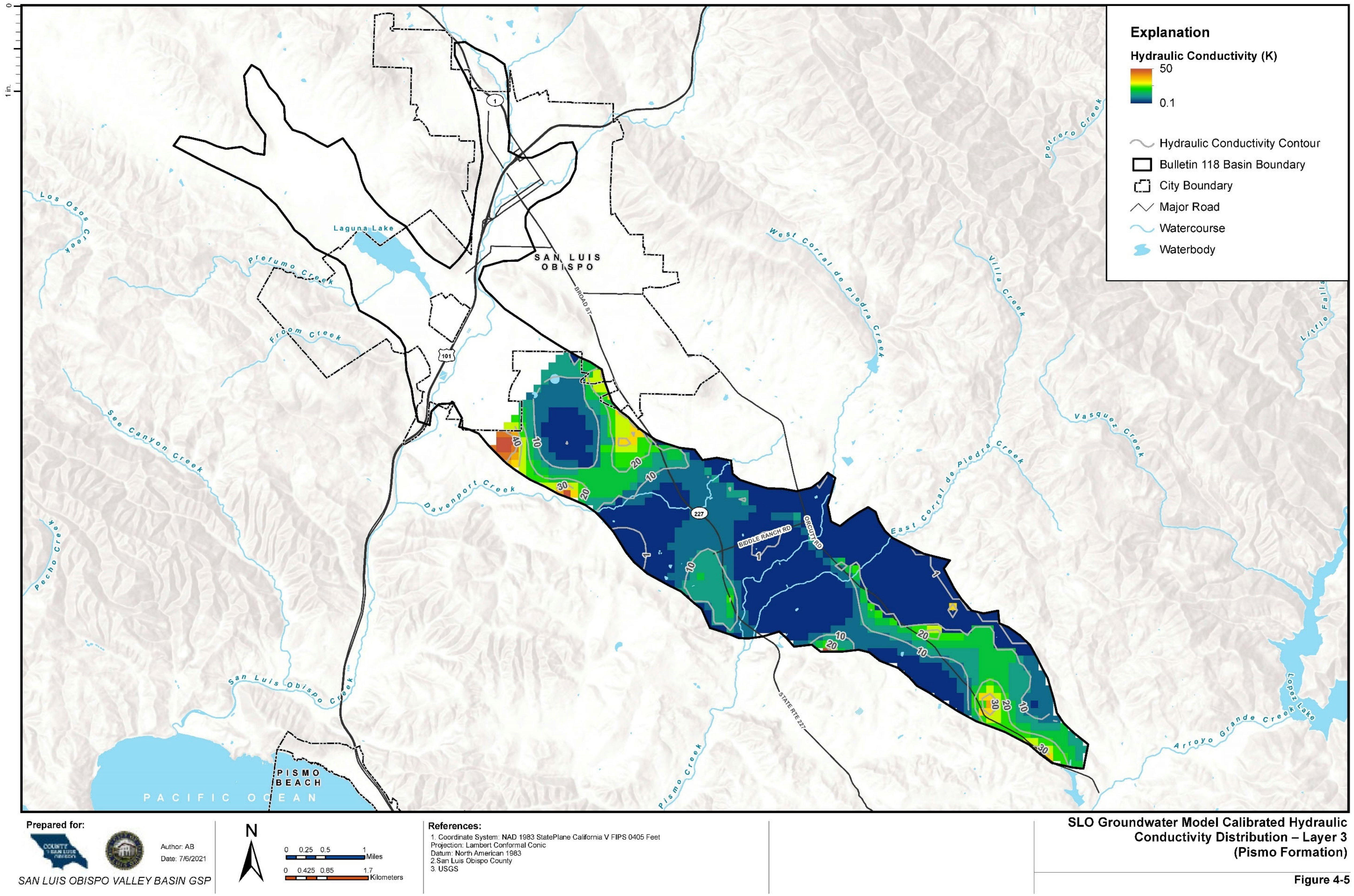
SLO Groundwater Model Calibrated Hydraulic Conductivity Distribution – Layer 1 (Alluvium)

Figure 4-3



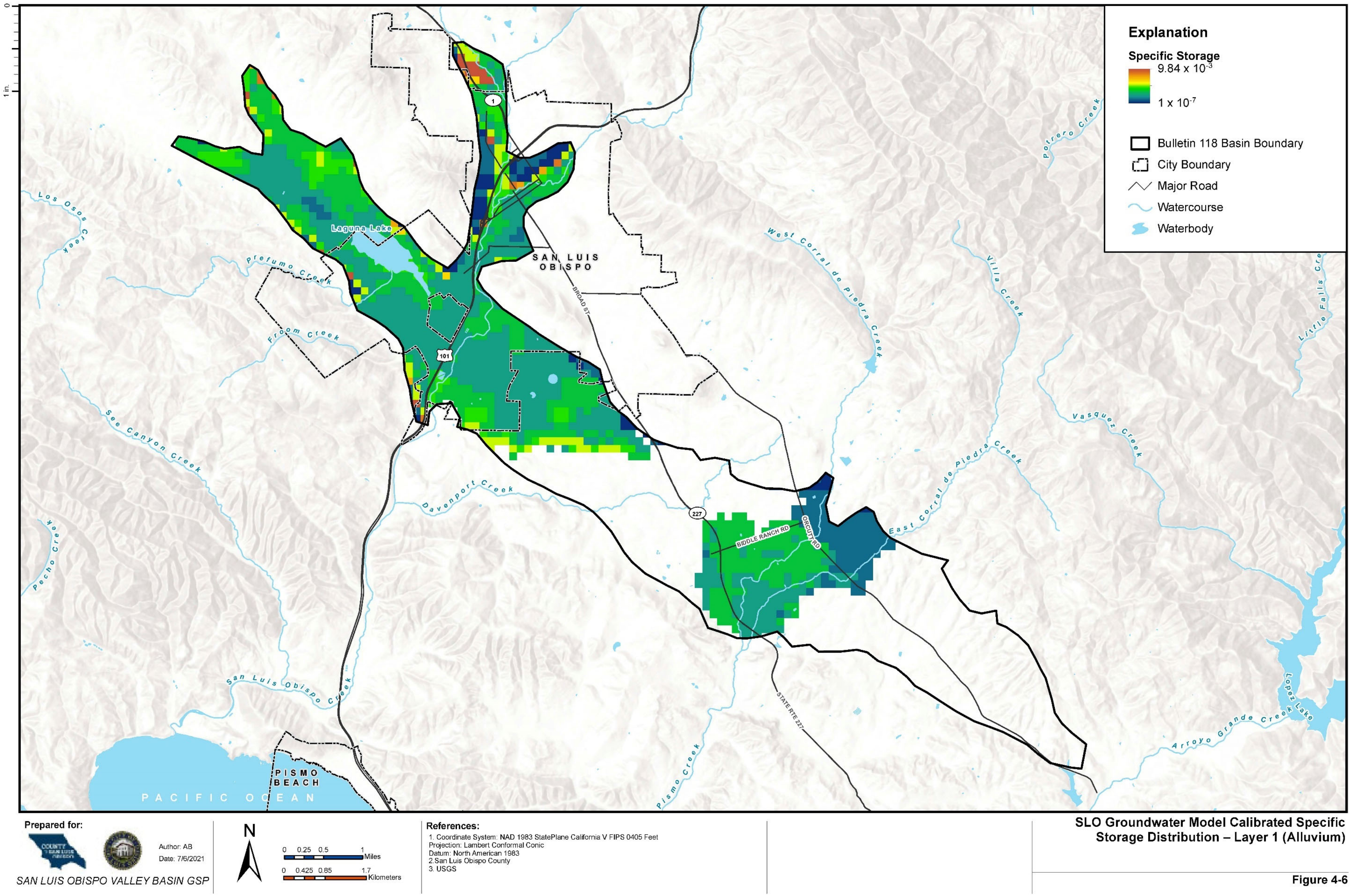
SLO Groundwater Model Calibrated Hydraulic Conductivity Distribution – Layer 2 (Paso Robles Formation)

Figure 4-4



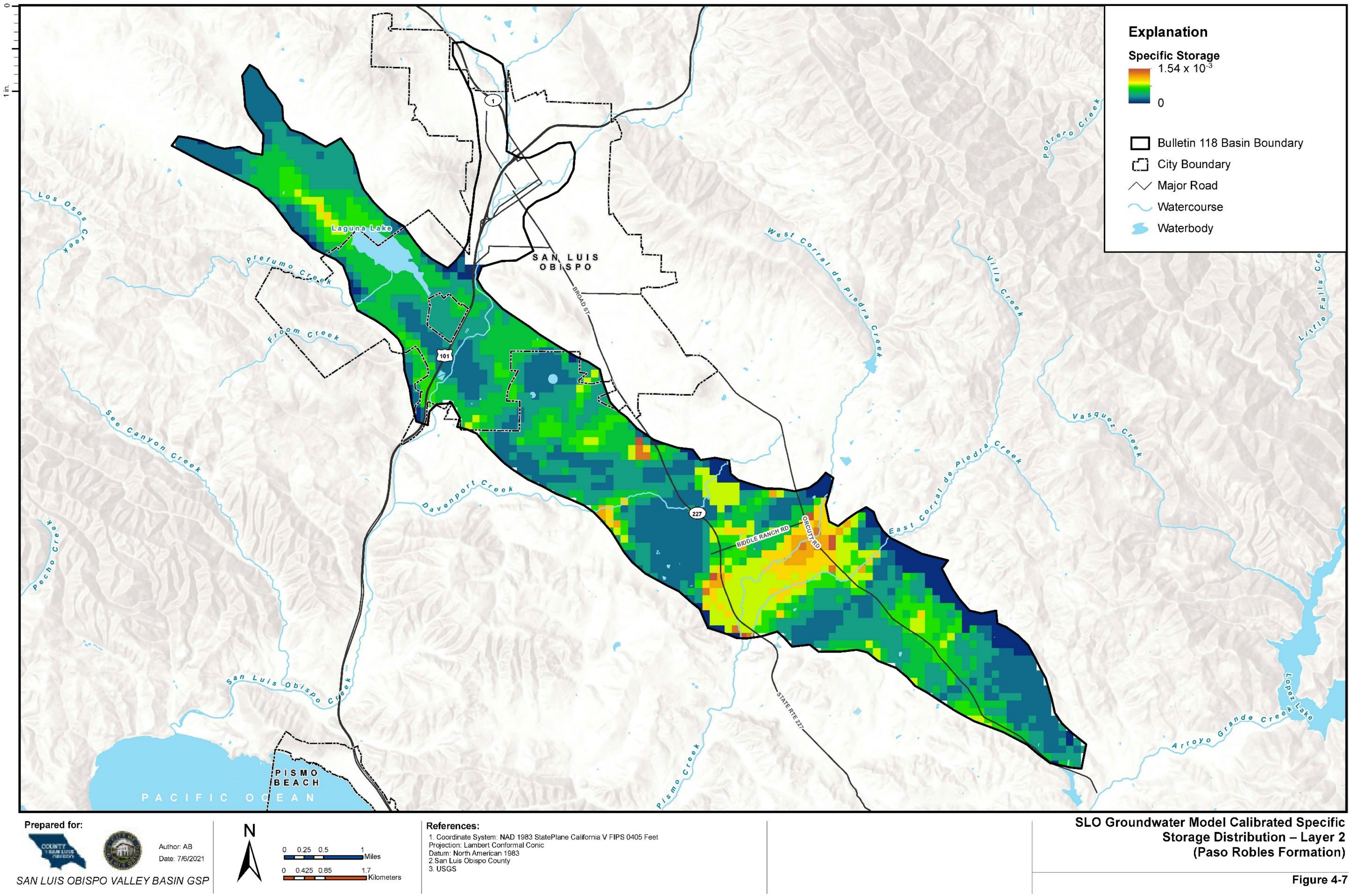
SLO Groundwater Model Calibrated Hydraulic Conductivity Distribution – Layer 3 (Pismo Formation)

Figure 4-5



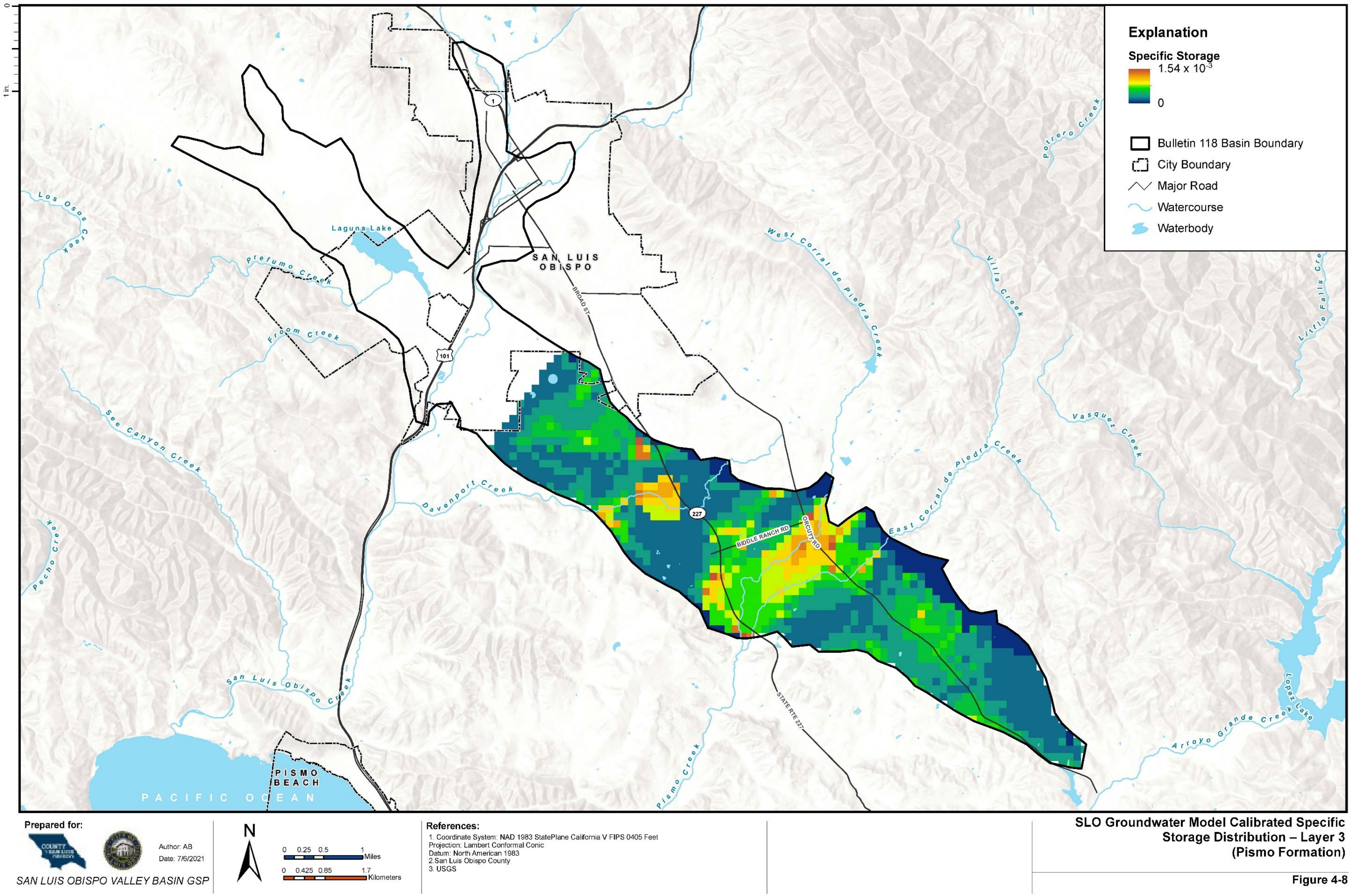
SLO Groundwater Model Calibrated Specific Storage Distribution – Layer 1 (Alluvium)

Figure 4-6



SLO Groundwater Model Calibrated Specific Storage Distribution – Layer 2 (Paso Robles Formation)

Figure 4-7



SLO Groundwater Model Calibrated Specific Storage Distribution – Layer 3 (Pismo Formation)

Figure 4-8

Section 5. Sensitivity Analysis

Sensitivity analysis is the process of identifying the model parameters that have the most effect on calibrated model results. The general approach to complete a sensitivity analysis is to systematically vary selected model parameters or boundary conditions, and measure their effect on model results. Model results may be assessed using modeled water levels or calibration statistics.

For the purpose of evaluating the integrated model, the following parameters were selected for sensitivity analysis. These parameters were selected based on previous modeling experience with identification of sensitive and significant model parameters, and consideration of the local hydrogeologic setting. The summary of calibrated values for these parameters are presented in Table 4-4. (The values for pumping used in the model were obtained from the analytical water budget analysis.)

- Horizontal hydraulic conductivity.
- Storage (specific storage and specific yield)
- Streambed Conductance
- Pumping

Each of these parameters was varied by plus and minus 20% of the final calibrated value. The effect of this variation in parameter values on the calibrated model is measured by the effect on the sum of residuals squared (RSS), a common calibration statistic. Results are presented in Figure 5-1, and discussed below.

The most sensitive parameter among the four parameters evaluated is pumping. The change in the RSS from the calibrated model ranged from -8.7% to 8.2% of the baseline RSS value. Municipal and agricultural pumping was estimated during the water budget based on available information regarding agricultural practices and residential development, and these estimates were incorporated into the model. Pumping locations were assigned based on GIS well data provided by the county. It was observed during calibration that the distribution of agricultural pumping locations had a significant impact on calibration of representative wells in the Edna Valley. One of the management actions proposed in the Implementation Plan (Chapter 10 of the GSP) is a well metering and reporting program to gather information on non-de minimis wells in the Basin. This plan will provide better data on pumping amounts and locations within the Basin, and will inform future revisions to the model.

The second most sensitive parameter among the four parameters evaluated is aquifer storage. The change in the RSS from the calibrated model ranged from 5.3% to -3.8% of the baseline RSS value. Data on storativity in the Basin is sparse. It is necessary to measure water levels in an observation well during a constant rate aquifer test in order to calculate storativity, and this is rarely done for municipal or agricultural wells. Values typical of confined aquifers were used as initial estimates, and some distribution of storativity values was generated using PEST. Storativity can have a significant impact on seasonal fluctuations of water levels in an aquifer. This parameter should be evaluated further in future model revisions.

The third most sensitive parameter among the four parameters evaluated is streambed conductance. The change in the RSS from the calibrated model ranged from 1% to -0.9% of the baseline RSS value. Streambed conductance is a lumped parameter conceptually incorporating hydraulic conductivity of alluvium, model cell size, and thickness of alluvial sediments. It is not directly measurable. Streambed conductance may have a more significant effect on modeled water levels in the Edna Valley than the San Luis Valley due to the seasonal recharge from East and West Corral de Piedras Creeks, and observed water level fluctuations that mimic surface water flow patterns.

The least sensitive parameter among the four parameters evaluated is horizontal hydraulic conductivity. The change in the RSS from the calibrated model ranged from 1% to 0.1% of the baseline RSS value. This is the only parameter among those evaluated that had higher RSS values than the baseline calibrated value for both the increase and decrease of parameter value variations. This indicates that the calibrated horizontal hydraulic conductivity field may be close to optimal, and significant changes in the distributed parameter field don not have correspondingly large effects on calibration.

Uncertainty analysis is an option for model evaluation that is mentioned in the DWR Groundwater Modeling BMP document. In uncertainty analysis, the methodology is essentially identical to that of sensitivity analysis, in that model parameters are varied and the effect on model output is evaluated. However, in uncertainty analysis, variation of model parameters is performed on the predictive model (instead of the calibrated historical model), and results are measured as changes in water level from the calibrated predictive model runs (instead of changes on calibration statistics). The modeling team judged that given the admitted uncertainty regarding pumping volumes and locations, streambed parameters, and storage parameters, that a formal uncertainty analysis is likely premature. The results would likely be quite similar to the sensitivity analysis just presented. It will be considered during any future revisions to improve the model.

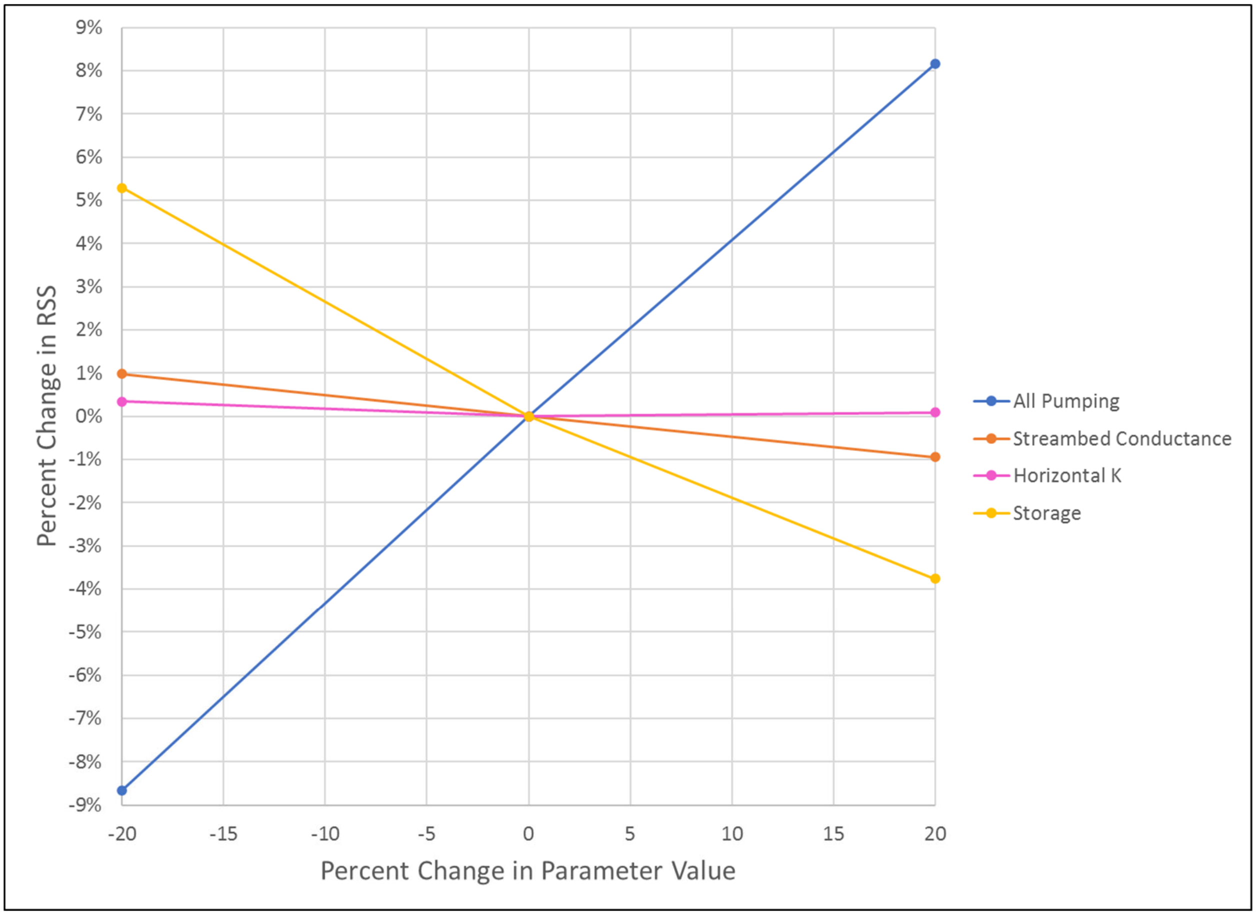


Figure 5-1. Model Sensitivty Analysis Results

Section 6. Summary, Areas for Model Improvement, and Next Steps

This TM has presented the data summary, revised HCM, final model calibration results, and sensitivity analysis for the GSFLOW model of the San Luis Obispo Valley Groundwater Basin and its contributing watersheds. The model calibration results are within industry standards, and the model is judged by the modeling team to be adequate for the objective of assessing projects and management actions identified in the GSP.

Projects and management actions identified by the GSAs as potential actions to assess using the model include reduction of agricultural pumping, reduction of mutual water company pumping, installation of a recharge basin, and relocation of the Sentinel Peak Pismo Creek discharge point from its present location to a location within the Basin. These simulations were performed. Changes in water levels from baseline conditions at representative wells are documented in Chapter 9 of the GSP.

The GSP process mandated by SGMA requires updates to the GSP every 5 years. During these updates, models may be revised considering new data and information collected during the intervening period between the last version of the GSP and the new one. As such, it is expected that this GSFLOW model will be updated to incorporate new data generated by an improved monitoring network, updated water level data from existing calibration targets, potential revisions to the HCM, and other factors. During the development of the model, numerous areas were identified as areas for potential improvement when the GSP is updated in 5 years. Some of these are discussed below.

Potential areas for model revision and improvement include:

1. Representation of the groundwater/surface water interaction in Edna Valley is a significant area to focus on in the future. Although long-term trends in water level declines were captured, many of the modeled results for wells in the vicinity of West Corral de Piedras Creek do not accurately capture the amplitude of seasonal or drought cycle fluctuations in water levels. Because of their proximity to the creek, it is speculated that there may be a stronger influence of seasonal surface water flow on water levels in this area than the model is capturing. Improvements to the surface water monitoring network as proposed in Chapter 7 of the GSP will provide important additional data describing the surface water flow regime that could help with this important component of the Basin aquifer system.
2. A revision to the HCM to include a fourth model layer representing bedrock beneath the Basin may be appropriate. If this change is implemented it may more accurately represent some wells that are screened in both the alluvial sediments and the underlying Monterey Formation, and simulate the expected vertical flow from underlying bedrock into the lowest of the aquifer strata throughout the Basin. In addition, it may not be necessary to have all four layers active in the upper watershed. It may improve run times if only the top layer is active in the upper part of the bedrock contributing watershed, and incorporate bedrock layers two through four closer the Basin boundary.
3. A more detailed evaluation of vertical hydraulic conductivity (Kv) for all three model layers in the Edna Valley may help the representation of seasonal and drought cycle water level fluctuations for wells in this area. Kv was initially determined during the PEST runs of the annual

stress period version of the model, allowing Kv to be estimated independent of horizontal K. Much of the PEST-generated distribution was manually revised during final calibration. A closer inspection of Kv in areas where seasonal amplitude of water level changes is not captured may be appropriate.

4. Assess and improve precipitation input distribution and increase volume, especially from 1995-1998, because water levels in Edna do not exhibit the rise that they get in the comparable wet water year 2005. Because of the water year 2005 water level response, the model response to wet years appears adequate, so it is inferred that the spatial distribution of precipitation input can possibly be improved.
5. Modeled change in storage calculation for period of record for both SLO Valley and Edna Valley are less than the analytic estimates presented in Chapter 6 of the GSP (water budget), especially in Edna Valley. Again, the change in storage is level during wet period from WY 95 thru 98 which is counter intuitive; the model needs more water during this period.
6. Outflow from the entire SLO basin is modeled as an average of 10,500 AFY whereas the analytic estimate presented in Chapter 6 is 16,000 AFY. If the water budget estimate is closer to reality, (which is uncertain since there is no reliable stream gage data measuring flow out of the basin), then this indicates the model could use more precipitation volume input. Improvements in the Surface Water monitoring network proposed in Chapter 7 of the GSP will help with this evaluation.
7. Based on items 4 through 6, it appears that model may be running on the dry side which leads to more numerical convergence issues and mass balance discrepancies, and to counter this the GW model “borrows” water from the basin outflow. The model fails to reach convergence during 29 daily time steps out of the 12,783 daily GSFLOW iterations. The groundwater model has zero mass balance errors for all the 12,783 time steps. The surface water component of GSFLOW model has significant mass balance errors for 12 of the 12,783 days, which occur during very wet days. Eleven of the 12 occurrences and a mass of approximately 50 to 100 acre-ft per month or 10% of the total flow of that month. On the wettest day on 1-3-2006 a mass balance error of 3,000 acre-ft per month occurs or 10% of the total flow for that month.
8. Based on item 7 the model could be numerically improved for those 12 days. However, without reliable stream gage data we will not know if this error actually makes the model better or worse. Nor do we know if Chapter 6 water budget estimates (16,000 AFY) are better or worse than the modeled outflow results (10,500 AFY). It is therefore important to install stream gages that measure the outflow of the basin at key locations so we can more reliably estimate the correct volume of surface water leaving the basin. With this improved surface water outflow estimates, it would makes sense to address and improve on the issues mention in Bullet 4 thru 7 for the 5-year model update.
9. Groundwater evapotranspiration was not explicitly modeled because the UZF Package removed water above ground surface during the simulation that effectively conceptualized as ET. This was primarily due to long model run time issues during calibration process. Now that the model is calibrated and has a comparatively shorter run time (4-5 hours) it may make sense to explicitly model groundwater ET during future revisions to provide a little bit more spatial control of how much and where it happens. Groundwater ET is minimal in the Edna Basin and predominantly occurs SLO Basin, but the since the model calibration is excellent in the area of known groundwater ET statistically we do not expect great improvement with respect to water levels.

10. Water level calibration has the largest residuals either close to the mountain front (northern Basin boundary) or in the main SLO/Edna border pumping depression. Improvements near the mountain front could be effected through structural changes in local layer elevations, storage, pumping, return flow and/or K, but local refinement of these parameters were not very sensitive.
11. Similarly, the water levels in Greengate and Christensen Representative Wells were also not very sensitive. It may be advisable to revisit PEST for a more focused assessment of K and S in these area; however, it is not practically feasible to use PEST for a model that takes 4 to 5 hours to run. In addition for these two key wells pumping distribution was varied to greater success. For the key wells a more detailed evaluation of agricultural pumping in their vicinity will be collected through the proposed metering and reporting program.
12. Implementation of the metering and reporting program for non-de minimis wells in Edna Valley will provide important information with respect to the volume and distribution of pumping in Edna Valley. It was determined during calibration and during sensitivity analysis that model results are quite sensitive to pumping data. More accurate data on well locations and reported pumping will be a significant improvement over the estimated values used to date.

Next steps that will provide improvement to any model updates as outlined in Chapter 10 of the GSP (Implementation Plan) include implementation of an expanded groundwater level monitoring network, installation of multiple stream gages in the Basin (and development of reliable rating curves for existing gages on San Luis Creek), implementation of a metering and reporting plan for non-de minimis wells.

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Appendix A –Groundwater Hydraulic Parameters

Appendix A Table of Contents

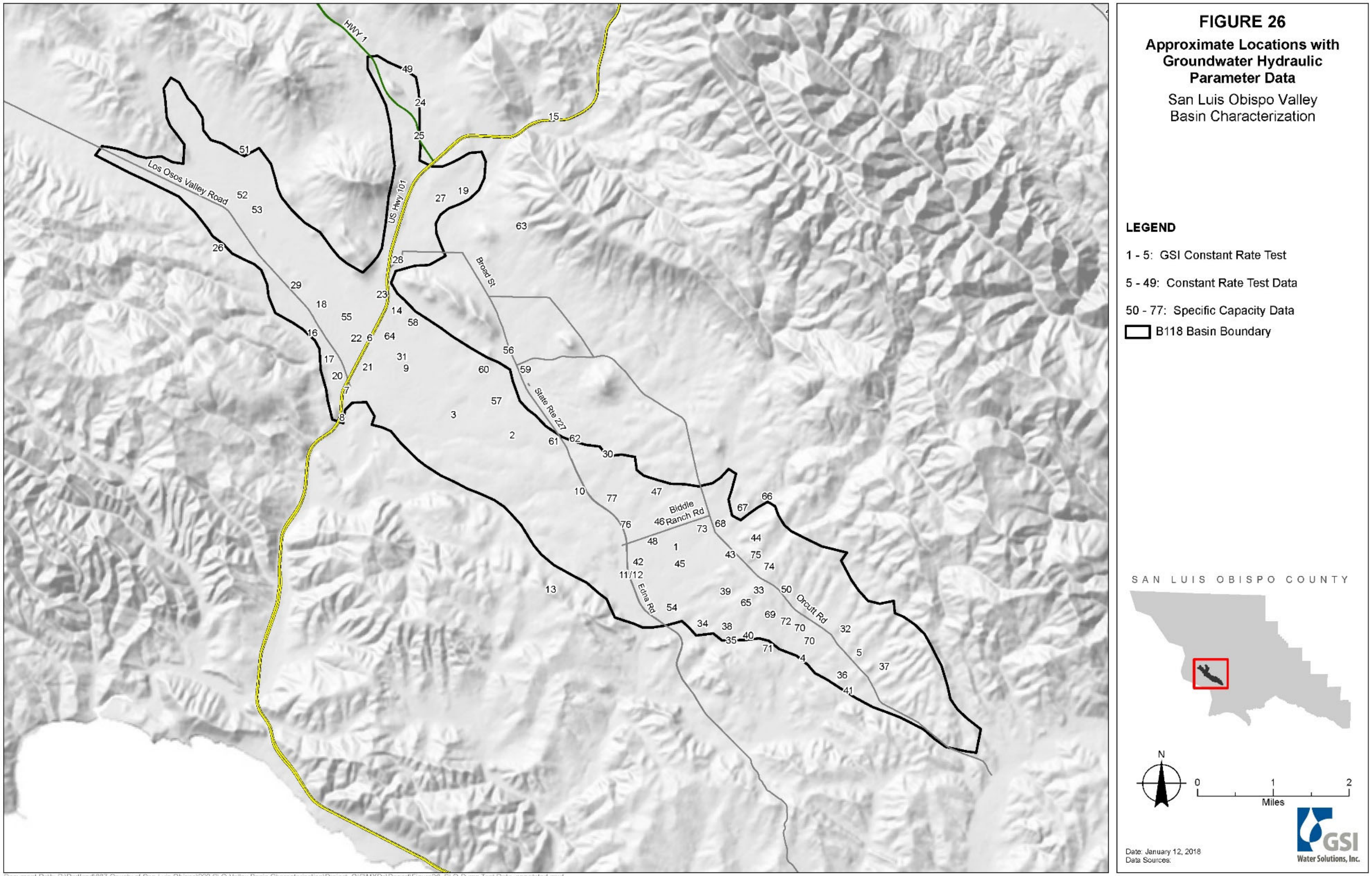


FIGURE 26
Approximate Locations with Groundwater Hydraulic Parameter Data
San Luis Obispo Valley Basin Characterization
LEGEND
1 - 5: GSI Constant Rate Test
5 - 49: Constant Rate Test Data
50 - 77: Specific Capacity Data
B118 Basin Boundary
SAN LUIS OBISPO COUNTY
Miles
Los Osos Valley Road
US Hwy 101
HWY 1
Broad St
State Rte 227
Biddle Ranch Rd
Edna Rd
Orcutt Rd
Date: January 12, 2018
Data Sources:

San Luis Obispo Valley Basin water well pump test data summary

Label No.	Date Drilled	Pump Test Date	Pumping Rate (GPM)	Static Water Level (feet bgs)	Pumping Water Level (feet bgs)	Drawdown (feet)	Specific Capacity (gpm/foot)	Est. Transmissivity (gpd/foot)	Screen Length (feet)	Hydraulic Conductivity (ft/day)	Total Depth (feet)	Perforations	Formation Screened
1		7/31/2017	60	74.3	133	58.7	1.02	2,880 - 4,525	280	1.37 - 2.15	440	180-200; 240-380; 320-440	Pismo
2		8/8/2017	27	21	27.5	6.5	4.2	3,605 - 4,620			98		Paso Robles
3		8/24/2017	55	15.58	78	62.42	0.9	3,227 - 4,840					Paso Robles
4		11/21/2017	265	67.6	155.2	87.6	3.03	1,600	300	2.82 - 3.11	500	200-500	Pismo
5	12/4/2017	12/9/2017	37	132	144.9	12.9	2.87	5,692 - 9,678	200	3.8 - 6.5	300	90-290	Paso Robles/Pismo
6	2/7/2003	2/18-21/2003	350	7.5	39.6	32.1	11	23,100	60	51.3	145	45-85; 115-135	Alluvium/Paso Robles
7	1/31/2003	2/6/2003	400-450	8.92	28.67	19.75	33.3	66,600	45	197.3	80	25-70	Alluvium/Paso Robles
8	2/10/2003	2/19/2003	250	5.5	28.92	23.42	9.3	18,600	30	82.7	70	30-60	Alluvium/Paso Robles
9	4/18/1996	4/19-21/1996	3.7	11.86	23.36	11.5	0.32	187	15	1.7	70	52-67	Alluvium
10	1/23/2013	2/5-9/2013	135	46.78	114.41	67.63	2	3,992	60	8.9		80-100; 140-180	Paso Robles/Pismo
11	8/18/1992	5/31/1992	656	52.4	122.3	69.90	9.38	5,773	200	3.8	440	130-190; 290-430	Pismo/Bedrock
12	4/4/2001	5/9/2001	500	70	85	15	33.33	66,667	180	49.4	520	160-200; 370-510	Pismo/Bedrock
13		5/12-16/2014	149	258.25	295.1	36.85	4.35	8,700	190	6.1	550	280-420; 490-540	Pismo/Obispo or Bedrock
14	6/15/1988	6/30/1988	135	20.5	25.9	5.4	25	50,000	20	333.3	80	50-70	Alluvium/Paso Robles
15	7/12/1988	7/15/1988	80	24	42	18	4.44	8,889	30	39.5	57	27-57	Alluvium
16	7/22/1988	7/26/1988	300	11.5	Incomplete Data						140	40-130	Alluvium/Paso Robles
17	4/20/1989	5/16/1989	250	11.5	53.3	41.8	5.98	15,000	70	28.6	140	60-130	Alluvium/Paso Robles
18	7/27/1988	9/2/1988	95	22	59	37.0	2.57	5,135	70	9.8	180	55-125	Alluvium/Paso Robles
19	7/25/1988	8/4/1988	70	24	27.3	3.3	21.21	42,424	20	282.8	48	28-48	Alluvium
20	10/6/1989	10/24/1989	375	10.42	33.58	23.16	16.19	21,300	95	29.9	175	60-120; 140-175	Paso Robles/Pismo
21	6/28/1989	7/6/1989	200	10.4	38.5	28.1	7.12	21,120	60	46.9	175	50-90; 150-170	Alluvium/Paso Robles
22	4/26/1989	5/10/1989	900	11	39.3	28.3	31.80	63,604	80	106.0	140	42-122	Alluvium/Paso Robles
23		6/14/1989	500	20	47	27	18.52	37,037			60	?	Alluvium
24	12/22/1989	12/27/1989	50	11	31.2	20.2	2.48	4,950	15	44.0	53	33-48	Bedrock
25	4/18/1989	4/20/1989	100	14	26	12	8.33	16,667	10	222.2	44	34-44	Alluvium
26		7/18/1986	60	55	280	225	0.27	533	80	0.9	296	220-300	Bedrock
27		5/15/1989	80	9.92	31	21.08	3.80	26,400	20	176	49	29-49	Alluvium
28		4/22/1993	165	19.63	33.4	13.77	11.98	87,120	30	387.2	65	30-60	Alluvium
29		10/10/1990	25	39.5	78.5	39	0.64	400	80	0.67	145	60-140	Paso Robles
30		7/20/2011	20	46.5	272	225.5	0.09	177	140	0.169	300	160-300	Bedrock
31		6/26/1991	100	20	58	38	2.63	24,000	40	80	140	90-130	Paso Robles
32		4/12/1994	90	53.46	120	66.54	1.35	2,640	85	4.141	170	85-170	Pismo
33		6/26/1989	596	51.2	147.5	96.3	6.19	3,311	280	1.577	400	60-120; 160-360; 380-400	Paso Robles/Squire
34		6/15/2007	350	65.5	138	72.5	4.83	10,266				200-?	
35		6/15/2007	300	37.5	134	96.5	3.11	7,401				170-?	
36		6/9/1985	295	36.25	98.45	62.2	4.74	33,807			240		Paso Robles/Pismo
37		2/10/1997	300	110.2(?)	131.3	21.2	14.15	39,600	220	24	490	190-290; 350-410; 430-490	Pismo
38		8/6/2014	150	166	215	49	3.06	3,046			300		
39		8/7/2014	158	171	219	48	3.29	3,627			310		
40		12/12/2008	170	116	186	70	2.43	5,081					
41		12/22/2005	350	39.6	82	42.4	8.25	18,480	230	10.71	430?	200-430	
42		6/29/2016	150	131.8	226.1	94.3	1.59	10,850	100	14.47	290	180-280	Pismo
43		6/30/1993	100	39.66	78.83	39.17	2.55	1,508	60	3.35	110	50-110	Paso Robles
44		7/21/1993	70	10.5	21.5	11	6.36	2,174	40	7.25	100	20-40; 80-100	Paso Robles/Bedrock
45		3/25/2008	200	76.7	219.3	142.6	1.40	3,105	200	2.07	400	130-170; 220-380	Pismo
46		4/3/2007	300	34.6	112.3	77.7	3.86	9,542	260	4.89	480	220-480	Bedrock
47		4/9/2007	400	28.3	78	49.7	8.05	26,400	240	14.67	420	180-420	Pismo
48		12/17/2015	150	114	266	152	0.99	851 - 1,414	?		299	?	Pismo
49		10/28/2010	600	26.5	32.3	5.8	103.45	158,400					Alluvium/Paso Robles

San Luis Obispo Valley Basin groundwater basin water well specific capacity data summary

Label No.	Date Drilled	Specific Capacity Test Date	Pumping Rate (GPM)	Static Water Level (feet bgs)	Pumping Water Level (feet bgs)	Drawdown (feet)	Specific Capacity (gpm/foot)	Duration (hours)	Est. Transmissivity (gpd/foot)	Screen Length (feet)	Estimated Hydraulic Conductivity (ft/day)	Total Depth (feet)	Perforations	Formation Screened
48			435				6-10		10,000-20,000			250?		Paso Robles/Pismo
49		May 1999	12	10	24	14	0.86	4	1,714	?		30		Alluvium
50	1995	2002	18	19	63	44	0.41	12	818			86		Alluvium/Paso Robles
51	2003	2003	3.5	16	42	26	0.13	72	269			80		Alluvium/Paso Robles
52		7/18/1966	130			60	2.17	20	4,333	30	19.3	90	60-90	Paso Robles
53		4/15/1987	200			30	6.67	12	13,333	30	59.3	110	80-110	Paso Robles
54		12/22/1972	60			30	2	8	4,000	25	21.3	75	50-75	Alluvium
55		1980	24			110	0.22	8	436	80	0.7	160	80-160	Bedrock
56		9/11/1991	15			13	1.15	8	2,308	40	7.7	90	50-90	Alluvium
57		9/12/1959	1.25			8	0.16	4	313	10	4.2	28	18-28	Alluvium
58		3/4/1957	45			18	2.5	12	5,000	17	39.2	37	20-37	Alluvium
59		3/15/1961	12			6	2	5	4,000	5	106.7	85	40-43; 75-77	Alluvium/Paso Robles
60		3/30/1956	8			4	2	2	4,000	15	35.6	32	17-32	Paso Robles
61		9/18/1989	5			20	0.25	1	500	10	6.7	50	40-50	Bedrock
62		8/29/1990	4			14	0.29	4	571	30	2.5	50	20-50	Alluvium
64		8/7/2014	47	206	257	51	0.92	1.5	1,843			340		Unknown
65		7/21/1993	75	22	33	11	6.82	4	13,636	50	36.36	100	50-100	Bedrock
66		7/23/1993	69	11	16.25	5.25	13.14	4.5	26,286	55	63.72	100	25-65; 85-100	Paso Robles/Bedrock
67		July 1993?	32	40	95?			4				120	60-120	Paso Robles
68		7/19/2012 5/19/2014 4/24/2017	83 104 109	45 82 178	87 123 212	42 41 34	2.0 2.5 3.2							Paso Robles/Pismo
69		5/9/2014 4/24/2017	94 124	182 85	196 117	14 32	6.7 3.9							Paso Robles/Pismo
70		4/24/2017	206	100	123	23	9.0							Paso Robles/Pismo
71		7/19/2012 5/19/14 4/24/17	320 367 483	98 133 104	101 183 141	3 50 37	106.7 7.3 13.1							Paso Robles/Pismo
72		12/5/12 5/19/14 4/24/17	93 55 81	86 140 50	101 65 152	15 12 15	6.2 4.6 5.4							Paso Robles/Pismo
73		12/11/12 4/24/17	23 30	55 25	57 26	2 1	15.5 30.0							Paso Robles/Pismo
74		12/11/2012	17	62	66	4	4.7							Paso Robles/Pismo
75		12/5/2012 5/19/14 4/24/17	133 104 127	73 96 89	98 152 126	25 56 37	5.3 1.9 3.4							Paso Robles/Pismo
76		12/5/2012 5/19/14 4/24/17	96 91 91	71 94 85	98 123 99	27 29 14	3.6 3.1 6.5							Paso Robles/Pismo
33		7/19/2012 5/19/14 4/24/17	183 169 259	107 86 75	135 132 135	28 46 60	6.5 3.7 4.3							Paso Robles/Pismo
32		4/24/2017	311	116	176	60	5.2							Paso Robles/Pismo
1		4/24/2017	65	29	49	20	3.3							Paso Robles/Pismo

Appendix B –GSFLOW Groundwater Calibration Figures

Appendix B List of Figures

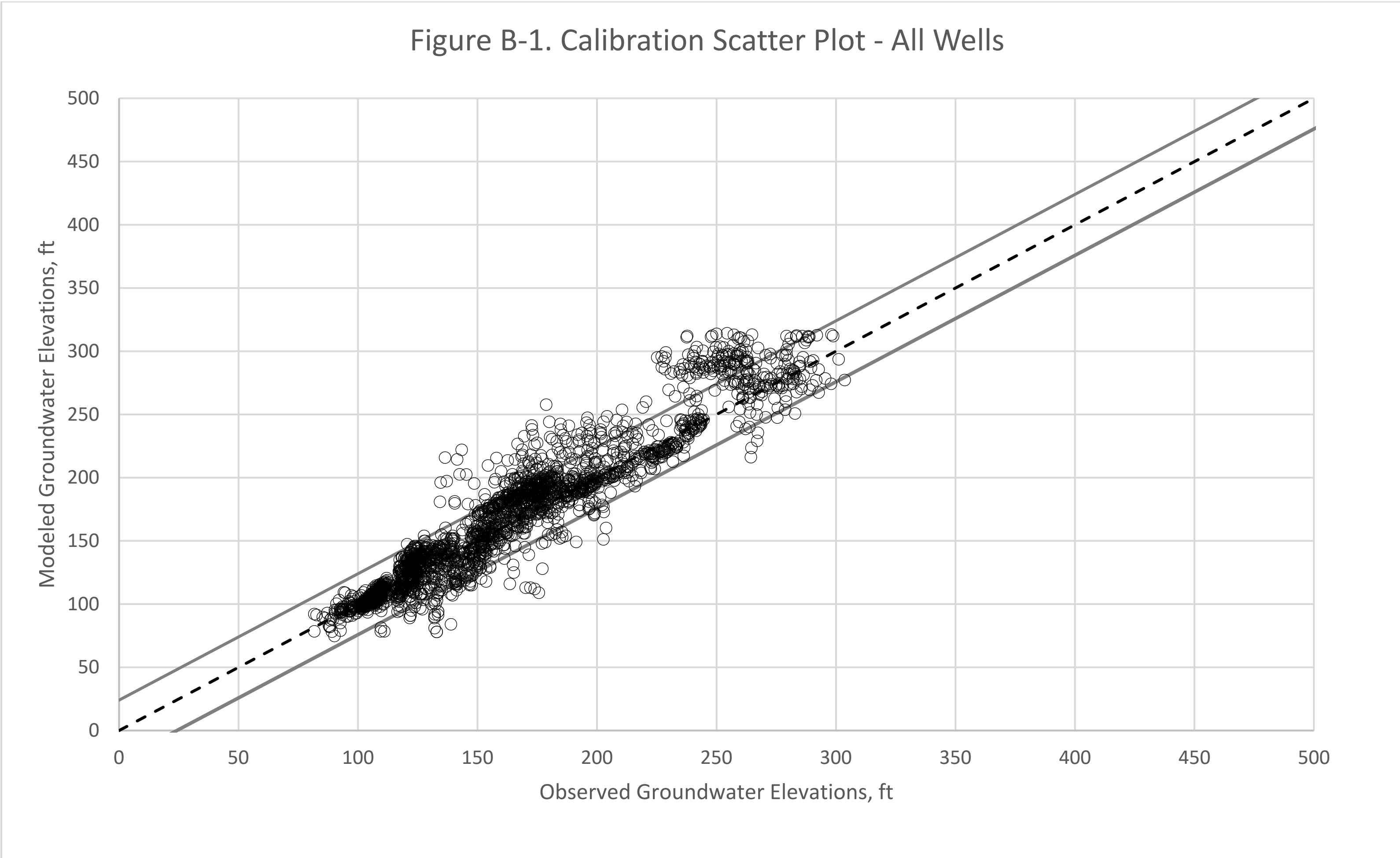


Figure B-1. Calibration Scatter Plot - All Wells
Modeled Groundwater Elevations, ft
Observed Groundwater Elevations, ft
0
50
100
150
200
250
300
350
400
450
500

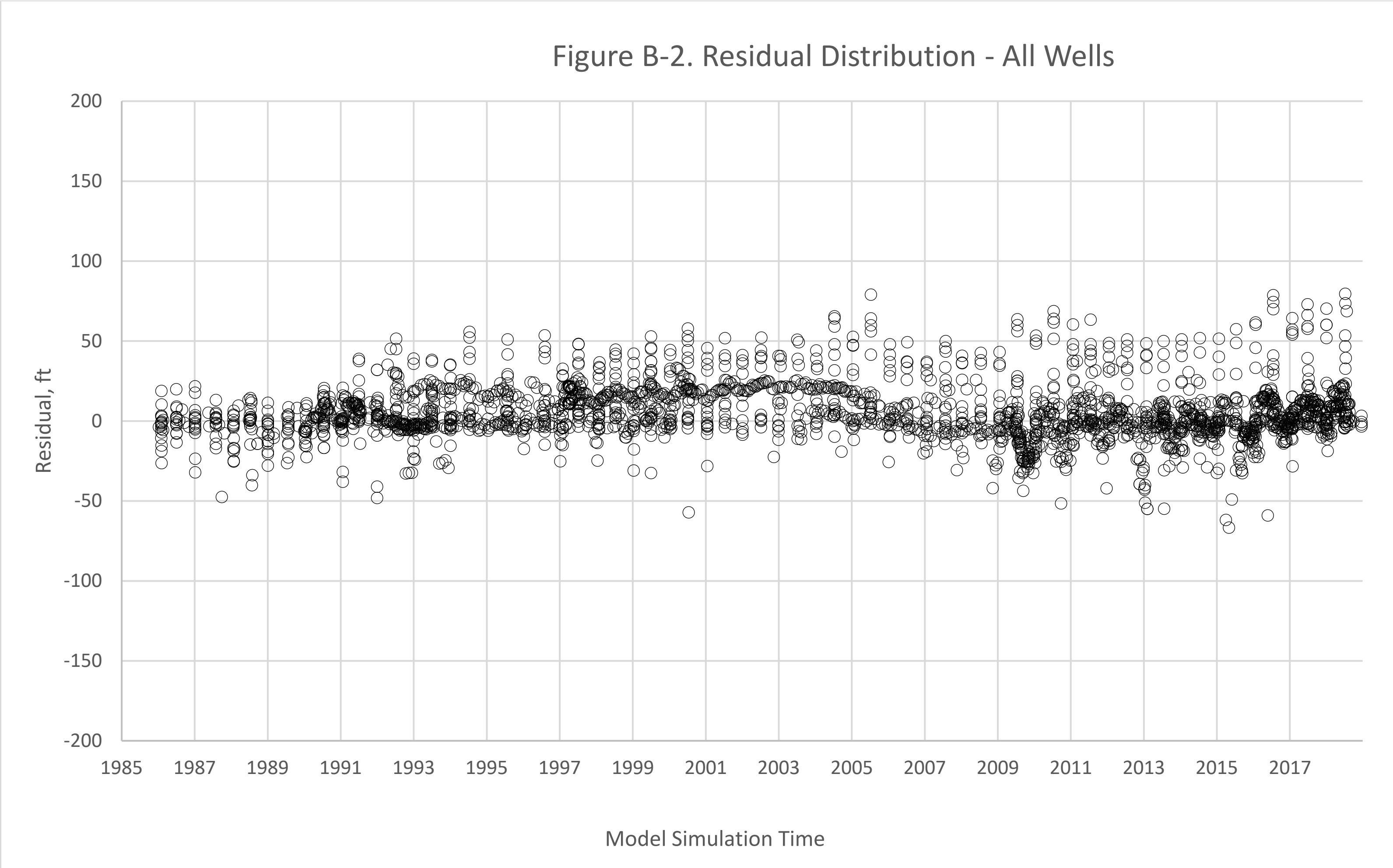
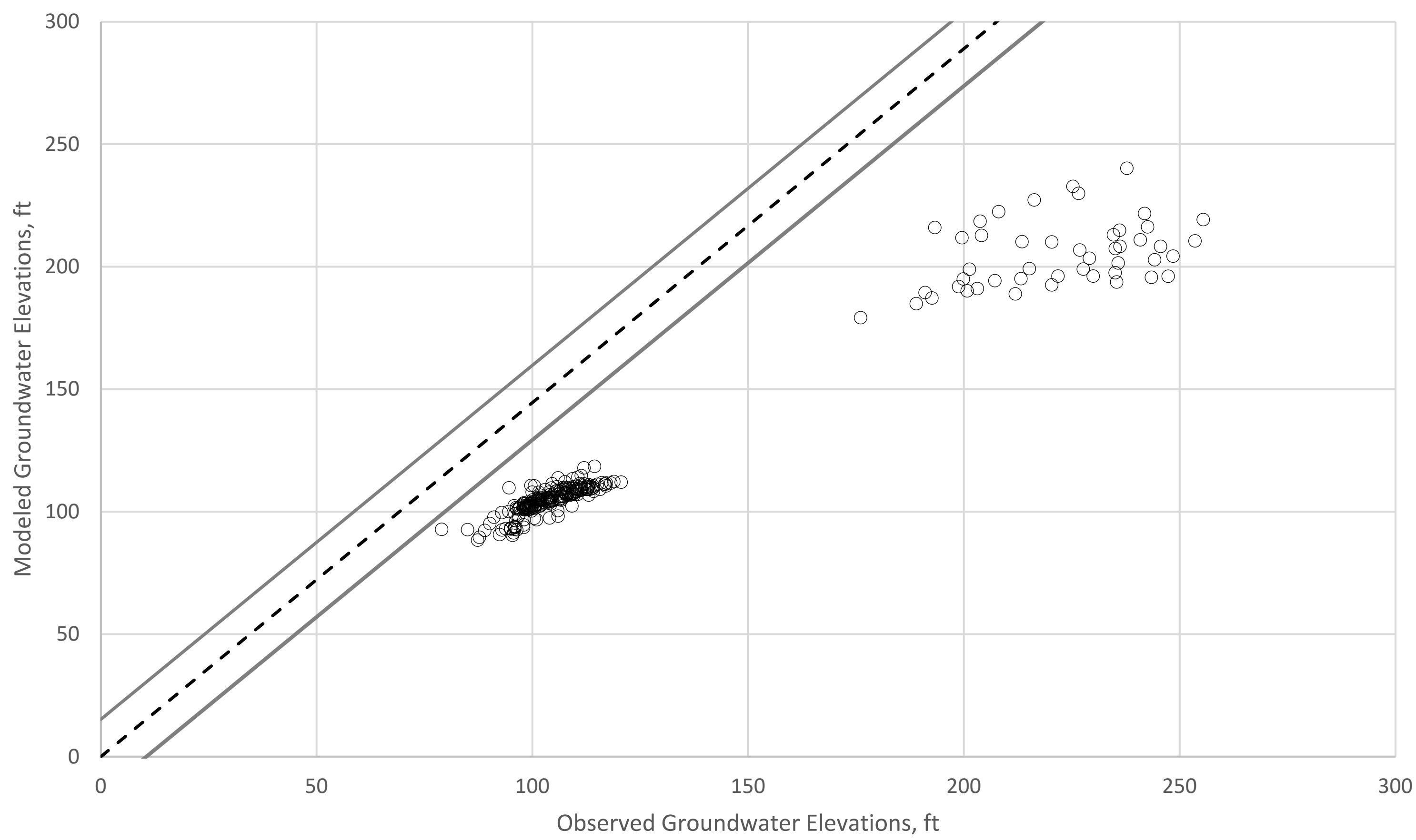


Figure B-2. Residual Distribution - All Wells
Residual, ft
200
150
100
50
0
-50
-100
-150
-200
1985
1987
1989
1991
1993
1995
1997
1999
2001
2003
2005
2007
2009
2011
2013
2015
2017
Model Simulation Time

Figure B-3. Calibration Scatter Plot - SLO Key Wells



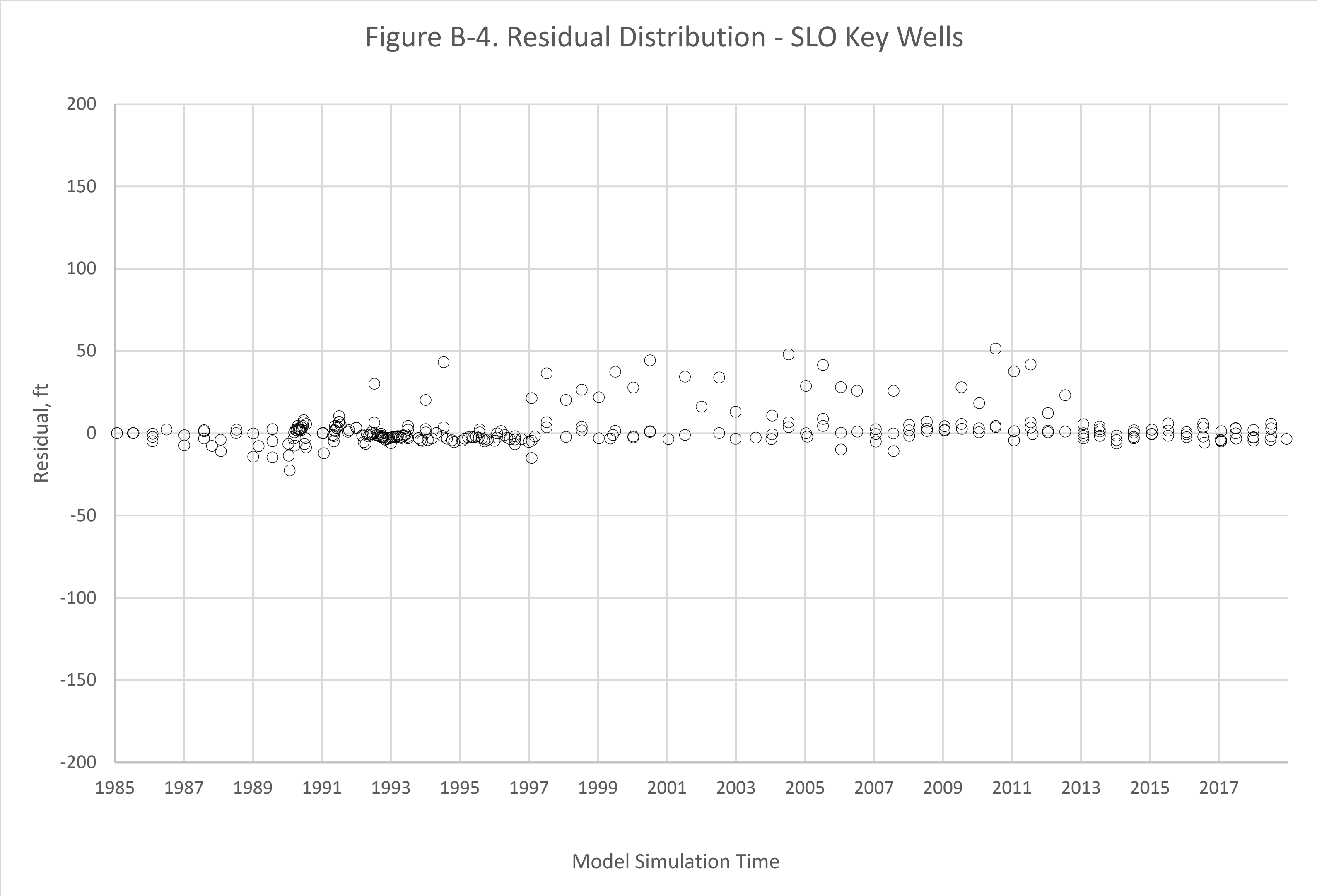


Figure B-4. Residual Distribution - SLO Key Wells
Residual, ft
200
150
100
50
0
-50
-100
-150
-200
1985
1987
1989
1991
1993
1995
1997
1999
2001
2003
2005
2007
2009
2011
2013
2015
2017
Model Simulation Time

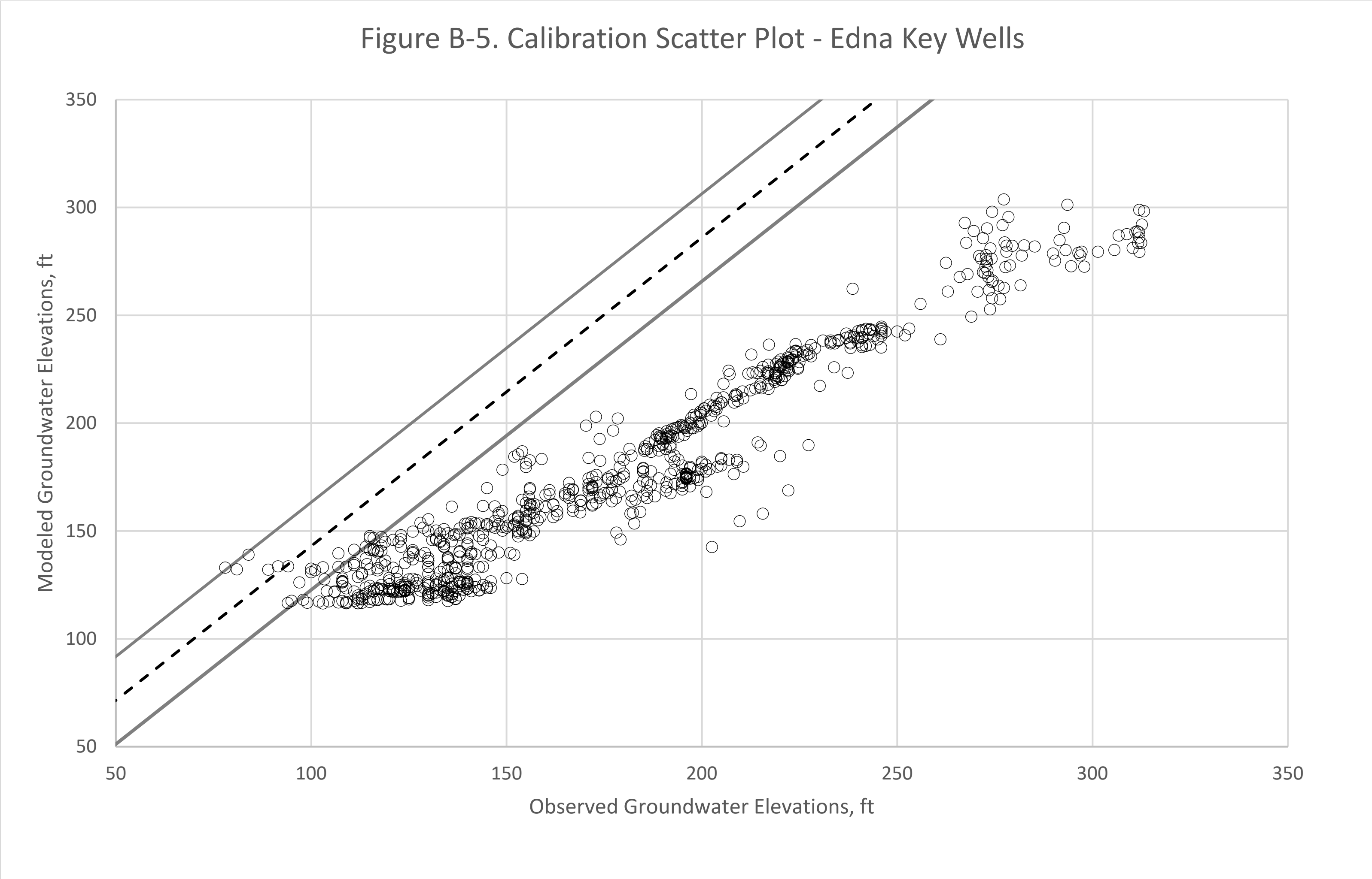


Figure B-5. Calibration Scatter Plot - Edna Key Wells
Modeled Groundwater Elevations, ft
Observed Groundwater Elevations, ft
350
300
250
200
150
100
50
50
100
150
200
250
300
350

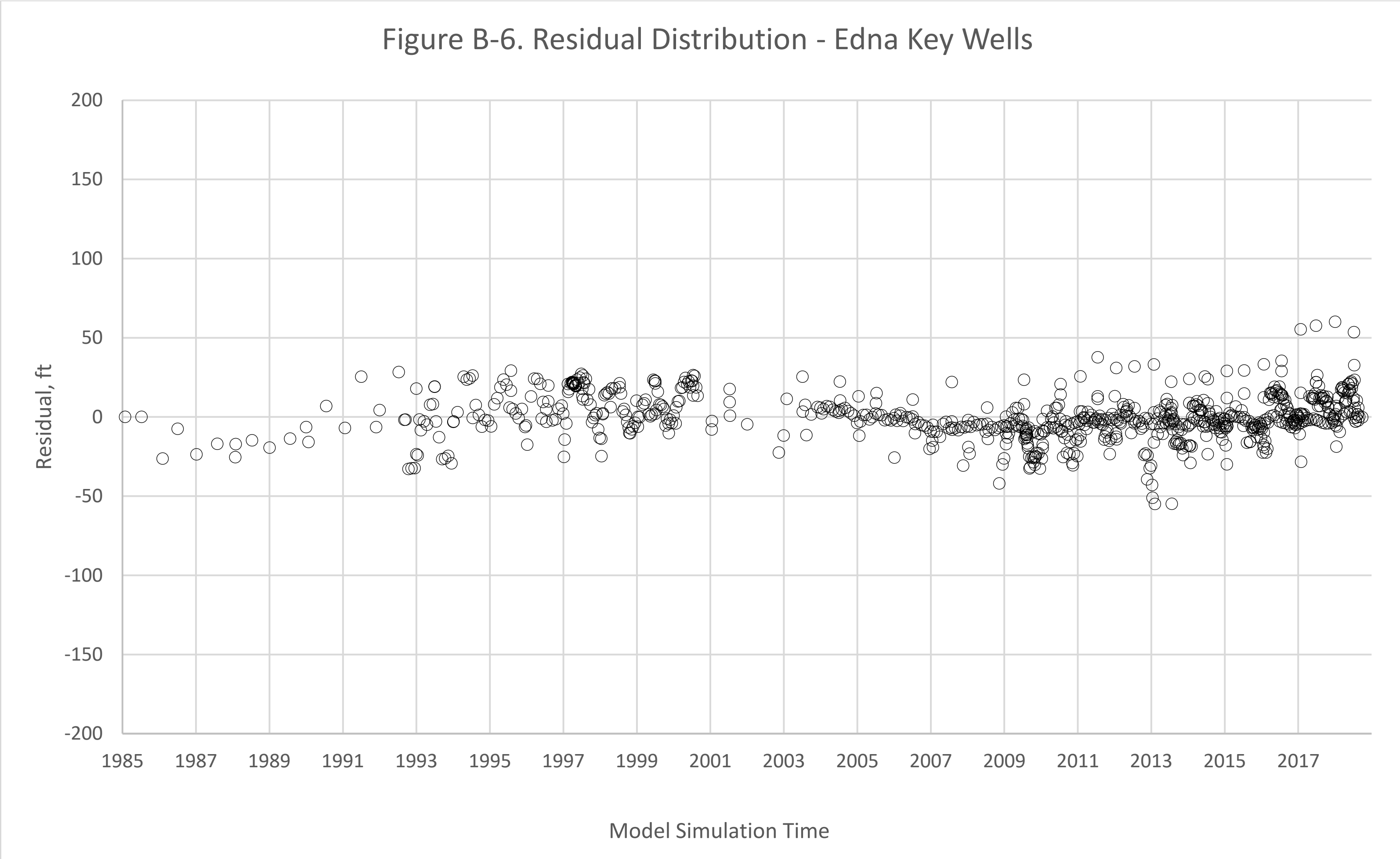


Figure B-6. Residual Distribution - Edna Key Wells
Residual, ft
200
150
100
50
0
-50
-100
-150
-200
1985
1987
1989
1991
1993
1995
1997
1999
2001
2003
2005
2007
2009
2011
2013
2015
2017
Model Simulation Time

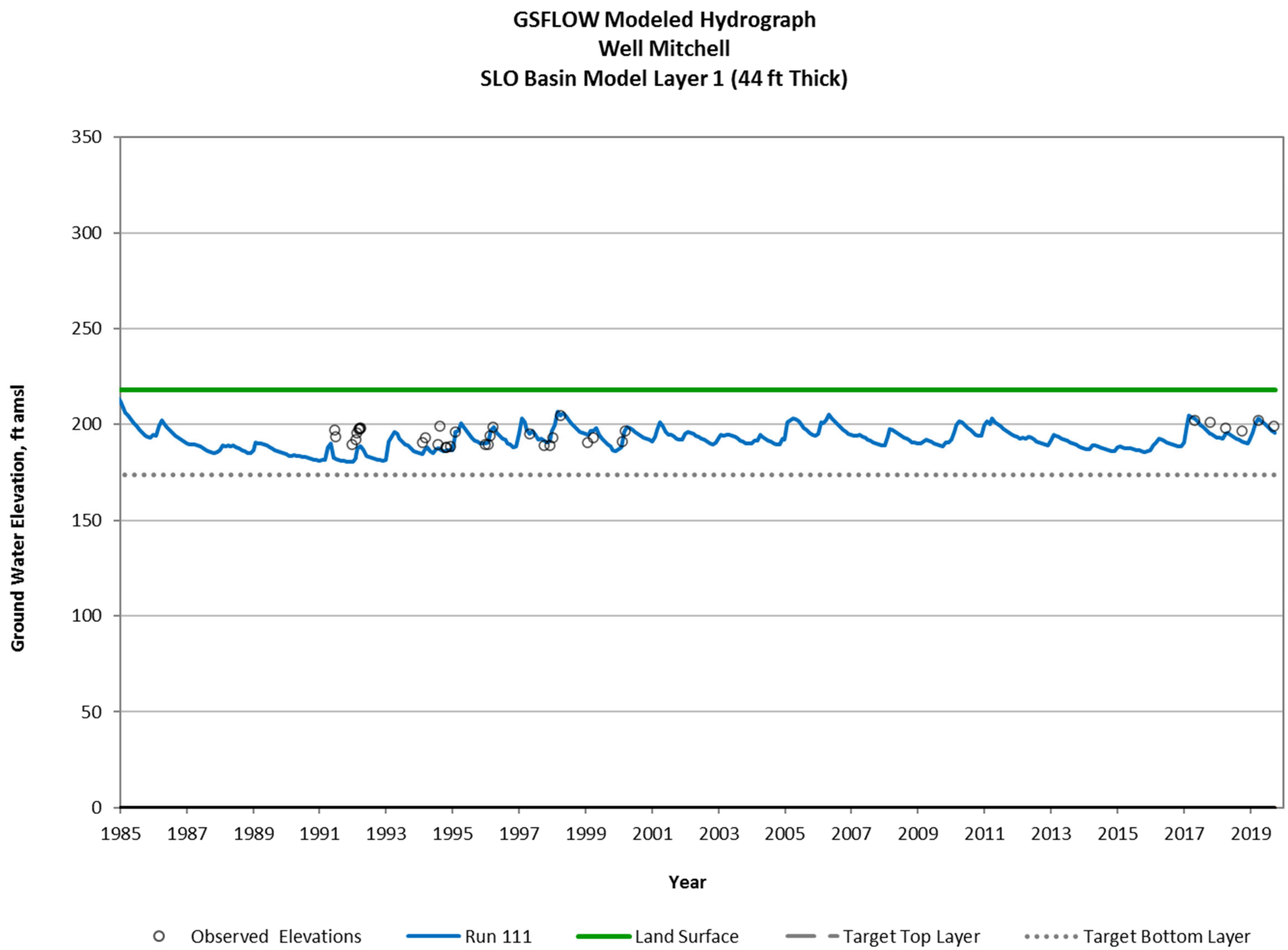

GSFLOW Modeled Hydrograph
Well Mitchell
SLO Basin Model Layer 1 (44 ft Thick)
Ground Water Elevation, ft amsl
350
300
250
200
150
100
50
0
1985
1987
1989
1991
1993
1995
1997
1999
2001
2003
2005
2007
2009
2011
2013
2015
2017
2019
Year
Observed Elevations
Run 111
Land Surface
Target Top Layer
Target Bottom Layer

Figure B-7

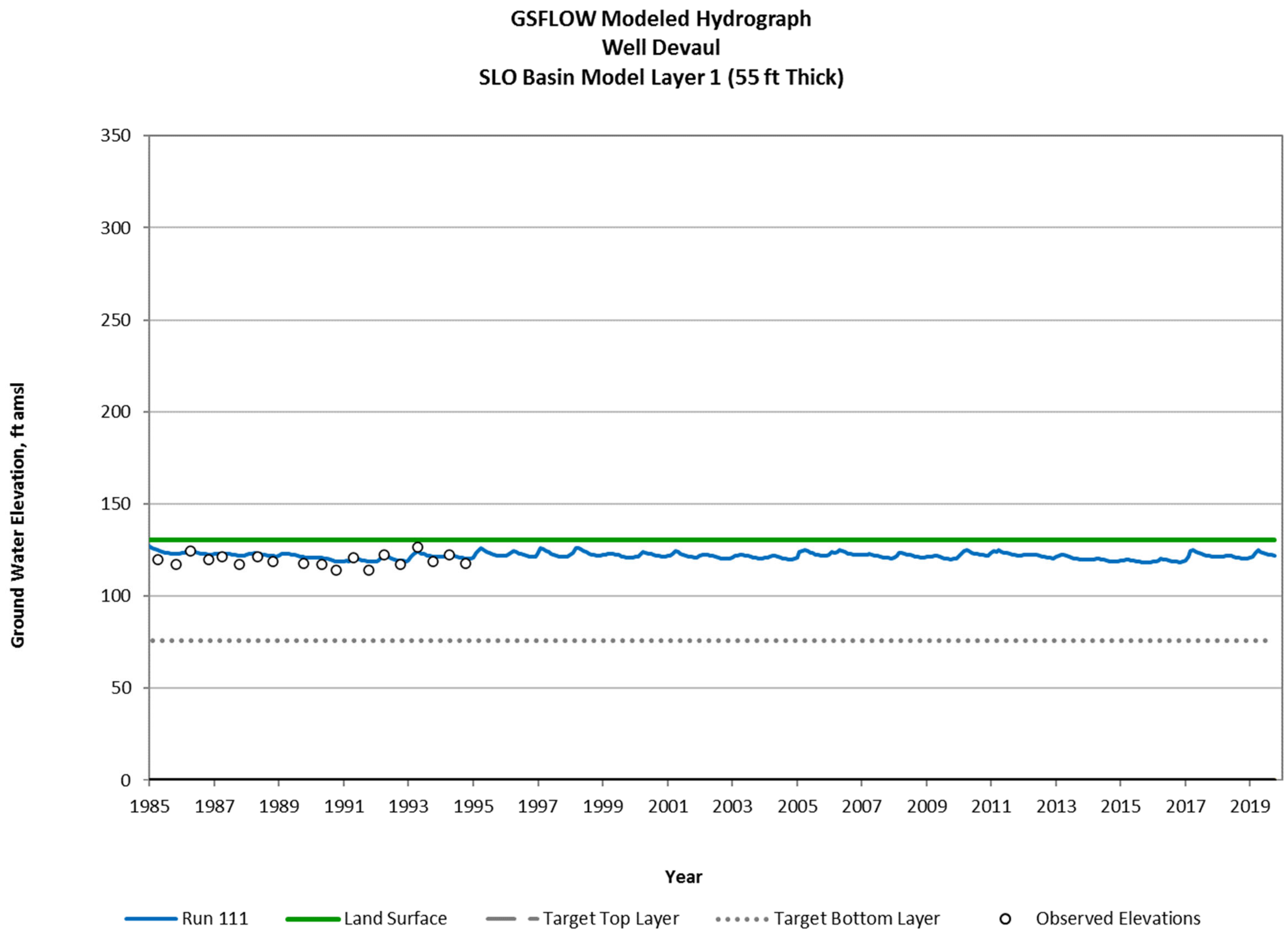

GSFLOW Modeled Hydrograph
Well Devaul
SLO Basin Model Layer 1 (55 ft Thick)
Ground Water Elevation, ft amsl
350
300
250
200
150
100
50
0
1985
1987
1989
1991
1993
1995
1997
1999
2001
2003
2005
2007
2009
2011
2013
2015
2017
2019
Year
Run 111
Land Surface
Target Top Layer
Target Bottom Layer
Observed Elevations

Figure B-8

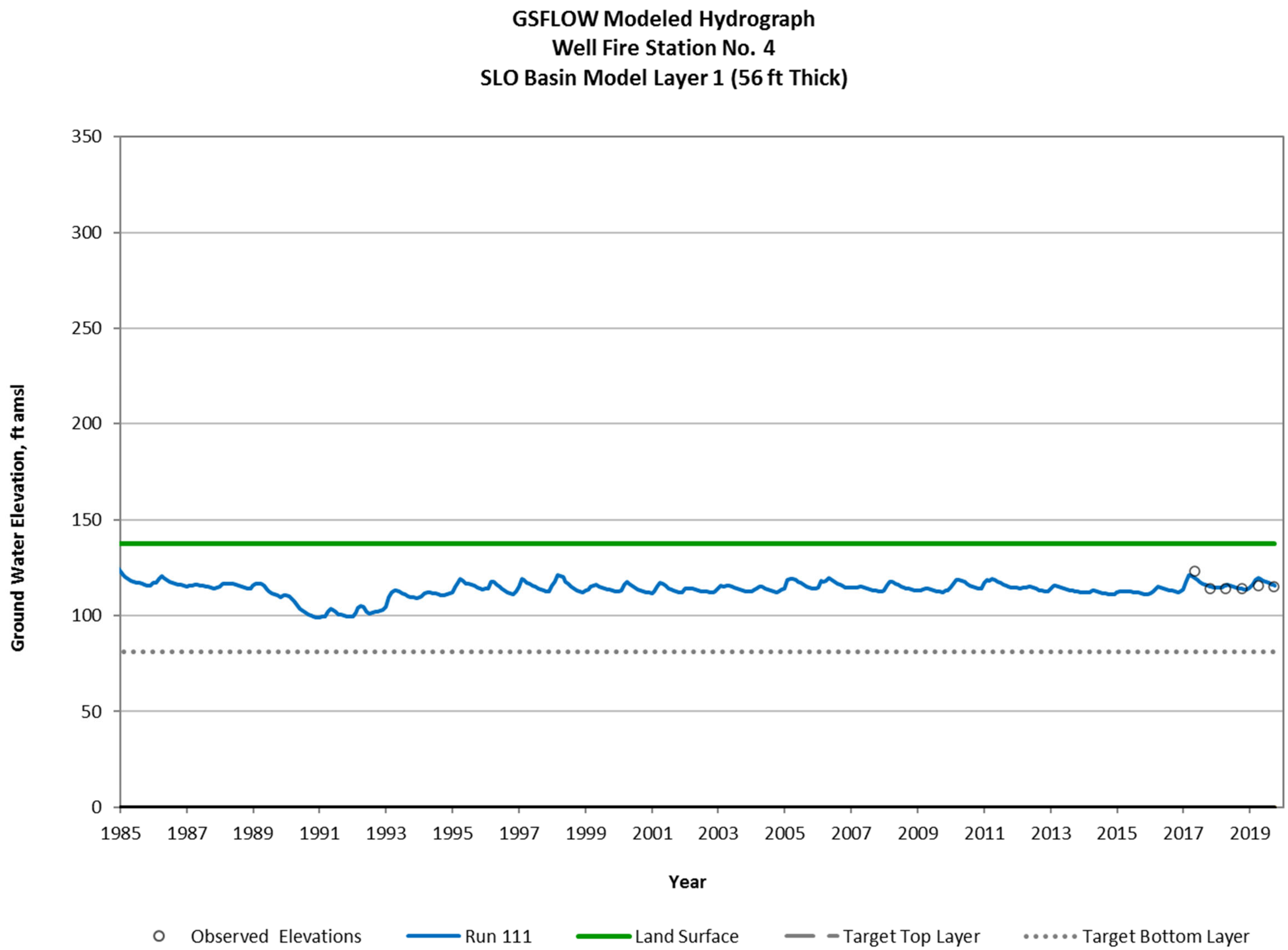

GSFLOW Modeled Hydrograph
Well Fire Station No. 4
SLO Basin Model Layer 1 (56 ft Thick)
Ground Water Elevation, ft amsl
350
300
250
200
150
100
50
0
1985
1987
1989
1991
1993
1995
1997
1999
2001
2003
2005
2007
2009
2011
2013
2015
2017
2019
Year
Observed Elevations
Run 111
Land Surface
Target Top Layer
Target Bottom Layer

Figure B-9

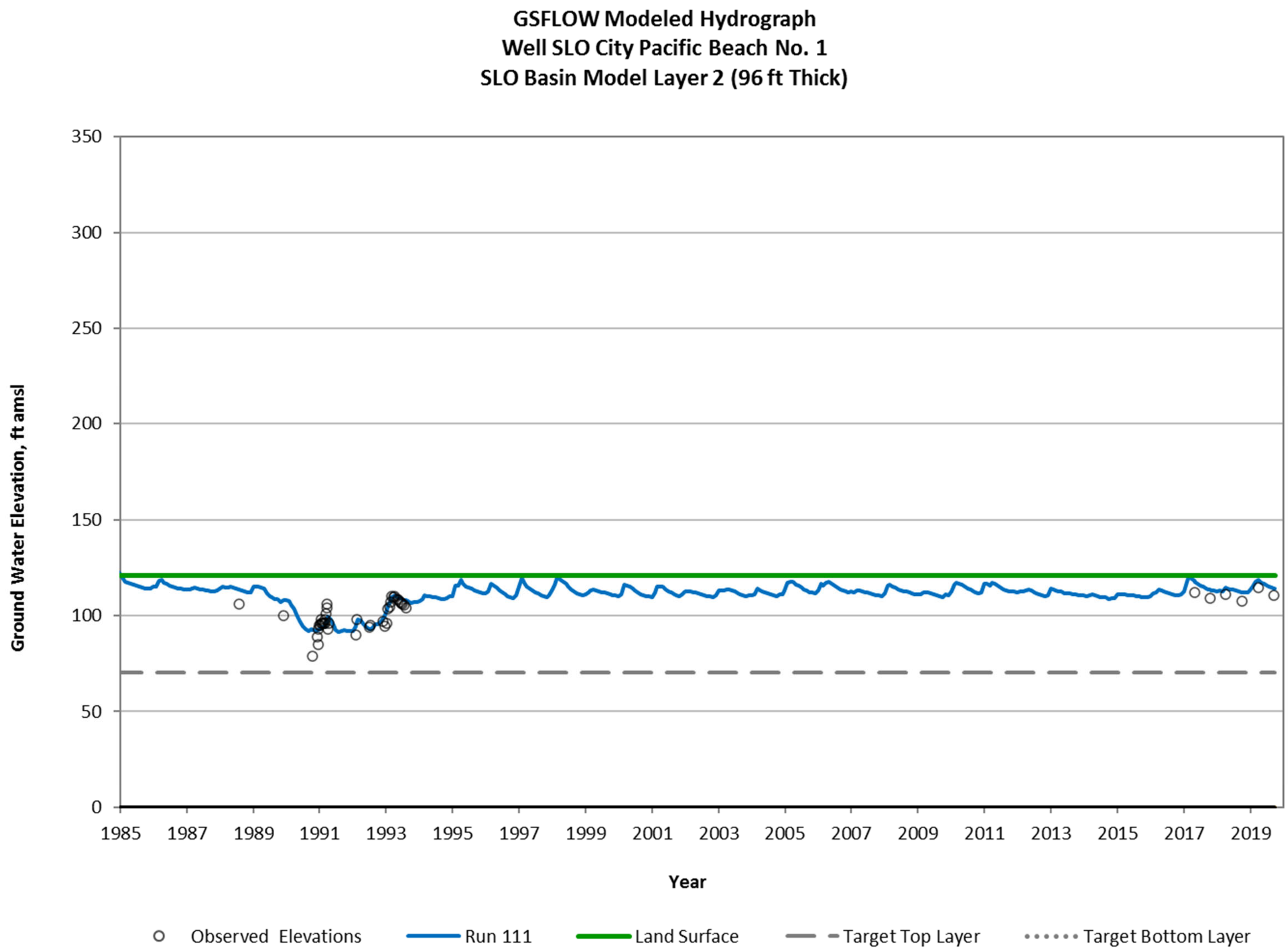

GSFLOW Modeled Hydrograph
Well SLO City Pacific Beach No. 1
SLO Basin Model Layer 2 (96 ft Thick)
Ground Water Elevation, ft amsl
350
300
250
200
150
100
50
0
1985
1987
1989
1991
1993
1995
1997
1999
2001
2003
2005
2007
2009
2011
2013
2015
2017
2019
Year
Observed Elevations
Run 111
Land Surface
Target Top Layer
Target Bottom Layer

Figure B-10

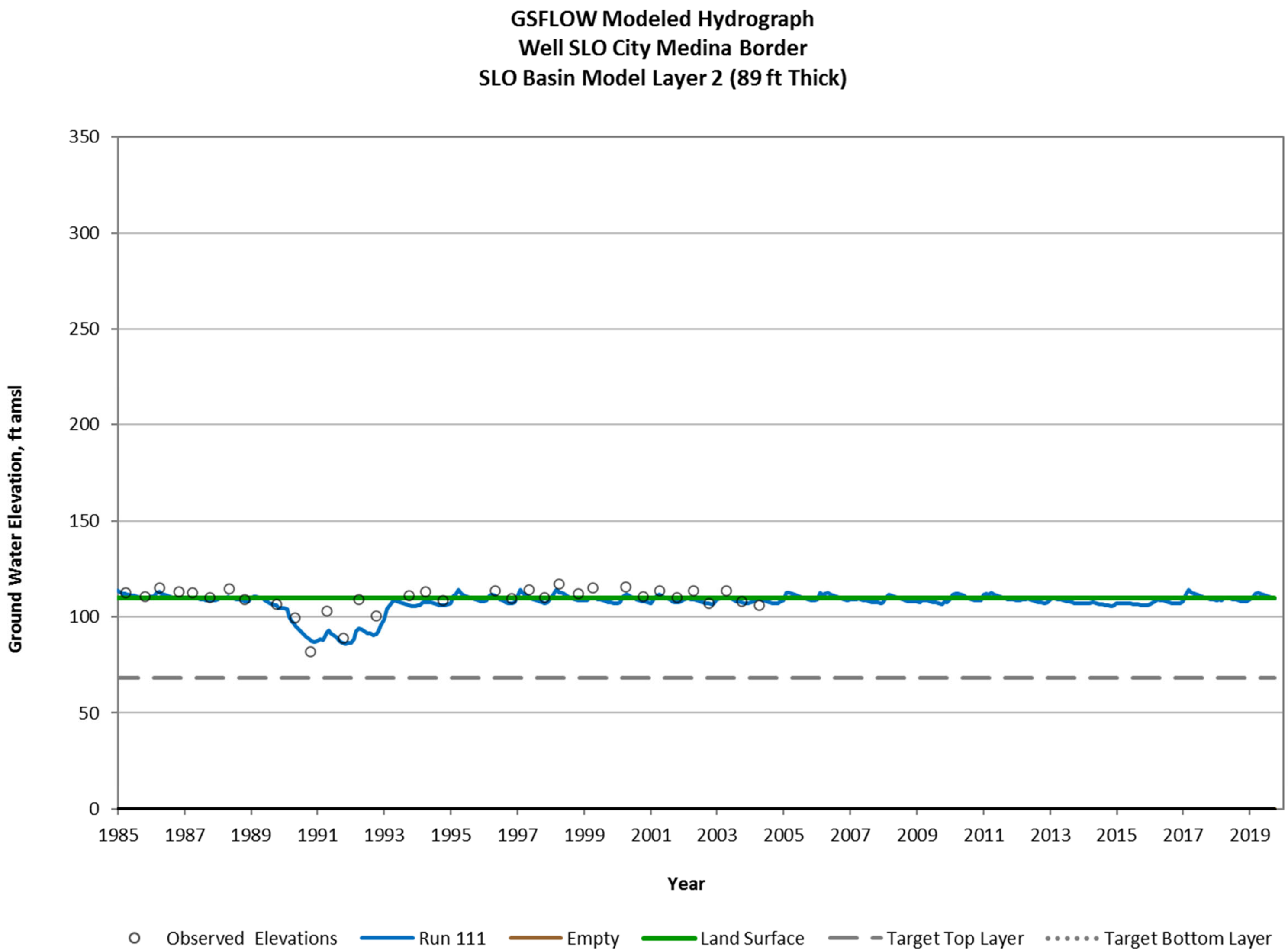

GSFLOW Modeled Hydrograph
Well SLO City Medina Border
SLO Basin Model Layer 2 (89 ft Thick)
Ground Water Elevation, ft amsl
350
300
250
200
150
100
50
0
1985
1987
1989
1991
1993
1995
1997
1999
2001
2003
2005
2007
2009
2011
2013
2015
2017
2019
Year
Observed Elevations
Run 111
Empty
Land Surface
Target Top Layer
Target Bottom Layer

Figure B-11

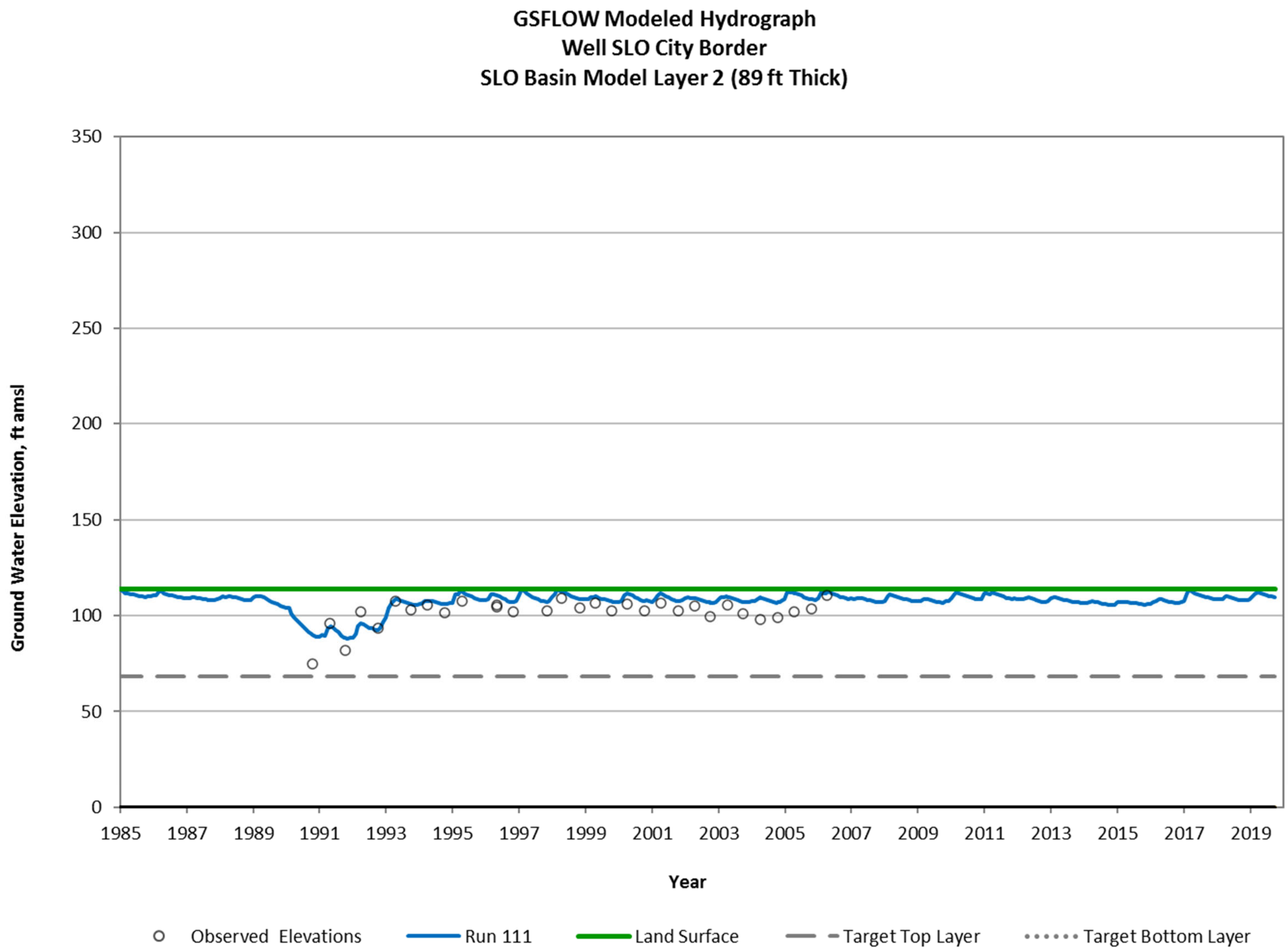

GSFLOW Modeled Hydrograph
Well SLO City Border
SLO Basin Model Layer 2 (89 ft Thick)
Ground Water Elevation, ft amsl
350
300
250
200
150
100
50
0
1985
1987
1989
1991
1993
1995
1997
1999
2001
2003
2005
2007
2009
2011
2013
2015
2017
2019
Year
Observed Elevations
Run 111
Land Surface
Target Top Layer
Target Bottom Layer

Figure B-12

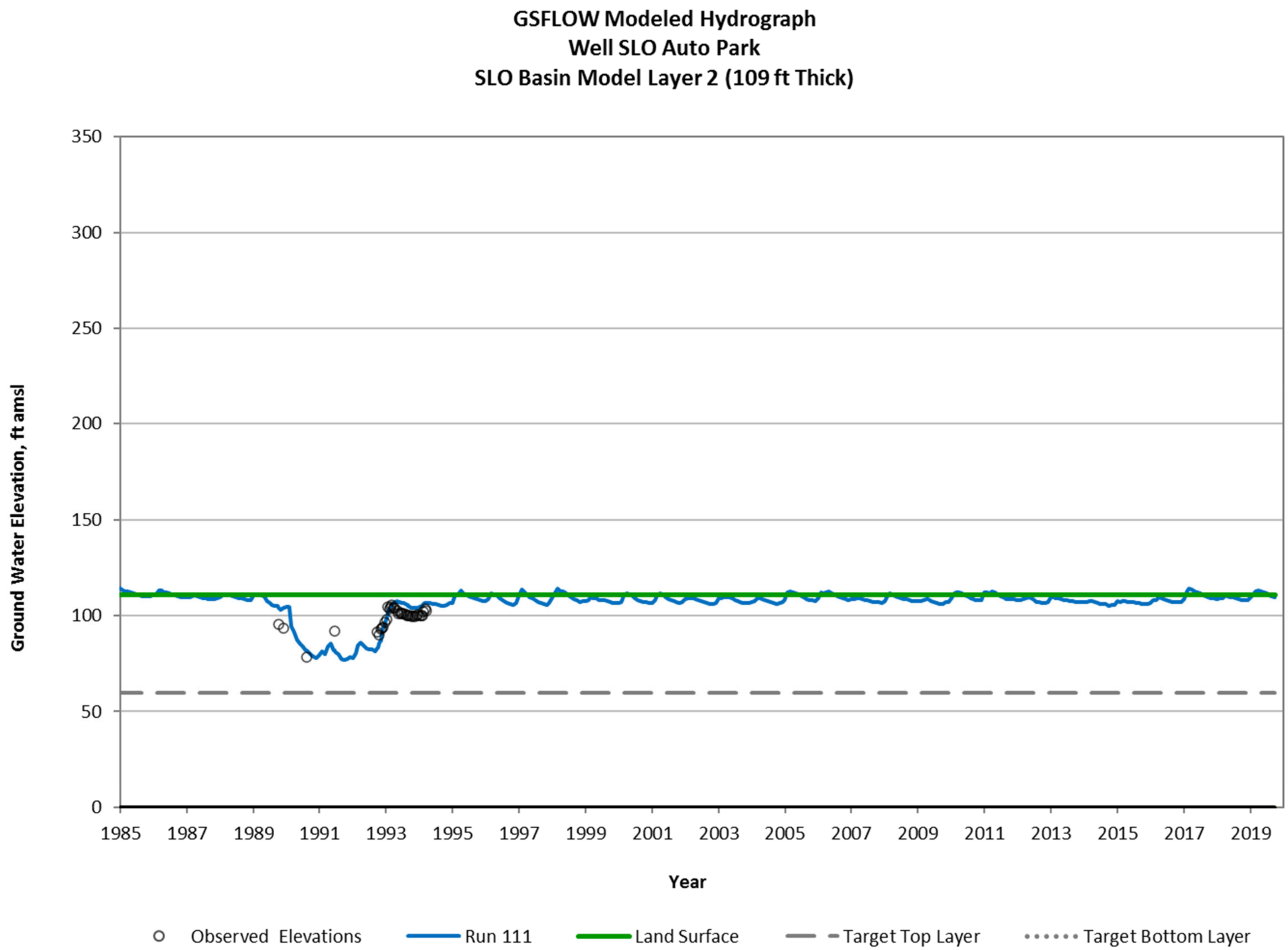

GSFLOW Modeled Hydrograph
Well SLO Auto Park
SLO Basin Model Layer 2 (109 ft Thick)
Ground Water Elevation, ft amsl
350
300
250
200
150
100
50
0
1985
1987
1989
1991
1993
1995
1997
1999
2001
2003
2005
2007
2009
2011
2013
2015
2017
2019
Year
Observed Elevations
Run 111
Land Surface
Target Top Layer
Target Bottom Layer

Figure B-13

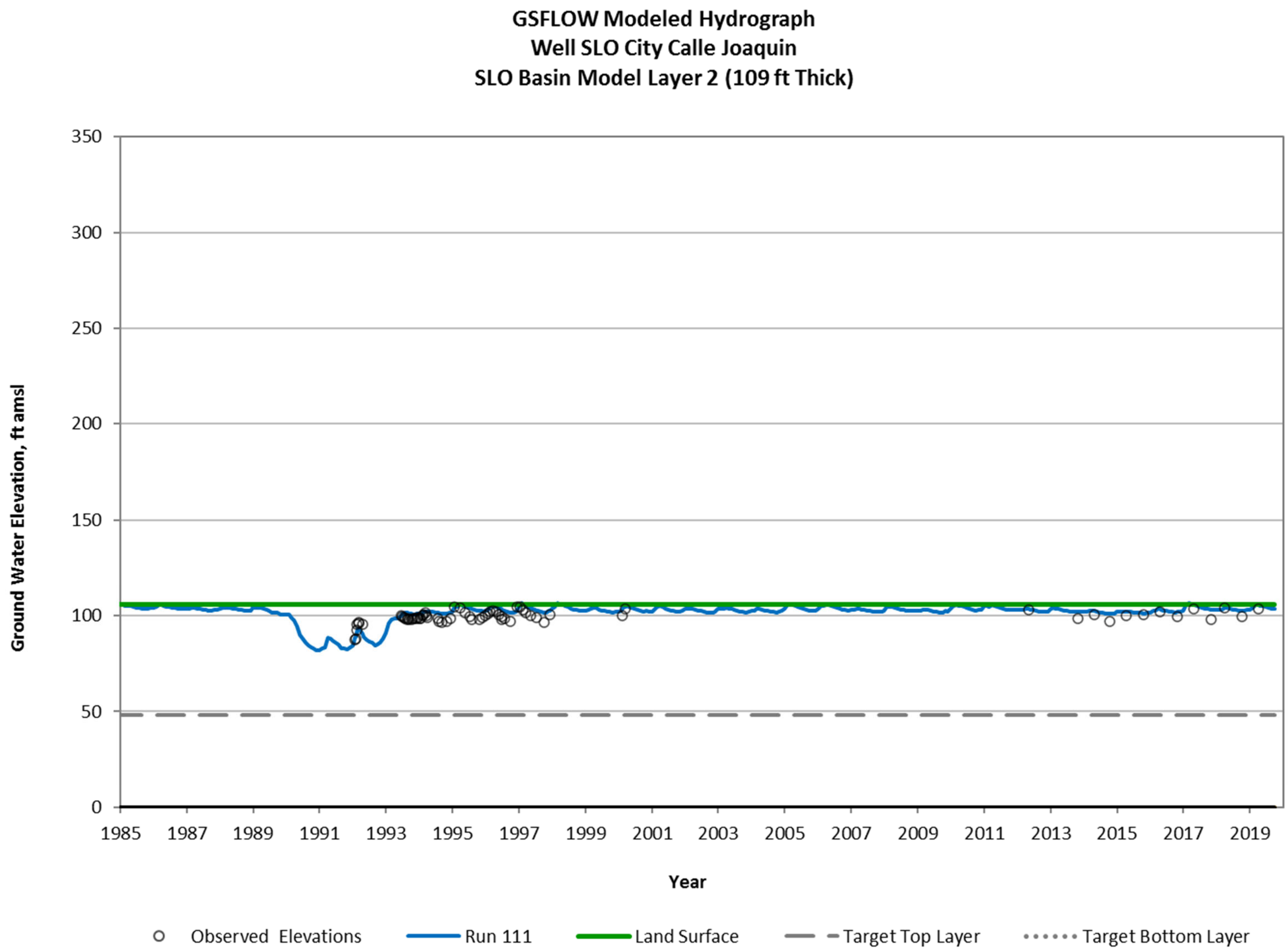

GSFLOW Modeled Hydrograph
Well SLO City Calle Joaquin
SLO Basin Model Layer 2 (109 ft Thick)
Ground Water Elevation, ft amsl
350
300
250
200
150
100
50
0
1985
1987
1989
1991
1993
1995
1997
1999
2001
2003
2005
2007
2009
2011
2013
2015
2017
2019
Year
Observed Elevations
Run 111
Land Surface
Target Top Layer
Target Bottom Layer

Figure B-14

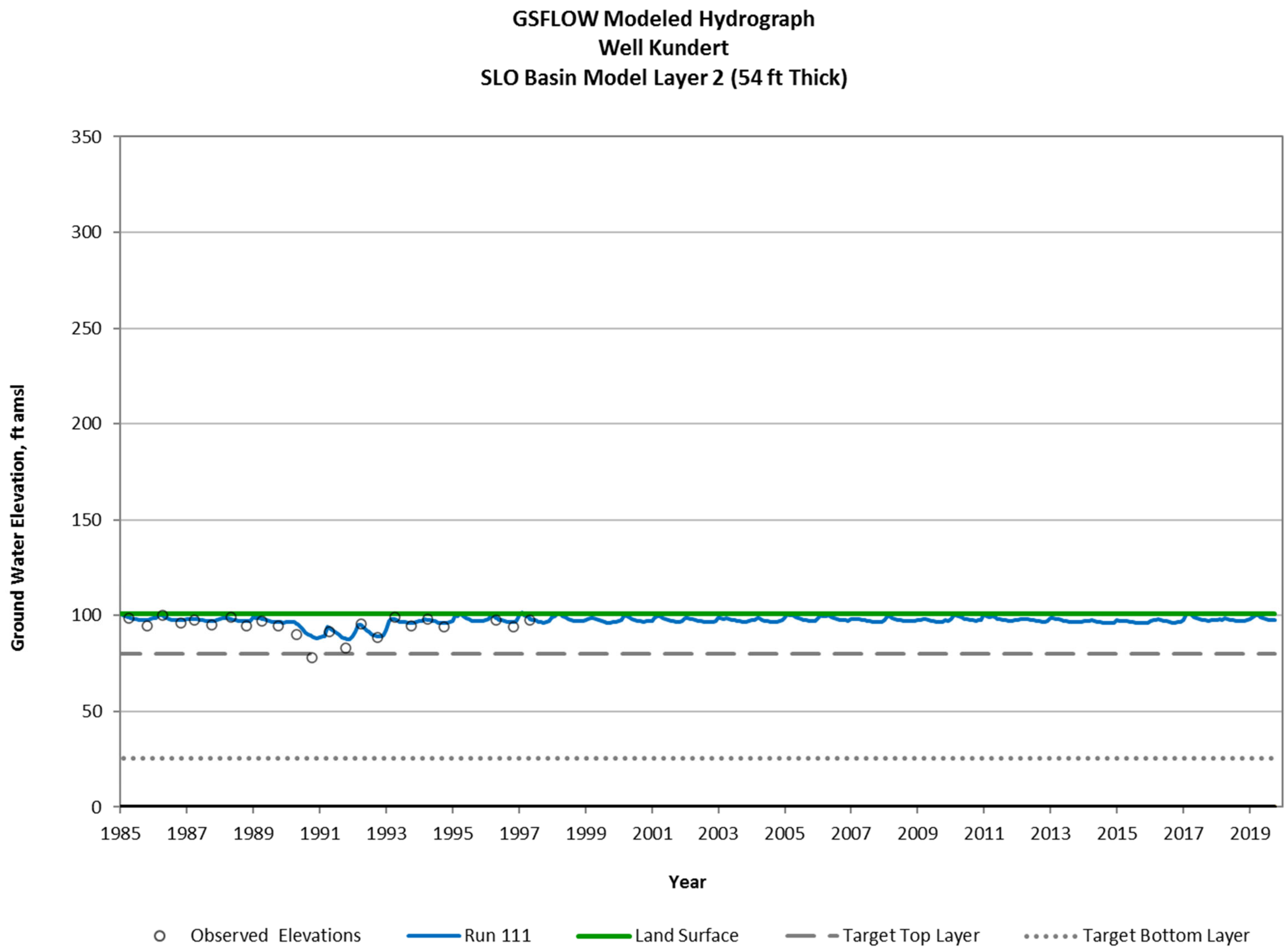

GSFLOW Modeled Hydrograph
Well Kundert
SLO Basin Model Layer 2 (54 ft Thick)
Ground Water Elevation, ft amsl
350
300
250
200
150
100
50
0
1985
1987
1989
1991
1993
1995
1997
1999
2001
2003
2005
2007
2009
2011
2013
2015
2017
2019
Year
Observed Elevations
Run 111
Land Surface
Target Top Layer
Target Bottom Layer

Figure B-15

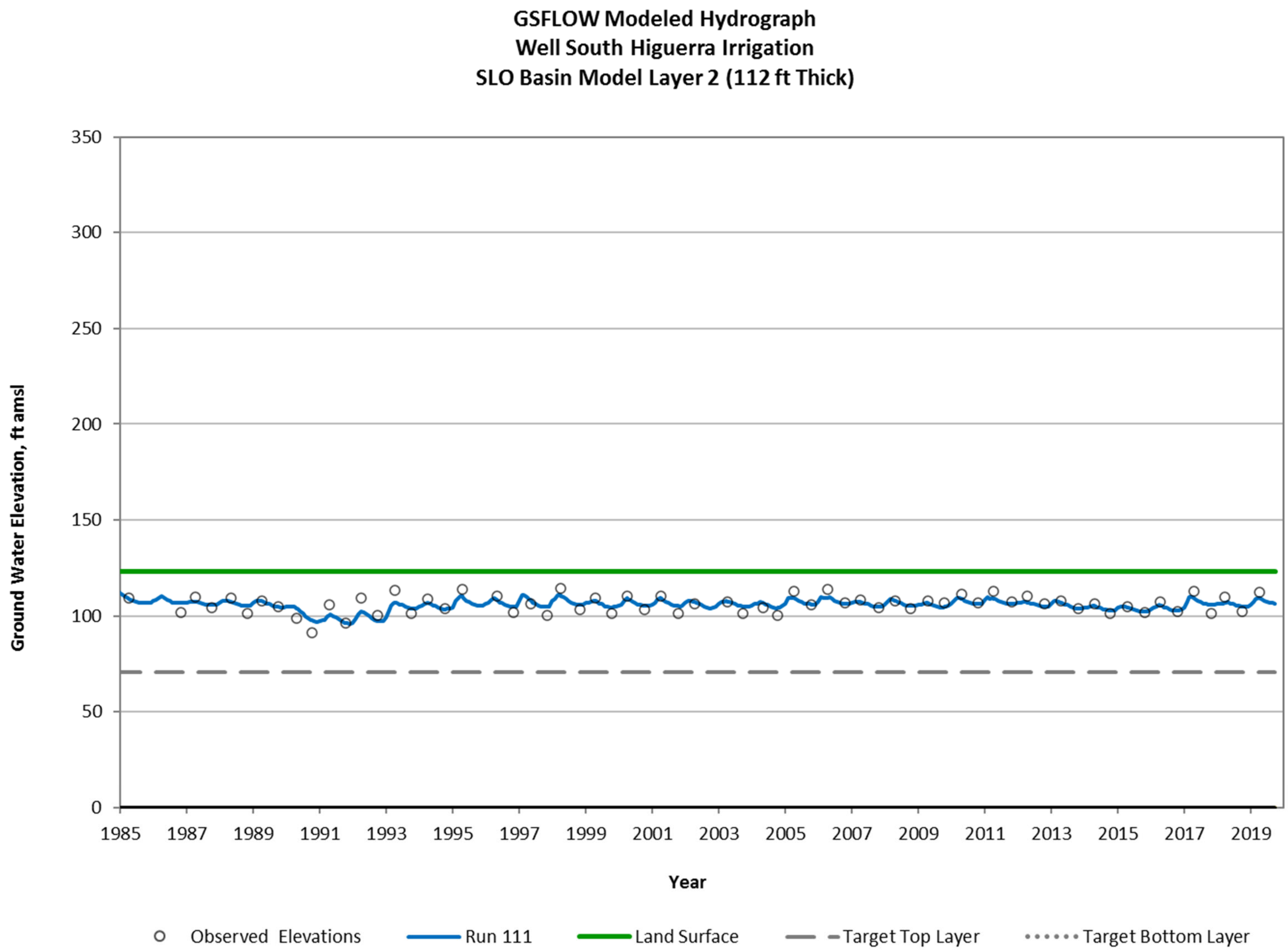

GSFLOW Modeled Hydrograph
Well South Higuerra Irrigation
SLO Basin Model Layer 2 (112 ft Thick)
Ground Water Elevation, ft amsl
350
300
250
200
150
100
50
0
1985
1987
1989
1991
1993
1995
1997
1999
2001
2003
2005
2007
2009
2011
2013
2015
2017
2019
Year
Observed Elevations
Run 111
Land Surface
Target Top Layer
Target Bottom Layer

Figure B-16

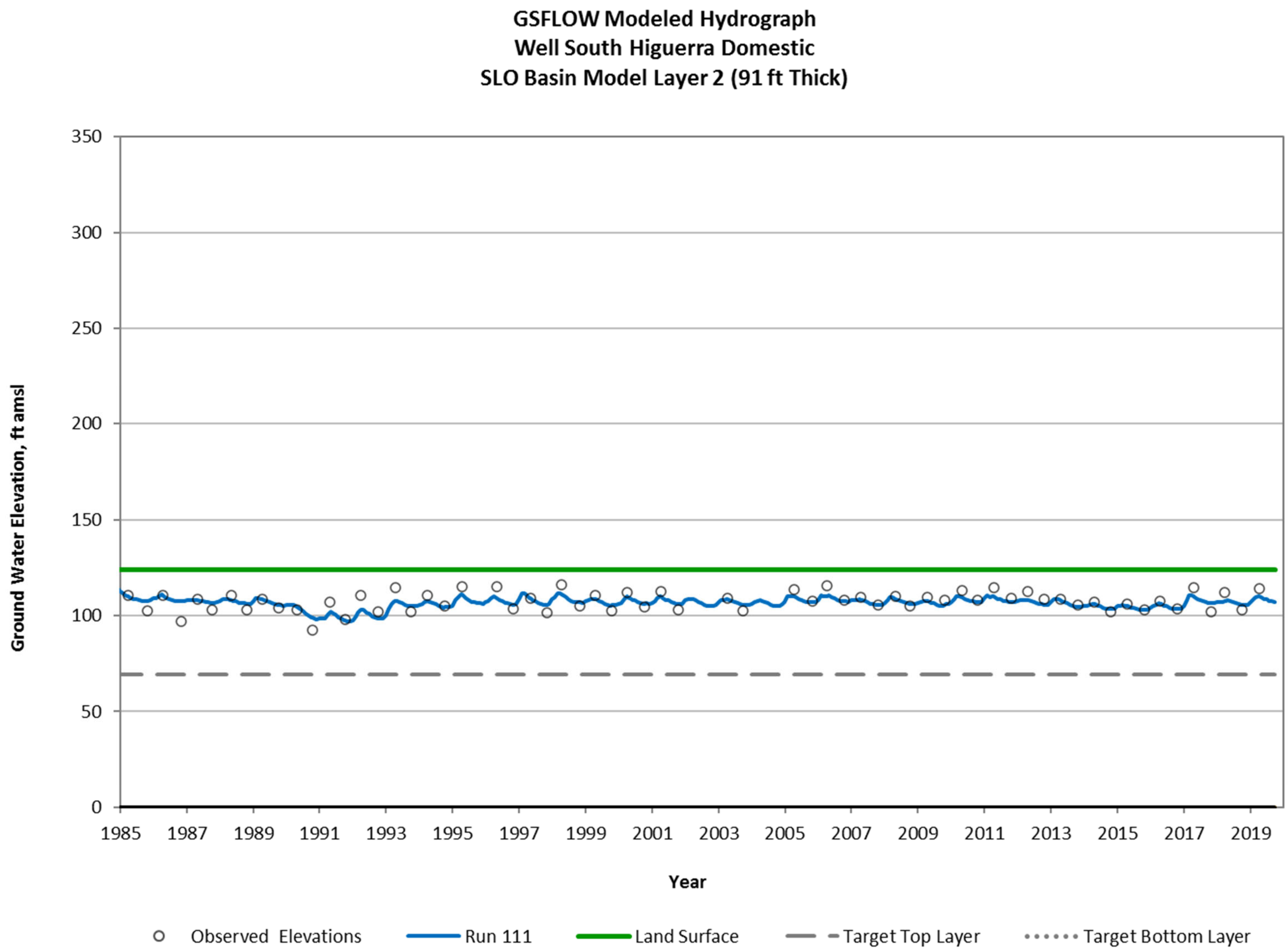

GSFLOW Modeled Hydrograph
Well South Higuerra Domestic
SLO Basin Model Layer 2 (91 ft Thick)
Ground Water Elevation, ft amsl
350
300
250
200
150
100
50
0
1985
1987
1989
1991
1993
1995
1997
1999
2001
2003
2005
2007
2009
2011
2013
2015
2017
2019
Year
Observed Elevations
Run 111
Land Surface
Target Top Layer
Target Bottom Layer

Figure B-17

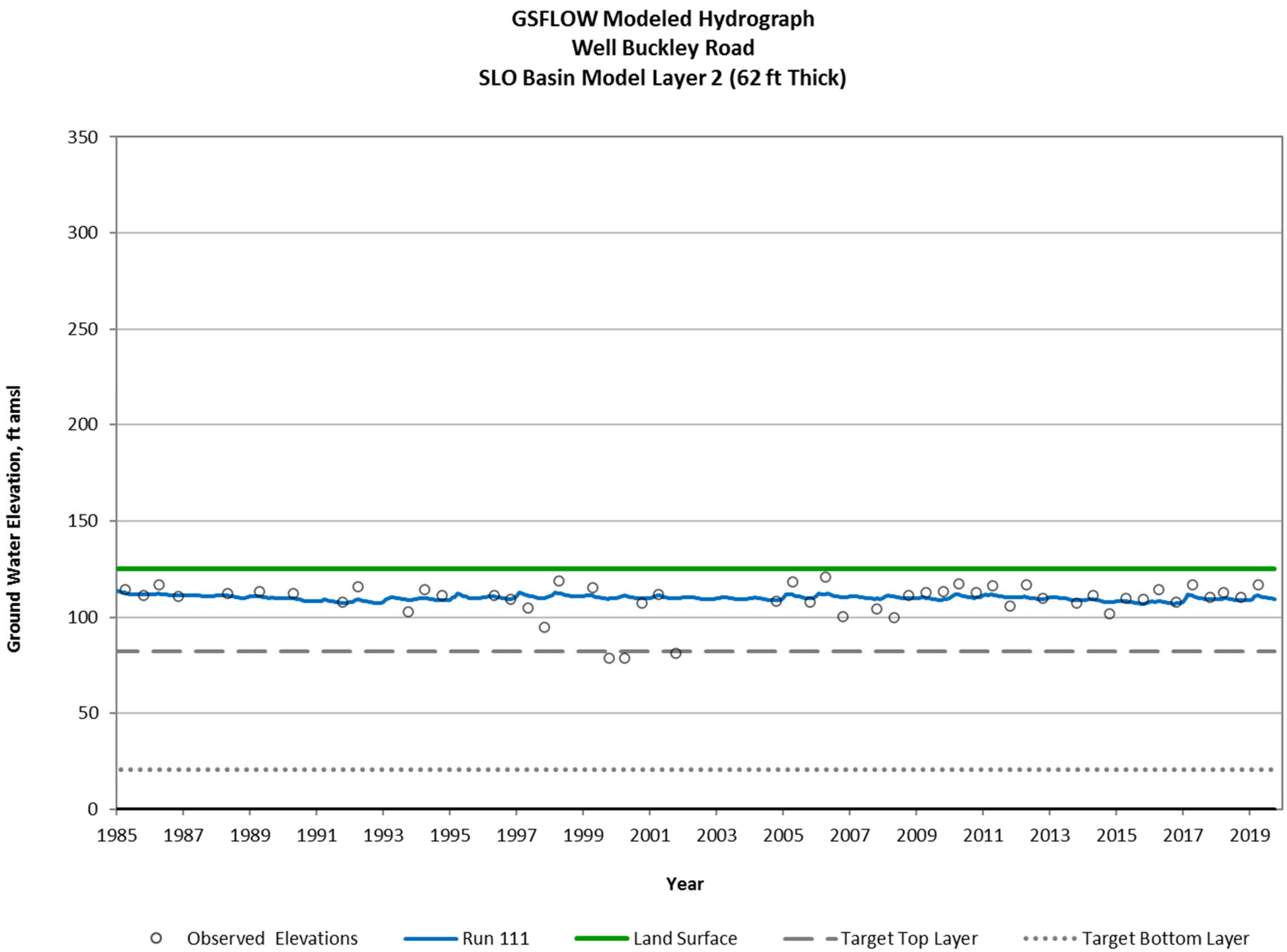

GSFLOW Modeled Hydrograph
Well Buckley Road
SLO Basin Model Layer 2 (62 ft Thick)
Ground Water Elevation, ft amsl
350
300
250
200
150
100
50
0
1985
1987
1989
1991
1993
1995
1997
1999
2001
2003
2005
2007
2009
2011
2013
2015
2017
2019
Year
Observed Elevations
Run 111
Land Surface
Target Top Layer
Target Bottom Layer

Figure B-18

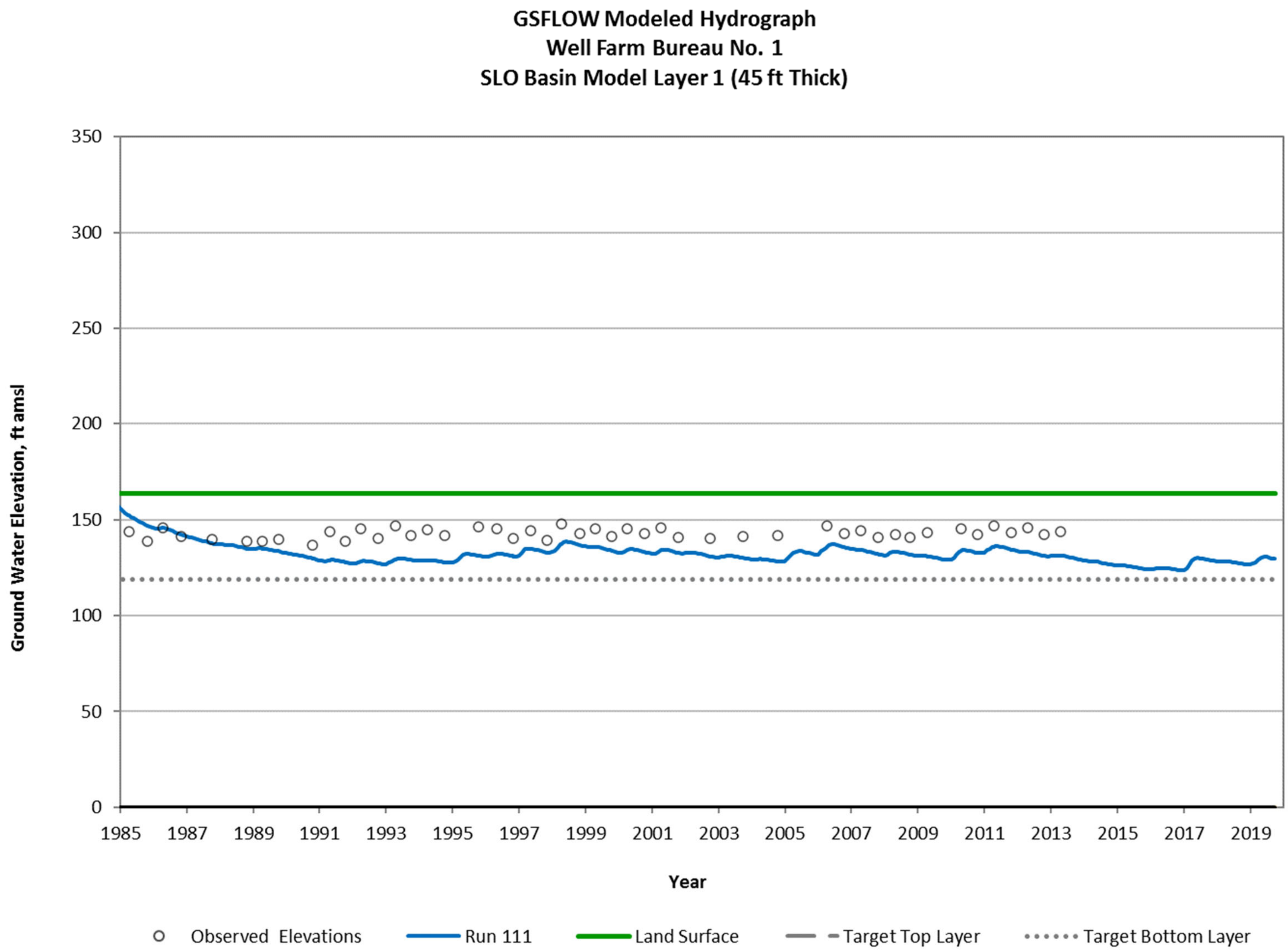

GSFLOW Modeled Hydrograph
Well Farm Bureau No. 1
SLO Basin Model Layer 1 (45 ft Thick)
Ground Water Elevation, ft amsl
350
300
250
200
150
100
50
0
1985
1987
1989
1991
1993
1995
1997
1999
2001
2003
2005
2007
2009
2011
2013
2015
2017
2019
Year
Observed Elevations
Run 111
Land Surface
Target Top Layer
Target Bottom Layer

Figure B-19

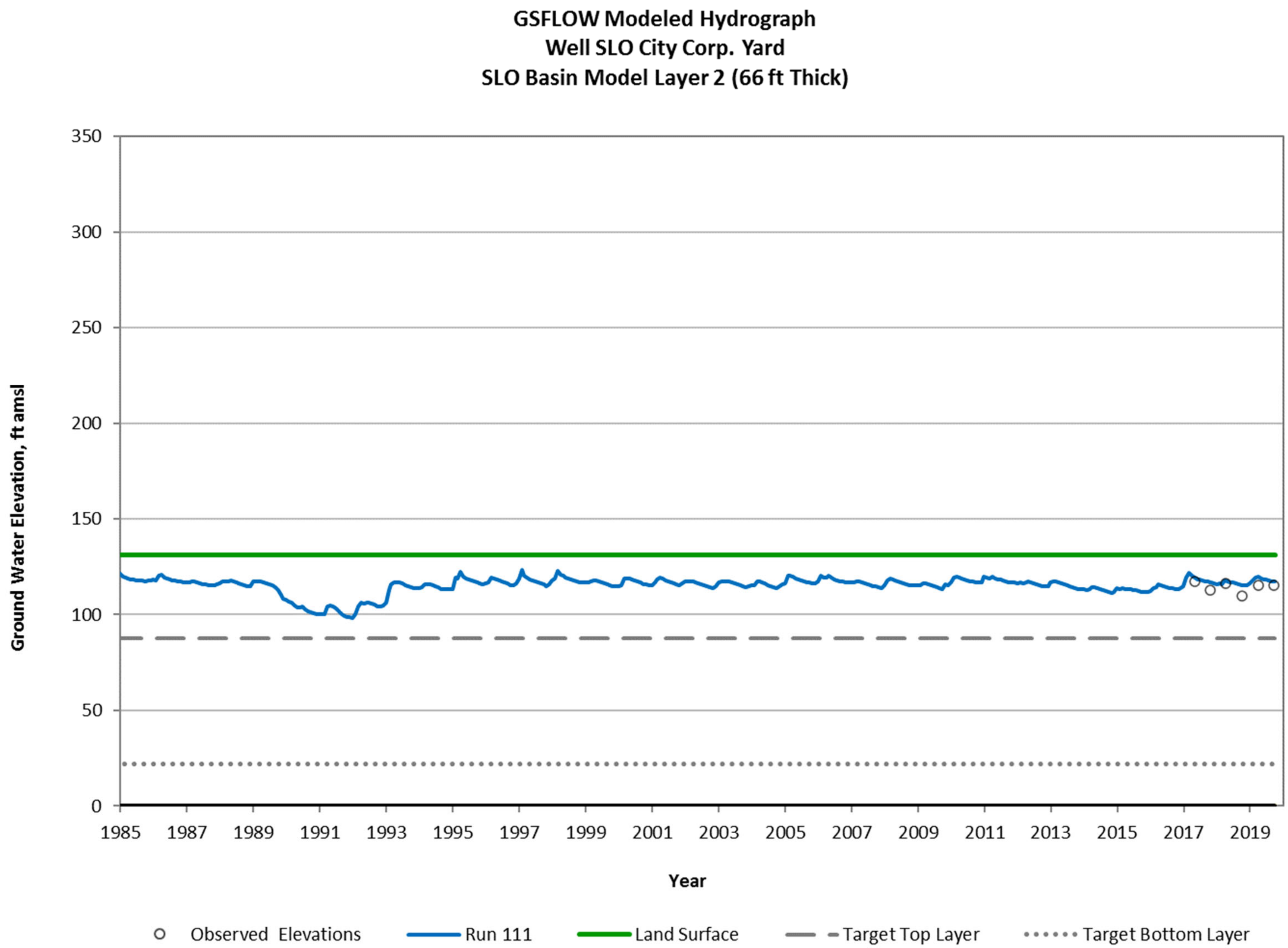

GSFLOW Modeled Hydrograph
Well SLO City Corp. Yard
SLO Basin Model Layer 2 (66 ft Thick)
Ground Water Elevation, ft amsl
350
300
250
200
150
100
50
0
1985
1987
1989
1991
1993
1995
1997
1999
2001
2003
2005
2007
2009
2011
2013
2015
2017
2019
Year
Observed Elevations
Run 111
Land Surface
Target Top Layer
Target Bottom Layer

Figure B-20

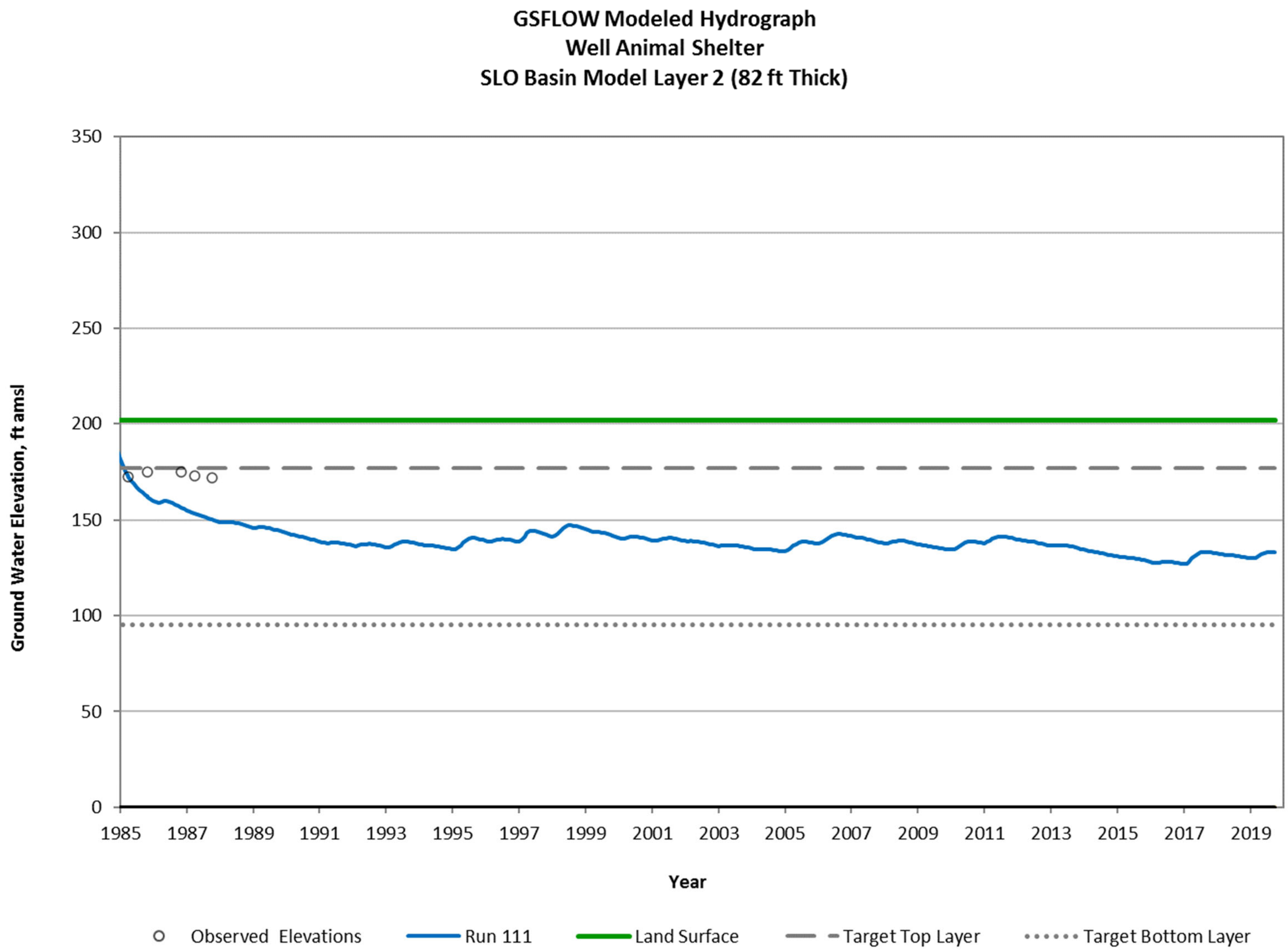

GSFLOW Modeled Hydrograph
Well Animal Shelter
SLO Basin Model Layer 2 (82 ft Thick)
Ground Water Elevation, ft amsl
350
300
250
200
150
100
50
0
1985
1987
1989
1991
1993
1995
1997
1999
2001
2003
2005
2007
2009
2011
2013
2015
2017
2019
Year
Observed Elevations
Run 111
Land Surface
Target Top Layer
Target Bottom Layer

Figure B-21

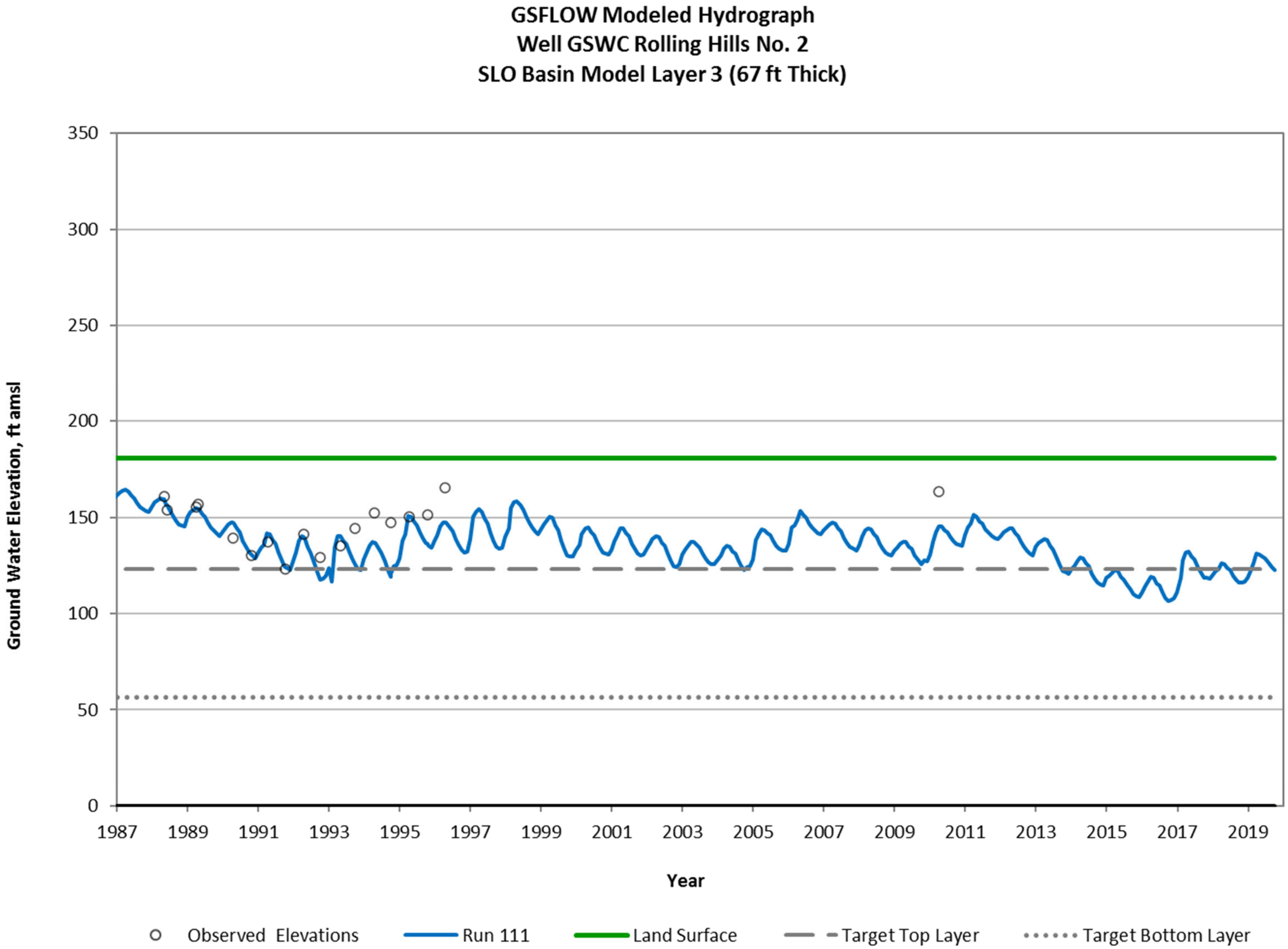

GSFLOW Modeled Hydrograph
Well GSWC Rolling Hills No. 2
SLO Basin Model Layer 3 (67 ft Thick)
Ground Water Elevation, ft amsl
350
300
250
200
150
100
50
0
1987
1989
1991
1993
1995
1997
1999
2001
2003
2005
2007
2009
2011
2013
2015
2017
2019
Year
Observed Elevations
Run 111
Land Surface
Target Top Layer
Target Bottom Layer

Figure B-22

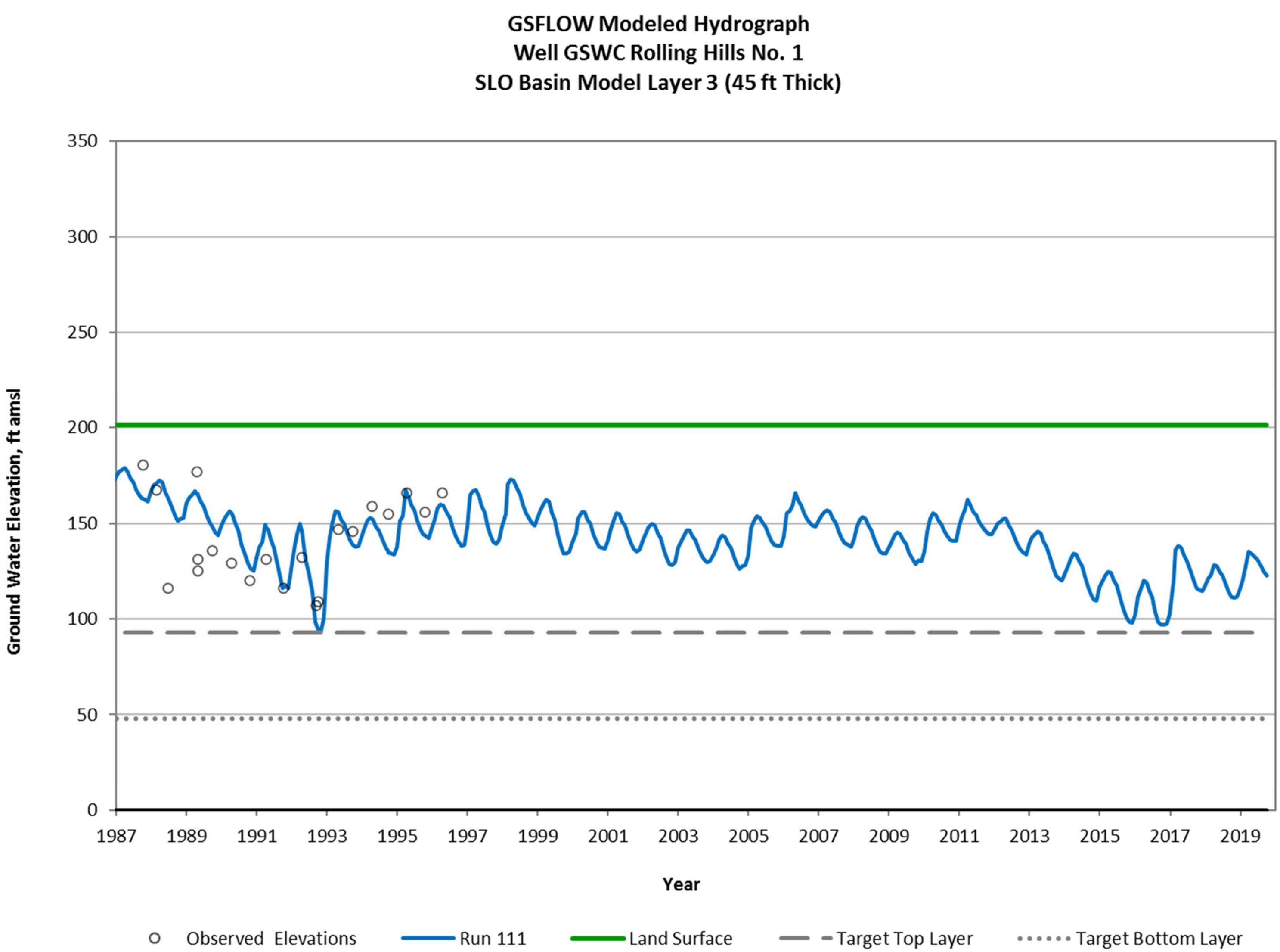

GSFLOW Modeled Hydrograph
Well GSWC Rolling Hills No. 1
SLO Basin Model Layer 3 (45 ft Thick)
Ground Water Elevation, ft amsl
350
300
250
200
150
100
50
0
1987
1989
1991
1993
1995
1997
1999
2001
2003
2005
2007
2009
2011
2013
2015
2017
2019
Year
Observed Elevations
Run 111
Land Surface
Target Top Layer
Target Bottom Layer

Figure B-23

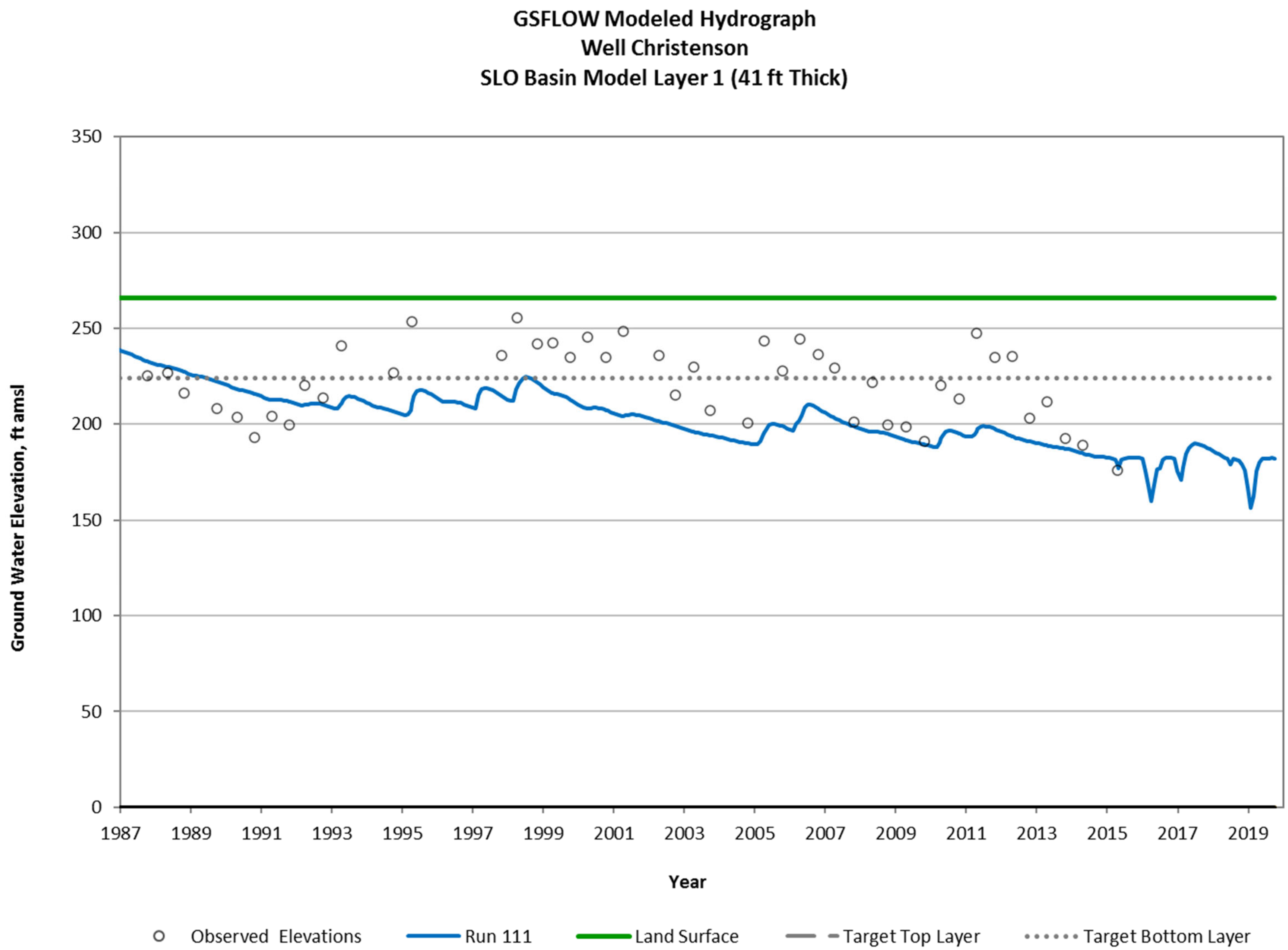

GSFLOW Modeled Hydrograph
Well Christenson
SLO Basin Model Layer 1 (41 ft Thick)
Ground Water Elevation, ft amsl
350
300
250
200
150
100
50
0
1987
1989
1991
1993
1995
1997
1999
2001
2003
2005
2007
2009
2011
2013
2015
2017
2019
Year
Observed Elevations
Run 111
Land Surface
Target Top Layer
Target Bottom Layer

Figure B-24

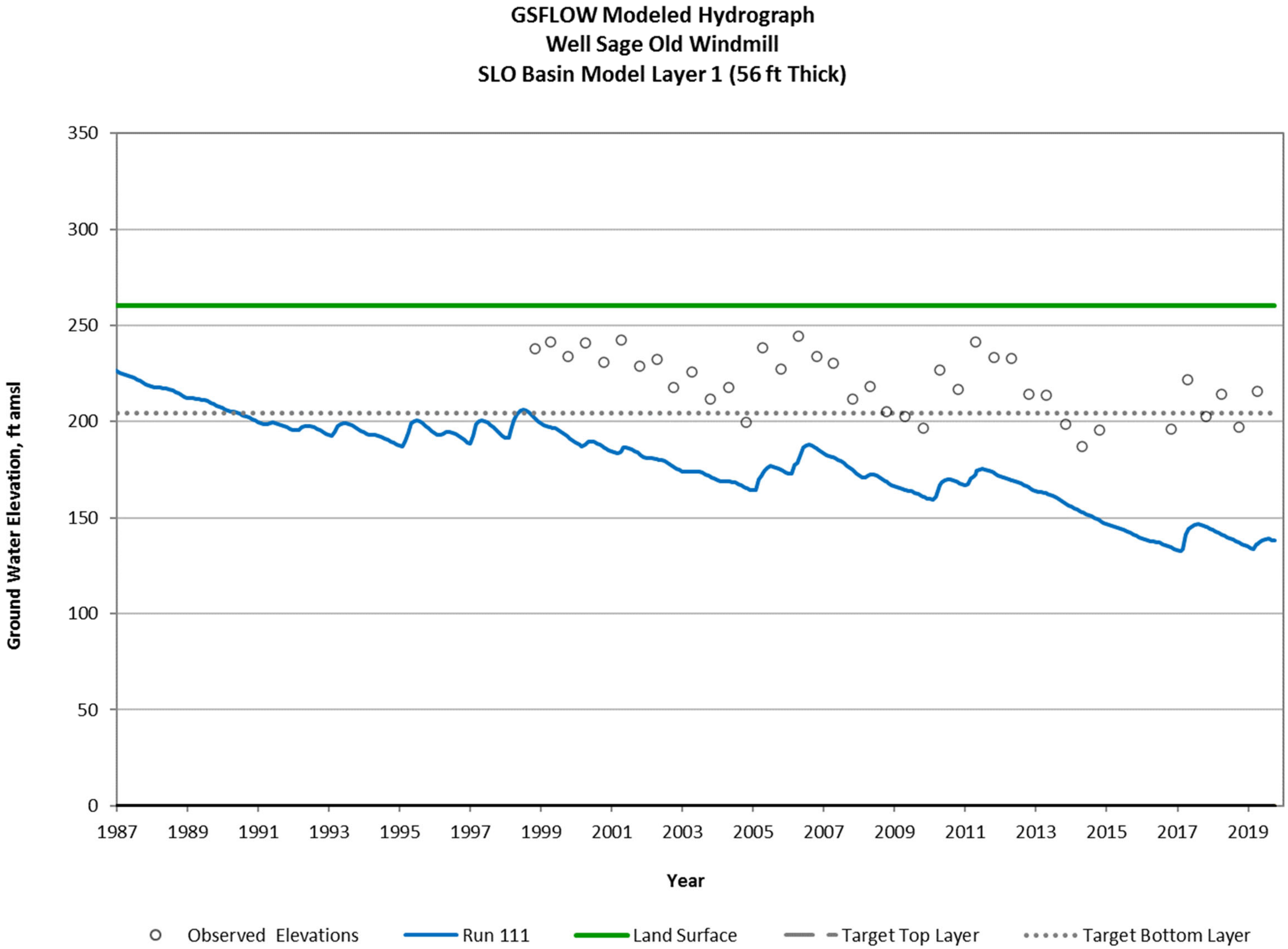

GSFLOW Modeled Hydrograph
Well Sage Old Windmill
SLO Basin Model Layer 1 (56 ft Thick)
Ground Water Elevation, ft amsl
350
300
250
200
150
100
50
0
1987
1989
1991
1993
1995
1997
1999
2001
2003
2005
2007
2009
2011
2013
2015
2017
2019
Year
Observed Elevations
Run 111
Land Surface
Target Top Layer
Target Bottom Layer

Figure B-25

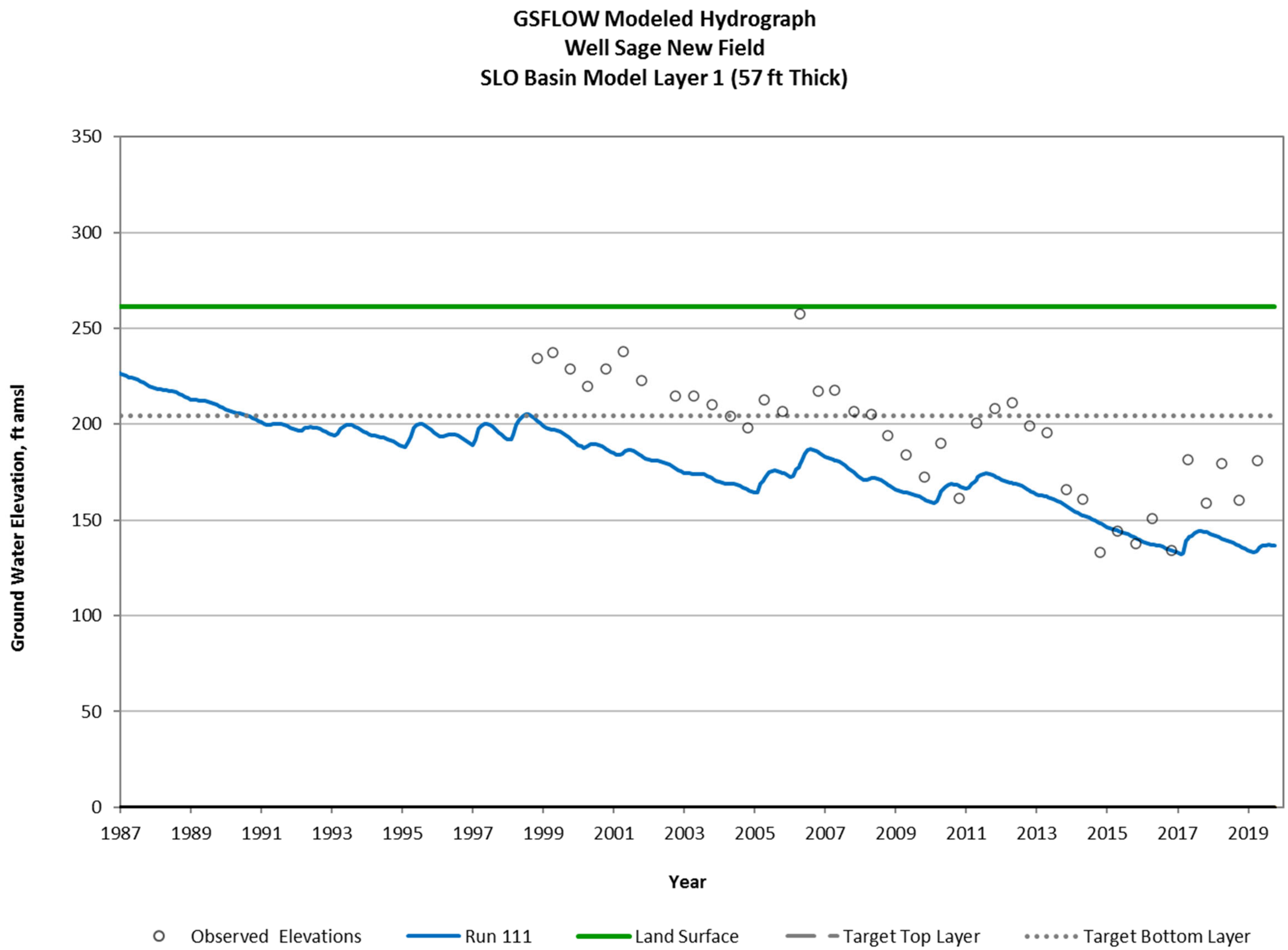

GSFLOW Modeled Hydrograph
Well Sage New Field
SLO Basin Model Layer 1 (57 ft Thick)
Ground Water Elevation, ft amsl
350
300
250
200
150
100
50
0
1987
1989
1991
1993
1995
1997
1999
2001
2003
2005
2007
2009
2011
2013
2015
2017
2019
Year
Observed Elevations
Run 111
Land Surface
Target Top Layer
Target Bottom Layer

Figure B-26

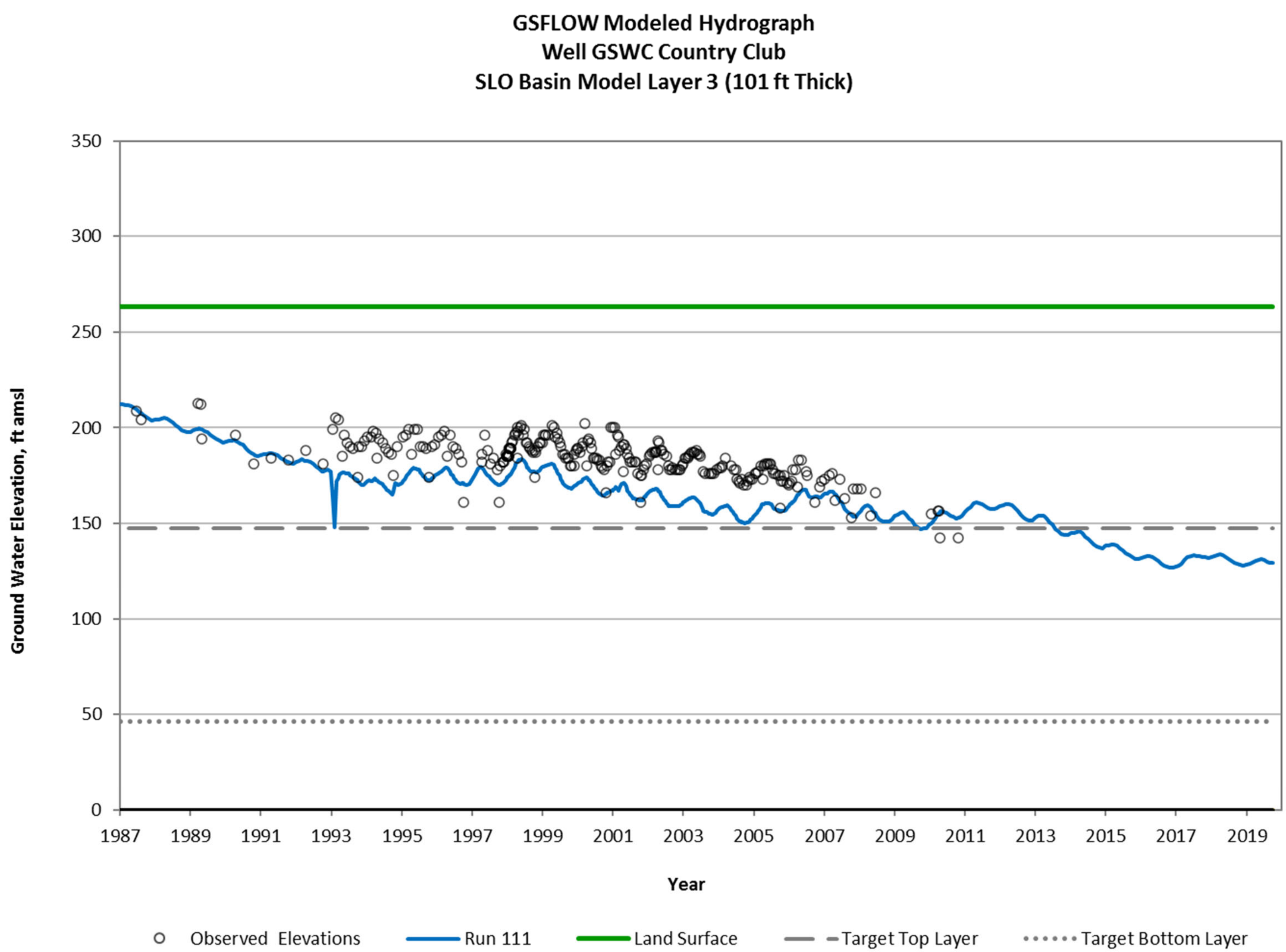

GSFLOW Modeled Hydrograph
Well GSWC Country Club
SLO Basin Model Layer 3 (101 ft Thick)
Ground Water Elevation, ft amsl
350
300
250
200
150
100
50
0
1987
1989
1991
1993
1995
1997
1999
2001
2003
2005
2007
2009
2011
2013
2015
2017
2019
Year
Observed Elevations
Run 111
Land Surface
Target Top Layer
Target Bottom Layer

Figure B-27

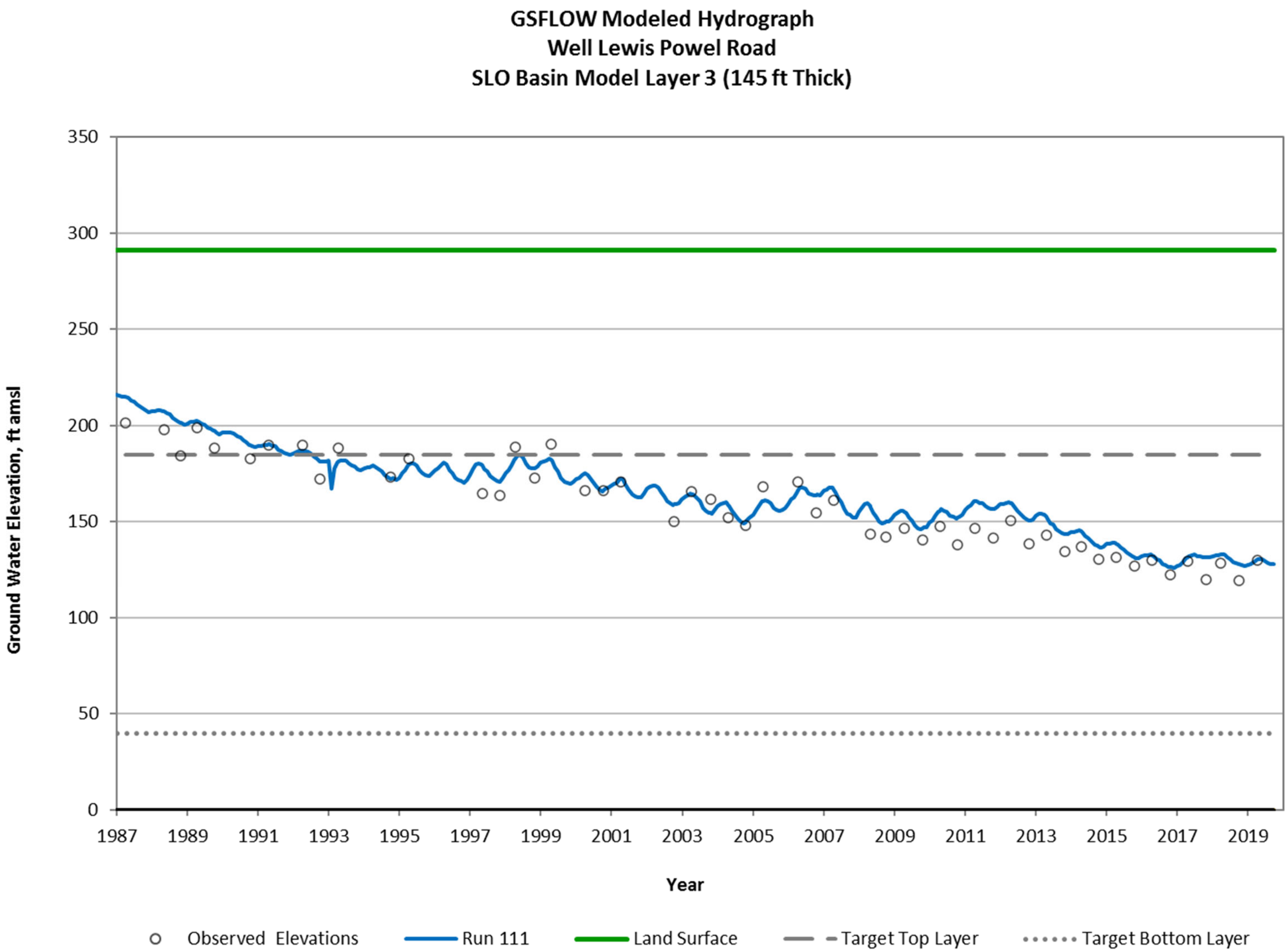

GSFLOW Modeled Hydrograph
Well Lewis Powel Road
SLO Basin Model Layer 3 (145 ft Thick)
Ground Water Elevation, ft amsl
350
300
250
200
150
100
50
0
1987
1989
1991
1993
1995
1997
1999
2001
2003
2005
2007
2009
2011
2013
2015
2017
2019
Year
Observed Elevations
Run 111
Land Surface
Target Top Layer
Target Bottom Layer

Figure B-28

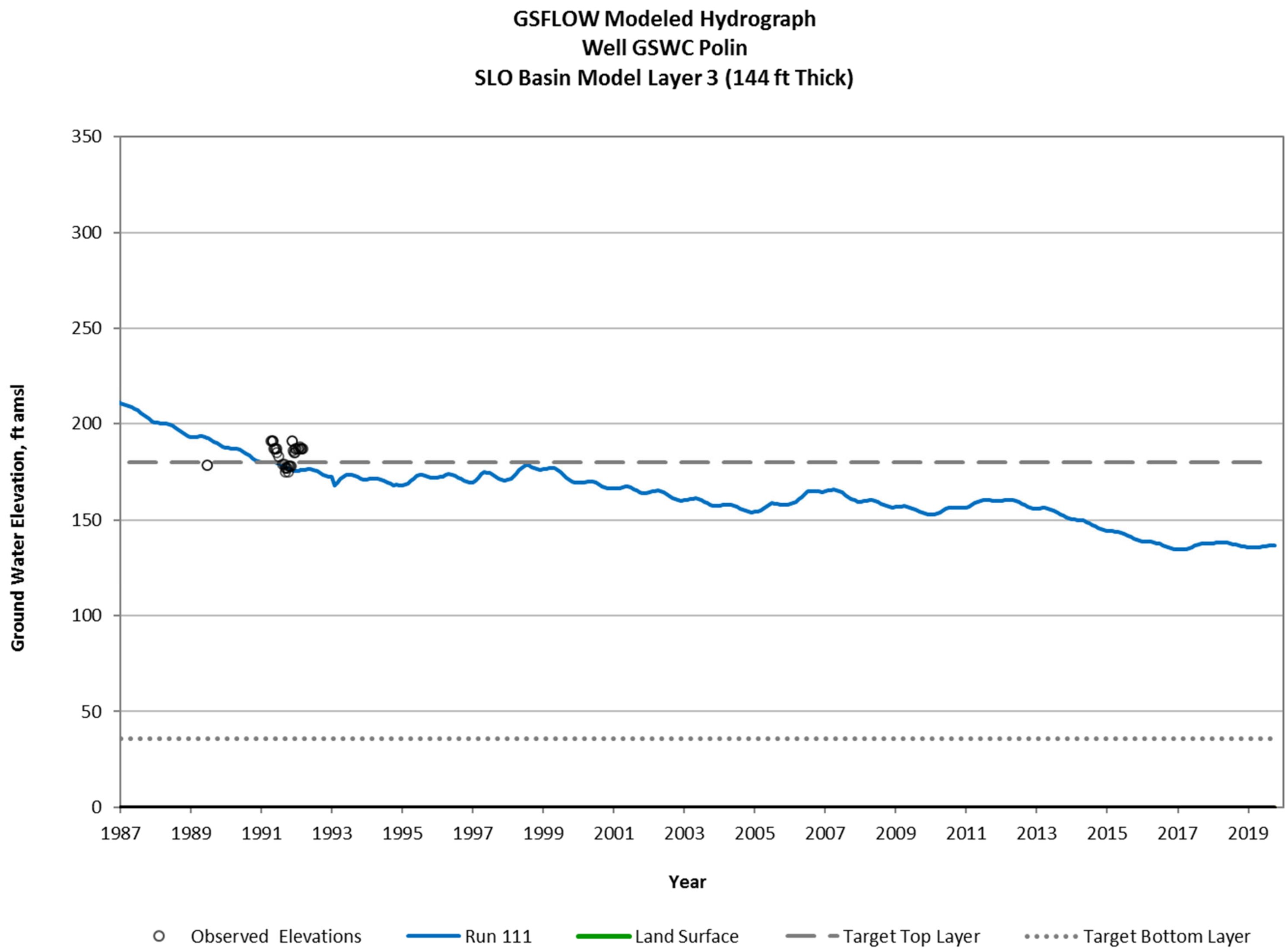

GSFLOW Modeled Hydrograph
Well GSWC Polin
SLO Basin Model Layer 3 (144 ft Thick)
Ground Water Elevation, ft amsl
350
300
250
200
150
100
50
0
1987
1989
1991
1993
1995
1997
1999
2001
2003
2005
2007
2009
2011
2013
2015
2017
2019
Year
Observed Elevations
Run 111
Land Surface
Target Top Layer
Target Bottom Layer

Figure B-29

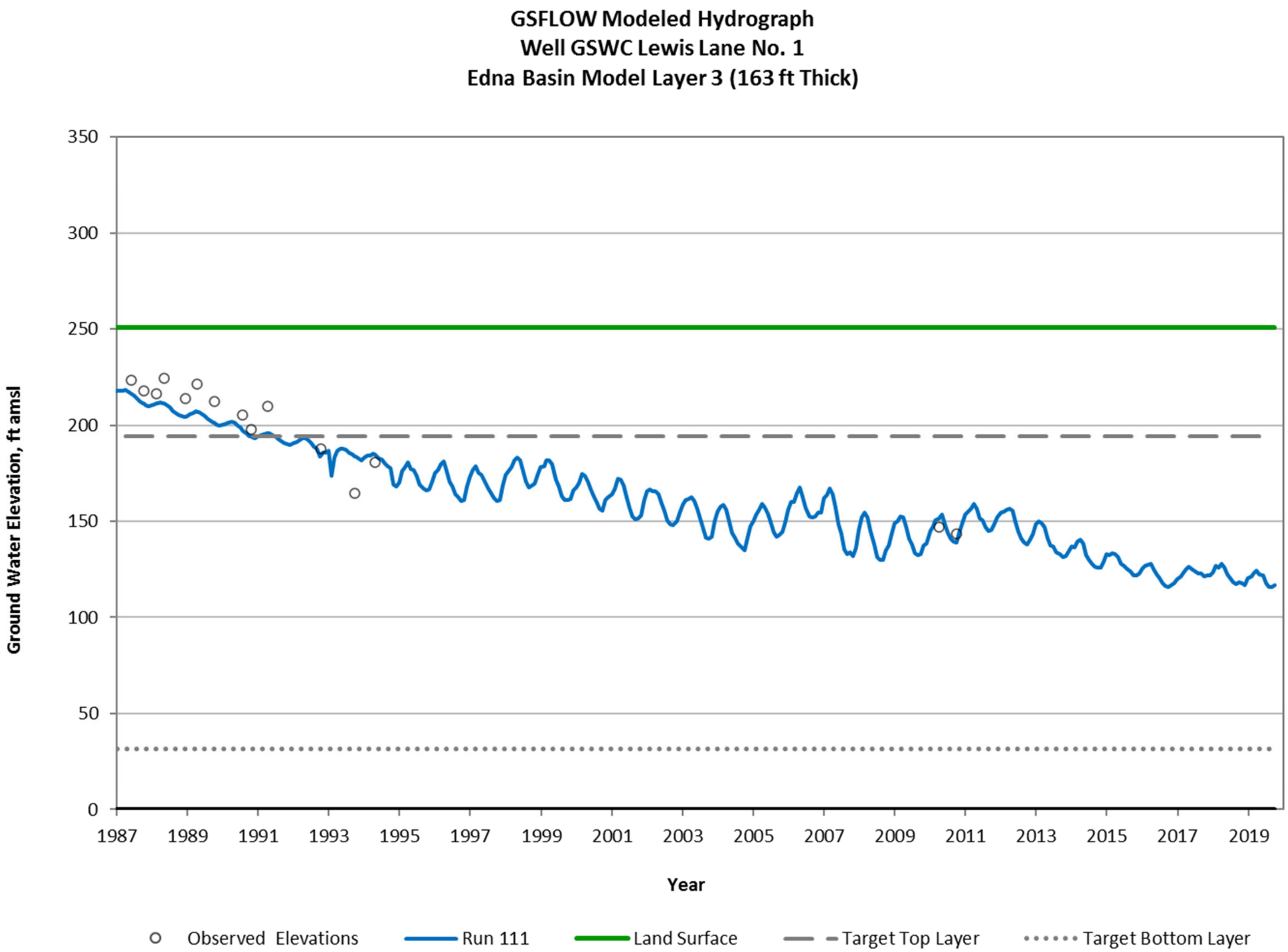

GSFLOW Modeled Hydrograph
Well GSWC Lewis Lane No. 1
Edna Basin Model Layer 3 (163 ft Thick)
Ground Water Elevation, ft amsl
350
300
250
200
150
100
50
0
1987
1989
1991
1993
1995
1997
1999
2001
2003
2005
2007
2009
2011
2013
2015
2017
2019
Year
Observed Elevations
Run 111
Land Surface
Target Top Layer
Target Bottom Layer

Figure B-30

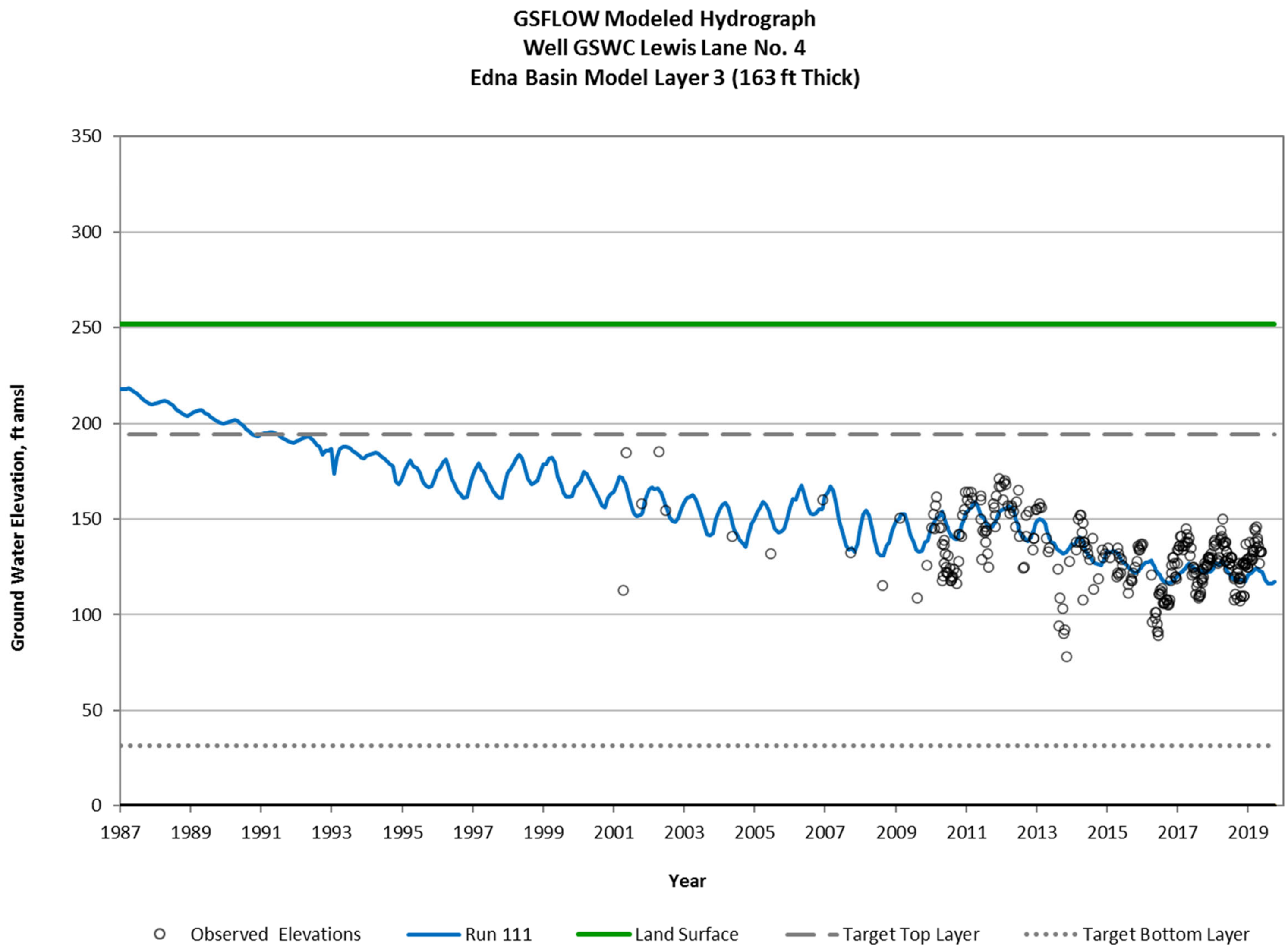
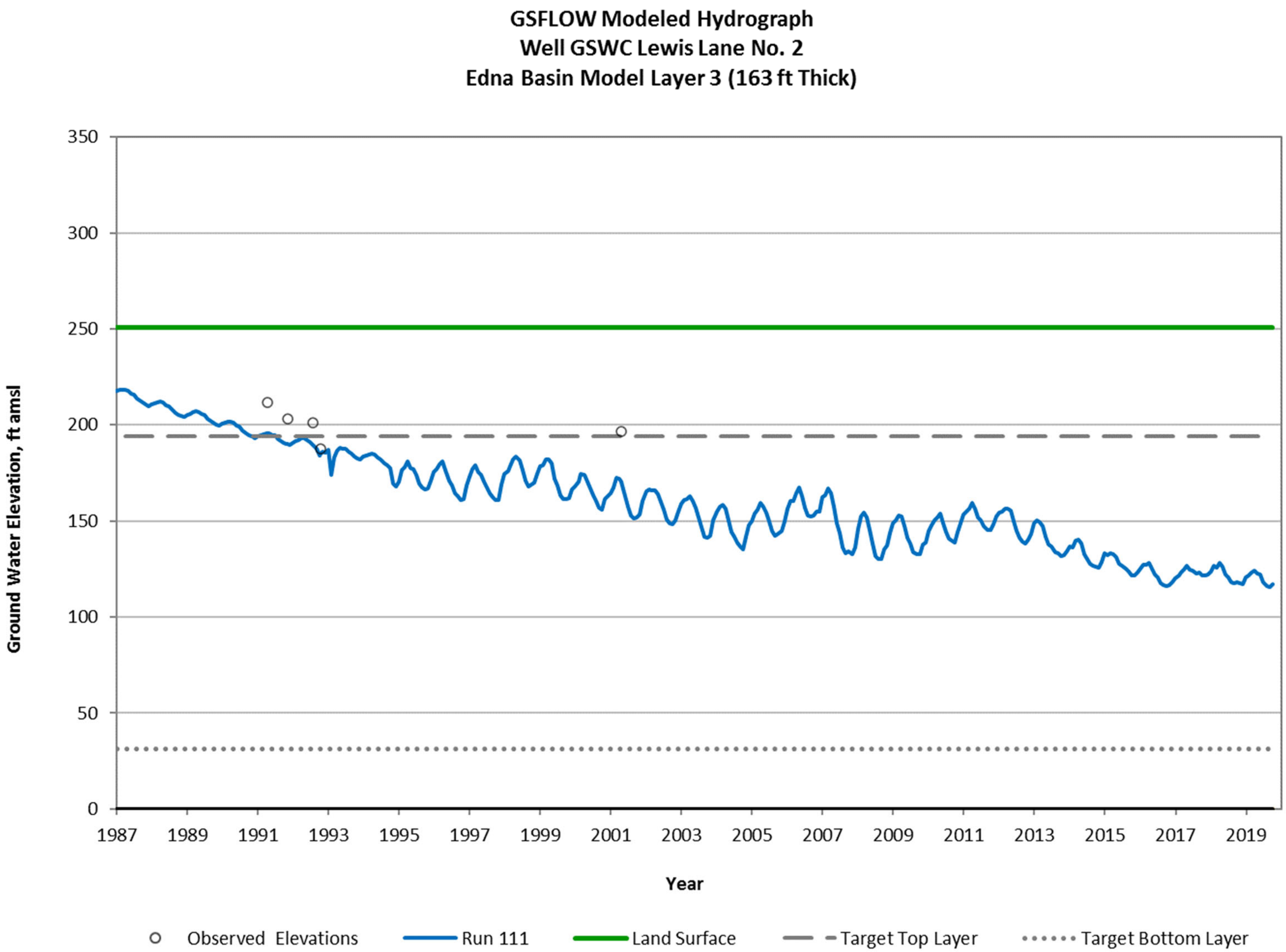

GSFLOW Modeled Hydrograph
Well GSWC Lewis Lane No. 4
Edna Basin Model Layer 3 (163 ft Thick)
Ground Water Elevation, ft amsl
350
300
250
200
150
100
50
0
1987
1989
1991
1993
1995
1997
1999
2001
2003
2005
2007
2009
2011
2013
2015
2017
2019
Year
Observed Elevations
Run 111
Land Surface
Target Top Layer
Target Bottom Layer

Figure B-31


GSFLOW Modeled Hydrograph
Well GSWC Lewis Lane No. 2
Edna Basin Model Layer 3 (163 ft Thick)
Ground Water Elevation, ft amsl
350
300
250
200
150
100
50
0
1987
1989
1991
1993
1995
1997
1999
2001
2003
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2007
2009
2011
2013
2015
2017
2019
Year
Observed Elevations
Run 111
Land Surface
Target Top Layer
Target Bottom Layer

Figure B-32

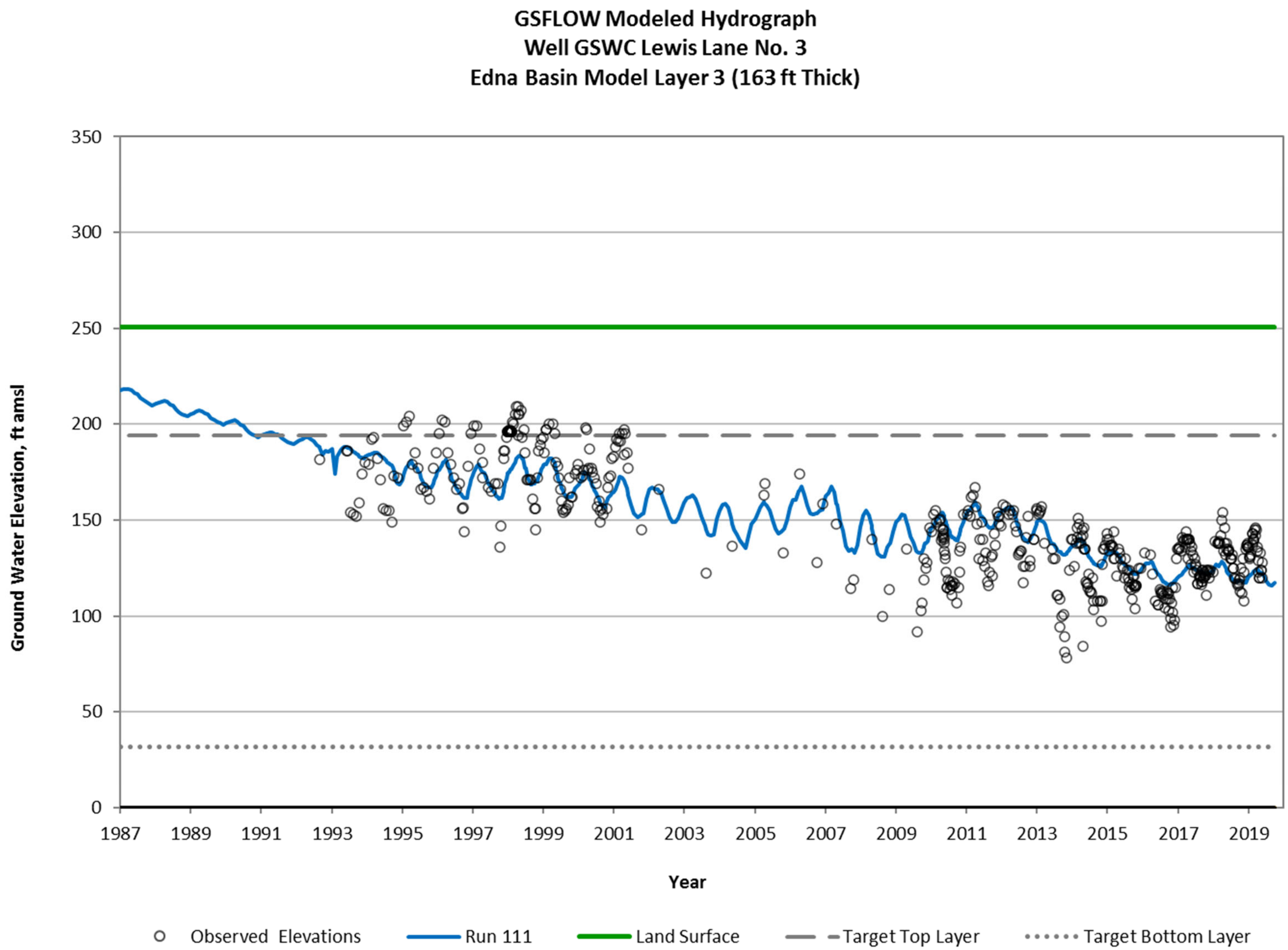
GSFLOW Modeled Hydrograph
Well GSWC Lewis Lane No. 3
Edna Basin Model Layer 3 (163 ft Thick)
Ground Water Elevation, ft amsl
350
300
250
200
150
100
50
0
1987
1989
1991
1993
1995
1997
1999
2001
2003
2005
2007
2009
2011
2013
2015
2017
2019
Year
Observed Elevations
Run 111
Land Surface
Target Top Layer
Target Bottom Layer

Figure B-33

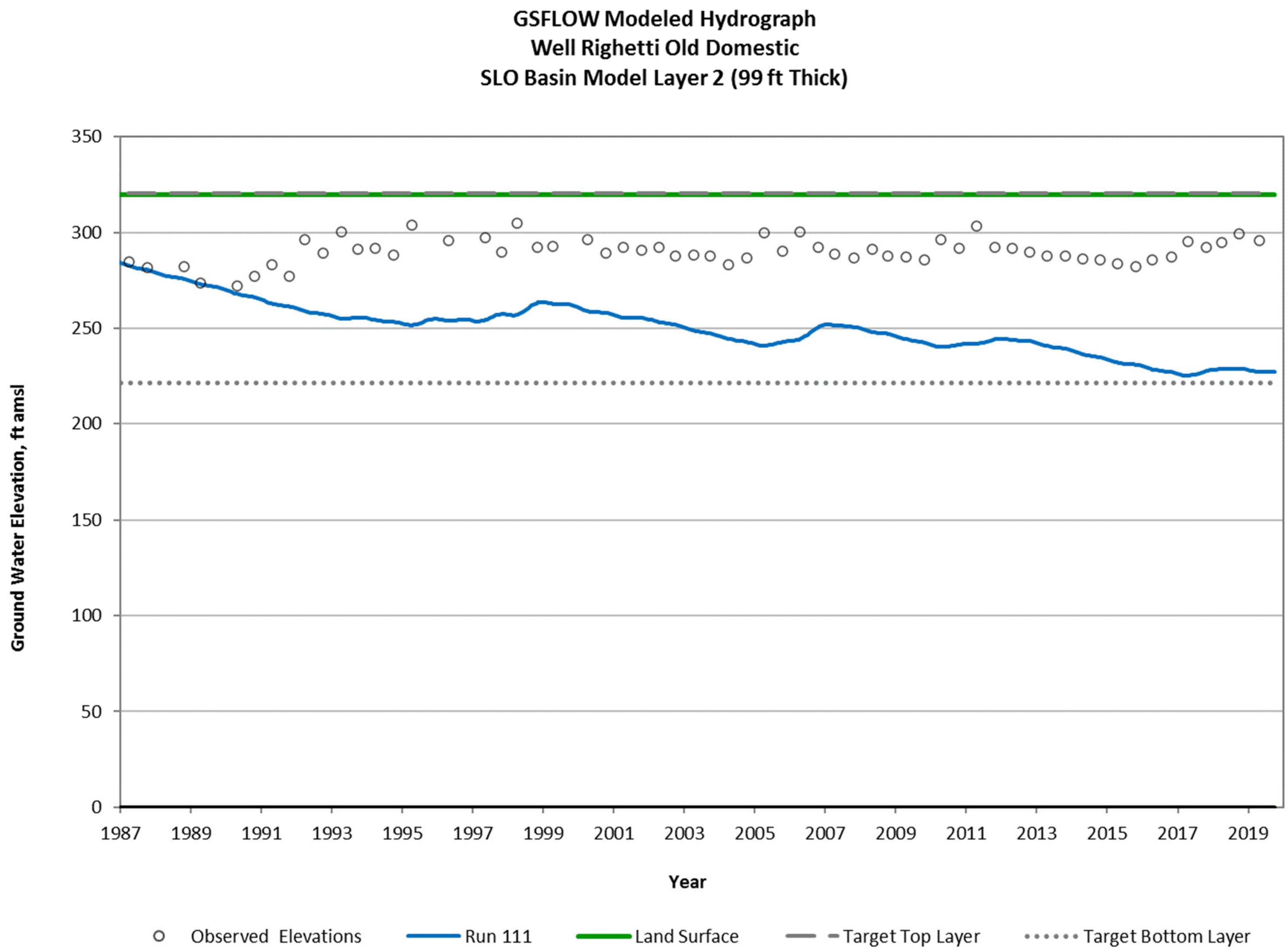
GSFLOW Modeled Hydrograph
Well Righetti Old Domestic
SLO Basin Model Layer 2 (99 ft Thick)
Ground Water Elevation, ft amsl
350
300
250
200
150
100
50
0
1987
1989
1991
1993
1995
1997
1999
2001
2003
2005
2007
2009
2011
2013
2015
2017
2019
Year
Observed Elevations
Run 111
Land Surface
Target Top Layer
Target Bottom Layer

Figure B-34

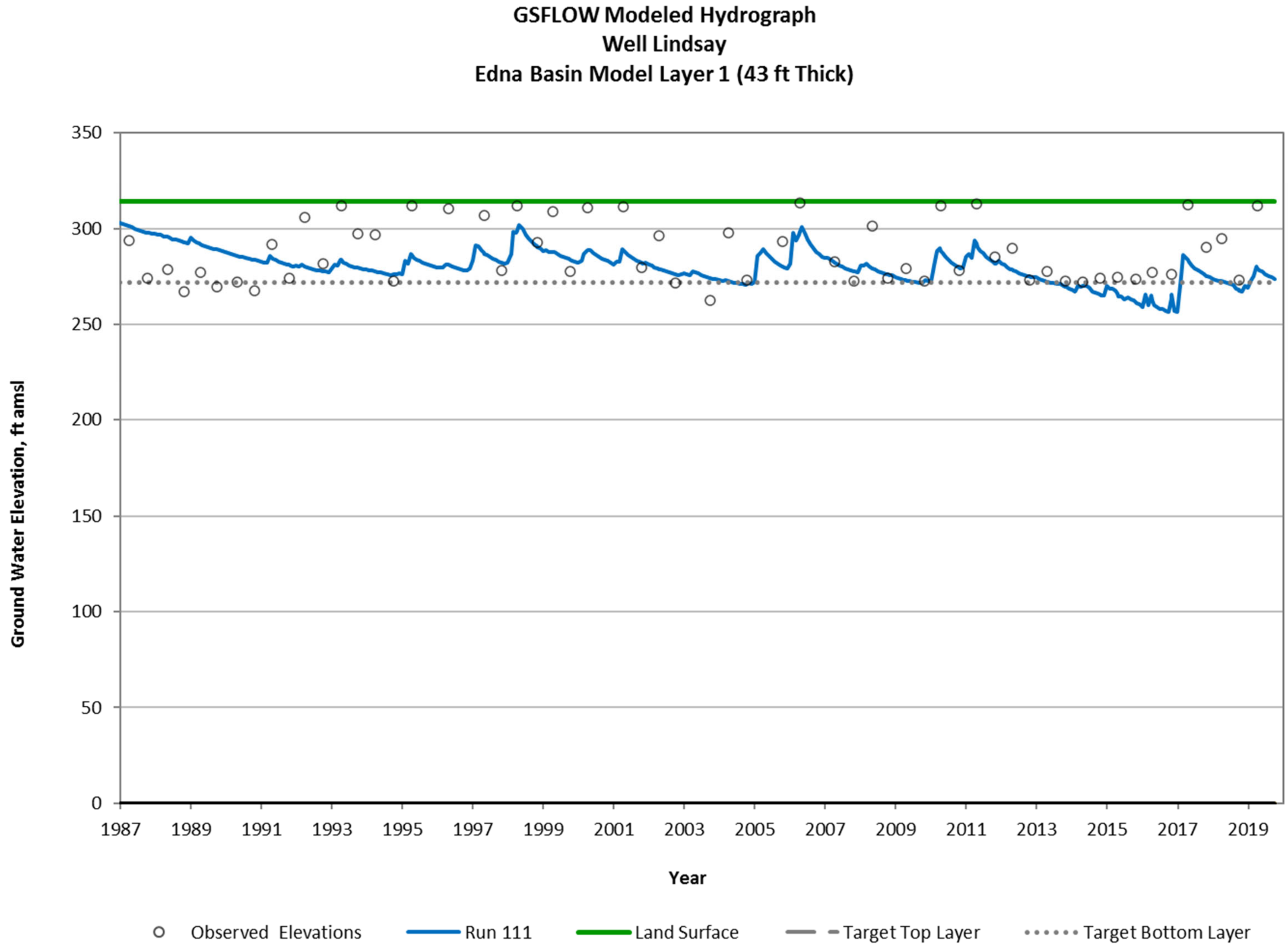
GSFLOW Modeled Hydrograph
Well Lindsay
Edna Basin Model Layer 1 (43 ft Thick)
Ground Water Elevation, ft amsl
350
300
250
200
150
100
50
0
1987
1989
1991
1993
1995
1997
1999
2001
2003
2005
2007
2009
2011
2013
2015
2017
2019
Year
Observed Elevations
Run 111
Land Surface
Target Top Layer
Target Bottom Layer

Figure B-35

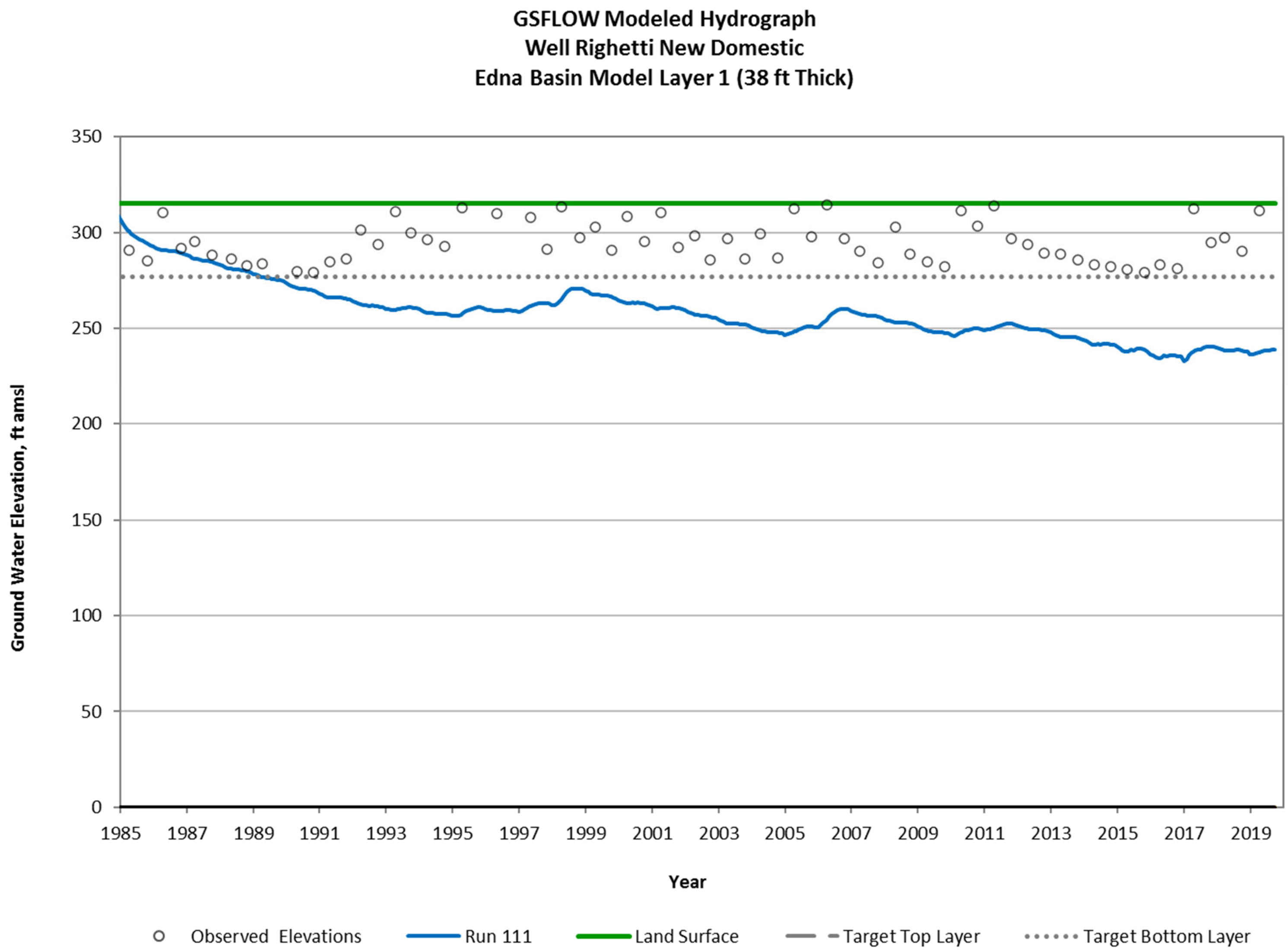
GSFLOW Modeled Hydrograph
Well Righetti New Domestic
Edna Basin Model Layer 1 (38 ft Thick)
Ground Water Elevation, ft amsl
350
300
250
200
150
100
50
0
1985
1987
1989
1991
1993
1995
1997
1999
2001
2003
2005
2007
2009
2011
2013
2015
2017
2019
Year
Observed Elevations
Run 111
Land Surface
Target Top Layer
Target Bottom Layer

Figure B-36

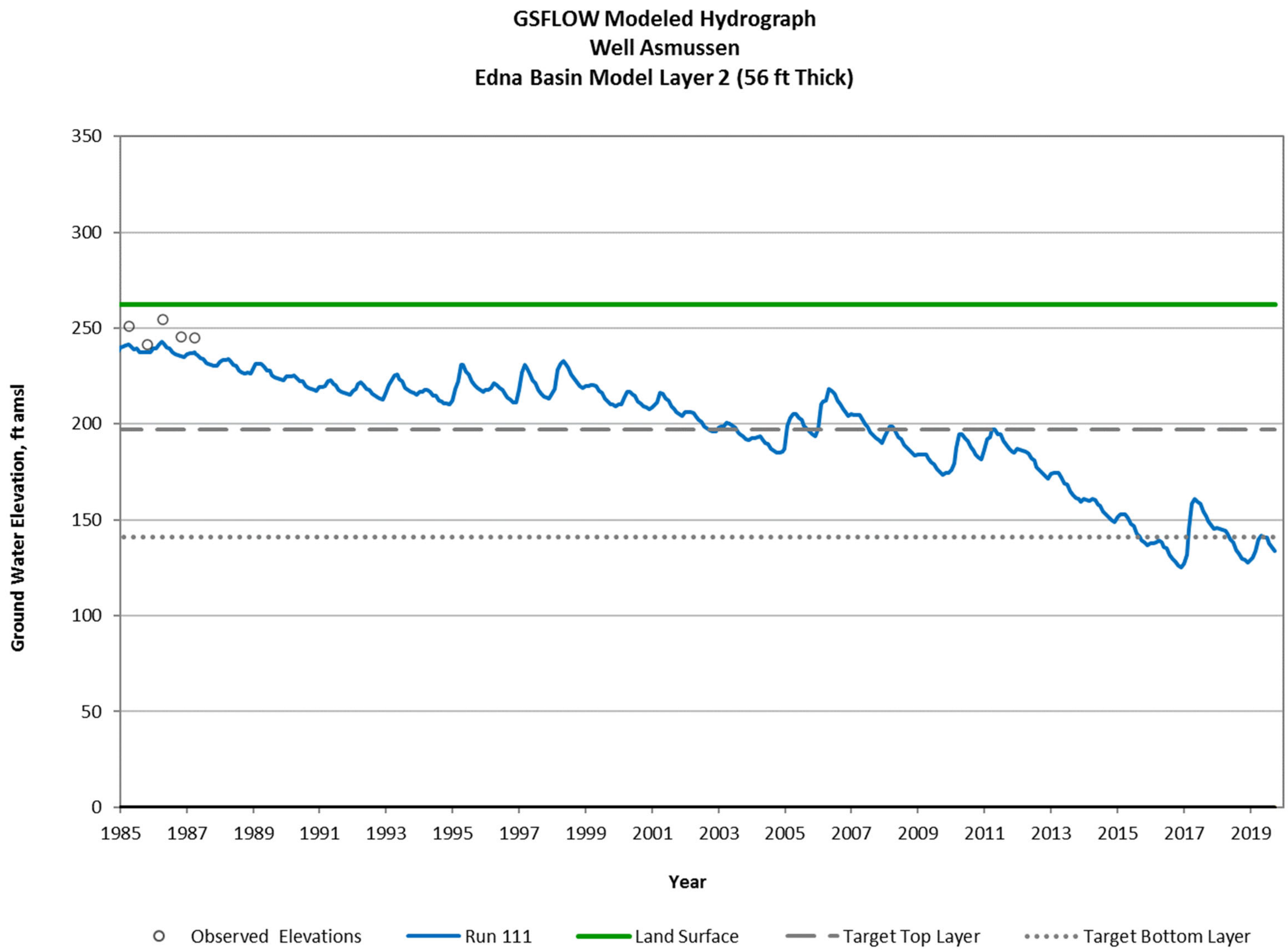
GSFLOW Modeled Hydrograph
Well Asmussen
Edna Basin Model Layer 2 (56 ft Thick)
Ground Water Elevation, ft amsl
350
300
250
200
150
100
50
0
1985
1987
1989
1991
1993
1995
1997
1999
2001
2003
2005
2007
2009
2011
2013
2015
2017
2019
Year
Observed Elevations
Run 111
Land Surface
Target Top Layer
Target Bottom Layer

Figure B-37

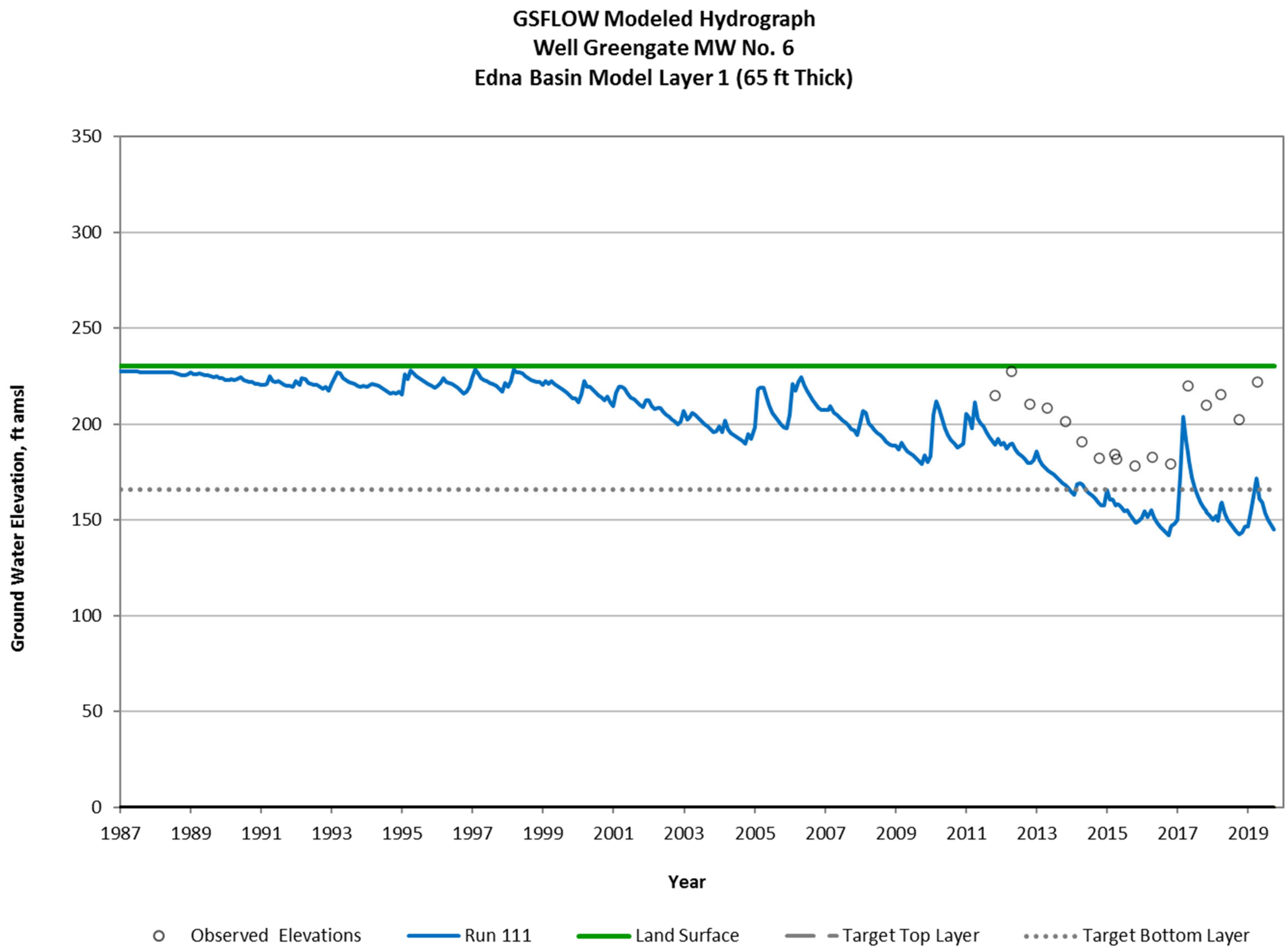
GSFLOW Modeled Hydrograph
Well Greengate MW No. 6
Edna Basin Model Layer 1 (65 ft Thick)
Ground Water Elevation, ft amsl
350
300
250
200
150
100
50
0
1987
1989
1991
1993
1995
1997
1999
2001
2003
2005
2007
2009
2011
2013
2015
2017
2019
Year
Observed Elevations
Run 111
Land Surface
Target Top Layer
Target Bottom Layer

Figure B-38

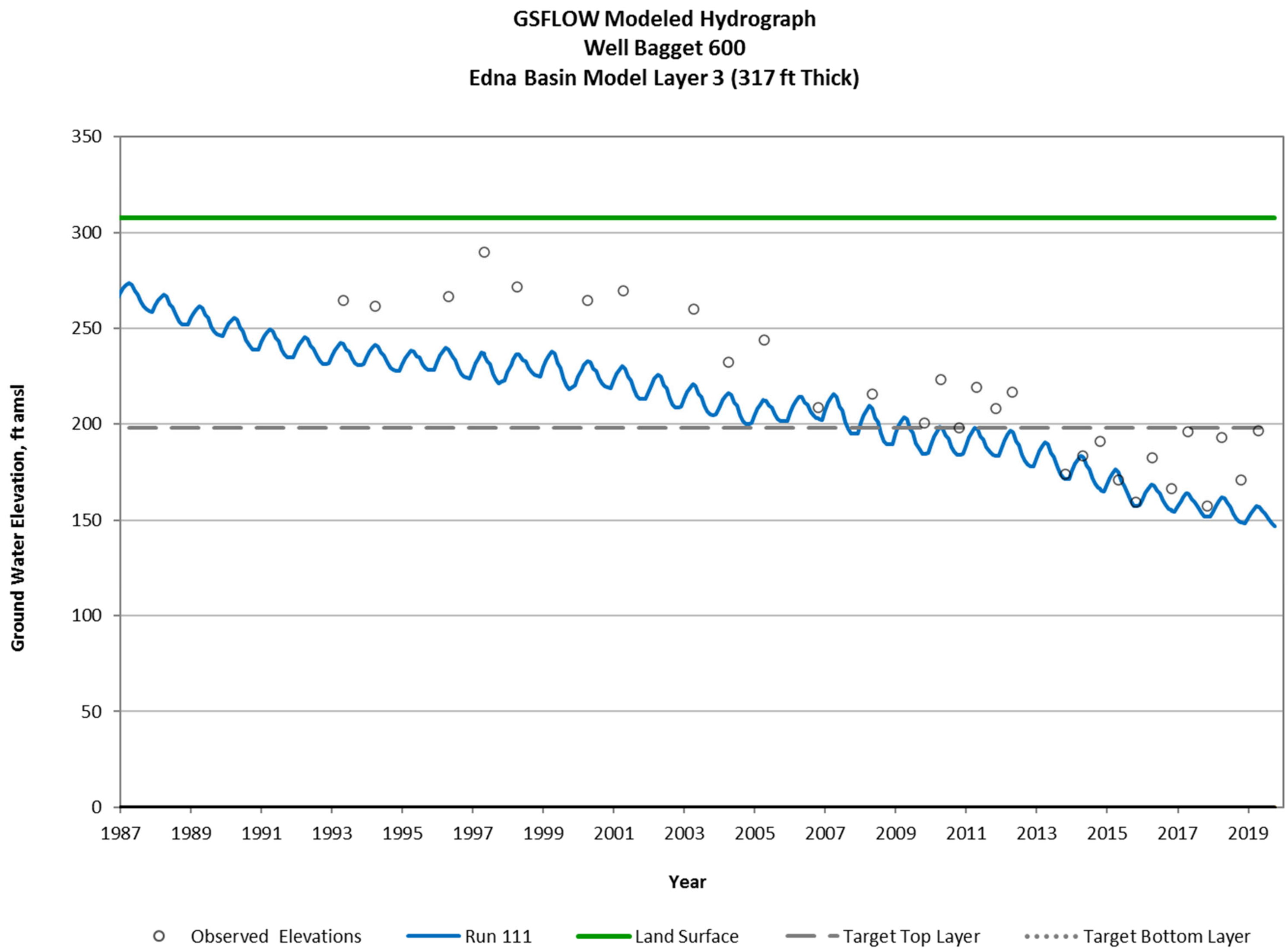
GSFLOW Modeled Hydrograph
Well Bagget 600
Edna Basin Model Layer 3 (317 ft Thick)
Ground Water Elevation, ft amsl
350
300
250
200
150
100
50
0
1987
1989
1991
1993
1995
1997
1999
2001
2003
2005
2007
2009
2011
2013
2015
2017
2019
Year
Observed Elevations
Run 111
Land Surface
Target Top Layer
Target Bottom Layer

Figure B-39

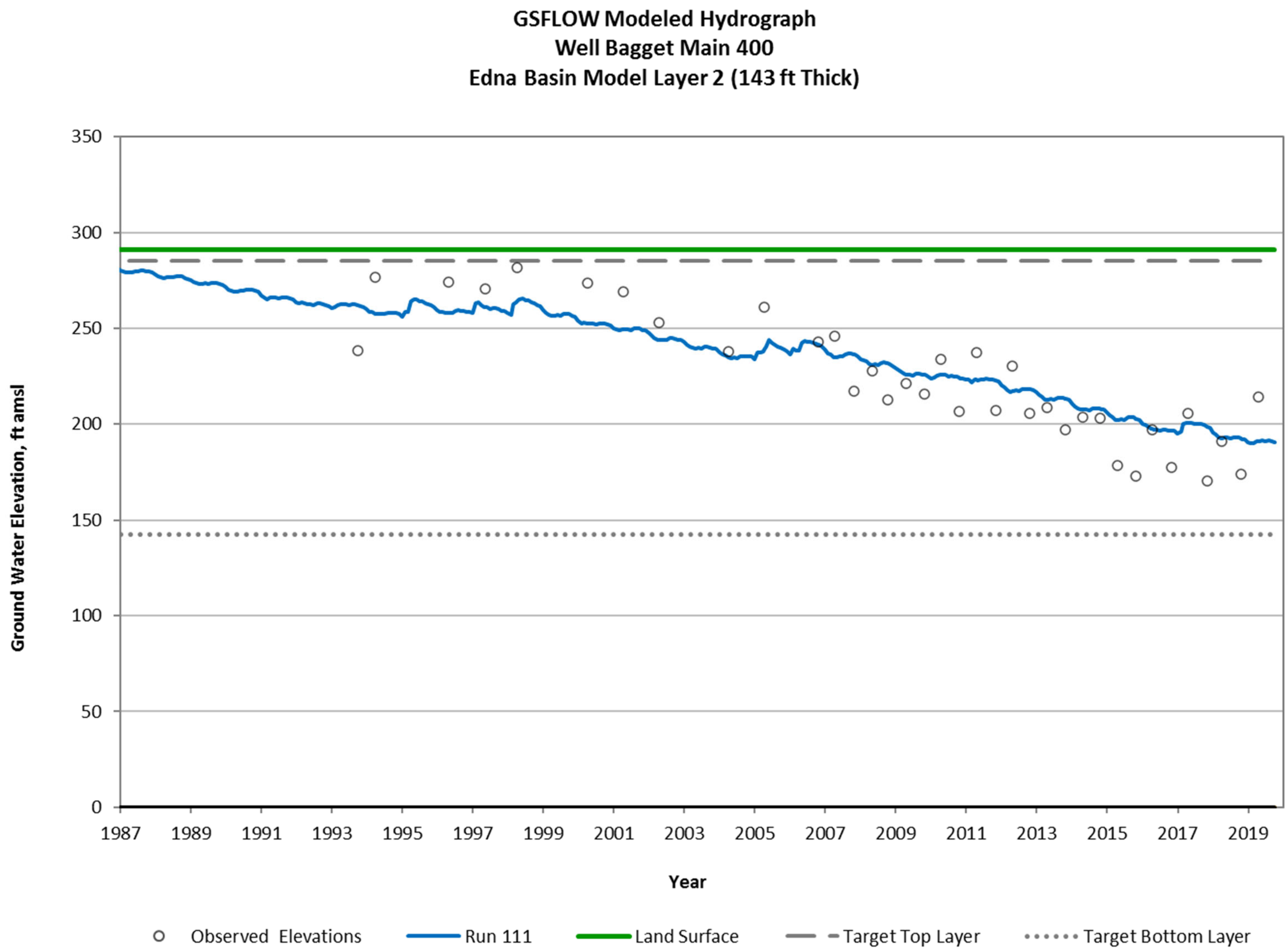
GSFLOW Modeled Hydrograph
Well Bagget Main 400
Edna Basin Model Layer 2 (143 ft Thick)
Ground Water Elevation, ft amsl
350
300
250
200
150
100
50
0
1987
1989
1991
1993
1995
1997
1999
2001
2003
2005
2007
2009
2011
2013
2015
2017
2019
Year
Observed Elevations
Run 111
Land Surface
Target Top Layer
Target Bottom Layer

Figure B-40

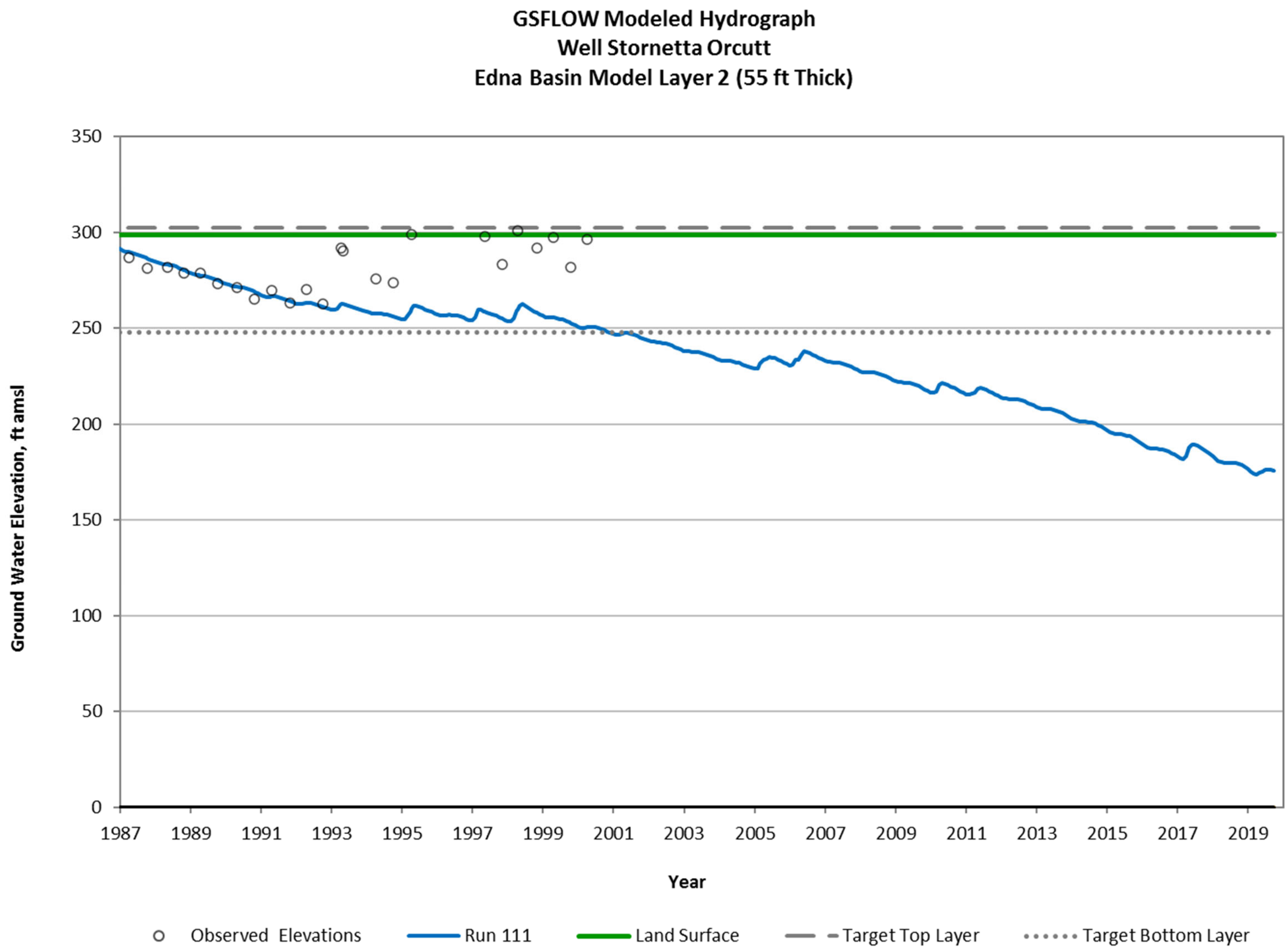
GSFLOW Modeled Hydrograph
Well Stornetta Orcutt
Edna Basin Model Layer 2 (55 ft Thick)
Ground Water Elevation, ft amsl
350
300
250
200
150
100
50
0
1987
1989
1991
1993
1995
1997
1999
2001
2003
2005
2007
2009
2011
2013
2015
2017
2019
Year
Observed Elevations
Run 111
Land Surface
Target Top Layer
Target Bottom Layer

Figure B-41

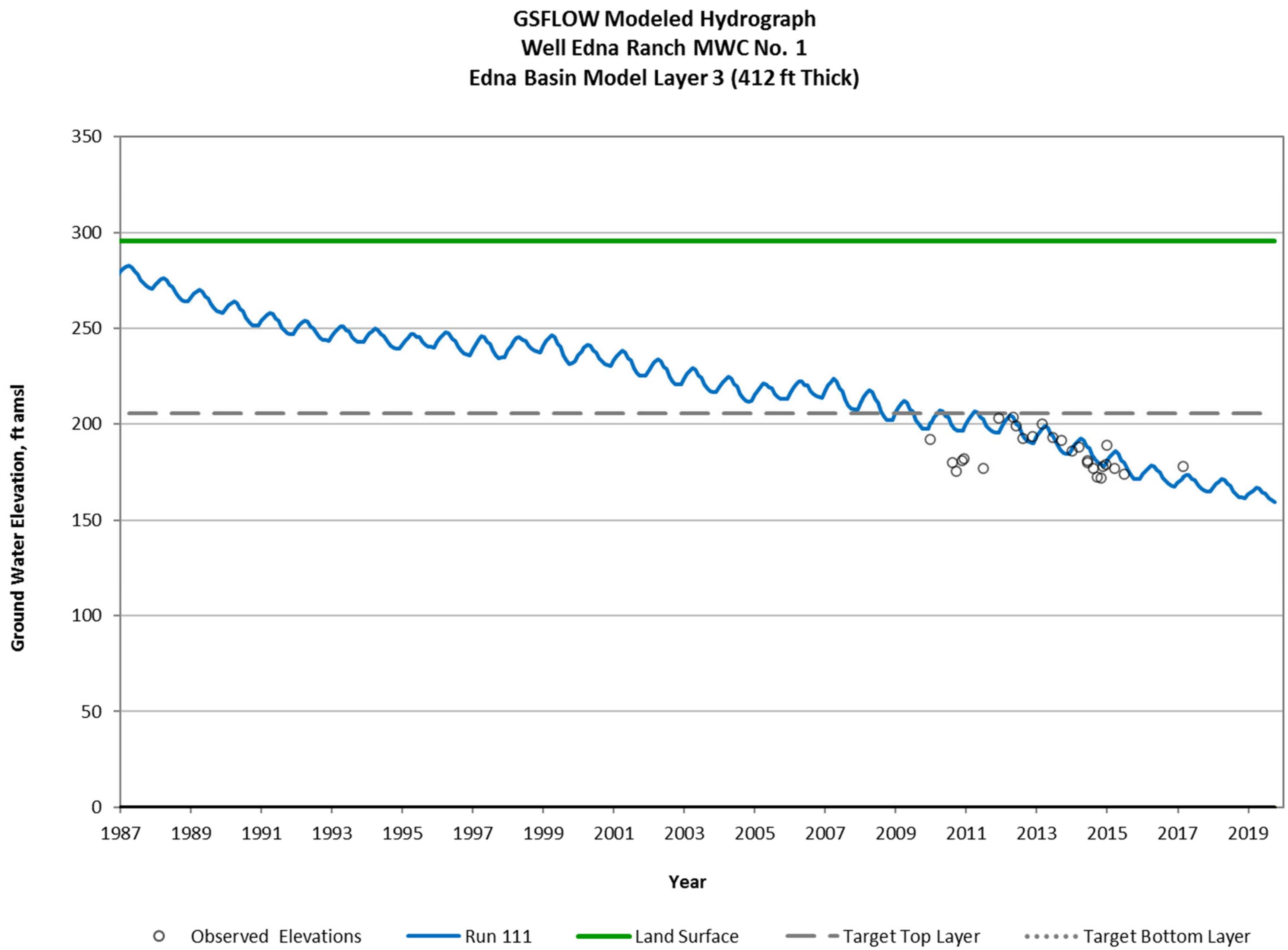
GSFLOW Modeled Hydrograph
Well Edna Ranch MWC No. 1
Edna Basin Model Layer 3 (412 ft Thick)
Ground Water Elevation, ft amsl
350
300
250
200
150
100
50
0
1987
1989
1991
1993
1995
1997
1999
2001
2003
2005
2007
2009
2011
2013
2015
2017
2019
Year
Observed Elevations
Run 111
Land Surface
Target Top Layer
Target Bottom Layer

Figure B-42

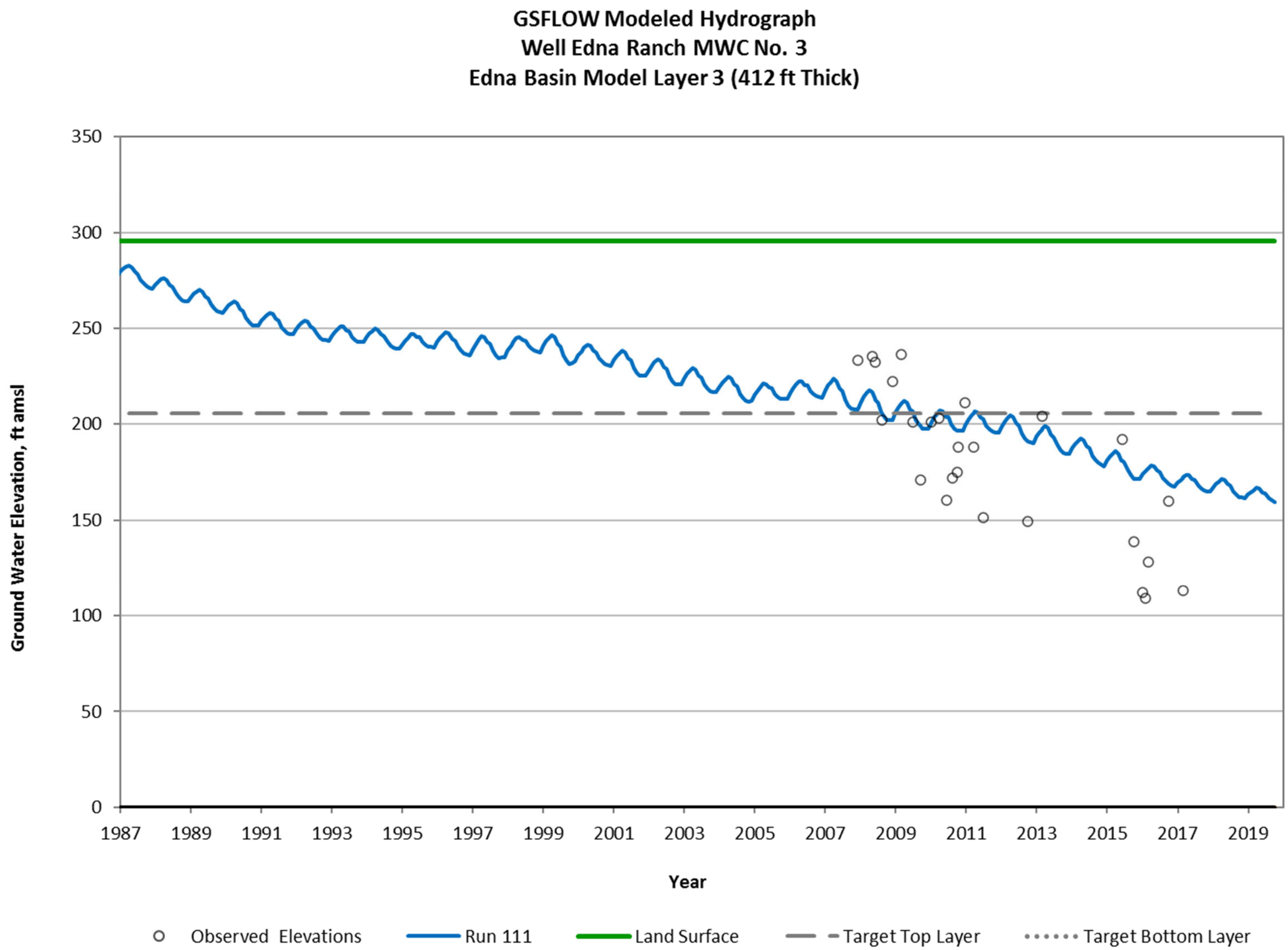
GSFLOW Modeled Hydrograph
Well Edna Ranch MWC No. 3
Edna Basin Model Layer 3 (412 ft Thick)
Ground Water Elevation, ft amsl
350
300
250
200
150
100
50
0
1987
1989
1991
1993
1995
1997
1999
2001
2003
2005
2007
2009
2011
2013
2015
2017
2019
Year
Observed Elevations
Run 111
Land Surface
Target Top Layer
Target Bottom Layer

Figure B-43

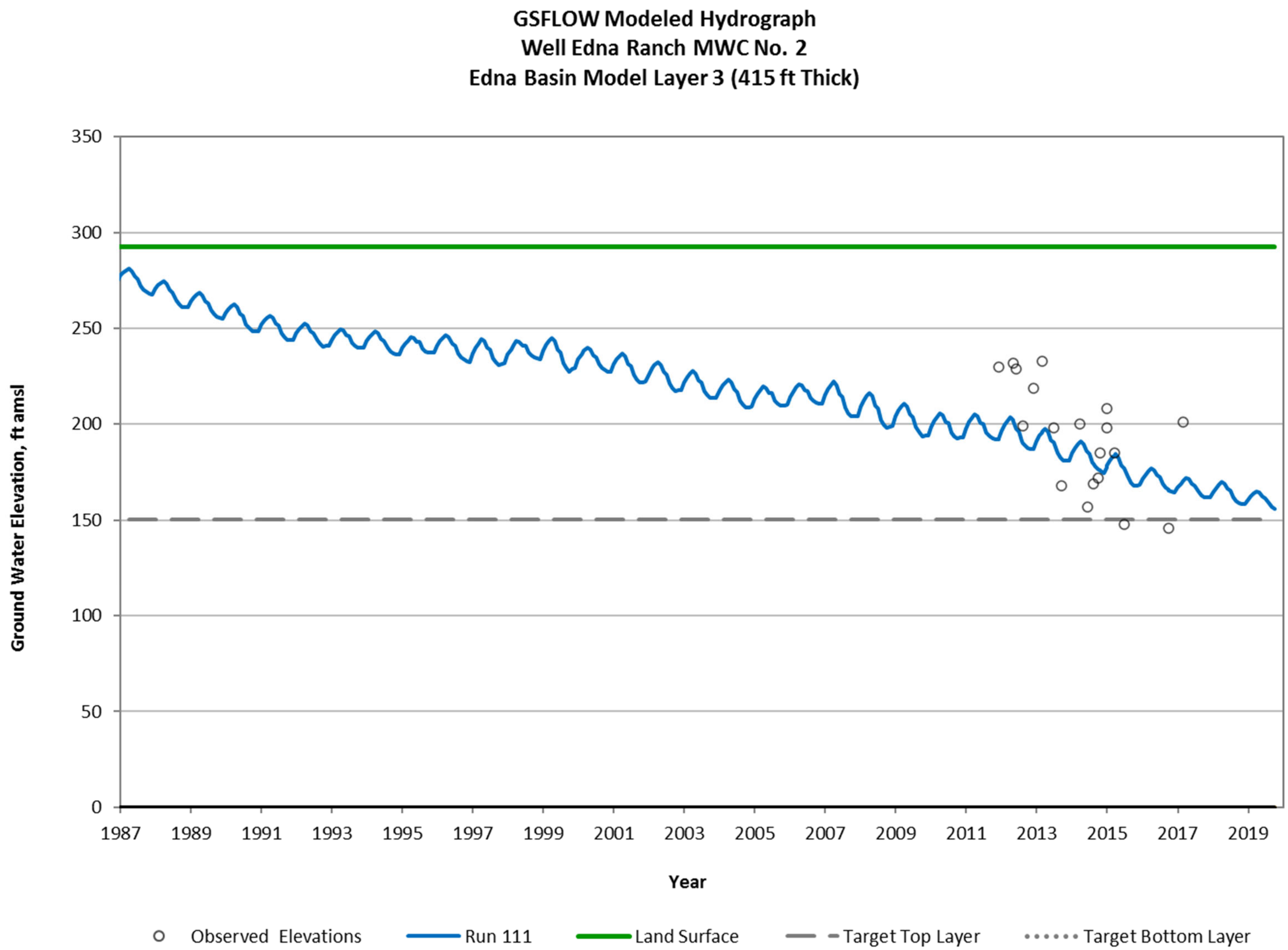
GSFLOW Modeled Hydrograph
Well Edna Ranch MWC No. 2
Edna Basin Model Layer 3 (415 ft Thick)
Ground Water Elevation, ft amsl
350
300
250
200
150
100
50
0
1987
1989
1991
1993
1995
1997
1999
2001
2003
2005
2007
2009
2011
2013
2015
2017
2019
Year
Observed Elevations
Run 111
Land Surface
Target Top Layer
Target Bottom Layer

Figure B-44

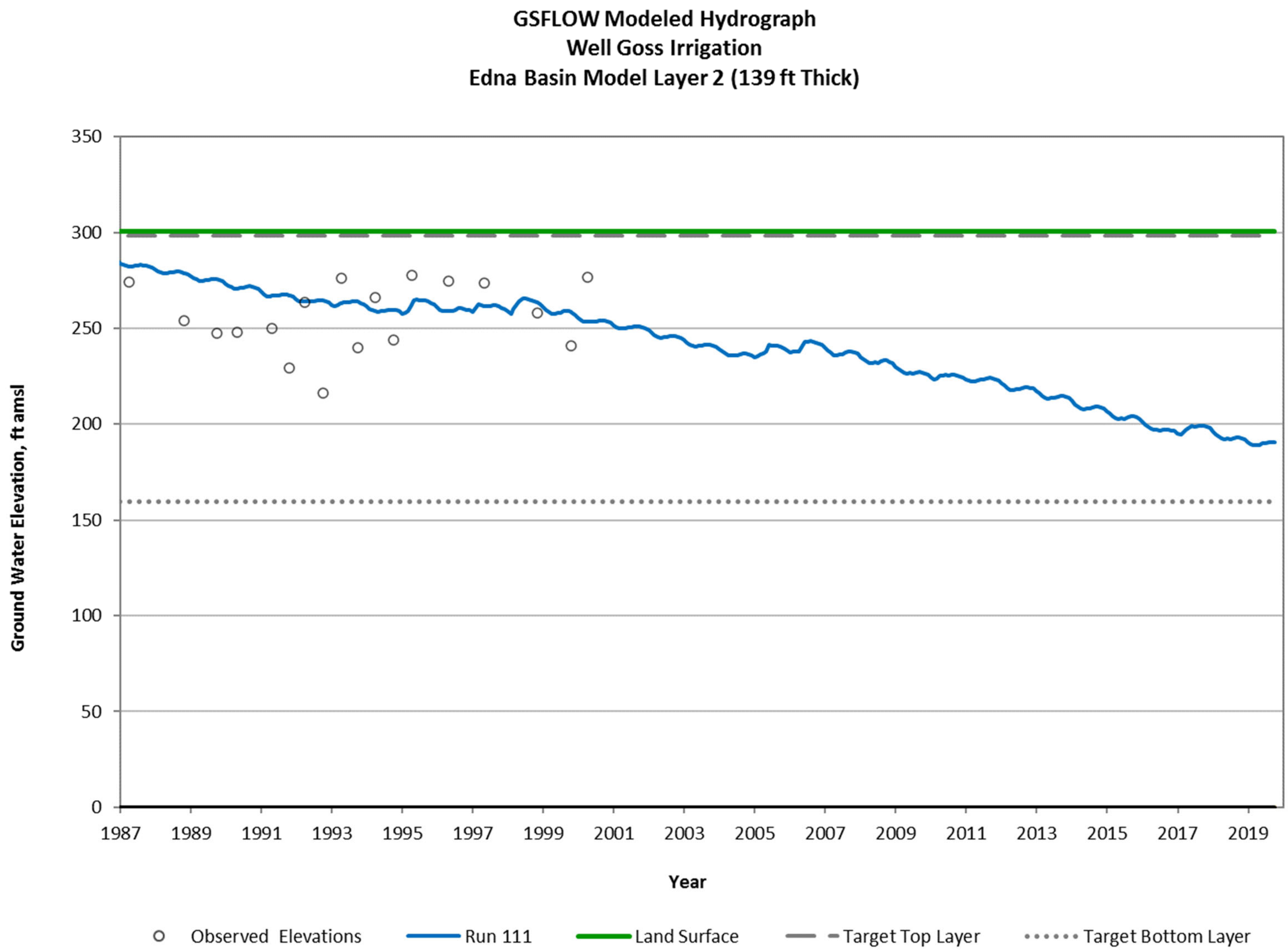
GSFLOW Modeled Hydrograph
Well Goss Irrigation
Edna Basin Model Layer 2 (139 ft Thick)
Ground Water Elevation, ft amsl
350
300
250
200
150
100
50
0
1987
1989
1991
1993
1995
1997
1999
2001
2003
2005
2007
2009
2011
2013
2015
2017
2019
Year
Observed Elevations
Run 111
Land Surface
Target Top Layer
Target Bottom Layer

Figure B-45

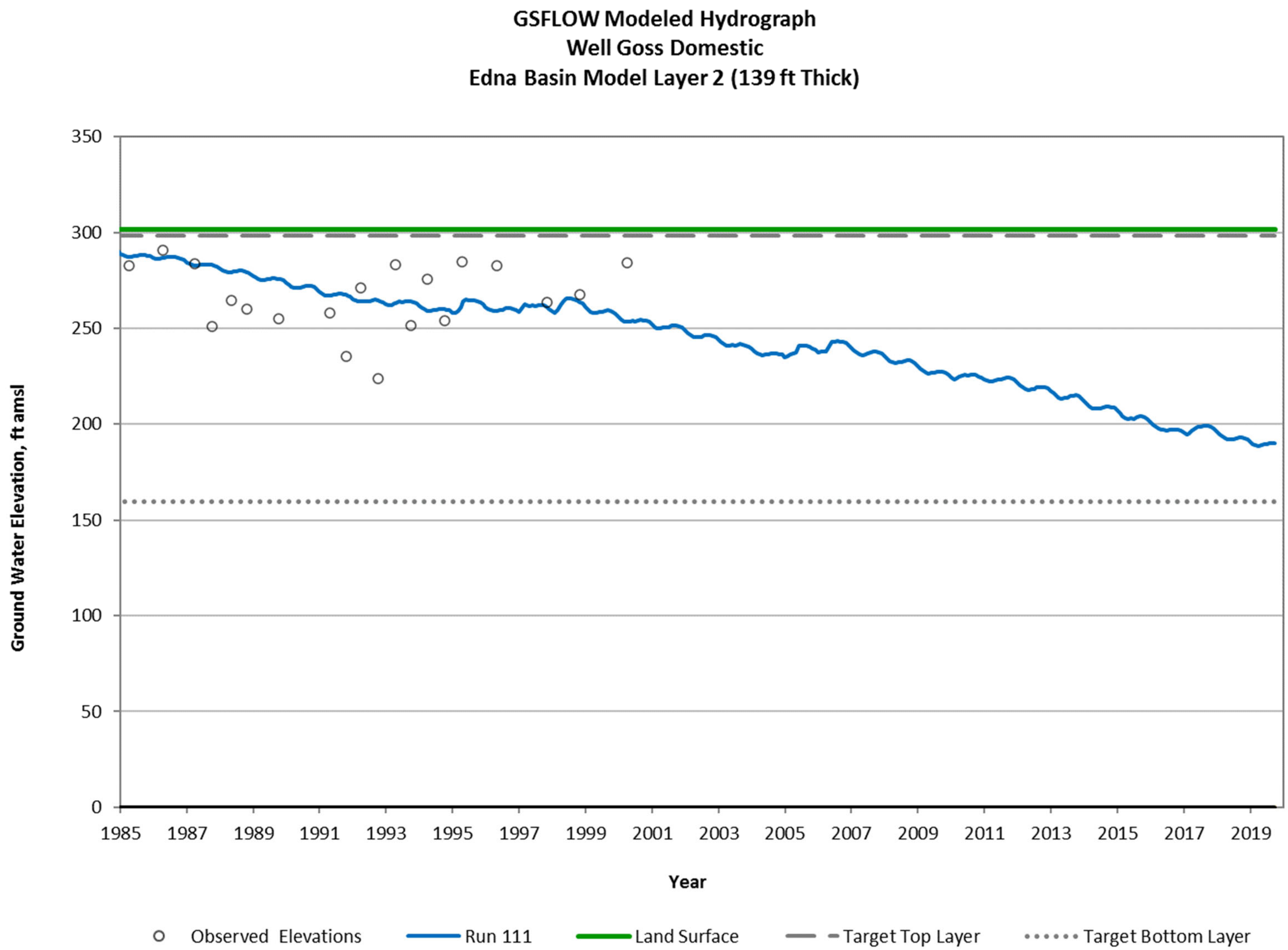
GSFLOW Modeled Hydrograph
Well Goss Domestic
Edna Basin Model Layer 2 (139 ft Thick)
Ground Water Elevation, ft amsl
350
300
250
200
150
100
50
0
1985
1987
1989
1991
1993
1995
1997
1999
2001
2003
2005
2007
2009
2011
2013
2015
2017
2019
Year
Observed Elevations
Run 111
Land Surface
Target Top Layer
Target Bottom Layer

Figure B-46

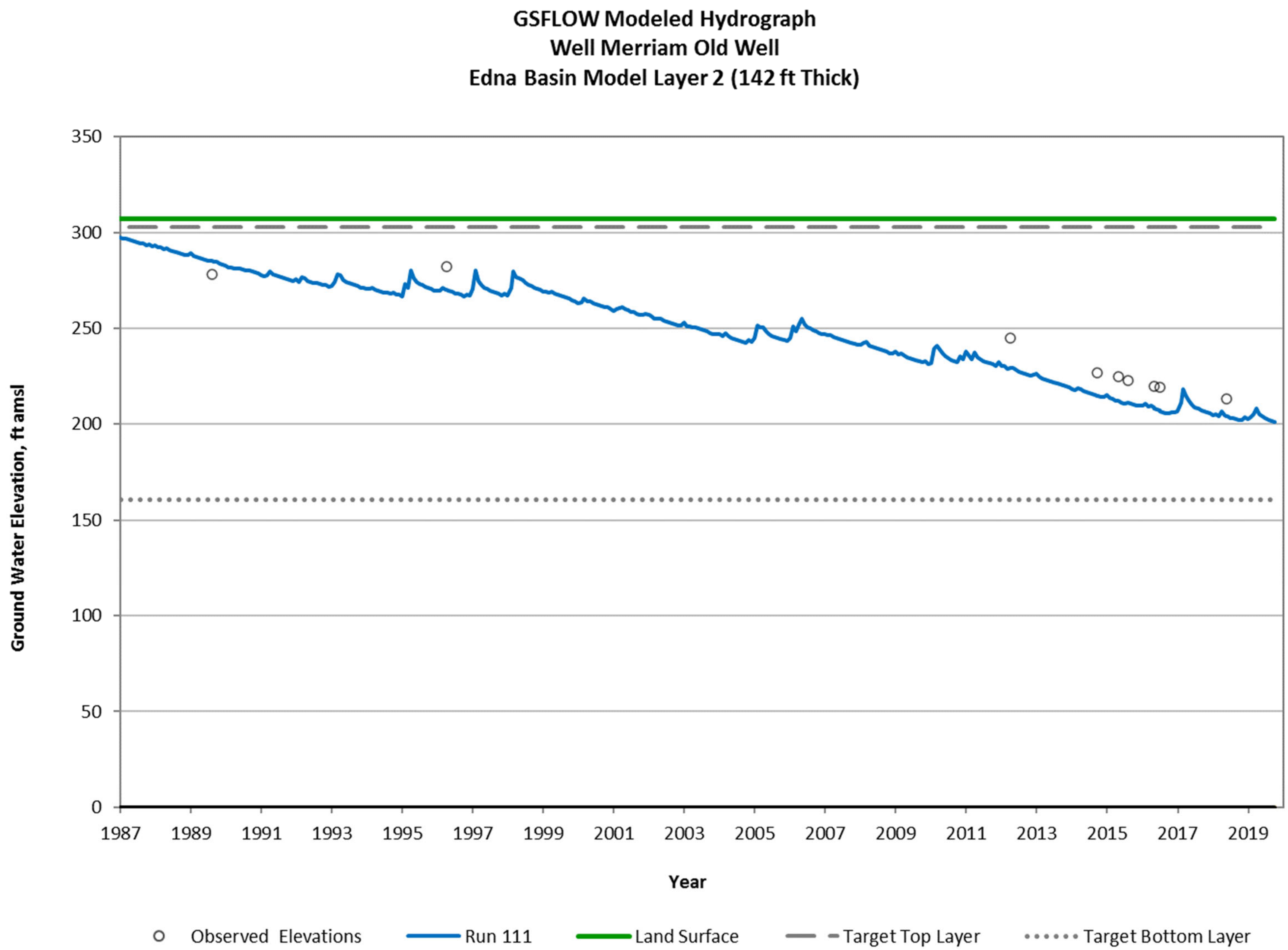
GSFLOW Modeled Hydrograph
Well Merriam Old Well
Edna Basin Model Layer 2 (142 ft Thick)
Ground Water Elevation, ft amsl
350
300
250
200
150
100
50
0
1987
1989
1991
1993
1995
1997
1999
2001
2003
2005
2007
2009
2011
2013
2015
2017
2019
Year
Observed Elevations
Run 111
Land Surface
Target Top Layer
Target Bottom Layer

Figure B-47

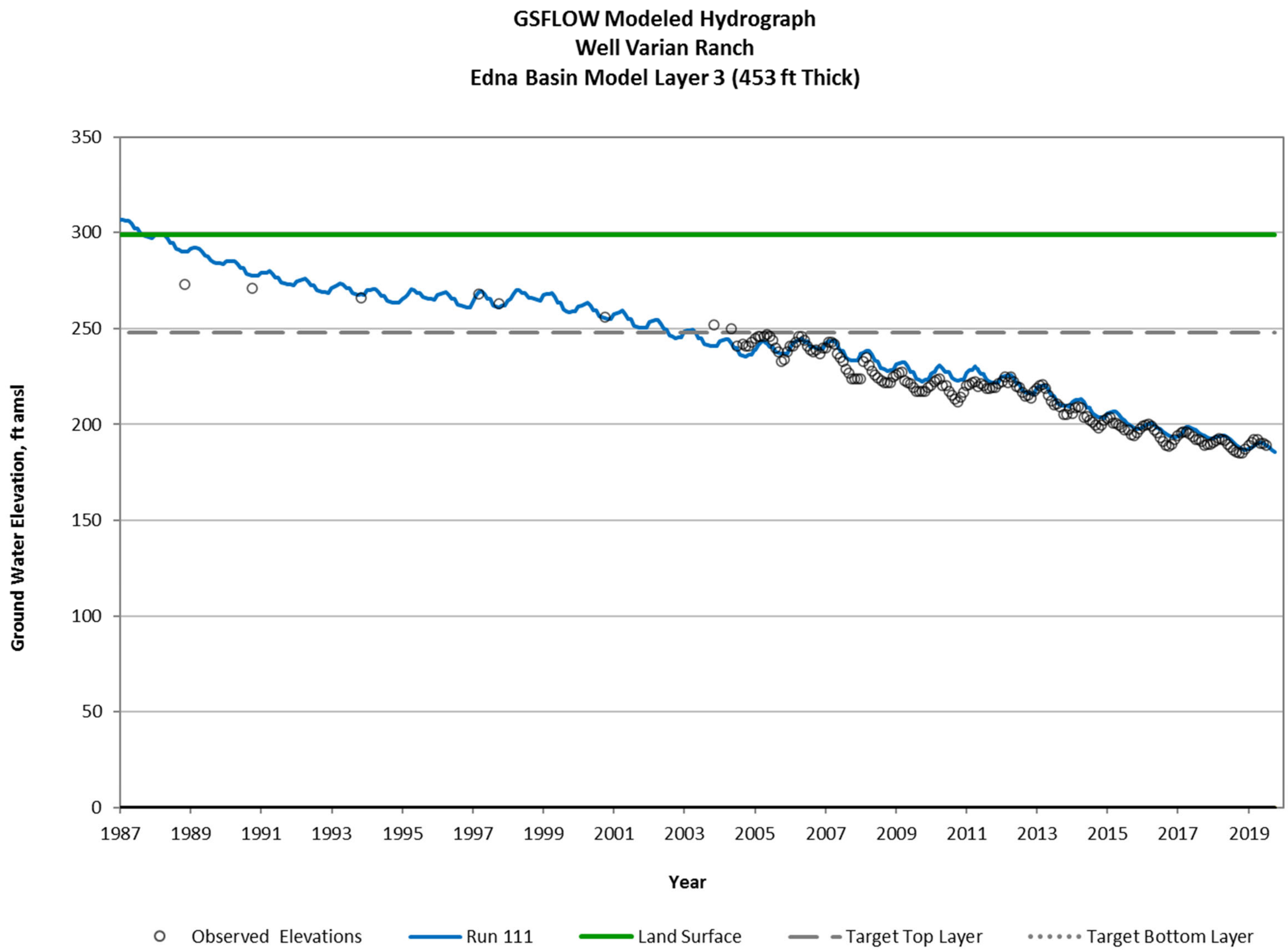
GSFLOW Modeled Hydrograph
Well Varian Ranch
Edna Basin Model Layer 3 (453 ft Thick)
Ground Water Elevation, ft amsl
350
300
250
200
150
100
50
0
1987
1989
1991
1993
1995
1997
1999
2001
2003
2005
2007
2009
2011
2013
2015
2017
2019
Year
Observed Elevations
Run 111
Land Surface
Target Top Layer
Target Bottom Layer

Figure B-48

DRAFT

Cleath-Harris Geologists, Inc.
75 Zaca Lane, Suite 110
San Luis Obispo, CA 93401
(805) 543-1413

TECHNICAL MEMORANDUM

Date: November 21, 2019

To: Dick Tzou, PE
Water Resources Engineer
County of San Luis Obispo

From: Neil D. Currie, PG
Project Geologist
Cleath-Harris Geologists

Subject: Optional Task 2.4B Geophysical Survey

As part of the development of the Groundwater Sustainability Plan for the San Luis Obispo groundwater basin, Cleath-Harris Geologists (CHG) has completed Task 2.4B, the passive seismic geophysical survey of a bedrock divide identified in the 2018 Characterization Report. [1] The results of this effort are reported herein.

CONDUCT OF WORK

To complete the investigation of the bedrock divide between the San Luis Obispo and Edna Valley portions of the groundwater basin, CHG reviewed and interpreted existing well completion reports, reviewed existing surface geology maps, and performed a geophysical survey of the area of interest. The passive seismic data collected during the survey was post-processed, calibrated and modeled to estimate the depth to bedrock across the area of interest. Data sets from well completion reports, surface maps, and the geophysical survey were then used to generate contours of the depth of permeable sediments and a saturated thickness map across the area of interest. These contours were also used to develop cross-sections for comparison with prior work.

AREA OF INVESTIGATION

A bedrock divide was identified south of San Luis Obispo County Airport in the 2018 Characterization Report. CHG established an area of investigation which was bounded by Davenport Creek Road in the west, Buckley Road and Highway 227 to the north, Greystone Place to the east and the hill fronts to the south. This area is outlined in Figure 1.

1 GSI Water Solutions, 2018, San Luis Obispo Valley Basin Characterization and Monitoring Well Installation, prepared for San Luis Obispo County Flood Control and Water Conservation District, January 18, 2018.

REVIEW OF WELL COMPLETION REPORTS

Within the area of investigation, the Characterization Report had utilized 22 wells to contour the base of permeable sediments. As part of the effort to identify well logs suitable for calibrating passive seismic data, CHG reviewed Well Completion Reports (WCRs) in the area. This resulted in the identification of an additional 38 wells which intersected the base of permeable sediments within the area of interest. Data from these wells was combined with the geophysical results to contour the base of permeable sediments. These wells are illustrated in Figure 1.

PASSIVE SEISMIC GEOPHYSICAL METHOD (HVSR) BACKGROUND

The horizontal to vertical spectral ratio (HVSR) passive seismic geophysical method relies on the observation that all materials in nature have a natural resonance frequency. When energy-induced vibrations interact with a material, the amplitude of vibrations increase at the specific resonance frequency of the material. In complex earth systems, this amplitude increase will occur at multiple frequencies, with each corresponding to a compositional layer. When the spectral ratio of horizontal to vertical frequencies are plotted, the highest (peak) amplitude generally corresponds to the interface between overlying unconsolidated sediments and underlying consolidated bedrock. By analyzing the amplitude and frequencies of vibrations at ground surface, the depths and general composition of layers can be modeled to provide insight into subsurface conditions.

To collect data, a high precision accelerometer is utilized. As the instrument records, it detects natural background noise transmitted into the ground from varied sources including ocean waves, traffic, wind movement through trees, and distant machinery. Both the frequency and amplitudes of this sound is recorded along three orthogonal axes. This data is used to approximate subsurface conditions with a model.

The simplest of the HVSR models is a two layer system in which the top layer is lower velocity unconsolidated sediments and the bottom layer is higher velocity bedrock. Under these conditions, the relationship between the peak resonance frequency and sediment thickness overlying bedrock can be express using the following equation.[2]

$$f = \frac{v}{4h}$$

For the above equation, f is resonance frequency in hertz, v is the shear wave velocity of the upper layer in meters per second, and h is the thickness of the upper layer in meters. With this method, a recording is taken adjacent to a well where h is known, and the data processed to identify f, the peak resonating frequency. The equation is then used to determine the velocity v

2 Ibs-von Seht, M., and Wohlenberg, J., 1999, Microtremor measurements used to map thickness of soft sediments, Bulletin of the Seismological Society of America, v. 89, p.250-259.

of pressure waves through the sediment. This velocity may then be held constant to determine thickness (h) at nearby locations where no well is present, but measured resonance frequencies are available.

The physical definition of the basin boundary as presented in the 2018 Characterization Report and used herein is the occurrence of unconsolidated or loosely consolidated sediments down to the contact with the basement rock of Miocene-aged formations and Franciscan Assemblage. This definition fits with the passive seismic methodology described above, where the highest amplitudes of the horizontal to vertical spectral ratio generally correspond to the interface between overlying unconsolidated sediments and underlying consolidated bedrock. In practice, both amplitude and pattern recognition are useful in interpreting the pseudo-depth profiles generated by HVSR.

GEOPHYSICAL DATA COLLECTION

After identifying existing wells, seven survey lines were laid out to provide coverage in the area of interest. A total of 64 stations were surveyed in completing these lines. Locations of each survey point are included in Figure 2. At each station, a Tromino 3G+ digital accelerometer was utilized to collect passive seismic data, with each recording being one hour duration. Following collection, data was first post-processed using the Grilla software package included with the instrument, then forward-modeled using OpenHVSR[3] software. Figure 3 shows an example of two traces collected during the survey. This figure illustrates both the typical peak shape observed in the area that demarks the base of permeable sediments, and the downward shift in frequency associated with greater soft-sediment thickness.

RESULTS OF SURVEY

Combining geophysical points with well data brought the total number of contoured points to 123 from the original 22 used for the Characterization Report in the study area. This data set, along with mapped surface geology was used to contour the base permeable sediments within the area of interest (Figure 4). Additionally, this data was used to generate elevations showing the base of permeable sediments which are overlain on cross-sections previously developed for the Characterization Report (Figures 5, 6, and 7). These contours are generally in agreement with those previously developed, with some notable differences.

Portions of three Characterization Report cross-sections pass through the area of investigation: A-A’, E-E’, and F-F’. Line A-A’, which trends roughly northwest to southeast, is in agreement with the geophysical survey (Figure 7). The red line plotted on cross section shows the

3 Bignardi, S., Yezzi, A.J., Fiusello, S., and Comelli, A., 2018, OpenHVSR - Processing toolkit; Enhanced HVSR processing of distributed microtremor measurements and spatial variation of their informative content, Computers & Geosciences, v. 20, p. 10-20.

interpretation of the base of permeable sediments based on geophysics and additional well data. The dashed orange line on the cross-section highlights the original base of permeable sediments. Along this line, the refined base of permeable sediments corresponds well with the original.

Two significant revisions occur in the assessment of the base of permeable sediments along Line E-E' (Figure 5). The first occurs at Well #17182 and is attributable to differences in the assigned well elevation. The second major revision occurs at Well #529099 where a soft brown shale logged at 140 feet below ground surface (bgs) is interpreted as the base of permeable sediments, rather than a blue clay which is logged at 115 feet bgs (Figure 5).

For the latter revision, CHG's selection of the soft shale was based on the geophysical survey, wherein the change in velocity between the shale and the overlying unconsolidated sediments provides a sharper signal peak than the shift between unconsolidated sand and unconsolidated clay. This sharper peak (Figure 3 at Base of Permeable Sediments) was subsequently used to calibrate velocities for the unconsolidated sediments and the deeper consolidated sediments.

Increased point density along Line F-F' highlights several structural features that lie between the contoured (logged) wells utilized in the Characterization Report (Figure 6). These include two synclinal structures and an anticline. The first syncline occurs just south of Well #E0161526 (Figure 4). The deepest portion of this syncline lies under the eastern half of the Crestmont subdivision. In this area, the base of permeable sediments is approximately 30 feet above msl. This is 150 feet deeper than at the nearby bedrock divide locality.

South of this syncline is a northwest/southeast trending anticlinal structure that underlines the boundary between the Crestmont subdivision and the vineyard to the south (Figure 4 and 6). This structural high was not previously mapped. Based on well and geophysical data, bedrock rises to an elevation of 184 feet above sea level within the eastern portion of the anticline, and may restrict flow between adjacent synclines (Figure 4).

Geophysical and well data also highlighted the second synclinal structure which underlies the vineyard at the south end of the area of investigation (Figure 4 and Figure 6). This syncline is deeper than the one which lies to the north, reaching -60 feet below sea level at its lowest point. Examination of well completion reports for wells located on the golf course suggests this structure continues to east. Basin sediments south of the syncline are truncated by the Edna Fault zone. The location of this fault boundary has been moved farther south on Line F-F' (Figure 6), based on the Characterization Report geology map and well data.

Geophysical work and interpreted contours confirm the presence of a bedrock divide between the San Luis Obispo and Edna Valley portions of the groundwater basin. This divide is composed of rocks from the Franciscan, Monterey, and Obispo Formations and is largely impermeable. The divide is generally higher in elevation to the south (near Davenport Creek) and lower elevation to the north in the Hidden Springs Road area. Based on preliminary Spring 2019 groundwater contours of the area, saturated thickness across the divide was up to fifty feet (Figure 8).

A saturated thickness map of groundwater basin sediments is shown in Figure 9, based on the difference in elevation between water level contours for Spring 2019 and the base of permeable sediments. The greatest saturation and associated groundwater storage capacity is present along the two synclinal axes, as expected. Groundwater along the southern syncline is mostly stored within the Pismo Formation, while groundwater along the northern syncline is mostly within the Paso Robles Formation. Between these synclines is an anticline where basin saturation is less than 50 feet thick, becoming unsaturated both at the bedrock divide and at the eastern limits of the study area.

SUMMARY AND CONCLUSIONS

The geophysical survey conducted by CHG has confirmed the presence of a bedrock divide between the Edna Valley and San Luis Obispo portions of the groundwater basin. This divide ranges in elevation from approximately 100 feet above mean sea level to 180 feet above mean sea level. Saturated thickness across this interval ranged from none to an estimated 50 feet. Additionally, the geophysical survey identified two synclines and an anticline which underlie the area. These structures, along with the bedrock divide, affect groundwater flow within this portion of the basin.

FIGURES

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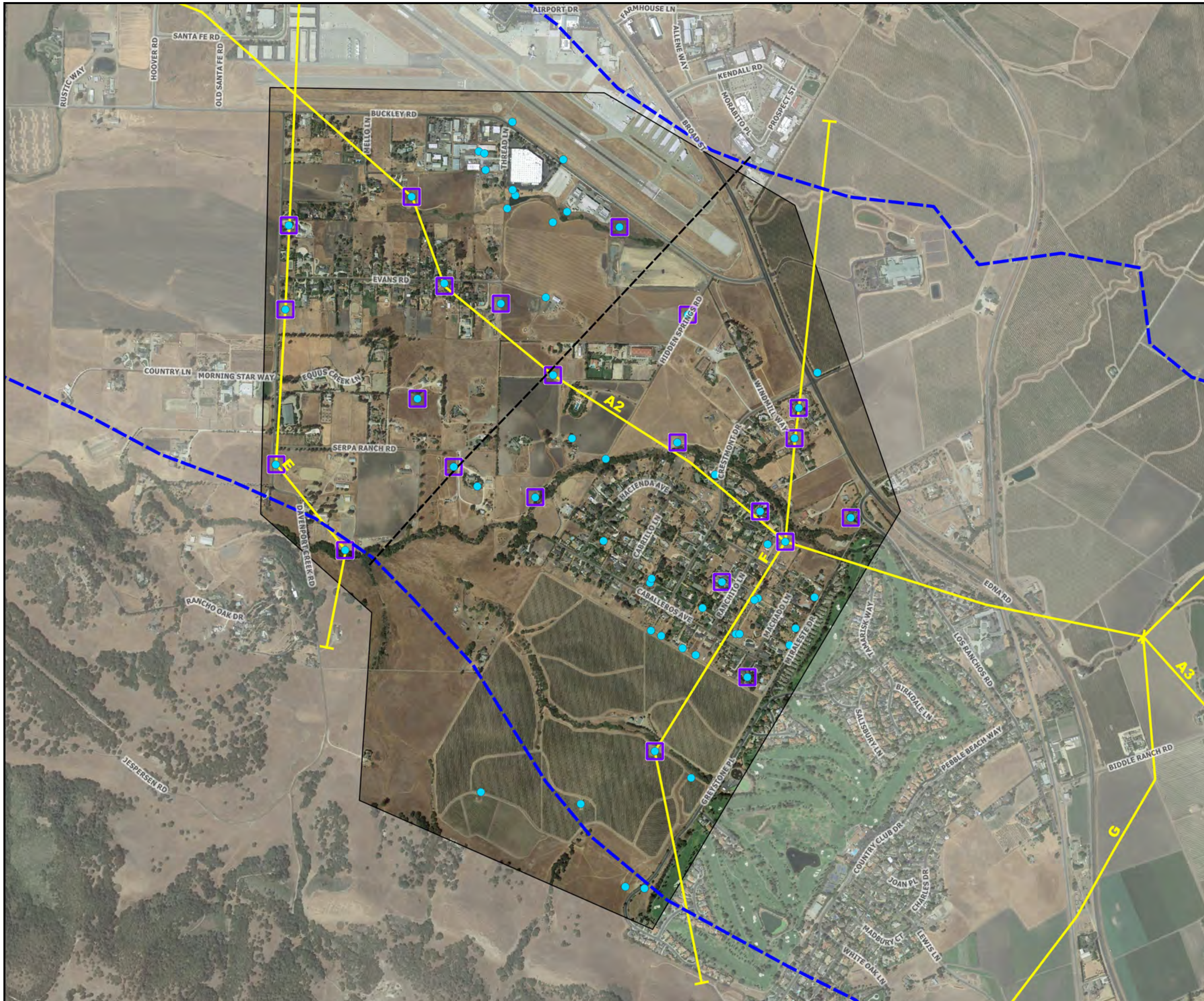

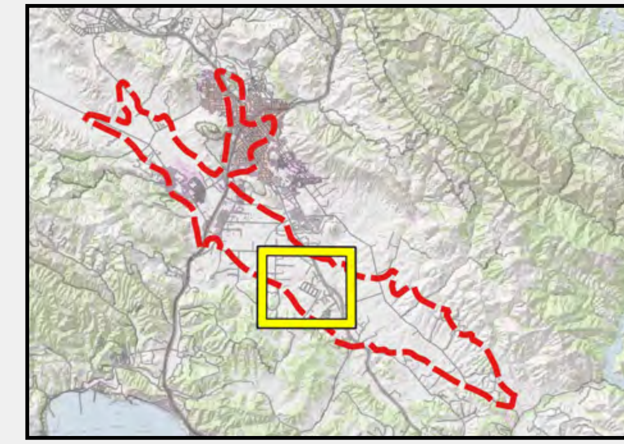

Explanation

- SLO Valley Groundwater Basin Boundary
- Cross-section Line (GSI)
- Bedrock Divide (GSI)
- Lithologic Bedrock Well (GSI)
- Lithologic Bedrock Well (CHG)

0 1200 2400 ft

NORTH

Figure 1
Area of Investigation

Passive Seismic
Geophysical Survey (Task 2.4B)

County of San Luis Obispo

Cleath-Harris Geologists

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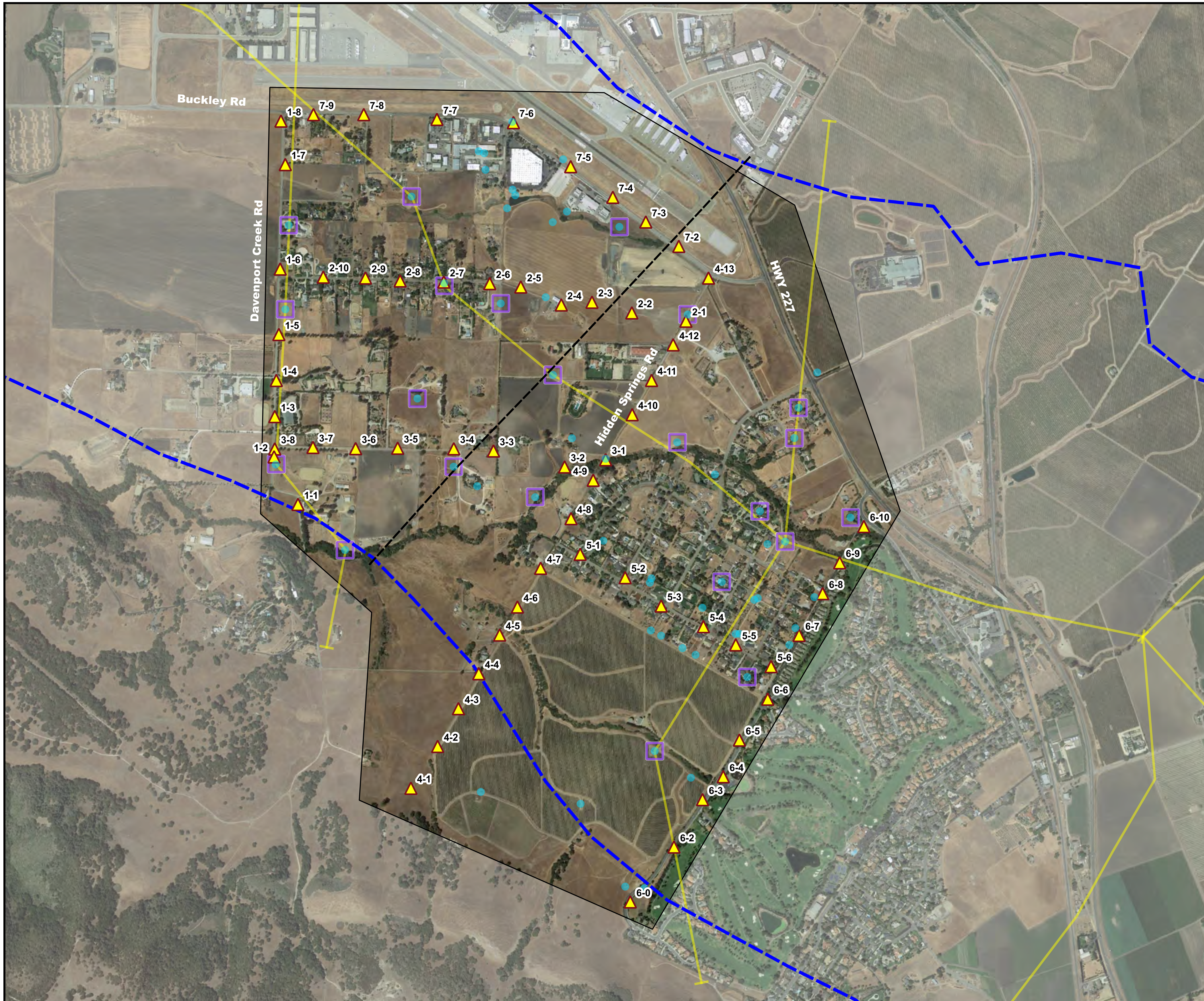
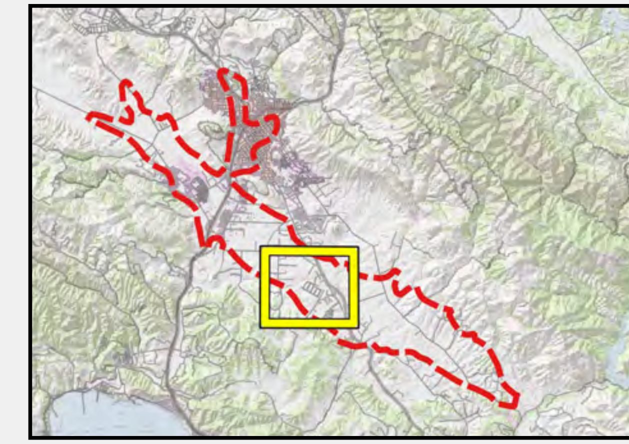




Explanation

- SLO Valley Groundwater Basin Boundary
- Cross-section Line (GSI)
- Bedrock Divide (GSI)
- Lithologic Bedrock Well (GSI)
- Lithologic Bedrock Well (CHG)
- Geophysical Survey Point

0 1200 2400 ft

NORTH

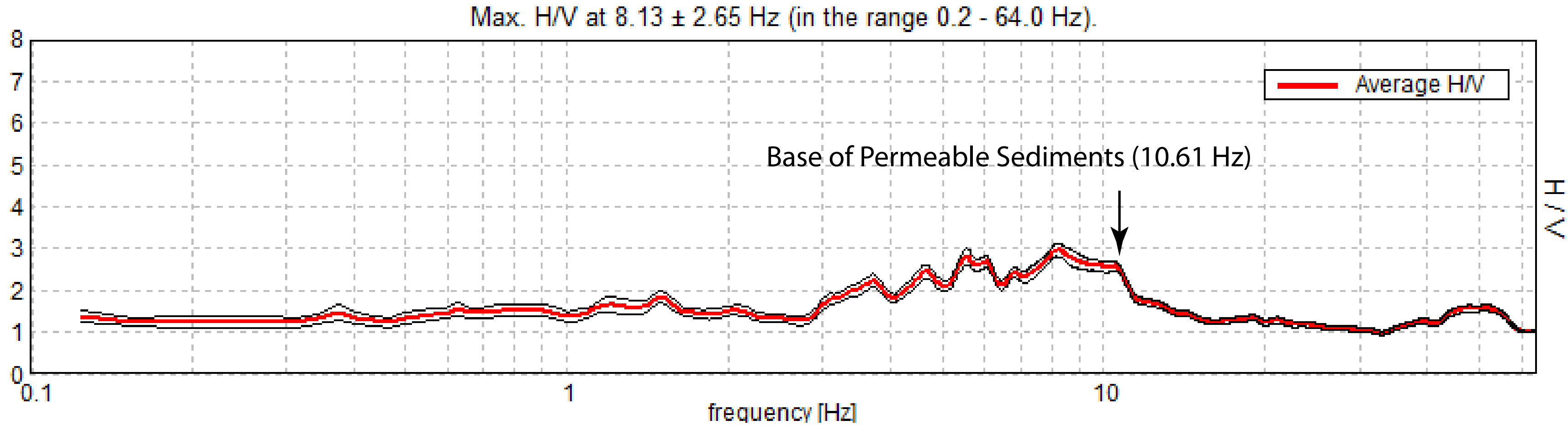
Figure 2
Geophysical Survey Locations

Passive Seismic
Geophysical Survey (Task 2.4B)

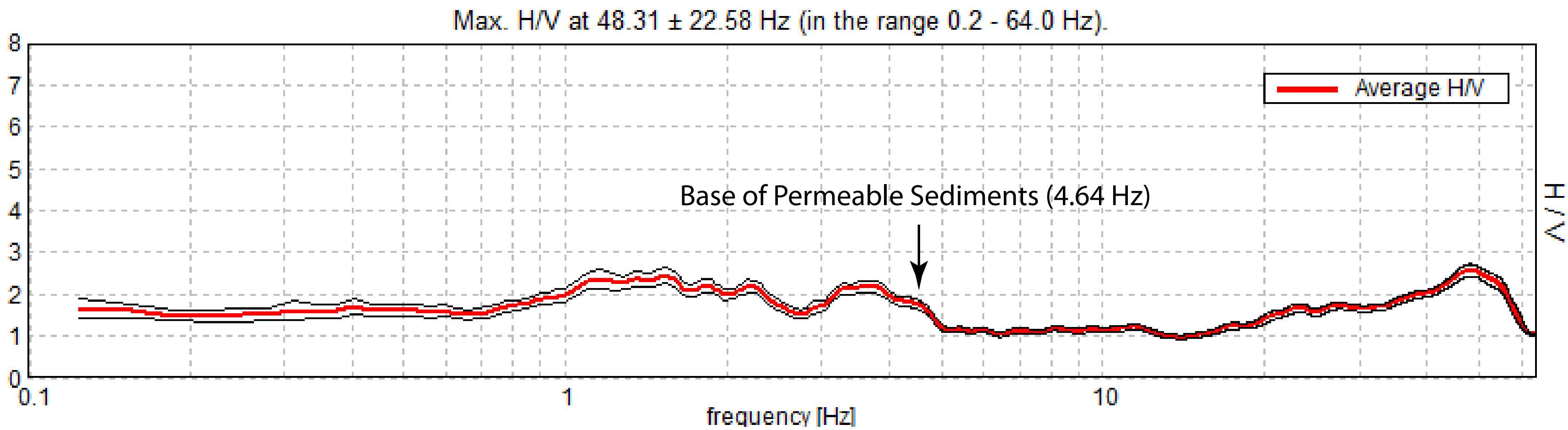
County of San Luis Obispo

Cleath-Harris Geologists

DRAFT



Station 3-4 (nearest bedrock high)- Modeled depth of 25 feet below ground surface. Location is illustrated in FIgure 2.

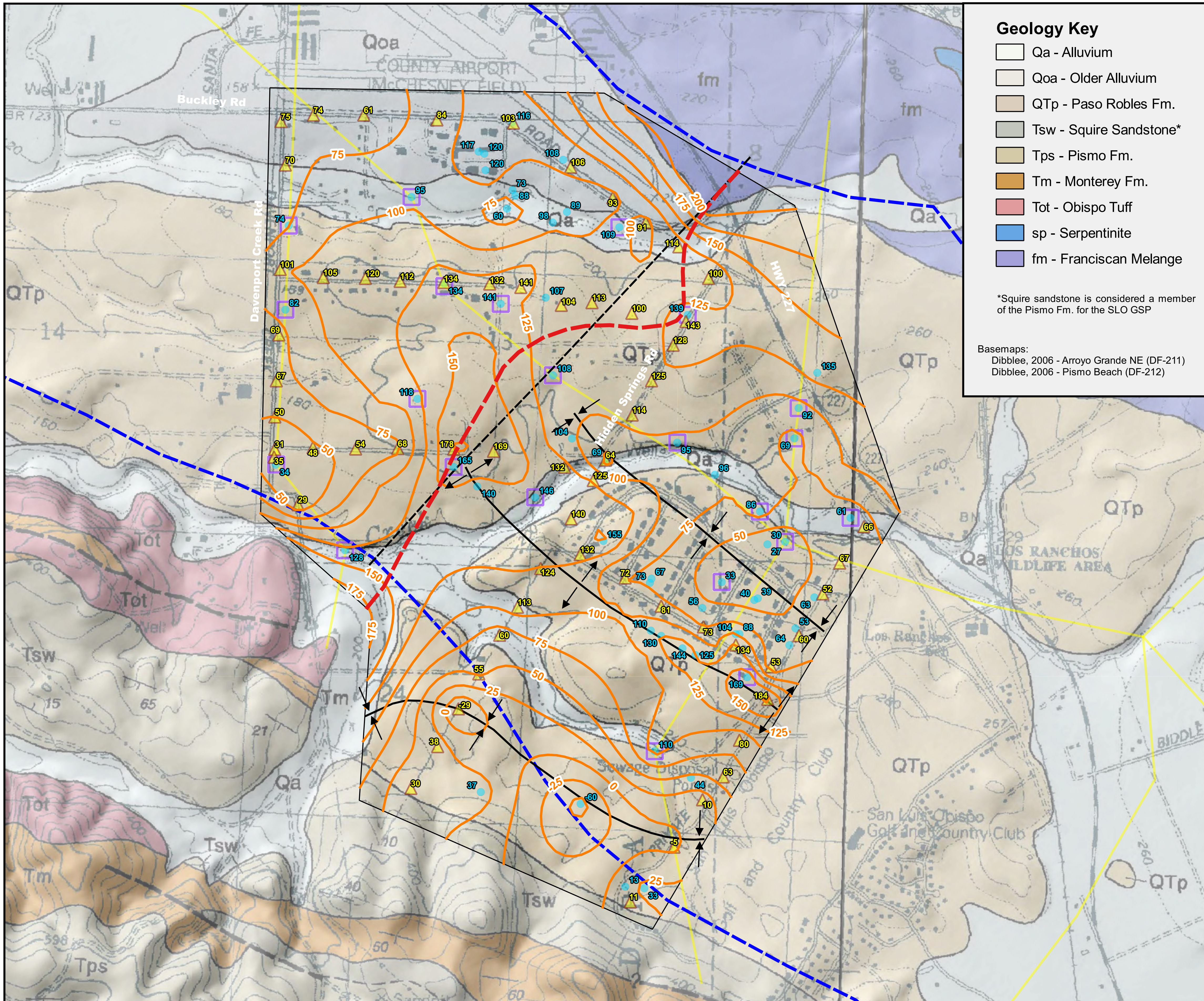


Station 1-2 (near Well #529099)- Modeled depth of 136 feet below ground surface. Location is illustrated in Figure 2.

Figure 3
Example Tromino Traces
Passive Seismic Geophysical Survey- (Task 2.4B)
County of San Luis Obispo

Cleath-Harris Geologists

DRAFT

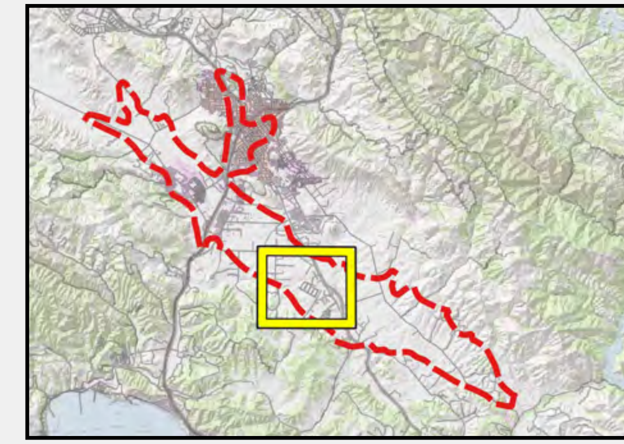


Geology Key

- Qa - Alluvium
- Qoa - Older Alluvium
- QTp - Paso Robles Fm.
- Tsw - Squire Sandstone*
- Tps - Pismo Fm.
- Tm - Monterey Fm.
- Tot - Obispo Tuff
- sp - Serpentinite
- fm - Franciscan Melange

*Squire sandstone is considered a member of the Pismo Fm. for the SLO GSP

Basemaps:
Dibblee, 2006 - Arroyo Grande NE (DF-211)
Dibblee, 2006 - Pismo Beach (DF-212)



Explanation

- SLO Valley Groundwater Basin Boundary
- Cross-section Line (GSI)
- Bedrock Divide (GSI)
- Lithologic Bedrock Well (GSI) *
- 104 Lithologic Bedrock Well (CHG) *
- 60 Geophysical Survey Point *
- Contour - Bedrock Surface Elevation *
- Bedrock Divide (CHG interpreted)

Geologic Structure

Anticline Syncline Fault

* All elevations shown are in feet above mean sea level

0 1200 2400 ft

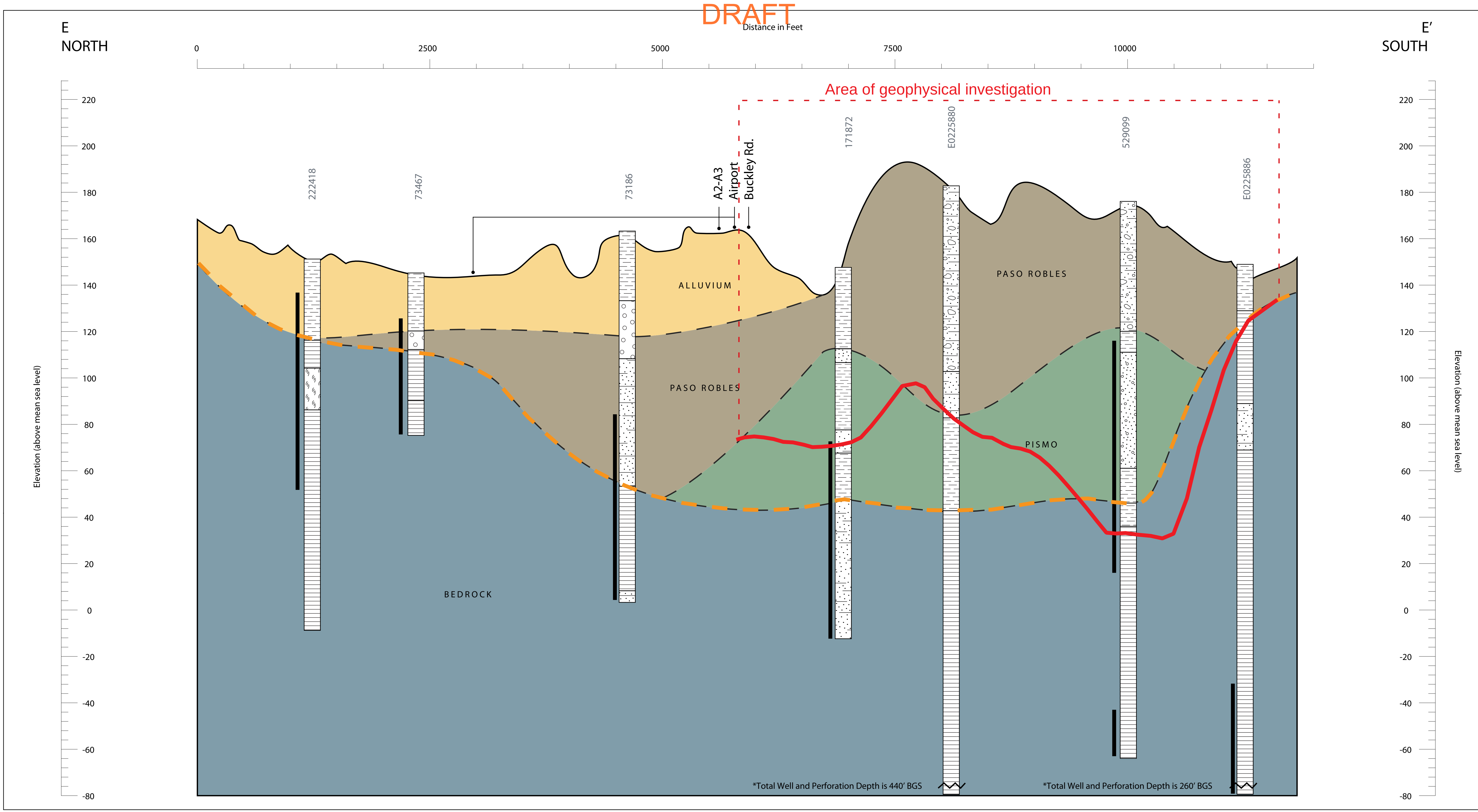
NORTH

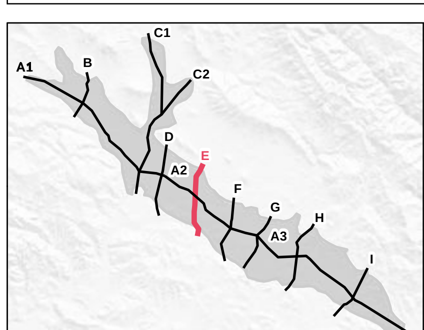
Figure 4
Contoured Bedrock Surface

Passive Seismic Geophysical Survey (Task 2.4B)

County of San Luis Obispo

Cleath-Harris Geologists





LEGEND

Alluvium	Clay	Rock	Silty Sand
Paso Robles	Fill	Sandstone	Sand
Pismo	Clayey Gravel	Clayey Sand	Sand and Gravel
Bedrock	Gravel	Serpentine	With Shell Fragments
Perforated	Silt	Shale	

VERTICAL EXAGGERATION:
25X

Figure 5
Cross-section E (CHG Modified)

CHG modified bedrock surface
GSI original bedrock surface

Cross Section E-E′
San Luis Obispo Valley Basin Characterization

GSI
Water Solutions, Inc.

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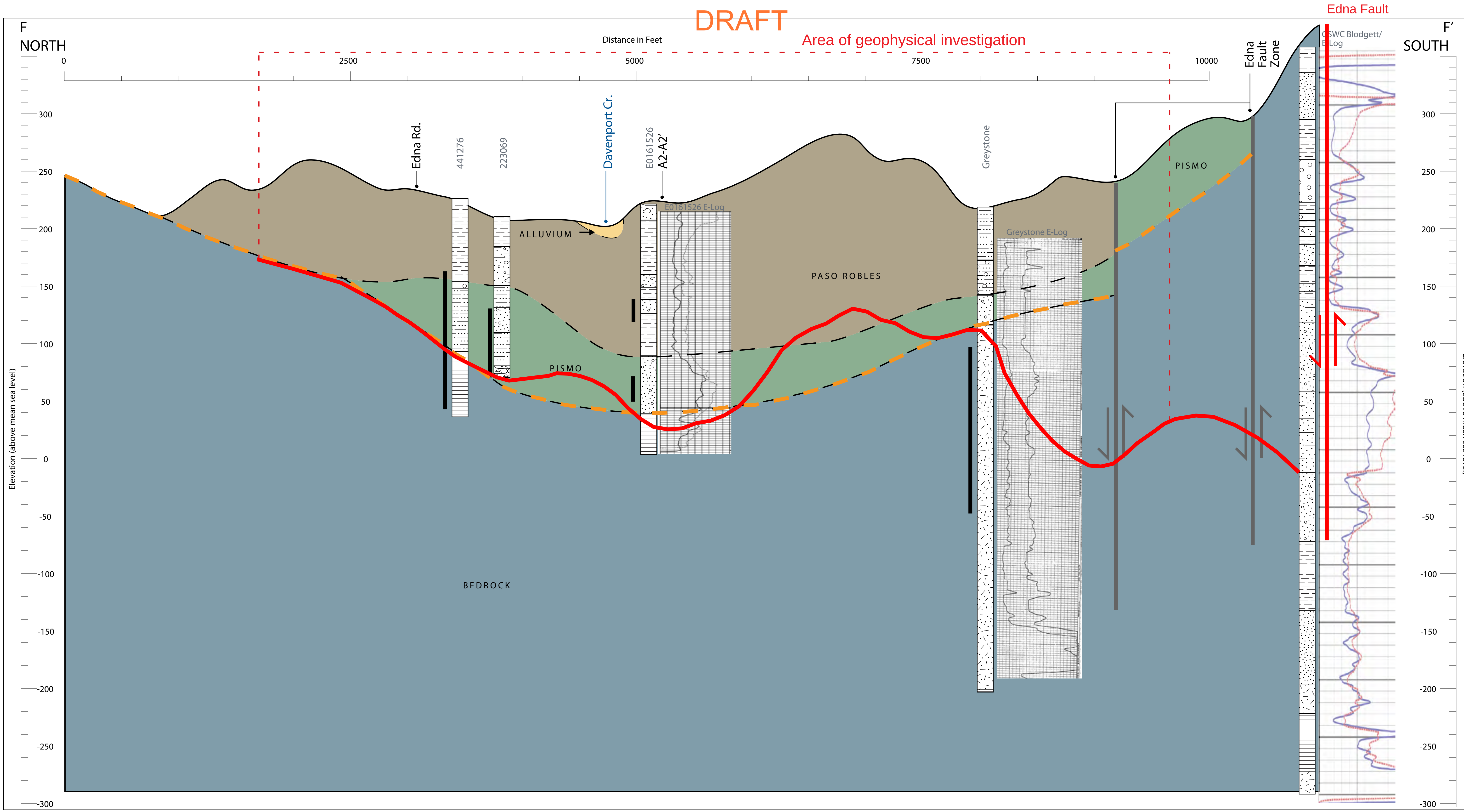

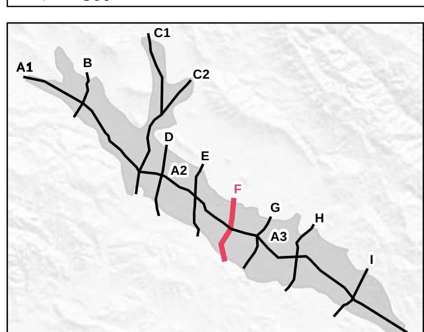

LEGEND

Alluvium	Clay	Rock	Silty Sand
Paso Robles	Fill	Sandstone	Sand
Pismo	Clayey Gravel	Clayey Sand	Sand and Gravel
Bedrock	Gravel	Serpentine	With Shell Fragments
Perforated	Silt	Shale	

VERTICAL EXAGGERATION:
10X

Figure 6
Cross-section F (CHG Modified)

CHG modified bedrock surface — CHG modified fault
GSI original bedrock surface — GSI original faults

Cross Section F-F′
San Luis Obispo Valley Basin Characterization

GSI Water Solutions, Inc.

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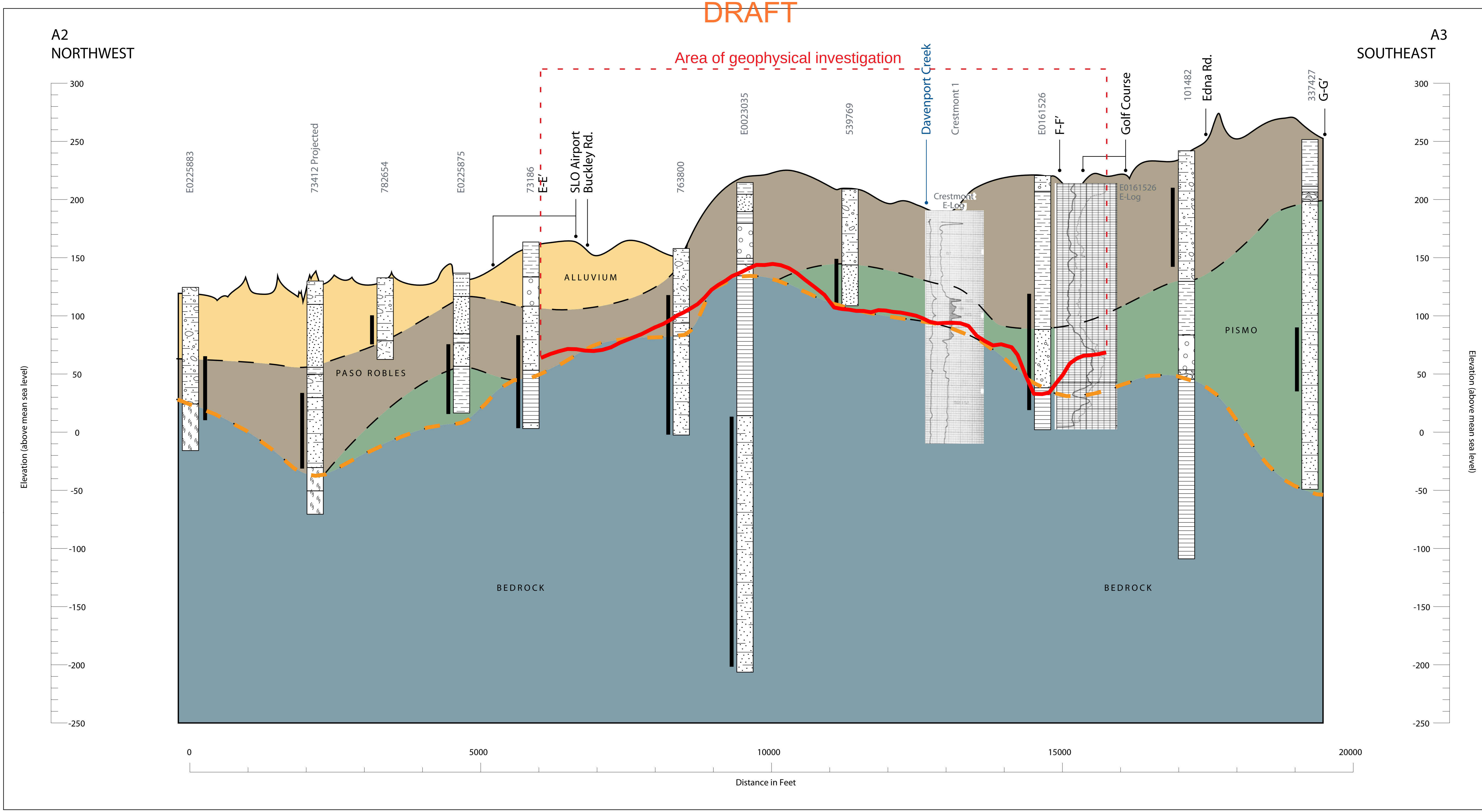

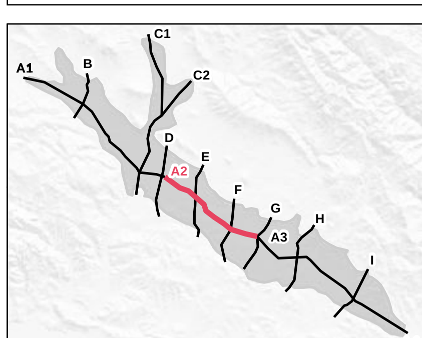

LEGEND

Alluvium	Clay	Rock	Silty Sand
Paso Robles	Fill	Sandstone	Sand
Pismo	Clayey Gravel	Clayey Sand	Sand and Gravel
Bedrock	Gravel	Serpentine	With Shell Fragments
Perforated	Silt	Shale	

VERTICAL EXAGGERATION:
20X

Figure 7
Cross-section A2-A3 (CHG Modified)

CHG modified bedrock surface
GSI original bedrock surface

Cross Section A2-A3
San Luis Obispo Valley Basin Characterization

GSI Water Solutions, Inc.

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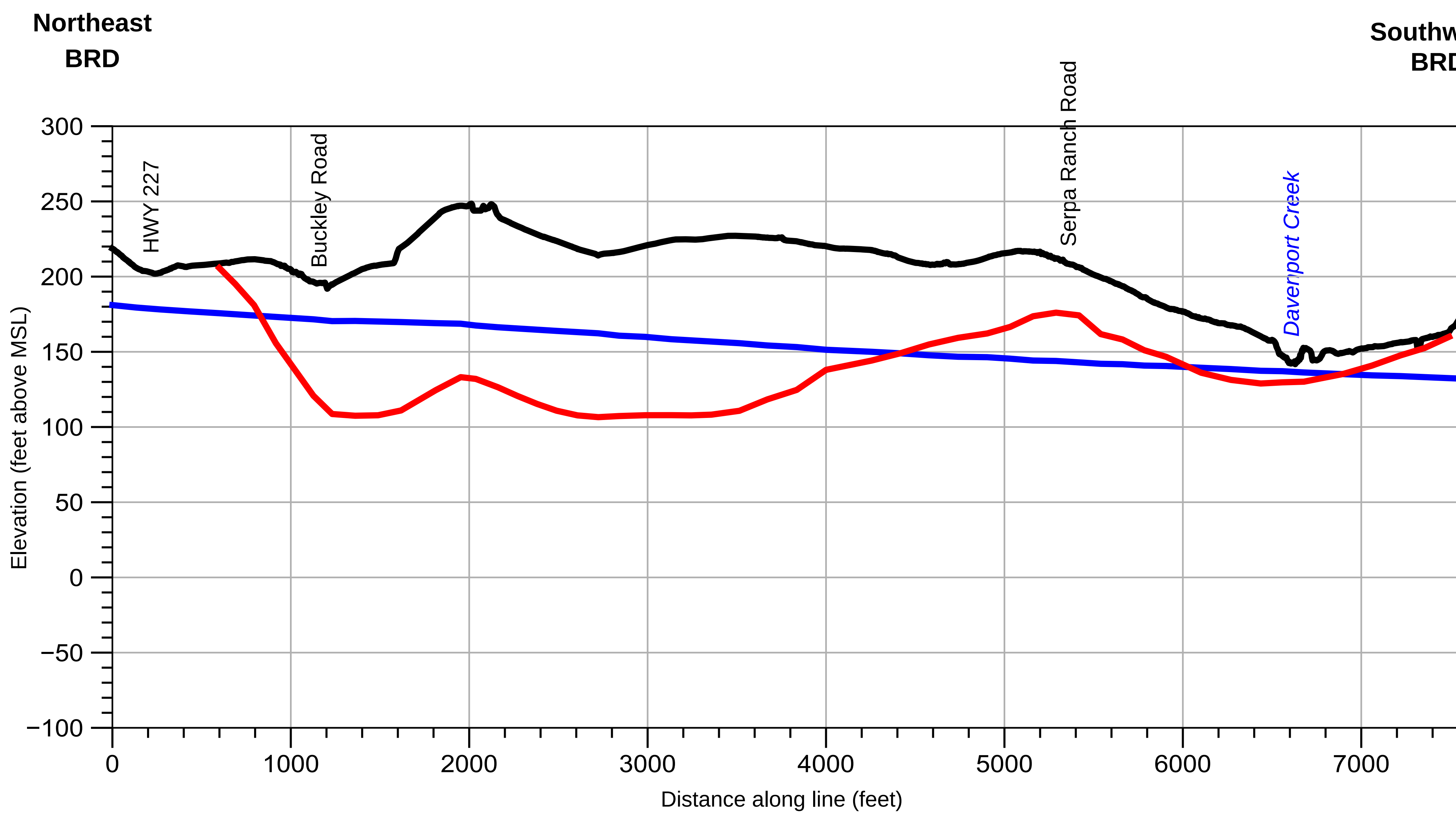

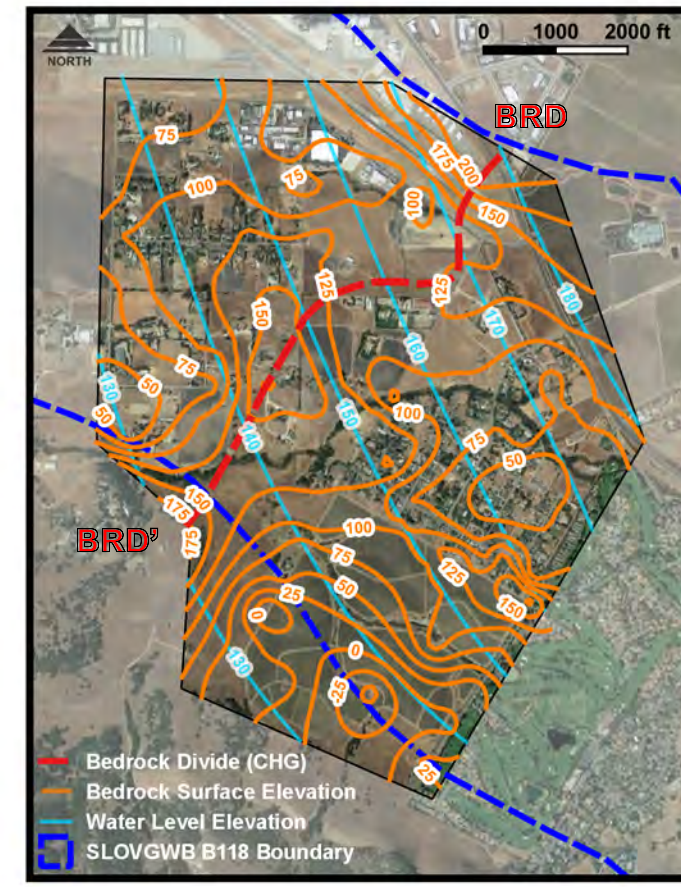

Explanation

Ground surface

Bedrock surface (interpreted by CHG from geophysical survey data)

Groundwater surface - Spring 2019 (data compiled by CHG from various sources)

Figure 8
Cross-section BRD - BRD'
Along Bedrock Divide Line

Passive Seismic Geophysical Survey
(Task 2.4B)

County of San Luis Obispo

CLEATH-HARRIS GEOLOGISTS

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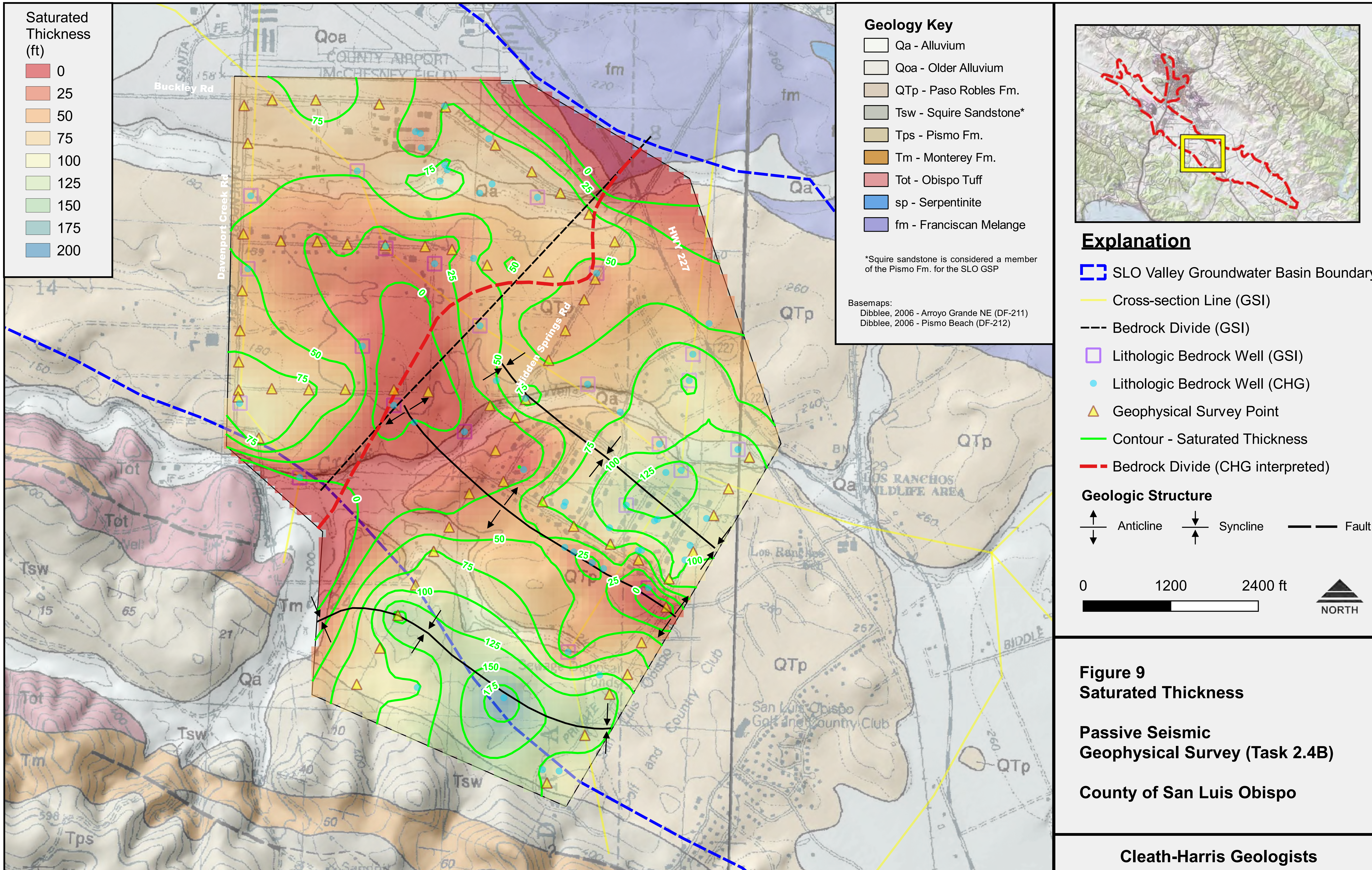

Saturated Thickness (ft)
0
25
50
75
100
125
150
175
200
Geology Key
Qa - Alluvium
Qoa - Older Alluvium
QTp - Paso Robles Fm.
Tsw - Squire Sandstone*
Tps - Pismo Fm.
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Basemaps:
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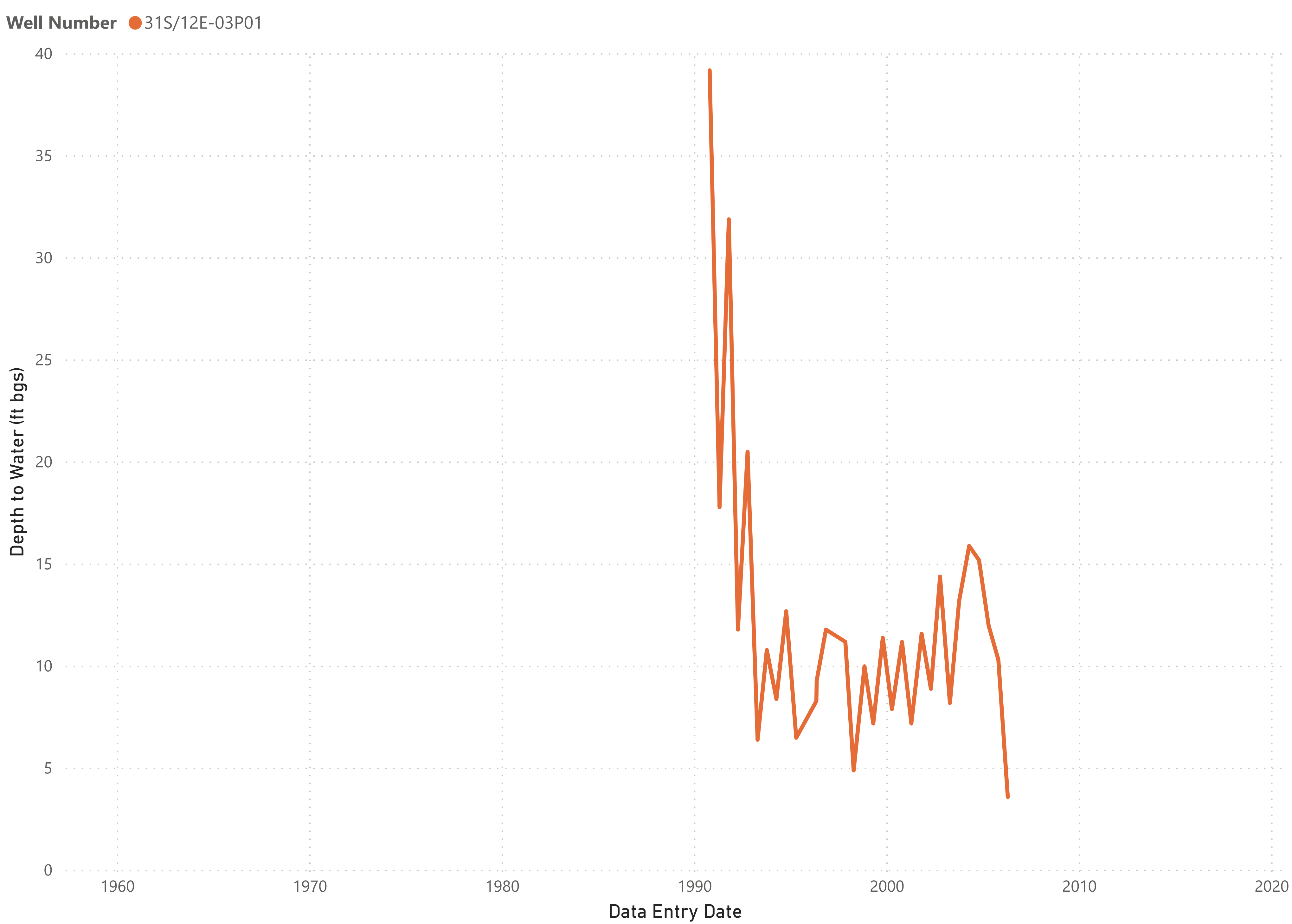
Explanation
SLO Valley Groundwater Basin Boundary
Cross-section Line (GSI)
Bedrock Divide (GSI)
Lithologic Bedrock Well (GSI)
Lithologic Bedrock Well (CHG)
Geophysical Survey Point
Contour - Saturated Thickness
Bedrock Divide (CHG interpreted)
Geologic Structure
Anticline
Syncline
Fault
0
1200
2400 ft
NORTH
Buckley Rd
Davenport Creek Rd
Hidden Springs Rd
HWY 227
Qoa
COUNTY AIRPORT
McCHESNEY FIELD
fm
Qa
QTp
Tot
Tsw
Tm
Tps
LOS RANCHOS WILDLIFE AREA
San Luis Obispo Golf and Country Club
BIDDLE
Figure 9
Saturated Thickness
Passive Seismic Geophysical Survey (Task 2.4B)
County of San Luis Obispo
Cleath-Harris Geologists

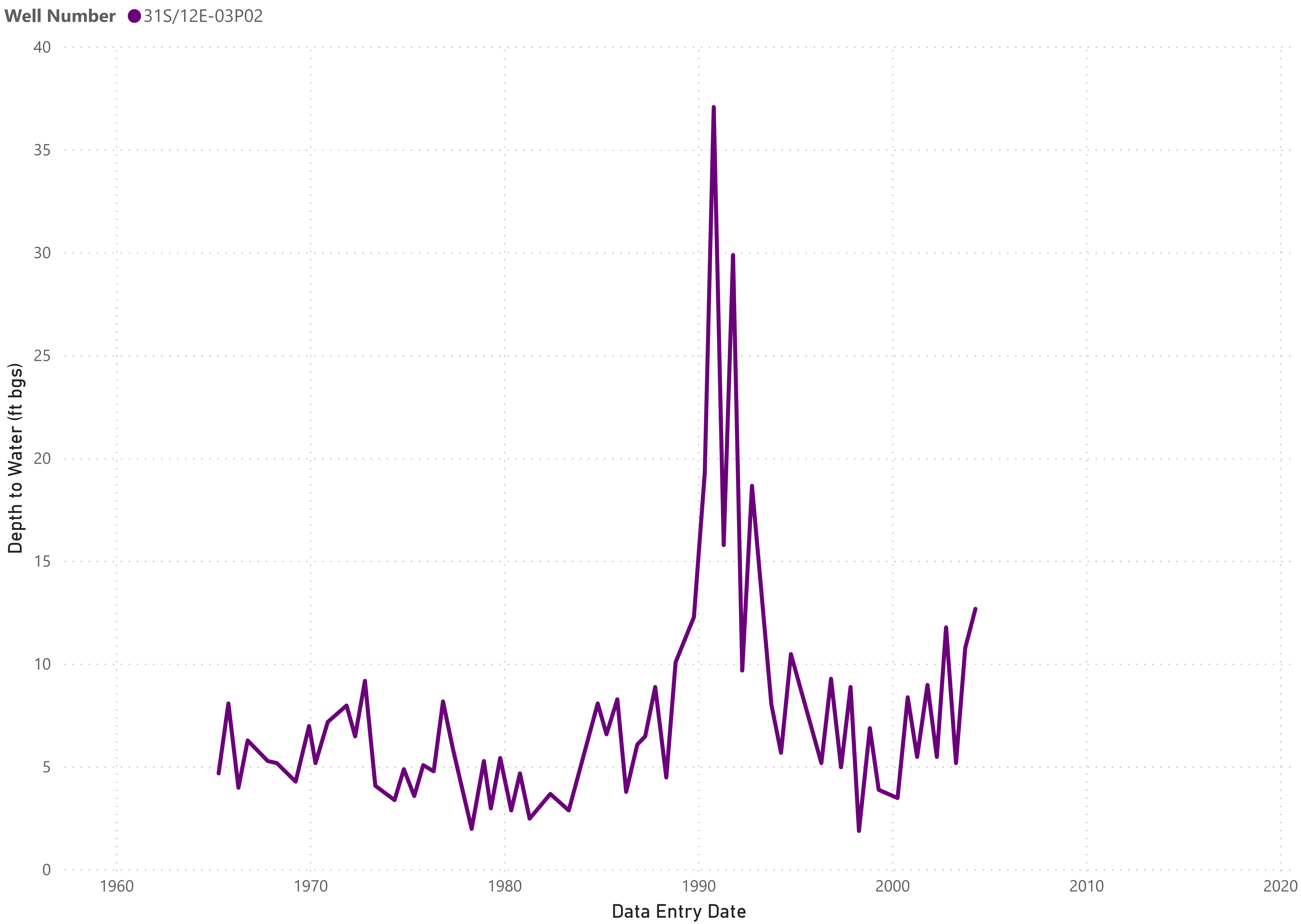
Depth to Water



Well Location (larger = more samples)...

Well Number	Earliest Data Entry Date	Latest Data Entry Date
30S/12E-29Q01	10/22/1962	11/20/1970
30S/12E-32J01	11/18/1958	10/04/1994
31S/12E-03P01	10/12/1990	04/11/2006
31S/12E-03P02	04/05/1965	04/08/2004
31S/12E-10D03	05/09/2012	10/09/2019
31S/12E-10F03	04/05/1965	05/05/1997
31S/12E-10G02	04/05/1965	10/03/2019
31S/12E-10H03	04/12/1984	10/03/2019
31S/12E-12E03	04/05/1965	04/19/2013
31S/12E-12N01	10/22/1962	11/20/1970
31S/12E-12Q03	04/06/1965	10/06/1987
31S/12E-13J01	10/11/1970	04/15/1996
31S/12E-14C01	11/19/1958	10/03/2019
Total	**11/01/1953**	**10/09/2019**

Depth to Water



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Well Number	Earliest Data Entry Date	Latest Data Entry Date
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31S/12E-10D03	05/09/2012	10/09/2019
31S/12E-10F03	04/05/1965	05/05/1997
31S/12E-10G02	04/05/1965	10/03/2019
31S/12E-10H03	04/12/1984	10/03/2019
31S/12E-12E03	04/05/1965	04/19/2013
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31S/12E-14C01	11/19/1958	10/03/2019
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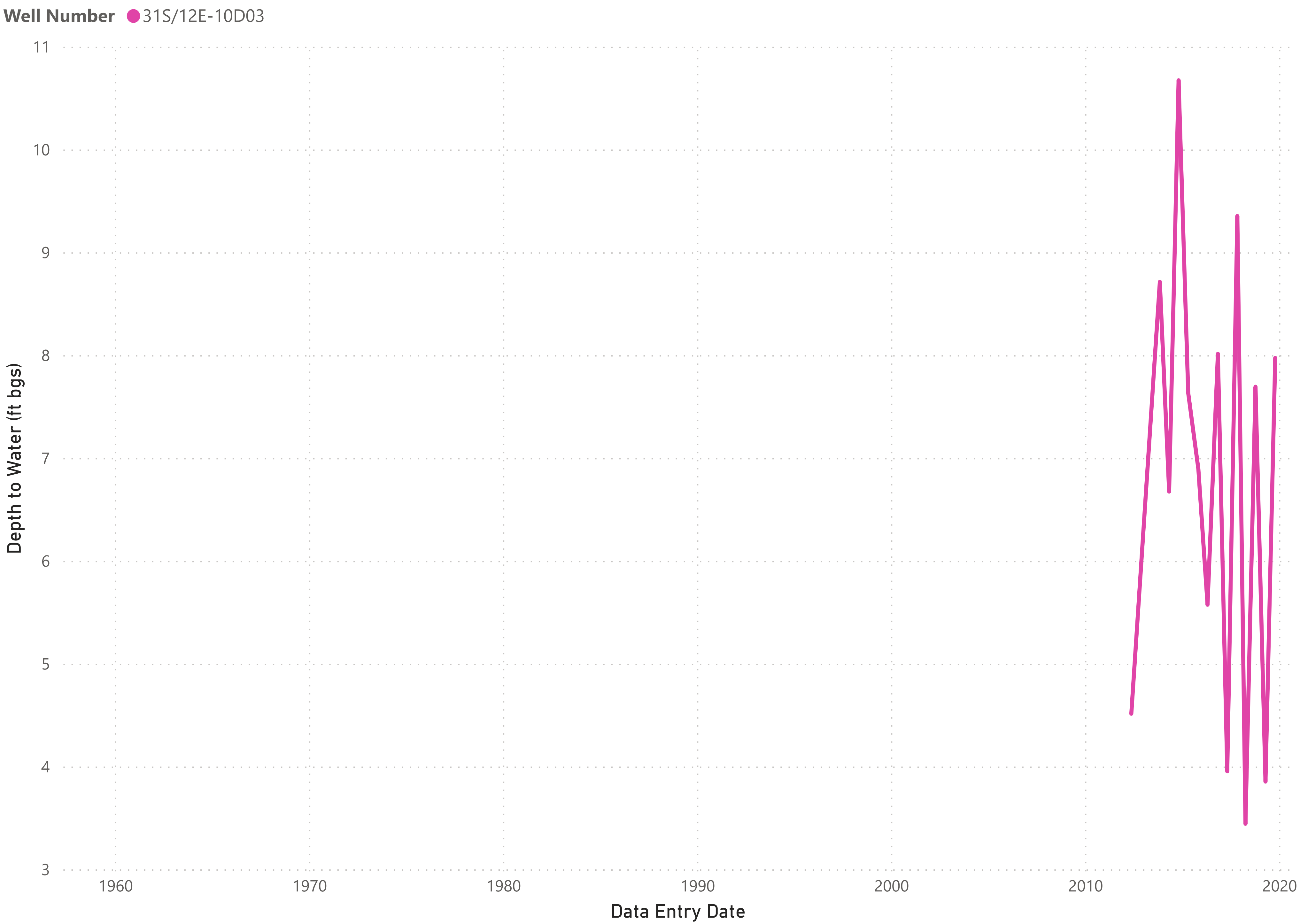
Depth to Water



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31S/12E-12E03	04/05/1965	04/19/2013
31S/12E-12N01	10/22/1962	11/20/1970
31S/12E-12Q03	04/06/1965	10/06/1987
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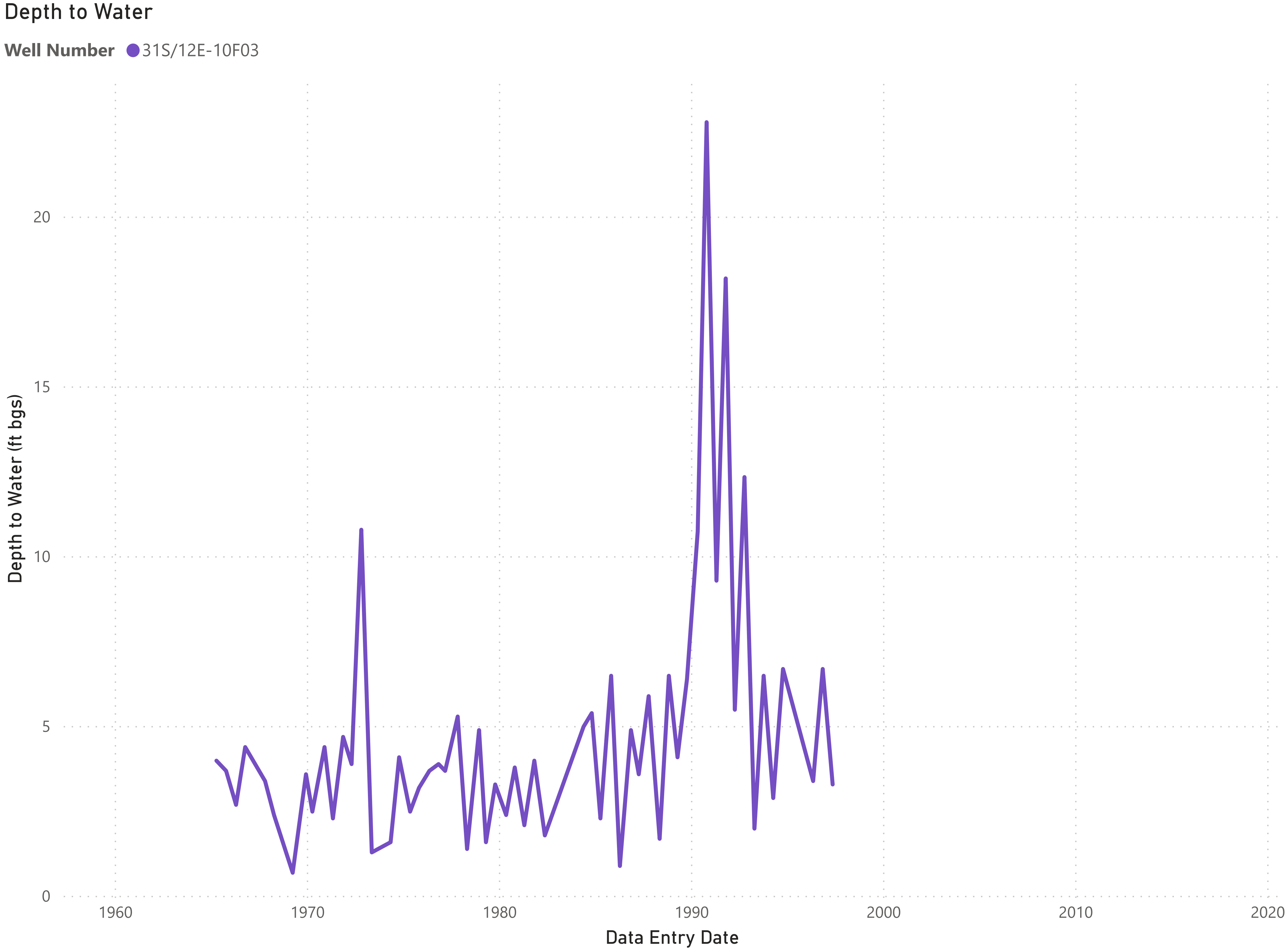

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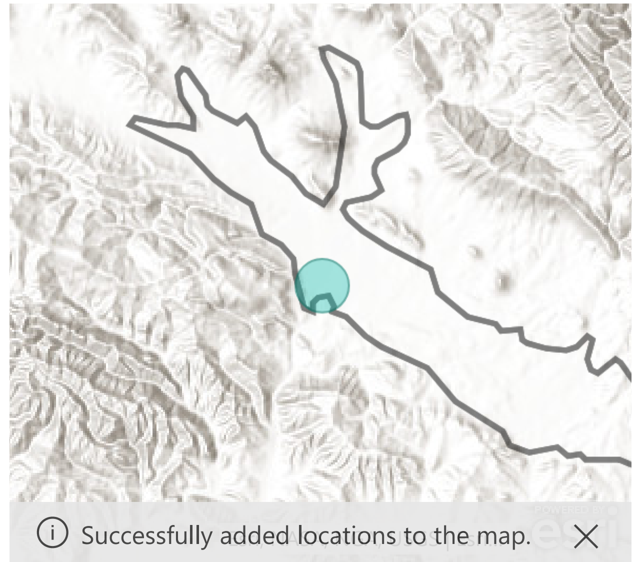

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31S/12E-10D03	05/09/2012	10/09/2019
31S/12E-10F03	04/05/1965	05/05/1997
31S/12E-10G02	04/05/1965	10/03/2019
31S/12E-10H03	04/12/1984	10/03/2019
31S/12E-12E03	04/05/1965	04/19/2013
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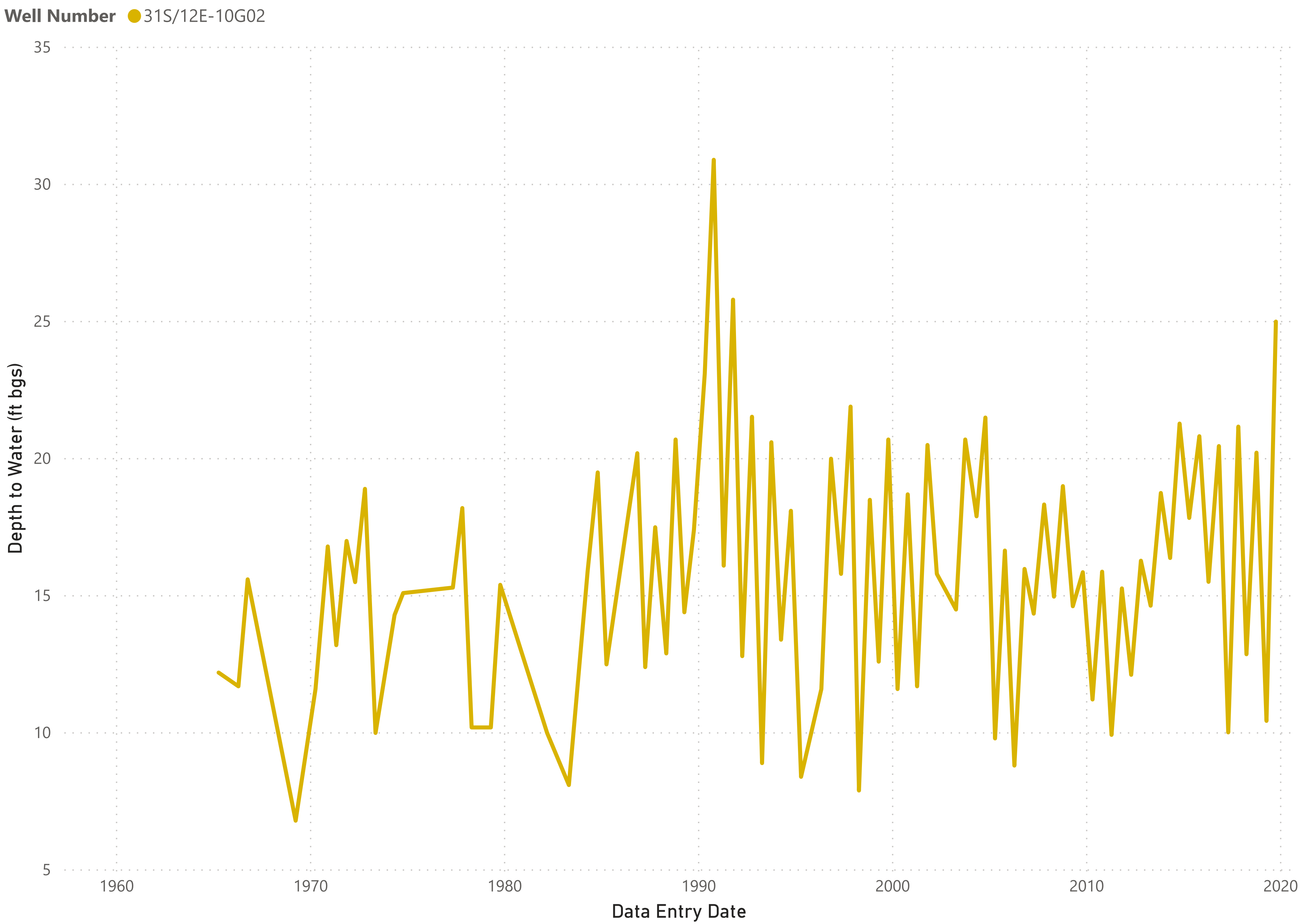
Depth to Water



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31S/12E-10F03	04/05/1965	05/05/1997
31S/12E-10G02	04/05/1965	10/03/2019
31S/12E-10H03	04/12/1984	10/03/2019
31S/12E-12E03	04/05/1965	04/19/2013
31S/12E-12N01	10/22/1962	11/20/1970
31S/12E-12Q03	04/06/1965	10/06/1987
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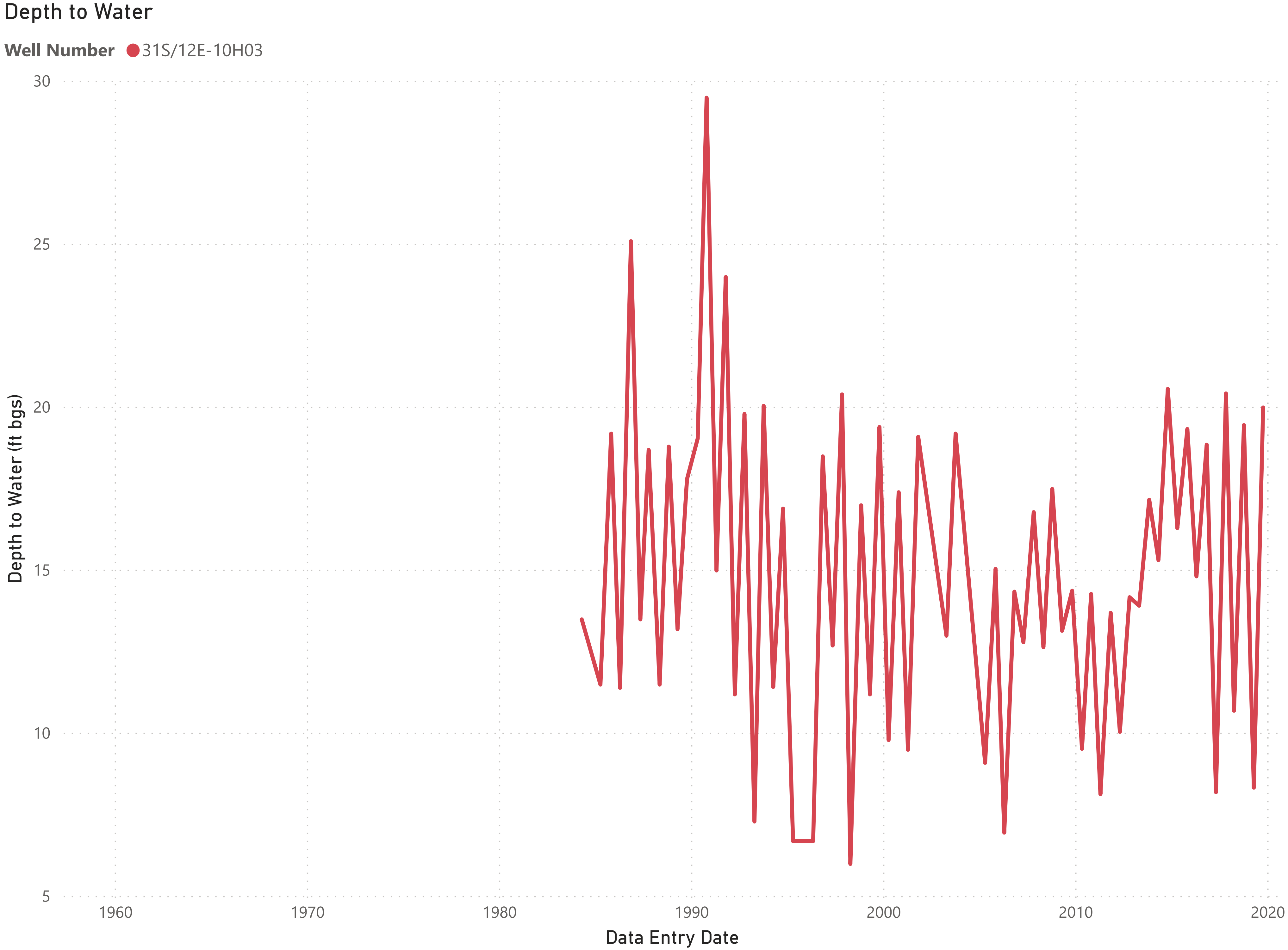

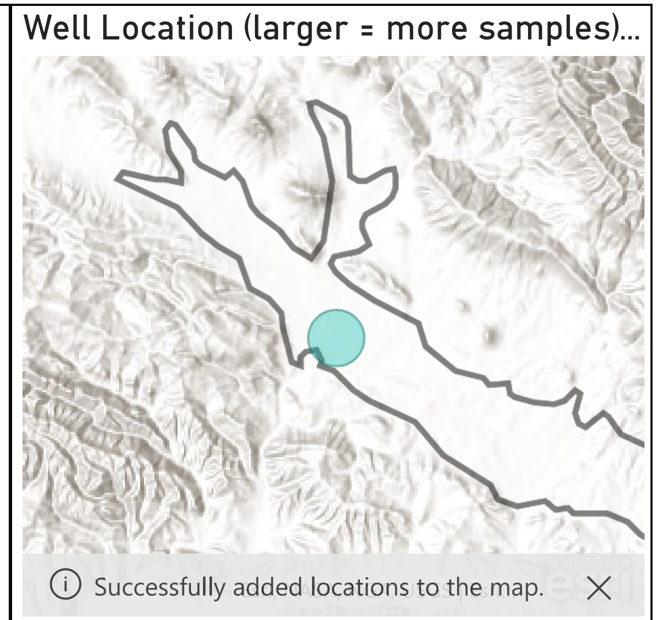

Well Number	Earliest Data Entry Date	Latest Data Entry Date
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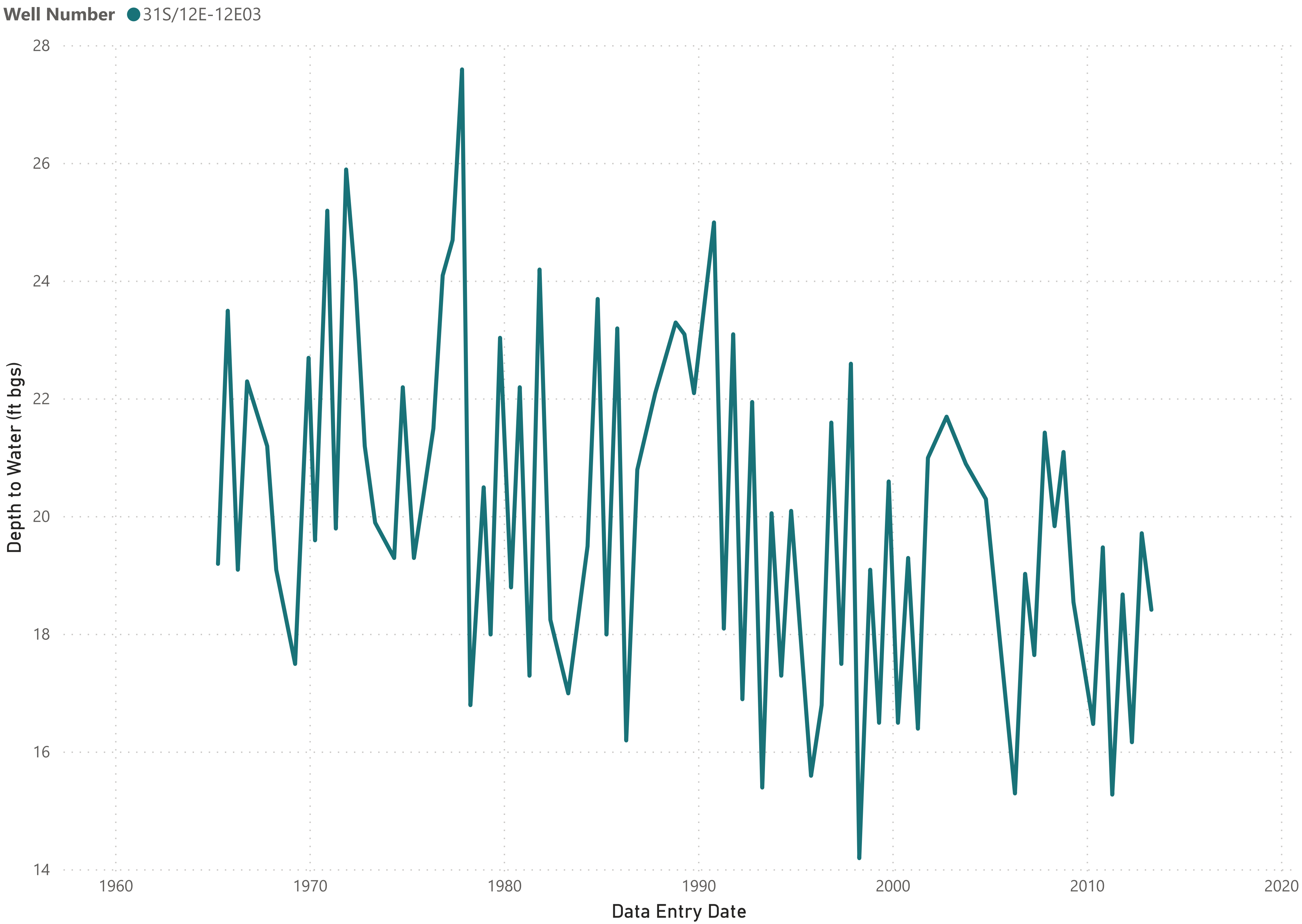
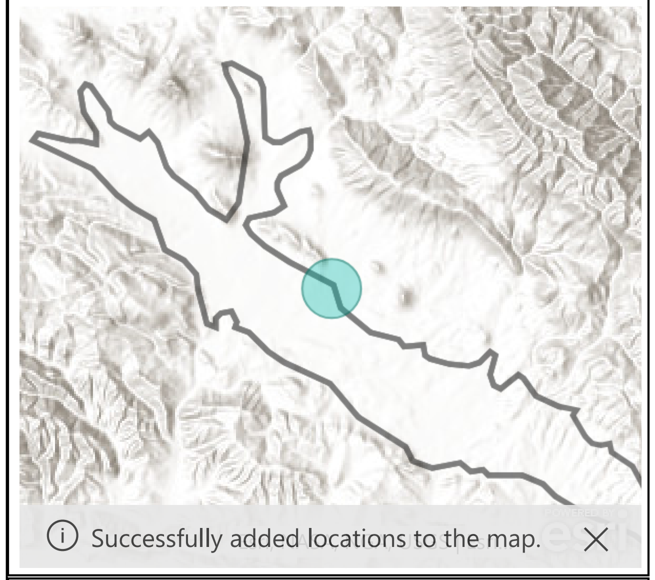
Depth to Water



Well Location (larger = more samples)...



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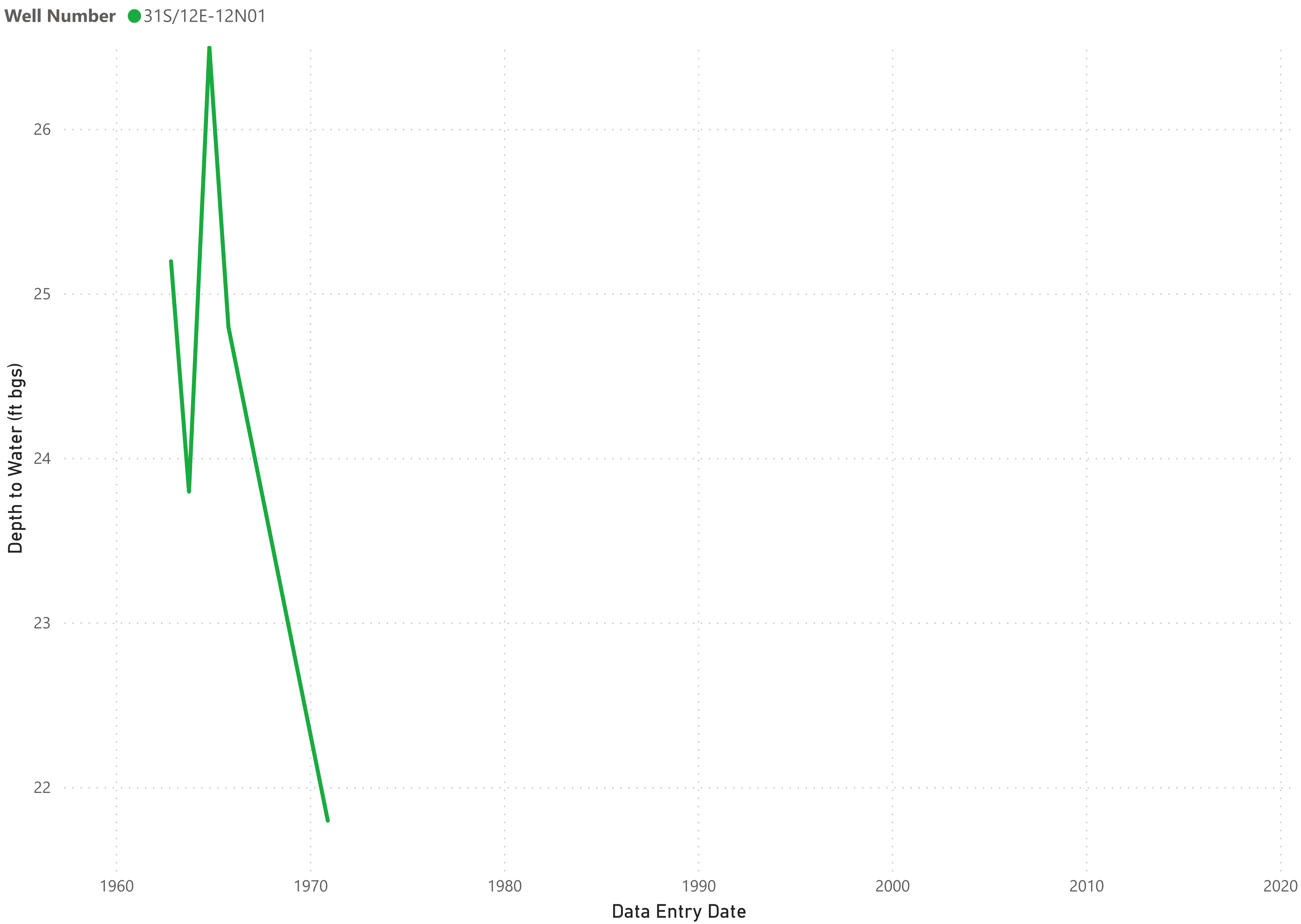
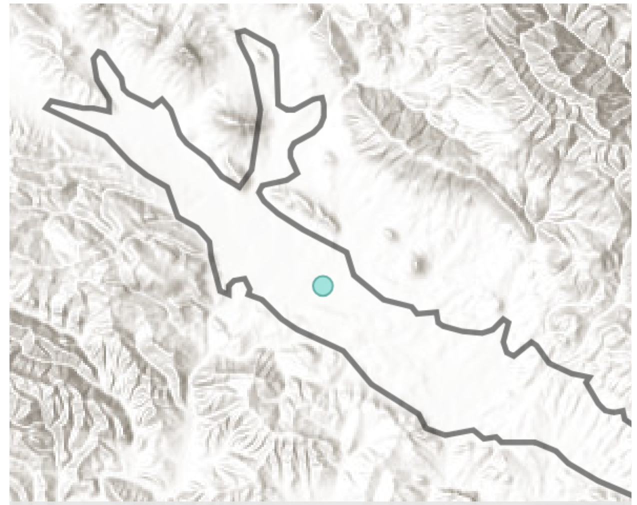
Depth to Water



Well Location (larger = more samples)...



Successfully added locations to the map.

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31S/12E-10D03	05/09/2012	10/09/2019
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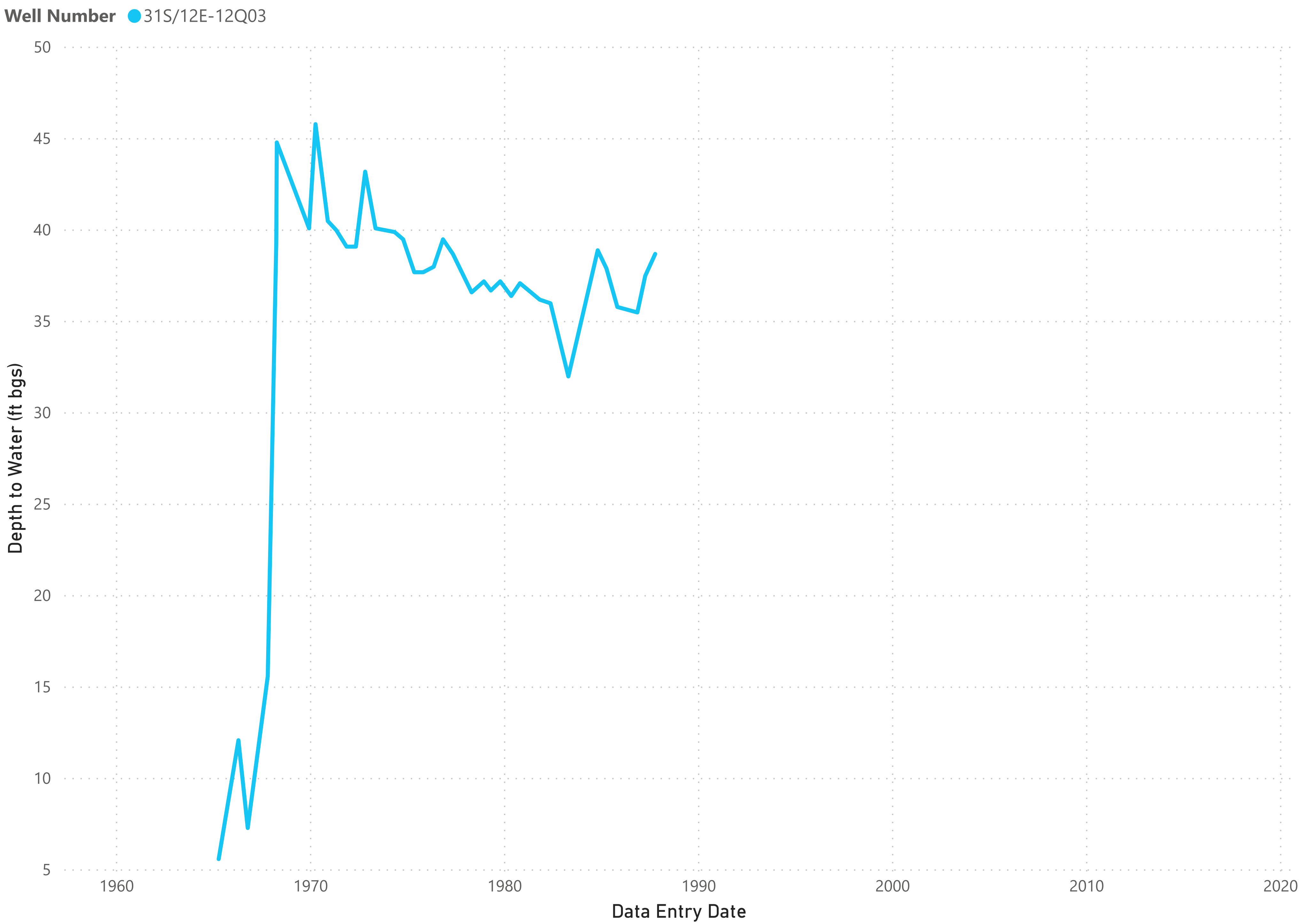
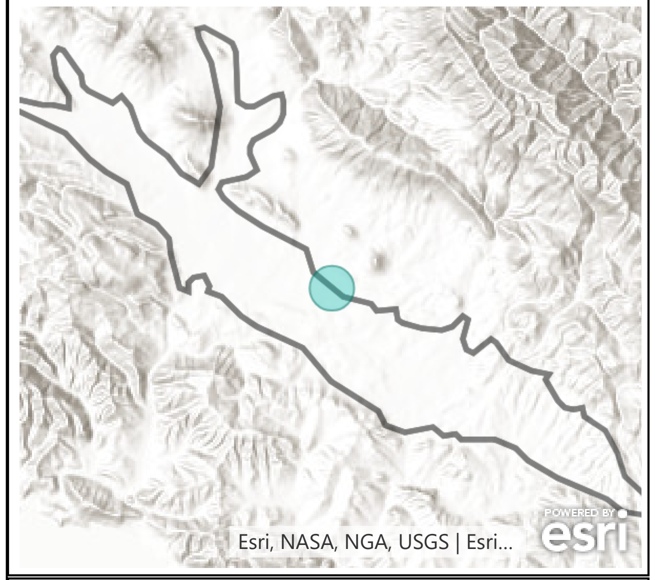
31S/12E-10G02	04/05/1965	10/03/2019
31S/12E-10H03	04/12/1984	10/03/2019
31S/12E-12E03	04/05/1965	04/19/2013
31S/12E-12N01	10/22/1962	11/20/1970
31S/12E-12Q03	04/06/1965	10/06/1987
31S/12E-13J01	10/11/1970	04/15/1996
31S/12E-14C01	11/19/1958	10/03/2019
Total	**11/01/1953**	**10/09/2019**

Depth to Water

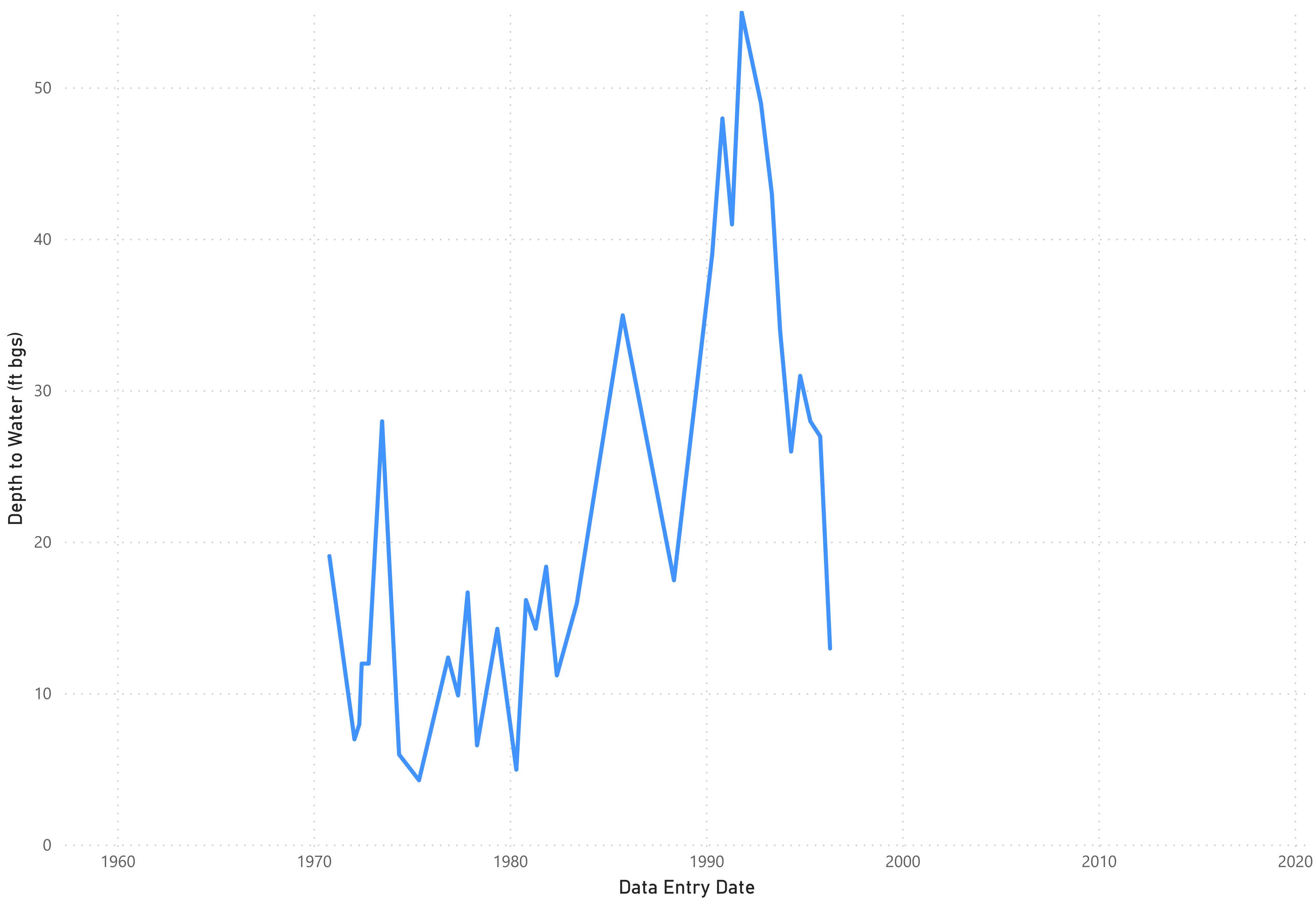


Well Location (larger = more samples)...

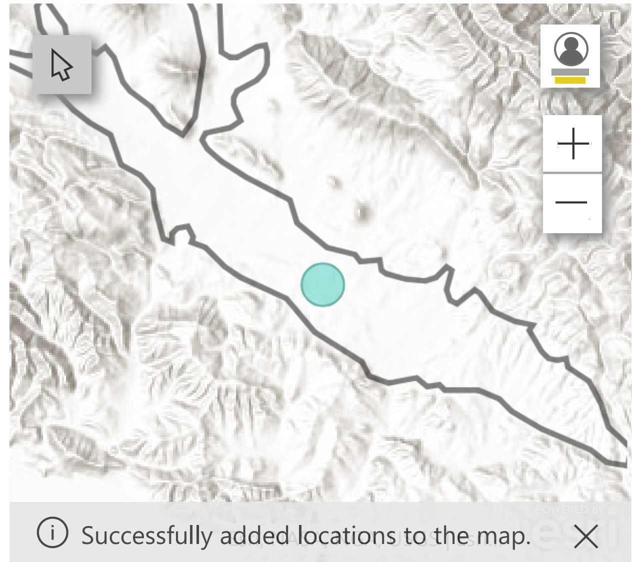


Well Number	Earliest Data Entry Date	Latest Data Entry Date
30S/12E-29Q01	10/22/1962	11/20/1970
30S/12E-32J01	11/18/1958	10/04/1994
31S/12E-03P01	10/12/1990	04/11/2006
31S/12E-03P02	04/05/1965	04/08/2004
31S/12E-10D03	05/09/2012	10/09/2019
31S/12E-10F03	04/05/1965	05/05/1997
31S/12E-10G02	04/05/1965	10/03/2019
31S/12E-10H03	04/12/1984	10/03/2019
31S/12E-12E03	04/05/1965	04/19/2013
31S/12E-12N01	10/22/1962	11/20/1970
31S/12E-12Q03	04/06/1965	10/06/1987
31S/12E-13J01	10/11/1970	04/15/1996
31S/12E-14C01	11/19/1958	10/03/2019
Total	**11/01/1953**	**10/09/2019**

Depth to Water

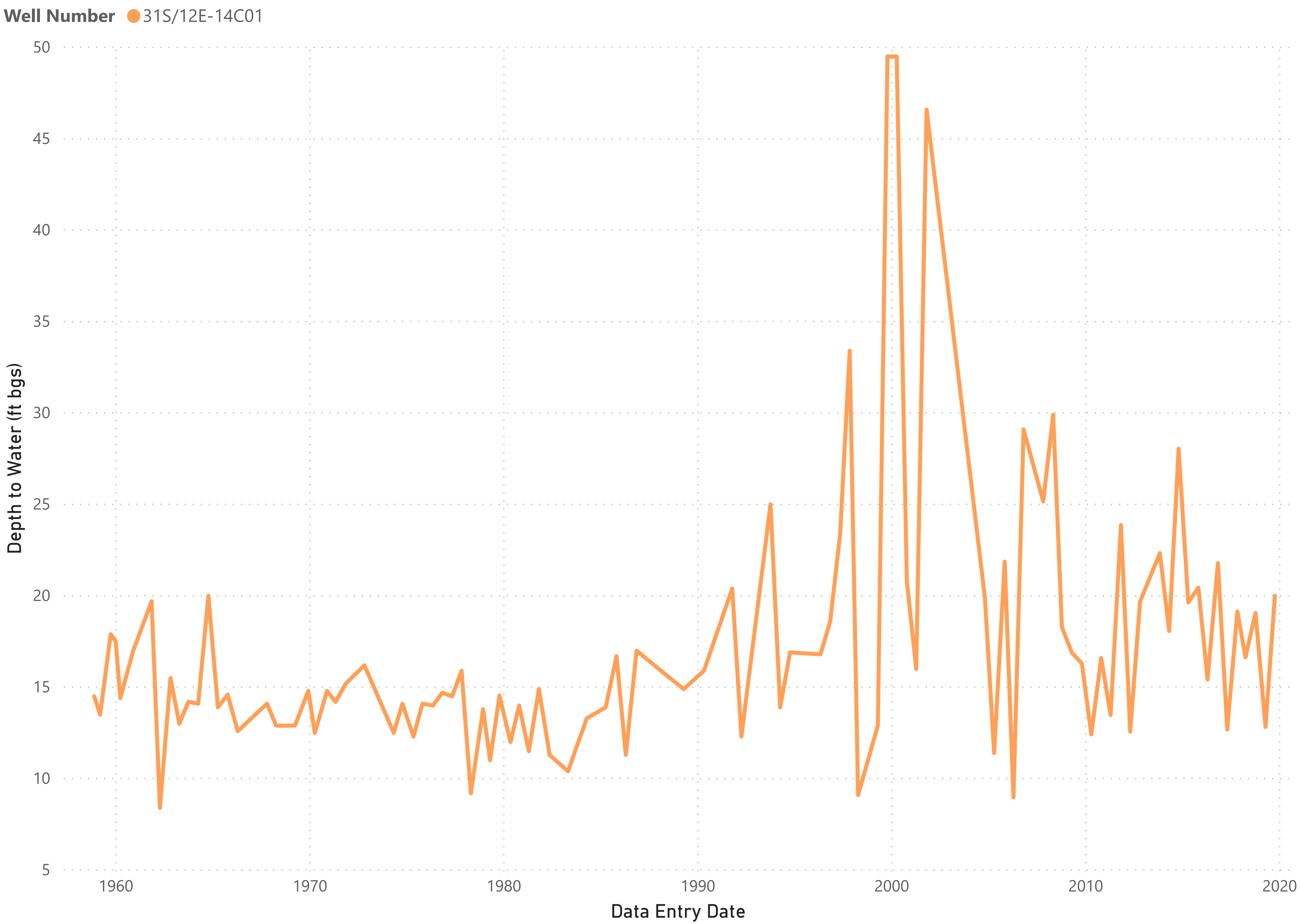


Well Location (larger = more samples)...

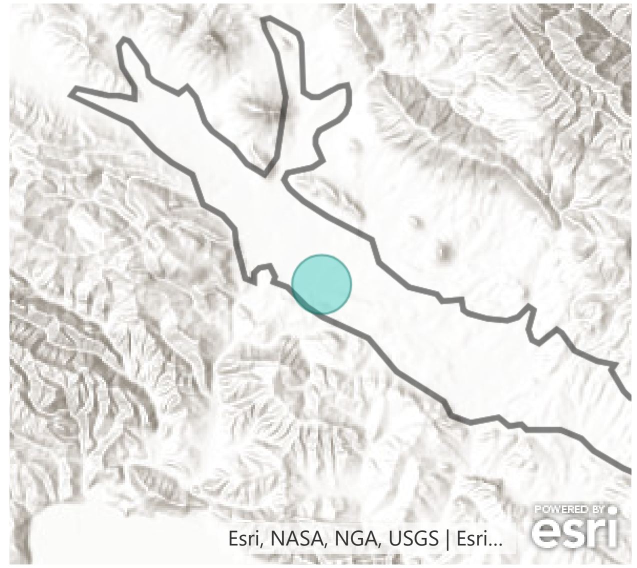


Well Number	Earliest Data Entry Date	Latest Data Entry Date
30S/12E-29Q01	10/22/1962	11/20/1970
30S/12E-32J01	11/18/1958	10/04/1994
31S/12E-03P01	10/12/1990	04/11/2006
31S/12E-03P02	04/05/1965	04/08/2004
31S/12E-10D03	05/09/2012	10/09/2019
31S/12E-10F03	04/05/1965	05/05/1997
31S/12E-10G02	04/05/1965	10/03/2019
31S/12E-10H03	04/12/1984	10/03/2019
31S/12E-12E03	04/05/1965	04/19/2013
31S/12E-12N01	10/22/1962	11/20/1970
31S/12E-12Q03	04/06/1965	10/06/1987
31S/12E-13J01	10/11/1970	04/15/1996
31S/12E-14C01	11/19/1958	10/03/2019
Total	**11/01/1953**	**10/09/2019**

Depth to Water

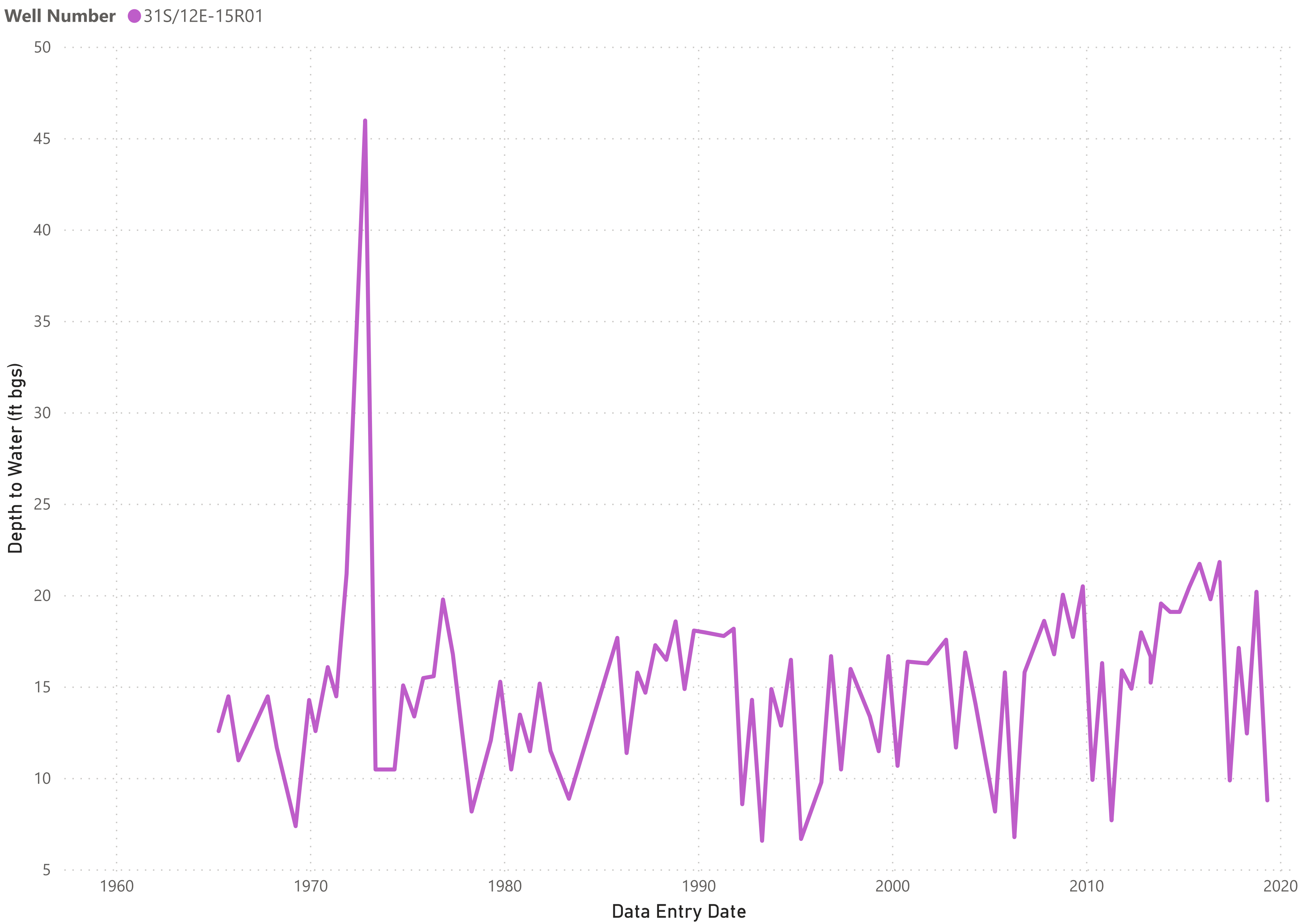


Well Location (larger = more samples)...

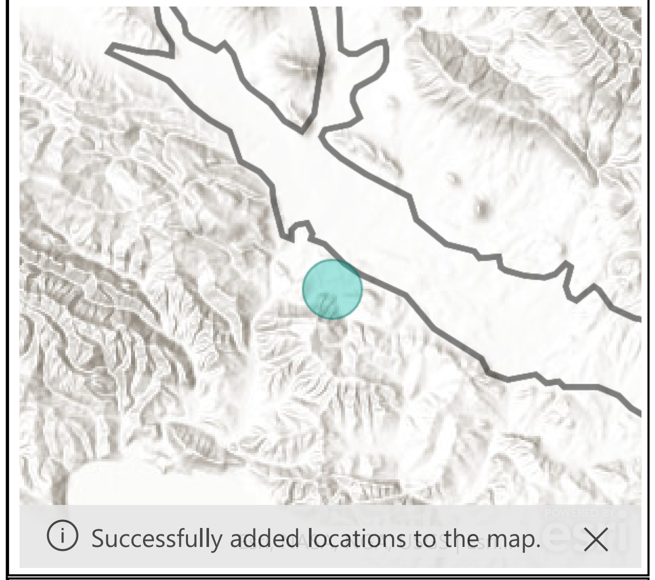


Well Number	Earliest Data Entry Date	Latest Data Entry Date
30S/12E-29Q01	10/22/1962	11/20/1970
30S/12E-32J01	11/18/1958	10/04/1994
31S/12E-03P01	10/12/1990	04/11/2006
31S/12E-03P02	04/05/1965	04/08/2004
31S/12E-10D03	05/09/2012	10/09/2019
31S/12E-10F03	04/05/1965	05/05/1997
31S/12E-10G02	04/05/1965	10/03/2019
31S/12E-10H03	04/12/1984	10/03/2019
31S/12E-12E03	04/05/1965	04/19/2013
31S/12E-12N01	10/22/1962	11/20/1970
31S/12E-12Q03	04/06/1965	10/06/1987
31S/12E-13J01	10/11/1970	04/15/1996
31S/12E-14C01	11/19/1958	10/03/2019
Total	**11/01/1953**	**10/09/2019**

Depth to Water



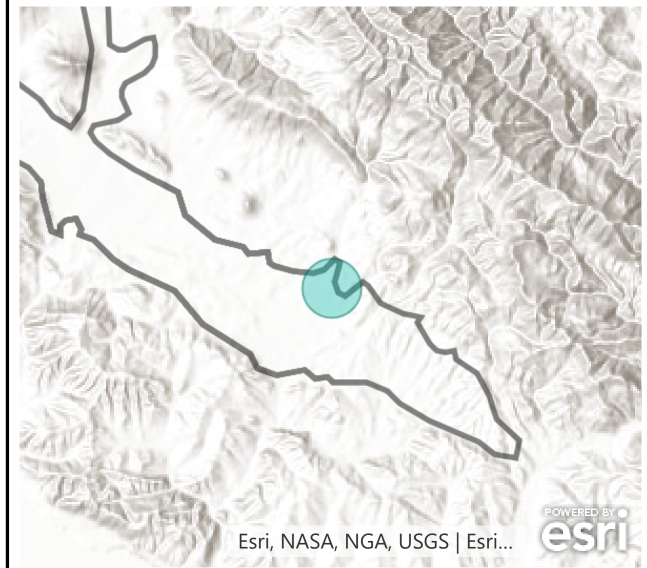
Well Location (larger = more samples)...



Well Number	Earliest Data Entry Date	Latest Data Entry Date
31S/12E-14C01	11/19/1958	10/03/2019
31S/12E-15R01	04/05/1965	04/25/2019
31S/12E-28C01	04/20/1965	05/02/1979
31S/12E-28C03	04/30/1974	10/11/1979
31S/12E-28N01	11/19/1958	04/09/1963
31S/12E-32C01	12/03/1959	10/16/1980
31S/12E-32D01	12/30/1959	05/08/1975
31S/12E-32D02	12/30/1959	05/08/1975
31S/12E-33E02	04/07/1964	10/11/1979
31S/12E-34N01	10/08/1965	05/02/1977
31S/13E-16N01	11/19/1958	10/07/2019
31S/13E-17B01	12/11/1974	10/23/1975
31S/13E-17Q04	12/11/1974	10/07/2019
31S/13E-17R01	05/02/1970	10/03/2019
Total	**11/01/1953**	**10/09/2019**

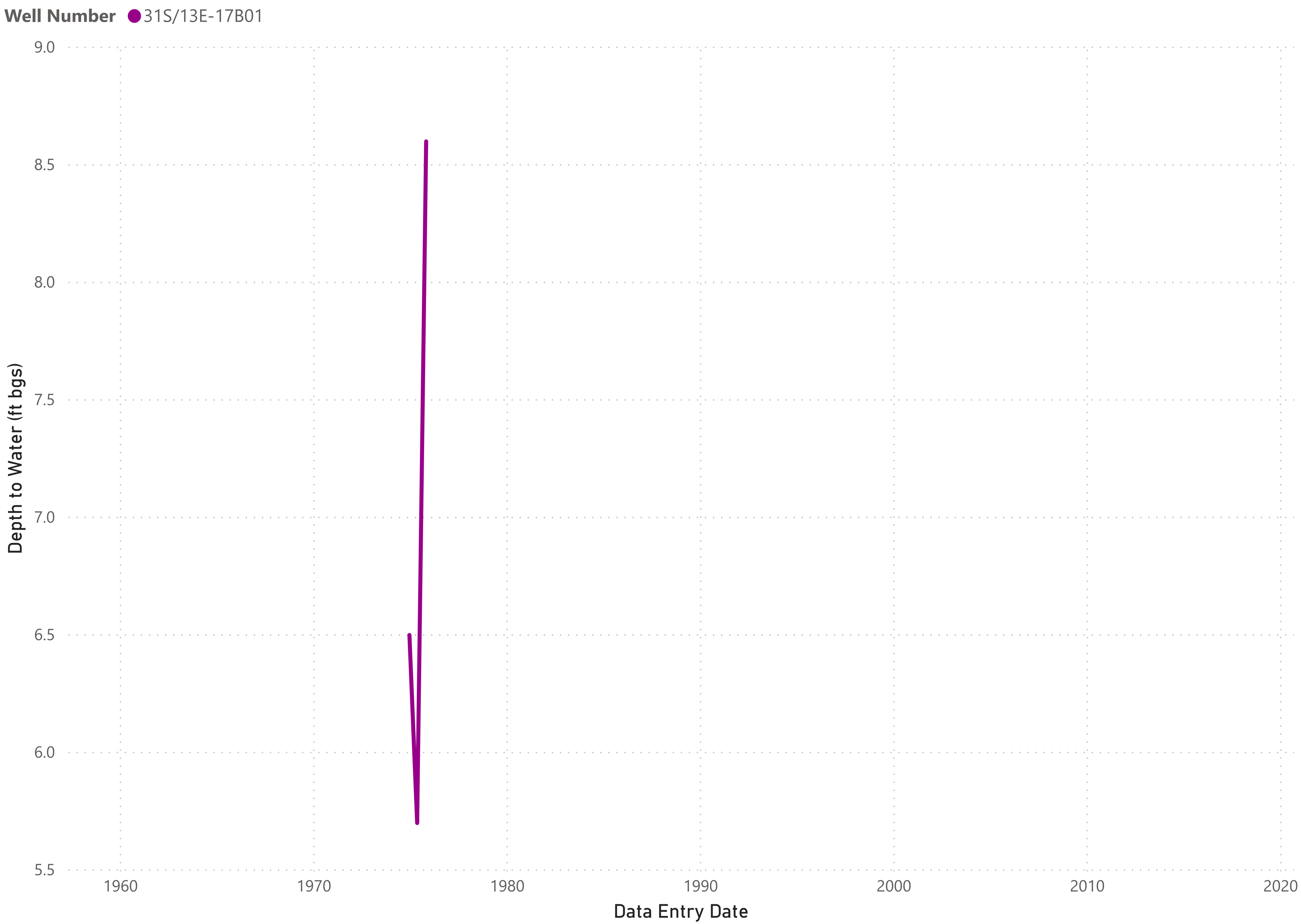
Depth to Water

Well Location (larger = more samples)...

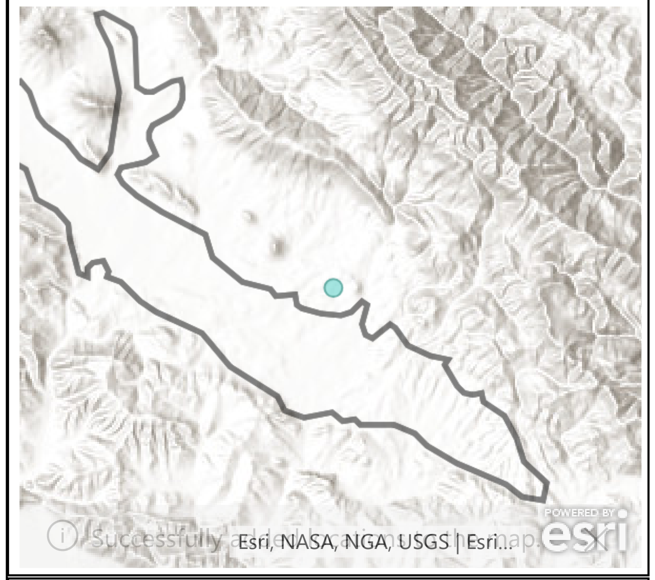


Well Number	Earliest Data Entry Date	Latest Data Entry Date
31S/12E-28N01	11/19/1958	04/09/1963
31S/12E-32C01	12/03/1959	10/16/1980
31S/12E-32D01	12/30/1959	05/08/1975
31S/12E-32D02	12/30/1959	05/08/1975
31S/12E-33E02	04/07/1964	10/11/1979
31S/12E-34N01	10/08/1965	05/02/1977
31S/13E-16N01	11/19/1958	10/07/2019
31S/13E-17B01	12/11/1974	10/23/1975
31S/13E-17Q04	12/11/1974	10/07/2019
31S/13E-17R01	05/02/1970	10/03/2019
31S/13E-18J01	12/10/1974	05/02/1979
31S/13E-18J02	12/10/1974	05/04/1987
31S/13E-18J03	10/23/1975	04/01/1987
Total	**11/01/1953**	**10/09/2019**

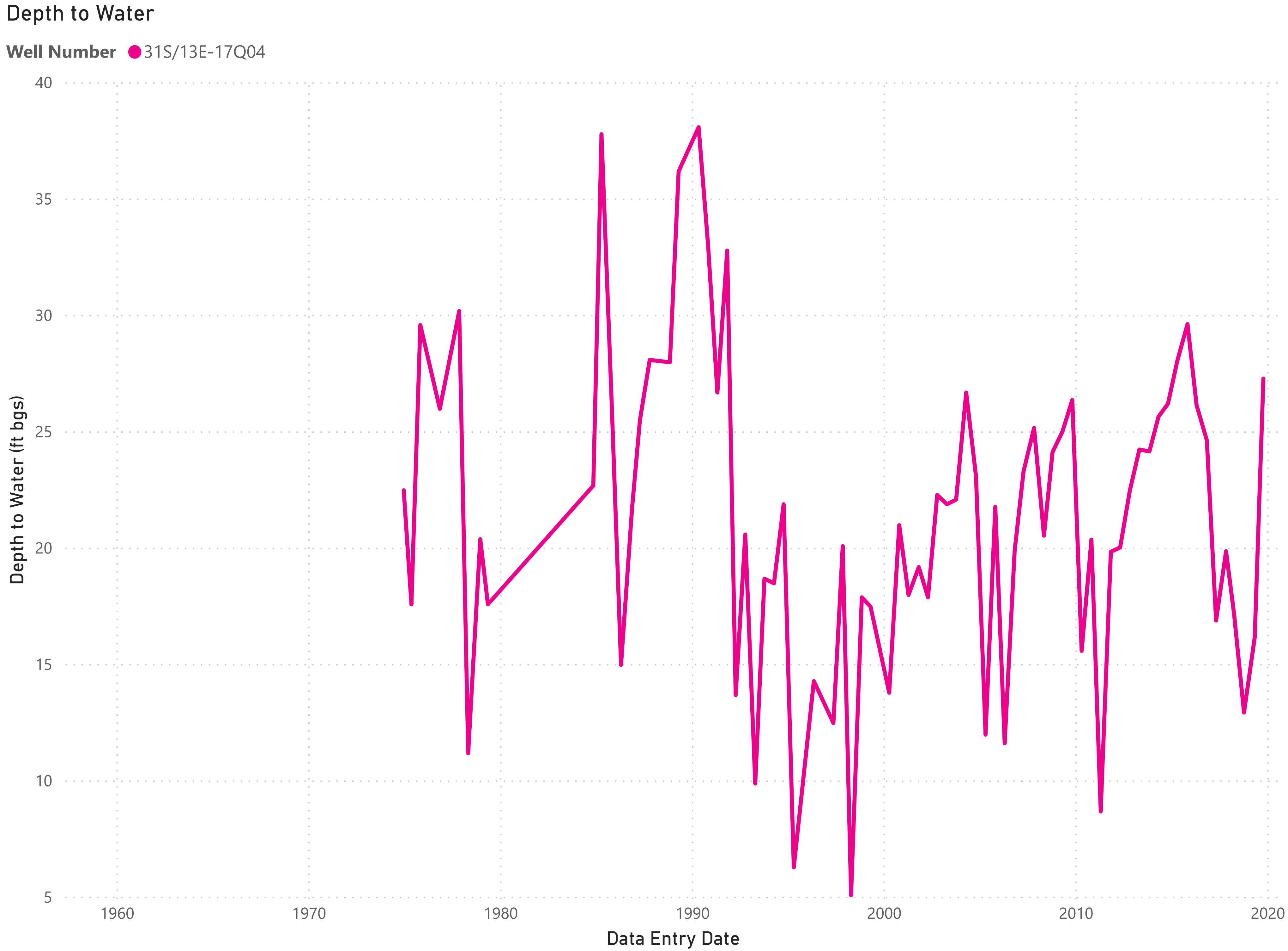
Depth to Water

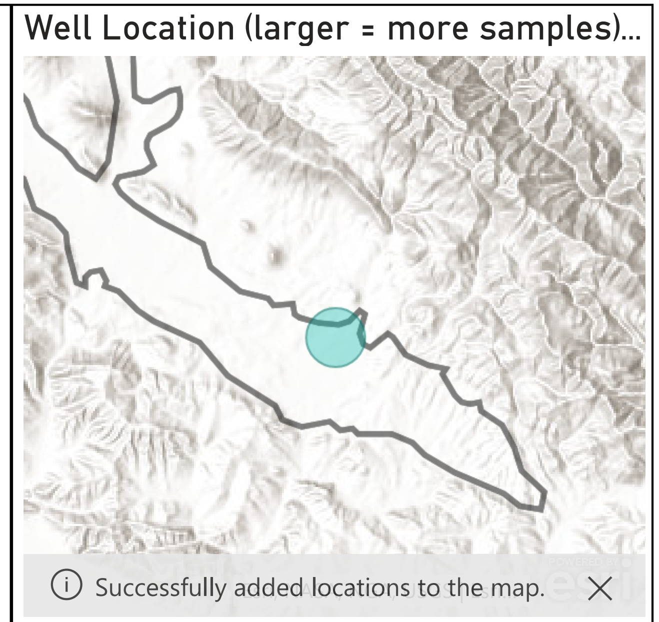


Well Location (larger = more samples)...

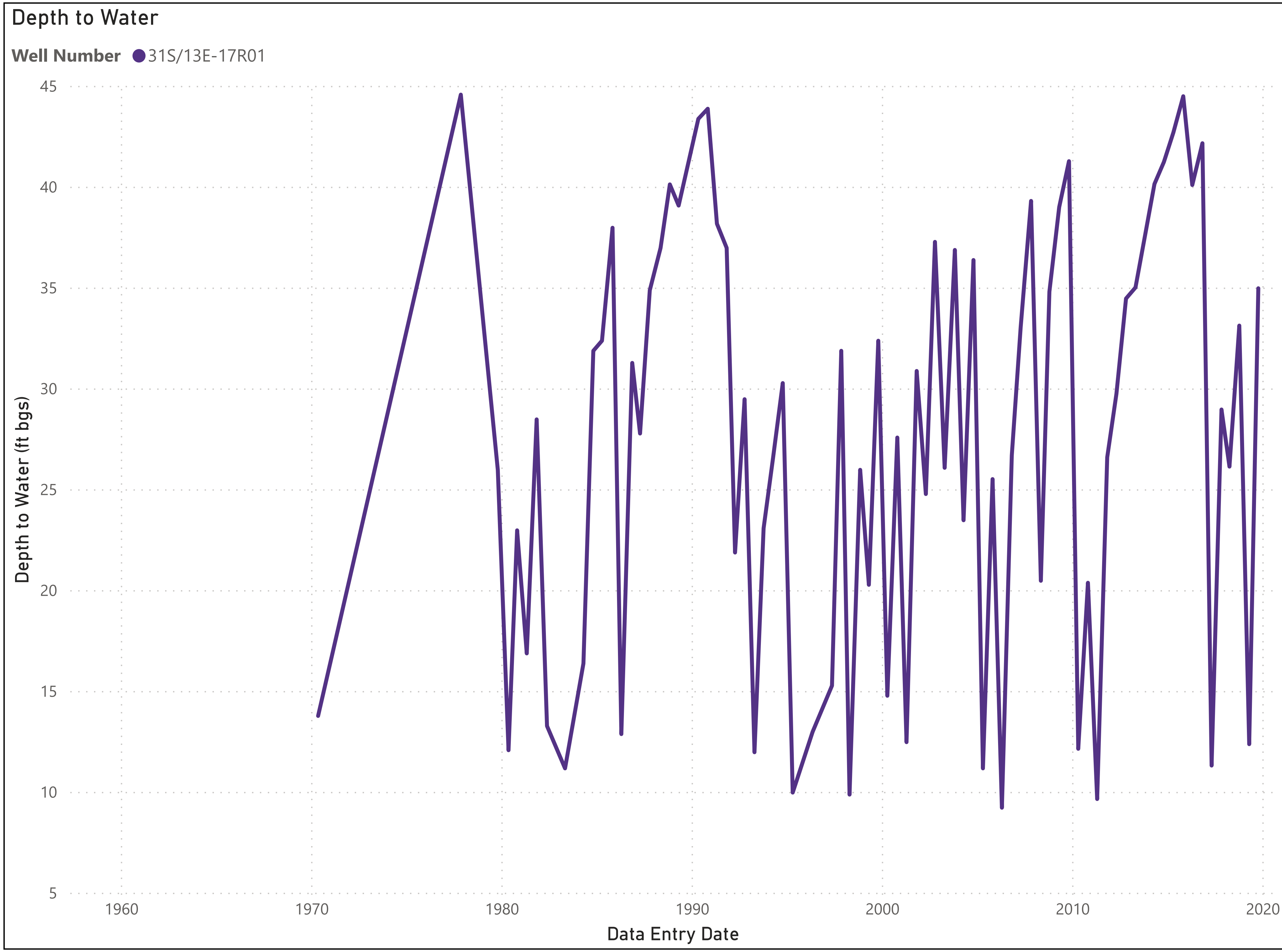


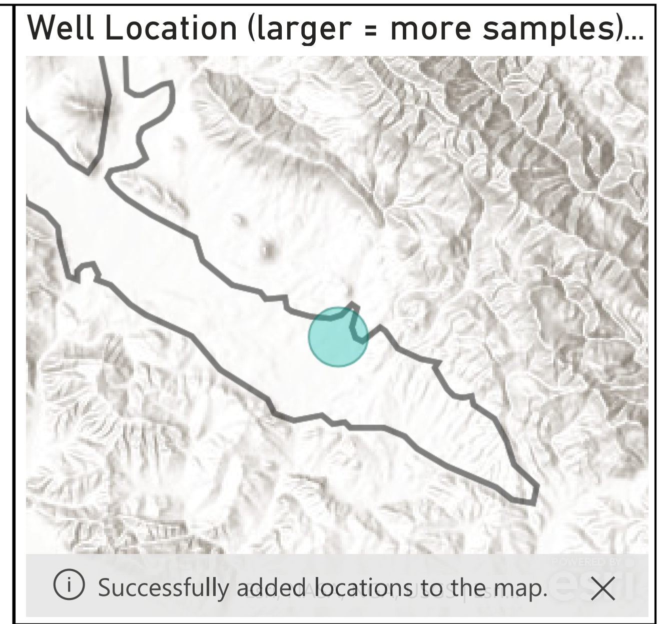
Well Number	Earliest Data Entry Date	Latest Data Entry Date
31S/12E-28N01	11/19/1958	04/09/1963
31S/12E-32C01	12/03/1959	10/16/1980
31S/12E-32D01	12/30/1959	05/08/1975
31S/12E-32D02	12/30/1959	05/08/1975
31S/12E-33E02	04/07/1964	10/11/1979
31S/12E-34N01	10/08/1965	05/02/1977
31S/13E-16N01	11/19/1958	10/07/2019
31S/13E-17B01	12/11/1974	10/23/1975
31S/13E-17Q04	12/11/1974	10/07/2019
31S/13E-17R01	05/02/1970	10/03/2019
31S/13E-18J01	12/10/1974	05/02/1979
31S/13E-18J02	12/10/1974	05/04/1987
31S/13E-18J03	10/23/1975	04/01/1987
Total	**11/01/1953**	**10/09/2019**





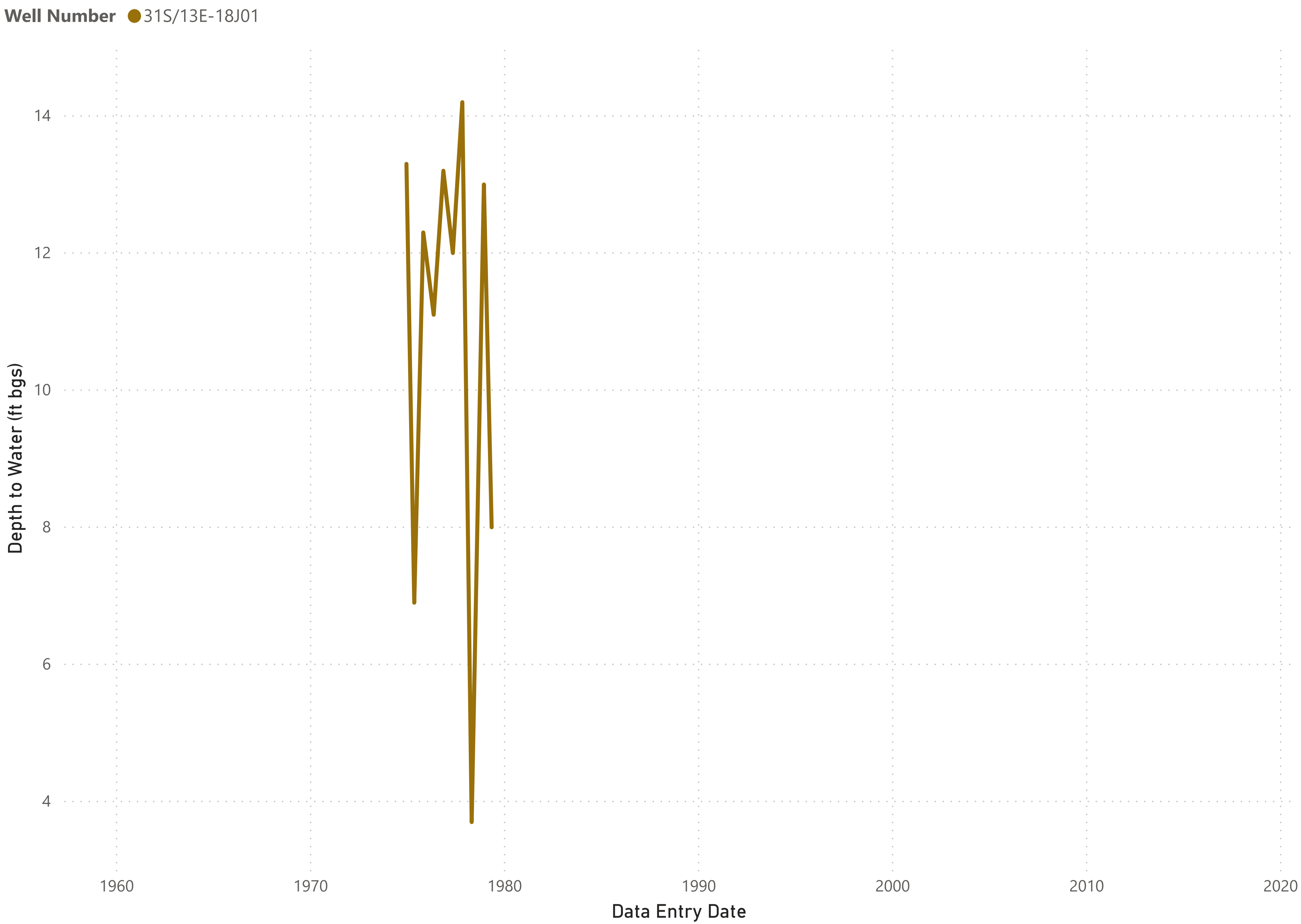
Well Number	Earliest Data Entry Date	Latest Data Entry Date
31S/12E-33E02	04/07/1964	10/11/1979
31S/12E-34N01	10/08/1965	05/02/1977
31S/13E-16N01	11/19/1958	10/07/2019
31S/13E-17B01	12/11/1974	10/23/1975
31S/13E-17Q04	12/11/1974	10/07/2019
31S/13E-17R01	05/02/1970	10/03/2019
31S/13E-18J01	12/10/1974	05/02/1979
31S/13E-18J02	12/10/1974	05/04/1987
31S/13E-18J03	10/23/1975	04/01/1987
31S/13E-18N01	04/05/1965	04/15/1996
31S/13E-18R01	12/10/1974	05/04/1987
31S/13E-18R02	12/10/1974	05/06/1976
31S/13E-19A03	12/10/1974	04/04/1987
Total	**11/01/1953**	**10/09/2019**



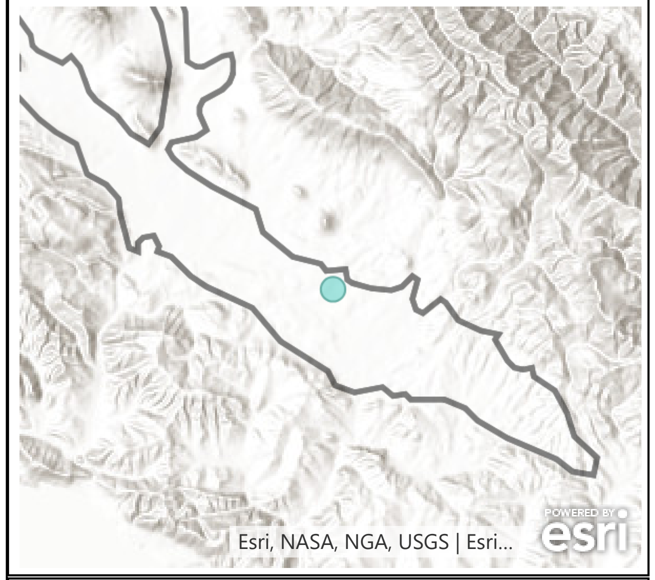


Well Number	Earliest Data Entry Date	Latest Data Entry Date
31S/12E-28N01	11/19/1958	04/09/1963
31S/12E-32C01	12/03/1959	10/16/1980
31S/12E-32D01	12/30/1959	05/08/1975
31S/12E-32D02	12/30/1959	05/08/1975
31S/12E-33E02	04/07/1964	10/11/1979
31S/12E-34N01	10/08/1965	05/02/1977
31S/13E-16N01	11/19/1958	10/07/2019
31S/13E-17B01	12/11/1974	10/23/1975
31S/13E-17Q04	12/11/1974	10/07/2019
31S/13E-17R01	05/02/1970	10/03/2019
31S/13E-18J01	12/10/1974	05/02/1979
31S/13E-18J02	12/10/1974	05/04/1987
31S/13E-18J03	10/23/1975	04/01/1987
Total	**11/01/1953**	**10/09/2019**

Depth to Water

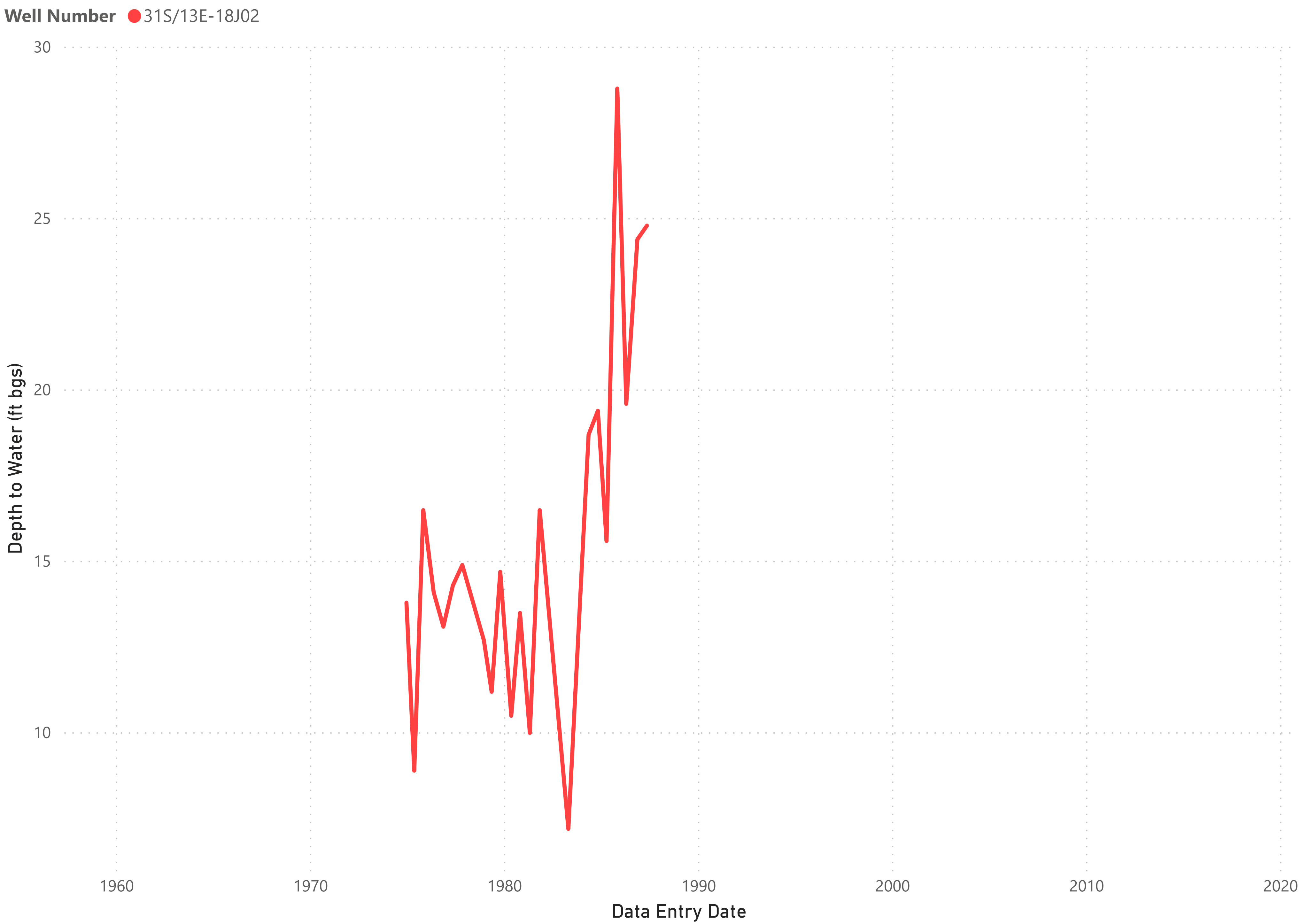


Well Location (larger = more samples)...

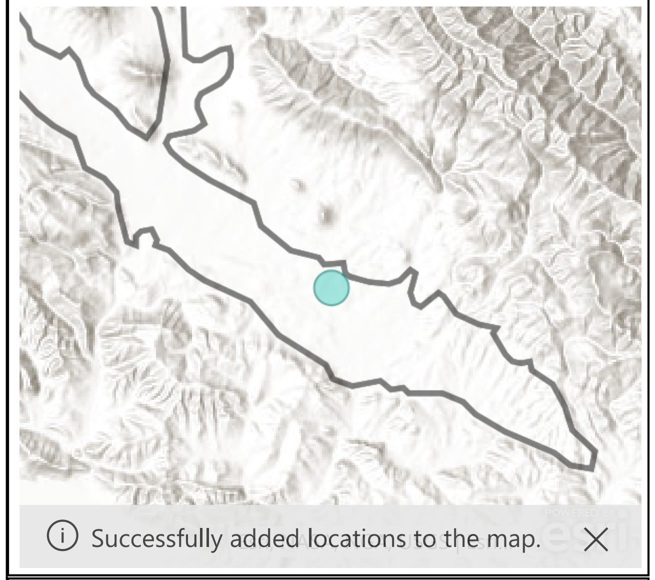


Well Number	Earliest Data Entry Date	Latest Data Entry Date
31S/12E-28N01	11/19/1958	04/09/1963
31S/12E-32C01	12/03/1959	10/16/1980
31S/12E-32D01	12/30/1959	05/08/1975
31S/12E-32D02	12/30/1959	05/08/1975
31S/12E-33E02	04/07/1964	10/11/1979
31S/12E-34N01	10/08/1965	05/02/1977
31S/13E-16N01	11/19/1958	10/07/2019
31S/13E-17B01	12/11/1974	10/23/1975
31S/13E-17Q04	12/11/1974	10/07/2019
31S/13E-17R01	05/02/1970	10/03/2019
31S/13E-18J01	12/10/1974	05/02/1979
31S/13E-18J02	12/10/1974	05/04/1987
31S/13E-18J03	10/23/1975	04/01/1987
Total	**11/01/1953**	**10/09/2019**

Depth to Water

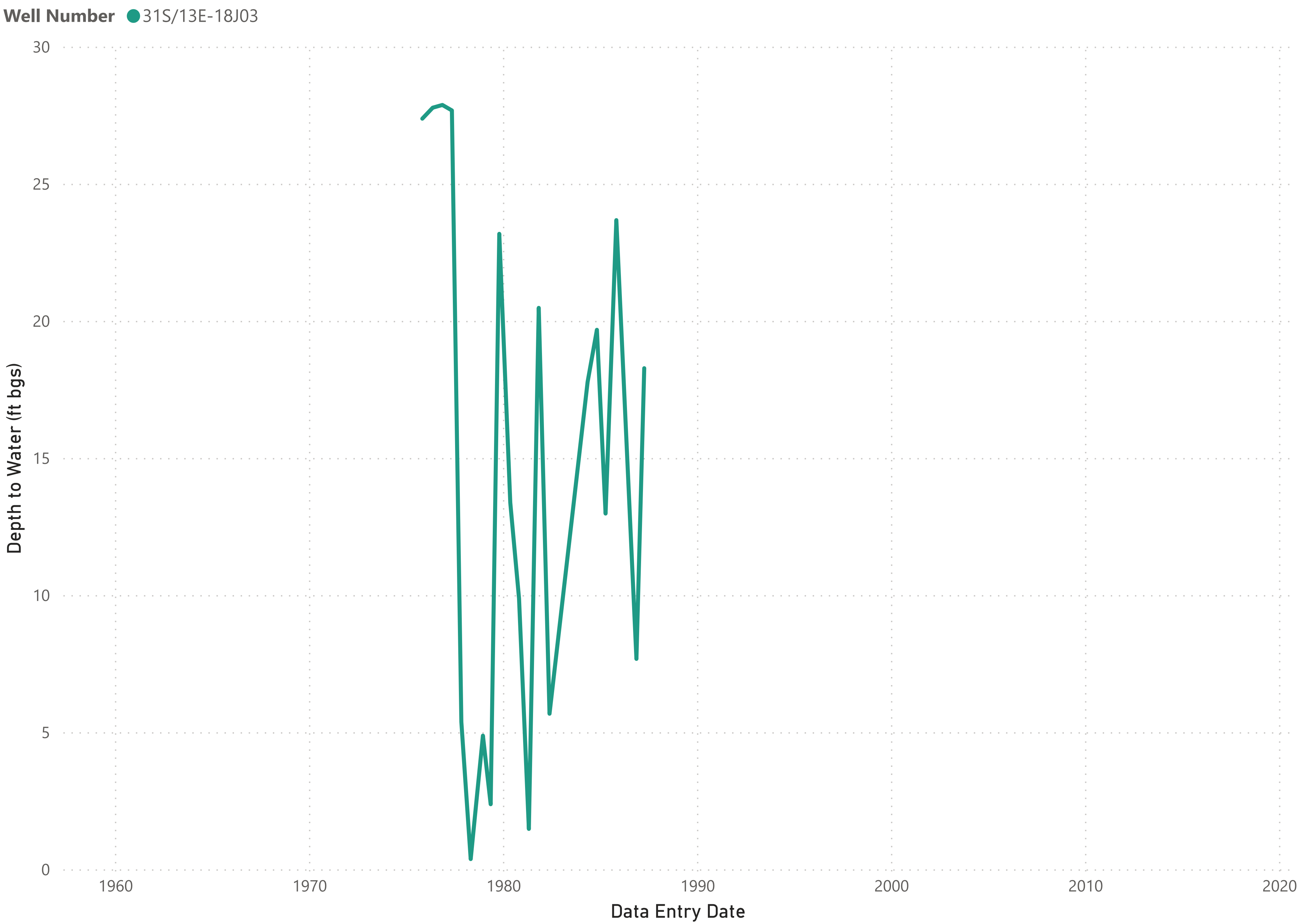


Well Location (larger = more samples)...



Well Number	Earliest Data Entry Date	Latest Data Entry Date
31S/12E-33E02	04/07/1964	10/11/1979
31S/12E-34N01	10/08/1965	05/02/1977
31S/13E-16N01	11/19/1958	10/07/2019
31S/13E-17B01	12/11/1974	10/23/1975
31S/13E-17Q04	12/11/1974	10/07/2019
31S/13E-17R01	05/02/1970	10/03/2019
31S/13E-18J01	12/10/1974	05/02/1979
31S/13E-18J02	12/10/1974	05/04/1987
31S/13E-18J03	10/23/1975	04/01/1987
31S/13E-18N01	04/05/1965	04/15/1996
31S/13E-18R01	12/10/1974	05/04/1987
31S/13E-18R02	12/10/1974	05/06/1976
31S/13E-19A03	12/10/1974	04/04/1987
Total	**11/01/1953**	**10/09/2019**

Depth to Water

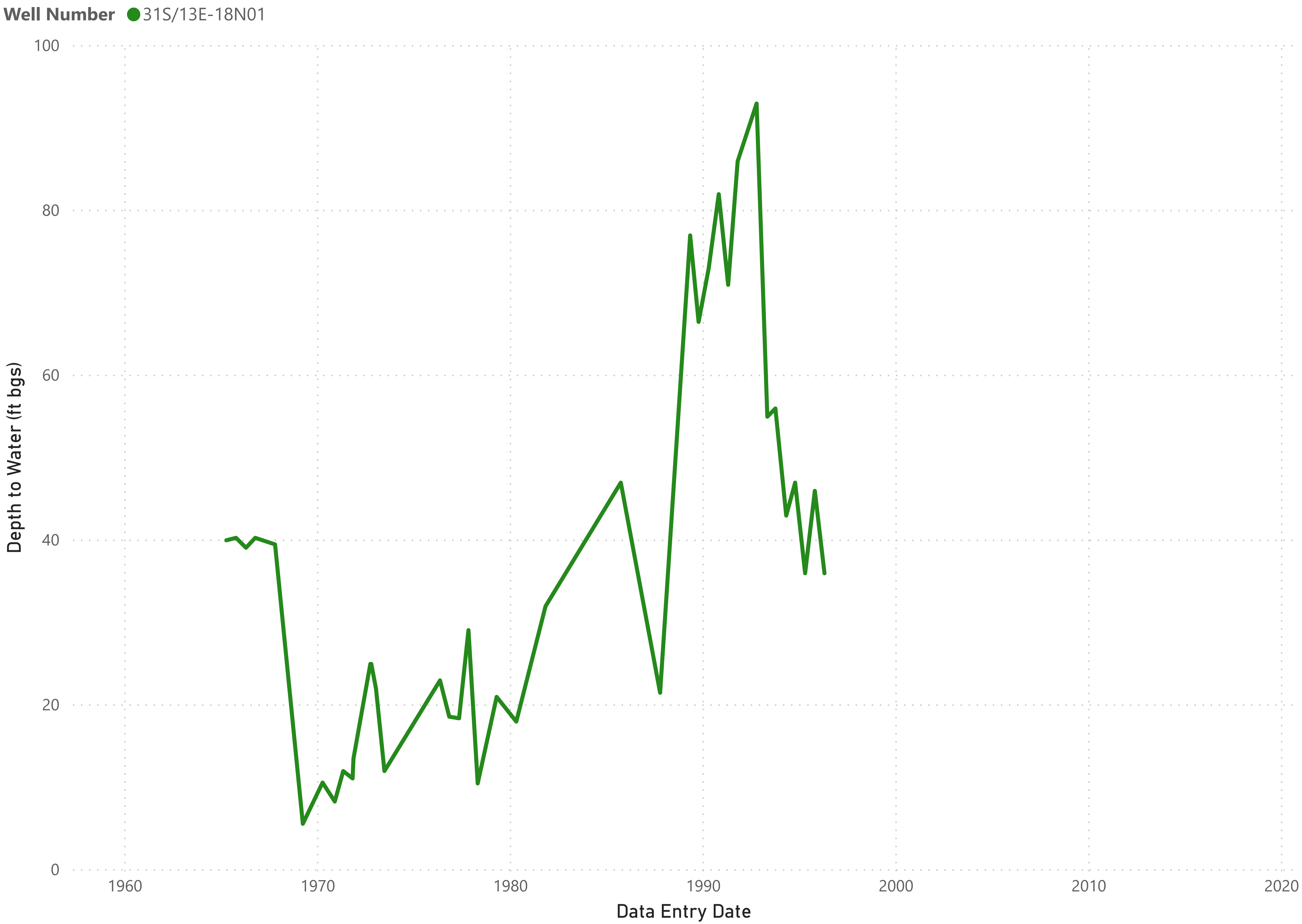


Well Location (larger = more samples)...

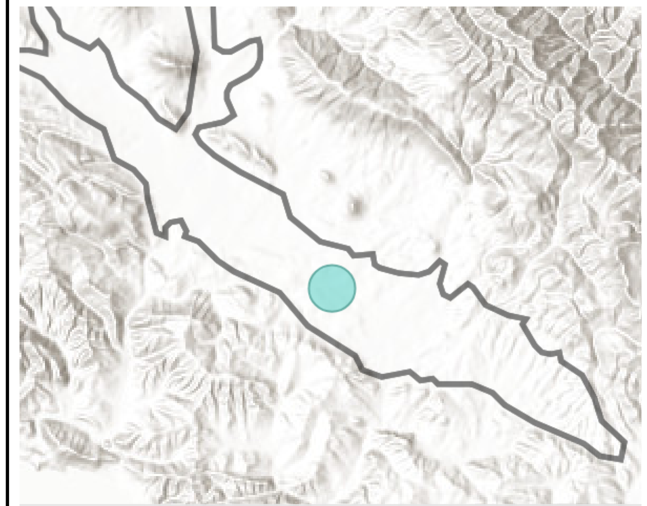
Successfully added locations to the map.

Well Number	Earliest Data Entry Date	Latest Data Entry Date
31S/12E-33E02	04/07/1964	10/11/1979
31S/12E-34N01	10/08/1965	05/02/1977
31S/13E-16N01	11/19/1958	10/07/2019
31S/13E-17B01	12/11/1974	10/23/1975
31S/13E-17Q04	12/11/1974	10/07/2019
31S/13E-17R01	05/02/1970	10/03/2019
31S/13E-18J01	12/10/1974	05/02/1979
31S/13E-18J02	12/10/1974	05/04/1987
31S/13E-18J03	10/23/1975	04/01/1987
31S/13E-18N01	04/05/1965	04/15/1996
31S/13E-18R01	12/10/1974	05/04/1987
31S/13E-18R02	12/10/1974	05/06/1976
31S/13E-19A03	12/10/1974	04/04/1987
Total	**11/01/1953**	**10/09/2019**

Depth to Water



Well Location (larger = more samples)...

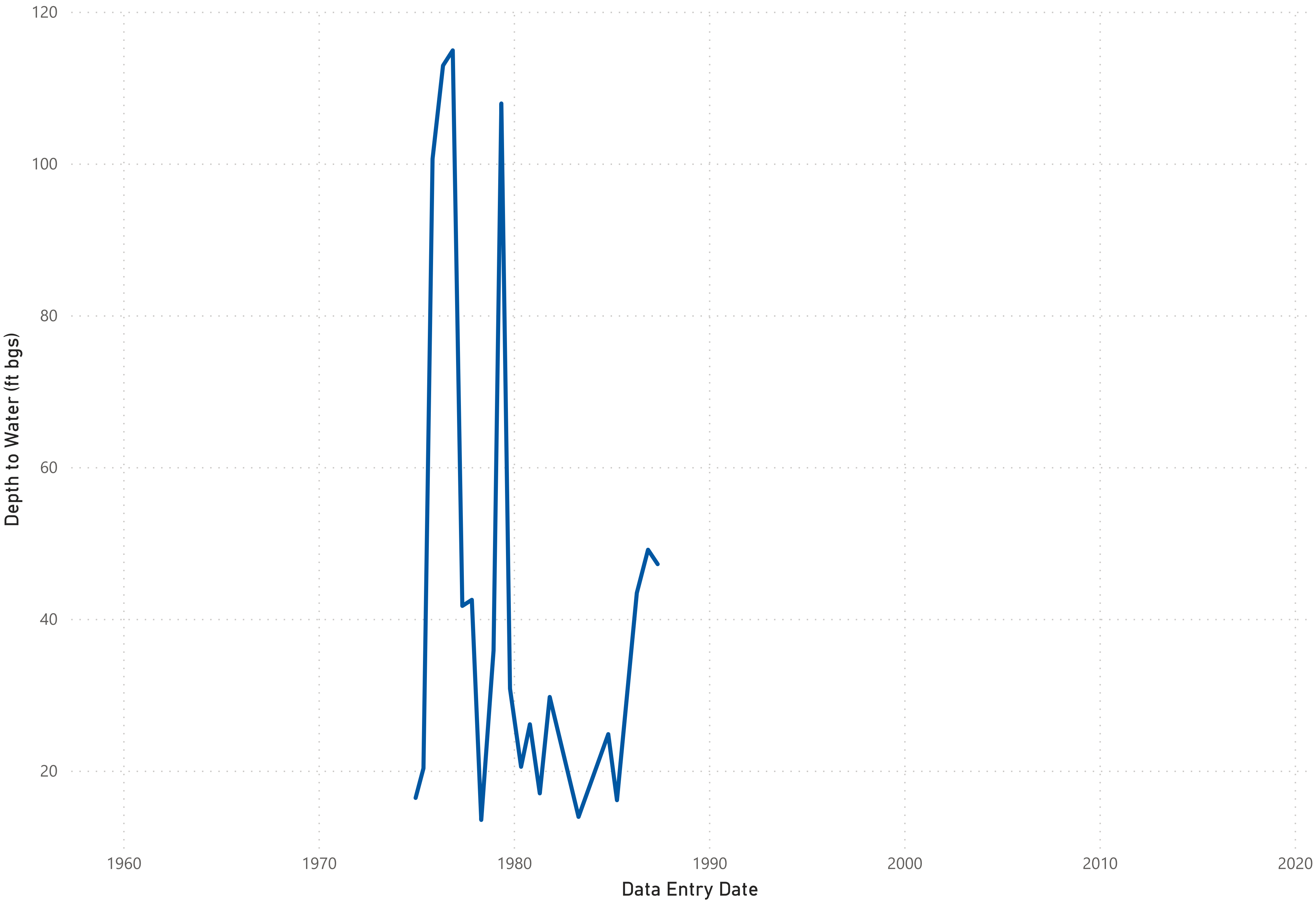


Successfully added locations to the map.

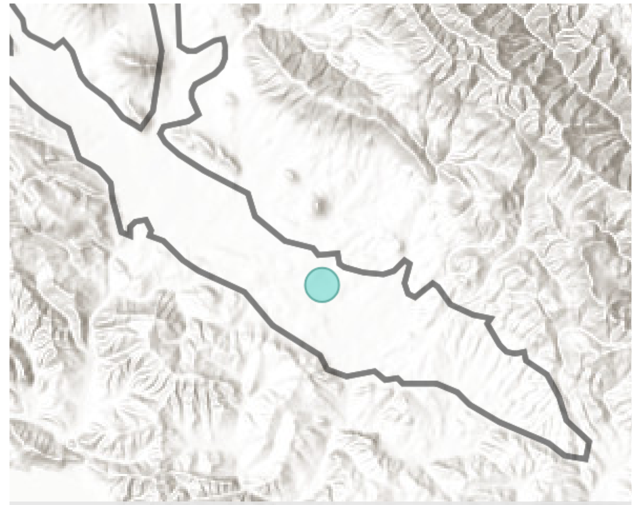
Well Number	Earliest Data Entry Date	Latest Data Entry Date
31S/12E-33E02	04/07/1964	10/11/1979
31S/12E-34N01	10/08/1965	05/02/1977
31S/13E-16N01	11/19/1958	10/07/2019
31S/13E-17B01	12/11/1974	10/23/1975
31S/13E-17Q04	12/11/1974	10/07/2019
31S/13E-17R01	05/02/1970	10/03/2019
31S/13E-18J01	12/10/1974	05/02/1979
31S/13E-18J02	12/10/1974	05/04/1987
31S/13E-18J03	10/23/1975	04/01/1987
31S/13E-18N01	04/05/1965	04/15/1996
31S/13E-18R01	12/10/1974	05/04/1987
31S/13E-18R02	12/10/1974	05/06/1976
31S/13E-19A03	12/10/1974	04/04/1987
Total	**11/01/1953**	**10/09/2019**

Depth to Water

Well Number ● 31S/13E-18R01



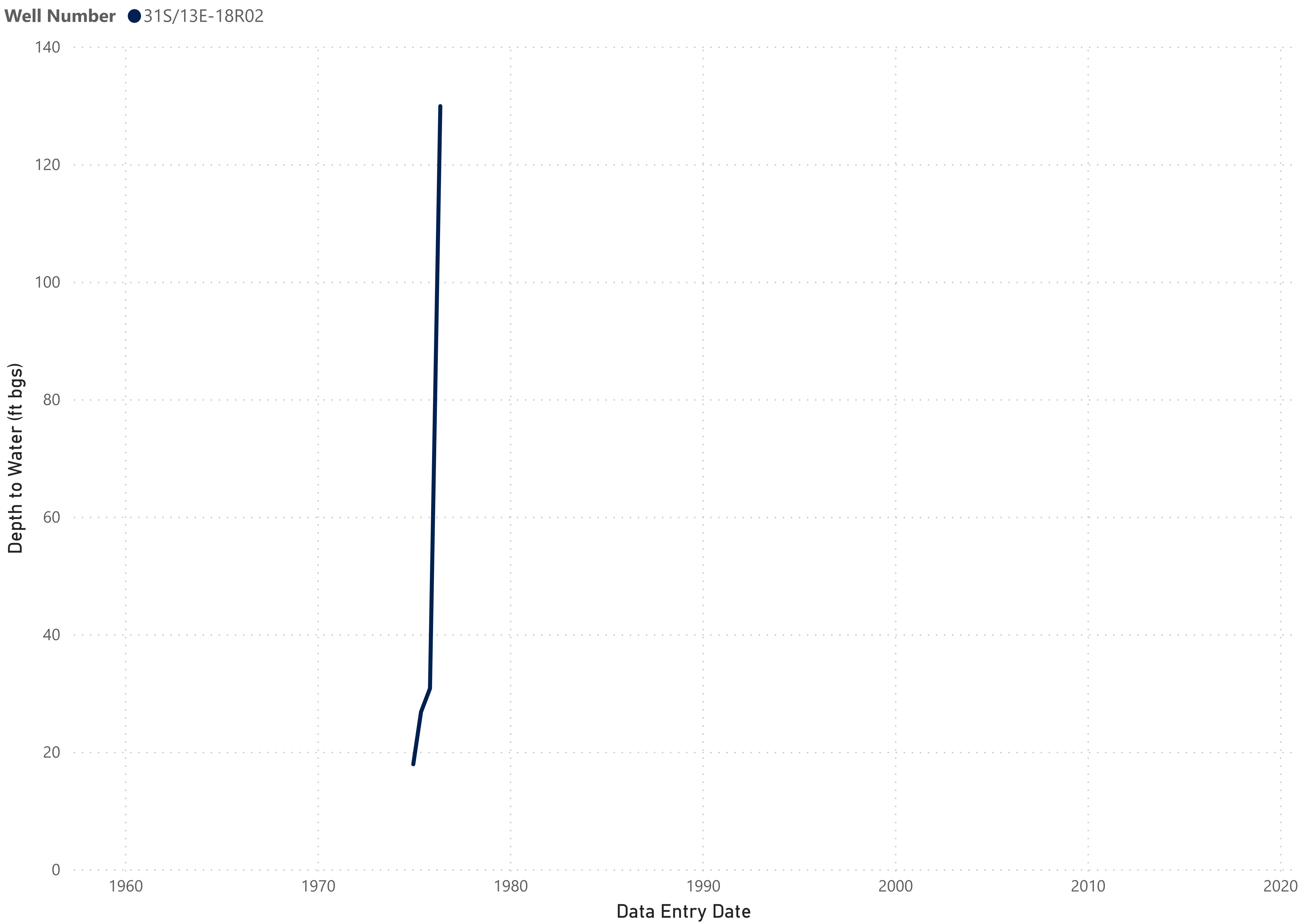
Well Location (larger = more samples)...



ⓘ Successfully added locations to the map.

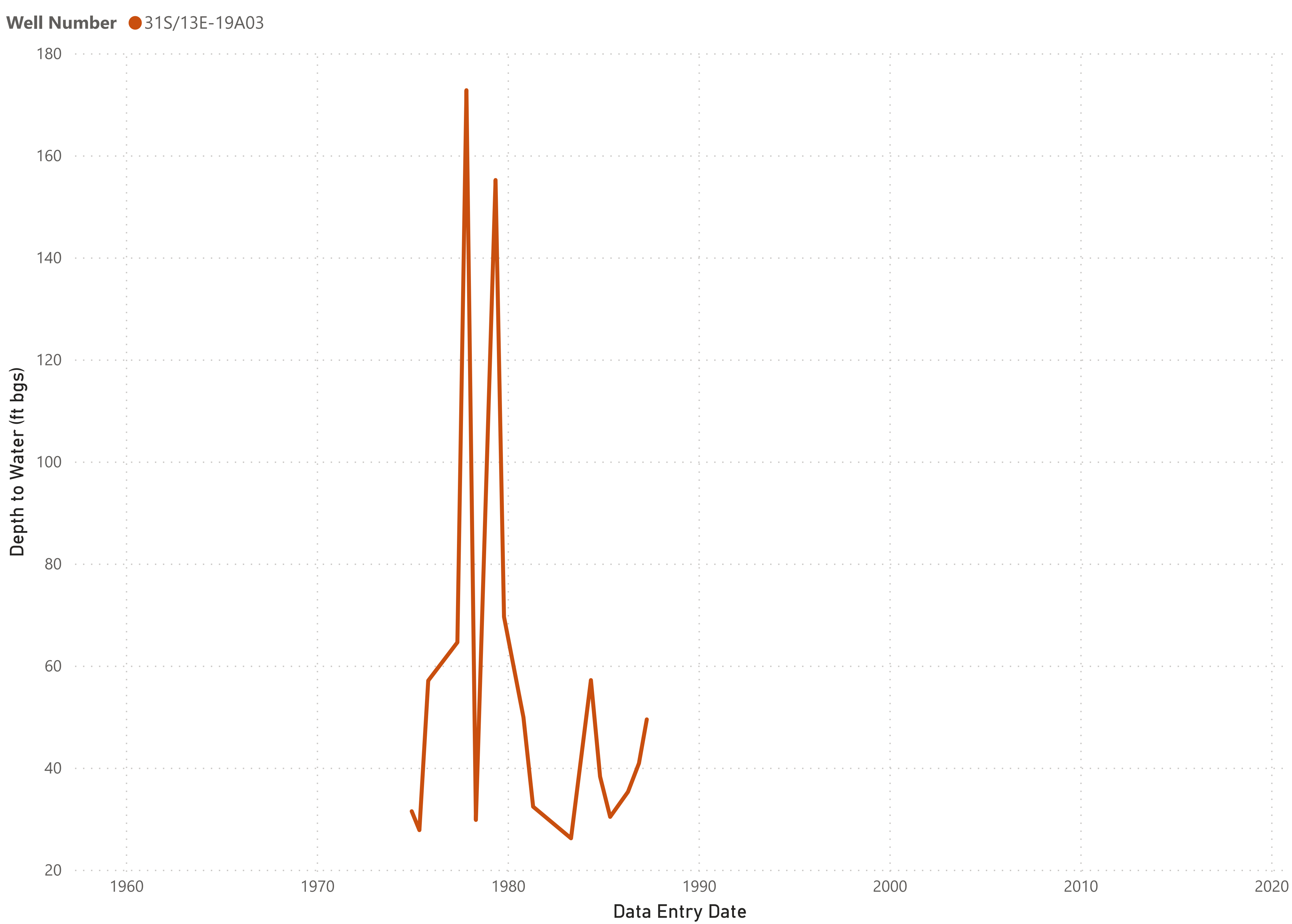
Well Number	Earliest Data Entry Date	Latest Data Entry Date
31S/12E-33E02	04/07/1964	10/11/1979
31S/12E-34N01	10/08/1965	05/02/1977
31S/13E-16N01	11/19/1958	10/07/2019
31S/13E-17B01	12/11/1974	10/23/1975
31S/13E-17Q04	12/11/1974	10/07/2019
31S/13E-17R01	05/02/1970	10/03/2019
31S/13E-18J01	12/10/1974	05/02/1979
31S/13E-18J02	12/10/1974	05/04/1987
31S/13E-18J03	10/23/1975	04/01/1987
31S/13E-18N01	04/05/1965	04/15/1996
31S/13E-18R01	12/10/1974	05/04/1987
31S/13E-18R02	12/10/1974	05/06/1976
31S/13E-19A03	12/10/1974	04/04/1987
Total	**11/01/1953**	**10/09/2019**

Depth to Water



Well Location (larger = more samples)...

Well Number	Earliest Data Entry Date	Latest Data Entry Date
31S/12E-33E02	04/07/1964	10/11/1979
31S/12E-34N01	10/08/1965	05/02/1977
31S/13E-16N01	11/19/1958	10/07/2019
31S/13E-17B01	12/11/1974	10/23/1975
31S/13E-17Q04	12/11/1974	10/07/2019
31S/13E-17R01	05/02/1970	10/03/2019
31S/13E-18J01	12/10/1974	05/02/1979
31S/13E-18J02	12/10/1974	05/04/1987
31S/13E-18J03	10/23/1975	04/01/1987
31S/13E-18N01	04/05/1965	04/15/1996
31S/13E-18R01	12/10/1974	05/04/1987
31S/13E-18R02	12/10/1974	05/06/1976
31S/13E-19A03	12/10/1974	04/04/1987
Total	**11/01/1953**	**10/09/2019**



Well Location (larger = more samples)...

Well Number	Earliest Data Entry Date	Latest Data Entry Date
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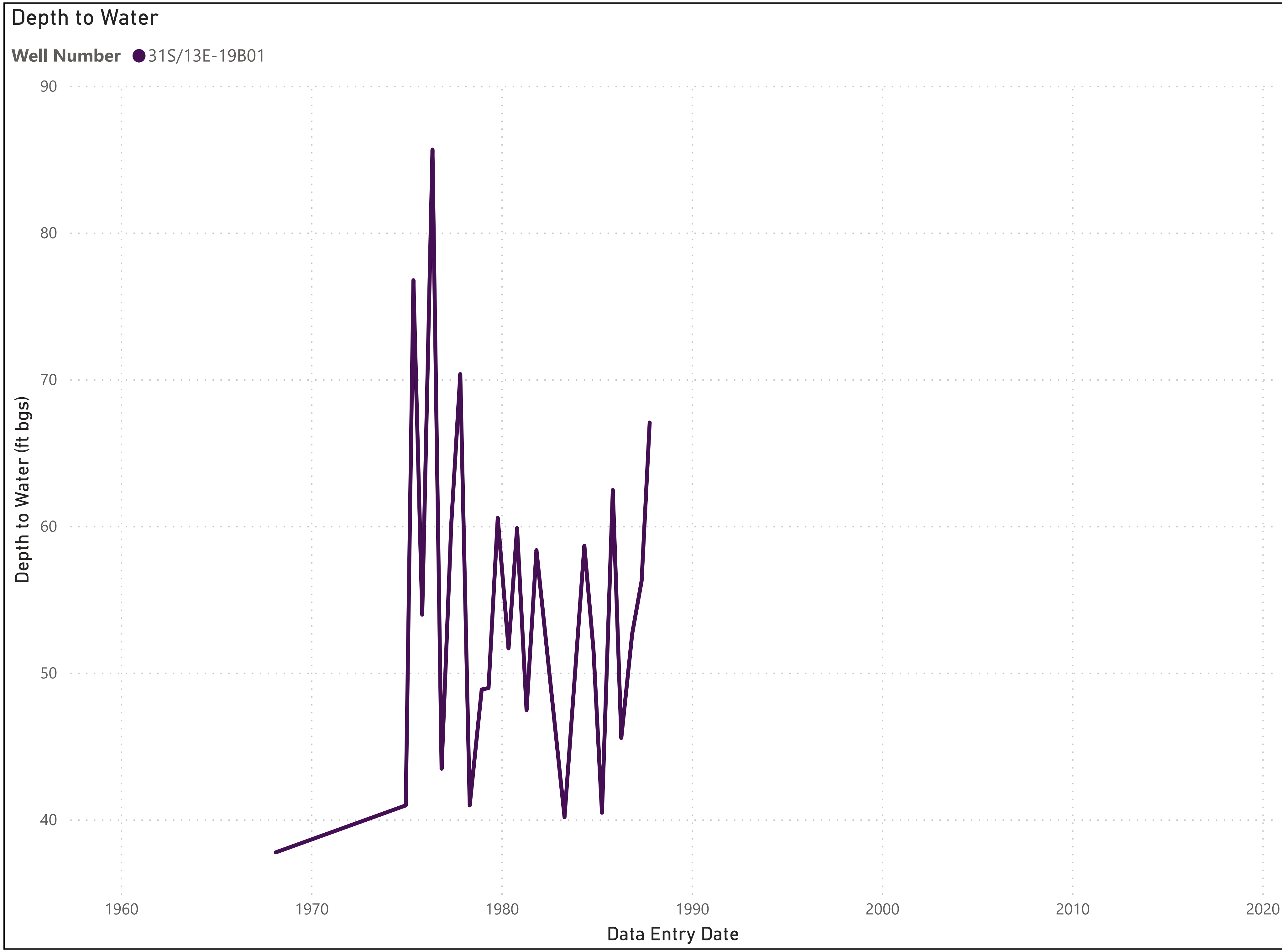
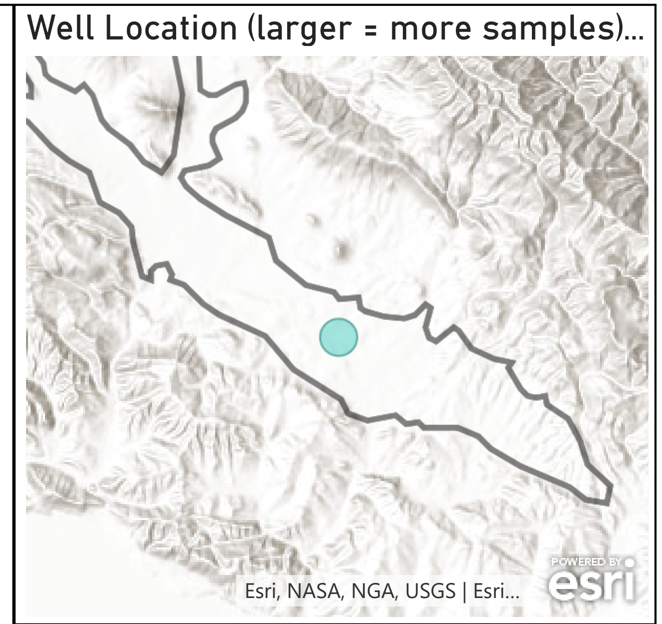
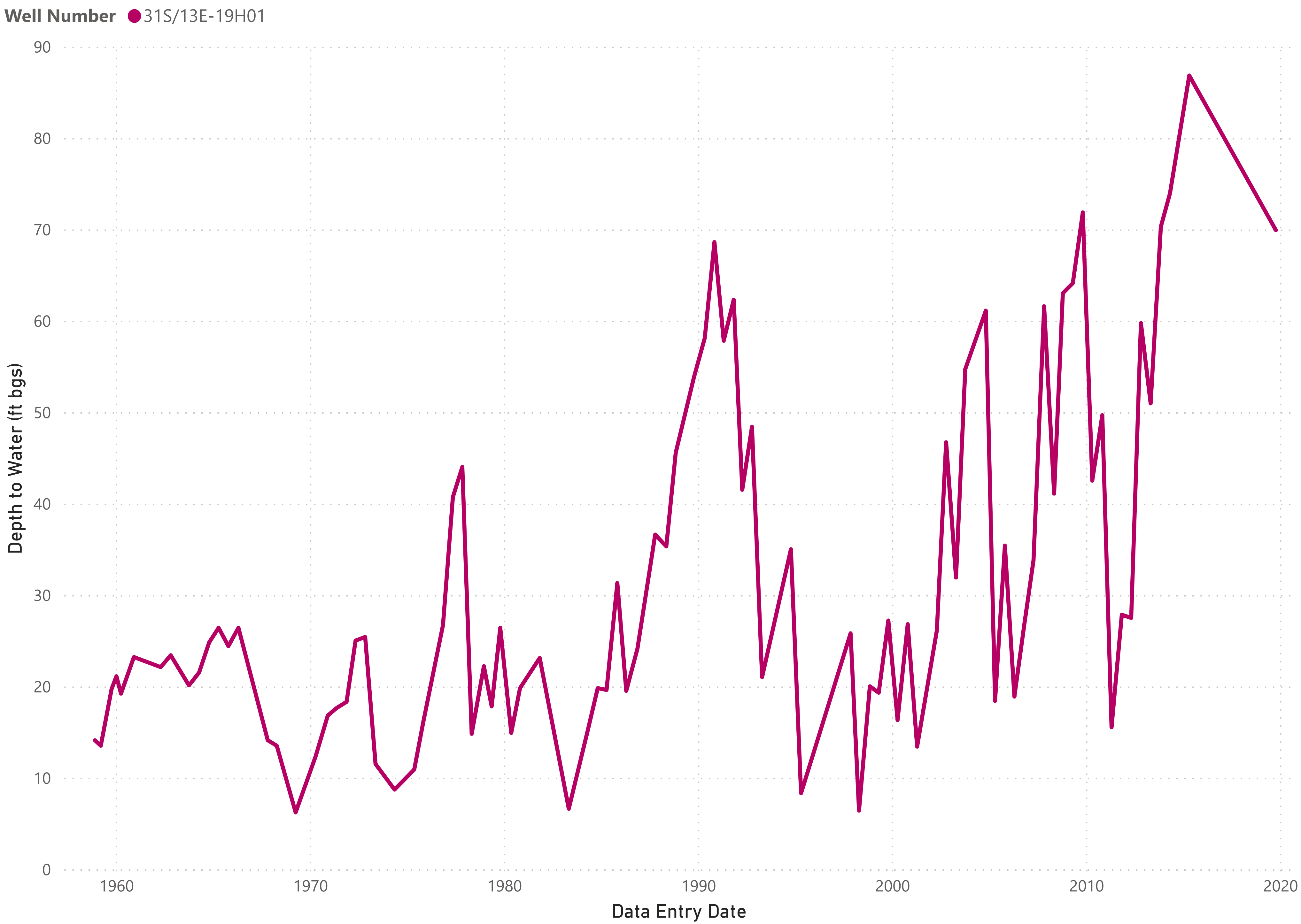
31S/13E-17R01	05/02/1970	10/03/2019
31S/13E-18J01	12/10/1974	05/02/1979
31S/13E-18J02	12/10/1974	05/04/1987
31S/13E-18J03	10/23/1975	04/01/1987
31S/13E-18N01	04/05/1965	04/15/1996
31S/13E-18R01	12/10/1974	05/04/1987
31S/13E-18R02	12/10/1974	05/06/1976
31S/13E-19A03	12/10/1974	04/04/1987
31S/13E-19B01	02/10/1968	10/06/1987
31S/13E-19H01	11/19/1958	10/03/2019
31S/13E-19H04	10/27/1977	04/04/1987
31S/13E-19L01	04/05/1965	10/19/2010
Total	**11/01/1953**	**10/09/2019**



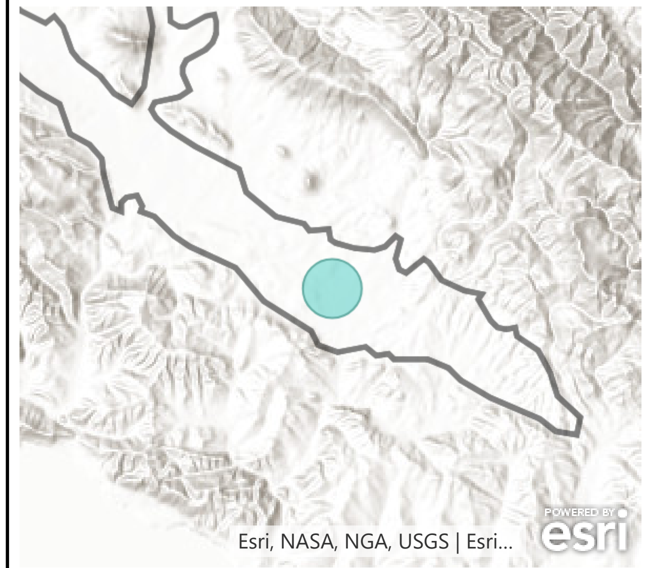


Well Number	Earliest Data Entry Date	Latest Data Entry Date
31S/13E-17Q04	12/11/1974	10/07/2019
31S/13E-17R01	05/02/1970	10/03/2019
31S/13E-18J01	12/10/1974	05/02/1979
31S/13E-18J02	12/10/1974	05/04/1987
31S/13E-18J03	10/23/1975	04/01/1987
31S/13E-18N01	04/05/1965	04/15/1996
31S/13E-18R01	12/10/1974	05/04/1987
31S/13E-18R02	12/10/1974	05/06/1976
31S/13E-19A03	12/10/1974	04/04/1987
31S/13E-19B01	02/10/1968	10/06/1987
31S/13E-19H01	11/19/1958	10/03/2019
31S/13E-19H04	10/27/1977	04/04/1987
31S/13E-19L01	04/05/1965	10/19/2010
Total	**11/01/1953**	**10/09/2019**

Depth to Water



Well Location (larger = more samples)...



Well Number	Earliest Data Entry Date	Latest Data Entry Date
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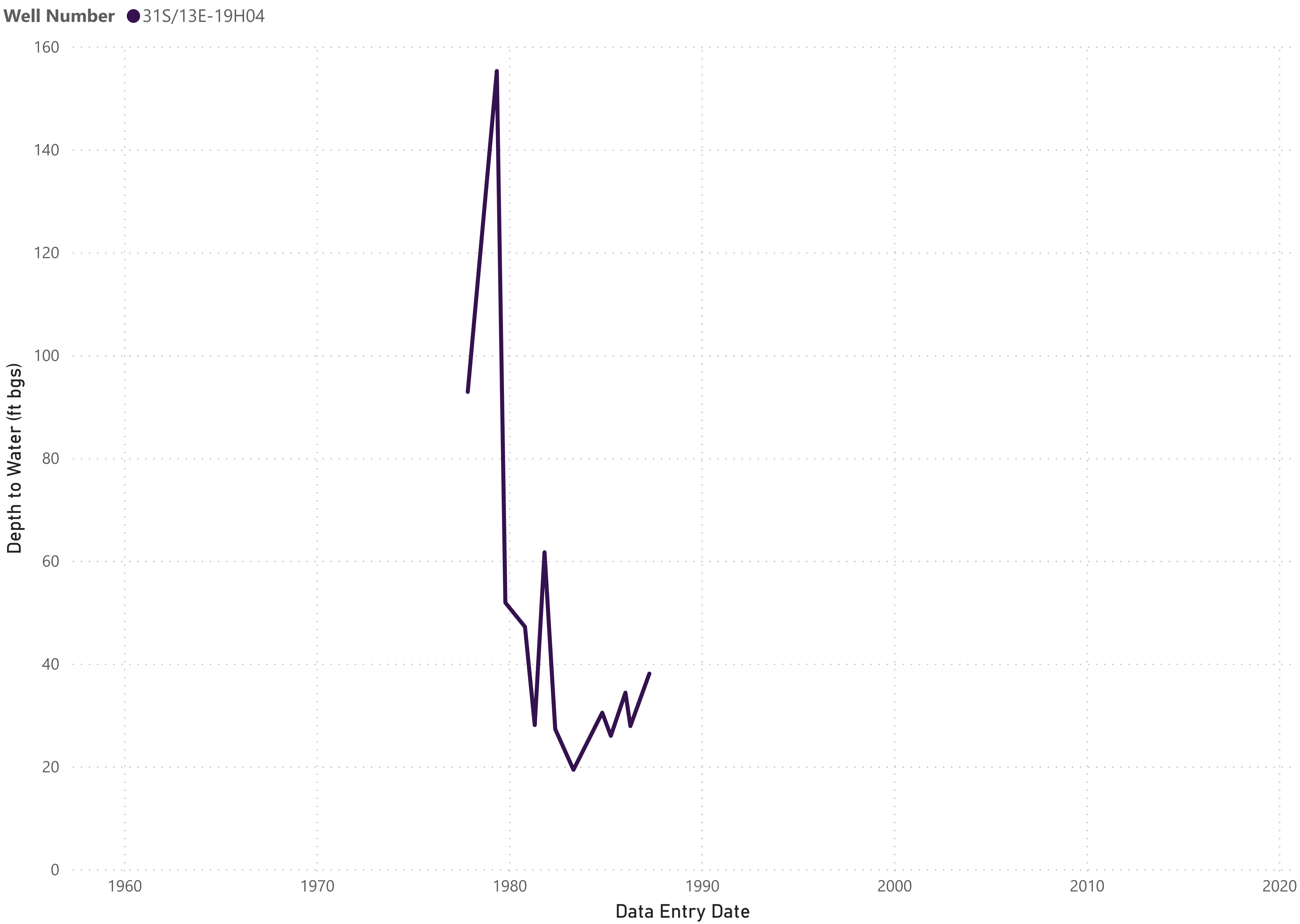
31S/13E-18N01	04/05/1965	04/15/1996
31S/13E-18R01	12/10/1974	05/04/1987
31S/13E-18R02	12/10/1974	05/06/1976
31S/13E-19A03	12/10/1974	04/04/1987
31S/13E-19B01	02/10/1968	10/06/1987
31S/13E-19H01	11/19/1958	10/03/2019
31S/13E-19H04	10/27/1977	04/04/1987
31S/13E-19L01	04/05/1965	10/19/2010
31S/13E-19Q01	12/16/1976	10/07/2019
31S/13E-19R01	11/01/1977	10/19/2012
31S/13E-19R02	10/14/1992	10/14/2001
31S/13E-19R03	10/07/1994	04/04/2019
Total	**11/01/1953**	**10/09/2019**

Depth to Water



Well Location (larger = more samples)...

Well Number	Earliest Data Entry Date	Latest Data Entry Date
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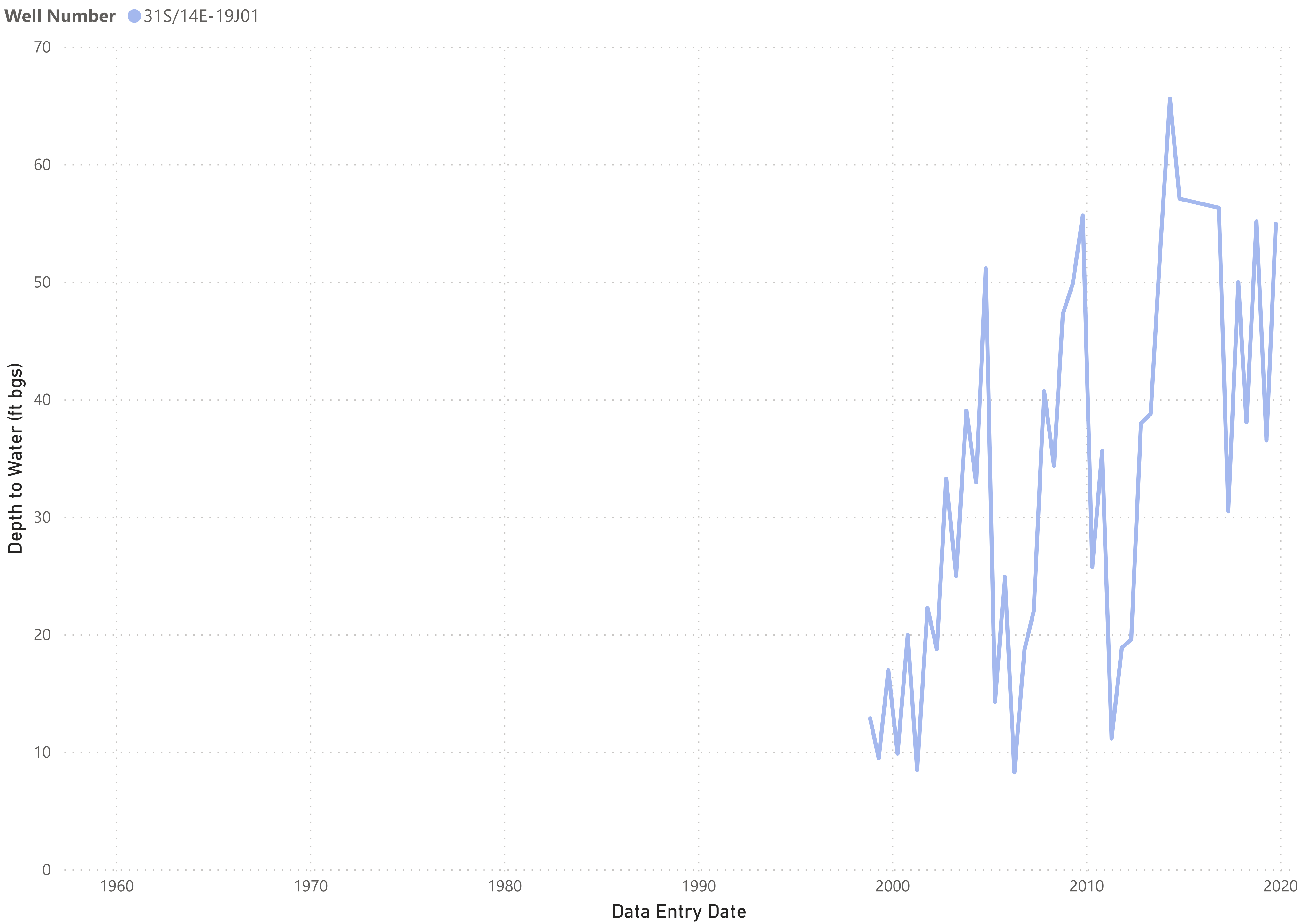
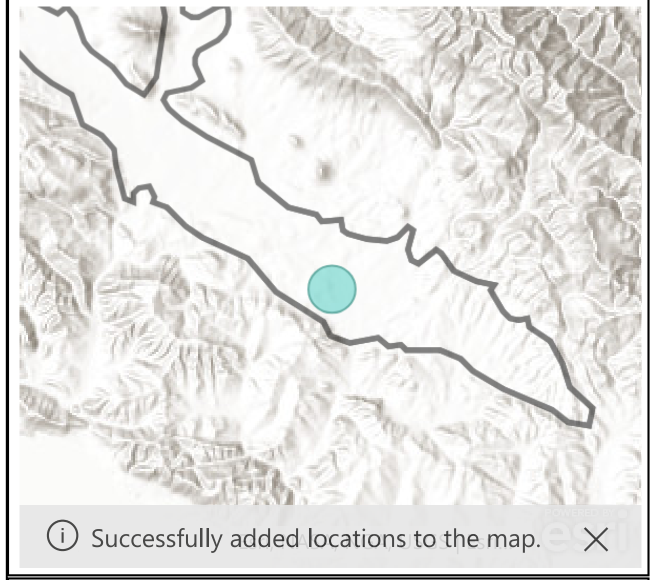
31S/13E-18R01	12/10/1974	05/04/1987
31S/13E-18R02	12/10/1974	05/06/1976
31S/13E-19A03	12/10/1974	04/04/1987
31S/13E-19B01	02/10/1968	10/06/1987
31S/13E-19H01	11/19/1958	10/03/2019
31S/13E-19H04	10/27/1977	04/04/1987
31S/13E-19L01	04/05/1965	10/19/2010
31S/13E-19Q01	12/16/1976	10/07/2019
31S/13E-19R01	11/01/1977	10/19/2012
31S/13E-19R02	10/14/1992	10/14/2001
31S/13E-19R03	10/07/1994	04/04/2019
Total	**11/01/1953**	**10/09/2019**

Depth to Water

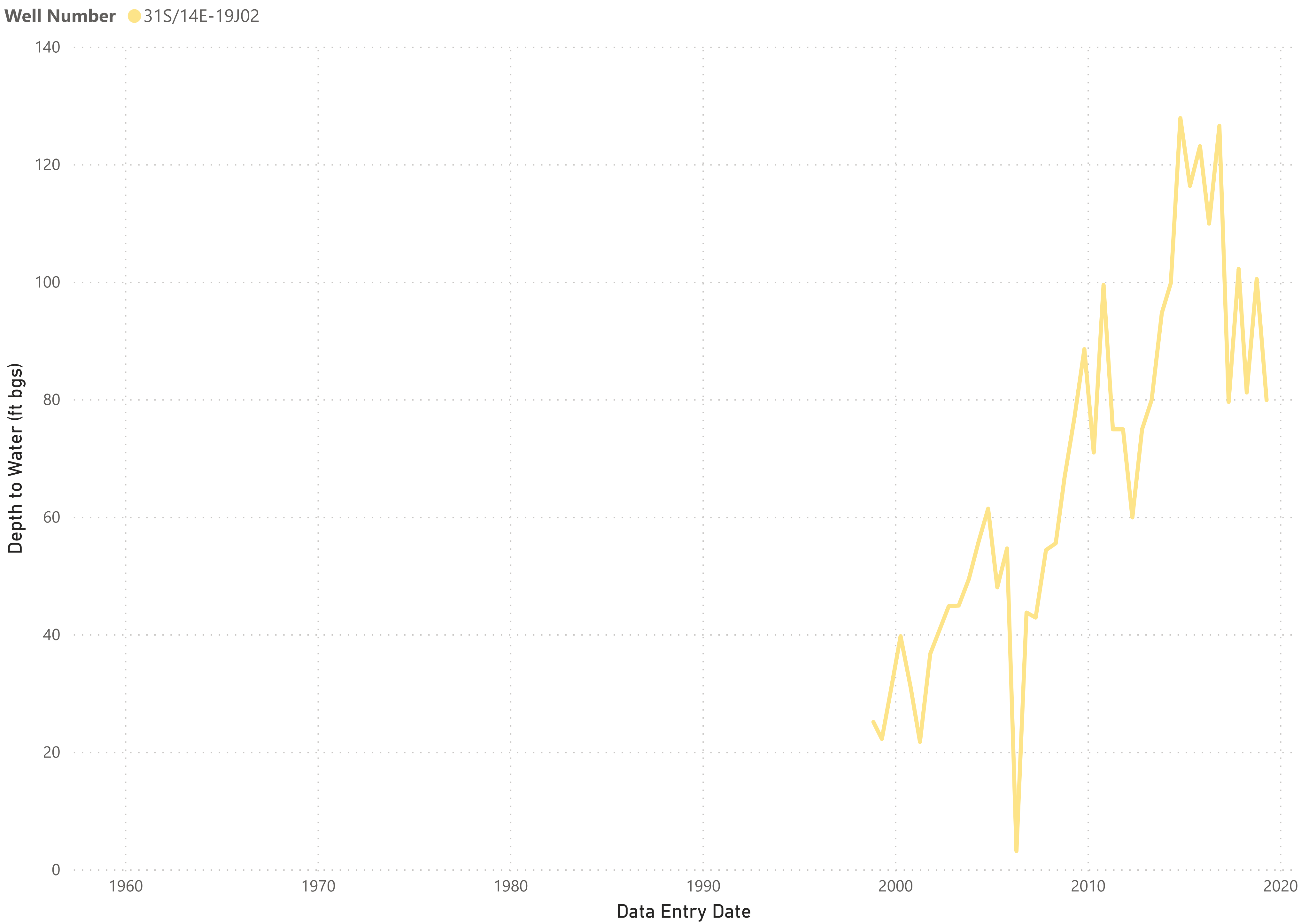


Well Location (larger = more samples)...



Well Number	Earliest Data Entry Date	Latest Data Entry Date
31S/13E-27D03	04/05/1965	04/03/2000
31S/13E-27M01	11/01/1953	04/03/2000
31S/13E-27M02	12/11/1974	04/03/2000
31S/13E-27M03	10/01/1993	10/07/2019
31S/13E-28J03	04/30/1993	10/07/2019
31S/13E-29B03	05/06/1975	10/23/1975
31S/13E-29C01	04/05/1965	04/04/1987
31S/13E-29F05	10/09/1964	11/20/1970
31S/13E-29F06	10/28/2011	10/03/2019
31S/13E-34L01	11/01/1977	10/02/1979
31S/13E-34P01	12/11/1974	05/02/1979
31S/14E-19J01	11/04/1998	10/03/2019
31S/14E-19J02	11/04/1998	04/09/2019
Total	**11/01/1953**	**10/09/2019**

Depth to Water



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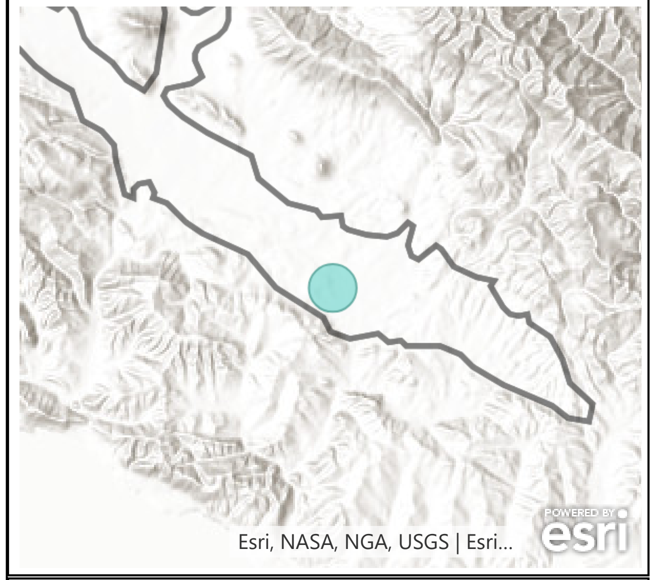
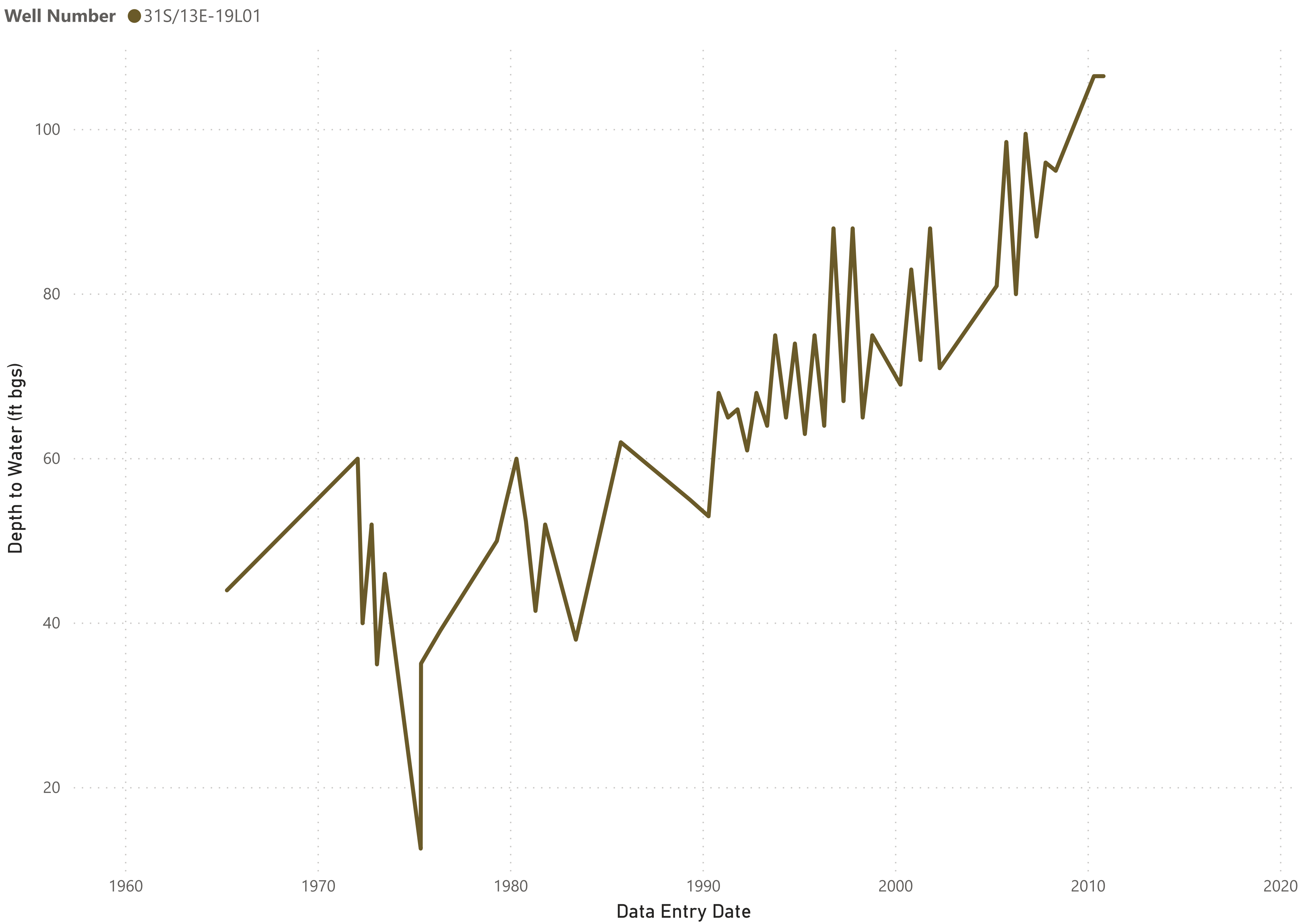


Well Number	Earliest Data Entry Date	Latest Data Entry Date
31S/13E-27D03	04/05/1965	04/03/2000
31S/13E-27M01	11/01/1953	04/03/2000
31S/13E-27M02	12/11/1974	04/03/2000
31S/13E-27M03	10/01/1993	10/07/2019
31S/13E-28J03	04/30/1993	10/07/2019
31S/13E-29B03	05/06/1975	10/23/1975
31S/13E-29C01	04/05/1965	04/04/1987
31S/13E-29F05	10/09/1964	11/20/1970
31S/13E-29F06	10/28/2011	10/03/2019
31S/13E-34L01	11/01/1977	10/02/1979
31S/13E-34P01	12/11/1974	05/02/1979
31S/14E-19J01	11/04/1998	10/03/2019
31S/14E-19J02	11/04/1998	04/09/2019
Total	**11/01/1953**	**10/09/2019**

Depth to Water



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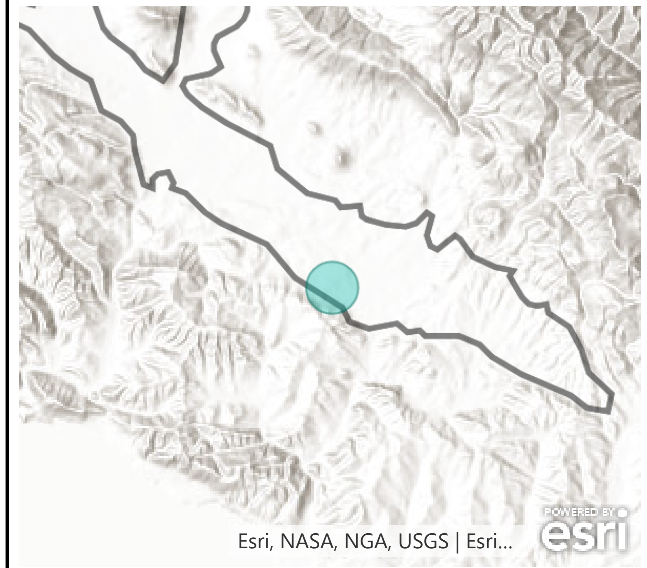

Well Number	Earliest Data Entry Date	Latest Data Entry Date
31S/13E-19A03	12/10/1974	04/04/1987
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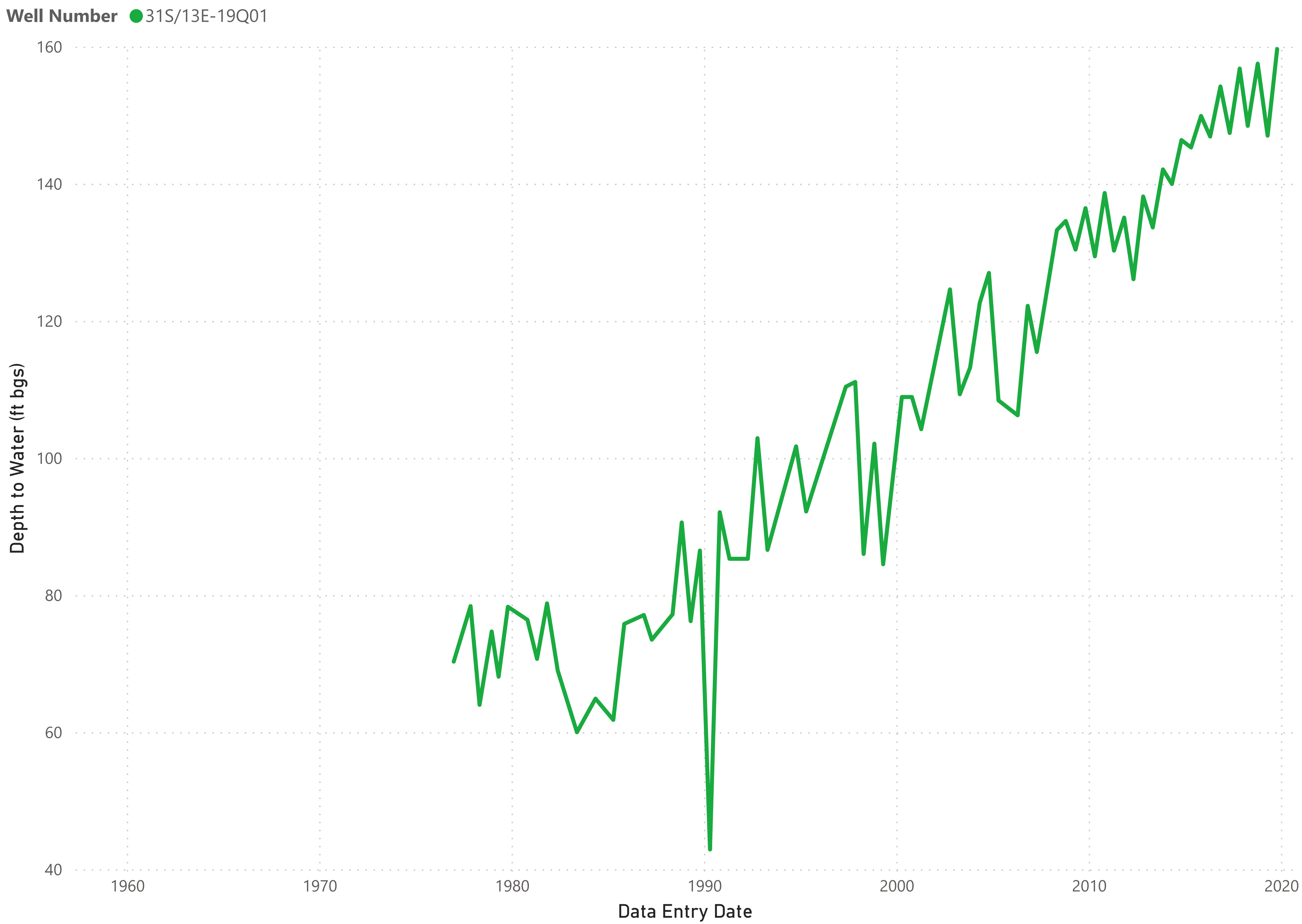
31S/13E-19H01	11/19/1958	10/03/2019
31S/13E-19H04	10/27/1977	04/04/1987
31S/13E-19L01	04/05/1965	10/19/2010
31S/13E-19Q01	12/16/1976	10/07/2019
31S/13E-19R01	11/01/1977	10/19/2012
31S/13E-19R02	10/14/1992	10/14/2001
31S/13E-19R03	10/07/1994	04/04/2019
31S/13E-19R04	04/15/2001	04/10/2019
31S/13E-20G01	12/10/1974	05/04/1987
31S/13E-20K01	12/10/1974	05/04/1987
31S/13E-27D03	04/05/1965	04/03/2000
Total	**11/01/1953**	**10/09/2019**

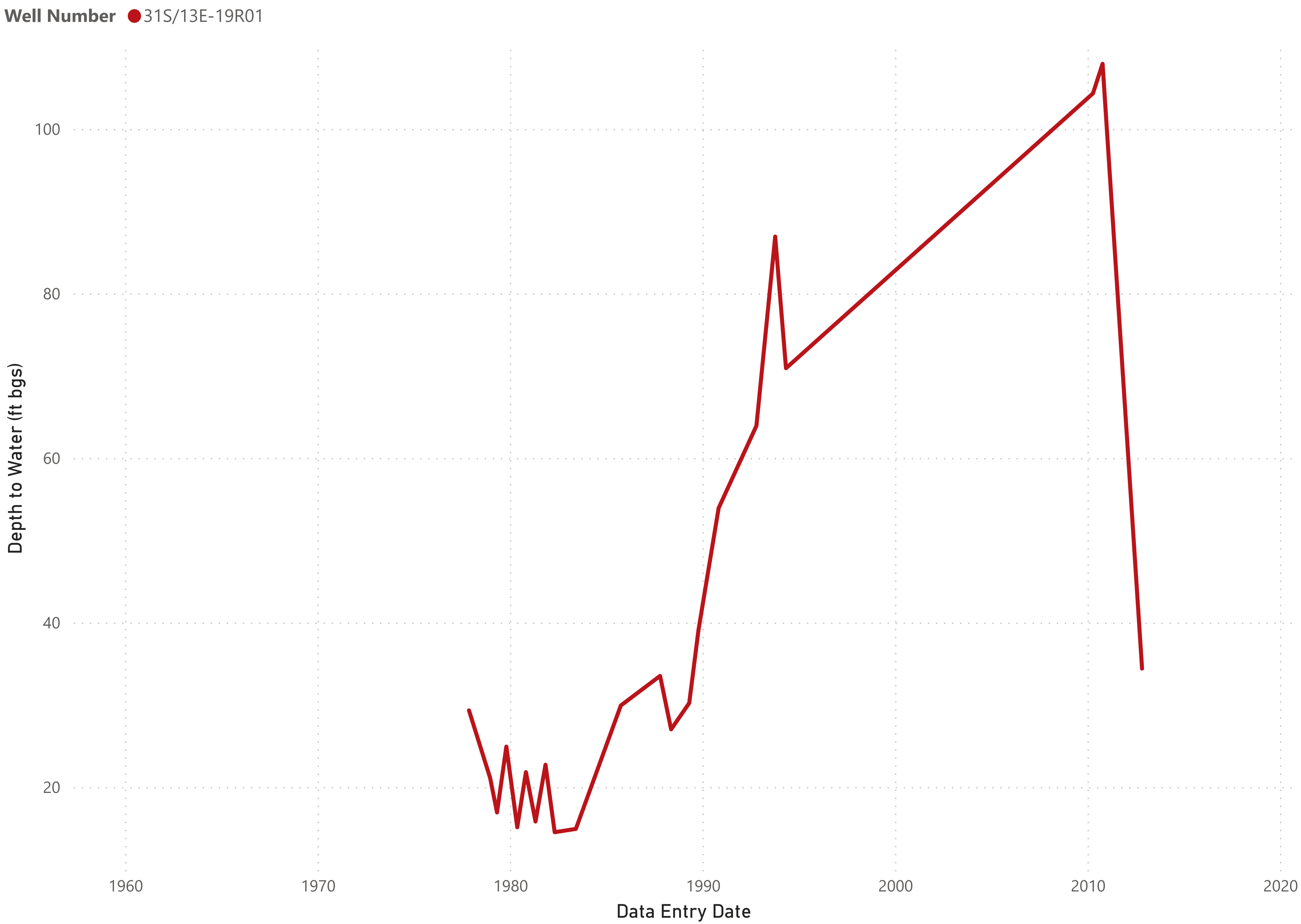
Depth to Water



Well Location (larger = more samples)...

Well Number	Earliest Data Entry Date	Latest Data Entry Date
31S/13E-19A03	12/10/1974	04/04/1987
31S/13E-19B01	02/10/1968	10/06/1987
31S/13E-19H01	11/19/1958	10/03/2019
31S/13E-19H04	10/27/1977	04/04/1987
31S/13E-19L01	04/05/1965	10/19/2010
31S/13E-19Q01	12/16/1976	10/07/2019
31S/13E-19R01	11/01/1977	10/19/2012
31S/13E-19R02	10/14/1992	10/14/2001
31S/13E-19R03	10/07/1994	04/04/2019
31S/13E-19R04	04/15/2001	04/10/2019
31S/13E-20G01	12/10/1974	05/04/1987
31S/13E-20K01	12/10/1974	05/04/1987
31S/13E-27D03	04/05/1965	04/03/2000
Total	**11/01/1953**	**10/09/2019**

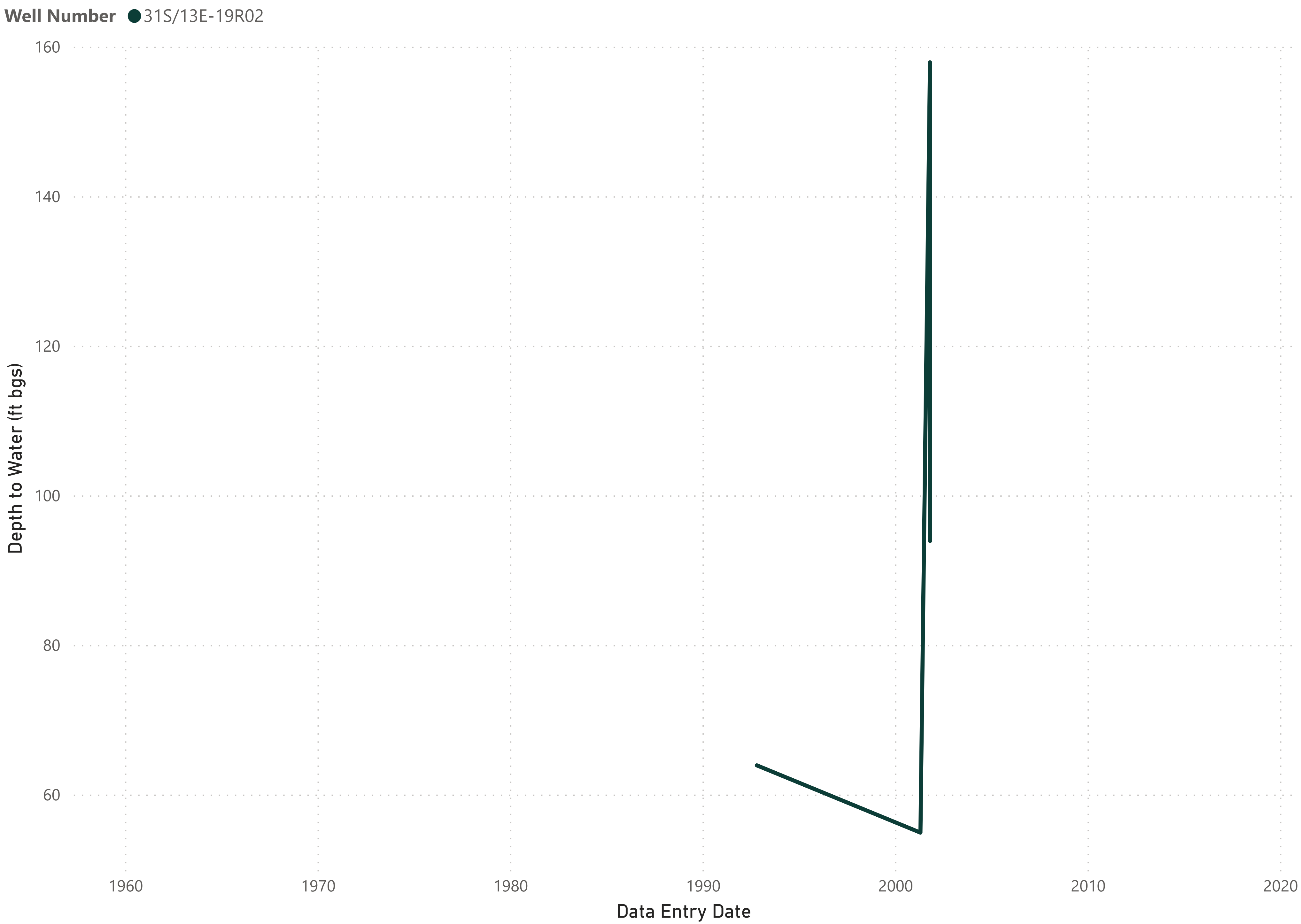
Depth to Water



Well Location (larger = more samples)...

Well Number	Earliest Data Entry Date	Latest Data Entry Date
31S/13E-19A03	12/10/1974	04/04/1987
31S/13E-19B01	02/10/1968	10/06/1987
31S/13E-19H01	11/19/1958	10/03/2019
31S/13E-19H04	10/27/1977	04/04/1987
31S/13E-19L01	04/05/1965	10/19/2010
31S/13E-19Q01	12/16/1976	10/07/2019
31S/13E-19R01	11/01/1977	10/19/2012
31S/13E-19R02	10/14/1992	10/14/2001
31S/13E-19R03	10/07/1994	04/04/2019
31S/13E-19R04	04/15/2001	04/10/2019
31S/13E-20G01	12/10/1974	05/04/1987
31S/13E-20K01	12/10/1974	05/04/1987
31S/13E-27D03	04/05/1965	04/03/2000
Total	**11/01/1953**	**10/09/2019**

Depth to Water



Well Location (larger = more samples)...

Well Number	Earliest Data Entry Date	Latest Data Entry Date
31S/13E-19A03	12/10/1974	04/04/1987
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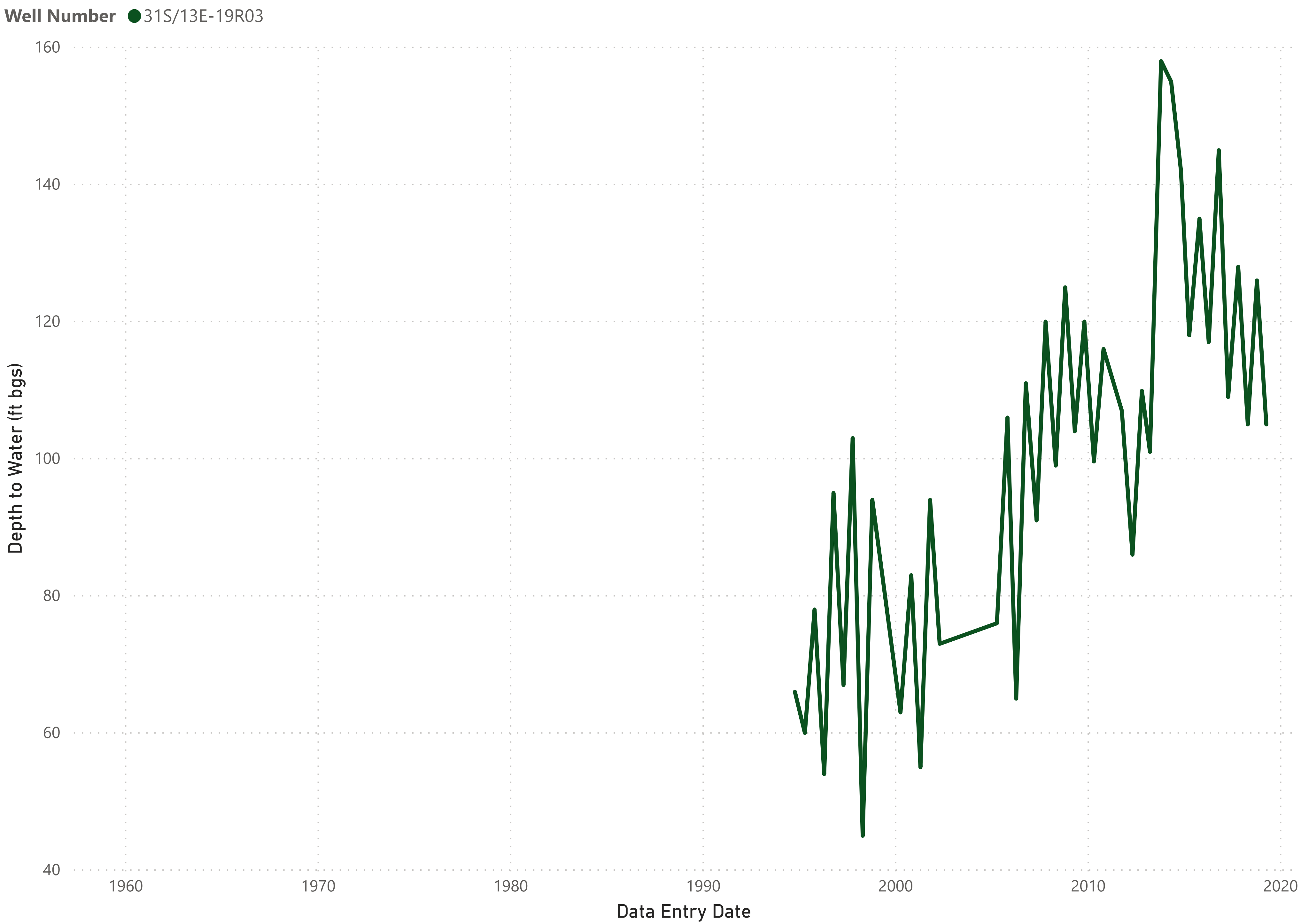
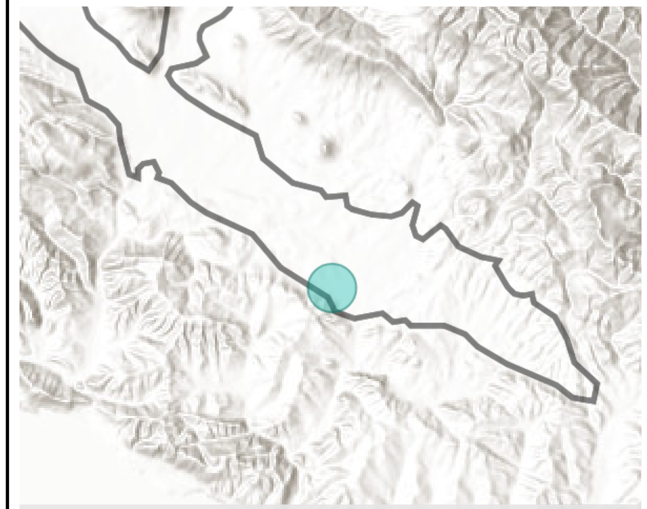
31S/13E-19H01	11/19/1958	10/03/2019
31S/13E-19H04	10/27/1977	04/04/1987
31S/13E-19L01	04/05/1965	10/19/2010
31S/13E-19Q01	12/16/1976	10/07/2019
31S/13E-19R01	11/01/1977	10/19/2012
31S/13E-19R02	10/14/1992	10/14/2001
31S/13E-19R03	10/07/1994	04/04/2019
31S/13E-19R04	04/15/2001	04/10/2019
31S/13E-20G01	12/10/1974	05/04/1987
31S/13E-20K01	12/10/1974	05/04/1987
31S/13E-27D03	04/05/1965	04/03/2000
Total	**11/01/1953**	**10/09/2019**

Depth to Water



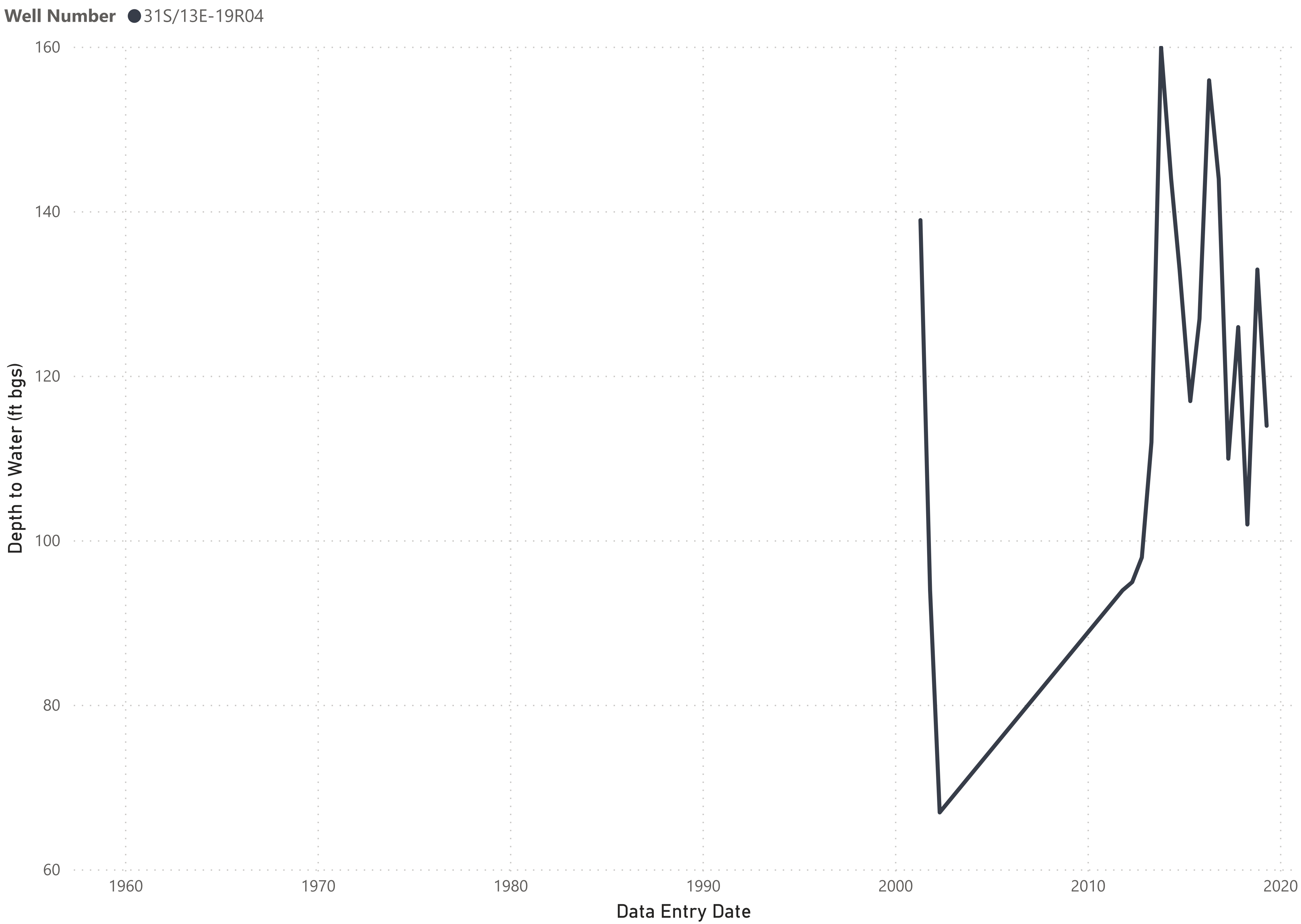
Well Location (larger = more samples)...



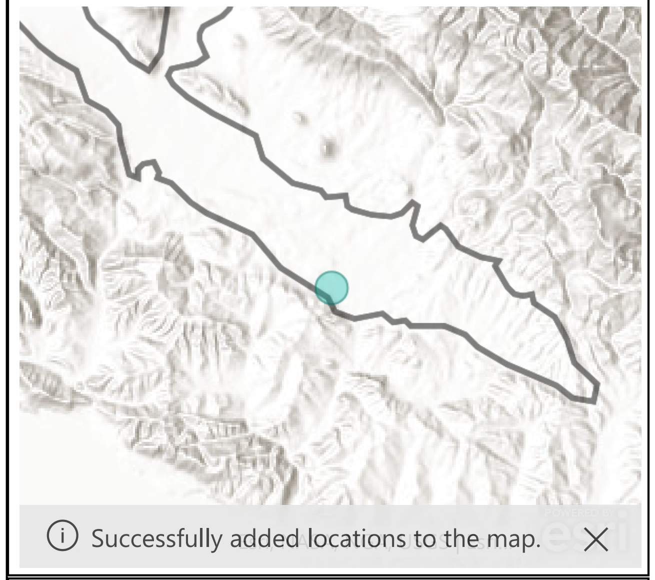
Successfully added locations to the map.

Well Number	Earliest Data Entry Date	Latest Data Entry Date
31S/13E-19A03	12/10/1974	04/04/1987
31S/13E-19B01	02/10/1968	10/06/1987
31S/13E-19H01	11/19/1958	10/03/2019
31S/13E-19H04	10/27/1977	04/04/1987
31S/13E-19L01	04/05/1965	10/19/2010
31S/13E-19Q01	12/16/1976	10/07/2019
31S/13E-19R01	11/01/1977	10/19/2012
31S/13E-19R02	10/14/1992	10/14/2001
31S/13E-19R03	10/07/1994	04/04/2019
31S/13E-19R04	04/15/2001	04/10/2019
31S/13E-20G01	12/10/1974	05/04/1987
31S/13E-20K01	12/10/1974	05/04/1987
31S/13E-27D03	04/05/1965	04/03/2000
Total	**11/01/1953**	**10/09/2019**

Depth to Water



Well Location (larger = more samples)...



Well Number	Earliest Data Entry Date	Latest Data Entry Date
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31S/13E-19Q01	12/16/1976	10/07/2019
31S/13E-19R01	11/01/1977	10/19/2012
31S/13E-19R02	10/14/1992	10/14/2001
31S/13E-19R03	10/07/1994	04/04/2019
31S/13E-19R04	04/15/2001	04/10/2019
31S/13E-20G01	12/10/1974	05/04/1987
31S/13E-20K01	12/10/1974	05/04/1987
31S/13E-27D03	04/05/1965	04/03/2000
31S/13E-27M01	11/01/1953	04/03/2000
31S/13E-27M02	12/11/1974	04/03/2000
31S/13E-27M03	10/01/1993	10/07/2019
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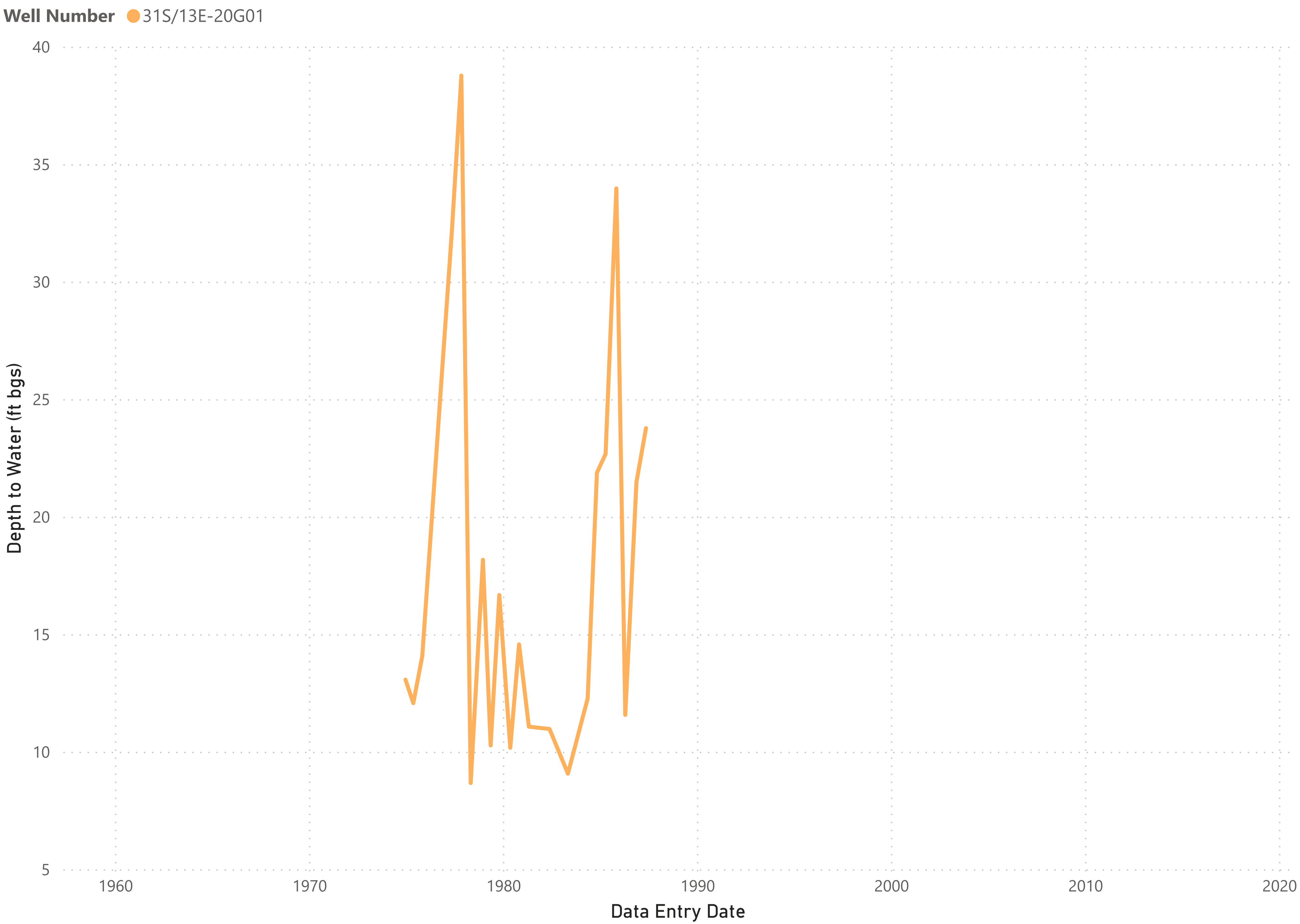
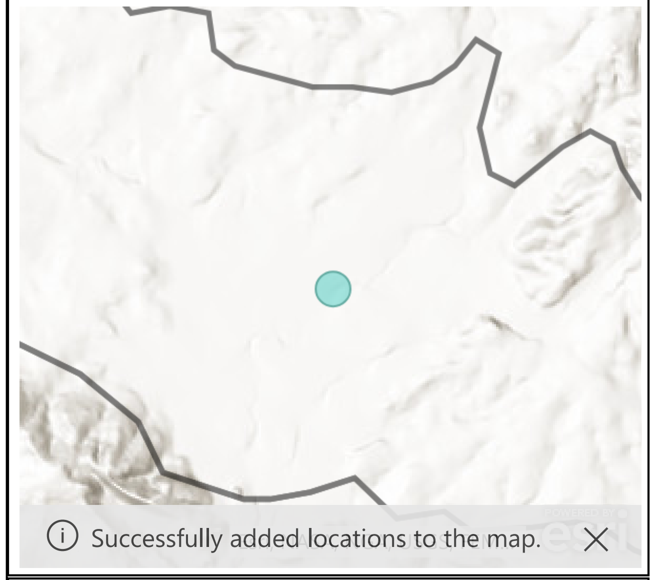
Total	**11/01/1953**	**10/09/2019**

Depth to Water



Well Location (larger = more samples)...



Well Number	Earliest Data Entry Date	Latest Data Entry Date
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31S/13E-19R01	11/01/1977	10/19/2012
31S/13E-19R02	10/14/1992	10/14/2001
31S/13E-19R03	10/07/1994	04/04/2019
31S/13E-19R04	04/15/2001	04/10/2019
31S/13E-20G01	12/10/1974	05/04/1987
31S/13E-20K01	12/10/1974	05/04/1987
31S/13E-27D03	04/05/1965	04/03/2000
31S/13E-27M01	11/01/1953	04/03/2000
31S/13E-27M02	12/11/1974	04/03/2000
31S/13E-27M03	10/01/1993	10/07/2019
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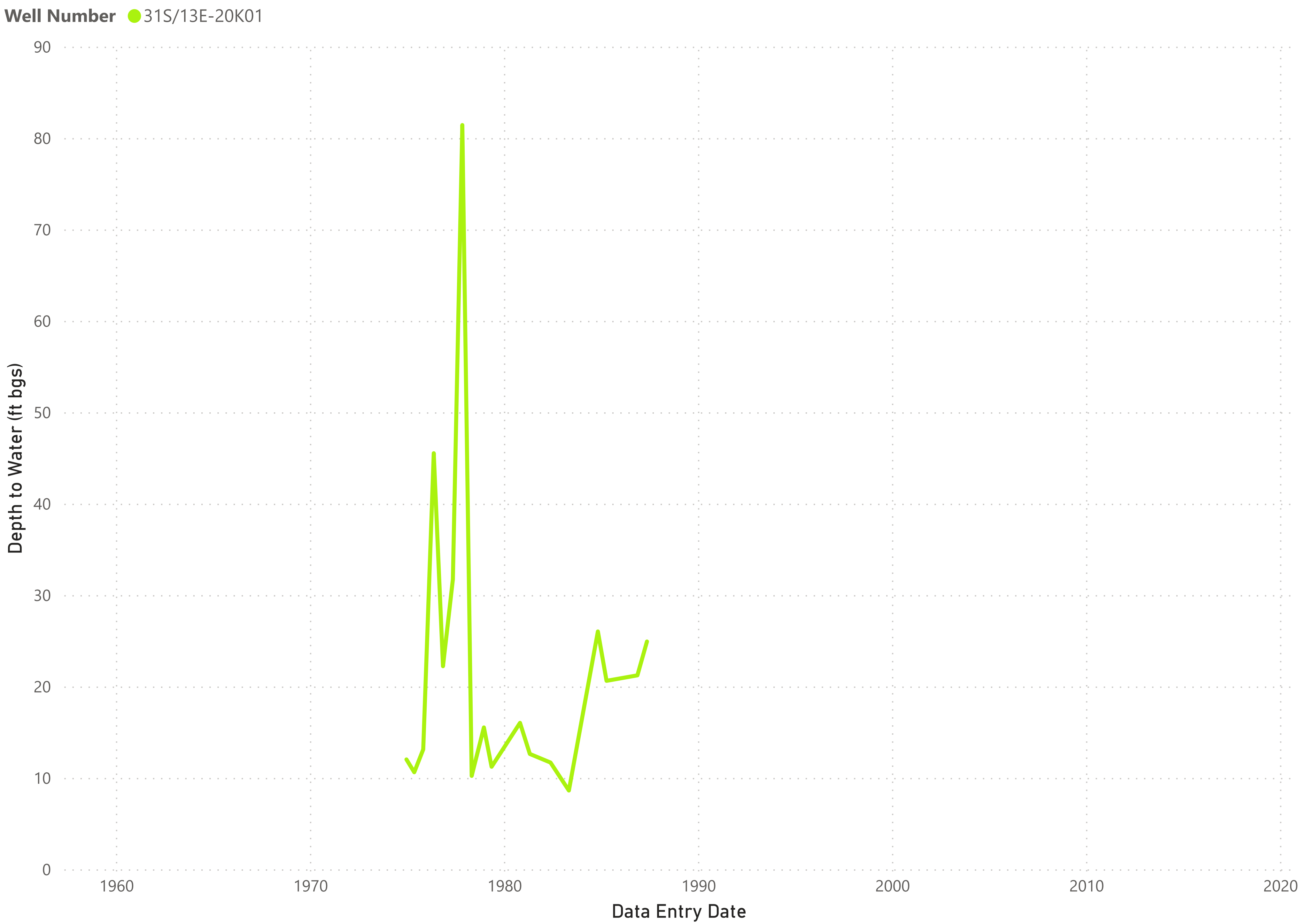
Total	**11/01/1953**	**10/09/2019**

Depth to Water



Well Location (larger = more samples)...

Well Number	Earliest Data Entry Date	Latest Data Entry Date
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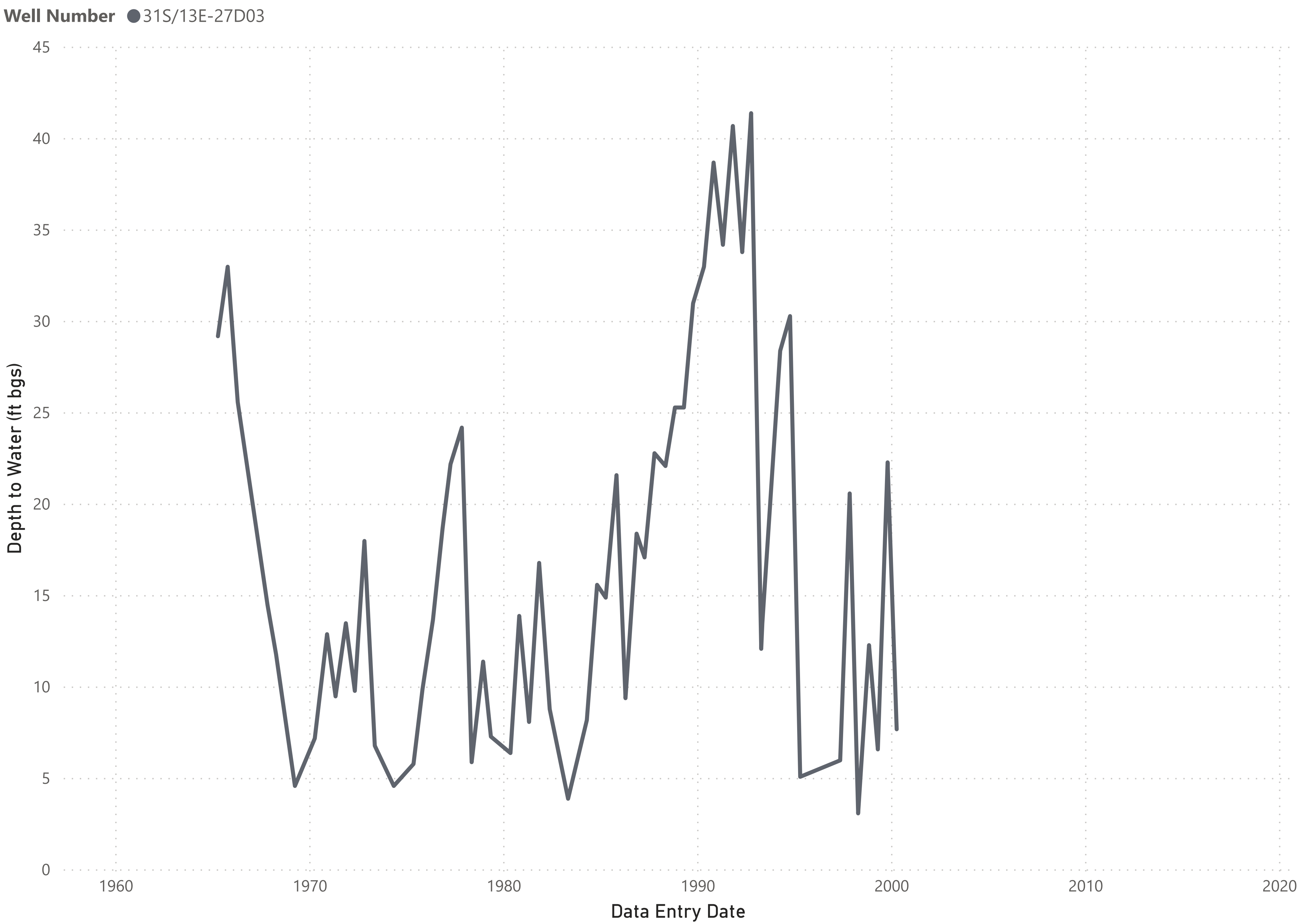
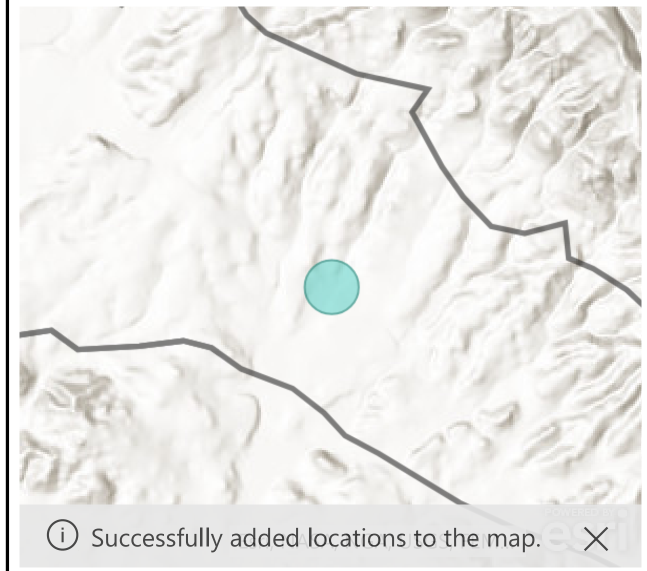
31S/13E-19R04	04/15/2001	04/10/2019
31S/13E-20G01	12/10/1974	05/04/1987
31S/13E-20K01	12/10/1974	05/04/1987
31S/13E-27D03	04/05/1965	04/03/2000
31S/13E-27M01	11/01/1953	04/03/2000
31S/13E-27M02	12/11/1974	04/03/2000
31S/13E-27M03	10/01/1993	10/07/2019
31S/13E-28J03	04/30/1993	10/07/2019
31S/13E-29B03	05/06/1975	10/23/1975
31S/13E-29C01	04/05/1965	04/04/1987
31S/13E-29F05	10/09/1964	11/20/1970
31S/13E-29F06	10/28/2011	10/03/2019
Total	**11/01/1953**	**10/09/2019**

Depth to Water



Well Location (larger = more samples)...



Well Number	Earliest Data Entry Date	Latest Data Entry Date
31S/13E-19L01	04/05/1965	10/19/2010
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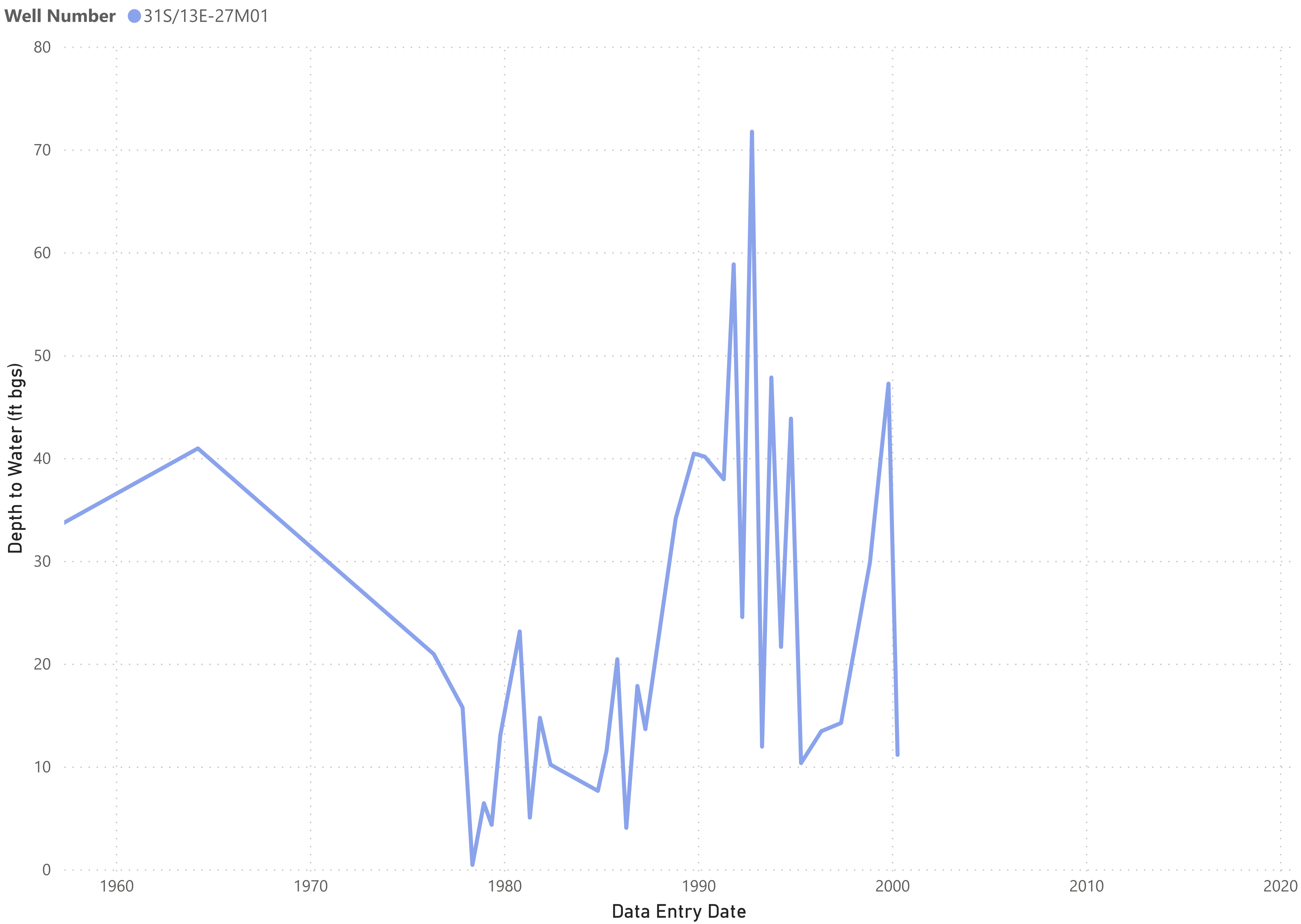
31S/13E-19R01	11/01/1977	10/19/2012
31S/13E-19R02	10/14/1992	10/14/2001
31S/13E-19R03	10/07/1994	04/04/2019
31S/13E-19R04	04/15/2001	04/10/2019
31S/13E-20G01	12/10/1974	05/04/1987
31S/13E-20K01	12/10/1974	05/04/1987
31S/13E-27D03	04/05/1965	04/03/2000
31S/13E-27M01	11/01/1953	04/03/2000
31S/13E-27M02	12/11/1974	04/03/2000
31S/13E-27M03	10/01/1993	10/07/2019
31S/13E-28J03	04/30/1993	10/07/2019
Total	**11/01/1953**	**10/09/2019**

Depth to Water



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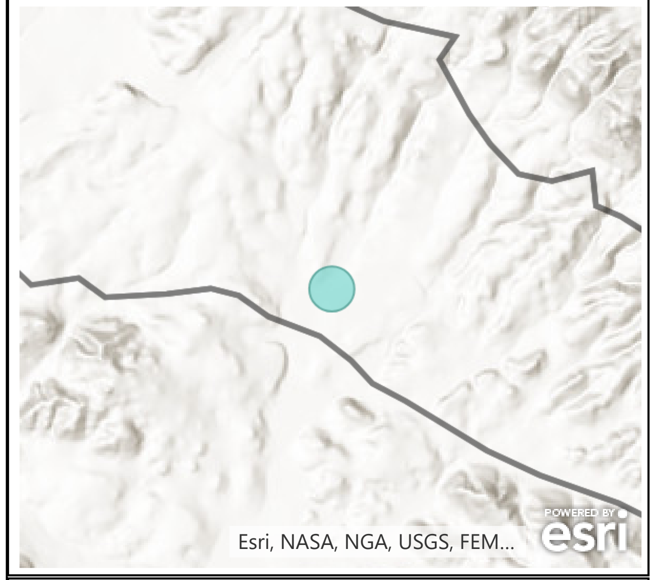

Well Number	Earliest Data Entry Date	Latest Data Entry Date
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31S/13E-19R04	04/15/2001	04/10/2019
31S/13E-20G01	12/10/1974	05/04/1987
31S/13E-20K01	12/10/1974	05/04/1987
31S/13E-27D03	04/05/1965	04/03/2000
31S/13E-27M01	11/01/1953	04/03/2000
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31S/13E-27M03	10/01/1993	10/07/2019
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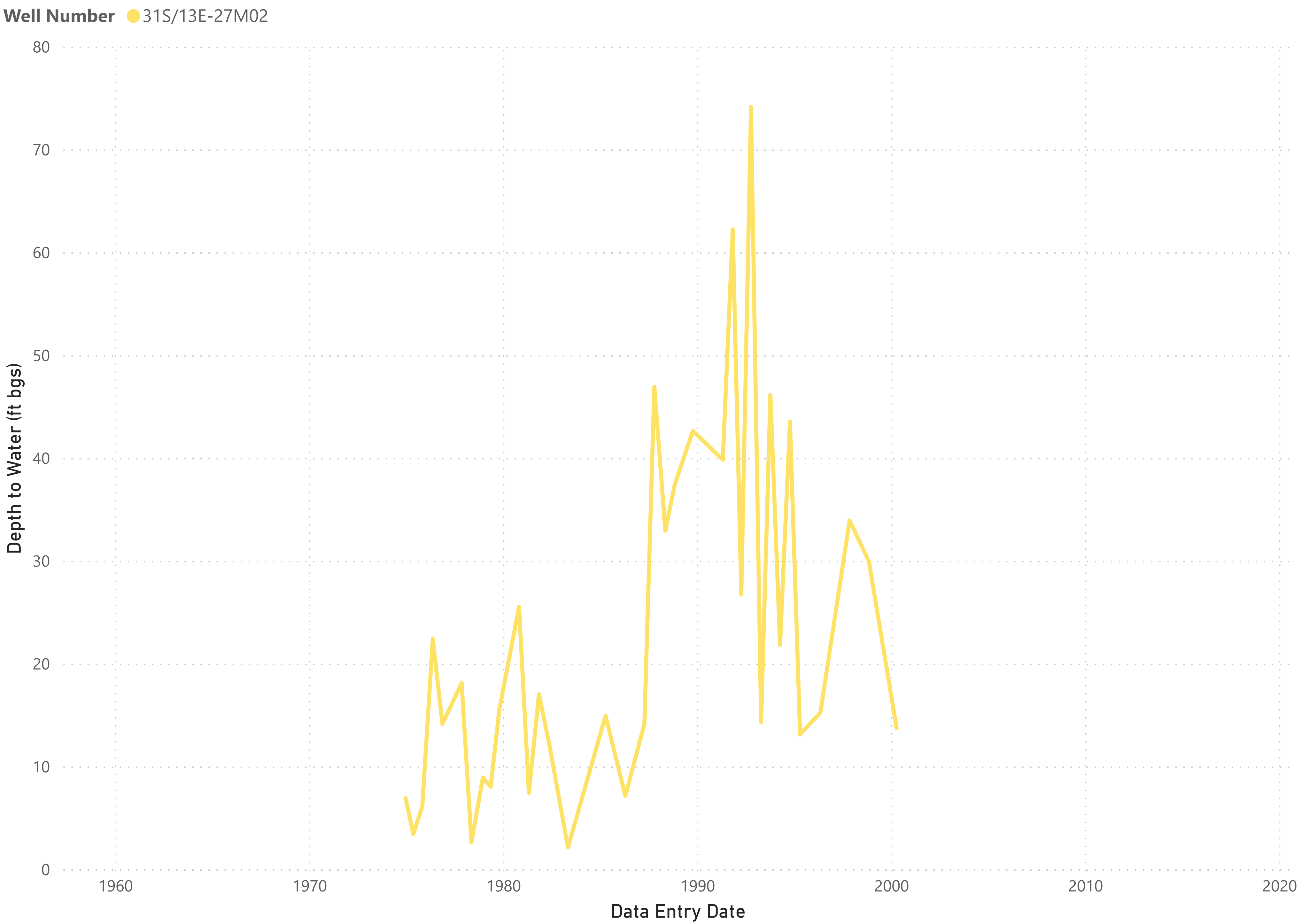
31S/13E-29B03	05/06/1975	10/23/1975
31S/13E-29C01	04/05/1965	04/04/1987
31S/13E-29F05	10/09/1964	11/20/1970
31S/13E-29F06	10/28/2011	10/03/2019
Total	**11/01/1953**	**10/09/2019**

Depth to Water



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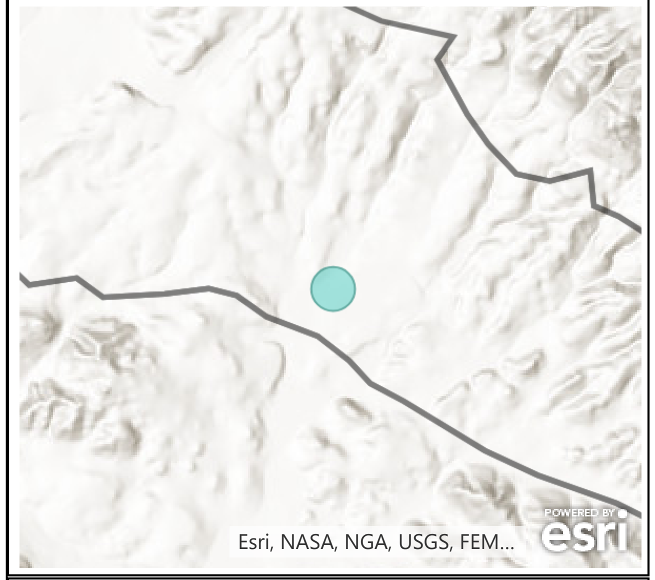

Well Number	Earliest Data Entry Date	Latest Data Entry Date
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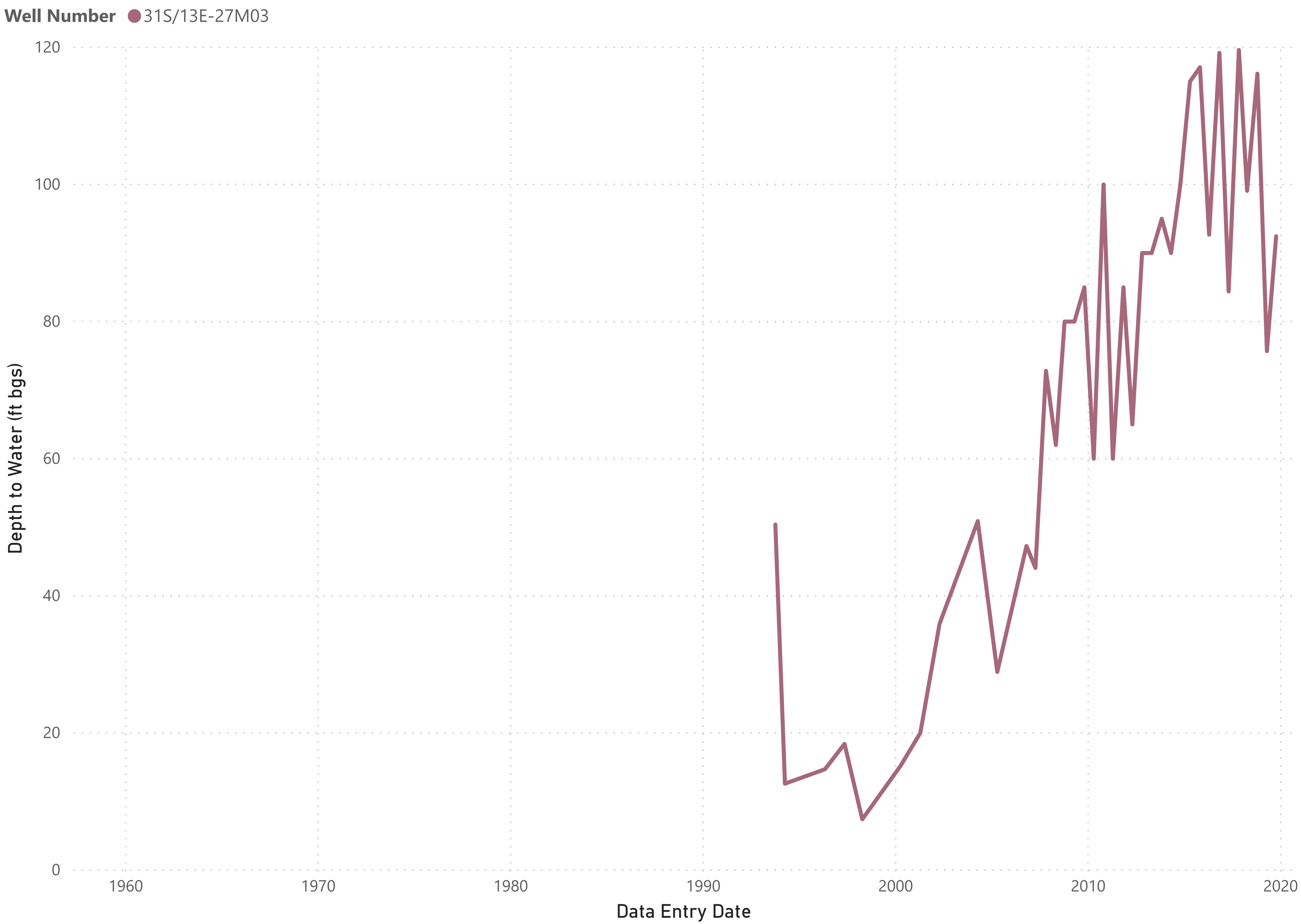
Depth to Water



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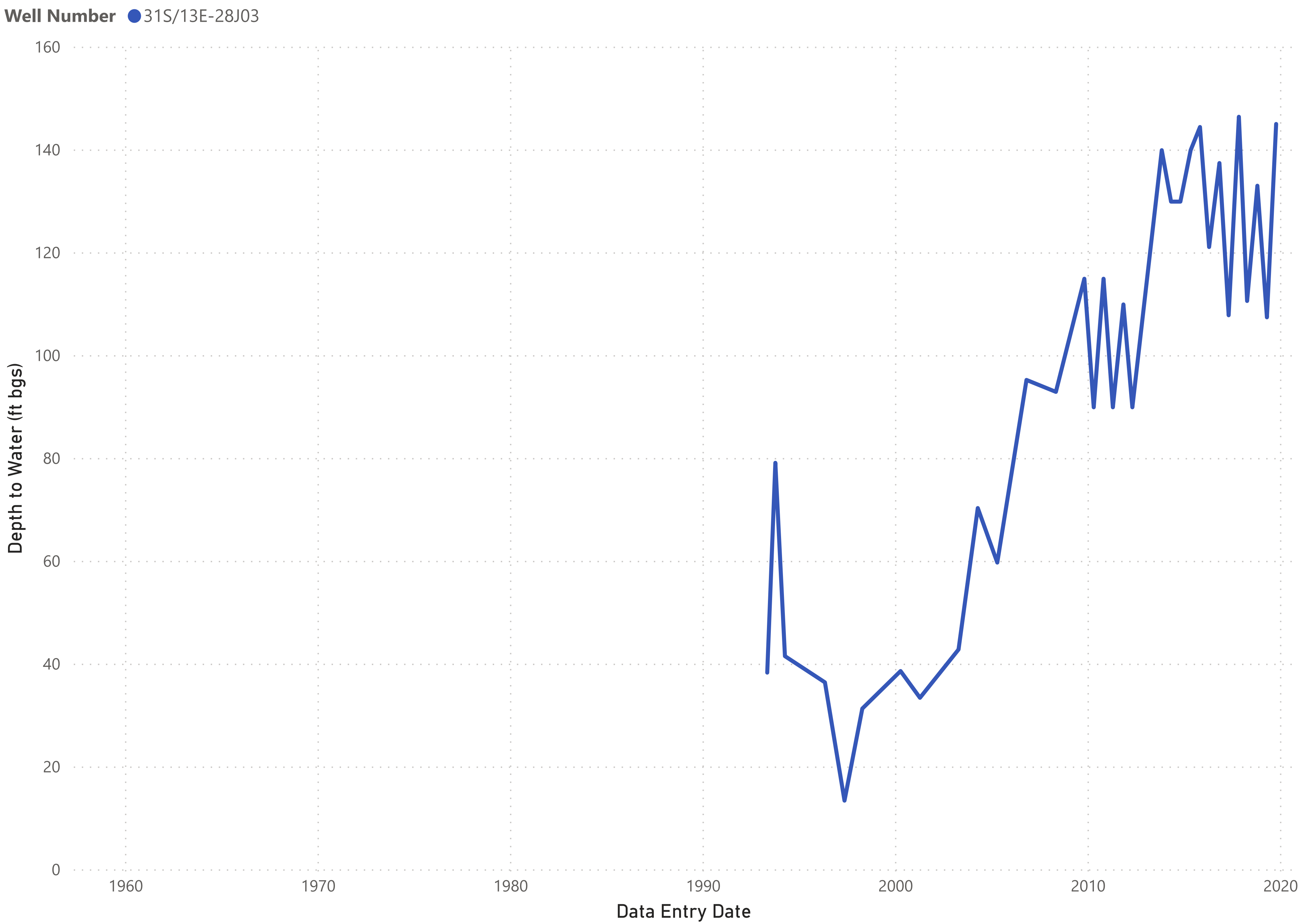

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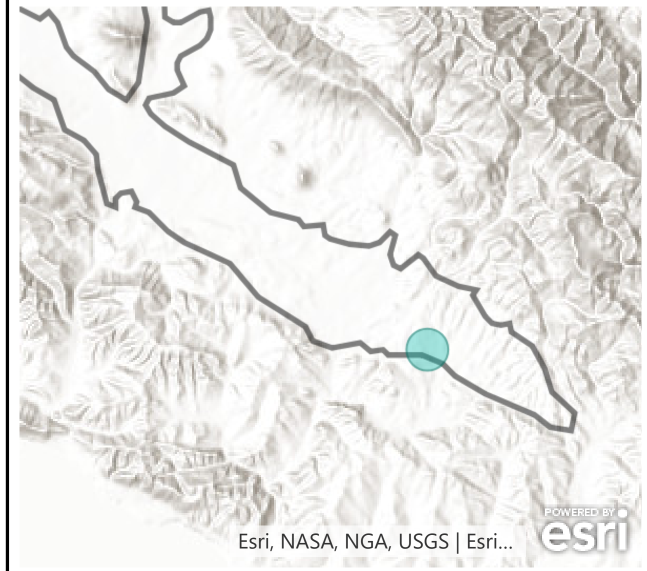

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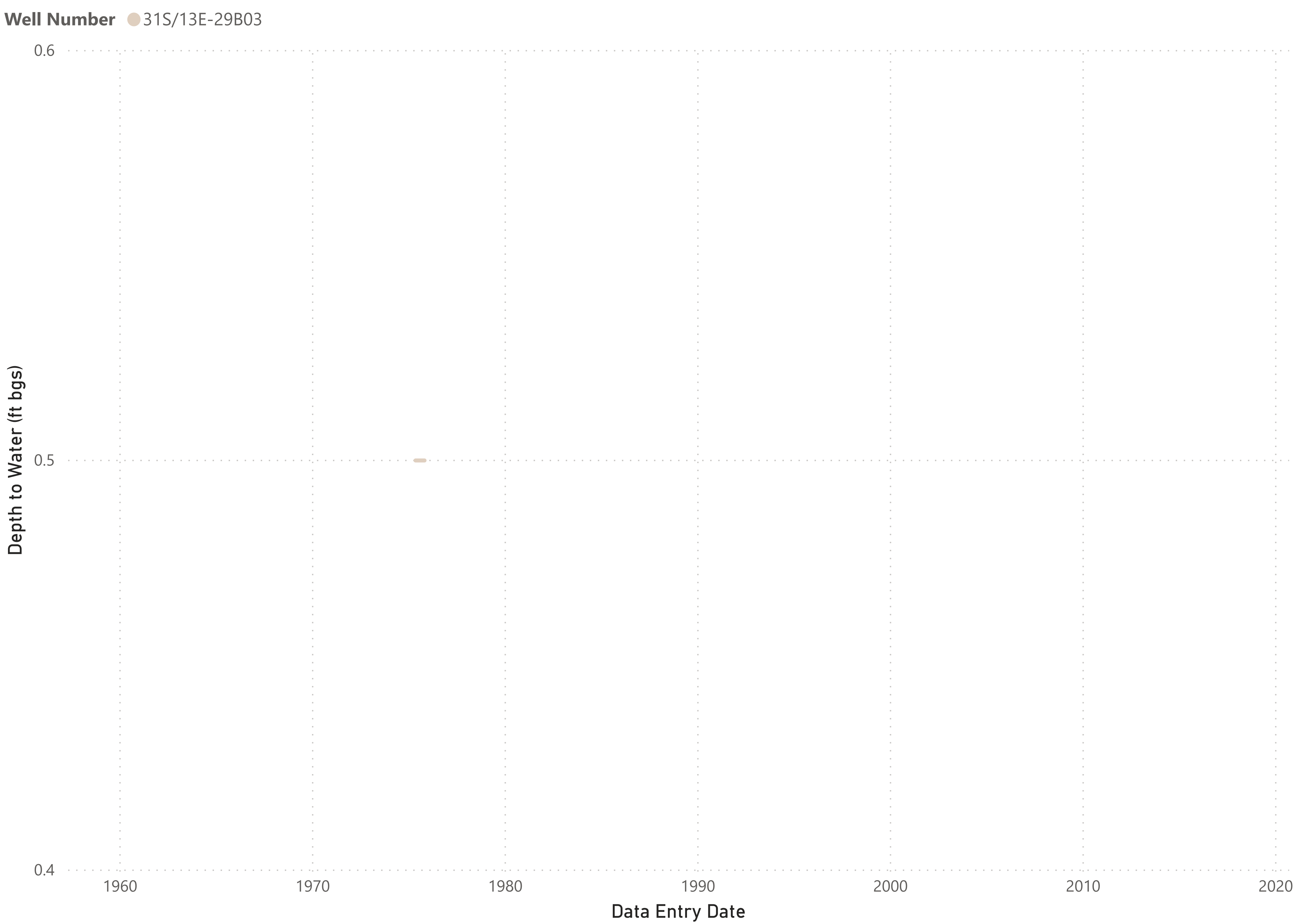

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31S/13E-29C01	04/05/1965	04/04/1987
31S/13E-29F05	10/09/1964	11/20/1970
31S/13E-29F06	10/28/2011	10/03/2019
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31S/14E-19J01	11/04/1998	10/03/2019
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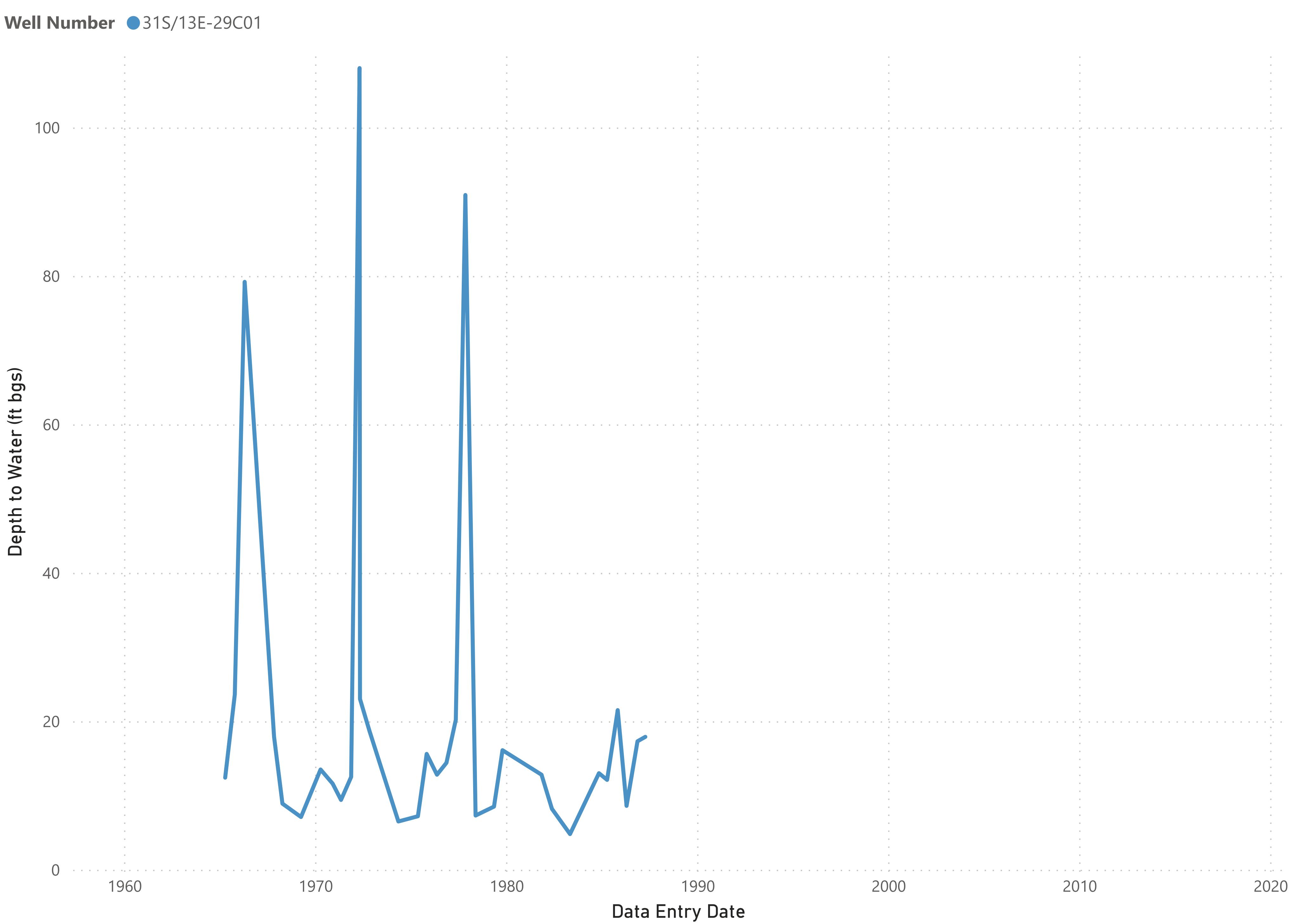

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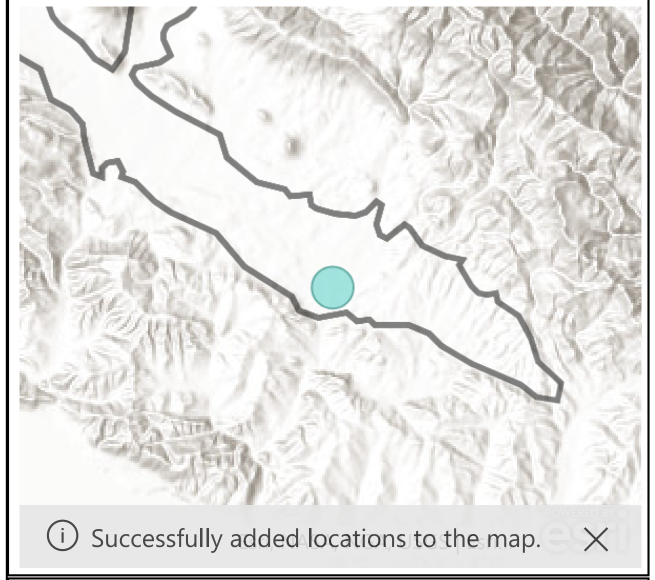

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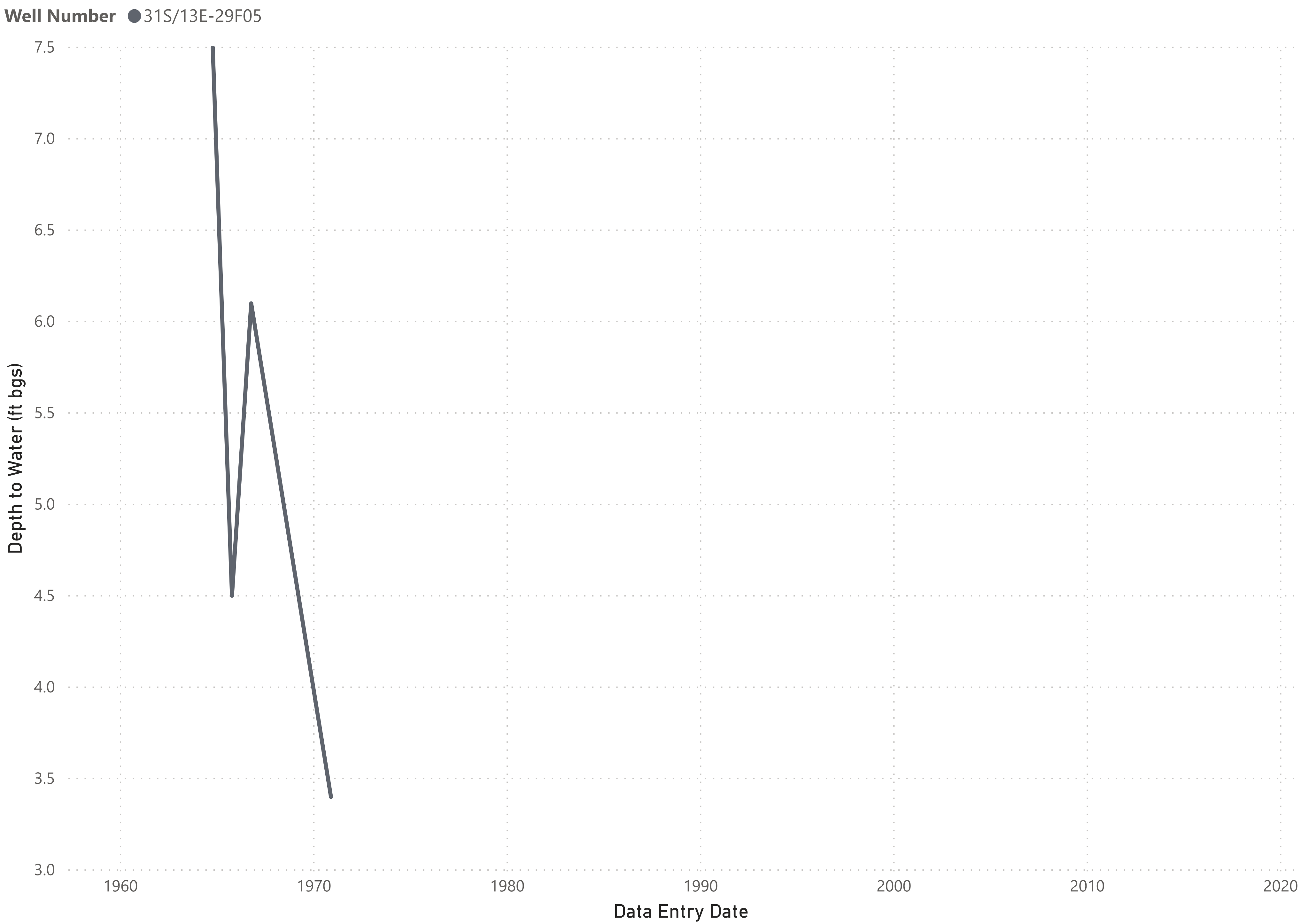

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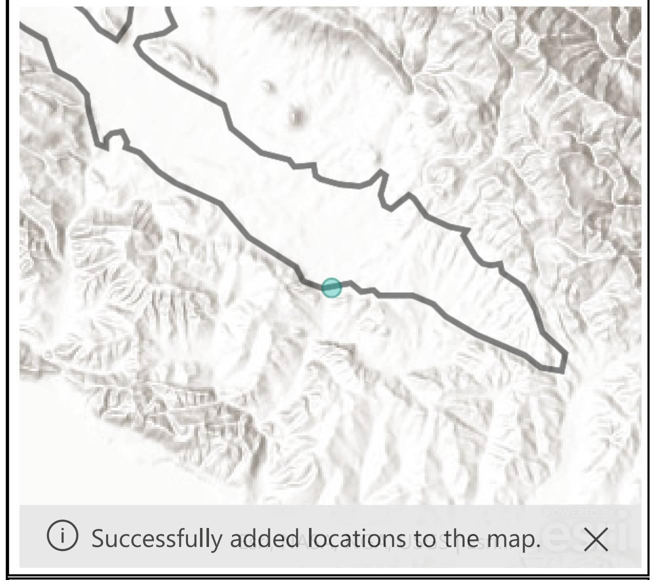

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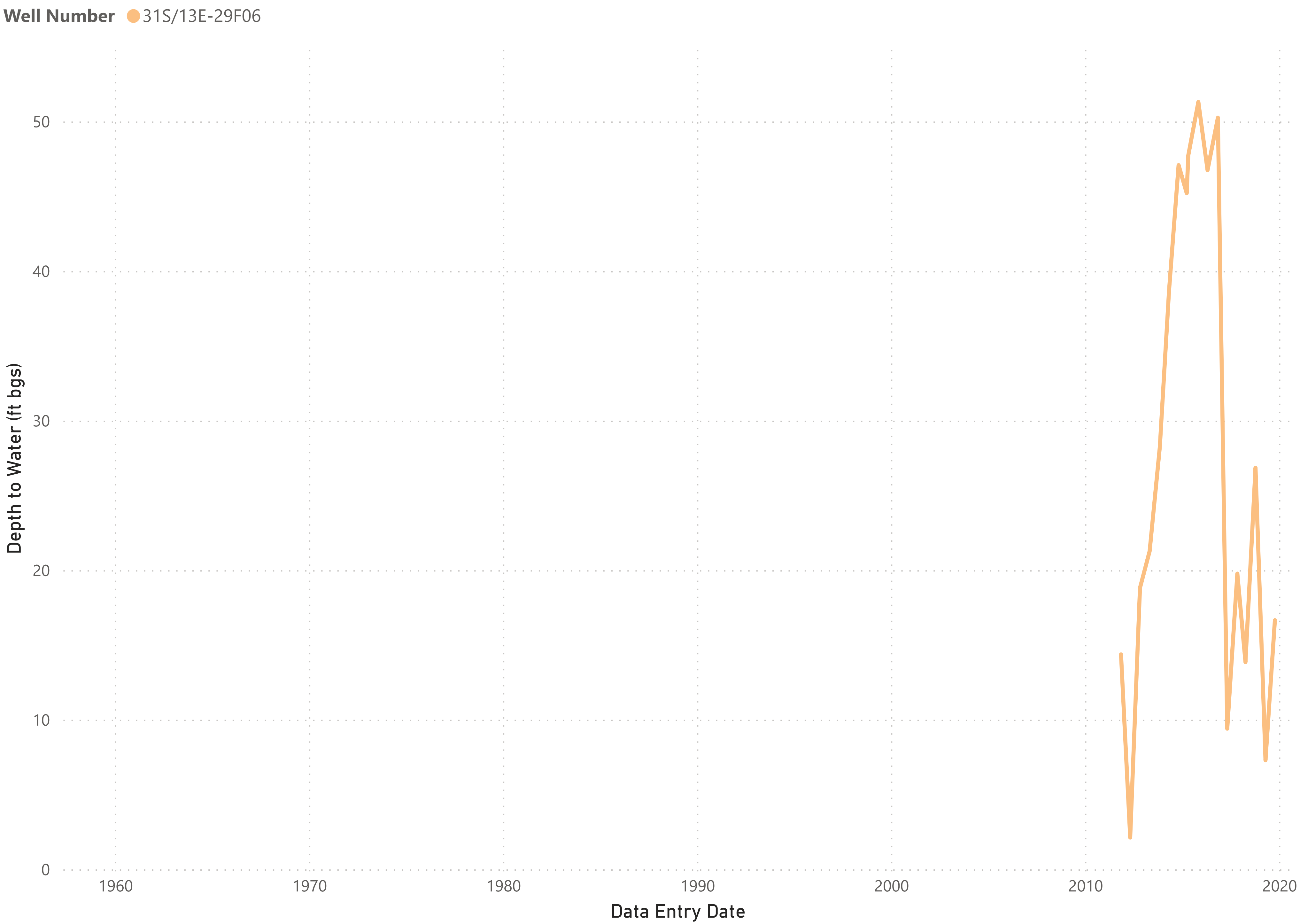

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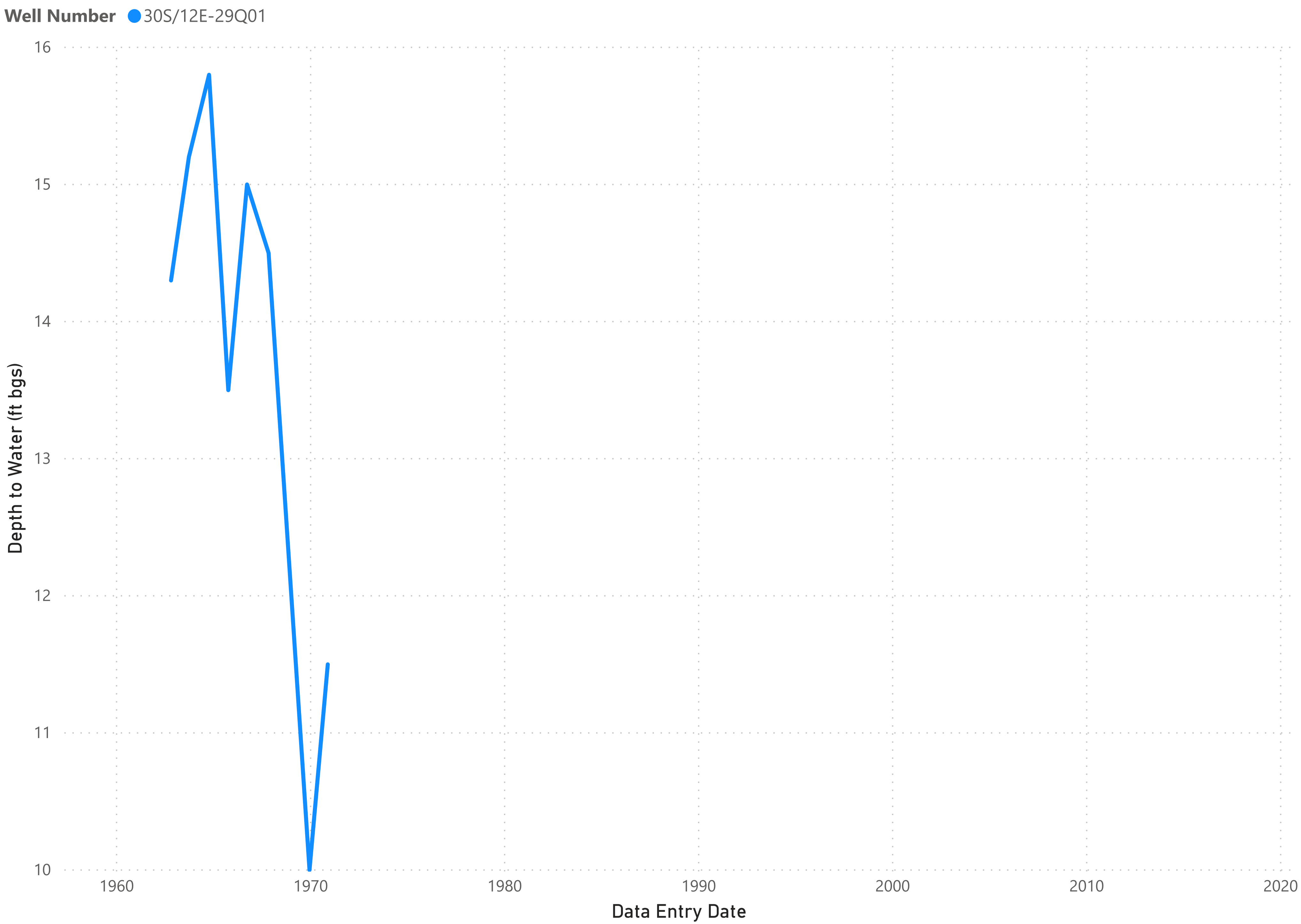

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31S/12E-03P01	10/12/1990	04/11/2006
31S/12E-03P02	04/05/1965	04/08/2004
31S/12E-10D03	05/09/2012	10/09/2019
31S/12E-10F03	04/05/1965	05/05/1997
31S/12E-10G02	04/05/1965	10/03/2019
31S/12E-10H03	04/12/1984	10/03/2019
31S/12E-12E03	04/05/1965	04/19/2013
31S/12E-12N01	10/22/1962	11/20/1970
31S/12E-12Q03	04/06/1965	10/06/1987
31S/12E-13J01	10/11/1970	04/15/1996
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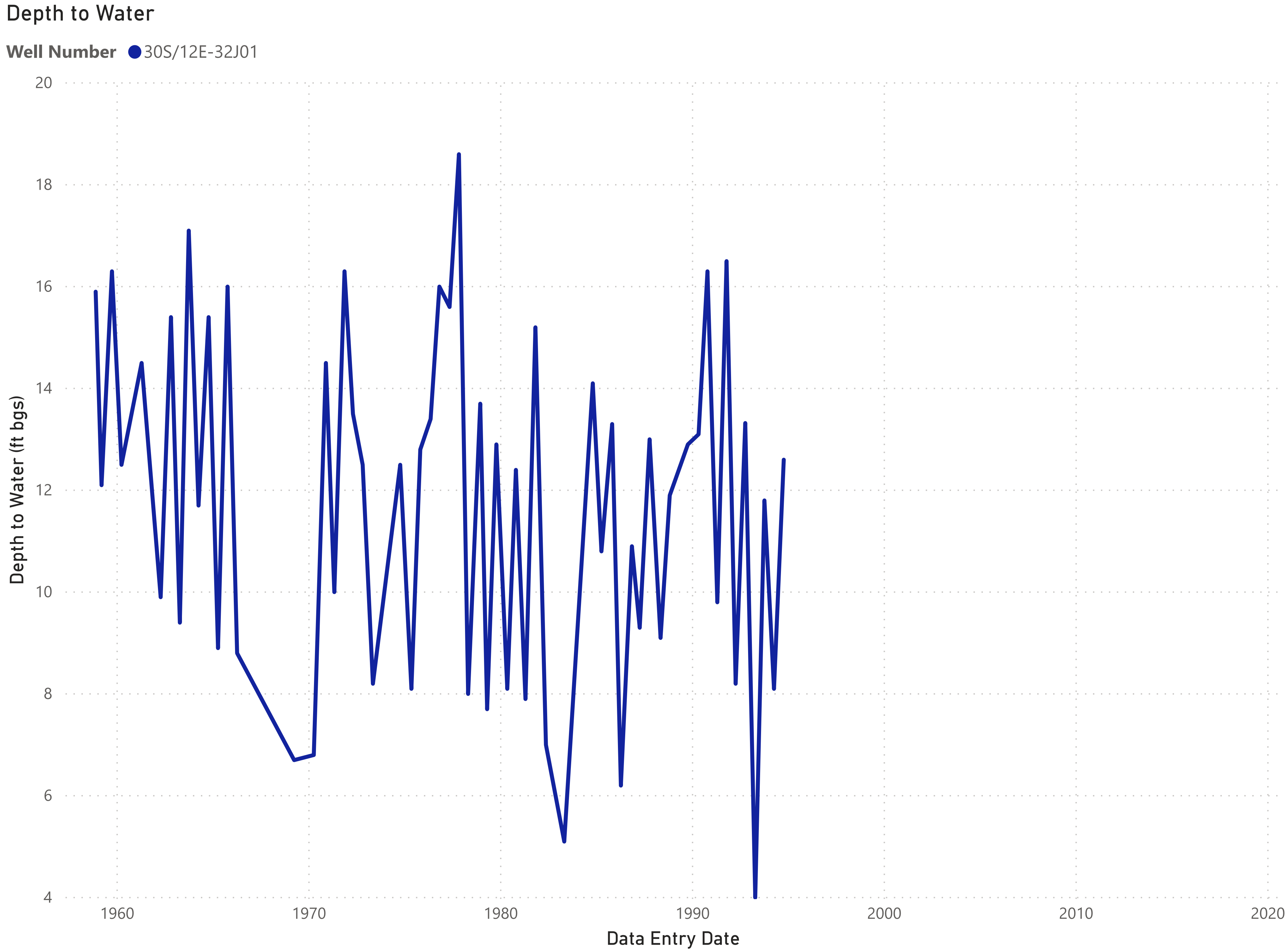
Total	**11/01/1953**	**10/09/2019**



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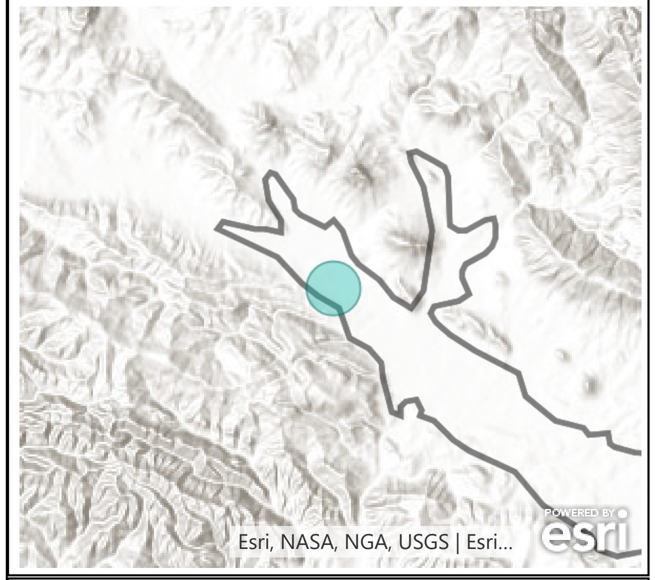

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31S/12E-10D03	05/09/2012	10/09/2019
31S/12E-10F03	04/05/1965	05/05/1997
31S/12E-10G02	04/05/1965	10/03/2019
31S/12E-10H03	04/12/1984	10/03/2019
31S/12E-12E03	04/05/1965	04/19/2013
31S/12E-12N01	10/22/1962	11/20/1970
31S/12E-12Q03	04/06/1965	10/06/1987
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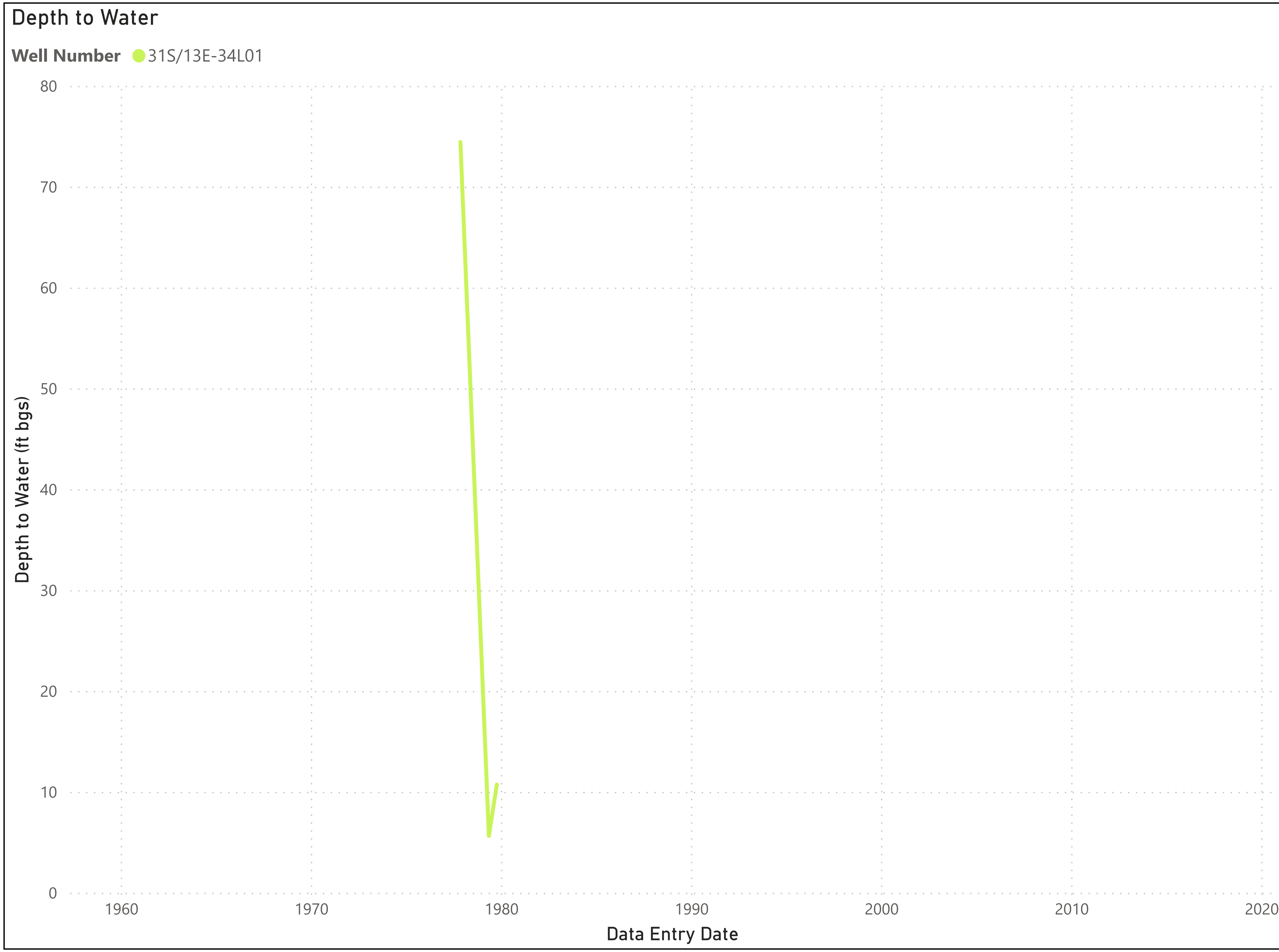

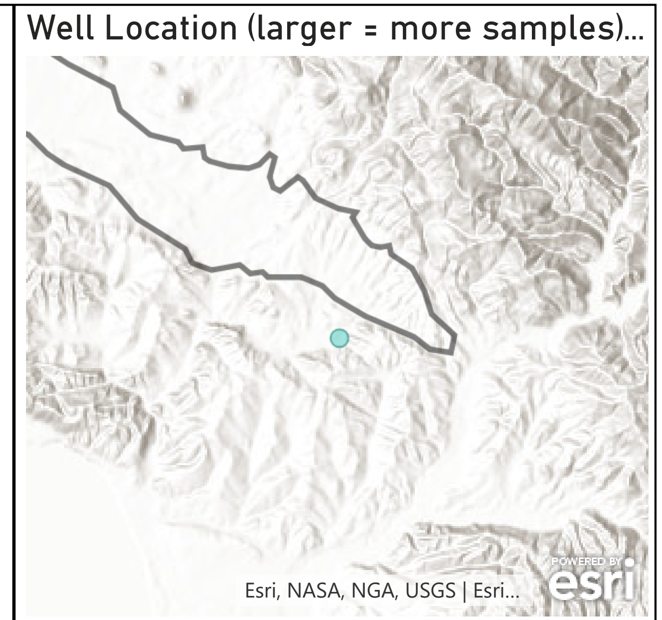

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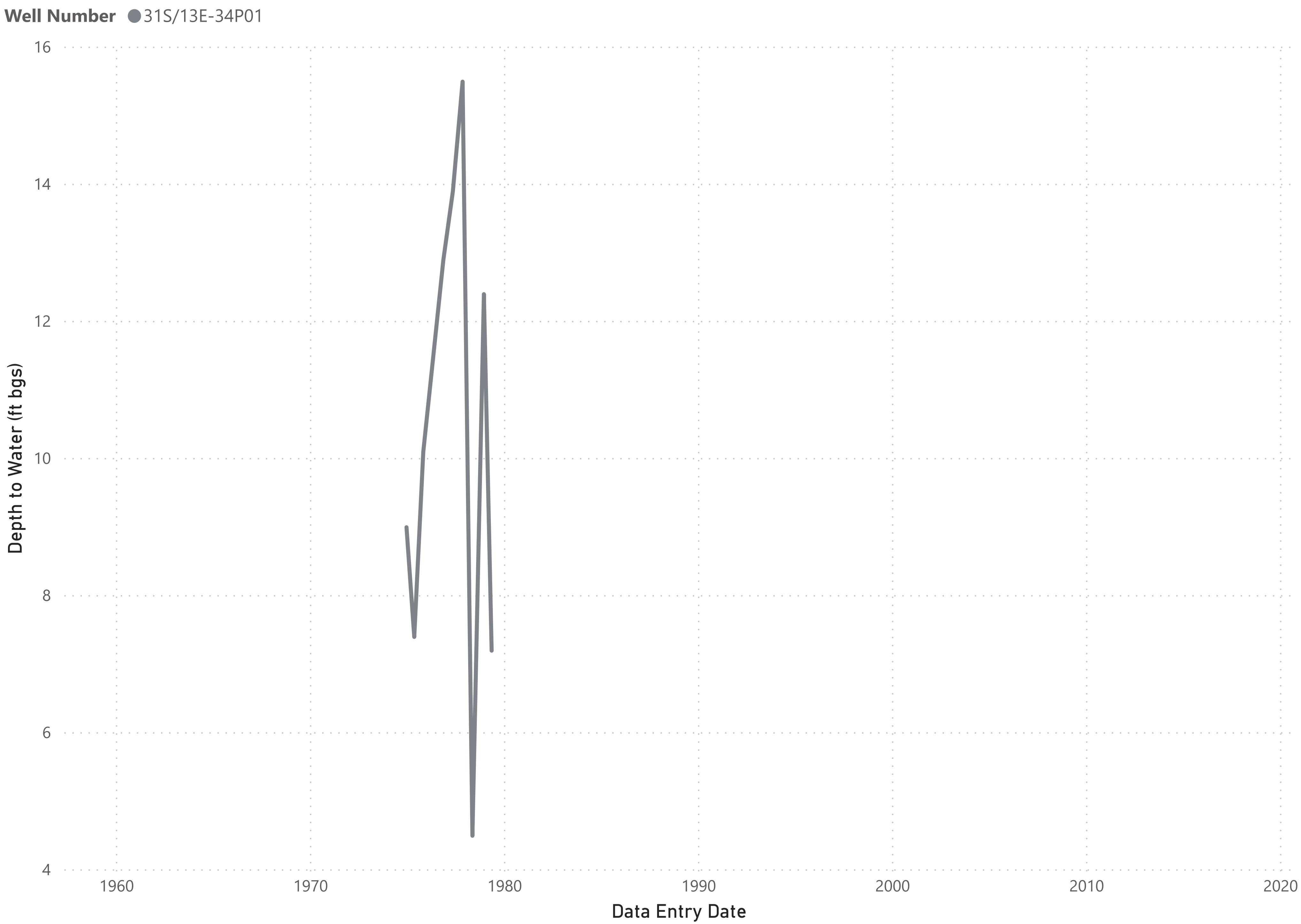

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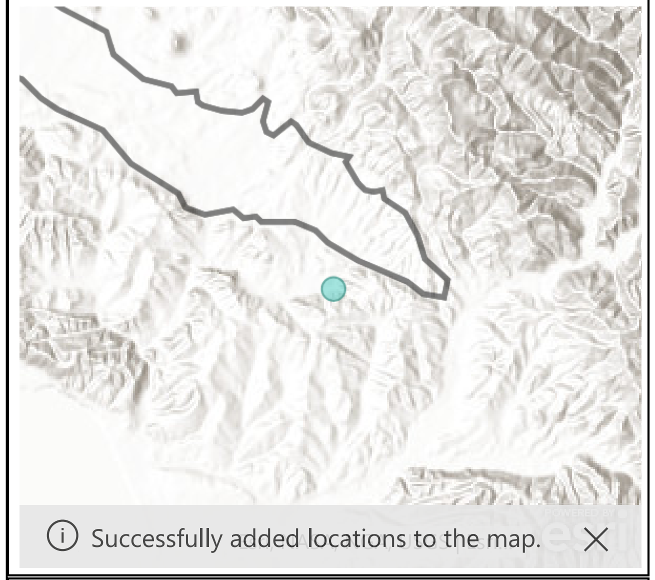

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Data Management

Groundwater Level Measurement Procedures for the San Luis Obispo Valley Groundwater Basin GSP

Streamflow Measurement in Natural Channels

Data Management Plan

Groundwater Level Measurement Procedures for the San Luis Obispo Valley Groundwater Basin GSP

Introduction

This document establishes procedures for measuring and recording groundwater levels for the SLO Basin Groundwater Monitoring Program, and describes various methods used for collecting meaningful groundwater data.

Static groundwater levels obtained for the groundwater monitoring program are determined by measuring the distance to water in a non-pumping well from a reference point that has been referenced to sea level. Subtracting the distance to water from the elevation of the reference point determines groundwater surface elevations above or below sea level. This is represented by the following equation:

$$E_{GW} = E_{RP} - D$$

Where:

E_{GW}	=	Elevation of groundwater above mean sea level (feet)
E_{RP}	=	Elevation above sea level at reference point (feet)
D	=	Depth to water (feet)

References

Procedures for obtaining and reporting water level data for the SLO Basin Groundwater Monitoring Program are based on a review of the following documents.

- State of California, Department of Water Resources, 2016, *Best Management Practices for the Sustainable Management of Groundwater: Monitoring Protocols, Standards, and Sites*, December 2016.
- State of California, Department of Water Resources, 2014, *Addendum to December 2010 Groundwater Elevation Monitoring Guidelines for the Department of Water Resources' California Statewide Groundwater Elevation Monitoring (CASGEM) Program,* October 2, 2014.
- State of California, Department of Water Resources, 2010, *Groundwater Elevation Monitoring Guidelines*, prepared for use in the California Statewide Groundwater Elevation Monitoring (CASGEM) program, December 2010.
- U.S. Geological Survey, 2011, *Groundwater Technical Procedures of the U.S. Geological Survey*, Techniques and Methods 1-A1, compiled by William L. Cunningham and Charles W. Schalk.
- U.S. Geological Survey, 1977, *National Handbook of Recommended Methods for Water-Data Acquisition*, a Unites States contribution to the International Hydrological Program.

Well Information

Table 1 below lists important well information to be maintained in a well file or in a field notebook. Additional information that should be available to the person collecting water level data include a description of access to the property and the well, the presence and depth of cascading water, or downhole obstructions that could interfere with a sounding cable.

Table 1
Well File Information

Well Completion Report	Hydrologic Information	Additional Information to be Recorded
Well name	Map showing basin boundaries and wells	Township, Range, Section and ¼-¼ Section
Well Owner	Name of groundwater basin	Latitude and Longitude (Decimal degrees)
Drilling Company	Description of aquifer	Assessor's Parcel Number
Location map or sketch	Confined, unconfined, or mixed aquifers	Description of well head and sounding access
Total depth	Pumping test data	Reference point elevations
Perforation interval	Hydrographs	Well use and pumping schedule if known
Casing diameter	Water quality data	Date monitoring began
Date of well completion	Property access instructions/codes	Land use

Reference Points and Reference Marks

Reference point (RP) elevations are the basis for determining groundwater elevations relative to sea level. The RP is generally a point on the well head that is the most convenient place to measure the water level in a well. In selecting an RP, an additional consideration is the ease of surveying either by Global Positioning System (GPS) or by leveling.

The RP must be clearly defined, well marked, and easily located. A description, sketch, and photograph of the point should be included in the well file. Additional Reference Marks (RMs) may be established near the wellhead on a permanent object. These additional RMs can serve as a benchmark by which the wellhead RP can be checked or re-surveyed if necessary. All RMs should be marked, sketched, photographed, and described in the well file.

All RPs for Groundwater Monitoring Program wells should be reported based on the same horizontal and vertical datum by a California licensed surveyor to the nearest tenth of one foot vertically, and the nearest one foot horizontally. The surveyor's report should be maintained in the project file.

In addition to the RP survey, the elevation of the ground surface adjacent to the well should also be measured and recorded in the well file. Because the ground surface adjacent to a well is rarely uniform, the average surface level should be estimated. This average ground surface elevation is referred to in the USGS Procedural Document (GWPD-1) and DWR guidelines as the Land Surface Datum.

Water Level Data Collection

Prior to beginning the field work, the field technician should review each well file to determine which well owners require notification of the upcoming site visit, or which well pumps need to be turned off to allow for sufficient water level recovery. Because groundwater elevations are used to construct groundwater contour maps and to determine hydraulic gradients, the field technician should coordinate water level measurements to be collected within as short a period of time as practical. Any significant changes in groundwater conditions during monitoring events should be noted in the Annual Monitoring Report. For an individual well, the same measuring method and the same equipment should be used during each sampling event where practical.

A static water level should represent stable, non-pumping conditions at the well. When there is doubt about whether water levels in a well are continuing to recover following a pumping cycle, repeated measurements should be made. If an electric sounder is being used, it is possible to hold the sounder level at one point slightly above the known water level and wait for a signal that would indicate rising water. If applicable, the general schedule of pump operation should be determined and noted for active wells. If the well is capped but not vented, remove the cap and wait several minutes before measurement to allow water levels to equilibrate to atmospheric pressure.

When lowering a graduated steel tape (chalked tape) or electric tape in a well without a sounding tube in an equipped well, the tape should be played out slowly by hand to minimize the chance of the tape end becoming caught in a downhole obstruction. The tape should be held in such a way that any change in tension will be felt. When withdrawing a sounding tape, it should also be brought up slowly so that if an obstruction is encountered, tension can be relaxed so that the tape can be lowered again before attempting to withdraw it around the obstruction.

Despite all precautions, there is a small risk of measuring tapes becoming stuck in equipped wells without dedicated sounding tubes. If a tape becomes stuck, the equipment should be left on-site and re-checked after the well has gone through a few cycles of pumping, which can free the tape due to movement/vibration of the pump column. If the tape remains stuck, a pumping contractor will be needed to retrieve the equipment. A dedicated sounding tube may be installed by the pumping contractor at that time.

All water level measurements should be made to an accuracy of 0.01 feet. The field technician should make at least two measurements. If measurements of static levels do not agree to within 0.02 feet of each other, the technician should continue measurements until the reason for the disparity is determined, or the measurements are within 0.02 feet.

Record Keeping in the Field

The information recorded in the field is typically the only available reference for the conditions at the time of the monitoring event. During each monitoring event it is important to record any conditions at a well site and its vicinity that may affect groundwater levels, or the field technician's ability to obtain groundwater levels. Table 2 lists important information to record, however, additional information should be included when appropriate.

Table 2
Information Recorded at Each Well Site

Well name	Changes in land use	Presence of pump lubricating oil in well
Name and organization of field technician	Changes in RP	Cascading water
Date & time	Nearby wells in use	Equipment problems
Measurement method used	Weather conditions	Physical changes in wellhead
Sounder used	Recent pumping info	Comments
Reference Point Description	Measurement correction(s)	Well status

An example of a field log sheet from DWR is attached.

Measurement Techniques

Four standard methods of obtaining water levels are discussed below. The chosen method depends on site and downhole conditions, and the equipment limitations. In all monitoring situations, the procedures and equipment used should be documented in the field notes and in final reporting. Additional detail on methods of water level measurement is included in the reference documents.

Graduated Steel Tape

This method uses a graduated steel tape with a brass or stainless steel weight attached to its end. The tape is graduated in feet. The approximate depth to water should be known prior to measurement.

- Estimate the anticipated static water level in the well from field conditions and historical information;
- Chalk the lower few feet of the tape by applying blue carpenter's chalk.
- Lower the tape to just below the estimated depth to water so that a few feet of the chalked portion of the tape is submerged. Be careful not to lower the tape beyond its chalked length.
- Hold the tape at the RP and record the tape position (this is the "hold" position and should be at an even foot);
- Withdraw the tape rapidly to the surface;
- Record the length of the wetted chalk mark on the graduated tape;
- Subtract the wetted chalk number from the "hold" position number and record this number in the "Depth to Water below RP" column;
- Perform a check by repeating the measurement using a different RP hold value;
- All data should be recorded to the nearest 0.01 foot;
- Disinfect the tape by wiping down the submerged portion of the tape with single-use, unscented disinfectant wipe, or let stand for one minute in a dilute chlorine bleach solution and dry with clean cloth.

The graduated steel tape is generally considered to be the most accurate method for measuring static water levels. Measuring water levels in wells with cascading water or with condensing water on the well casing causes potential errors, or can be impossible with a steel tape.

Electric Tape

An electric tape operates on the principle that an electric circuit is completed when two electrodes are submerged in water. Most electric tapes are mounted on a hand-cranked reel equipped with batteries and an ammeter, buzzer or light to indicate when the circuit is completed. Tapes are graduated in either one-foot intervals or in hundredths of feet depending on the manufacturer. Like graduated steel tapes, electric tapes are affixed with brass or stainless steel weights.

- Check the circuitry of the tape before lowering the probe into the well by dipping the probe into water and observe if the ammeter needle or buzzer/light signals that the circuit is completed;
- Lower the probe slowly and carefully into the well until the signal indicates that the water surface has been reached;
- Place a finger or thumb on the tape at the RP when the water surface is reached;
- If the tape is graduated in one-foot intervals, partially withdraw the tape and measure the distance from the RP mark to the nearest one-foot mark to obtain the depth to water below the RP. If the tape is graduated in hundredths of a foot, simply record the depth at the RP mark as the depth to water below the RP;
- Make all readings using the same needle deflection point on the ammeter scale (if equipped) so that water levels will be consistent between measurements;

- Make check measurements until agreement shows the results to be reliable;
- All data should be recorded to the nearest 0.01 foot;
- Disinfect the tape by wiping down the submerged portion of the tape with single-use, unscented disinfectant wipe, or let stand for one minute in a dilute chlorine bleach solution and dry with clean cloth;
- Periodically check the tape for breaks in the insulation. Breaks can allow water to enter into the insulation creating electrical shorts that could result in false depth readings.

The electric tape may give slightly less accurate results than the graduated steel tape. Errors can result from signal “noise” in cascading water, breaks in the tape insulation, tape stretch, or missing tape at the location of a splice. All electric tapes should be calibrated annually against a steel tape that is maintained in the office and used only for calibration.

<u>Air Line</u>

The air line method is usually used only in wells equipped with pumps. This method typically uses a 1/8 or 1/4-inch diameter, seamless copper tubing, brass tubing, stainless steel tubing, or galvanized pipe with a suitable pipe tee for connecting an altitude or pressure gage. Plastic (i.e. polyethylene) tubing may also be used, but is considered less desirable because it can develop leaks as it degrades. An air line must extend far enough below the water level that the lower end remains submerged during pumping of the well. The air line is connected to an altitude gage that reads directly in feet of water, or to a pressure gage that reads pressure in pounds per square inch (psi). The gage reading indicates the length of the submerged air line.

The formula for determining the depth to water below the RP is: **d = k – h** where d = depth to water; k = constant; and h = height of the water displaced from the air line. In wells where a pressure gage is used, h is equal to 2.31 ft/psi multiplied by the gage reading. The constant value for k is approximately equivalent to the length of the air line.

- Calibrate the air line by measuring an initial depth to water (d) below the RP with a graduated steel tape. Use a tire pump, air tank, or air compressor to pump compressed air into the air line until all the water is expelled from the line. When all the water is displaced from the line, record the stabilized gage reading (h). Add d to h to determine the constant value for k.
- To measure subsequent depths to water with the air line, expel all the water from the air line, subtract the gage reading (h) from the constant k, and record the result as depth to water (d) below the RP.

The air line method is not as accurate as a graduated steel tape or electric and is typically accurate to the nearest one foot at best. Errors can occur from leaky air lines, or when tubing becomes clogged with mineral deposits or bacterial growth. The air line method is not desirable for use in the Groundwater Monitoring Program.

<u>Pressure Transducer</u>

Electrical pressure transducers make it possible to collect frequent and long-term water level or pressure data from wells. These pressure-sensing devices, installed at a fixed depth in a well, sense the change in pressure against a membrane. The pressure changes occur in response to changes in the height of the water column in the well above the transducer membrane. To compensate for atmospheric changes, transducers may have vented cables or they can be used in conjunction with a barometric transducer that is installed in the same well or a nearby observation well above the water level.

Transducers are selected on the basis of expected water level fluctuation. The smallest range in water levels provides the greatest measurement resolution. Accuracy is generally 0.01 to 0.1 percent of the full scale range.

Retrieving data in the field is typically accomplished by downloading data through a USB connection to a portable computer or data logger. A site visit to retrieve data should involve several steps designed to safeguard the stored data and the continued useful operation of the transducer:

- Inspect the wellhead and check that the transducer cable has not moved or slipped (the cable can be marked with a reference point that can be used to identify movement);
- Ensure that the instrument is operating properly;
- Measure and record the depth to water with a graduated steel or electric tape;
- Document the site visit, including all measurements and any problems;
- Retrieve the data and document the process;
- Review the retrieved data by viewing the file or plotting the original data;
- Recheck the operation of the transducer prior to disconnecting from the computer.

A field notebook with a checklist of steps and measurements should be used to record all field observations and the current data from the transducer. It provides a historical record of field activities. In the office, maintain a binder with field information similar to that recorded in the field notebook so that a general historical record is available and can be referred to before and after a field trip.

<u>Quality Control</u>

The field technician should compare water level measurements collected at each well with the available historical information to identify and resolve anomalous and potentially erroneous measurements prior to moving to the next well location. Pertinent information, such as insufficient recovery of a pumping well, proximity to a pumping well, falling water in the casing, and changes in the measurement method, sounding equipment, reference point, or groundwater conditions should be noted. Office review of field notes and measurements should also be performed by a second staff member.

All field tapes (both steel and electric) used for the monitoring program should be calibrated annually against another acceptable steel tape. An acceptable steel tape is one that is maintained in the office for use only in calibrating the field tapes. Adjustments for tape calibration should be applied and noted.

STATE OF CALIFORNA
THE RESOURCES AGENCY
DEPARTMENT OF WATER RESOURCES

WELL DATA

STATE WELL NUMBER	COUNTY	REFERENCE POINT ELEV.	MEASURING AGENCY
			DWR

NO MEASUREMENT	QUESTIONABLE MEASUREMENT
0. Measurement discontinued	0. Caved or deepened
1. Pumping	1. Pumping
2. Pump house locked	2. Nearby pump operating
3. Tape hung up	3. Casing leaky or wet
4. Can't get tape in casing	4. Pumped recently
5. Unable to locate well	5. Air or pressure gauge measurement
6. Well has been destroyed	6. Other
7. Special	7. Recharge operation at or nearby well
8. Casing leaky or wet	8. Oil in casing
9. Temporarily inaccessible	

DATE	N M	Q M	TAPE AT RP	TAPE AT WS	RP to WS	OBSR VR	COMMENTS

DWR 1213

Figure 4 – Example of Water Level Well Data Field Collection Form

Streamflow Measurement in Natural Channels

The most practical method for measuring streamflow in natural channels is the velocity-area method, which has the following computation[1]:

$$Q = \sum_{i=1}^{n} (a_i v_i)$$

where:

Q = total discharge (reported in cubic feet per second).

a_i = cross-sectional area of flow for the *i*th segment of the *n* segments into which the cross section is divided (square feet), and

v_i = the corresponding mean velocity of flow normal to the *i*th segment (feet per second).

The conceptual model for the velocity area-method is shown below. A stream is divided into segments, each with an individual area and velocity, which are then multiplied and summed using the above equation.

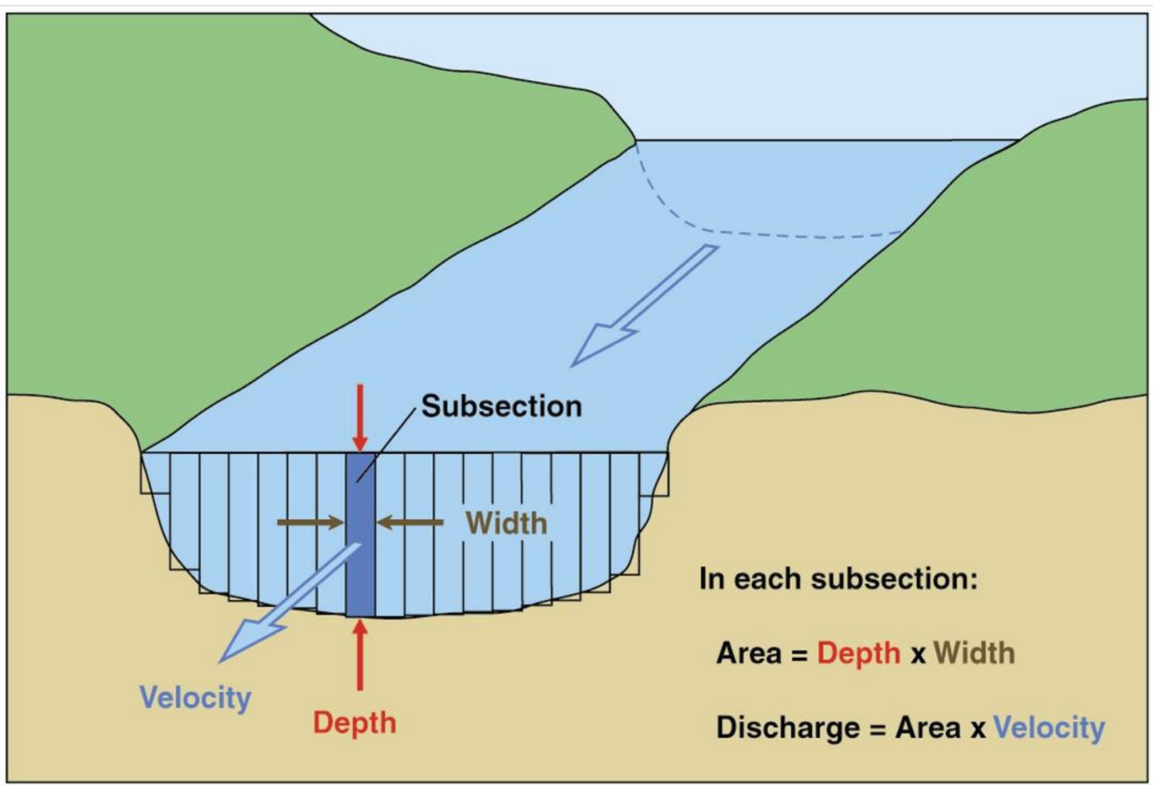

Diagram of Channel cross-section with segments for discharge computation (USGS)

In natural channels, stream gages are used to record stage (feet), which is the height of water in the stream above an arbitrary point, usually at or below the stream bed. The stage is then converted to streamflow through the use of a rating curve, or stage-discharge relation. A rating curve incorporates information collected that is specific to each site, including the cross-sectional area of

[1] Turnipseed, D.P. and Sauer, V.B., 2010. Discharge Measurements at Gaging Stations, USGS Techniques and Methods 3-A8.

the channel and the average velocity for a given flow stage. These rating curves are developed using depth profiles and average flow velocity measurements during storm-runoff events. Rating curves may need to be revised periodically as they can shift due to changes in channel geometry. Measuring average flow velocity across a channel at different stream stages is the most challenging part of developing a rating curve.

DRAFT

San Luis Obispo Valley Basin Data Management Plan

Data Management System to Support Implementation of the Sustainable Groundwater Management Act

Prepared for:

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City of San Luis Obispo GSA

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August 31, 2020

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Figures

Tables

1. Introduction

The purpose of this Data Management Plan (DMP) is to describe the planned Data Management System (DMS) and the process for collection, review, and upload of data used to develop a Groundwater Sustainability Plan (GSP) for the San Luis Obispo Valley Groundwater Basin (SLO Basin). This document does not provide final specifications for a complete DMS. Rather, it describes the data needed to comply with SGMA, the method to be used for data collection, and the plan for DMS development.

1.1 SGMA DMS Requirements

The Sustainable Groundwater Management Act (SGMA) requires development of a DMS. The DMS stores data relevant to development of a groundwater basin's GSP as defined by the GSP Regulations (California Code of Regulations, Title 23, Division 2, Chapter 1.5, Subchapter 2).

The GSP Regulations give general guidelines for a DMS:

> ***§ 352.6. Data Management System***
>
> *Each Agency shall develop and maintain a data management system that is capable of storing and reporting information relevant to the development or implementation of the [Groundwater Sustainability] Plan and monitoring of the basin.*
>
> *Note: Authority cited: Section 10733.2, Water Code.*
> *Reference: Sections 10727.2, 10728, 10728.2, and 10733.2, Water Code.*
>
> ***§ 352.4. Data and Reporting Standards***
>
> *(c) The following standards apply to wells:*
>
> *(3) Well information used to develop the basin setting shall be maintained in the Agency's data management system*
>
> *Note: Authority cited: Section 10733.2, Water Code.*
> *Reference: Sections 10727.2, 10727.6, and 10733.2, Water Code.*
>
> ***§ 354.40. Reporting Monitoring Data to the Department***
>
> *Monitoring data shall be stored in the data management system developed pursuant to Section 352.6. A copy of the monitoring data shall be included in the Annual Report and submitted electronically on forms provided by the Department.*
>
> *Note: Authority cited: Section 10733.2, Water Code.*
> *Reference: Sections 10728, 10728.2, 10733.2, and 10733.8, Water Code.*

To comply with SGMA, the SLO Basin DMS will store data that is relevant to development and implementation of the GSP as well as for monitoring and reporting purposes.

2. Data Needs for SGMA

The SLO Basin is in San Luis Obispo County, California. The county spans multiple groundwater basins – 6 of which are engaged in SGMA activity. Each basin complying with SGMA is required to store data in a DMS. Rather than host several systems, a county-wide DMS will be implemented to support county data initiatives for SGMA and other non-SGMA data initiatives.

Figure 1. Groundwater Basins in San Luis Obispo County[1]

SGMA defines sustainable groundwater management as "the management and use of groundwater in a manner that can be maintained during the planning and implementation horizon without causing undesirable results."[2] Furthermore, SGMA outlines six undesirable results as follows:[3]

> *One or more of the following effects caused by groundwater conditions occurring throughout the basin:*
>
> *(1) 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*

---

[1] Source: California Department of Water Resources, SGMA Data Viewer, accessed August 14, 2020.
[2] §10721(v)
[3] §10721(x)

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.

(2) Significant and unreasonable reduction of groundwater storage.

(3) Significant and unreasonable seawater intrusion.

(4) Significant and unreasonable degraded water quality, including the migration of contaminant plumes that impair water supplies.

(5) Significant and unreasonable land subsidence that substantially interferes with surface land uses.

(6) Depletions of interconnected surface water that have significant and unreasonable adverse impacts on beneficial uses of the surface water.

The presence or absence of the six undesirable results in a groundwater basin is determined by monitoring and reviewing data for six sustainability indicators (one for each undesirable result). A set of associated measurable objective and minimum threshold will be assigned for each indicator and will be included in the DMS.

There are multiple metrics by which the sustainability indicators may be observed. The sustainability indicators and their respective metrics, as defined in the GSP Regulations and described by the California Department of Water Resources (DWR) in the Sustainable Management Criteria Best Management Practice (BMP) document,[4] are shown in **Figure 2**.

Figure 2. DWR's Sustainability Indicators and Metrics

Sustainability Indicators	Lowering GW Levels	Reduction of Storage	Seawater Intrusion	Degraded Quality	Land Subsidence	Surface Water Depletion
Metric(s) Defined in GSP Regulations	• Groundwater Elevation	• Total Volume	• Chloride concentration isocontour	• Migration of Plumes • Number of supply wells • Volume • Location of isocontour	• Rate and Extent of Land Subsidence	• Volume or rate of surface water depletion

[4] https://water.ca.gov/LegacyFiles/groundwater/sgm/pdfs/BMP_Sustainable_Management_Criteria_2017-11-06.pdf.

Table 1 describes the types of data that may possibly be monitored for each sustainability indicator. Sustainability indicators do not need to be tracked by every available monitoring type.

Table 1. Monitoring data for the SGMA sustainability indicators

Sustainability Indicator	Monitoring Data Types							
					Water Quality			
	Water Level	Extensometer	GPS	InSAR	Chloride	±10 constituents	Stream stages	Well and/or Site Data
Lowering groundwater levels	✓							✓
Reduction of storage	✓							✓
Seawater intrusion	✓				✓			✓
Degraded quality	✓				✓	✓		✓
Land subsidence	✓	✓	✓	✓				✓
Surface water depletion	✓						✓	✓

The DMS will accommodate data relevant to each sustainability indicator. The monitoring data types listed in **Table 1** represent the various data sets required to populate the DMS for tracking sustainability indicators. However, there is additional data that is readily available and may be included in the DMS to assist with preparation of GSPs and to support annual reporting.

3. Data Sources

Table 2 illustrates the data sources that will be used to populate the DMS to support GSP development, sustainability indicator monitoring, and annual reporting. The data categories listed below inform the design of the DMS and support the data needs presented previously in **Table 1**.

Table 2. Data Sources to Populate the DMS

Data Category	State and Federal Data Sources						Local Data Sources	
	California Statewide Groundwater Elevation Monitoring (CASGEM)	Well Logs	California Data Exchange Center (CDEC)	Geotracker Groundwater Ambient Monitoring and Assessment (GAMA)	United States Geological Survey (USGS)	Irrigated Lands Program	Participating Agencies	Other Groundwater Users*
Well and Site Info	✓	✓		✓	✓		✓	✓
Lithology	✓	✓		✓	✓		✓	
Water Level	✓				✓		✓	✓
Water Quality				✓	✓	✓	✓	
Subsidence					✓		✓	
Precipitation			✓				✓	
Land Use							✓	
Surface Water (Diversions, Stream Gages)			✓				✓	
Pumping							✓	✓

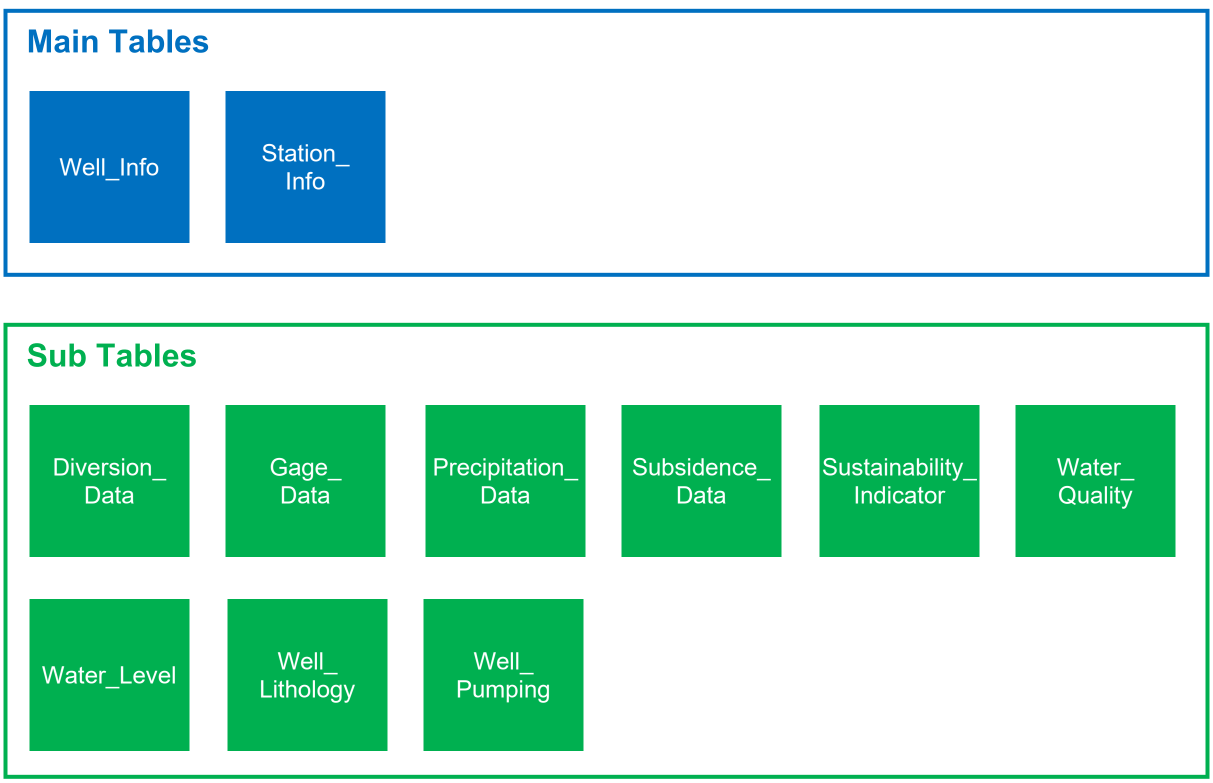
*Private parties and mutual water companies

4. Data Structure

The DMS will be comprised of a database plus an online web viewer. Data stored in the DMS will be separated by categories into tables. The tables shall contain columns and rows of data. Each field will hold a specific type of data, such as a number, text, or date. The planned DMS data tables are shown as **Figure 3**. The figure is color-coordinated to show the relationship between tables:

- **Main tables (Blue)** – Each dataset will be associated with EITHER a well or a station (e.g., extensometer). These are the main tables and include point data with unique identification and locations.
- **Sub tables (Green)** – Sub tables are related to the main tables and hold additional details about a well or site (e.g., correlation of a well with a water level measurement).

Figure 3. DMS Tables



A brief description of the main and sub tables is provided as **Table 3**.

Table 3. DMS Table Descriptions

Table	Description
Main Tables	
Station_Info	Information about type of station (recharge site, diversion, gage, extensometer, GSP) and location information
Well_Info	General information about well, including well construction and screen information
Sub Tables	
Diversion_Data	Diversion volume measurements for a diversion site or managed recharge
Gage_Data	Measurements collected at river or stream gages
Precipitation_Data	Volumetric measurements collected at precipitation monitoring stations
Subsidence_Data	Measurements collected at subsidence monitoring stations (e.g., extensometer)
Sustainability_Indicator	Minimum Thresholds and Measurable Objectives set for monitoring network sites tracking Sustainable Management Criteria for SGMA compliance
Water_Quality	Contains water quality data for wells or any other type of site
Water_Level	Water level measurements for wells
Well_Lithology	Lithologic information at a well site (each well may have many lithologies at different depths)
Well_Pumping	Pumping or recharge measurements for wells

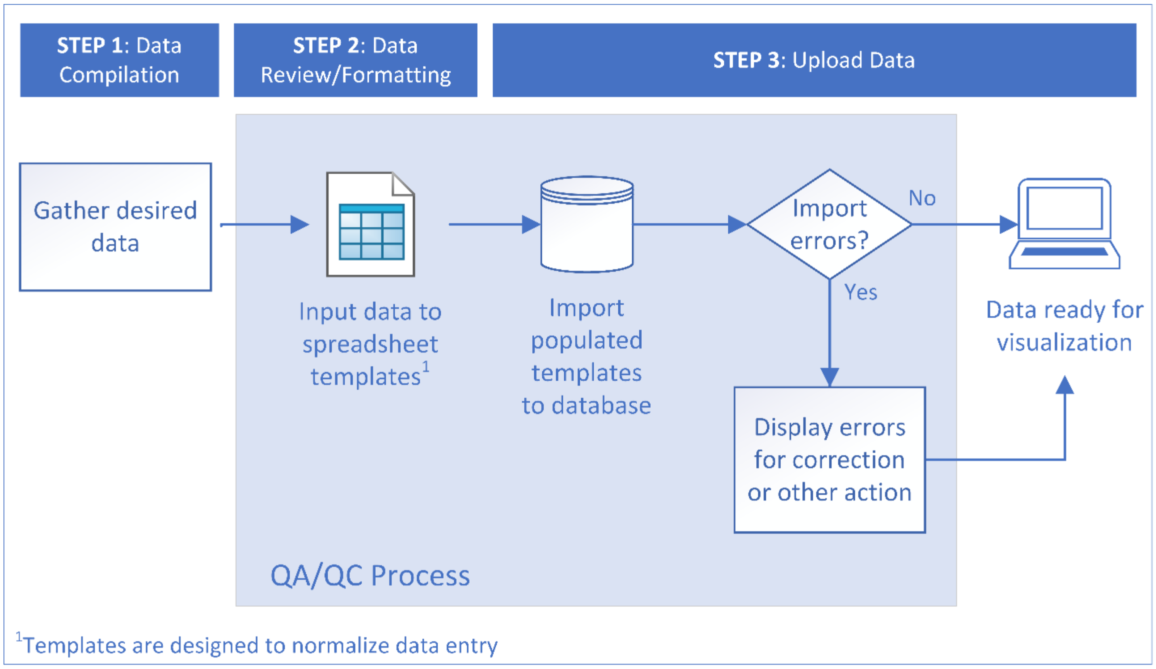
5. Data Import

Importing data to the DMS consists of three steps, as shown on **Figure 4** and listed below:

1. Data compilation
2. Data review and formatting
3. Upload data

The DMS shall be designed to use this process to import data for all basins in San Luis Obispo County. The DMS development team will upload data to support the SLO Basin GSP. Data for other basins will be loaded by other teams' GSP efforts.

Figure 4. Template Import Process for Local Data



5.1 Data Compilation (STEP 1)

Historical data must be gathered to populate the DMS. Select state and federal data (as provided earlier in **Table 2**) for the SLO Basin will be compiled by the GSAs and their consultant(s). Participating agencies and other stakeholders will compile local data and data for other basins in the County.

5.2 Data Formatting and Review (STEP 2)

After the data is compiled, it shall be normalized by use of Microsoft Excel templates designed exclusively for the DMS. Each of the main and sub tables, described previously in **Section 4**, will have a template.

The tables below list and describe the templates planned for the DMS. There are three types of data templates:

- Groundwater well data templates: for data associated with a well.
- Station data templates: for data associated with a station. A station is defined as any site, that isn't a groundwater well, tracking DMS data (e.g., extensometer).
- Independent data templates: for data that is not associated with a single well or station.

Table 4. Well Data Templates

Template	Description
WELL_INFO	Well site information including construction and location
WELL_SCREEN	Screened intervals associated with a well site
WELL_AQUIFER	Aquifers associated with a well site
WELL_LITHOLOGY	Lithologic information at a well site (each well may have many lithologies at different depths)
WELL_WATER_LEVEL	Water level measurements taken at wells
WELL_PUMPING	Pumping or recharge measurements for wells
WELL_WATER_QUALITY	Water quality data collected at well sites
WELL_SUST_INDICATOR	Minimum Thresholds, Measurable Objectives, and Interim Milestones set for wells (not stations)

Table 5. Station Data Templates

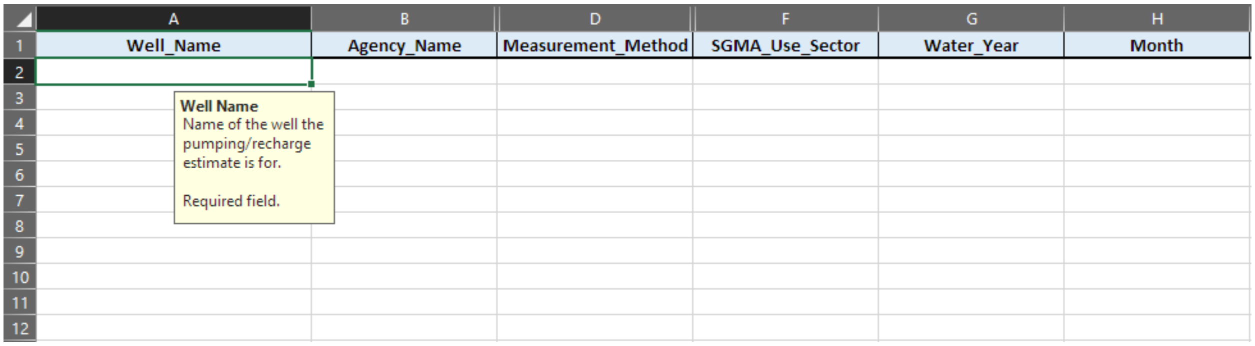
Template	Description
STATION_INFO	Information about a non-well station (e.g., recharge site) and location information
STATION_PRECIPITATION_DATA	Volumetric measurements collected at stations such as precipitation monitoring sites
STATION_SUBSIDENCE_DATA	Measurements from subsidence stations
STATION_GAGE_DATA	Measurements collected at river and stream gages
STATION_WATER_QUALITY	Water quality data collected at non-well stations
STATION_DIVERSION_DATA	Diversion volume measurements for a diversion site or managed recharge
STATION_SUST_INDICATOR	Minimum Thresholds, Measurable Objectives, and Interim Milestones set for stations (not wells)

Table 6. Independent Data Templates

Template	Description
AGENCY	Addresses and other identifying information about the source agencies for data in the system
WATER_YEAR	Water year type (e.g., dry)
DOCUMENT	Document information including file type, name, and file path

The data templates will include rules restricting formatting and alphanumeric properties to provide quality assurance/quality control (QA/QC) and to prevent errors and duplication when importing. The templates include pop-up windows to describe the type of data that should be entered in each column. If a specific filter must be applied, then only values that meet the criteria will appear in a drop-down list. **Figure** 5 provides a screenshot of an example Excel template.

Figure 5. Example Template (Well Pumping)



When data is compiled it must also be reviewed for accuracy. The template restrictions described above provide one level of QA/QC. As a second level of QA/QC, the initial set of compiled historical data will be reviewed by the consulting team before it is migrated into the database. This review will be focused and limited in scope. It will include the following manual checks:

- Identifying outliers that may have been introduced during the original data entry process
- Identifying potential duplication of data
- Removing or flagging questionable data
- Visualizing data in various software platforms outside the DMS to further assess the quality of the data

After the historical data is populated, future data will be reviewed by the County before it is fully imported to the DMS.

5.3 Data Upload (STEP 3)

Once the data is formatted and reviewed it will be uploaded to the DMS and displayed with a visualization tool (described in the next section). When loading the data, an automated check will be run by the DMS to capture errors or duplicates, if any, and a response will be generated to indicate errors so they may be corrected.

The upload templates will be available for download in the DMS interface to load future data.

6. SGMA Data Viewer

The DMS will include a user-friendly web viewer to display the SGMA data including the SGMA-specific sustainable management criteria (SMC) information such as representative monitoring sites, minimum thresholds, measurable objectives, and interim milestones.

The DMS SGMA data will display both with a map view and a detail view. Clicking on a point on the map will reveal details of the selected well or feature. The viewer will generate a hydrograph for points with water level data, and time-series graphs for water quality and subsidence data. The visual design of the Data Viewer (with test data) is shown in **Figure 6.**

Figure 6. Design for Data Viewer

The types of data to be visualized on the map and available via the map's navigation menu are listed in **Table 7**.

Table 7. Map Viewer Navigation

Menu Navigation	Description
Groundwater Levels	Water level data and associated wells with well completion reports.
Groundwater Storage	GSA groundwater storage monitoring network sites.
Water Quality	Water quality well and station data for greater than 100 constituents.
Land Subsidence	Subsidence data from extensometers and other stations plus InSAR data.
Interconnected Surface Water	Data related to the interconnected surface water sustainability indicator such as proximity wells, river and stream gages, precipitation stations, and more.
Seawater Intrusion	Sites tracking the SGMA seawater intrusion sustainability indicator.

Hydrogeologic Conceptual Model (HCM)	Data useful for development of a hydrogeoglogic conceptual model of the basin including suitability of soil for recharge, geologic maps, and fault maps.
Boundaries	GSA and other relevant boundaries.

There are two categories of data displayed on the map viewer: data stored in the DMS and reference data drawn directly from outside sources that is useful for groundwater management. All the data discussed in the previous sections, **3. Data Sources** and **4. Data Structure**, referred to data to be stored in the DMS database. **Table 8** below displays a list of reference data that is available for display in the map viewer but is tied directly to an external source (such as CDEC), not to the data stored in the DMS.

Table 8. Reference Data Not Stored in the DMS Database

Menu Navigation	Data Title	Source
Groundwater Levels	DWR Periodic Groundwater Measurements	• California Natural Resources Agency Open Data Platform https://data.cnra.ca.gov/dataset/periodic-groundwater-level-measurements • Water Data Library http://wdl.water.ca.gov/waterdatalibrary
	DWR Continuous Groundwater Measurements	• https://data.cnra.ca.gov/dataset/continuous-groundwater-level-measurements • http://wdl.water.ca.gov/waterdatalibrary
	USGS Periodic Groundwater Measurements	• https://nwis.waterdata.usgs.gov/usa/nwis/gwlevels
	Seasonal Groundwater Level Reports	DWR Enterprise Water Management database (EWM), which includes water level data previously stored in the DWR Water Data Library and CASGEM databases.
	Well Completion Reports	• https://data.cnra.ca.gov/dataset/well-completion-reports • https://gis.water.ca.gov/arcgis/rest/services/Environment/i07_WellCompletionReports/FeatureServer • https://gis.water.ca.gov/arcgis/rest/services/Environment/i07_WellCompletionReports/MapServer
Water Quality	Water Quality Portal (WQP)	• https://www.waterqualitydata.us/
Land Subsidence	DWR Extensometers	• https://data.cnra.ca.gov/dataset/wdl-ground-surface-displacement
	USGS Extensometers	• https://waterservices.usgs.gov/rest/Site-Test-Tool.html
	TRE ALTAMIRA InSAR Dataset	• Image Server: https://gis.water.ca.gov/arcgisimg/rest/services/SAR • Download @OpenData: https://data.cnra.ca.gov/dataset/tre-altamira-insar-subsidence
	NASA JPL InSAR Dataset	• Image Server: https://gis.water.ca.gov/arcgisimg/rest/services/SAR • Download @OpenData: https://data.cnra.ca.gov/dataset/nasa-jpl-insar-subsidence
Interconnected Surface Water	CDEC Stations	• http://cdec.water.ca.gov/

Menu Navigation	Data Title	Source
Water Budget	Statewide Crop Mapping 2014	• Feature Server: https://gis.water.ca.gov/arcgis/rest/services/Planning/CropMapping2014/FeatureServer • Map Server: https://gis.water.ca.gov/arcgis/rest/services/Planning/CropMapping2014/FeatureServer • Download and API @OpenData: https://data.cnra.ca.gov/dataset/crop-mapping-2014
Hydrogeologic Conceptual Model	UC Davis SAGBI	• California Soil Resource Lab at UC Davis and UC-ANR.
	Soil Survey Geographic Database	• https://services.arcgis.com/P3ePLMYs2RVChkJx/ArcGIS/rest/services/DownloaderBasinsv2/FeatureServer/0 • http://www.arcgis.com/home/item.html?id=c2b408ba5c0a4fe1a79377906935c1a4
	CGS Geologic Map - 750k Generalized	• Metadata: https://maps.conservation.ca.gov/cgs/metadata/GDM_002_GMC_750k_v2_metadata.html • Webmap: https://maps.conservation.ca.gov/cgs/gmc/ • Service: http://spatialservices.conservation.ca.gov/arcgis/rest/services/CGS/GeologicMapCA/MapServer/21
	Quaternary Surficial Deposits	• Project Website: http://www.conservation.ca.gov/cgs/fwgp/Pages/sr217.aspx • Metadata: https://maps.conservation.ca.gov/cgs/metadata/QSD_metadata.html • Webmap: https://maps.conservation.ca.gov/cgs/qsd/ • Service: https://spatialservices.conservation.ca.gov/arcgis/rest/services/CGS/GeologicMapCA/MapServer
	Fault Activity Map of California	• Metadata: https://maps.conservation.ca.gov/cgs/metadata/GDM_006_FAM_750k_v2_metadata.html • Webmap: https://maps.conservation.ca.gov/cgs/fam/ • Service: https://spatialservices.conservation.ca.gov/arcgis/rest/services/CGS/FaultActivityMapCA/MapServer
Boundaries	GSA Boundaries	• DWR Bulletin-118 basin boundaries or as provided by client
	County Boundaries	• https://data.cnra.ca.gov/dataset/california-counties
	Canals and Aqueducts	• https://data.cnra.ca.gov/dataset/canals-and-aqueducts-local
	Disadvantaged Communities Blocks	• https://data.cnra.ca.gov/dataset/census-block-group-2010
	Disadvantaged Communities Places	• https://data.cnra.ca.gov/dataset/census-place-2016
	Disadvantaged Communities Tracts	• https://data.cnra.ca.gov/dataset/census-tract-2010
	Water Agencies	• https://data.cnra.ca.gov/dataset/water-districts
	CASGEM Groundwater Basins Prioritization – 2019 -	• https://data.cnra.ca.gov/dataset/ca-bulletin-118-groundwater-basins

7. DMS User Types

All data stored in the DMS will be accessible by administrative users, based on user permissions. Some sensitive data, such as private well data, may require a higher level of permission to retrieve. These permissions will be determined by the client.

Monitoring sites and their associated datasets are added to the DMS by managing entity administrators. In addition to user permissions, access to the monitoring datasets is controlled through assigning one of three options to the data type as follows:

- **Private data** – Private data are monitoring datasets only available for viewing, depending on user type, by the entity's associated users in the DMS.
- **Shared data** – Shared data are monitoring datasets available for viewing by all users in the DMS, except for public users.
- **Public data** – Public data are monitoring datasets that are available publicly that can be viewed by all user types in the DMS; public datasets may also be published to other websites or DMSs as needed.

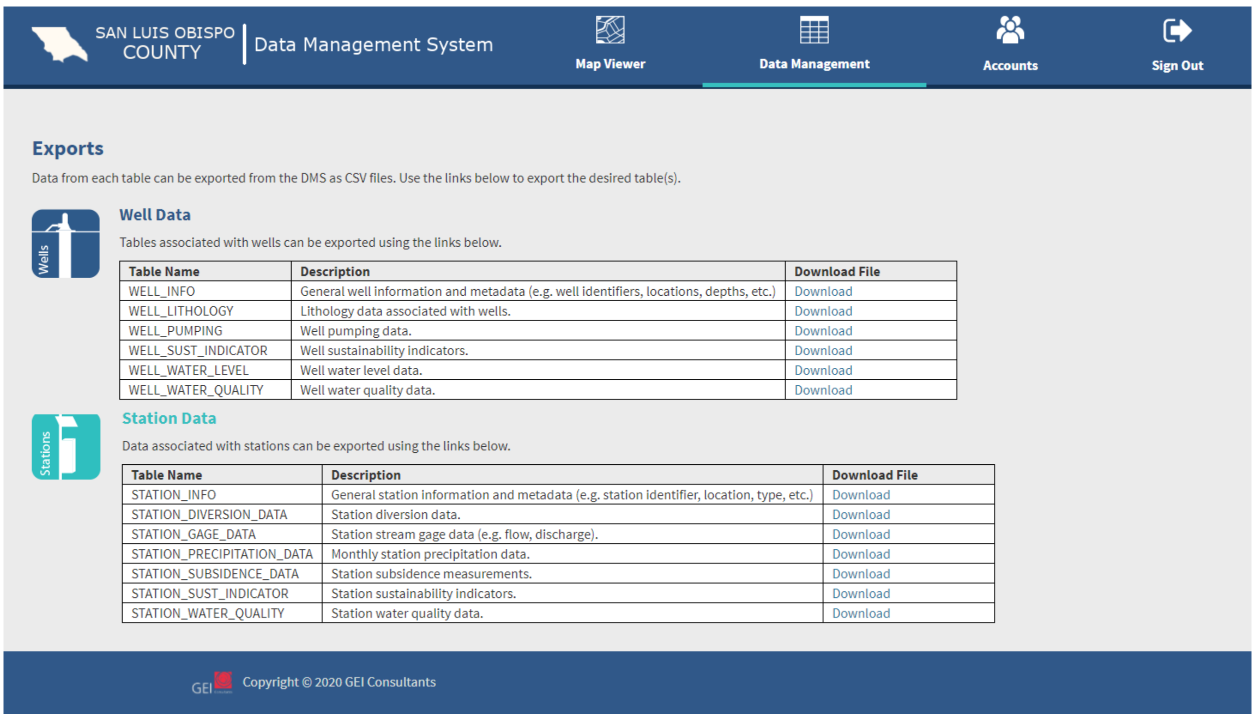
Managing entity administrators can set and maintain data access options for each data type associated with their entity.

8. Data Retrieval

Data may be retrieved in several ways: via the map viewer, by table, or by report type.

- **Map Viewer**: The map viewer will be used to retrieve small amounts of data currently displayed on screen.
- **By Table**: The Exports page will allow for export of entire DMS tables as comma-separated values (CSV) files. **Figure 7** illustrates the design for the Exports page.
- **By Report Type**: Reporting templates will be created to extract the specific group of data required for annual reporting to DWR.

Figure 7. SLO County Exports Page Design



Exports

Data from each table can be exported from the DMS as CSV files. Use the links below to export the desired table(s).

Wells

Well Data

Tables associated with wells can be exported using the links below.

Table Name	Description	Download File
WELL_INFO	General well information and metadata (e.g. well identifiers, locations, depths, etc.)	Download
WELL_LITHOLOGY	Lithology data associated with wells.	Download
WELL_PUMPING	Well pumping data.	Download
WELL_SUST_INDICATOR	Well sustainability indicators.	Download
WELL_WATER_LEVEL	Well water level data.	Download
WELL_WATER_QUALITY	Well water quality data.	Download

Stations

Station Data

Data associated with stations can be exported using the links below.

Table Name	Description	Download File
STATION_INFO	General station information and metadata (e.g. station identifier, location, type, etc.)	Download
STATION_DIVERSION_DATA	Station diversion data.	Download
STATION_GAGE_DATA	Station stream gage data (e.g. flow, discharge).	Download
STATION_PRECIPITATION_DATA	Monthly station precipitation data.	Download
STATION_SUBSIDENCE_DATA	Station subsidence measurements.	Download
STATION_SUST_INDICATOR	Station sustainability indicators.	Download
STATION_WATER_QUALITY	Station water quality data.	Download

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Response to Public Comments

SLO Valley Basin Groundwater Sustainability (GSP) Public Comments

Last Updated: 9/29/21

ID	Name	Comment Subject	Comment	Date/Time	Response
1	James Waldsmith	GSP Chapters 1 & 2 - DRAFT	Could you send me a copy of the presentations presented on 9-11-19 in PDF format? In reviewing the available download of chapters 1 and 2 I do not find any of the Hydrology data presented. Please confirm receipt of this communication.	9/14/2019 13:24	Yes.
2	Toby Moore	GSP Chapters 1 & 2 - DRAFT - Agency Informatio n	Golden State Water Company is of the opinion that an advisory body, similar or with the same structure of the current Groundwater Sustainability Commission (GSC), may be beneficial and perhaps necessary for GSP implementation. The MOU establishing the GSC contemplates this and does have language stating the following, "Depending on the content of the GSP the Parties may decide to enter into a new agreement to coordinate implementation." Inclusion of this language in Section 2.3.2 is recommended. Please consider the addition of the following text before the last sentence in Section 2.3.2. "The Parties may decide to enter into a new agreement to coordinate GSP implementation."	10/31/201 9 9:17	The text is updated accordingly.
3	George Donati	SLO Basin GSP Chapters 3 & 4 - DRAFT	3.1 SLO Bain Introduction - We need to include the history of the Edna Valley Basin. In the 1950's - 1960's the East branch of the Corral de Piedra creek was dammed to install a 500 acre foot reservoir. In the 1970's, this dam was raised for a 1000 acre foot reservoir. This dam removed all flow of water into the Edna Valley Basin as the water was used for crop irrigation outside of the Edna Valley Basin. The flow downstream of the dam is not properly managed by the owner of the dam and the state water board. This has greatly reduced the re-charge of the Edna Valley Basin for the past 50 years. 3.4.1 Water Source Types - This states " Excluding the Edna Valley Golf Course, all water demand in the SLO Basin are met with groundwater" - This needs to be clarified. The Golf course uses ground water to irrigate the course, and the golf course sells groundwater water to Golden State Water Company for residential use. 3.4.2 Water Use Sectors - Industrial - The ground water wells that supply water to the Price Canyon Oil Field are just outside of the basin boundary. Why are these wells not considered to use groundwater from the Edna Valley Basin since a natural flow from the creek passes adjacent to these wells? 3.6.1.3 We are monitoring the flow of San Luis Obispo Creek as surface water leaves the San Luis Basin. Why not monitor the flow of the other major creeks, east and west Corral de Piedra at the edge of the Edna Valley Basin to determine the flow that is leaving the Basin? Or better yet, the flow that could be coming into the basin below the Dam on the East side of the valley.	1/30/2020 8:10	3.1 The text is amended to include mention of the construction of the reservoir on West Corral de Piedras Creek. Self-reported outflows from the Righetti Reservoir are discussed in further detail in Chapter 6- Water Budget. 3.4.1 Comment noted. The text is updated to make the clarification. 3.4.2 The Price Canyon Oil Field wells are outside of the SLO Basin and not under the jurisdiction of the GSP. Additionally, they are screened in bedrock formations which are not part of the Basin sediments. 3.6.1.3 Comment noted. Chapter 7 Monitoring Network identifies the lack of a stream gage on East and West Corral de Piedras as a data gap and recommends additional gages be installed and monitored as part of the Implementation Plan.
4	Toby Moore	Communic ation and Engageme nt Plan	Appendix B of the plan describes the Groundwater Communication Portal's functionality which includes a repository of comments provided by stakeholders. However, it does not indicate whether the comments submitted will be visible or available via other means for stakeholders to review. Currently there appears to not be such functionality. As a member of the Groundwater Sustainability Commission, I feel this functionality is helpful and would encourage its implementation.	8/29/2019 9:20	Noted. The comments will be posted to SLOwaterbasin.org at the conclusion of the public comment period associated with the Chapter or technical memorandum. In addition, all public comments and responses are to be included as an appendix to the final GSP.

ID	Name	Comment Subject	Comment	Date/Time	Response
5	Sally Kruger	General Comments	Hi there, saw you on the GSP call yesterday and don't know if you know that we used to live on Righetti Road just down from the Righetti dam and had a creek (WCDPC) running through our property that used to have lots of steelhead in it. Unfortunately, between climate change, droughts and the dam, the steelhead have pretty much disappeared. I found yesterday's meeting to have a very interesting figure in it. The one that estimates a sustainable basin for the SLO Valley is estimated to be 5600 AF. The Righetti dam has State water right permits to hold back 991 AF. (The largest private reservoir in the State) Of course, their property and the dam are not within the boundaries of the watershed for which the plan is being developed. But I couldn't help but be astonished that the permits allow them almost 20% of the water needed to maintain the whole slo water basin and all the vineyards and ag as well as residents contained in it. I've spent a great deal of my time and energy working with Creeklands conservation, CDFW and SWRCB over the last 15 years to try to restore the water and the fish. I'm sure you would know as many of the city's projects have very long time lines. We now live in town, but I continue to work on "my" creek. Just some interesting info for you. Again, thanks, Sally	6/29/2020 12:53	Comment noted. Thank you for the information. One point that needs clarification is that total storage capacity of the reservoir is not equivalent to the annual allowable diversion; Self-reported outflows from the reservoir in recent years average 350 AFY. The terms of the surface water diversion permit associated with Righetti Reservoir are under the purview of the State Water Board. To the extent that any review of the permit conditions results in any additional water being released to West Corral de Piedras Creek, it will be beneficial to the basin.
6	Mark Capeli	SLO GSP Chapter 5 -- DRAFT - 5.8 Potential Groundwater Dependent Ecosystems See letter dated May 29, 2020 appended to the Response to Comments.	Enclosed with this letter are NOAA's National Marine Fisheries Service (NMFS) comments on Chapter 5: Groundwater Conditions of the San Luis Obispo Valley Groundwater Basin (SLO Valley Basin) Groundwater Sustainability Plan (GSP).	5/29/2020 14:59	1. Graphs #1, #3, and #4 do not include data for recent years. However, data from other wells in the vicinity and knowledge of groundwater use patterns in the SLO Creek Valley support our statement that no trends of declining groundwater storage is evident. The data gaps are recognized. Ground surface elevation will be included on the graphs when finalized. 2. Page 24 Chapter 5 references areas identified by Stillwater Percolation Zone Study with "naturally high percolation potential that through management actions ...could enhance local groundwater supplies...". The management actions referenced here would be recharge basins. The source of the recharge water is not indicated, and any diversions from the natural creek would be evaluated in light of potential effects on steelhead habitat. 3. Comments were made regarding identification of GDEs based on a 30-foot depth to water. This is a desktop evaluation threshold based on TNC guidelines to identify potential GDEs. Additional GDE field characterization is recommended in the monitoring plan for streams and creeks in the Basin. The TNC threshold is not specific to oaks, so that comment is removed. 4. If groundwater elevations have not declined below historical levels in the vicinity of a stream, as is the case along SLO Creek, this is an indicator that anthropogenic activities have not resulted in lowered water levels. If water levels are consistent over the past 30 years, it is implied as per Darcy’s Law that stream conditions have not been impacted in this area due to groundwater usage.

ID	Name	Comment Subject	Comment	Date/Time	Response
					Additional stream corridor characterization and monitoring is recommended in Chapter 7, Monitoring Networks. Few wells have complete periods of record, but comparisons with nearby wells that span the gaps in the period of record, and knowledge of groundwater use patterns in the area, can illuminate the conditions along a stream corridor.
7	Steph Wald	General Comments	Ch 5 comments Thank you for the opportunity to comment on Chapter 5 Groundwater Conditions of the SLO Basin Groundwater Sustainability Plan. We previously provided comments dated January 7, 2018, in the earlier phases of the development of the SLO Valley Basin. Those comments provided direction on a framework for addressing Groundwater Dependent Ecosystems (GDE) under SGMA by The Nature Conservancy. Thank you for utilizing the framework and careful consideration of GDE's in Chapter 5.Regarding the integration of technical datasets on GDE's, Figure 5-15 identifies potential GDEs and that those identified are not yet verified. While a monitoring network for future planning efforts may verify GDEs through subsequent field reconnaissance, I would suggest that project development could be informed by having GDE verification sooner rather than later. If this is not possible, and there isn't enough data to label them unlikely GDE different language to label them might be appropriate such as less likely GDEs. Page 25, second paragraph, second sentence, add The Stillwater study identifies much of the drainage area of East and West Corral de Piedras Creeks, as well as area of alluvium of smaller streams to the southeast, as having high recharge potential. Thank you.	6/1/2020 14:24	Comment noted. Chapter 7 includes a recommendation for the GDE's to be further evaluated in the Implementation Phase of the GSP.
8	Toby Moore	DRAFT_SLOGSP_Modeling_TM No.1.pdf - Section 5. MODFLOW: Groundwater Flow Model	In section 5.1.5 "Well Pumpage", the memo identifies that the model will estimate well extractions for all wells except those owned and used for "municipal pumpage by the City will be represented in the specific wells owned and operated by the City". Golden State Water Company (GSWC) also owns and operates a public water system (GSWC - Edna System) and their municipal well extractions are metered and should be inputs into the model as opposed to estimates. Suggested text: "CHG estimates of historical well pumpage developed for the water budget analysis will be incorporated into the historical calibration of the groundwater model. Municipal pumpage by the City and Golden State Water Company (GSWC) will be represented in the specific wells owned and operated by the City and GSWC, respectively."	6/15/2020 16:41	Metered pumpage for Golden State MWC, Edna Ranch MWC, and Varian Ranch MWC are included in the model. Text is changed to reference all municipal supplies.

ID	Name	Comment Subject	Comment	Date/Time	Response
9	Jean-Pierre Wolff	General Comments	Dave, Sometime ago I mentioned to you that within the Edna Valley watershed there are several permitted reservoirs diverting surface water flow from the creeks flowing into the basin. As such these diversions impact the ecosystem and groundwater recharge through percolation. The largest of these privately owned reservoirs is the Righetti reservoir which in 1990 was granted a 4th SWRCB permit which nearly doubled the allowable capacity from 552 AF to 951 AF. The four permits are 20496, 15444, 14086 and 12887 West Corral de Piedra Creek. These permits are regularly reviewed by the SWRCB when expiring and part of the permit extension/renewal process includes an evaluation of potential impact on the downstream hydrology and ecosystem, in this case the threaded steelhead trout habitat is mentioned in previous studies and reports. Additionally, since the SLO Basin and Edna Valley is now a DWR designated high priority basin this additional information needs to be part of the record. When comparing and contrasting the annual basin recharge deficit versus upstream surface water diversion, the impact of a 951 AF reservoir and to a smaller extent the cumulative effect of other smaller reservoirs should not be ignored in the sustainability plan. As an example, the groundwater basin study being currently performed for the Arroyo Grande Basin does include the impact of Lopez Lake discharge flow rates for basin recharge and its ecosystem. I respectfully suggest that this consideration and evaluation be made part of the Sustainability Plan. Feel free to circulate my input to your colleagues collaborating on the work product. Regards, Jean-Pierre Jean-Pierre Wolff Ph.D. Grower and Vintner	6/29/2020 12:56	Our understanding of the permit is that a total storage capacity of 951 AFY is allowed as storage. Details of required outflow releases through the dam are specific to the permit conditions. The current permit relies on self-reporting of downstream flow releases by the dam operator. This is what is simulated in the model and the water budget, in the absence of more specific data. Chapter 6 (Water Budget) indicates that recent self-reported releases average about 350 AFY. The terms of the surface water diversion permit associated with Righetti Reservoir are under the purview of the State Water Board. To the extent that any permit review results in any additional water being released to West Corral de Piedras Creek, it will be beneficial to the basin.
10	Howard Carroll	Draft_SLO_GSP_Chapter_6.pdf	Groundwater Sustainability Plan SLO Basin have reviewed the exhibits and participated in your video presentations, but as a small farmer in the Edna Valley (25 acres) I do not possess the technical information nor the practical insight of my neighboring agricultural operations. Mr. George Donati, General Manager of Pacific Coast Farming, has farmed over two decades in the Edna Valley and during that period managed over 2,000 acres of irrigated crops. I value the science and broad overview of farming operations he brings to the group. Recently, I reviewed his comments to Chapter 6 and support his recommendations for investigation, analysis of points of conflict, clarification and study he has brought to your attention. With both the diversified population overlying the SLO Basin and the long-term impacts of the GSP, it becomes essential to devote time and resources to respond to questions and suggestions. Howard Carroll2175 Biddle Ranch Road San Luis Obispo, CA 93401	9/30/2020 12:40	Comment noted. We also appreciate Mr. Donati's experience and contributions to help us try to clarify this difficult chapter.

ID	Name	Comment Subject	Comment	Date/Time	Response
11	Brent Burchett	Draft_SLO_GSP_Chapter_6.pdf — Part 1	Certainly the preparation of this Chapter 6: Groundwater Budget is a complex task, and we remain willing to partner with staff and stakeholders in the SLO Basin to improve the current draft that is presented for comment. San Luis Obispo County Farm Bureau respectfully submits several suggestions and questions here for further discussion. We caution there is still insufficient data to paint a fully accurate picture of what is occurring in the Basin and what policies will actually achieve our mutual goal of achieving groundwater sustainability. Absent critical data that we all might wish existed, we should use a more robust monitoring network going forward to learn from actual outcomes of different management decisions across the Basin. Our groundwater challenges were not created overnight, and we have to be realistic about what we know is occurring, and what is simply our best guess today in 2020. This Groundwater Sustainability Plan will require long-term cooperation and open communication among the agriculture community, and the more realistic and forthright we can be about our current data strengths and weaknesses, the better we can find a path forward that works for everyone. The conclusion that the Edna Valley Subbasin is in 1,100 AFY overdraft is not fully supported by this document. We are disappointed that there appears to be a general presumption that over-pumping in Edna Valley is occurring and a partial narrative is presented here to support that presumption. For example, it is unclear why the Boyle analysis from 1991 is relied on for some areas but not in others. Look at Page 9, Table 6-2: Historical Water Budget -Edna Valley Subarea. This table is significant and will likely be a key reference point for the development of regulations for the Basin. Unfortunately, Table 6-2 currently suffers from a lack of data. We are concerned about the figures for precipitation versus stream inflows for 2010-2019. In 2011, 2016, 2017 and 2019, inflows are reported as less than outflows. This seems counter intuitive. It appears that there is only one stream for actual data for this period. It appears that a third of the years show stream outflows greater than inflows (1993, 1997, 2000, 2001, 2003, 2005, 2006, 2011, 2016 and 2019). All of these years except 2016 are wet or above-normal precipitation years. What factors might cause this difference between outflows and inflows, is it infiltration? Please explain how the of Precipitation figures were derived for Table 6-2.	9/30/2020 18:35	1. The 1100 AFY deficit value is supported by pumping estimates and water level trends. We relied on the Boyle Report for some historical data. 2. Table 6-2 Diversion of inflow to reservoir and basin runoff are the contributing factors. 3. Because all streams have increased watershed area in the downstream direction, it is not unreasonable to observe outflows exceeding inflows for wet years. In wet years the runoff from the basin contributes significantly to stream outflow. Outflow on SLO Creek may be greater due to WWTP effluent.
12	Brent Burchett	Draft_SLO_GSP_Chapter_6.pdf — Part 2	On Page 31, the use of Department of Water Resources assumptions on precipitation infiltration for the Arroyo Grande-Nipomo Mesa area of the Santa Maria groundwater Basin and reference to the Paso Robles groundwater Basin are troubling. Heavy clay soils (soils consisting of more than 50 percent clay) are the predominant soil type in the Edna Valley Subbasin. To use Arroyo Grande or Paso Robles average soil types (that are generally sandy or calcareous, respectively) to presume 11-13 inches of precipitation are required before percolation occurs into the Edna Valley is inaccurate. Another example of insufficient data is on the discussion of surface water diversions on Page 30. Reported annual surface water diversions ranged from 14 acre-feet to 900 acre-feet, with average annual diversion over the base period estimated at 350 acre-feet per year (AFY). What specific data points were used to derive this 350 AFY average? Was this data self-reported by the reservoir owner? This diversion is significant as it affects the largest stream coming into Edna Valley. The description on Page 22, Section 6.3.1 Historical Time Period, does not make sense. What was the basis for selecting certain years for groundwater storage calculations? The interval between those years is not consistent and excludes 2016. By excluding 2016, it suggests that the 2014 low point will not be the low point going forward, while an	9/30/2020 18:35	1. These values are based on field studies by Blaney in Ventura County and the Lompoc Valley (less sandy conditions than the Nipomo Mesa), which were considered applicable by DWR and Fugro to central coast basins. We are making the same assumption. 2. Yes, the self-reported diversions from 2010-2018 were correlated with precipitation. Reservoir evaporation was also factored in. 3. The years selected for estimating storage using the specific yield method were to determine storage at the beginning and ending of the base period and to illustrate storage trends. This is mentioned on page 22. The specific years selected do not change the overall decline in storage over the base period or the estimated overdraft. Yes, 2016-2019 shows an upward trend in storage in the water budget, but this was also a wet period that followed a severe drought. Overdraft takes into account both wet and dry

ID	Name	Comment Subject	Comment	Date/Time	Response
			equally valid point could be made that the 2016-2019 trend indicates an upward trend in storage. If storage is increasing, is the Basin really in overdraft? On Page 49, Table 6-14, the exclusion of 2016 paints an inaccurate picture. If 2016 was included, the significant increase from 2016-2019 would be apparent, an increase that was likely due to greater rain coupled with conservation efforts. Since the SLO Subarea was stable from 2014-2016, the 5,970 acre-feet increase is in the Edna Subarea, probably rising from 10,000 acre-feet in 2016 to 105,630 in 2019. The absence of 2016 is problematic. On Page 26, Table 6-6: Land Cover Acreages, why are the totals for Irrigated Agriculture different than those presented in Table-5: Irrigated Agriculture Acreages? We look forward to continued dialogue with all of the stakeholders and appreciate consideration of our comments.		periods. Most of the annual diversion amount is from Righetti reservoir, which is self-reported. 4. Including 2016 will not change the overall loss in storage over the base period, which is the main factor in overdraft. The water budget does show an increase in storage from 2016 to 2019. 5. Table 6-6 and Table 5 Irrigated Agriculture Acreages are not different for years that appear in both tables. In much of Edna Valley, Fall 2015 was the low point in groundwater elevations. Water budget calculations and storage calculations were made for years which had the most robust data, and interpolated in between these years consistent with other observed trends, Yes, there has been some recovery in the 2016-2019 period, but the evaluation is over the long term starting in 1987. Consistent declining water levels indicate Edna Valley is in overdraft.
13	Howard Carroll	Workshop #3 Sustainable Goal Setting	Sustainable Goal Setting Comments: I have reviewed the options for both the Minimum Thresholds (MT), the Measurable Objectives (MO) and the respective diagrams and charts. It appears some off the options are a step backwards in the management of our water. I endorse goals that will allow agricultural operations to continue in a sustainable envelop rather than force a reduction of agricultural operations when we are above the water levels in last year of the 2015 drought. Therefore, I support MT alternative #3 and MO alternative #4.I believe the long-term solution to the MT and MO of the Edna basin is by enhancing the water resources that are available. Importing recycled water from the City of San Luis Obispo, move the release point of reverse osmosis treated water from Sentinel Oil upstream and look carefully at the storage and releases of the Righetti Dam. Private and governmental cooperation could make these options a reality and really provide sustainability for our water basis.	10/27/2020 16:00	Your endorsements for the SMCs are noted. Two of the projects you mention (City recycled water and Sentinel Peak discharge as supplemental sources) are included in the Projects and Management Actions chapter. The terms of the surface water diversion permit associated with Righetti Reservoir are under the purview of the State Water Board. To the extent that any review process of this permit results in any additional water being released to West Corral de Piedras Creek, it will be beneficial to the basin.
14	Fintan du Fresne	Workshop #3 Sustainable Goal Setting	Firstly, I greatly support efforts to collectively manage this very important resource. My background is in geology and I have been involved in grape growing the Edna Valley for 15 years now. As a geologist I have a deep concern with establishing thresholds and objectives on such a limited data set. Both the number of wells used and the limited length of most well data do not allow a scientifically rigorous record of the basin to be established. With this in mind, if MT and MO must be set to comply with SGMA, we should at this stage use those that allow the greatest flexibility: MT 3 and MO 4.	10/30/2020 9:00	Your comments on the proposed SMCs are noted. The period of record of available data is used in establishing SMCs, and this data will improve in the future with an expanded monitoring well network.

ID	Name	Comment Subject	Comment	Date/Time	Response
15	Nathan Carlson	Workshop #3 Sustainable Goal Setting	As the manager of an agricultural business within the Edna Valley, the sustainability and livelihoods of many of my employees, vendors, and business partners rest upon our ability to continue to operate and farm securely into the future. We operate several water wells to support our business, and have put in place best practices to preserve and conserve our water resources. Our farming operations have been certified under an audited Sustainability program since 2014, and our production process and facility have just this year attained a Sustainability certification as well only the fourth winery to achieve this level of certification. What I have learned from our process of continuous improvement is that in order to make good decisions, it is necessary to measure consistently and accurately over a long period of time, in order to understand trends and priorities. In the process of seeing the water budgets in development, I have concerns that not enough data has been collected to lock the basin into restrictions based on estimates and questionable data. For this reason, I would urge adoption of the Minimum Threshold alternative #3, and the Measurable Objective Alternative #3 for the time being. Together with collection of data over the first five years, we will have a stronger basis to enact future guidelines for the basin. What does make sense today is for our basin to seek supplemental water sources that have been identified, such as recovered water from the city of San Luis Obispo, and to pursue mandated releases from reservoirs that trap and deprive the basin of its natural recharge. Meanwhile, we and other users will continue to pursue strategies of water use reduction, reclamation and storage, and reduction of landscape and crop demands as replanting decisions are made.	10/30/2020 11:18	Water budget calculations and storage calculations were made for years which had the most robust data, and interpolated in between these years consistent with other observed trends.

ID	Name	Comment Subject	Comment	Date/Time	Response
16	Jeanne Blackwell	General Comments	Can you really have a discussion about groundwater protection without recognizing the constant threat of over a million gallons a day of toxic, radioactive waste, man made chemicals, hydrogen sulfide to mention just a few that is deposited each day at the Arroyo Grande Oil Field that sits on 3 active fault lines? This water could potentially reach any ground water in the county and contaminate it. Once the groundwater is contaminated and with the construct of the fault lines no water anywhere in the county is safe. And the reason for that is none of the wells at the Arroyo Grande Oil Field have been certified safe by the EPA Class I Underground Injection Control program mandated under CFR 144.11. So, the biggest threat to our water is the elephant in the room and I would like to know if you are going to address this issue. Every community and municipality's ground water in SLO County is threatened with irreversible and irreparable water damage because of the unlicensed, un permitted, illegal and unlawful dumping of toxic waste in the unincorporated areas of SLO county. The Board of Supervisors is the lead agency and responsible for allowing the Oil to operate without permit or license. It seems to be it would behoove every municipality that depends on clean, unencumbered groundwater would demand the Board of Supervisors get the proper and necessary certification and official verification that the Arroyo Grande Oil Field is safe to dispose of radioactive toxic and other hazardous waste without fear or threat of contamination for 10,000 years or until the toxic waste becomes inert, whichever comes first. I would like to know what you intend to do about the illegal dumping in our backyard. Thank you.	6/29/2020 14:15	The Arroyo Grande oil field is outside of and downgradient from the San Luis Obispo Valley Groundwater Basin,and is not regulated under SGMA. Additionally, those wells are completed in bedrock formations which are not part of the Basin sediments. Under appropriate operations and permitted conditions, oil field extractions operations are not anticipated to endanger water supply or quality in SLO Basin. Effluent from the Sentinel Peak water treatment plant has undergone tertiary treatment and is being considered as a possible supplemental water source for the Edna Valley agricultural stakeholders under the Projects and Managements Actions evaluations.
17	George Donati	Draft_SLO_GSP_Chapter_6.pdf - 6.3.5 Total Groundwater in Storage	To: Dick Tzou and all Consultants — My biggest question for the Edna Valley Basin, how can these consultants come up with a Sustainable Yield of less than 3500 AFY in a basin, when the Basin contains Groundwater Storage Estimates of an average of 120,000 AF? This Sustainable yield is only 3% of the storage. If you read the paragraphs below table 6-14, they explain why they increased the groundwater storage to a much higher number in the Edna Basin than previous consultants. It used to be 34,000 AF of storage. However even with this 3.5X increase in storage, the sustainable yield did not increase at all. In fact it decreased. These numbers do not make sense at all to me.	9/28/2020 13:53	Safe yield is determined by stopping storage and water level declines; it is not a function of total groundwater in storage. The sustainable yield estimate is the level of pumping that would not result in continued decline in water levels or groundwater in storage. Safe yield is not a function of total Basin groundwater in storage. For example, Paso basin has about 30million AF storage but only 60,000 AFY safe yield (0.2%). Consistent declining water levels indicate Edna Valley is in overdraft.
18	Chris Darway	General Comments	The graph for pumping does not have an accurate trajectory for two reasons: (1) the trajectory for 2007 to 2019 should be down and not up; and (2) the trajectory being down since 2015 is dramatic. Conservation measures after drought.	9/29/2020 16:48	Assuming we are talking about Figure 6-8, the trajectory for groundwater extraction is shown as decreasing pumping from 2007-2019. The visual trajectory appears “up” only because the bars are below the zero line, so a decreasing trajectory is toward the top of the page.

ID	Name	Comment Subject	Comment	Date/Time	Response
19	Chris Darway	General Comments	Why is 2016 data being excluded? I keep rereading the Water Budget material and came across the reasoning for those years at p 22: "These years include the beginning and ending years in the base period, along with sufficient intervening years to characterize change in storage trends through the base period". This is highly discretionary. Look at the intervals between the years chosen: 4,5,3,7,6,3 and 5 years. More important, by excluding 2016, they allow the argument that the 2014 low point will not be the low point going forward, when an equally valid point is that the 2016-19 trend indicates an upward trend in storage. If increasing storage, where is the overdraft?	9/29/2020 16:49	Hydrologic base periods are selected according to several criteria, including length of record, inclusion of at least one extended wet period and dry period, beginning and ending at a similar point in the cumulative precipitation curve, etc. However, 2016 data is not excluded. Tables 6-1, 6-2, and 6-3 present estimates for all water budget components for every year from 1987-2019.
20	Chris Darway	General Comments	On page 44 why did you choose the years shown in table 6-14? There were 21 representative wells (note some of our wells weren't developed until the early 1990s and then select the years for water levels without any explanation as to why those years?	9/29/2020 16:50	The years presented in Table 6-14 are years for which water level maps were generated, which were then used to estimate changes in storage based on the water levels between those years. Often it is not easily discernible in a basin scale water level map to see water level changes between successive years
21	Earl Darway	General Comments	How can consultants come up with a Sustainable Yield of less than 4000 AFY in a basin, when the Basin contains Groundwater Storage Estimates of an average of 120,000 AF? This Sustainable yield is only 3% of the storage.	9/29/2020 16:51	Safe yield is not dependent on the total amount of groundwater in storage. The sustainable yield estimate is the level of pumping that would not result in continued decline in water levels or other undesirable effects. Safe yield is determined by stopping storage and water level declines; it is not a function of total groundwater in storage. For example, Paso basin has about 30million AF storage but only 60,000 AFY safe yield (0.2%).

ID	Name	Comment Subject	Comment	Date/Time	Response
22	George Donati	Draft_SLO_GSP_Chapter_6.pdf - 6.3.4 Historical Groundwater Budget — Part 1	To Dick Tzou and all Consultants, Again in the Groundwater Budget, I find estimated and incorrect Data. Or, I do not understand the Data. My questions are below: Groundwater: 1. I do not see where streambed infiltration is counted here? Why not if over 5000 AFY flows through our streams? 2. Explain all these inflow and outflow numbers? Are they estimates? • Page 5. This map may need to be updated. This map shows irrigated acres inside and outside the basin. How is this going to be managed by SGMA? Wells outside of the basin DO affect the basin. How are these wells going to be managed by SGMA? • Page 26. Table 6.6. Land Cover. Why is Irrigated AG in the Edna Valley, 2001 2016, a different total in this table than the subtotal of irrigated AF in Table 6.5? 237 acres of Developed Urban. Is this homes and businesses? • Page 27. Stream inflow to Basin. No mention here of the Dam preventing stream inflow to the Edna Basin. • Page 30. Stream inflow was adjusted due to the Dam. However you used 2010 to 2018 as an average for the entire 33 years. Maximum diversion of 900 AFY does not make sense in the big rain years with over 5000 AFY flowing out of the creeks. And this includes ET? According to your water budget ET of precipitation amounts to a 58% - 90% loss. Please check these numbers. • Page 31. ET of Precipitation. You are using Arroyo Grande/Nipomo Mesa (Sandy Soils) and Paso Robles to estimate how much rain we need to have before infiltration starts. Edna is mainly heavy clay soils and is no comparison to sandy/ calcareous soils. Using 11-13 rain before percolation is not correct. • Page 36. Table 6-8. This data does not make logical sense. Lots of Assumptions here. We need real Data! • Page 40. Urban groundwater extractions. Are the individual homeowner wells being counted here? Does the septic leach field counter the extraction? How much ground water does the golf course use? • Page 41. Agricultural Groundwater Extractions. These are all Estimated! Why not get real data and then use real data to determine groundwater extractions. • Page 43. Table 6-11. Consumptive Water use. Are you using the low, med or High to estimate water use?	9/30/2020 11:50	1. Streambed infiltration is counted under groundwater/surface water interaction (Section 6.3.3; page 30). On the main tables (6-1 to 6-3), is it shown as an outflow item from surface water budget and inflow item for groundwater budget. 2. Explanation of all the inflow and outflow numbers are presented in Chapter 6. Inflow and outflow items are estimates derived from hard data such rainfall, water levels, temperature, irrigated acreage, aerial imagery, municipal pumping, surface water deliveries, and WWTP discharges. 3. Acreages shown outside the basin are irrigated by wells located in the basin. These may be updated as new information comes forward. Management of wells outside the basin are not under the purview of SGMA. 4. The acreage totals for the overlapping years in these two tables (2011, 2013, and 2016) are not different, they are the same. Yes, 237 acres are homes and businesses. 5. Reservoir impacts to streamflow is presented in the very next paragraph, although because of the need to insert two figures, the chapter text resumes on page 30. 6. The dataset was from 2010 to 2018, so not just those two years. Rather than an average, the dataset was used to correlate reported diversions with rainfall. 7. Maximum diversion is self-reported by reservoir operator and based on limit of reservoir size, not amount of rainfall. 8. These values are based on field studies by Blaney in Ventura County and the Lompoc Valley (less sandy conditions than the Nipomo Mesa), which were considered applicable by DWR and Fugro to central coast basins. We are making the same assumption. 9. The data indicates lower thresholds for irrigated land, which makes logical sense. Local field studies for infiltration thresholds were not part of scope of work for this planning document. They could be done in the future. 10. Yes, individual homeowners are counted and septic return flows partially counter the extraction. The golf courses are irrigated in part with recycled water and in part with groundwater, which are accounted for separately in the water budget. Golf course groundwater use is included in groundwater extractions (Urban). Recycled water use on golf courses is accounted for through the ET of applied water (urban) and infiltration of applied water (urban). 11. Yes, metering agricultural wells for groundwater use would be useful. 12. Each year has a specific value based on the daily soil moisture budget (Figure 6-17). The low, medium and high values are shown in the table for perspective.

ID	Name	Comment Subject	Comment	Date/Time	Response
23	George Donati	Draft_SLO_GSP_Chapter_6.pdf - 6.3.4 Historical Groundwater Budget — Part 2	• Page 49. Table 6-14. Groundwater storage. This is our reservoir to use when in drought years and this can be replenished in large rainfall years. If this is truly groundwater storage, then we can re-fill this reservoir in the wet years, and use it in the drought years. Correct? How did 3300 AF sustainable yield get calculated from a 120,000 AF reservoir? • Page 50. Change in Storage 1987-2019. The Edna Valley shows a 27,000 AF decline over these 33 years, which is less than 100 AF/year. They state this is reasonable. However they again omit the fact that the 1000AF dam does not let water into our basin. If they calculate this loss, the Edna Valley actually has gained storage over the past 33 years. • Page 53. Table 6-17. Estimated Overdraft. These numbers are not real data. They cannot use the Boyle study for some of their data, and then not use the Boyle study for the conclusion of available water at 4,000 AF/year. • Page 56. Current Water Budget. 1. Current years (2016-2019), Rain increased by 1500 AFY. 2. Stream flow INTO our basin decreased by 140 AFY. How can this be? 3. Groundwater extractions. Where do they get these numbers. They are not reasonable to go higher in wet years of 2016-2019 when Ag Irrigation is much less. 4. Streamflow OUT of the Basin. In the 33 year total of 3580 is only 50 AFY less than the inflow into the Basin. This would mean that there is only 50 AFY of infiltration into the basin???? However the Groundwater Budget shows 1890 AFY infiltration.??? Thank you, George Donati	9/30/2020 11:50	1. If the replenishment in wet years does not balance the storage loss in dry years, no amount of storage will be sustainable. They are not directly related. The 3,300 AFY yield is based on being able to balance the elements of inflow and outflow over long-term climatic conditions (wet and dry). 2. A decline of 27,440 acre-feet over 33 years is 830 AFY loss in storage, not less than 100. The reservoir is estimated to withhold an average of 350 AFY of surface inflow to the basin, so removing the reservoir would only partially offset the loss in storage. Sustainable yield is calculated on a pumping amount under which continued declines will not occur. 3. The Boyle report was used to fill some of the historical surface water (imported water) data which came from City records. The conclusions of the Boyle report are provided as a comparison to the current water budget. 4. The reservoir on West Corral de Piedra Creek diverted enough streamflow to cause inflow to go down while rainfall increased. 5. Average Ag irrigation from 2016-2019 was greater than during the base period (Table 6-19), so extractions going up makes sense. 6. There is an estimated 510 AFY of average stream infiltration in the basin (Table 6-19). The difference between stream inflow and stream outflow is only 50 AFY because there is significant surface water runoff within the basin, especially during high rainfall years. Additional declines which may be feasible for deep agricultural wells may not be feasible for shallower domestic wells.

ID	Name	Comment Subject	Comment	Date/Time	Response
24	Keith Watkins	Draft_SLO_GSP_Chapter_6.pdf - Part 1	Draft SLO GSP Chapter 6 Comments: • Page 7, first paragraph SLO Basin fills quicker and basin becomes full, preventing further recharge. When this occurs does some water flow back into the Edna basin if it is still not full? This would provide additional credits in wet years to the Edna basin. • Page 17, 6.1.1 Is the Base Period truly representative of the basins? Prior to 1987 was a very wet period, followed by a very dry period (1987 through 1991). The period chosen contains two extended droughts with individual wet years between. Wouldn't it make sense to have a wet period to balance the two extended droughts? • Page 19, 6.1.1 Rainfall totals are based on Cal Poly records with an attempt to balance with data from the gas company. This information slights the Edna basin where growers have historical data showing an average of 20% more rainfall than the numbers being used. Shouldn't we balance these number with additional data from south of the Edna basin? Possibly Arroyo Grande or Lopez Lake? • Page 31, Evapotranspiration of Precipitation Assumption that no water infiltrates when precipitation is below 11 inches. This does not account for heavy rain events early in the season that do penetrate below the crop root zone. Nor does it account for the fact that the crop is potentially already saturated from an irrigation allowing precipitation to penetrate much quicker. Basing this data from the Nipomo Mesa, which has much more wind than the Edna basin, also lowers the reliability of the numbers. • Page 33, Stream Outflow from Basin - Outflow on Pismo Creek is all based on data from two years at the end of a drought period (91). These years are not representative due to the lower water levels in the basin after a drought. So much of stream outflow is dependent on the intensity of the rain event. Actual data needs to be collected to determine when flows happen and at what volume in correlation with storm events. • Page 34, Infiltration These infiltration numbers do not take into account cultural practices that enhance infiltration and minimize runoff, such at soil chiseling, ground cover between rows, contouring of rows to catch water flow, and drains to catch flows and recycle to reservoir storage. Also, assumptions that no water infiltrates after 30of rainfall does not consider the timing and intensity of rain events • Page 37, Subsurface inflow. Water flows down gradient from the south end of the Edna basin, through the basin and out either Pismo Creek or into the SLO Basin. The model has flows out of Edna basin even during drought periods when the gradient should be reduced. Does the model consider this fact and reduce outflows to compensate for lower groundwater levels in the Edna basin?	9/29/2020 10:52	1. No, there is not enough pressure for groundwater in SLO Valley to flow upgradient into Edna Valley. 2. Figure 6-10 shows base period covers three dry periods, three wet periods, and one average period. It is balanced. 3. The spatially balanced average annual precipitation data in Figure 4-3 (Chapter 4) does not show the Edna Valley as having more rainfall than Cal Poly (actually less). The Figure supports using the Gas Company location for estimation of rainfall in the Basin. 4. The 11 inches is for agricultural fields and accounts for irrigation – otherwise the number is 18 inches (Table 6-8). Heavy rains in the early season are more likely to create runoff than infiltration – the soil moisture deficit needs to be met before infiltration can occur. 5. Outflow is not all based on two years of data, but only those two years can be used to check the numbers. Yes, we need stream flow data. 6. Agreed. The methodology does not account for individual grower practices or specific rain fall patterns. 7. Yes, that is considered, and the flow from Edna to SLO is an annual average based on high and low values (Page 39). Water does not flow from SLO Valley to Edna Valley; the hydraulic gradient is to the northwest. The Cal Poly data is the most robust dataset available in the basin. Average isohyetal contours based on long term records, and data from the Gas Company rain gage are used to estimate rainfall in other parts of the Basin. Base period selected based on several criteria, and must include at least one wet period and dry period, start and end on similar climatic conditions, etc. Additional stream flow data will be recommended to be collected as part of the implementation plan. The annual time step of the water budget requires some simplifying assumptions. The hydraulic gradient remains northward from Edna Valley to SLO Valley even in times of drought (see water level maps in Chapter 5).

ID	Name	Comment Subject	Comment	Date/Time	Response
25	Keith Watkins	Draft_SLO_GSP_Chapter_6.pdf - Part 2	• Page 49, Table 6-14 Groundwater Storage. From 1986 to 2005 (19 years) the average annual change was -349 ac-ft per year. Are we putting too much of an emphasis on the lowering of levels during the drought with this current evaluation? With Edna basin storage of over 105,000 ac-ft, setting target water levels lower than current pumping levels seems prudent to allow for sustainable agricultural operations and protection of the basins. • Page 53, 6.3.8 Utilizing Et to establish groundwater usage is not accurate when many growers utilize various methods to determine crop water demand. Many permanent crop growers utilize deficit irrigation to improve crop set, improve fruit quality, or meet winery demands. • Page 56, Table 6-19 - The current model assumes higher ag extractions, even with more acreage coming out of production? Stream inflows decrease even with an increase in precipitation. Stream outflows increasing, even with decreasing inflows. For the last four years, the model still shows a reduction in groundwater, even though we are showing a rise in the water levels (Table 6-14)? With so much contrary information, we need to build good data base to build our program on. We should take the next five years to build good information and use it to make the correct decisions on whether the basin is truly in a deficit position. Using data developed to substantiate the hypothesis does not create good policy.	9/29/2020 10:52	1. This will be evaluated in Chapter 8 - Sustainable Management Criteria. 2. The methodology used is the industry standard for estimating crop demand and is supported by DWR BMPs. It may not address specific grower practices but, short of water meters, is the most efficient way to evaluate demand on the basin scale. 3. There was still more average acreage from 2016-2019 than for the 1987-2019 base period (Table 6-5). 4. Stream inflow was less because of the upstream reservoir diverting flows after the drought. Stream outflow was more because the precipitation was greater and created more runoff. Without the reservoir, both the inflows and outflow would have been greater in 2016-2019, compared to the base period. 5. The rise in water levels mentioned is based on comparing 2014 storage to 2019 storage in Table 6-14 which is from the specific yield method. The reduction in groundwater over the last four years (2016-2019) is from the water balance. These are two different time periods and two different methods. The information is complex and may appear contrary. The status of the basin and magnitude of the deficit is based on accepted methodologies in accordance with DWR BMPs. Yes, we need to build good data to make the correct decisions. It would not be unreasonable to take the next five years to build on the available information and use it to make informed decisions on whether the basin is truly in a deficit position, provided that the actions taken do not result in avoidable, undesirable consequences.

ID	Name	Comment Subject	Comment	Date/Time	Response
26	George Christensen	General Comments	Comments on Chapter 6 of SLO Valley Basin GSP1) • Table 6-4: Historical Base Period Rainfall. This table causes me to challenge the credibility of the entire GSP. What kind of farmer, engineer, doctor, banker or venture capitalist is going to make critical decisions when more than 25% of the foundational data supporting the proposal is manufactured? Furthermore, to apply a simple constant value of 90% to all categories of the data seems like a bit of a "short cut" and a tad irresponsible. If we must follow this example of "creating datum", then I suggest doing an extrapolation for each of the year categories, e.g., dry, wet, Above Normal, Below Normal. I did a simple regression between Cal Poly and the Gas Co and sure enough it was close to a 90% relationship in the "wet" years. However, other years had lesser values with "dry" years having the lowest relationship of only 83%. Another oddity is all of the years are categorized into one of four categories: wet, dry, above normal or below normal. This states that a "normal" year does not exist where the measured rainfall fell within an expected range. Lack of a "normal" group will skew the data such that EVERY datum is abnormal and normalcy can never be observed or measured. Lack of a normal range immediately causes bias in the analysis of the data. To summarize, this table causes me to be skeptical of other data and conclusions set forth in this chapter. 2) For the Edna Valley subarea, several streams that provide critical recharge via percolation are impacted by private reservoirs totaling more than 900AF. While I believe that these reservoirs are permitted and well-maintained by the owners, data is not presented regarding the outflow from those reservoirs/dams which could impact the recharge of the Edna Valley subarea. I would like to see "credible data" be included into this model reflecting the effect these private water storage facilities are or are not having on the Edna Valley subarea. 3) While "the estimated average specific yield value for the Edna Valley subarea is also close to 30 percent greater for GSP storage calculations." (Section 6.3.5), where is the updated/revised sustainable yield for this newly sized subarea? Respectfully, George Christensen Vegetable grower	9/29/2020 17:11	1. The correlation between rainfall at Cal Poly and the Gas Company is robust (R2=0.9625) and used appropriately for adjusting annual rainfall to better represent the basin. The DWR classification for assigning the "type year" don't include normal years. 2. The self-reported groundwater diversions from the reservoir were used in the water budget and summarized on page 30. 3. The updated/revised sustainable yield for the Edna Valley is 3,300 AFY (section 6.3.7.) Note that storage and sustainable yield are not directly related.
27	Thomas Murrell	Workshop #3 Sustainable Goal Setting	We need to have accurate data before making decisions. Are there plans to install monitoring wells? if so, how much time is needed to get accurate information from those wells? Seems like we are using a lot of guesswork to create a very impactful policy. I don't think it is wise or fair to make policies that end up being too drastic. Proposed Monitoring Level No. 2 (Higher than drought levels) is too drastic. The goal should be to adopt reasonable polices and resource management so that the Edna Valley reaches a level of sustainability for all stakeholders. Agriculture is precious to the Edna Valley and San Luis Obispo. Let's help sustain it, not destroy it.	10/29/2020 10:28	Comments on alternative SMC proposals are noted, and were discussed and considered during public GSC meetings We are improving the dataset with about 40 wells in the GSP monitoring network.

ID	Name	Comment Subject	Comment	Date/Time	Response
28	George Donati	Workshop #3 Sustainable Goal Setting	1. Since 2008 the Edna Valley Growers have been asking the City of SLO to sell to us some of their tertiary treated water since we had heard that they are dumping it down the SLO creek to the ocean. We have gone through 1 long period of drought recently and we could have used that water during the drought rather than lowering our water table. The City continues to put up road blocks to sell us water. If we had this water available, we would not be in an overdraft of our basin . 2. The Righetti Dam releases into the creek need to be enforced. This is over 600 acre feet of water that should be flowing into the creek and into the basin. 3. Golden State Water needs to look into purchasing water from the State Water Pipeline so that they are not using water from the Edna Valley Basin. Golden State currently has a Selenium issue with their water. This could alleviate this Selenium issue to all other Domestic water users in the Basin. 4. We need to Augment Water storage in the basin with Sentinel Peak Resources R.O. water. This RO water is currently dumped into the Pismo Creek and flows to the ocean due to little to no percolation in this area. We propose to move the discharge point of this RO water further up the Corral de Piedra Creek so that this helps to maintain a live stream for fish and at the same time recharge the basin.	10/30/2020 9:21	Each of the projects listed is evaluated as part of the Projects and Management Actions Chapter (Chapter 9).

ID	Name	Comment Subject	Comment	Date/Time	Response
29	Brian Talley	Workshop #3 Sustainable Goal Setting	As we consider setting key goals and targets for management of the SLO Basin, goals that will likely have huge impacts on our future sustainability, I think two key issues are not receiving enough consideration. First, much of the data that forms the basis for decision making is incomplete, erroneous or contradictory. Second, not enough consideration is given potential supply enhancements that could materially affect the safe yield of the basin. Because of this, I favor a moderate approach to goal setting in the near term to learn more about how our basin responds to adaptive management practices over the longer term. For instance, much of Chapter 6 of the draft GSP is composed of estimated values. More significantly, it appears that the saturated thickness for well 31S/13E-27MO3 is dramatically understated at 60 feet when in fact it is 280 feet. This data is then interpolated to conclude that the saturated thickness for all wells in the Edna Valley is much less than it is. This in turn leads to a recommendation of drastic reduction in pumping in the Edna Valley, potentially to the MT2 level, which could be insufficient to support existing agricultural operations. Representative monitoring wells need to be selected and accurate drilling logs need to be reviewed so that we have a more accurate data and can base management decisions on that data. Meanwhile, there are a number of opportunities to enhance water supply in the basin that haven't received enough consideration. A group of Edna Valley growers has tried to purchase tertiary treated water from the City of San Luis Obispo since 2008. This could add 600-1000 AF to the basin supply. The same Edna Valley growers are in discussions with Sentinel Power to move their discharge point for RO treated water, a byproduct of their petroleum operations, further up the Corral de Piedra creek and adding as much as 1000 AF to the basin. The Righetti dam has operated inconsistently with the permit issued by Department of Water Resources. Ensuring that their releases comply with the permit would add 600 AF to the basin and enhance the Corral de Piedra creek fish habitat. Golden State Water is struggling with elevated Selenium in their wells: they should purchase the State Water they are entitled to, which would both alleviate their Selenium issue and enhance the supply of the basin. Farmers have adopted conservation measures including pressure compensating drip irrigation and the use of highly efficient micro sprinklers. Let's make sure that domestic users are as focused on conservation as farmers. True sustainability is a long game, with a horizon of 20 years as opposed to 5. We shouldn't make critical decisions now based on incomplete or erroneous data. At the same time, we need to explore every viable opportunity to enhance the water supply of the basin. Making bad decisions now could have devastating impacts on agriculture in the Edna Valley, one of our county's critical industries, as well as the foundation of San Luis Obispo's green belt, which is a defining characteristic of the city.	10/30/2020 9:40	We are improving the dataset with about 40 wells in the GSP monitoring network and proposed stream gages in Edna Valley. Construction Data for Well 27M03 has been corrected. The Projects and Management actions involving supplemental water sources that you mention are being considered in Chapter 9.

ID	Name	Comment Subject	Comment	Date/Time	Response
30	Jim McGarry	Draft_SLO_GSP_Chapter_6.pdf - 6.3 HISTORICAL WATER BUDGET	I do not see where streambed infiltration is counted here? Why not if over 5000 AFY flows through our streams? In aerial images for this small valley. Irrigated Ag acres. This page needs to be checked for accuracy. We do not want to rely on aerial images for this small valley. Urban groundwater extractions. Are the individual wells factored here? Does the septic leach field counter the extraction? How much ground water does the golf course use?	9/28/2020 14:08	Streambed infiltration is labelled as GW/SW interaction in Tables 6-1, 6-2, 6-3. Aerial images are reasonably accurate for this purpose. Yes, they are. Yes, total estimated pumpage from the water budget was distributed equally to all well locations provided in county well GIS data. . Golf Course use is included as part of Urban Demand per DWR Water Budget BMP and not reported separately.
31	Chris Darway	Draft_SLO_GSP_Chapter_6.pdf	Why is 2016 data being excluded? I keep rereading the Water Budget material and came across the reasoning for those years at p 22: "These years include the beginning and ending years in the base period, along with sufficient intervening years to characterize change in storage trends through the base period". This is highly discretionary. Look at the intervals between the years chosen: 4,5,3,7,6,3 and 5 years.	9/29/2020 16:47	2016 data is not excluded from the water budget. Tables 6-1, 6-2, and 6-3 present estimates for all water budget components for water years 1987-2019.Groundwater storage is estimated by the water budget for all years using all the available data over the base period. The years selected for estimating storage using the specific yield method were to calibrate the beginning and end of the base period and to illustrate storage trends. They do not change the overall decline in storage over the base period or the estimated overdraft.
32	James McGarry	General Comments	1. Since 2008 the Edna Valley Growers have been asking the City of SLO (using Rob Miller with the Wallace Group) to sell to us some of their tertiary treated water since we had heard that they are dumping it down the SLO creek to the ocean. We have gone through 1 long period of drought recently and we could have used that water during the drought rather than lowering our water table. The City continues to put up road blocks to sell us water. If we had this water available, we would not be in an overdraft of our basin (if we are at all). 2. The Righetti Dam releases into the creek need to be enforced. This is over 600 acre feet of water that should be flowing into the creek and into the basin.3.Golden State Water needs to start purchasing water from the State Water Pipeline so that they are not using water from the Edna Valley Basin. Golden State currently has a Selenium issue with their water as brought up by Toby Moore in the Workshop. This could alleviate this Selenium issue to all other Domestic water users in the Basin. 4. We need to Augment Water storage with Sentinel Peak Resources R.O. water by discharging the water that is currently going out to the ocean, further up the Corral de Piedra Creek. 7. Corral de Piedra creek needs to be brought back to life to save the fish. If this were done using surface water, then our basin would be in a plus balance. 8. During the last drought, very few domestic wells went dry (these were old wells that were not drilled to a sustainable level). Those unsustainable wells have been replaced. We can get through the next drought with MT's below the last drought levels.	10/30/2020 11:47	The projects listed are evaluated as part of the Projects and Management Actions Chapter 9.

ID	Name	Comment Subject	Comment	Date/Time	Response
33	Andy Mangano	Workshop #3 Sustainable Goal Setting - Part 1	Edna Ranch Mutual Water company (East) / Public Comment SLO Basin GSP — Stakeholders Workshop #3 — 10/01/2020 Edna Ranch Mutual Water Company (East) appreciates the opportunity to provide the following comments. We recognize the Basin faces challenges and we encourage a collaborative process whereby SGMA employs science and up to date accurate information to best determine a sustainable plan for all users. Observations: 1) in our initial review, there appears to be incomplete data which requires the consultant to base their conclusions on estimates, For example: A) There is a lack of data for stream inflows and outflows B) A lack of well drilling logs C) A lack of monitoring wells to accurately measure water levels D) The representative well most relevant to our MWC is 315/13E-27M03, which is depicted on page 26 of the workshop #3 materials. We understand the actual drilling logs show saturated thickness of 280 feet rather then 60 feet mentioned Suggestions: 2) Robust stream gauges, procurement of all well drilling logs for all representative wells, robust well metering locations and strategically located monitoring wells. 3) In the first 5 years, we should fully develop all revenant scientific data and at the same time, proceed cautiously given the lack of data, and the necessary reliance or guesses and estimates, that could be considered unreliable.4) In reviewing the Paso Robles GSP, we note there is a 5 year period of improved monitoring and fact gathering before any policies are implemented. We encourage Edna Valley adopt the same approach during the first 5 year period. We also recommend during this period to fully explore all augmentation opportunities and conservation measures.	10/31/2020 9:45	As part of the monitoring network the GSP will recommend additional stream gages. We are improving the dataset with 40 wells in the GSP monitoring network and will collect a robust dataset in the 5 years following the development of the GSP. Well construction data for 27M03 has been corrected.

ID	Name	Comment Subject	Comment	Date/Time	Response
34	Andy Mangano	Workshop #3 Sustainabl e Goal Setting - Part 2	5) SGMA requires a minimum of 10 years for the historical analysis. If the 10 year period had been adopted, the trend for groundwater pumping would be decreasing rather than increasing when using the 33 year model as depicted on Page 29 of 127 in Chapter 6 of the water budget. 6) Actual City of SLO greenbelt extends out to Edna Ranch. The City in 2014 adopted a policy in support of providing recycled water use within the City's Greenbelt. What is the status of this policy implementation? 7) The last page of the Workshop #3 materials projects an augmentation of 500 AFY that would raise the water levels by 33 feet. If the City could provide up to 1000 AFY of recycled water, it appears the water levels would increase for our representative (MO3) to 1995-99 levels as depicted in the graph on page 26. 8) Chapter 6 of the water budget, page 25 (70 of 127) shows there are 453 acres of row crops. Page 43 (88 of 127) indicates row crops (overhead sprinklers) use a median of 1.6 AFY and vineyards (drip irrigation) use 0.6 AFY. Does this mean that if row crops converted to drip irrigation there would be a corresponding reduction of 453 AFY? If row crops converted from overhead sprinklers to drip, would this not achieve a savings of 453 AFY? It appears a lot of water could be saved by converting overhead sprinklers to drip irrigation. Respectively Submitted By Edna Ranch Mutual Water Company (east) Board Of Directors	10/31/202 0 9:45	The management actions listed here will be considered in chapter 9/Projects and Management Actions. It will consider irrigation efficiency as a management action. However, it should be noted that increased irrigation efficiency also results in reduced irrigation return flows, so the net impact on the aquifer may not be significant.
35	Earl Darway	General Comments	There are two lines of numbers that are curious. 1/3 of the years show stream outflow exceeds inflow: 1993, 1997, 2000, 2001, 2003, 2005, 2006, 2011, 2016, and 2019. All these years are Wet of Above Normal, except 2016 Below Normal. Is this due to infiltration and / or GW/SW intersection? Does this make sense to you? Similar question regarding ET evaporation: In 8 Dry years, the evaporation essentially equaled the precipitation: Precip ET Evaporation1987 6780 66101990 5960 58602007 3810 38002009 5170 51002013 4640 46002014 4590 45502015 5230 51602018 6130 6020 The numbers above don't make sense.	9/30/2020 19:01	1. All streams increase in watershed area in the downstream direction. In wet years the runoff from the basin contributes significantly to stream outflow. 2. 2016 followed a severe drought, and diversion of inflow to the upstream reservoir was a contributing factor. 3. Since there is a need to overcome the soil moisture deficit before infiltration can occur, there is a minimum rainfall threshold the must be met every year. In dry years, this minimum can take of most or all of the available precipitation. That's why there's often little recharge in dry years.
36	Earl Darway	General Comments	Page 29 shows a gain of 5970 AFT for years 2016 -2019. The graph shows an upward trajectory for Edna. Table 6-14 should show the amount of storage for 2016. By not doing so, we miss the great increase from 2016-2019--most likely due to greater rain plus conservation efforts. Since the SLO subarea was stable during 2014-2016, the 5970 increase is in Edna--probably rising from about 100,000 AFT in 2016 to 105, 630 in 2019. Impressive and not apparent because 2016 numbers are not shown.	9/30/2020 19:01	Not finding referenced gain on page 29, but storage increase between 2016-2019 is estimated by water budget in Tables 6-1, 6-2, 6-3. Focusing on a partial rebound following severe drought doesn't resolve big picture declines. We must evaluate a long-term time period.

ID	Name	Comment Subject	Comment	Date/Time	Response
37	Robert Schiebelhut	Workshop #3 Sustainable Goal Setting	Revision Needed For Representative Well 31S/13E-27MO3: Page 22 of the materials presented at Workshop #3 depicts a graph of the Baggett Main Well--31S/13E-27MO3--a well at Edna Ranch. I believe the well log for this well was made available several years ago but in any event, I have recently forwarded the drilling log to David O' Rourke. In fact, the drilling log shows an actual depth of 400 feet with sands all the way to 400 feet. Bedrock was not encountered. Please revise the graph to show the well depth at 400 feet and al least 280 feet of Saturated Thickness--- instead of 60 feet. Thank you	10/26/2020 13:48	Comment noted, model and hydrograph have been corrected to reflect this.
38	Brian Bertelsen	Workshop #3 Sustainable Goal Setting	As a property owner in the Edna Valley, I fully support MT-3 and MO-4. Additionally, I am in favor of a 5 year period of collecting good, reliable data of the water basin and exploring all options to utilize recycled SLO water for farm irrigation purposes which helps this basin as well as allows the city of SLO to sustainably discharge its treated water.	10/30/2020 10:44	Comment on preferred SMCs is noted, and was discussed in public GSC meetings. Improved data collection will be a high priority in the implementation plan.
39	Brian Talley	Draft_SLO_GSP_Chapter_6.pdf	My family has farmed wine grapes and vegetables in the Edna Valley for more than 30 years. During this time, we've made numerous changes to reduce our water consumption and preserve this most precious resource. As I've reviewed the various documents in the Water Budget Chapter of the Groundwater Sustainability Plan for the SLO Basin, I'm struck by the complex and often contradictory nature of the data that underpins many of the findings and likely future decisions. My concern is that significant changes are contemplated based on erroneous or missing data, and this could have potentially devastating impacts on agriculture in our region. I encourage you to slow down and adopt a more adaptive approach that relies on better data to guide decision making. This should start with a robust and accurate monitoring system where stakeholders can monitor progress and agree on best practices to achieve mutually agreed upon objectives. The consequences of getting this wrong could not only destroy the livelihood of those of us farming in the Edna Valley, but have lasting negative impacts on land use in the valley. Just as my family has relied on an adaptive and evolving approach to manage our resources, so should we all as a group going forward.	9/29/2020 15:23	The monitoring well network has been expanded from 12 wells to 40 wells, and will provide better data during the first 5-year implementation period. The importance of agriculture to the local economy is understood by the GSAs. The SGMA legislation mandates a specific timeline. A plan with recommended SMCs must be filed by January 2022. Adaptive management through the 20-year planning period based on additional data is planned.

ID	Name	Comment Subject	Comment	Date/Time	Response
40	George Donati	Draft_SLO_GSP_Chapter_6.pdf - 6.3.3 Historical Surface Water Budget	To: Dick Tzou and all Consultants George Donati comments: I have reviewed the data in the Water Budget (Chapter 6). I find that much of the date is estimated, inaccurate, contradictory, and possibly manufactured. Many of my findings are outlined below. I have farmed in this valley since 1996 using ground water on permanent crops. We need to slow down our Sustainability Plan process so that we can gather accurate data to be able to make the correct long-lasting decisions. We need to have time to gather accurate data as the basis for our Sustainable plan. This will protect all homeowners, landowners, Farmers and residents while we accurately sustain the Edna Valley Basin. Again, below are my findings of data that I am questioning. Page 6. SLO subarea surface inflow watershed is 28,823 acres. Edna subarea inflow watershed is 10,145 acres. Edna is only 35% as big as SLO. Page 9. Figure 6-2. Surface Water: 1. Is the stream inflow above the Righetti dam or below? If below, then this cuts a lot of our watershed out of the equation. 2. What is ET of Precipitation? Why is this number almost always about 90% of total precipitation? This means that 90% of rainwater is evaporated during cloudy and rainy weather? Please explain. 3. Where is the stream inflow measured? Stream Inflow of 5480 AFY (2019) calculates into 3400 gallons per minute of water flowing into our basin below the dam in the creek for 365 days, 24 hours per day??? Or is this above the Dam? Can this be correct when we see no water flowing in these creeks? 4. Stream Outflow is higher than stream inflow? Where is this additional water coming from? 5. Riparian ET. How can this be the same number every year when we had long years of drought and no streamflow for many years? Thank You, George Donati	9/30/2020 12:09	Your comments on slowing down timeline for GSP submittal is duly noted. However, the SGMA legislation mandates a specific timeline. A GSP must be filed by January 2022, which will also include an adaptive management approach in implementing the plan in the next 20-years. The Edna Valley contributing watershed is smaller than the SLO Valley contributing watershed area, so the inflows into Edna Valley are smaller. 1. The stream inflow is below the Righetti Reservoir. 2. The estimated ET of precipitation is based on the minimum infiltration thresholds (ET of rainfall prior to deep percolation or runoff). On average, 74% of rainfall is estimated to evaporate (not 90%), while only 67% evaporates during a wet period (Table 6-20). These are reasonable values. 3. Stream flow on west corral de Piedra is estimated below the dam. The inflow is for all drainages, not just below the dam. Stream flow is intermittent within a wide range, from dry to peak flows of over 1,000 cubic feet per second (cfs)and mean daily flows of over 700 cfs (over 300,000 gallons per minute) recorded on Pismo Creek. During the high flows, much of the water passes through the basin. It would only take about 35 days with high flows (say 80 cfs average) to deliver 5,480 acre-feet of water. Yes, the creeks are dry most of the year. 4. The additional water is from Runoff from within the Basin. 5. It's a small enough number compared to the surface water budget to use as average over most years. During severe drought years it was reduced (Table 6-2).

ID	Name	Comment Subject	Comment	Date/Time	Response
41	Rick Rogers	Workshop #3 Sustainable Goal Setting - Part 1	NOAA's National Marine Fisheries Service respectfully submits the following comments regarding the "Draft Options for Basin Sustainability Goals Workshop Presentation Slides" presented to the public via webinar on October 1, 2020. We previously relayed these concerns via public comment during the September 9, 2020, SLO Groundwater Sustainability Meeting. Specifically, we are concerned that the SLO GSA continues to promote sustainable management criteria for streamflow depletion impacts that may be insufficiently protective of South-Central California Coast steelhead, listed as threatened under the federal Endangered Species Act. Per SGMA regulations, the required metric for the undesirable result of interconnected surface water (ISW) depletion is the rate or volume of surface water depletions caused by groundwater use that has adverse impacts on beneficial uses of the surface water and may lead to undesirable results (California water code 23 CCR 354.28(c)(6)). SGMA requires that if a proxy metric is used, then significant correlation must be established between the two metrics (CCR 354.36(b). Unfortunately, the October 1 Workshop Presentation ("Draft Options for Basin Sustainability Goals") continues to propose utilizing groundwater elevations experienced during our recent historical drought as a proxy for ISW depletion, despite there being no identified correlation between those groundwater elevation and "adverse impacts on beneficial uses of the surface water". Identified beneficial uses of San Luis Creek, Pismo Creek, and many other streams traversing the basin are designated by the Central Coast Regional Water Quality Control Board (CCRWQCB) 2017 Basin Plan, and include preserving cold water habitat (COLD), steelhead migration (MIGR), steelhead spawning and rearing (SPAWN), and protecting threatened and endangered species (RARE).The proposed sustainable management criteria neither analyzes nor establishes any ecologically-meaningful relationship between groundwater levels and impacts to these beneficial uses of surface water.	10/28/2020 11:02	The GSP monitoring network identifies stream gages on SLO Creek and East and West Corral de Piedras and will be considered for MO's and MT's once data has been collected. Water level data in alluvial wells in SLO Valley indicate there has been no historical declines in water levels that would impact SLO Creek. Water level data in alluvial wells in Edna Valley and anecdotal information from residents indicates that Corral de Piedras Creeks go dry every summer, and are seasonally disconnected from the underlying aquifer.
42	Rick Rogers	Workshop #3 Sustainable Goal Setting - Part 2	ISW depletion impacts instream aquatic habitat primarily by reducing groundwater accretion to a gaining stream, or accelerating ISW depletion from a losing stream. The impacts can be both physical (e.g., pool volume shrinks as water surface elevation declines) and chemical (e.g., water quality can suffer as pools and riffles lose connectivity). Thus, the appropriate method to determine whether pumping is having significant and unreasonable adverse impacts on beneficial uses of surface water and setting protective management criteria is to understand the level of impact (i.e., volume of ISW depletion) and how habitat quality and functionality change because of that impact, all evaluated on an ecologically pertinent time-scale. Further analysis is required throughout the SLO groundwater basin to establish localized relationships between ISW depletion and the instream habitat characteristics that result. Addressing these impacts will require data and analytical tools that the SLO GSA may not possess at this time. Thus, NMFS recommends the developing Groundwater Sustainability Plan elaborate sufficiently as to when, where, and how data informing streamflow depletion impacts will be collected during the first few years of GSP implementation, and clearly commit to developing a detailed analysis plan with interested stakeholders at a later date. The sustainable yield presented at the workshop is fatally flawed. Per SGMA regulations and guidance, sustainable yield can only be achieved if the basin is sustainable (i.e., avoiding all undesirable results, including depletion of ISW). As explained above, the proposed sustainable management criteria for ISW depletion (i.e., groundwater elevations consistent with extreme drought conditions) likely will not avoid adverse impacts on beneficial uses of surface water; thus, the presented sustained	10/28/2020 11:02	The GSP monitoring network identifies stream gages on SLO Creek and East and West Corral de Piedras and will be considered for MO's and MT's once data has been collected.

ID	Name	Comment Subject	Comment	Date/Time	Response
			yield estimates are likely invalid and inconsistent with SGMA regulations. Finally, excluding streams as "disconnected from groundwater" based upon a one-time 30-foot depth to groundwater measurement is a concept developed for discerning impacts to riparian vegetation (rooting depth for oak trees), and is not appropriate for analyzing threats to ESA-listed steelhead and their habitat.		

ID	Name	Comment Subject	Comment	Date/Time	Response
43	James Lokey	Workshop #3 Sustainable Goal Setting	These comments are in regard to the October 1st Stakeholder Workshop #3 presentation slides on Minimum Thresholds (MTs) and Measurable Objectives (MOs):We note on Slides 22 through 27 that the MT(1) for most of the representative wells is set at or near the lowest recorded water level for each well. However, on slide 27 for VRMWC Well #1 your team has recognized that this well has historically shown no ability to recover (other than seasonal partial recovery) over the long term. The MT for this well on slide 27 is set at 160 feet. Thus, in theory, we assume this setting would provide time for the GSA to take actions per the GSP that would reverse the long-term declining trend at this end of the aquifer. At our current rate of long-term decline, a Minimum Threshold of 160 feet for VRMWC Well #1 provides approximately 5 years of continued decline before reaching this MT. While we would prefer to halt this negative trend much sooner than 5 years from now, we understand the reality of the situation and it will take time to implement actions and fund projects to turn this around. We therefore concur with 160 fee as an acceptable MT for VRMWC Well #1, as long as the GSP sets a Measurable Objective that is at least 20 feet above the MT for this well. The MO2 for this well, to incorporate some recovery over the drought years, appears to be in an appropriate range to help provide a sustainable source of water for the long term at this far end of the basin. As shown in the attached chart of our Well #1 water table, as recorded at the lowest level each year since 1988, our water table was declining at an average annual rate of 1.4 feet per year. But since 2003, and over the last 17 years, that decline increased to over 4.24 feet per year on average, which is a 300% increase. The Varian Ranch Mutual Water Company and the residents of the Varian Ranch Development undertook a conscientious water conservation effort over those years which has resulted in the average water use per connection at Varian Ranch declining by over 40% compared to the years prior to 2003.Therefore, we would also ask the GSA to study if the steady decline in the water table at this well may be the result of heavier water use over the last 17 years with the increased number of vineyards and citrus groves that have been developed in the Edna Valley. While we recognize the economic vitality of the agricultural industry to our community and we certainly wish to work with our Agricultural neighbors in maintaining their operations, the water use of the 48 homes at the Varian Ranch development is deminimis when compared to all other uses in the basin and this fact needs to be addressed as the GSP is developed to bring the entire valley into a sustainable condition. We also encourage the GSA to fully explore all augmentation opportunities that may be available from within and outside the basin.	10/30/2020 17:57	Comments on proposed SMCs are noted and were discussed at GSC public meetings. Projects and Management Actions will discuss proposed augmentation possibilities to address the groundwater declines. It is recognized that Varian MWC pumping is a small amount when compared to agricultural pumping amounts.
44	Peter Orradre	Workshop #3 Sustainable Goal Setting	I am a property owner in Edna Valley and have a serious interest in how our water will be handled in the future. Please see my comments below. I am in support of the MT #3 which addresses the lower water levels than recent low droughts and MO #4 which addresses the Edna Valley wells the best. It is in everyone's best interest to adopt a water conservation program for all domestic and ag wells within the first 5 years of the GSP. This would be equitable for all users to use the most efficient practices. The most sensible approach to coming up with a successful long term plan starts with collecting accurate data versus using estimates or skewed models. I appreciate all your energy throughout this most important task. Sincerely, Peter Orradre	11/1/2020 14:19	Comment received, SMC priorities are noted, and were discussed in public GSC meetings.

ID	Name	Comment Subject	Comment	Date/Time	Response
45	Barbara Baggett	Workshop #3 Sustainable Goal Setting	Thank you the opportunity to comment. I have lived in the Edna Valley for 40 years. I appreciate the hard work of the consultants and staffs to develop the data on which we are to make decisions. But they had a disadvantage due to lack of data. For example, no real stream gauges or monitoring wells. Just production wells; and for those, incomplete drilling logs.. Incomplete rain records for this Valley. Not their fault but we need more information. As with the Paso Basin we need to use the first 5 years to develop full and complete data, especially reliable water level data. I have offered one of my inactive wells for monitoring. I join my neighbors in advocating for MT-3 and MO-4 for the first 5 years. I also applaud the efforts of those actively working on bringing in new water, especially recycled water from the City of San Luis Obispo, This will benefit all of us. I also support identifying and implementing all feasible conservations measures. Working together we can reach sustainability. Barbara Baggett	11/1/2020 11:02	Data will be collected in the first 5 years with a monitoring well network increased from 12 to 40 wells, as well as proposed stream gages. Comments on proposed SMCs are noted and were discussed at public meetings. New water sources are evaluated in Chapter 9, Projects and Management Actions.
46	Sarah Hinrichs	Workshop #3 Sustainable Goal Setting	As the CFO for an agricultural business, I oversee several Commercial, Industrial, Agricultural and Residential properties which depend upon water security for their ability to operate and as a large portion of their real estate value. We are careful and aware users of our water resources, and have put into place many conservation measures such as conversion to low-water use landscaping, calibration of our crop irrigation systems, and improving water storage and distribution systems to maximize efficiency. As the Edna Valley Basin begins to build a structure to regulate and manage our shared resources, I think is important to proceed with caution and seek robust data over the next several years. In considering the options laid out, I support the adoption of the Minimum Threshold alternative #3, and the Measurable Objective Alternative #4, in order to allow users security in their operations as this information is collected. Additionally, it makes sense to identify and pursue outside supplemental water sources, many of which have been identified already, to improve the water security of our basin. Together with conservation, storage, and distribution improvements, we can work together to preserve our property values and agricultural traditions into the future.	10/30/2020 14:32	Comments on proposed SMCs are noted and were discussed at public meetings. Supplemental water sources are evaluated in Chapter 9, Projects and Management Actions.

ID	Name	Comment Subject	Comment	Date/Time	Response
47	Bruce Falkenhagen	Workshop #3 Sustainable Goal Setting	Gentlemen: I have been following this issue for a while and very pleased that this seems to be moving ahead. I am a resident of the Edna Valley for 20 years with a 40 acre parcel just outside of the SLO Greenbelt. The property has little water beneath it down 500' to well below sea level, because it is all Monterey formation and holds water only in the limited fractures. I have three comments on the work to date: 1) I believe that the City of SLO needs to be much more active in giving it's reclaimed sewage water to help the Edna Valley basin. After all, it has declared almost the entire length of the Valley as IT'S greenbelt. So it would follow that the city should help keep it green and in agricultural crops. It doesn't, directionally it will push or even force landowners to convert their flat land to a higher and better use, like higher home density or industrial projects. And despite SLO making objections at that time that it is part of "their" greenbelt and that use should not be allowed suddenly has little basis or foundation. The argument by the developer would be very simple. SLO kept the water and would not allow it to be used to keep the Valley green and in agriculture, so SLO not only has lost the right to object, but by its actions or lack thereof, have in fact endorsed the project. They, the City, has done nothing to help hold the Greenbelt as a green belt. 2) We know the story of the Righetti dam. The owners/controllers must require and enforce the requirement for it to release the water that it is required to release which was part of it's building/development permit. I can not understand that the regulators have not enforced this permit requirement or whatever the document was that made the release requirement. 3) The backup data being relied upon to justify these actions and projections are filled with assumptions. Since so much is at stake here, and if the assumptions are wrong, the underpinnings of the program are gone and much money has been wasted. I agree with the concept that everything should be held in abeyance for 5 years, to see how accurate those projections were, and then discard the ideas found to be based on events/situations that did not occur, and focus on those that predicted properly and accurately. Thank you very much for your time, and thank everyone involved for donating so much of their time to move this forward.	11/1/2020 16:35	The City of SLO recycled water program is considered as a potential supplemental supply in Chapter 9. The terms of the surface water diversion permit associated with Righetti Reservoir are under the purview of the State Water Board. To the extent that any review process of this permit results in any additional water being released to West Corral de Piedras Creek, it will be beneficial to the basin. Additional data will be collected from a much-improved monitoring well network and stream gages in the first 5 years.

ID	Name	Comment Subject	Comment	Date/Time	Response
48	George Christensen	Workshop #3 Sustainable Goal Setting	There are four main points which I would like to make. 1) Credibility of data. Today's models are not based on observed or collected data. A significant portion of the data has been generated and interpolated from "similar" sites. I strongly urge the team to prioritize the collection of credible data from the monitoring wells for the next 5-7 years. After that date is analyzed and added into the models, we will need to re-evaluate. 2) Aggressive, regular replenishment of the Edna Valley aquifer. Over the next 5-7 years, I would like to see the team focus on these 3 initiatives that could significantly recharge the Edna Valley aquifer: (a) reach an agreement with the City of SLO for the discharge from the waste water treatment plant; (b) engage with Sentinel and land owners to move the Sentinel discharge location to a more advantageous location; (c) work with the Righetti ranch to release sufficient water to have a year-round steady flow in the Corral de Piedra Creek. 3) Agricultural Conservation. Provide seminars and information about new/modern water conservation equipment and process for the growers in the Edna Valley. 4) Based upon the points I have outlined above, I strongly support MT-3 and MO-4 for the next 5-7 years when we can re-evaluate AFTER we have gathered actual data. Respectfully, George Christensen Vegetable Grower	11/2/2020 11:56	The integrated groundwater/surface water model used is based on observed collected data from the basin including rainfall, water levels, municipal pumping volumes, irrigated acreage, and other data specific to the basin. The data management plan will increase monitoring wells to over 40 and fills in data gaps over the next 5 years. City recycled water and Sentinel Peak water are considered as potential supplemental supplies in Chapter 9. The terms of the surface water diversion permit associated with Righetti Reservoir are under the purview of the State Water Board. To the extent that this process results in any additional water being released to West Corral de Piedras Creek, it will be beneficial to the basin. Improvement of irrigation efficiency is considered as a management action in Chapter 9. However, it should be noted that improvements in this areas result in decreased amounts of irrigation return flow, so the net impact to the aquifer may be less than anticipated. Comments on proposed SMCs are noted.

ID	Name	Comment Subject	Comment	Date/Time	Response
49	June McIvor	Workshop #3 Sustainable Goal Setting	Dear SLO Water Basin GSC: Phase 2 Cellars, LLC dba Tolosa Winery appreciates the opportunity to provide input on the SLO Basin Groundwater Sustainability Plan. As we acutely feel the encroachment of commercial development right up against our surrounding vineyards, it is more important than ever to take steps which allow agriculture in Edna Valley to thrive as well as to protect the city's™s defining green belt. Setting the key goals and targets for management of the SLO Basin is the essential foundation of sustainability of the basin and of our critical agriculture industry. It must not be done on incomplete or erroneous data, and time should be taken to make sure data is accurate upon which to base management decisions. We are in favor of taking the first 5 years to gather good data, including improved monitoring that includes: stream gauges, strategically located monitoring wells, review of the drilling logs of each monitoring well, and ideally, robust monitoring of water levels in all wells every month of the year. While this data is collected and analyzed, we need to proceed cautiously with no required reduction in pumping; MT-3 is the most appropriate threshold. We also believe there is more that can be done to augment our basin. Opportunities include: Obtaining tertiary treated water from the City of SLO, rather than that valuable water being dumped to the ocean; Adoption of water conservation measures by all users in the Basin, not just by agriculture; Releases from the Righetti Dam into the West Corral de Piedra Creek, as required; Golden State Water purchasing water from the State Water Pipeline instead of using water from the Edna Valley Basin; Sentinel Peak Resources could discharge their R.O. water further up Corral de Piedra Creek, rather than the current discharge that goes out to the ocean. With all of these opportunities for augmenting the basin, we believe that MO-4 is the logical objective. Thank you for your consideration. June R. McIvor President & CEO Phase 2 Cellars, LLC dba Tolosa Winery	11/2/2020 12:05	Additional data will be collected in the first 5 years through improved monitoring well and stream gage networks. The projects that you mention are considered as potential sources for supplemental water. Comments on proposed SMCs are noted.

ID	Name	Comment Subject	Comment	Date/Time	Response
50	Brent Burchett	Workshop #3 Sustainable Goal Setting	These comments are submitted on behalf of the San Luis Obispo County Farm Bureau to provide additional stakeholder input on the Draft Options for Basin Sustainability Goals Stakeholder Workshop #3 (October 1, 2020) Presentation Slides. Based on feedback from farmers in the SLO Valley Basin, we recommend Minimum Threshold 3 and Measurable Objective 4. We share the goal of all basin stakeholders to achieve sustainability for all users, whether residential, municipal, or agricultural. As we detailed in comments submitted on September 30, 2020 regarding Chapter 6- Groundwater Budget, there are currently too many significant data deficiencies to proceed down a path of immediate cuts to farmers in the Basin. The current reliance on production wells as a data source creates inaccurate information for GSA decision-makers, and should be replaced over the next five years with monitoring wells. Our initial priority needs to be building a monitoring network to guide our actions in the decade to come. As we have not exhausted opportunities to supplement our existing water resources with sources like tertiary treated water from the City of San Luis Obispo, State Water, or water being released into the ocean, it would be reckless to balance the Basin solely on the backs of our farmers. Adopting Minimum Threshold 2 (Higher Water Levels than Recent Low Drought Water Levels) for any or all wells may be politically expedient, but such an approach could fail to actually achieve sustainability if assumptions about groundwater impact from specific farms or areas in the Basin are miscalculated. We do not want additional data monitoring for the sake of delaying negative impacts to agriculture. Rather, our Farm Bureau wants farming in the Edna Valley to remain viable for the next generation, and our City and County leaders have an obligation to sustain Edna Valley agriculture's essential contributions to our City and County's economy and quality of life. We know farmers will have to participate in a more robust well monitoring network, and we may have to make changes that affect agriculture, but let's equip our GSA to do so armed with better information than we have today.	11/2/2020 12:10	Comments on proposed SMCs are noted. The well monitoring network has been improved from 12 wells to 40 wells. potential projects mentioned for supplemental water are being considered in Chapter 9. The significance of agriculture to the local economy is recognized by the GSAs.
51	Robert Schiebelhut	Workshop #3 Sustainable Goal Setting	Some Additional Water Augmentation Suggestions: The ag community has been and continues to be committed to pursuing various feasible water augmentation projects. In addition to those that are under discussion, I would like the consultants and staff to consider the area under the Edna sub basin--the bedrock--as a potential source of water for our sub basin. Our sub basin does have active faults and may have water flows in the bedrock with enhanced recharge--or even a large captured pool of water. Can we initiate surface reconnaissance employing geophysics--e.g. seismic, magnetic, ground penetrating radar etc? Favorable indicators would justify deep drilling in the hope of locating important additional water sources. Also, the written materials presented to date show a good number of wells that extend into the bedrock, and in some cases, quite deep. Can we evaluate the drilling logs and production records of these wells to develop information to supplement our reconnaissance efforts? Additionally, would it make sense to explore potential important water sources not yet tapped up in our watersheds? I would appreciate our consultants and staff views on this as well. Thank you for you consideration. Bob Schiebelhut	11/2/2020 16:29	Additional water from bedrock wells is possible. The applicability of surface geophysical method to identify fracture patterns would need an independent evaluation. It should be noted that groundwater from deeper bedrock wells is often of relatively poorer quality than shallow wells, due to increased mineralization of the groundwater that occurs during prolonged exposure to the surrounding bedrock. Comment Noted.

ID	Name	Comment Subject	Comment	Date/Time	Response
52	Jena Wilson	Workshop #3 Sustainable Goal Setting	The Righetti Dam releases into the creek need to be enforced. This is over 600 acre feet of water that should be flowing into the creek and into the basin. Golden State Water needs to start purchasing water from the State Water Pipeline so that they are not using water from the Edna Valley Basin. Golden State currently has a Selenium issue with their water as brought up by Toby Moore in the Workshop. This could alleviate this Selenium issue to all other Domestic water users in the Basin. We need to Augment Water storage with Sentinel Peak Resources R.O. water by discharging the water that is currently going out to the ocean, further up the Corral de Piedra Creek. Corral de Piedra creek needs to be brought back to life to save the fish. If this were done using surface water, then our basin would be in a plus balance.	11/2/2020 17:42	The terms of the surface water diversion permit associated with Righetti Reservoir are under the purview of the State Water Board. To the extent that any review of the permit conditions results in any additional water being released to West Corral de Piedras Creek, it will be beneficial to the basin. The State Water and Sentinel Peak projects are evaluated in Chapter 9.
53	Jean-Pierre Wolff	Workshop #3 Sustainable Goal Setting	I would like to take this opportunity to express my appreciation for the significant effort put forward by the County of San Luis Obispo, the City of San Luis Obispo, the representatives of the Edna Valley, the consultants and the numerous volunteers who have contributed to this GSP thus far. When addressing water, the history of California has shown that it is at times challenging to decouple emotions and personal interest from science. In addition, the accurate projections of drought impact to hydrological models requires allowances for margin of error due to unknowns. Based on the various scenarios presented at the GSP workshop of October 1, 2020 I suggest that the Minimum Threshold alternative should be MT-1 based on the most recent significant drought. The Measurable Objective alternative should be based on M-4 allowing time to address and implement water conservation measures, water augmentation alternatives and applied innovation in water technology. During this ongoing GSP development, I suggest that a refresher evaluation be made in the Edna Valley agricultural land use and its associated ground water extraction to validate the various models assumptions. The successful implementation of the GSP will require three distinct efforts and course of action. Firstly, water conservation will need to become an integral part of the solution in order to meet the MO and MT. The agriculturists of the Edna Valley have already demonstrated some of these initiatives with ongoing implementations. Secondly, water augmentation must be addressed sooner than later. This year, our Governor has made a priority for California to reduce the impact of droughts and climate change through water portfolio diversification. The San Luis Obispo and Edna Valley Basin is in a unique position to address this issue. A good example are the opportunities for recycled water from the City of San Luis Obispo recently upgraded water treatment plant with its emphasis on recycled water and the nearby Price Canyon oil fields high quality recycled water production through reversed osmosis technology. Another opportunity of water augmentation is improved management of the upstream reservoir permittee to leverage conjunctive benefits of West Coral de Piedra Creek such as the downstream public trust surface water aquatic environmental benefits and ground water recharge through percolation.	11/2/2020 17:49	Comments on proposed SMCs are noted. Water conservation is nearly always the cheapest alternative to reduce groundwater pumping, and water augmentation will be integral to future management of the Basin. Management of Righetti Reservoir could improve the conjunctive use of SW and GW resources in the Basin and contributing watershed.

ID	Name	Comment Subject	Comment	Date/Time	Response
			Lastly, technology innovation will need to become part of the long-term solutions such as precision farming utilizing soil moisture sensors, local weather stations, accurate well monitoring to name a few.		

ID	Name	Comment Subject	Comment	Date/Time	Response
54	Chris Darway	General Comments	1. Page 29 shows a gain of 5970 AFT for years 2016 -2019. The graph shows an upward trajectory for Edna. Table 6-14 should show the amount of storage for 2016. By not doing so, we miss the great increase from 2016-2019--most likely due to greater rain plus conservation efforts. Since the SLO subarea was stable during 2014-2016, the 5970 increase is in Edna--probably rising from about 100,000 AFT in 2016 to 105, 630 in 2019. Impressive and not apparent because 2016 numbers are not shown. 2. There are two lines of numbers that are curious. 1/3 of the years show stream outflow exceeds inflow: 1993, 1997, 2000,2001,2003 , 2005, 2006, 2011, 2016, and 2019. All these years are Wet of Above Normal, except 2016 Below Normal. Is this due to infiltration and / or GW/SW intersection? Does this make sense to you? Similar question regarding ET evaporation: In 8 Dry years, the evaporation essentially equaled the precipitation: Precip ET Evaporation 1987 6780 6610 1990 5960 5860 2007 3810 3800 2009 5170 5100 2013 4640 4600 2014 4590 4550 2015 5230 5160 2018 6130 6020 The numbers above don't make sense.	11/3/2020 13:39	Tables 6-1, 6-2, 6-3 present annual water budgets for all water years from 1987 to 2019. Table 6-14 only indicates years for which water level maps were generated to estimate changes in storage between those years. It is often not possible to see significant changes in water levels in a basin scale map from year to year. Stream outflow could exceed inflow because there a greater area of contributing watershed; so that fact that wet years show greater SW outflow is not problematic. In dry years, ET can be approximately equal to precipitation, indicating most water is being used or evaporated, and little runs off.
55	Chris Darway	General Comments	How can consultants come up with a Sustainable Yield of less than 4000 AFY in a basin, when the Basin contains Groundwater Storage Estimates of an average of 120,000 AF? This Sustainable yield is only 3% of the storage.	11/3/2020 13:40	Safe yield is not a function of groundwater in storage. For example, Paso basin has about 30million AF storage but only 60,000 AFY safe yield (0.2%). Safe yield is determined by stopping storage and water level declines; it is not a function of total groundwater in storage. Sustainable yield and storage are not directly correlated.
56	Earl Darway	General Comments	Why is 2016 data being excluded? I keep rereading the Water Budget material and came across the reasoning for those years at p 22: "These years include the beginning and ending years in the base period, along with sufficient intervening years to characterize change in storage trends through the base period". This is highly discretionary. Look at the intervals between the years chosen: 4,5,3,7,6,3 and 5 years. More important, by excluding 2016, they allow the argument that the 2014 low point will not be the low point going forward, when an equally valid point is that the 2016-19 trend indicates an upward trend in storage. If increasing storage, where is the overdraft?	11/3/2020 13:40	2016 data is not excluded from the water budget. Groundwater storage is estimated by the water budget for all years using all the available data over the base period in Tables 6-1, 6-2, 6-3. The years selected for estimating storage using the specific yield method were to calibrate the beginning and end of the base period and to illustrate storage trends. They do not change the overall decline in storage over the base period or the estimated overdraft. Yes, 2016-2019 shows an upward trend in storage in the water budget, but this was also a wet period that followed a severe drought. Overdraft takes into account both wet and dry periods.
57	Earl Darway	General Comments	The graph for pumping does not have an accurate trajectory for two reasons: (1) the trajectory for 2007 to 2019 should be down and not up; and (2) the trajectory being down since 2015 is dramatic. Conservation measures after the drought.	11/3/2020 13:41	Assuming we are talking about Figure 6-8, the trajectory for groundwater extraction is shown as decreasing pumping from 2007-2019. The visual trajectory appears “up” only because the bars are below the zero line, so a decreasing trajectory is toward the top of the page.

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58	Earl Darway	General Comments	On page 44 why did you choose the years shown in table 6-14? There were 21 representative wells (note some of our wells weren't developed until the early 1990's) and then select the years for water levels without any explanation as to why those years?	11/3/2020 13:43	The years selected for estimating storage using the specific yield method were to determine storage at the beginning and ending of the base period and to illustrate storage trends. This is mentioned on page 22. The specific years selected do not change the overall decline in storage over the base period or the estimated overdraft.
59	Chris Darway	General Comments	Additional comment: Page 29 shows a gain of 5970 AFT for years 2016 -2019. The graph shows an upward trajectory for Edna. Table 6-14 should show the amount of storage for 2016. By not doing so, we miss the great increase from 2016-2019--most likely due to greater rain plus conservation efforts. Since the SLO subarea was stable during 2014-2016, the 5970 increase is in Edna--probably rising from about 100,000 AFT in 2016 to 105, 630 in 2019. Impressive and not apparent because 2016 numbers are not shown.	11/3/2020 13:43	Not finding referenced gain on page 29, but storage increase between 2016-2019 is estimated by water budget. Yes, 2016-2019 shows an upward trend in storage in the water budget, but this was also a wet period that followed a severe drought. Overdraft takes into account both wet and dry periods.
60	Karen Merriam	General comments	I am directly affected by the sustainable groundwater planning underway for the Edna Valley. I purchased 10 acres on Tiffany Ranch Road at the south end of the Edna Valley in 1996. There was no vegetation or structures on the land. There was a well that was drilled in 1989 to 115 ft. This well yielded fresh, abundant water from 60+ ft. below the surface when I began pumping in 1997 when I built my home on the property. In 2016 my well ran dry. It cannot be recharged and no further drilling is possible in that location. When I bought my property in '96, most of the land was dry land farming and cattle ranching. As documented, there has been exponential growth of irrigated agriculture on most of the land now surrounding my 10 acres and throughout Edna Valley. (I should note that I know of at least two neighboring wells that have also gone dry.) In 2016, after consultation with Tim Cleath, I was fortunate to find potable water after drilling to 300 ft in the corner of my property farthest from the original well. My understanding is that this is the only area on my property where a productive well can be placed. The cost of drilling, laying new water and electric pipes, etc. exceeded $30,000 four years ago. I am concerned that if present levels of demand for drawing on the Edna Valley water continue to expand, even my new well will not be sustainable. If the new well should fail, then my property will lose all value and will not be habitable. The excellent and thorough hydrogeologic mapping of the Edna Valley clearly shows that in the south end of the valley where my property is located, there is poor recharge available compared to other areas such as Coral de Piedra. Therefore, I strongly urge those who represent individual property owners such as me to support sustainability goals based on the data provided, and on consideration of drought resilience and equitable distribution of risk and cost. Minimum Water Levels should go no lower than levels observed at the 2015 drought culmination. According to all projections from climate scientists, the extremes of heat and drought we are now experiencing will likely only increase. It would be foolish to ignore this data. For this reason, I believe that we should plan for minimum higher water levels than recent recorded low drought water levels: Minimum Threshold Alternative #2. Thank you for your consideration of these comments.	11/17/2020	Comments on proposed SMCs are noted and were discussed at length during public GSC meetings. It is documented that smaller wells or wells on the margin of the basin have gone dry due or been removed from production due to declining water levels.

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61	George Christensen	DRAFT Chapter 7 - Monitoring Networks	January 22, 2021Comments on Chapter 7 - Monitory Networks for the SLO Basin GSP George Christensen Vegetable grower and resident - Edna Valley. A successful groundwater sustainability plan needs to include ALL consumers of the SLO basin. It has been brought to my attention that the currently proposed SGMA regulations only apply to MOST consumers of water in the SLO water basin, not ALL consumers. I believe that there are several hundred residential/domestic consumers who are not included in the scope of the SGMA. This is unreasonable as those unregulated consumers can and will certainly impact the basin's performance. If the SGMA is to be equitable, it must encompass all consumers including domestic/residential, commercial, industrial and agricultural in the SLO basin. Not representing all members from each group is unfair to both the regulated and unregulated groups. All consumers, regardless of size/capacity must be considered and included in the GSP. The challenge of shallow domestic wellsite has been said many times that one of the major goals of the GSP is to protect/prevent residential wells from going dry in drought conditions. While this is important, it cannot be the primary overriding goal of the GSP. Shallow residential wells have always been a concern during drought conditions in the Edna Valley. Homeowners with shallow wells are victims of poor decisions usually due to lack of information. 'Right sizing a residential well is the responsibility of the homeowner similar to ensuring the main electrical panel is sized large enough to support normal household operation. Just like upgrading the electrical panel on older homes is sometimes required to support changes in the home/lifestyle, so is upgrading the well to ensure an adequate water supply. The onus to remove the risk of residential wells going dry is solely on the homeowner, not on the homeowner's neighbors. It would be unfair to penalize the homeowner's neighbors simply because they failed to right size their well. I suggest that official guidelines/recommendations be generated for both new and existing homeowners in the Edna Valley to help them right size their residential well. The Righetti reservoir: Edna Valley basin's single biggest influencer. The Righetti reservoir has been around for 50+ years and in that time it has had a significant impact on the Edna Valley basin. The challenge is to understand what kind of impact, the size of the impact and mechanics of the impact. There are many theories and postulations, but none that I have found based upon actual hard facts. I believe that the reservoir has a significant impact on the Edna Valley basin but I lack data to substantiate that belief. I strongly encourage the GSP to include streamflow meters both in the watershed area above the reservoir and in the West Corral de Piedra creek immediately below the reservoir to improve our understanding of the impact of the Richetti Reservoir. Only then can we include the reservoir in the GSP. Good Data enables Good decisions And of course the corollary to the above statement is that poor or incomplete data will drive bad decisions. This is evidenced in several places in Chapter 7, but I will specifically focus upon Table 7-1.There are 18 wells listed for the Edna Valley. 9 of the 18 wells (50%!!) are missing either well depth, screen intervals or both. How can we expect good decisions when 50% of the critical data is missing? There isn't any way a credible prediction of wells going dry can be made with these critical pieces of data missing. EV-10 is indicated to have a State Well Completion Report. If that is true, then why isn't First Data Year, Last Data Year, Data period and Data count included? Is this just a simple oversight or a sign of a less than thorough inspection of data presented to the public? The summary is simple: We do not have enough high fidelity, accurate data today to drive major decisions.	1/22/2021 14:50	All well users are included in estimates of Basin pumping. However, domestic users who pumps less than 2 AFY (de minimums extractors) cannot be required to be metered by SGMA. Improved data on location of these wells would be useful. It is up to the GSAs to decide how deminimis extractors will be incorporated in the management of the basin via the GSP or with other regulation. Most shallow wells were right-sized for conditions at the time of installation and provided adequate production for domestic use at the time. Stream gages have been proposed for Streams in Edna Valley. The terms of the surface water permit for Righetti Reservoir are under the purview of the State Water Board. To the extent that process results in increased releases to Corral de Piedras Creek, it will be beneficial to the Basin. It is anticipated that a program will be implemented to improve data on the construction of the monitor wells. However, the primary data gathered from these wells in the future is water level data, which will be dependable and useful in basin management.

ID	Name	Comment Subject	Comment	Date/Time	Response
62	Keith Watkins	General Comments	Developing an adequate monitoring plan is crucial to developing operational plans for maintaining our basin. To develop good information, we need to invest in several new monitoring wells and track them for multiple years to be able to really know what our groundwater levels are doing. Chapter 7.1.2--The list of criteria is in many respects too vague. What does "proximity and frequency of nearby pumping wells" mean? Specifically, what is the minimum distance from other wells? How much "frequency" of nearby wells mean is allowed? What does "spatial distribution relative to the applicable sustainability indicators" mean? Same questions for "Groundwater use" and "impacts on beneficial uses and Basin users." In other words, how are we to know how to apply these criteria to evaluate the selection of the Representative Wells?	1/26/2021 8:43	Most of this text comes from the DWR BMP documents. We wouldn't want a monitoring well immediately adjacent to an active pumping well, but there is no set numerical distance criteria. Spatial distribution simply means not clustering too many wells in one area. Most of these are considerations to be considered holistically in concert with one another while developing the monitoring network. We believe the new monitoring network of 40 wells adequately addresses these criteria.
63	Chris Darway	General Comments	Chapter 7.1.2--The list of criteria is in many respects too vague. What does "proximity and frequency of nearby pumping wells" mean? Specifically, what is the minimum distance from other wells? How much "frequency" of nearby wells mean is allowed? What does " spatial distribution relative to the applicable sustainability indicators" mean? Same questions for "Groundwater use" and "impacts on beneficial uses and Basin users." In other words, how are we to know how to apply these criteria to evaluate the selection of the Representative Wells?	1/27/2021 13:03	Most of this text comes from the DWR BMP documents. It would not be desirable to have a monitoring well immediately adjacent to an active pumping well, but there is no set numerical distance criteria. Spatial distribution simply means not clustering too many wells in one area. Most of these are considerations to be considered holistically in concert with one another while developing the monitoring network. We believe the new monitoring network of 40 wells adequately addresses these criteria.
64	Chris Darway	General Comments	Table 7.1 -- Why monitor a well outside the Basin in Arroyo Grande water basin -- EV-18? 52 years of records and no depth of monitoring info.	1/27/2021 13:06	The primary reason for keeping this well is to document the presence of the groundwater divide between the SLO Basin and the Arroyo Grande Sub-basin.
65	Earl Darway	General Comments	7.2.1 Groundwater monitoring. This states there are a total of 40 monitoring wells in both basins. This states that there are 18 monitoring wells in the Edna basin, however, when I look at the detailed information in table 7-1, of the 18 "monitoring wells", only 6 of these wells are deep enough to be used to monitor our groundwater, 4 of these 6 wells are being used of Ag irrigation, and 1 is a public supply well for GSW. This leaves only 1 well that is an official monitoring well as described in 7.1.2. and this well does not meet the criteria outlined to be an official monitoring well. We need to establish official monitoring wells that meet the criteria before we move forward.	1/27/2021 13:11	Ultimately the goal is to have a dedicated monitoring well network. However, we must begin with what we have access to. There is no reason active wells cannot be used as monitoring wells as long as care is taken to ensure that wells are not pumping at the time of monitoring. This has been part of the data collection protocols for existing County groundwater level data. If a well is deep enough to intersect the water table, it is deep enough to monitor. Staff do not agree that the one dedicated monitoring well outlined by the commenter does not meet the criteria to be an official monitoring well. This well has no pump, known construction details, and a dependable boring log.

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66	George Donati	DRAFT Chapter 7 - Monitoring Networks	I have 3 comments and 1 question:1.Chapter 7.1.3. Scientific rational -SGMA regulations require that the GSP identify sites that do not meet BMPs. Also, if wells lack construction info, the GSP shall include a schedule to acquire monitoring wells with all the necessary information. As Table 7-1 shows, there are many wells that do not have BMP's and lack construction information. We need this data on the individual wells please.2.Table 7-1. San Luis valley has 11 monitoring wells that are not being used for other purposes. All of these wells are less than 100 ft deep. Not sure if this is deep enough to qualify the criteria. Edna Valley area has only 2 monitoring wells that are not being used for other purposes. One of these wells is very shallow at only 150 ft deep. EV 14 is a monitoring well and is the only well that meets the criteria in the entire Edna basin. Many wells outlined in table 7-1 are missing information which is required, or they are being pumped for Ag or Domestic purposes and will not give accurate data for monitoring the Edna basin. Should we have more proper monitoring wells so that we can monitor our ground water properly? Can we use the first 5 years to set this up?3.Table 7-2. They are asking for a monitoring well east of Crestmont road. John Silva's property, just east of the intersection of Crestmont and Hwy 227 has 4 wells and one of these could work. Please contact me if you are interested in one of these wells. Question - Just below this comment box on your web site there is a statement -While attachments (e.g., letters) will be read and considered, individual comments entered using the form will receive a response for each comment. I have never received a written response to any of my previous comments. Is there a plan to do this? Thank you, George Donati	1/27/2021 13:53	An ideal monitoring well is a well that meets all criteria, and a goal would be to move toward a complete network of dedicated monitoring wells. However, this should be considered a goal, not a requirement. We must move forward with what is available. There is nothing wrong with using active wells as monitoring wells as long as the wells cease pumping prior to the monitoring event. This has been part of the data collection protocols for existing County groundwater level data. Shallow wells (150 feet or less) are adequate for monitoring as long as they intersect the water table. We were unaware of the Silva well, that could be useful, we will contact you regarding that well. Yes, we are posting all initial responses to comments online for viewing. We will also incorporate the responses or any changes into the chapters as appropriate when they get finalized as a compiled document.
67	Robert Schiebelhut	DRAFT Chapter 7 - Monitoring Networks	Many in the Edna Valley believe that the SGMA process should include consideration of the actual impact of the Righetti reservoir on the Edna sub basin. There has never been a hydrology connecting the two. The State recognizes the nexus between the two. On February 21, 1991, the State Water Resources Control Board expressly reserved jurisdiction to modify the terms of the Righetti permits based on "the findings of the hydrology study now in progress of the Pismo Ground Water Basin and the Edna Valley. The study will include a safe yield estimate of the basin" (State Water Resources Control Board Order WR 91-02, page 8). The referenced study was never completed even though 30 years has passed. SGMA requires an appropriate study of the relevant factors to determine safe yield, and therefore our process should include a complete review of the impact of the Righetti reservoir on the Edna sub basin. In Chapter 7, page 119, the chart states that the Righetti Reservoir (one of the largest privately owned in California) is a beneficiary of about 21% of the Pismo watershed. The important watershed for determining the actual impact of the Reservoir is the West Corral de Piedra watershed. The State Water Resources Board's Decision 1672 (dated November 27, 1990 found that the Righetti Reservoir captures the stream flow of approximately 3000 acres of the 5300 acre West Corral de Piedra watershed--57%, not just 21%. This higher percentage reflects the substantial impact of the reservoir. Chapter 7.2.3.1 recommends two gauges for West and East Corral de Piedra at Orcutt Road. Why not a gauge above the Righetti Reservoir to better determine the actual stream diversion, rather just "estimating"? If we are to pay for measuring well #EV-18 which is outside the Basin, why not pay for a new gauge above the Basin, in the watershed for West Corral de Piedra?	1/28/2021 16:32	The terms of the surface water diversion permit associated with Righetti Reservoir are under the purview of the State Water Board. To the extent that any review of the permit conditions results in any additional water being released to West Corral de Piedras Creek, it will be beneficial to the basin. Monitoring well EV-18 is intended to document the groundwater divide between Edna Valley in SLO Basin and the Arroyo Grande Subbasin.. Stream gages in Edna Valley are proposed.

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68	Brian Talley	DRAFT Chapter 7 - Monitoring Networks - 7.2 MONITORING NETWORKS	A consistent concern for me is that we don't have enough data to make informed decisions about pumping restrictions. Let's take the prudent approach of studying our basin over the next 5 years to insure that we don't make rash decisions that threaten the sustainability of agriculture in the basin. In particular, we need representative monitoring wells. Landowners, myself included, are willing to provide locations for these wells. We also need a better understanding of the amount of diversion that is occurring as a result of the Righetti Reservoir. In-stream gauges should be installed both above and below the dam to quantify the diversion and ensure compliance with state permits.	1/30/2021 8:50	The monitoring well network has been increased from 12 to 40 wells. If there are additional locations available for MWs in areas with data gaps it could be helpful as we contemplate installation of new dedicated MWs. We will stay in touch.
69	Mark Capelli, Anthony Spina. NMFS	DRAFT Chapter 8 See letter dated June 3, 2021 appended to the Response to Comments.	Page 29: The draft Chapter 8 indicates the basin will be considered to have experienced undesirable results if any of the monitoring wells exceed the minimum threshold for two consecutive fall measurements. The standard of failing two consecutive fall measurements is not explained, and thus appears arbitrarily. Steelhead migration, spawning and rearing (beneficial uses of surface water as set by the Regional Water Quality Control Board1) are biological processes that can be impacted by a single streamflow depletion event. SGMA regulations require a minimum threshold be used to define an undesirable result, in this case streamflow depletion resulting in significant and unreasonable impact to beneficial uses of surface water. For a beneficial use such as steelhead rearing, a depletion of adequate streamflow can result in steelhead mortality, and is therefore irreversible. We therefore recommend that the standard for determining undesirable results be expressed in terms of minimum pool depth and/or surface flow during the summer and fall base flow periods.	6/3/21	The standard of two consecutive fall measurements was adopted to avoid triggering any far-reaching management actions such as pumping reductions on the basis of a single dry season. As has been discussed, groundwater systems react very slowly to changed conditions, and it was judged appropriate by the GSC and GSA members to utilize two consecutive measurements to avoid triggering any actions based on temporary conditions. Additionally, in the future more wells in the network will be equipped with transducers to gather continuous monitoring data. It may be appropriate to prioritize monitoring wells designated for depletion of ISW for transducers. At that point, the definition of the MT may need to be revised, as continuous data will be available. This text will be updated for clarification in Chapter 8. The GSP is intended to be a groundwater management plan.(Note: that the previous response stated “groundwater monitoring” and was intended to be “groundwater management”). Because there are numerous factors that affect instream flow conditions (rainfall, temperature, ET, etc.), it is not within the ability of this GSP to mandate instream flow conditions such as pool depth as an MT. The objective of the plan with respect to interconnected surface water is to manage groundwater such that there is no significant or unreasonable increase in depletion of ISW. As such, MTs are defined to disallow water levels from declining lower than recently historically observed conditions. Stillwater Sciences has prepared a TM on GDEs in the Basin that will be included as an appendix to the GSP.

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70	Mark Capelli, NMFS	DRAFT Chapter 8 See letter dated June 3, 2021 appended to the Response to Comments.	Page 29: Groundwater elevations may be necessary as a proxy for streamflow depletion due to a lack of data gathered to this point. However, there appears to be no attempt at correlating groundwater elevation thresholds with impacts to beneficial uses of surface water. In fact, many of the groundwater elevation minimum thresholds are set at the lowest (or below the lowest) groundwater elevations ever recorded within the basin. These thresholds are likely associated with severe groundwater over-pumping during dry periods, when groundwater depletion was greatest, and surface water discharge the lowest. Managing streamflow depletion conditions comparable with the severest drought conditions is not protective of surface water beneficial uses that support ESA-listed steelhead, and likely would result in adversely affecting steelhead and its identified critical habitat (see enclosed steelhead critical habitat and intrinsic potential maps for San Luis Obispo Creek and Pismo Creek). If the GSAs uses groundwater levels as a proxy for streamflow depletion, it should explain how the chosen minimum thresholds and measurable objectives adequately avoid adversely impacting surface water beneficial uses that support steelhead survival throughout the SLO Basin. If that effort proves problematic due to a lack of data at the present time, the GSAs should follow guidance by the California Department of Fish and Wildlife that recommends a conservative approach to groundwater dependent ecosystem protection in those situations (CDFW 2019).	6/3/21	The primary rationale for the selection of the MTs is protection of domestic water wells. Initially MTs were proposed that would be no lower than the observed low point in 2015, under the rationale that the stakeholders had managed to obtain household supplies and proceed with their operations under those extreme conditions, and so could do it again. See text on evaluating reduced water levels compared to domestic well depths. Ultimately the GSC members agreed that an additional 10 feet below observed low GW elevations would help protect agricultural businesses in the Edna Valley. For now, in the lack of data collection outlined in Chapter 7 (Monitoring Network) and Stillwater Sciences TM on GDEs, three existing wells located adjacent to streams are selected to monitor, and the MTs are set so that groundwater elevations will go no lower than observed seasonal low water levels, and by extension, surface water/groundwater interaction will not be negatively impacted in these areas. The MTs associated with the observed severe droughts is proposed as the MT, which should not be exceeded (I.e., water levels lower) under normal operating conditions. The MTs are not proposed to be the normal operating conditions of the aquifer.
71	Mark Capelli, NMFS	DRAFT Chapter 8 See letter dated June 3, 2021 appended to the Response to Comments.	Page 29, Section 8.9.2: The draft includes the following statement: *To avoid management conditions that allow for lower groundwater elevations than those historically observed, MTs [Minimum Thresholds]for these wells were set at the historic low water levels indicated on the hydrographs, which occur with regularity during every extended dry period evident in the record (Figures 8-9, 8-10).* As noted above, managing to perpetuate historically low groundwater elevations is not appropriate as a management threshold, since it does not adequately define the undesirable result of streamflow depletion on aquatic biological resources such as federally threatened South-Central Coast steelhead. Based upon fundamental hydrogeologic principles where the depletion rate is proportional to the difference between the water table and surface water, the amount of streamflow depletion associated with the proposed minimum thresholds would be the greatest on record (Sophocleous 2002, Bruner et al. 2011, Barlow and Leake 2012). This level of streamflow depletion would likely impact surface water beneficial uses to the extent that threatened steelhead would experience “harm” under	6/3/21	It is not the intent that the MTs are to “perpetuate historically low groundwater conditions.” It is the intent that the basin should be managed such that water levels do not go lower than the MTs. And for the MTs associated with GW/SW interaction, these MTs have been commonly observed in the historical period of record of water levels, and so are assumed to be appropriate to local conditions. Projects and supplemental water sources in Edna Valley are intended to improve streamflow conditions.

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			the ESA as well as result in adverse impacts to Groundwater Dependent Ecosystems (GDE) supporting a variety of native aquatic species.		
72	Mark Capelli, NMFS	DRAFT Chapter 8 See letter dated June 3, 2021 appended to the Response to Comments.	Page 30: Following the discussion on the relation between flow conditions in San Luis Obispo Creek and the underlying aquifer, the draft Chapter 8 asserts, "in both cases the amount of flux between the surface water and the groundwater system is small compared to the volume of water flowing down the creek." The point of this statement is unclear but seems to suggest that groundwater levels are not significantly influenced by the volume (including duration) of stream flow. However, this implication is contradicted by the statement, "In wetter years, when flows in the San Luis Obispo Creek are high there is [sic] greater amounts of discharge from the creek to the groundwater system." In general, higher and longer the duration flows in SLO Creek will increase the area of wetted stream bottom (i.e., the area of infiltration) as well as the duration of the infiltration of surface flows to the underlying groundwater basin. Furthermore, the assertion that stable groundwater levels at a specific well "suggest that the mechanisms of surface water/groundwater interaction have not been negatively impacted since the early 1990's" does not address the question of whether these stable conditions have had and are resulting in streamflow depletion impacts as defined under SGMA. Currently stable groundwater levels are not an indicator of sustainable groundwater conditions, or, more specifically, avoidance of significant and unreasonable effects on streamflow. The revised draft Chapter 8 should address this issue and clearly indicate how existing stable groundwater conditions are protective of GDE, such as rearing habitat for juvenile steelhead.		The text in this chapter has been revised to address these issues in greater detail, including discussion of Darcy's law and flow direction between stream and aquifer, more detailed hydrograph analysis of SLO Creek and Corral de Piedras Creeks, and a conceptual modeling evaluation of surface water/groundwater interaction. It is important to recognize that many factors contribute to instream flow conditions that are beyond the ability of a groundwater management plan to control (rainfall, temperature, etc.). The objective with respect to interconnected surface water (ISW) is to avoid groundwater conditions that result in significant or unreasonable increase in ISW depletion.
73	Mark Capelli, NMFS	DRAFT Chapter 8 See letter dated June 3, 2021 appended to the Response to Comments.	Page 31: The draft Chapter 8 states that, "by defining minimum thresholds in terms of groundwater elevations….the GSA will….manage potential changes in depletion of interconnected surface (sic [flows?])." The draft Chapter 8, however, has not established the required correlation between groundwater elevations and surface flows that would justify groundwater levels as a proxy for streamflow depletion, and has not quantified what level of streamflow depletion represents significant and unreasonable impacts to GDE, including but not limited to rearing habitat for juvenile steelhead. The draft Chapter 8 should identify the data needed to analyze the relationship of groundwater levels, streamflow depletion rates, and impacts to GDE, specifically spawning, rearing and migration of ESA-listed steelhead.		There is no technology or field method to directly measure depletions in surface water flow attributable to groundwater development. Estimates must be made using interpretation, modeling, and other methods of analysis. A discussion of Darcy's Law and direction of flow between the stream and aquifer has been added to the text of this section, as well as additional well hydrograph analysis, and a conceptual modeling exercise. However, it is a commonly accepted hydrologic principle that correlates groundwater elevations higher than the stream elevation and aquifer discharge to the stream. Survey data must be collected on stream channels and groundwater elevations to confirm this relationship. Proposed improvements to the monitoring network discussed in Chapter 7 and the Stillwater TM will improve the understanding of this dynamic.

ID	Name	Comment Subject	Comment	Date/Time	Response
74	Mark Capelli, NMFS	DRAFT Chapter 8 See letter dated June 3, 2021 appended to the Response to Comments.	Page 31: The draft Chapter 8 establishes minimum thresholds for streamflow depletions as "the lowest water levels observed in the period of record" for the chosen monitoring wells. As noted earlier, according to SGMA regulations a minimum threshold is used to define an undesirable result, in this case streamflow depletion resulting in significant and unreasonable impact to GDE, including, but not limited to rearing juvenile steelhead. The use of a streamflow depletion thresholds associated with the lowest recorded groundwater levels are inappropriate because they will not avoid significant and unreasonable impacts to GDE. The thresholds are inappropriate for avoiding impacts to ESA-listed steelhead resulting from streamflow depletion. To be consistent with the requirements of SGMA, the GSAs must develop thresholds that are likely to avoid adversely impacting steelhead, as well as other GDE.		If groundwater elevations have not been observed to decline below historical levels in the vicinity of a stream, as is the case along SLO Creek, this is an indicator that anthropogenic activities have not impacted stream conditions in this area in the period of record. The objective of the GSP with respect to ISW is to avoid groundwater conditions that will significantly or unreasonably increase depletion of ISW. Hydrograph analysis of wells along corral de Piedras Creeks indicate that this creek is seasonally disconnected from the aquifer; additional monitoring data can confirm or deny this assumption. Additional stream corridor characterization and monitoring is recommended in Chapter 7, Monitoring Networks, and in the Stillwater TM on GDEs that will be included as an appendix to the GSP. . .
75	Mark Capelli, NMFS	DRAFT Chapter 8 See letter dated June 3, 2021 appended to the Response to Comments.	Page 32: The draft Chapter 8 includes no information or analysis that supports the assertion that "maintaining groundwater levels close to historically observed ranges will continue to support groundwater dependent ecosystems." As noted above, there is an assumption embedded within the assertion that current groundwater levels support groundwater dependent ecosystems; this has not been supported by any data or analysis because such information is not presented in the draft document. Managing groundwater levels at historical lows is likely to adversely affect ESA-listed steelhead, and designated critical habitat for this species. To be consistent with the requirements of SGMA, the GSAs must develop minimum thresholds that are likely to avoid adversely impacting steelhead, as well as other GDE.		The statement "maintaining groundwater levels close to historically observed ranges will continue to support groundwater dependent ecosystems." is intended to apply to SLO Creek, where there have been no trends of declining GW levels. If WLs have not declined, and fish populations have existed during the period of record, it is argued that by extension, if GW levels continue at levels approximately equal to those observed in the past 30 years, then groundwater management will not have allowed conditions that lead to significant or unreasonable deletion of interconnected surface water.. Conditions in Corral de Piedras Creek will be better characterized after the implementation of the proposed monitoring plan discussed in Chapter 7 and in the Stillwater TM on GDEs.
76	Keith Watkins	General Comments	Chapter 9: Projects & Management Actions. Edna Valley Growers are willing to take the excess water that now flows to the ocean with no quantity guarantees from the City of San Luis Obispo. Edna Valley Growers are focused on beneficially utilizing excess water which is currently being wasted to the ocean for crop irrigation. The Growers can utilize San Luis Obispo's recycled water in the winter months when City demand is at its lowest. Water can be applied to dormant vineyards to build the soil moisture profile for the spring and summer. Deep rooted grape vines can utilize the water through the spring and summer lowering well water demand through out the valley. Citrus also can be irrigated in the winter months to offset later irrigation demand in drier periods. While we acknowledge that the available amount of water may decrease over time as the City develops additional internal programs, we recommend that grower deliveries not be characterized as a short term program, but a project that will continue to utilize excess water supplies whenever they may be available.The City acknowledges that it has excess capacity in the winter months and can not utilize all the recycled water it produces. Edna Valley Growers are willing to pay the cost to connect to the City recycled water system with no obligation by the City to deliver a guaranteed amount.	6/30/2021 2:05:00 PM	Your comments are noted. It is our understanding that negotiations with the City continue regarding this project, which could potentially help augment the overdraft in Edna Valley.

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			Edna Valley growers want to partner with the City to maintain the City's greenbelt for the benefit of all in the area.Connecting to the City's current 8" waterline system will provide acceptable capacity to the Edna Valley with no need for infrastructure improvements. Again, we will take what the system can provide. If water need to be boosted from the delivery point, Edna Valley Growers will install a booster pump and cover the costs of operation. Edna Valley Growers are willing to pay for the water supply which now flows to the ocean, including some level of profit to the City above the cost of pumping and electricity are covered. Based on some of our initial pricing concepts, up to $200,000 could be recouped annually by the City to provide lower costs to city customers.Edna Valley Growers want to work collaboratively with the City of San Luis Obispo to provide supplemental water to the City's Greenbelt. The current assumed water deficiency threatens not only the agricultural production and residential use in the Edna Valley but also the viability of the City's Greenbelt., as well as the City's economy which benefits from ag tourism, tasting rooms and event centers in the Edna Valley. I believe these comments should be incorporated into Chapter 9, Projects & Management Actions to show the potential more clearly for utilizing recycled water to offset agricultural demand and reduce assumed basin over-draft.		
77	Dan Dooley	Draft_SLO_GSP_Chapters_9_10.pdf - 9.5 Management Actions	See attached letter memo dated 7/21/2021 appended to the Response to Comments and submitted on behalf of Edna Ranch East.	7/21/2021 12:34:00 PM	Thank you for your comments, they are duly notes and kept for the record.
78	Tim Walters	Draft_SLO_GSP_Chapters_9_10.pdf	I understand the objective of managing the basin in a manner that sustains the existing water use patterns, however the objectives and goals ignore potential for agricultural, residential or commercial expansion in the future. In my opinion, it is naive to expect that the basin development whether ag or otherwise will remain static over time. the sustainable goals should recognize and include goals for sustaining existing conditions and forecast future growth within the basin.	6/24/2021 8:39:00 AM	Residential or commercial expansion in the City will be supplied from the City's water supply portfolio, which currently includes surface water from various sources, but does not include groundwater. However, as there have been no declines in groundwater levels in the San Luis Valley subarea, and the water budget for that subarea indicates a surplus, there is likely available groundwater for expansion in that subarea. It is documented in Chapter 6, and confirmed from hydrograph analysis, that the Edna Valley is in overdraft. If expansion of agricultural pumping is pursued in Edna Valley, the goal of sustainability in the Basin will be difficult to achieve.

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79	Timothy Delany, Central Coast Salmon Enhancement, dba Creeklands Conservation	Final Draft TechMemo_GDE_Assessment_SLO.pdf	See letter dated June 22, 2021 appended to the Response to Comments. Note: Please refer to attachment for proper line and page numbers, as well as formatting.	7/22/2021 5:15:00 PM	A letter from Creeklands was attached. Specific comments are addressed below.
80	Timothy Delany, Central Coast Salmon Enhancement, dba Creeklands Conservation	SLO Valley GDE Technical Memo, Chapter 7, Chapter 8 See letter dated June 22, 2021 appended to the Response to Comments.	Comment 1: "...we interpret the SLO Valley GDE Technical Memo to be a supporting document for the achievement of these steps. We respectfully request that the information and recommendations provided within the SLO Valley GDE Technical Memo be consistently incorporated into the Draft GSP Chapters to a greater degree than currently exists."	7/22/2021 5:15:00 PM	The recommendations for improved monitoring locations of the surface water network were directly incorporated into recommendations presented in Chapter 7, Monitoring Network. Text regarding SMCs in Chapter 8 for Depletion of ISW RMSs also references the eventual construction of new gages and development of rating curves for existing gages.
81	Timothy Delany, Central Coast Salmon Enhancement, dba Creeklands Conservation	Chapter 7 (Monitoring Network) See letter dated June 22, 2021 appended to the Response to Comments.	Comment 2: "Groundwater levels and GDEs should have different representative monitoring site (RMS) selection criteria. Whereas groundwater RMSs require a longer historical record to establish the definition for undesirable results, GDE undesirable results are straight-forward and actionable without 1 10 prior years of data for whatever given SMC and MT that is defined. For example, if a relationship between groundwater pumping at Well "A" can be correlated with critical habitat impairment using a nearby stream gage at Site "X", There is no need for Site X to have multiple years of data to establish a trend." "...The RMSs do not appear to anticipate the 10 eventual inclusion of the stream gage network in future revisions of the GSP."	7/22/2021 5:15:00 PM	The establishment of a quantifiable relationship between pumping and critical habitat impairment that you suggest is not straight-forward. Streamflow is dependent on multiple other factors not manageable in this GSP (rainfall, temp, ET, etc.). The goal of this groundwater management plan is to avoid groundwater conditions that can lead to significant or unreasonable deletion of interconnected surface water. To that end, groundwater levels are recommended as a proxy measurement, and conditions that unreasonably lower water levels in the vicinity of the ISW RMSs are intended to be avoided. Text in Chapters 7, 8, and 10 recognizes the data gap in the present surface water monitoring network and discusses the

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					necessity to obtain better surface water flow data to assess surface water/groundwater interaction in the future.
82	Timothy Delany, Central Coast Salmon Enhanceme nt, dba Creeklands Conservati on	Chapter 8 (Sustainab le Managem ent Criteria) See letter dated June 22, 2021 appended to the Response to Comments .	Comment 3: “We find no explanation earlier in Chapter 8, nor in Chapter 7, for why the flux between the aquifer and the interconnected stream must be measured to create a minimum threshold that is protective of GDEs... A rate of flow depletion can be correlated with changes in stage...”	7/22/2021 5:15:00 PM	Creeklands emphasizes the terms “rate or volume of surface water depletions” from SGMA regs but does not acknowledge the significance of the text immediately following, “...caused by groundwater use...”. It is beyond the ability of this groundwater management plan to control all variables that affect surface water depletions. Therefore, the management criteria proposed are that groundwater elevations around the ISW RMSs are not reduced such that depletion of ISW is significantly or unreasonably increased. If water levels near San Luis Creek are maintained near current levels, Darcy’s Law implies that the direction of flow will not be reversed from recent conditions. (Additional survey data of creek channel elevations and groundwater elevations is recommended.)
83	Timothy Delany, Central Coast Salmon Enhanceme nt, dba Creeklands Conservati on	Chapter 8 (Sustainab le Managem ent Criteria) See letter dated June 22, 2021 appended to the Response to Comments .	Comment 4: “This section does not adequately address how groundwater level measurements at the RMSs will be indicative of undesirable results to depletions of interconnected surface water. In other words, there is no language that qualifies well level measurements at the selected RMSs as useful indicators for harm that could be done to GDEs that rely on interconnected surface water or groundwater.	7/22/2021 5:15:00 PM	Additional text has been added to discuss the significance of Darcy’s Law, and the relative elevations of groundwater and stream flow with respect to the direction of flow between groundwater in the aquifer and surface water in the stream. In the case of San Luis Creek, it is stated that because water levels in the ISW RMS have not declined in the past 30 years, that this represents recent conditions. Therefore, if water levels are not significantly or unreasonably lowered below these elevations, no significant or unreasonable change in depletion of ISW will occur. In Edna Valley, additional text was added presenting hydrograph analysis that indicates that West Corral de Piedras are seasonally disconnected from the surrounding aquifer, and that this has been the case going back to the 1950s as is seen in the hydrograph for EV-01; therefore the character of the relationship between GW and ISW has not been significantly or unreasonably changed due to groundwater management practices in recent years.

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84	Timothy Delany, Central Coast Salmon Enhanceme nt, dba Creeklands Conservati on	Chapter 8 (Sustainab le Managem ent Criteria) See letter dated June 22, 2021 appended to the Response to Comments .	Comment 5: "Groundwater levels intermittently measured at the proposed wells (SLV-12, EV-01, EV-11) will not necessarily alert groundwater managers to imminent risks to instream habitat that is reliant on interconnected streamflow..."	7/22/2021 5:15:00 PM	It is acknowledged that conditions of groundwater/surface water interaction vary in time more quickly and frequently than groundwater levels distant from streams or creeks, and that twice-annual measurements may not capture important characteristics of this interaction. It is expected that pressure transducers will be installed in additional selected network monitoring wells to collect continuous monitoring data during the coming 5-year implementation period. It is recommended that ISW RMSs may be prioritized for installation of transducers over other wells more distant from the creeks.
85	Timothy Delany, Central Coast Salmon Enhanceme nt, dba Creeklands Conservati on	General Comments , Chapters 7 and 8 See letter dated June 22, 2021 appended to the Response to Comments .	"Although the importance of monitoring the gaining and losing reaches of streams within the groundwater basin is highlighted in Chapter 7, and referenced in Chapter 8, neither of these chapters give concrete or consequential future steps toward integrating the monitoring of these features with SMCs or MTs. Furthermore, none of the SMCs or MTs properly address GDEs that may be directly reliant on groundwater. The SLO Valley GDE Technical Memo highlights riparian and oak woodland GDEs in Table 2 of that document and suggests that groundwater levels could be used to determine sustainability indicators for them. More work will need to be done to find the appropriate thresholds for GDEs that are directly reliant on groundwater levels, but the current draft only discusses GDEs in the context of interconnected surface water and does not lay the foundation for GDEs that do not rely directly on surface water depletion."	7/22/2021 5:15:00 PM	Specific future steps to monitor stream conditions will be incorporated into scopes of work for implementation of data collection and annual reporting required under SGMA. The entities to perform this work have not yet been identified, and the scopes of work have not yet been specified. It is stated in the implementation plan *Chapter 10) that these actions will be pursued. One of the stated objectives of this GSP with respect is to avoid groundwater conditions that significantly or unreasonably alter groundwater conditions due to pumping that will significantly or unreasonably increase deletion of ISW. This objective should address conditions for all GDEs.
86	Timothy Delany, Central Coast Salmon Enhanceme nt, dba Creeklands Conservati on	General Comments , Chapters 7 and 8 See letter dated June 22, 2021 appended to the Response to	"The authors of the SLO Valley GDE Technical Memo note (on page 5, paragraph 2) that several monitoring wells are screened at unknown depths... Creek Lands has not evaluated the veracity of this particular statement but, if it is true, the potential use of these wells for establishing an indicator of interconnected surface water SMCs or other GDE indicators is cast in doubt until the exact screening depths are determined."	7/22/2021 5:15:00 PM	Specific knowledge of some well construction details is an acknowledged data gap. However, given that the HCM indicates that the geologic formations in the Basin function as a single hydrogeologic unit, with no laterally continuous confining layers existing between formations, this data gap is not considered a reason to preclude any wells from the monitoring network.,

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87	Timothy Delany, Central Coast Salmon Enhancement, dba Creeklands Conservation	General Comments, Chapters 7 and 8 See letter dated June 22, 2021 appended to the Response to Comments.	"Although they may not be able to establish numerical MTs for particular interconnected surface water undesirable results or GDE impacts, what is preventing the GSP from incorporating tentative or placeholder MTs? It would be much more promising to have an interconnected surface water MT that stated how the monitoring network would be used to monitor GDE impacts, without necessarily committing to a numerical value. ○ For example: "Discharge changes between the Andrews Street Gage and the Marsh Street 43 Gage will be used to establish a minimum threshold when better data becomes available" ○ or "Minimum surface water elevations dependent on interconnected 1 groundwater in Stenner Creek will be established when a correlation between near-stream groundwater elevations and the stream gage monitoring network are established." ○ These examples do not hold groundwater managers accountable to any thresholds that are not supported by good science, but create the necessary impetus for future research to address data gaps that are directly applicable to creating MTs that meet SGMA requirements for the proper consideration of GDEs. More specificity at this stage of the GSP development will benefit everyone in the future."	7/22/2021 5:15:00 PM	It is beyond the scope or ability of this GSP to define instream flow conditions as potential objective criteria for SMCs. This is a groundwater management plan, and the objective with respect to ISW is to avoid changes in groundwater conditions that results in significant or unreasonable increases to depletion of interconnected surface water.
88	Timothy Delany, Central Coast Salmon Enhancement, dba Creeklands Conservation	General Comments, Chapters 7 and 8 See letter dated June 22, 2021 appended to the Response to	As it stands, the current Draft GSP does not create a catalyst for future research or GSP revisions that achieve the proper level of protection for GDEs. The current drafts only list the types of data and analyses that may be sought in the future, without enough actionable language that will hold the GSC accountable for implementing effective research in pursuit of a monitoring network that protects GDEs.	7/22/2021 5:15:00 PM	SGMA requirements mandate the completion of annual reports for the Basin throughout the SGMA planning horizon (through 2042). These annual reports will document the implementation of many of the recommendations put forth in the implementation plan. The specific scopes of work or contractors to perform this work are not yet developed or selected.

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89	Julie Ridgeway	General Comments	The note on the bottom of the https://www.slowaterbasin.com/get-involved page regarding when the next meet is still says "Our next GSC Meeting is scheduled for December 9, 2020 and will be offered virtually. Click here for details" and links out to the December 9th meeting. Can this please be updated for this Wednesday's meeting?	8/16/2021 10:19:00 AM	The website has been updated.
90	David Blakely	SLOGSP_Public_Draft.pdf	September 5, 2021Re: Public Draft of the Groundwater Sustainability Plan Thank you for the opportunity to provide comments on the Public Draft of the Groundwater Sustainability Plan. I appreciate all of the good work being done to understand and plan for the sustainability of the SLO Basin. In general, my major concern with this plan is that it relies too much on unrealistic supply side solutions to the problem of overdraft of the Edna Sub Basin instead of focusing on demand management practices and changes in land use planning and other public policy initiatives that can improve that basin. This draft plan relies too much on the uncertain acquisition of State Water Project (SWP) water to back bill the overdraft of the sub basin. Given the past history and current reliability problems with the SWP this is a low to no probability solution. It is improper to suggest it as a solution when there is little to no chance it can or will be implemented. Focusing on getting access to the SWP will just delay any real solution to this sustainability issue in the Edna sub basin. While this plan does mention demand management solutions, they are all voluntary and have a low probability of implementation. Once again, these voluntary fixes are not real fixes at all and will delay any real solution to the sustainability problem of the Edna sub basin. An unrealistic reliance on the SWP and voluntary conservation measures can potentially jeopardize the entire plan and cause its approval by the State to be delayed and exacerbating the overdraft problem requiring even more draconian solutions. Below are some specific comments on the Draft Plan. All the best, David Blakely Comments: Page ES-16In the Section entitled: The seven projects evaluated as part of the GSP. It does not seem reasonable, to even consider using potable water from the State Water Project for	9/5/2021 3:39:00 PM	Chapter 9 describes the projects and management actions at a conceptual level and will be further evaluated including the development of the Supplemental Water Feasibility Study and Demand Management Plan. Many of your comments will be addressed during the development of the Supplemental Water Feasibility Study in the first year of the GSP Implementation which will be conducted in an open stakeholder environment and will focus on the feasibility of supplemental water sources including the State Water Project. As described in Chapter 9 Section 9.5 Management Actions, A Groundwater Extraction and Metering Plan will be developed and will provide a key metrics to evaluate the effectiveness of the demand management strategies that will be included in the Demand Management Plan.

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			agricultural uses. Given the need for potable water in the state it seems absurd to even consider this as an option. To even consider this as an option provides an inaccurate tilt to the conclusions of this study. I believe that any agricultural use of SWP be stricken from this document. Page 5-8 It is indicated that there is significant drop in the ground water levels in the Edna valley. The cause of this drop must be understood. If the drop is because of ground water pumping to irrigate the agricultural uses it must be contemplated to limit this pumping which may cause problems for residential uses in this area. The major problem is in the southern areas (Edna Valley) of the basin. County planning should address this precipitous water level drop and the city of SLO should understand its impact on the down gradient ground water levels. The map on page 5-14 illustrates this problem. This is not sustainable. Page 5-15 This map illustrates the effects of the resent drought and agricultural ground water pumping in this area. Continued or increased agricultural use in this area will be detrimental to all users in the basin. Page 5-35 Section 5.9.1 In the discussion of ground water suitability for drinking water there appears to be a nitrate problem. Can any of that increase in nitrates be attributed to agricultural uses overlying the basin? If there is a correlation, there should be a program to reduce this impact. Map on 5-3 Shows the areas of Nitrate concentration. These areas should have a plan to mitigate this impact as part of this document. Page 6-2 Table 6-11 This table appears to show that pasture uses are the most water intensive and vineyards tend to be much lower. If that is the case, then there should be a program to phase out pasture uses and transfer that water to other less demanding uses. Maybe a program like the one used in the Paso Basin for the open sale of water rights should be considered. Page 6-63 From the plan 6.6.1.1. Future Water Demand Assumptions For the purpose of evaluating the effects of climate change and future baseline water budget development, the assumption is made that there will be no increase in irrigated acreage or agricultural pumping over the SGMA planning horizon. There is no evidence in the record to indicate that this statement is true. It is appearing to be based on the statements of the users that are contributing to the overdraft. Evidence of the stabilization of this overdraft must be part of the record. There is no evidence in the record that indicates that there will be no increase in the amount of pastureland in the Edna Valley and there is no evidence that there will be a halt to any increases in water usage in this area. Page 8-58.3.2. Sustainability Strategy The sustainability strategy was developed and discussed at numerous public meetings of the GSC. Projects and management actions were developed collaboratively with GSA Staff, GSC members, and the public utilizing the guiding principles of the Sustainability Goal. A total of seven (7) projects are evaluated in Chapter 9 (Projects and Management Actions) and are centered around supplemental water sources that could be brought into the SLO Basin to mitigate the overdraft. In addition to the projects, three (3) management actions will be implemented. The implementation of a combination of projects and the management actions listed below will ensure that the SLO Basin will operate within the sustainable yield and achieve sustainability as described in the following sections of this Chapter.		

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			• State Water Project for Edna Valley Agricultural Irrigation • Stater Water Project Recharge Basin within the Edna Valley area. • State Water Project to the Golden State Water Company • State Water Project to the Edna and Varian Ranch Mutual Water Companies • City of SLO Recycled Water for Edna Valley Agriculture • Varian Ranch Mutual Water Company Arroyo Grande Subbasin Wells • Price Canyon Discharge Relocation • Expand Monitoring Network • Develop and Implement Groundwater Extraction Metering Plan • Develop Demand Management Plan It is ludicrous to assume that the SWP will help in any way to solve this problem. The agricultural stakeholders appear to think that there is a solution by using SWP water to help replenish their over drafted water supply. There is a very low probability that the SWP can provide a solution to this problem. There must be an explanation of how it makes sense to use potable water for agricultural uses and there also must be an explanation of the reliability of the SWP in suppling water to be used to solve this overdraft issue. The focus should be on figuring out a way to better utilize the limited resource that has been determined by this report as the sustainable yield in that sub region. The solution is not in increasing supply but by demand management. The County of SLO must develop policies that do not further degrade the sustainability of the Edna Valley sub basin. Page 8-24 Agricultural Land Uses and Users the MT for reduction in groundwater storage may limit or reduce non-de minimis production in the Basin by reducing the amount of available water. The practical effect of these MTs on agricultural users is that current levels of agricultural pumping may not be sustainable without development of additional sources of water to the Basin. Owners of undeveloped agricultural lands that are currently not irrigated may be particularly impacted because the additional groundwater pumping needed to irrigate these lands could increase the Basin pumping beyond the sustainable yield, violating the MT. Existing agricultural operations may also be limited in their use of more water-intensive crops, expansion of existing irrigated lands, and by periods of extended drought that decrease the quantity of water naturally returning to the basin. Once again, this report indicates that the solution to the over drafting of the Edna Valley is to develop new sources of water. The SWP is an unreliable source. The focus of this report should be to work on the demand portion of the overdraft problem. There are many strategies for doing this. Many strategies will have little impact on the current users and increase sustainability in the basin. Page 6-9 Chart The city of SLO should not be transferring any of its water to Ag users who are over pumping their aquifers. The city needs all the water they can get. I have not heard the city indicate that they have surplus water to sell to anyone. If the city has excess reclaimed water, they should be developing a delivery system to use it appropriately within the city. On this chart two projects are listed to deliver water via the		

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			SWP to GSWC and Mutual Water Companies for a total of 100 AFY of water. Before such a plan should be considered water reliability from the SWP must be considered. The sunk cost of any new water deliveries from the SWP must be considered as they may be so high that the price of this water is not acceptable. Just because you can list the SWP as a solution to the problem with sustainability in this area does not mean that it a solution to that issue. The problem is compounded if this new water is growth inducing leading to no net gain in fixing the sustainability issue. If the new water is growth inducing an Eir will be required leading to more cost and future delays. To include the SWP as any mitigation to this problem is a distraction and provide at best a false hope that the problem of sustainability can be corrected with SWP. Page 9-11Table 9-5 Once again the plan dishonestly presents the SWP as a potential solution to the issues of overdraft. Page 9-12 The SWP water is a treated water supply and may require dichlorination before being used for agricultural purposes. This statement from this document illustrates one of the problems with using SWP water. This problem is identified but there is no discussion on how dichlorination works and what the environmental impacts might be SWP water for irrigation use to offset pumping could be purchased from 1) District subcontractors that receive their SWP water through Lopez and Chorro Valley Participants, 2) Santa Barbara County Participants or 3) a portion of the SLOCFCWCD's unsubscribed Table A amount (14,463 AFY). Any necessary agreements/terms would need to be identified, negotiated, and developed amongst relevant parties, and environmental review would need to be conducted, to facilitate the transfers. The recent adoption of the Water Management Tools Amendment to the SWP Contracts by the SLOCFCWCD and the Santa Barbara County Flood Control and Water Conservation District (SBCWCFCD) presents new opportunities for obtaining SWP water supply and delivery capacity to Edna Valley. This section illustrates the insurmountable problems with the notion that the SWP can ever be possible as a solution to the overdraft issue. This is another reason why it is silly to include it as a potential The model was run continuously for the time period from water years 1987 through 2044. This project simulation assumes that 1,000 AFY of SWP water is available for agriculture to offset irrigation supply currently supplied by groundwater. This statement is misleading at best. There has never been a year in which the SWP has been able to deliver the full entitlements of the system. The planning done for this scenario should at least be based on honest delivery amounts. Another assumption that cannot be made is that the SWP water will be available in 2026. Given the strong desire for urban use of the SWP water I do not believe that there will ever be a decision to allow that water to be used for ag purposes. Page 9-15 9.4.1.2. Supply Reliability (§ 354.44.6) The latest estimates of anticipated SWP availability under future conditions are included in the Department of Water Resources 2019 SWP Delivery Capability Report (DCR) (DWR, 2019). The 2019 DCR anticipates approximately 58% of the SLOCFCWCDs and 59% of the SBCFCWCD. This is evidence that the SWP indicates a small amount of water can actually be delivered. Therefore, to get 1000 AF of state water a much larger amount will need to be purchased. Even in wet years the SWP is not able to deliver its contracted amounts. This report identifies this reliability problem but goes on as if the full entitlement can be delivered. Its analysis		

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			assumes full delivery and though it states this delivery issue it does not include it in documentation to justify its use. To use the SWP as a mitigation to the overdraft problem will make it appear that the basin is working toward a solution. In reality this non solution and its pursuit will make worse the overdraft problem because no real action will be taken.9.4.1.4. Project Implementation (§ 354.44.4) Investigating the use of SWP as a supplemental water source would occur within the first year of implementation. Following the recommendations of the feasibility study, negotiations to acquire SWP from the identified sellers could take up to 5 years. The design and construction of the turnout and pipeline could occur concurrent with the negotiations and occur within 5 years. This is an unrealistic and dishonest timeline. Nothing dealing with the SWP can happen in 5 years. There is no evidence in this record that indicates this project can happen in five years. Simply stating that it can happen in 5 years and realistically even getting to a decision on this solution could take much longer if at all. As stated in 9.4.1.7 the regulatory process will delay any implementation of this solution. Page 9-16 This section provides information that indicate that the transfer of water from the city to the over drafted basin is not a viable solution either. At the beginning of this process the city may be able to provide some water, but the city has indicated that it will probably be reducing this water to the basin users. May reasons are given as to why the city will reduce the quantity of available water to outside users. Therefore, this should be eliminated from the list of potential solutions to the overdraft issue. Page 9-379.5.3.2. Irrigation Efficiency Improvements. The information in this section may be correct but it not proper to use this data in connection to demand management in the Edna valley. This model assumes that crop uses will remain constant and then through efficiency this constant use will be reduced. The flaw in this scenario is that it does not control for change in use to a more water intensive use. The report also states that even the information in this model is conceptual. Without more concrete factual information to suggest that irrigation efficiency will help to improve the overdraft in the basin this solution is purely speculative. Page 9-38 9.5.3.3. Volunteer Water Efficient Crop Conversion. Any mitigation that relies on voluntary participation is by its nature unreliable and should not be considered as a mitigation for overdraft. The same is true for Volunteer Land Fallowing. Unless these solutions are required there is a very low probability of their implementation. Page 10-2 10.1.3. Implementation Costs. Implementation Cost should be borne by the entities causing the lack of sustainability not by the general public. The general public did not cause this problem. It should be fixed by those users contributing to the overdraft. Page 10-3 In this timeline the scheduling for the Project Implementation is extremely optimistic. The report should do a better job of realistically projecting the timing for Project Implementation. Once again, the cost to develop the Supplemental Water Feasibility Study should be funded by the property owners who will benefit by its implementation. The people causing the overdraft and lack of sustainability of the sub basin should shoulder the cost of the project that will fix the problem they have created. We are privatizing the benefits and socializing the cost. Section 10.2 makes it appear that costs are anticipated to be covered by project proponents yet there is no discussion of methods to be used to make this happen.		

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91	Mark Capelli and Rick Rogers	SLOGSP_Public_Draft.pdf	See attached letter dated September 9, 2021. 9SEP2021_Slo valley draft Final GSP comment letter_MC review.pdf	9/9/2021 12:16:00 PM	All comments made by NMFS in response to the original response to comments are noted. The GSAs believe that hydrograph analysis of wells with the longest period of record indicates that SLO Creek is connected to the surrounding aquifer, and Corral de Piedras Creeks are seasonally disconnected from the aquifer. The GSAs also believe that the hydrograph analysis presented indicates no observable trends of declining water levels in the alluvial wells, and that this indicates no change in the character of SW/GW interaction in SLO Creek or Corral de Piedras Creeks over the past three decades. Additional data proposed to be collected in the implementation period, including installation of pressure transducers for collection of continuous data in select wells, will help to clarify the nature of SW/GW flux in the Basin. Darcy's Law posits that the flux between an aquifer and a stream is dependent upon the hydraulic gradient of the groundwater surface (the other components of Darcy's Law, aquifer hydraulic conductivity and area of flow, are assumed not to change). If the GW elevation is decreased and the hydraulic gradient decreased, the lower GW elevation will correspond to a lesser amount of GW/SW flux. Thus, a specific GW elevation corresponds to a specific amount of SW/GW flux. The GSAs believe that although adequate data are not currently available to numerically quantify the amount of flux from the aquifer to the stream, that Darcy's law supports the contention just presented that specific GW elevations/gradients correspond to a specific quantity of flux. This is the rationale for using groundwater elevation as a proxy for SW/GW flux. Therefore, the groundwater elevation MTs selected by the GSAs are intended to reflect a <u>quantity</u> of GW/SW

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					flux that is not numerically defined or measurable but defined in terms of the groundwater levels. Significant depletions of ISW as characterized by GW elevations below the MTs therefore reflect the quantities of flux between SW and GW that the GSAs consider unreasonable. And because the groundwater elevation MTs are defined within the range of water levels observed in the historical record, that this approach will not cause significant or unreasonable depletion of interconnected surface water. Additional text was added to Chapter 8 to clarify this point. The GSAs recognize that additional data will improve the understanding and characterization of interconnected SW/GW interactions in the Basin. Additional wells and stream gages have been proposed to be added to the monitoring network in the upcoming implementation period. The GSA s recognize that the City of SLO has an agreement to release a prescribed minimum amount of water to SLO Creek from their Water Reclamation Facility, intended to support and enhance the surface water flow regime in SLO Creek . These flows benefit fisheries and GDEs along SLO Creek and are not impacted by any proposals in this GSP. In addition, surface water diversions on West Corral de Piedras Creek upstream from Edna Valley are under the purview of the SWRCB. They are in the process of regulatory review, and to the extent that this independent process results in any additional flows being released from the reservoir to flow downstream, it will benefit environmental flows and fisheries conditions in Edna Valley portion of the Basin.

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92	Keith Watkins	General Comments	As currently written, the GSP requires ag production wells to be metered to determine applied water to crops. This requirement is extremely expensive for growers to install, (many are very small producing less than 30 GPM) and meters are difficult to maintain. The accuracy of meters is also questionable. An alternative would be to utilize a satellite based consumptive use program that is currently being used in the San Joaquin Valley. This program is reliable and has been approved by DWR. Here is a brief description of the monitoring program: Cal Poly's Irrigation Training and Research Center ITRC has pioneered a remote sensing technique to determine actual plant evapotranspiration using satellite imagery. This technique, called ITRC METRIC, utilizes data from LandSAT images along with ground based weather to accurately compute actual evapotranspiration of all vegetation in a region. This data is used by many in the Central Valley for groundwater management, groundwater modeling, and net groundwater pumping evaluations. This process has been approved by the DWR as a tool for basin groundwater sustainability management in lieu of groundwater pump flow meters. In some areas we have provided actual monthly ETc from 1992 to present. ITRC will provide monthly and annual ITRC METRIC actual crop evapotranspiration (ETc) for Edna Valley. While this process does not require crop type/land use information, we will utilize field level crop type information to inform growers of the average/typical evapotranspiration for the various crops grown in Edna Valley. We will also provide this information on a field/parcel basis to individual growers for their own information. The largest outflow from the Edna Basin is ETc. However, the methods used in the groundwater model for determining ETc has a high degree of uncertainty. ITRC METRIC results can first be used to determine the actual uncertainty in the existing model. Eventually, it can be used to improve the groundwater model with much more accurate evapotranspiration data. The following items will be completed: 1. ITRC METRIC will be processed for one or two years selected by the Edna Valley growers. Up to two images will be processed per month for each year. 2. Crop/land use information will be obtained by surveying the fields in Edna Valley. These will be compared to land use information from NASS and DWR. A land use shapefile will be developed and made available to Edna Valley growers. 3. The evapotranspiration from each field will be determined and summarized by crop. The mean and range of ET for each crop will be summarized on a monthly and annual basis. 4. ETc by field will be provided for growers to examine and use. 5. An irrigation scheduling best management practices (BMP) guide will be developed with localized evapotranspiration estimates that more accurately reflect Edna Valley conditions. BMP options will include real time remote sensing, soil moisture assessment, plant based assessments, evapotranspiration estimation techniques, etc.I would recommend adding this type of monitoring to the plan to give growers an option over meters.	9/10/2021 11:21:00 AM	In Section 9.5.2.2 Non-De Minimis Extraction and Reporting Program the GSP states that "During the first five years of implementation, this Plan calls for the development of a Groundwater Extraction Metering and Reporting Plan for non de minimis users to report extractions using metering devices or other suitable methods. Water Code Section 10725.8 provides GSAs the power through their GSPs to measure the use of groundwater extraction facilities for non de minimis extractions." The GSAs may consider alternatives to metering including satellite based remote sensing techniques during the development of the Groundwater Extraction and Metering Plan.

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93	Christine Mulholland	SLOGSP_Public_Draft.pdf	September 13, 2021Comments on the Public Draft of the Groundwater Sustainability Plan To whom it may concern: The draft GSP appears to be based on the desires of the largest consumers of water in the basin and the pipe dream of imported water as the solution to bringing the basin into long term sustainability. There were about 10 million people in California when I was born and there are nearly 40 million Californians now. But there is no more water in California now than 70 years ago. Indeed, there is a lot less, in great part due to irrigated agriculture pushing into every nook and cranny of the state. Ground water basins have been pumped dry and now, with climate change upon us, there is great unlikelihood that recharge is possible in the short timeframe of SGMA. It is shear folly to believe that the State Water Project will be able to provide the answer. That system is over subscribed and unable to fulfill current obligations. The City of San Luis Obispo voted, twice, not to buy into the SWP, and that vote must be honored. And the Plan's timeframe of 5 years to bring more water is an unrealistic pipe dream. Clear thinking tells us that sustainability means living within our means. We have outpaced our available resource base with too many acres planted and irrigated, and too much residential development welcoming more people than can be served for the long term. The Plan must be clear. The property owners causing the depletion of the basin must be the ones who pay to fix the problem. Large water users must cut back substantially, including removal of some irrigated agriculture. Residential development must be halted until the basin is balanced. The GSP should be working on modifying land use policy so that each proposed use of groundwater must prove it will not deplete the resource. And current water pumpers must be allocated less than now used until balance is restored. Christine Mulholland San Luis Obispo	9/11/2021 2:55:00 PM	Groundwater basins in California are in differing levels of condition across the State. This GSP is drafted to return the SLO Valley Basin to sustainability and does not have relation to any other basins within the State. This GSP also does not identify the purchase of State Water Project water by the City of San Luis Obispo. The plan does however examine the potential for the purchase of State Water Project water by non-City entities. Projects are identified within the GSP to mitigate overpumping of the Edna Valley subarea of the Basin. Should these projects not be fully developed or executed, pumping reductions or restrictions may be required within the basin. The characteristics of water use within the basin indicate that most of these pumping reductions would need to be made by agricultural operations within the basin.
94	tim walters	SLOGSP_Public_Draft.pdf - Executive Summary	please include the following language as a policy within the document. Supplemental water projects that are implemented for existing irrigated agriculture are likely to require proactive demand management, especially with reference to the planting of new irrigated crops, the replacement of existing crops with those of higher demand, or the implementation of other related land uses that require additional basin production. Otherwise, the benefits of a supplemental agricultural supply will be reduced or eliminated by offsetting increases in demand from new planting. Agricultural demand management measures are expected to be documented in the Demand Management Plan, in collaboration with the agricultural stakeholders funding the related supplemental water projects. Such measures would be implemented in the specific areas that benefit from a given supplemental water project and may include the following restrictions: 1. Planting of irrigated crops on acreage that is not currently irrigated, or irrigated within three years, prior to the publishing of the draft GSP; and Planting of crops that will generate a higher water demand than that used for existing irrigated acreage, prior to the publishing of the draft GSP. Crop restrictions that are necessary to	9/15/2021 12:48:00 PM	Text in Section 9.5.3 Demand Management Plan of the GSP has been added to include the following: "Water Code Section 10726.4 gives GSAs the power to control extractions by, among other things, regulating, limiting or suspending extractions subject to certain requirements or limitations. This GSP calls for the development of a Demand Management Plan that will include the documentation of water conservation measures taken by purveyors, irrigation efficiencies of the agricultural fields, water efficient crop conversion, and volunteer crop fallowing. The Demand Management Plan may also provide for mandatory pumping limitations consistent with Water Code Section 10726.4 which would be implemented and enforced via a separately developed regulation. Such regulation would need to be based on the development of a defensible methodology under SGMA, and may be based on the development of a methodology for determining (1) baseline pumping in specific areas considering groundwater level trends in areas of decline, estimated available volume of water in those

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			preserve the benefits of any supplemental water project should be an integral part of the project planning and implementation process.		areas, and land uses and corresponding irrigation requirements; and (2) whose use must be limited and by how much considering, though not limited to, water rights, water conservation measures, and evaluation of anticipated benefits from projects bringing in supplemental water or other relevant actions individual extractors take." The development of the Demand Management Plan will occur in an open stakeholder process and your comment will be discussed. The methodology, baseline, and determination of pumping restrictions would be incorporated into regulations that could be developed by the County Board of Supervisors for the unincorporated areas of the Basin and could consider the progress of the Projects and Management Actions and the Sustainability Goals described in the Plan.
95	Neil Havlik	San Luis Obispo Basin Groundwater Sustainability Plan	Mr. Dick Tzou County of San Luis Obispo RE: San Luis Obispo Basin Groundwater Sustainability Plan Dear Mr. Tzou: The Coastal San Luis Resource Conservation District (CSLRCD) has for a number of years been interested in and supportive of efforts to improve groundwater recharge in the Edna Valley portion of the San Luis Obispo Groundwater Basin. We have worked in the past with Freeport McMoran, predessesors to Sentinel, regarding beneficial reuse of their reverse-osmosis treated produced water, which is currently discharged into Pismo Creek at a location which does not allow for any significant infiltration of said water into the groundwater table. Our work identified a route to pump said water up into the Edna Valley to a discharge point some 3-4 miles upstream, where the discharge would provide both in-stream habitat enhancements to West Corral de Piedra Creek, and recharge of the Edna Valley groundwater basin. We even identified a route for the pipeline and completed a mitigated environmental impact report on the route. Unfortunately, about that time Freeport had other financial issues that occupied them and our proposal did not move into construction; however, it could still do so today. We have also worked with the Edna Valley Growers Association and the City of San Luis Obispo to identify a route for extension of the recycled water system ("purple pipe") from its current terminus near Islay Hill Park on into the Edna Valley. We have offered to serve as the holder of open space or conservation easements for users of recycled City water to ensure that said water is used strictly for groundwater recharge and does not become a source of water for unwanted residential growth in	Sep 14, 2021	The Price Canyon Discharge Relocation Project and the City of SLO RW for Ag Irrigation projects will be further evaluated as part of the Supplemental Water Feasibility Study as described in Chapter 10 (Implementation Plan). The development of the Supplemental Water Feasibility Study will be conducted in an open stakeholder environment and the GSAs welcome CSLRCDs participation.

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			Edna Valley. In short, CSLRCD has been involved in efforts addressing sustainability of groundwater in the Edna Valley for years. We would like to continue that involvement, and ask that the GSP take advantage of the work that we have done to date, and include our organization as a member of the sustainability group. Thank you.		
96	Cheryl McLean	General Comments	GSP Commission: Since today is the last day to submit comments (Sunday 9/19/21) & I just heard about it yesterday I am sending this to strongly concur with former mayor Peg Pinard's insightful comments. It is extremely disappointing that this critical issue has not received widespread meaningful city resident discussion & input. Due to Climate Change past water histories are no longer an indicator for our city's future water sufficiency. Already permitted massive new real estate developments with water entitlements in addition to new densification of established residential neighborhoods are a huge water demand gamble. The West has a history of droughts but in the new reality of Climate Change we cannot afford to take risks with our declining water supply. Please recognize the disastrous situation you are potentially creating. Sincerely, Cheryl McLean San Luis Obispo	9/19/2021 4:50:00 PM	Ms. Pinard's comments will be provided to the City of San Luis Obispo City Council and City staff, as many are unrelated to SGMA. The GSP included significant public outreach including direct mailers, paid online advertising, an extensive e-mail list, City Council Updates, public workshops, etc. Details regarding the public outreach efforts can be found in the Communication and Engagement Plan. The GSP contains climate change projections and if the climate in SLO County becomes dryer than projected, the same standards for operating the basin in a sustainable manner will be required.
97	Robert Shanbrom	General Comments	1) Respectfully, as Andy Pease is, to my knowledge, privately employed in designing water conservation systems, she has an inherent conflict of interest in overseeing this, or any other, water policy. She should recuse herself and another person appointed.2) The report is ridiculously neglectful of climate change projections. The obvious general trend as the planet warms is for climatic zones to migrate poleward. That means that we will gradually become part of the Sonoran Desert. If, for example, such small a change as LA's climate migrating northward to SLO occurs we will go from an average of about 23 inches of rainfall a year (Calpoly data) to 14 inches (USC data). Such an apocalyptic change in climate, a reasonable assumption, must be accounted for.3) As North County also draws from Lake Nacimiento, any water that we can save in SLO has the potential to be used to make up for North County's catastrophic water situation/outlook.4) We are, at this very moment, looking at the nightmare scenario, a scenario that was never considered by city staff in my many communications with them: THAT LAKE NACIMIENTO COULD GO DRY IN 2022. Ignoring the new climatic conditions, in the drought of the 1980s there was a year in which Naci got just 8,000 AF of supply, not enough to even cover our County allotment, much less all the other obligations. And last year, but for one single storm, Naci would have added ZERO ACRE-FEET. Mind you, this is not a highly likely possibility, but we are planning for decades, not for a single year. Any SWP must take into consideration the worst case projected climatic scenario, NOT HISTORIC DATA.5) Previous councils worked diligently to secure water for our town. Why would this council want to undo their work,	9/19/2021 7:33:00 PM	Much of this comment is related to the City's management of surface water and will be provided to City staff. Regarding climate change planning, The climate change projections utilized within the GSP were approved by the GSC and City and County staff. These climate change projections document likely climate change scenarios that could impact the groundwater basin. Since SGMA requires adaptive management of groundwater resources, the submission of annual reports, and 5-year interim reports, climate change-related projections may be altered in the future if better information becomes available or if these models are proven to be inaccurate.

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			especially in the face of climate change. There are many faces of climate change denial and I feel that this plan is one more tragic example		
98	Sandra Rowley	Public_Draft_Appendices.pdf	Over the years there has been a lot of turnover in City staff, and I imagine in county staff and the various agencies, commissions and committees as well. Too many times former members of these bodies do not or cannot pass along the depth and breadth of their knowledge when they leave and, thus, institutional memory and insights can be lost. This situation seems similar to the recently proposed changes to the City's Parking District Program update, i.e., changing the plan to accommodate one segment of the city while ignoring the effects on another segment. In this case it's writing a plan to accommodate one area of the county without taking into account the potential effects on other areas of the county. Mrs Peg Pinard has held positions in the city and the county which have enabled her to gain knowledge about the interrelationships of various parts and aspects of the county. In the case of her recent correspondence (Sept 17, 2021) it is about our groundwater - where it is and where it goes, how things are interconnected, and the history regarding what has been done and why. If you do not have her correspondence, please check with the San Luis Obispo City Clerk to obtain a copy.I learned a lot from reading the input she has provided. I hope you do, too, and that you will incorporate her comments into your discussion(s) and into the formulation of the plan. If it takes additional meetings and an expansion of participants, so be it. It's better to do something correctly than to have to deal with unintended consequences afterward	9/19/2021 7:45:00 PM	Ms. Pinard's comments will be provided to the City of San Luis Obispo City Council and City staff, as many are unrelated to SGMA. The GSP included significant public outreach including direct mailers, paid online advertising, an extensive e-mail list, City Council Updates, public workshops, etc. Details regarding the public outreach efforts can be found in the Communication and Engagement Plan. The GSP contains climate change projections and if the climate in SLO County becomes dryer than projected, the same standards for operating the basin in a sustainable manner will be required.
99	Timothy Delany	SLOGSP_Public_Draft.pdf - Chapter 8 Sustainable Management Criteria	To whom it may concern: Creek Lands Conservation (CLC) previously submitted comments on July 22, 2021 for drafts of GSP chapters. We have reviewed responses to those comments, as well as subsequent revisions that are in the Public Draft GSP. We are pleased to see some of the comments have resulted in changes, but there are concerns that have still not been addressed to our satisfaction. Creek Lands has also reviewed new comments from NMFS, dated September 9, 2021 for this Draft GSP. We generally concur with the concerns expressed in that letter and would like to see responses to those comments. There appears to be some disagreement about whether the GSP should include surface water sustainability indicators in a groundwater sustainability plan. CLCs position is that there is a place for surface water indicators in the GSP, or at least the GSP should include a more detailed defense of how Sustainability Indicators (SI) will adequately protect Interconnected Surface Water (ISW) and Groundwater Dependent	9/19/2021 4:34:00 PM	As part of the management actions the monitoring network will expand from the current SLOCFCWCD monitoring network of 12 wells to the new network of 40 monitoring wells as presented in Chapter 7 (Monitoring Network) within the first two years of the GSP implementation. Chapter 7 describes a proposed monitoring network that has adequate spatial resolution to properly monitor changes to groundwater and surface water conditions relative to SMCs within the Basin. The network will provide data with sufficient temporal resolution to demonstrate short-term, seasonal, and long-term trends in groundwater and related surface conditions. Included in Chapter 7 are recommendations

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			Ecosystems (GDEs) from impacts caused by groundwater management actions, especially near the Minimum Thresholds (MT). The nexus between groundwater and surface water is clearly acknowledged by SGMA and groundwater management can have a direct influence on ISW depletion. Therefore, Sustainability Indicators should capture the impacts of groundwater management actions on the beneficial uses of ISW, including GDEs. Unless a clear relationship between the SLO Basin's groundwater levels and ISW depletion is established, the GSA will not have a GSP that can prevent groundwater management actions from unreasonably impacting GDEs or the beneficial uses of ISW. As it is currently written, the Public Draft GSP does not provide an ISW Sustainability Indicator that will perform well enough to prevent ISW depletion that produces undesirable results. Comment 1The statement defining undesirable results for the depletion of ISW is still inadequate: The Basin will be considered to have undesirable results if any of the representative wells monitoring interconnected surface water display exceedances of the minimum threshold values for two consecutive Fall measurements. Creek Lands addressed this statement in our previous comments, including a detailed description of the ways in which this indicator could fail to detect undesirable results. Two consecutive fall measurements will not necessarily detect the changes in ISW depletion that can result in impacts to GDEs or threatened species in the creeks. The time and spatial scales of the Sustainability Indicator need to be similar to the time and spatial scales of the potential impacts. A single day of creek drying, if attributable to groundwater management actions, could lead to undesirable results but would not necessarily be detected using the definition above. A definition that uses a higher resolution groundwater measurement is requested if a surface water flow indicator cannot be used. Comment 2 (Follow-up for response to Comment 4 in CLC's July 22, 2021 letter) Creek Lands understands the concept of Darcy's Law and its implications for the creeks in the SLO Basin. There are certainly groundwater levels at which the gradient from the groundwater elevation to the surface water elevation in the creeks is sufficient to support GDEs. However, the GSP does not provide enough evidence that the hydraulic gradient at the historically low groundwater levels is a level that will avoid undesirable results. The MTs should be set higher until the GSA has more confidence about the relationship between the hydraulic gradient and ISW depletion. Creek Lands Conservation appreciates the time and effort that has gone into preparing this draft of the GSP, as well as the time taken to engage with comments and accept feedback. We hope that our comments have been useful to the GSA and to stakeholders in this process. Responses to or questions about out comments are welcome, and you may reach out to us using the contact information below.		for additional monitoring sites to better understand the groundwater and surface water interactions which include five surface water gages which will be paired with five monitoring wells and includes high resolution transducer data.

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			Sincerely,Timothy Delany Hydrologisttim@creeklands.org Office: (805) 473-8221		
100	Allan Cooper	General Comments	Since the deadlines for comments for all 10 chapters of this document have come and gone, it is unclear what additional topics within this report are being solicited between July 22, 2021 and September 19, 2021. My comments were sent to the San Luis Obispo City Council on July 16, 2021 (see below) which applied to Chapter 9 and 10: Projects & Management Actions and Implementation, but they do not appear in the GSAs Public Comments section last updated on July 26, 2021. I was hoping that Council would forward these comments on through the proper channels (i.e., the Groundwater Sustainability Agency (GSA) which is accessed through www.slowaterbasin.com) but they did not. Is it still possible to enter these comments into the permanent record? With regards to full transparency, on July 20, 2021 the City Council was advised that during a public comment period, staff will return to the City Council on September 7, 2021 to report on the GSP Administrative Draft and an outline of any significant changes made to the GSP draft chapters. However, on September 7, 2021 this item appears as Item 6.c as on the consent agenda. Though the September 19 deadline for comment on this GSP Administrative Draft was mentioned by Council Member Pease, this item was not pulled for discussion and we believe it should have been. Nor did this item, as it appeared in the staff report, elucidate on any significant changes made to the GSP draft chapters. Nevertheless I would like to add to my original comments by making the following points: Current in-City recycled water demands are increasing while influent into the WRRF is decreasing due to high levels of water conservation. I have heard that recycled water has already been shut off to City parks and golf courses. Yet, the City still feels that it is in the position to provide 500-700 acre feet of recycled water to Edna Valley. Though, according to my calculations, we presently have adequate potable water reserves, we clearly do not have an adequate recycled water supply. So how is this possible? It is commendable that prior to provision of non-potable/recycled water, the property to be served will record a conservation, open space, Williamson Act, or other easement instrument to maintain the area being served in agriculture and open space while non-potable/recycled water is being provided. But will these easement instruments be suspended once the recycled water is no longer being provided? I hope not. It is anticipated that the City could provide 500-700 acre-feet of recycled water annually with quantities decreasing as new in-City users come online. Currently, new in-City	9/19/2021 3:46:00 PM	The City has conducted significant modeling demonstrating that adequate recycled water is available to potentially be sold outside of City limits. City parks and the City golf course still receive recycled water. The statement that adequate recycled water is unavailable to provide in-City customers is inaccurate. The details and limitations of provision of recycled water outside of City limits would be negotiated between the City and any potential buyer. This GSP identifies this as a potential project and identifies existing policies that allow for this use, as well as certain findings and limitations related to the sale of recycled water. This plan does not obligate the City or the Edna Valley Growers to enter into an agreement for the sale/purchase of recycled water. On September 7, 2021 the City Council received a report related to the release of the public draft of the GSP. At this time there was an opportunity for public comment for this item and none was received. On several occasions prior to this date the City Council received items related to SGMA and the GSP, including a study session. During these meetings one public comment was received. In addition to opportunities to provide the City Council with comment, there have been dozens of GSP meetings and workshops soliciting public feedback, as well as an opportunity to provide written comment about each individual chapter of the GSP, as it was drafted.

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			users are coming online practically every day. So what triggers this decrease? This so-called trigger should be explicitly described somewhere in this document.		
101	Roger Longden	SLOGSP_Public_Draft.pdf	I have read Peg Pinard's dissertation on SLO's ground water basin. And I do agree that much more input is needed from regular users. Either that or no one will be around when the wells run dry. Climate awareness is one huge factor and must play a part. Face it! The West is simply getting dryer. Roger Longden 805-234-6666	9/19/2021 12:59:00 PM	Ms. Pinard's comments will be provided to the City of San Luis Obispo City Council and City staff, as many are unrelated to SGMA. The GSP included significant public outreach including direct mailers, paid online advertising, an extensive e-mail list, City Council Updates, public workshops, etc. Details regarding the public outreach efforts can be found in the Communication and Engagement Plan. The GSP contains climate change projections and if the climate in SLO County becomes dryer than projected, the same standards for operating the basin in a sustainable manner will be required.
102	claretta Longden	SLOGSP_Public_Draft.pdf	Listen to Peg Pinard.	9/19/2021 11:57:00 AM	See response to Ms. Pinard's comment (Comment 106). Additionally, Ms. Pinard's comments will be provided to the City of San Luis Obispo City Council.
103	Roberta Foster	General Comments	I concur with Peg Pinard's comments on securing sustainable ground water in the SLO Basin.	9/19/2021 8:22:00 AM	See response to Ms. Pinard's comment (Comment 106). Additionally, Ms. Pinard's comments will be provided to the City of San Luis Obispo City Council.

ID	Name	Comment Subject	Comment	Date/Time	Response
104	Karen L Adler	General Comments	I concur with Peg Pinard's assessment of the ground water situation! SLO City needs to curtail their blatant tree cutting so every developer can get the most money out of the land! What a slap in the face to the residents of SLO!	9/18/2021 7:01:00 PM	See response to Ms. Pinard's comment (Comment 106). Additionally, Ms. Pinard's comments will be provided to the City of San Luis Obispo City Council.
105	Jean-Pierre Wolff Ph.D.	General Comments	Comments pertaining to the basin water quality tests to be performed as part of the GSP:The current proposed plan is to perform water quality tests every five years and make an evaluation of which wells to monitor and test. I suggest that the GSA reviews and references in its GSP the Central Coast Regional Water Quality Control Board (RWQCB) Ag Order 4.0 groundwater monitoring requirements. These requirements will provide easy access and at no extra cost without duplication of effort groundwater quality trend monitoring and individual wells data. In addition, the data available will provide a much more robust set of data points and trends. The following is a brief summary of the information which will become available. All groundwater quality data will be reported on GeoTracker and publicly available. Requirements can be implemented individually or through third-party assistance. On-farm domestic wells starts in 2022, reporting yearly for nitrate, TCP 123 (limited tests based on results), temperature, pH, specific conductance. Primary irrigation wells starts in 2022, reporting yearly for nitrate, TDS, temperature, pH, specific conductance. Starting in 2023 a groundwater quality trend monitoring work plan is to be developed for individual and alternatively third-party approach. Comments pertaining to the basin surface water aquatic habitat GSP. The San Luis Obispo County received additional State grant funding to develop a GSP under SGMA for the Arroyo Grande (AG) groundwater basin. This basin unlike the SLO-Edna Valley basin is not a high priority basin and did not fall under the same rigorous requirements of DWR. The technical analysis resulting from the development of the GSP includes as significant amount of information for the preparation of an Arroyo Grande Creek habitat Conservation Plan. This will include interconnections of the groundwater basin and the Arroyo Grande Creek watershed including an emphasis on the steelhead trout, a designated threatened species as determined by NOAA and the California Department of Fish and Wildlife. When comparing and contrasting the AG and SLO basin creeks habitat evaluations/considerations there is a much weaker set of analysis and studies considerations in the SLO basin. Yet It is important to note that in this instance there are significant similarities between the two basins. Both have reservoirs and dams and both have creeks discharging directly into the Pacific Ocean specifically listed by name as of significant importance by NOAA as part of the South Central California Coast Steelhead (Oncorhynchus mykiss) Recovery Plan established in	9/18/2021 6:33:00 PM	Thank you for your comments. The monitoring network does incorporate the relevant water quality data that is collected as part of the Central Coast Regional Water Quality Control Board (RWQCB) Ag Order and any new relevant data will be evaluated during the annual and five-year update reports. During the first five years of Implementation a Supplemental Water Feasibility Study will further evaluate projects that will increase streamflow in Corral de Piedras Creek including the Price Canyon Discharge Relocation Project. As described in Section 9.5 Management Actions, a groundwater extraction and metering plan will be developed and the data will provide a key metric to evaluate the effectiveness of the demand management strategies that will be included in the Demand Management Plan.

ID	Name	Comment Subject	Comment	Date/Time	Response
			2013. Previous commenters have raised the topic of the SLO basin surface water aquatic habitat concerns with relatively neutral results, However, as both the AG and SLO GSP's are now in further development and refinement, the inconsistency and differences of emphasis between the two plans is becoming more obvious and questions the balance of aquatic environmental values and focus assigned to each basin. The AG basin emphasis on aquatic habitat protection has been very obvious and numerous in public hearings, GSA representatives and technical analysis. The role of the SLO County Flood Control and Water Conservation District in the AG GSP does not solely nor contributorily justify the disparity and weaker consideration of Federal and State Environmental Agencies priorities between the two GSP's. Some of the lessons learned and aquatic habitat conservation from the AG GSP should be integrated in to the SLO GSP. In addition, these actions can be supplemented with a more robust external water augmentation effort to increase instream flow, reduce ground water pumping along with the increased water conservation activities taking place by the Edna Valley farming community .Respectfully submitted,Jean-Pierre Wolff Ph.D		
106	Peg Pinard	General Comments	Sept. 17, 2021Submitted by: Peg Pinard Former Mayor, City of San Luis Obispo and Chairperson, San Luis Obispo County Board of Supervisors I am very please to see that the SLO Basin was designated by the State as a high-priority basin which means the basin's management agencies are required to develop a groundwater sustainability plan". With this as the goal, there are a number of points I would like to make regarding this San Luis Obispo Valley Basin (SLO Basin) Groundwater Sustainability Plan (GSP)1.Limited Input2. SLO City's Water Supply3.Definition of the Basin4.The Model Used5.Nature of Local Agriculture6.Environmental Relationship between "Above Ground" and "Below Ground" Limited Input The list of people who gave input to this plan appears to have been garnered from primarily one sector of the basin, ie; Edna Valley. There was a reference to a forum from some of the respondents but, although I have been very involved in the city's water management plan (ever since the city, literally, hit rock bottom with our available water supply when I was on the city council), I did not hear of any meeting about this plan (nor did any of the usually informed residents, that I know). This is unfortunate because there were a lot of statements made that would have benefitted from a wider discussion had the focus been on the needs of the entire basin as well as the farmers in the Edna Valley. SLO City's Water Supply Based on dozens of previous comments, one thing in particular needs to be clarified. There is no excess SLO City water that is being "wasted going down the creek to the ocean". When SLO residents' water was being rationed, down to how many gallons they could use a day, there was a demand for the city to get new water sources any way they could. The most obvious one available at that crises time was to recycle the water that we already	9/17/2021 7:24:00 PM	Comments will be provided to the City of San Luis Obispo City Council and City staff, as many are unrelated to SGMA. The GSP included significant public outreach including direct mailers, paid online advertising, an extensive e-mail list, City Council Updates, public workshops, etc. Details regarding the public outreach efforts can be found in the Communication and Engagement Plan. The GSP contains climate change projections and if the climate in SLO County becomes dryer than projected, the same standards for operating the basin in a sustainable manner will be required. Additionally, the SLO Basin and its boundaries have been identified by the Department of Water Resources (DWR) and were not defined by this GSP or the GSAs. Comments regarding the extent of the basin, as understood by the commenter, are technically inaccurate and have been disproven by several studies of the basin boundaries. The commenter also made several comments specifically related to land-use management, especially regarding protection of recharge areas. The GSP is not a mechanism for controlling land use decisions that are the authority of land use authorities. Potential groundwater recharge areas will need research outside of the SGMA process to better understand, define, and utilize for recharge purposes. In response to a series of comments related to agricultural water use in the Edna Valley area, the GSP is written in order to return the basin to sustainable levels of discharge and recharge. This

ID	Name	Comment Subject	Comment	Date/Time	Response
			had. In order to achieve this, residents agreed to raise their own water (and sewer) rates to make this happen. We even negotiated a pipe-line-exchange deal with an oil company so that we could use the lines they didn't need anymore in order to get our recycled water to our largest users mainly our parks and schools. Imagine our surprise and, yes, dismay, when the regulatory agencies decided that, even though this was NOT WATER FROM THE CREEK, that we would be required to take our recycled water and release a good portion of it to the creek. In other words, the amount of water naturally coming down the creek was going to be artificially augmented from the water residents had planned (and paid for!) to use from recycling. While the regulatory agency's goal was noble, ie, to augment water for downstream fishery needs (and yes, that release also helped recharge aquifers) the main justification for requiring the additional release was not what we had planned on when we agreed to the higher level of treatment. Residents had planned to use that recycled water! So, believe me, that, if that water was ever to be designated as "extra" the residents of the city would be demanding that it be available for their uses as they had planned and paid for! Definition of the Basin It was very surprising to see the definition of the basin pretty much end at Laguna Lake. That is not what we learned during the drought (in the late 80's) when we did multiple "well studies" in our efforts to get whatever water we could from our wells. The most surprising information was when a dye-test was done to try and understand the basin under the Dalidio property The city wanted to know where it came from and where it went. Actually, it shouldn't have been surprising because once we got the information, the topography all made sense. Historically, it was called Marsh Street for a reason! Water collected there, seeped into the ground, and was a primary recharge collection area for water that traveled down the Los Osos Valley. This aquifer was important for the wells that served Los Osos. This understanding was so important that, when we were originally having discussions with the Dalidios about the development for their property, the plans included a new lake that would still allow for the function of being a primary recharge area for Los Osos. Those original plans tried to acknowledge what was needed environmentally while still being able to accommodate appropriate development. Since the sewer plant was nearby, we even discussed how we could augment that lake by bringing the high tertiary-level-treated, recycled water across the freeway. The lake" could then function as an asset for everyone. This concept for the use of recycled water was later put into practice at Cypress Ridge in Arroyo Grande where the homes are even sold as Lakeside Homes! One of the main take aways from that whole discussion was the need to identify where the major recharge areas were so that we could make sure that we consciously aided the ability to recharge our precious aquifers. The city, and county, were supposed to red line' these areas so that we didn't lose them. This was supposed to be a priority! We could accommodate development without having to destroy the very environment we depended on! As mentioned above, they could even become a selling point! As I see this plan, there does not appear to be any recognition or designation of important recharge areas that must be kept as sacrosanct. While I'm not a soil scientist, I doubt that there is much recharge ability through concrete. And, where is the accountability for the part of this aquifer that serves Los Osos? The Model Used		GSP will be updated on an ongoing basis to ensure that the basin is operated in a sustainable manner, including the pumping for local agricultural operations.

ID	Name	Comment Subject	Comment	Date/Time	Response
			There were a lot of comments about what years were used for the calculations. Apparently, the year 2016 caused a lot of discussion. But I can't help thinking that the whole focus is wrong no matter what years are used. The past is no longer a reliable indicator for the future! That's what the whole issue is about in recognizing Global Warming and, as we are seeing, it's happening a lot faster than was originally thought. We aren't talking about seasonal differences any more differences where taking multiple years and averaging them would bring us a fairly reasonable plan. It's now a whole different ball game! I haven't heard of any climate projection that says that things are going to get better - or even stay the same. In fact, it's just the opposite. The west is getting hotter and drier - not just here but all over. Green house gasses and carbon emissions, continue to accelerate. Where is this current reality taken into consideration? This is not a time for the proverbial "burying one's head in the sand" and pretend it isn't real. If people don't plan for what is already knowable then people have to realize that they will be deliberately creating very severe conflicts. much more severe than the ones that already exist. The Nature of Local Agriculture One property owner described the situation very accurately when she said that her previously reliable well had gone dry and that she had doubts about how her new, much deeper (and costlier) well would last. In the past, the valley had been mostly dry land farming. At first, I remember that businesses like Talley Farms were doing amazing things with their existing crops utilizing innovative irrigation practices that reflected, and respected, the diminishing water availability. But then, the valley changed with the influx of more intensive water uses. This is exactly the situation that old-timers from the north county, told me happened in Paso Robles. The aquifers could handle some increase in production, but not all that had been allowed to happen. "Big business" could afford to dig deeper, while regular folks were watching their wells go dry. This is probably a "sacred cow" for the Edna Valley farmers, but the ever-growing level of agriculture appears to be going beyond the sustainable capacity of the basin. People who have inhabited this land for decades, shouldn't be having to bear the cost of having to dig deeper and deeper for their water while others, who can simply write-off any of these expenses as a business deduction are allowed to take so much. A Basin Plan cannot have undiscussed sacred cows. Â It needs "to put everything on the table, including what level of agriculture the valley can reasonably sustain for ALL the residents in the valley. The City of San Luis Obispo's water is not up for grabs - and, truth be told, the city has its own issues with regard to putting everything on the table in being honest and responsible regarding sustainability for its residents. Environmental Relationship between "Above Ground" and "Below Ground" Rick Rogers (NOAA's National Marine Fisheries) really tried to get the discussion of a Basin Plan on a reasonable and responsible track. There is an interrelationship between what happens above ground and what happens below it. Â Ignore that relationship at one's own peril. We are seeing the effects, and, if we don't change course, the effects are going to be even greater when combined with other global warming factors. The exponential curve that we see with regard to carbon emissions holds true for other factors like deforestation - no matter what chart one uses, the reality is the same. Trees are the bridge between the two ecosystems above and below the ground. Yet we are		

ID	Name	Comment Subject	Comment	Date/Time	Response
			cutting them down with total disregard for the effects. Besides being the cheapest, most effective and reliable carbon sequesters that we have, they have multiple other functions that are seldom discussed. They slow the rain down as it hits the ground, allowing for more time to percolate the soil. The roots hold that water in the soil, again, allowing for the water to slow down as it nourishes and sustains the quality of the soil through its mycorrhizal networks. The leaves not only capture water but they are key for the tree's transpiration of moisture into the atmosphere - thus feeding the atmospheric river and attracting rain clouds for our own areas. This doesn't even begin to talk about all the biological benefits of trees. Crops of all kinds need pollinators and beneficial insects and birds to keep the bad bugs under control. Where do you think our beneficials and birds live? Many farmers know this, but are silent regarding the relationship between the trees' benefits to farmers and the negative effect of cutting the trees down. As we have experienced in this county, some business investors (I really can't call them farmers, sorry) don't care at all and just cut down thousands of trees that are in their way' for making every last buck that they can. The result is that we all pay the cost for such disregard for this interrelationship. It's been very short-term thinking! Â Lest anyone think it's just the agricultural interests that have been destructive with the land by destroying the benefits that trees naturally bring to all of us, just know that the City of San Luis Obispo, a supposedly environmentally-conscious city has done no better. One of the impacts of cutting down over 560 mature trees with the San Luis Ranch project (and a couple of other major projects) is that the city just agreed to put about 22,400 more pounds of carbon into the atmosphere EVERY YEAR. The city itself added to the amount of carbon being put into the atmosphere since they cut down even more trees to make room for a new entrance to the project. It takes a sense of responsibility for a developer to plan building around the mature, existing trees. It takes a willingness to not push for every dollar that one can make by simply clearcutting the land. And, when that sense is missing, it takes a city council or Board of Supervisors willing to stand up to the pressure from the monied interests. That isn't happening. This isn't a comment about not building or not having a farm, it's about being truly conscious of what we are doing and taking responsibility for the factors that will affect all of us, and future generations, in the long run. A Basin Plan needs to account for all of these significant factors that affect the capacity and sustainability of the basin. Respectfully submitted, Peg Pinard Former Mayor, City of San Luis Obispo and Chairperson, San Luis Obispo County Board of Supervisors		

ID	Name	Comment Subject	Comment	Date/Time	Response
107	Ngodoo Atume	General Comments	Hello, I am writing on behalf of Audubon California, Clean Water Action, Clean Water Fund, Local Government Commission, The Nature Conservancy, and Union of Concerned Scientists with the attached comments 1. Beneficial uses and users are not sufficiently considered in GSP development. 2. Climate change is not sufficiently considered. 3. Data gaps are not sufficiently identified and the GSP needs additional plans to eliminate them. 4. Projects and Management Actions do not sufficiently consider potential impacts or benefits to beneficial uses and users.	9/17/2021 3:19:00 PM	1. The GSP included significant public outreach including direct mailers, paid online advertising, an extensive e-mail list, City Council and County BOS Updates, public workshops, etc. Details regarding the public outreach efforts can be found in the Communication and Engagement Plan and is summarized in Figure 2-3. The following groups were targeted stakeholder groups, general public, land use agencies, private and rural groundwater users, ag water users, urban/industrial users, integrated water management, environmental and conservations orgs, economic development, human right to water (DAC's and Rural Community Assistance Corp) and the Tribes. As indicated in the GSP, Tribal interests were contacted and informed of the GSP development process, and that they indicated that they would engage in the Implementation Phase of the GSP. 2. Section 6.6 Projected Water Budget considers climate change scenarios. When the projects are further evaluated climate change will be considered. 3. Data gaps are evaluated in Chapter 7 and will be further evaluated in the Expand Monitoring Network Management Action as described in Chapter 9. 4. The projects are conceptual in nature and the potential impacts or benefits will be further evaluated as projects and management actions are developed.
108	Genevieve Czech	General Comments	It is the SLO residents hope that the Groundwater Basin Plan under discussion is taking the needs of the entire basin as well as the Edna Valley farmers. We cannot forecast present and future resources and needs based upon past data/analyses. Global warming has put an urgent timeline on planning. Peg Pinard has stressed the need to maintain our recharge stations for precious aquifers, and to add the component of trees sequestering carbon dioxide and storing water, and affecting water flow in our creeks. Allan Cooper has challenged the assurances of adequate recycled water supply. Please heed their important contributions to the analysis and ensure that communication on meetings and reports reaches the individuals who are traditionally included in this planning. Whale Rock water will be consumed once again by returning students to the Cal Poly campus, and additional new students. Nationally we have seen the Colorado River under duress like never before in its water distribution, and we cannot forecast the severity or duration of the drought in San Luis Obispo County and California and the American West. May you be well advised in this all important planning approval. Respectfully, Genevieve Czech, 612 Stanford Drive, SLO	9/19/2021 9:48 PM	Ms. Pinard's comments will be provided to the City of San Luis Obispo City Council and City staff, as many are unrelated to SGMA. The GSP included significant public outreach including direct mailers, paid online advertising, an extensive e-mail list, City Council Updates, public workshops, etc. Details regarding the public outreach efforts can be found in the Communication and Engagement Plan. The GSP contains climate change projections and if the climate in SLO County becomes dryer than projected, the same standards for operating the basin in a sustainable manner will be required. Comments regarding inadequate volumes of recycled water availability will be forwarded to City staff and have been demonstrated to be inaccurate by the City's recycled water availability modeling.

UNITED STATES DEPARTMENT OF COMMERCE
National Oceanic and Atmospheric Administration
NATIONAL MARINE FISHERIES SERVICE
West Coast Region
501 West Ocean Boulevard, Suite 4200
Long Beach, California 90802-4213

May 29, 2020

John Diodati
Interim Director, Public Works Department
County of San Luis Obispo County
976 Osos St #207
San Luis Obispo, California 93408

Re: NOAA's National Marine Fisheries Service comments on the draft Groundwater Sustainability Plan (Chapter 5) for the San Luis Obispo Valley Groundwater Basin

Dear Mr. Diodati:

Enclosed with this letter are NOAA's National Marine Fisheries Service's (NMFS) comments on "Chapter 5: Groundwater Conditions" of the San Luis Obispo Valley Groundwater Basin (SLO Valley Basin) Groundwater Sustainability Plan (GSP).

The GSP is intended to meet the requirement of the California Sustainability Groundwater Management Act (SGMA). The SMGA includes specific requirements to identify and consider impacts to Groundwater Dependent Ecosystems (GDE) that have significant and unreasonable adverse impacts on all recognized beneficial uses of groundwater and related surface waters (Water Section 10720), including fish and wildlife and botanical resources.

As explained more fully in the enclosed comments, the draft Chapter 5 does not adequately address the recognized instream beneficial uses of the SLO Valley Basin, which underlies San Luis Obispo Creek and Pismo Creek, or other GDE, potentially affected by the management of groundwater within the SLO Valley Basin. In particular, the draft Chapter 5 does not adequately recognize or analyze the important relationship between the groundwater extractions and potential adverse effects on the federally threatened South-Central California Coast steelhead (*Oncorhynchus mykiss*). The reasons for this assessment are set forth in the enclosure. NMFS recommends that the revised draft Chapter 5 be re-circulated to give interested parties an opportunity to review and comment before it is finalized.

NMFS appreciates the opportunity to provide the enclosed comments on the draft Chapter 5. If you have a question regarding this letter or enclosure, please contact Mr. Mark H. Capelli in our Santa Barbara Office (805) 963-6478 or mark.capelli@noaa.gov. Mr. Rick Rogers (707-578-8552; rick.rogers@noaa.gov) in our Santa Rosa Office.

Sincerely,

Anthony P. Spina
Chief, Southern California Branch
California Coastal Office

cc:

Natalie Stork, Chief, DWR, Groundwater Management Program
Mark Nordberg, DWR
Trevor Joseph, CDWR, Senior Engineering Geologist
James Nachbaur, SWRCB
Rick Rogers, NMFS
Julie Vance, Regional Manager, Region 4, CDFW
Kristal Davis-Fadtke, Water Branch, CDFW
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Annee Ferranti, Environmental Program Manager Resource Conservation, CDFW
Suzanne De Leon, Region 4, CDFW
Don Baldwin, CDFW
Robert Holmes, CDFW
Mary Ngo, CDFW
Roger Root, USFWS
Chris Dellith, USFWS
Kristie Klose, USFS
Ronnie Glick, CDP&R
Fred Otte, City of San Luis Obispo

Enclosure

NOAA's National Marine Fisheries Service's Comments on the draft Groundwater Sustainability Plan (Chapter 5) for the San Luis Obispo Valley Groundwater Basin (March 2020)

May 29, 2020

Introduction

NOAA's National Marine Fisheries Service (NMFS) is responsible for protecting and conserving anadromous fish species listed under the Endangered Species Act, including the federally threatened South-Central California Coast (SC-CCS) Distinct Population Segment (DPS) of Steelhead (*Oncorhynchus mykiss*) which utilize San Luis Obispo Creek and Pismo Creek. NMFS listed SC-CCS, including the populations in the Santa San Luis Obispo Creek and Pismo Creek watersheds (which overlies a portion of the SLO Valley Basin), as threatened in 1997 (62 FR 43937), and reaffirmed the threatened listing in 2006 (71 FR 5248).

On March 12, 2020, the California Department of Water Resources (DWR) has designated the SLO Valley Basin a "Medium" priority for groundwater management, requiring the development of a final Groundwater Sustainability Plan (GSP) by January 31, 2022, pursuant to the 2014 SGMA. Several watercourses that overlie portions of the SLO Valley Basin, including San Luis Obispo Creek and the headwaters of Pismo Creek, support federally threatened SC-CCS DPS of steelhead.

Surface water and groundwater are hydraulically linked in the SLO Valley Basin, and this linkage is critically important in creating seasonal habitat for threatened SC-CCS steelhead. Where the groundwater aquifer supplements streamflow, the influx of cold, clean water is essential for maintaining suitable water temperature and surface flow. Pumping from these aquifer-stream complexes can adversely affect freshwater rearing areas for juvenile steelhead by lowering groundwater levels and interrupting the hyporheic flow between the aquifer and the stream, particularly during the naturally low flow summer and fall months. Thus, groundwater extraction in the SLO Valley Basin can and is expected to adversely affect threatened S-CCC steelhead through a reduction in the amount and extent of freshwater rearing sites for this species.

Steelhead Life History: Habitat Requirements

While adult steelhead spend a majority of their adult life in the marine environment, much of this species' life history phase (migration to and from spawning areas, spawning, incubation of eggs and the rearing of juveniles) occurs in the freshwater environment, including in the main stem and tributaries. Many of the natural limiting factors (such as seasonal variation in rainfall, runoff, and ambient air and water temperatures) are exacerbated by the artificial modification of these freshwater habitats. This includes both surface and sub-surface extractions that lower the water table and can, in turn, affect the timing, duration, and magnitude of surface flows essential for steelhead migration, spawning and rearing, based on NMFS' extensive experience assessing the influence of surface and groundwater withdrawals on this species.

Seasonal instream conditions can prevent the species from completing its life cycle. In particular, the over-summering period can be challenging to juvenile steelhead survival and growth. Lowered water tables that are hydrologically connected to surface flows and subjected to groundwater pumping during the dry season can affect rearing individuals by reducing vegetative cover, and directly by reducing or eliminating the summertime surface flows. (Barlow and Leake 2012, Heath 1983).

Groundwater inputs to surface flows can buffer daily temperature fluctuations in a stream (Hebert 2016, Barlow and Leake 2012, Brunke et al. 1996, Heath 1983). Artificially reducing the groundwater inputs would likely expand or shrink the amount of fish habitat and feeding opportunities for rearing juvenile steelhead, and reduce the likelihood that juvenile steelhead would survive the low-flow period and successfully emigrate to the estuary and the ocean (CBEC and Podlech 2015, Croyle 2009, Glasser et al. 2007, Sophocleous 2002, Fetter 1997).

NMFS' South-Central California Steelhead Recovery Plan identifies groundwater extraction from San Luis Obispo Creek and Pismo Creek as likely caused by both surface water diversions and pumping hydraulically connected groundwater, and is ranked as a "Very High Threat" to steelhead survival in San Luis Obispo Creek and Pismo Creek (NMFS 2013. Table 12-2. Threat source rankings in the San Luis Obispo Terrace Biogeographic Population Subgroup. p. 12-17).

San Luis Obispo Creek and Pismo Creek: Steelhead Recovery

NMFS' South-Central California Steelhead Recovery Plan (2013) designated both San Luis Obispo Creek and Pismo Creek as Core 1 populations within the San Luis Obispo Terrace Biogeographic Population Group. Core 1 populations are populations identified as having the highest priority for recovery based on a variety of factors, including:

- the intrinsic potential of the population in an unimpaired condition;
- the role of the population in meeting the spatial and/or redundancy viability criteria;
- the current condition of the populations;
- the severity of the threats facing the populations;
- the potential ecological or genetic diversity the watershed and population could provide to the species; and,
- the capacity of the watershed and population to respond to the critical recovery actions needed to abate those threats.

(NMFS 2013, Table 7.1 Core 1, 2, and 3 *O. mykiss* populations within the South-Central California Steelhead Recovery Planning Area. pp. 7-7 – 7-8.)

As part of NMFS' recovery planning for the threatened SC-CCS DPS of steelhead, the intrinsic potential of individual watersheds to support a viable population of steelhead in an unimpaired state is assessed and ranked. The intrinsic potential habitat for San Luis Obispo Creek and Pismo Creek ranked in the upper half of all the watersheds within the threatened SC-CCS DPS of steelhead based on the amount of potential habitat (in an unimpaired state) in each watershed within the SC-CCS DPS. See Figure 1 and 2, "Intrinsic Potential Steelhead Spawning and Rearing Habitat maps for San Luis Obispo Creek and Pismo Creek included as part of Enclosure

NMFS also designated critical habitat for the threatened SC-CCS DPS of steelhead in 2005 (70 FR 52488). This designation included the main stem and tributaries of San Luis Obispo Creek and Pismo Creek, portions of which traverse the SLO Valley Basin. Critical habitat provides: 1) freshwater spawning habitat with water quality and quantity conditions and substrate supporting spawning, incubation, and larval development, 2) freshwater rearing sites with water quality and floodplain connectivity to form and maintain physical habitat conditions and support juvenile growth and mobility, water quality and forage supporting juvenile development, and natural cover such as shade, submerged and overhanging vegetation, and 3) freshwater migration corridors free of passage obstructions to promote adult and juvenile mobility and survival.

Critical habitat throughout the threatened SC-CCS DPS of steelhead has been adversely affected by loss and modification of primary constituent elements (substrate, water quality and quantity, water temperature, channel morphology and complexity, riparian vegetation, passage conditions, etc.) through activities such as groundwater extractions and related surface-water diversions (NMFS 2013). Thus many of the constituent elements of critical habitats have been significantly degraded (and in some cases lost) in ways detrimental to the biological needs of steelhead. These habitat modifications have hindered the ability of designated critical habitat to provide for the survival and ultimately recovery of the threatened SC-CCS DPS of steelhead. See Figures 3 and 4, "Critical Steelhead Habitat maps for San Luis Obispo Creek and Pismo Creek included as part of this Enclosure.

NMFS has developed a South-Central California Steelhead Recovery Plan (NMFS 2013) that provides a strategy for the recovery of the species (including a threats assessment, recovery actions, and recovery criteria). Among the threats to the steelhead habitats in the San Luis Obispo Creek and Pismo Creek watersheds identified in this recovery plan are surface-water diversions for groundwater replenishment, and related groundwater extractions, to support agricultural and urban developments that utilize groundwater resources (NMFS 2013. pp. 12-1 through 12-20) .

NMFS has also issued a 5-Year Status Review: Summary and Evaluation of the South-Central California Coast Steelhead Distinct Population Segment (NMFS 2016). This Status Review noted that the ". . . SWRCB generally lacks the oversight and regulatory authority over groundwater development comparable to surface water developments for out-of-stream beneficial uses, though SGMA in 2014 partially addresses this inadequacy for some water basins." (p. 38). The Status Review further noted that:

> "The below normal precipitation and reduced runoff has adversely affected aquatic habitat for steelhead in a variety of other ways, resulting in: 1) depleted groundwater basins which provide base flows that support critical over-summering habitat for rearing *O. mykiss*; 2) reduced hydrological connectivity between seasonally wet and dry stream sections in interrupted streams; 3) restricted instream movement of rearing *O. mykiss*; 4) delayed or reduced breaching time of sandbars at the mouth of coastal estuaries, affecting water quality, and limiting both the upstream migration of adult *O. mykiss* and the

> downstream emigration of juveniles and kelts. Riparian habitat has also been adversely affected by the reduction in groundwater levels and the reduction of surface flows, affecting water temperatures and food availability." (p. 48).

To address the identified threats to threatened steelhead in the San Luis Obispo Creek and Pismo Creek watersheds NMFS' South-Central California Steelhead Recovery Plan identifies a number of recovery actions targeting surface diversions and groundwater extraction (NMFS 2013, Table 8-1. Recovery Actions Glossary. pp. 8-7 – 8-8).

These include for San Luis Obispo Creek:

> SLO-SCCCS-6.1 Conduct groundwater extraction analysis and assessment. Conduct hydrological analysis to identify groundwater extraction rates, effects on the natural stream pattern (timing, duration and magnitude) of surface flows in the mainstem and tributaries, and the estuary, and effects on all *O. mykiss* life history stages, including adult and juvenile *O. mykiss* migration, spawning, incubation, and rearing habitats.
>
> SLO-SCCCS-6.1 Develop and implement groundwater monitoring and management program. Develop and implement groundwater monitoring program to guide management of groundwater extractions to ensure surface flows provide essential support for all *O. mykiss* life history stages, including adult and juvenile *O. mykiss* spawning, incubation and rearing habitats.
>
> Table 12-12. South-Central California Steelhead DPS Recovery Action Table for San Luis Obispo Creek, p 12-58.

Similarly for Pismo Creek:

> Pis-SCCCS-6.1 Conduct groundwater extraction analysis and assessment. Conduct hydrological analysis to identify groundwater extraction rates, effects on the natural stream pattern (timing, duration and magnitude) of surface flows in the mainstem and tributaries, and the estuary, and effects on all *O. mykiss* life history stages, including adult and juvenile *O. mykiss* migration, spawning, incubation, and rearing habitats.
>
> Pis-SCCCS-6.1 Develop and implement groundwater monitoring and management program. Develop and implement groundwater monitoring program to guide management of groundwater extractions to ensure surface flows provide essential support for all *O. mykiss* life history stages, including adult and juvenile *O. mykiss* spawning, incubation and rearing habitats.
>
> Table 12-13. South-Central California Steelhead DPS Recovery Action Table for Pismo Creek, p. 12-63.

Both San Luis Obispo Creek and Pismo Creek currently supports a threatened population of steelhead that is critical to the future survival and recovery of the broader threatened SCCCS DPS of Steelhead.

Management of the groundwater of the SLO Valley Basin has affected the water resources and other related natural resources throughout the San Luis Obispo Creek and Pismo Creek watersheds. When analyzing impacts on steelhead or other aquatic organisms resulting from groundwater and related streamflow diversions, identifying flow levels that effectively support essential life functions of this organism is critical (Barlow and Leake 2012). Specifically, it is essential to explicitly provide for the protection of habitats, including those recognized instream beneficial uses that are dependent on groundwater such as fish migration, spawning and rearing, as well as other Groundwater Dependent Ecosystems GDE (California Department of Water Resources 2016, Heath 1983).

Specific Comments

On page 21, the draft Chapter 5 states the following with regard to decreasing groundwater storage in the northern portion of the basin:

> *"The long-term stability of groundwater elevations in these hydrographs indicates that groundwater extractions and natural discharge in the areas of these wells are in approximate equilibrium with natural recharge and subsurface capture, and that no trends of decreasing groundwater storage are evident."*

However, in Figure 5-11, three of the graphs depicting groundwater trends over time for the northern basin do not include data from the last few decades (e.g., graphs #1, #3, and #4 present data up to 1995, 2005, and 2012, respectively). Relying on data that has gaps ranging from several years to a few decades limits their utility in describing recent or current trends in groundwater storage. The revised draft should recognize and address this limitation. In addition, to improve the utility of the graphs, each should include the respective ground-surface elevation at the well location. Finally, it appears that data collection at some wells was not systematically collected on a set time schedule. This limitation should recognized and addressed as well.

On page 24, the draft Chapter 5 states:

> "The Percolation Zone Study of Pilot-Study Groundwater Basins in San Luis Obispo County, California identified areas with relatively high natural percolation potential that, through management actions, could enhance local groundwater supplies for human and ecological benefits to the aquatic environment for steelhead habitat."

However, it not clear what specific management actions are referred to here. If the management actions involve diversion of flows from either San Luis Obispo Creek or Pismo Creek, the effects of these diversions must be assessed on steelhead use, as well as other GDE.

On page 30, the draft Chapter 5 references a 30-foot difference in surface water and groundwater elevation as a determinant for evaluating hydraulic disconnection between the two. The 30-foot metric, as referenced in Rohde *et al.* (2019), is based upon rooting depths of oak trees. How groundwater supports oak tree ecology is very different from how groundwater accretion to surface flow supports stream-dwelling organisms for other GDE (explained below), and the former should not be used to inform the latter.

This same issue arises in Section 5.8.2 in a discussion of GDE impacts within East and West Corral de Piedras creeks. Finally, the draft Chapter 5 recognizes that oak rooting depths can be up to 70 feet (page 34), which would appear to contradict the basis for using 30 feet within their GDE analysis.

The life-cycle of steelhead often requires occupying seasonal habitat that may only have flowing water during wetter periods of the year (Quinn 2015, Boughton et al. 2009), especially in more arid regions at the southern extent of their range (e.g., central and southern California). The extent of connection is seasonally transient, and changes in the water table and river flow can and do alter the state of connection (Cook et al. 2010, Brunner et al. 2011). In short, whether a stream or river reach is gaining or losing, or whether 30 feet separates groundwater/surface water at a specific time of year, is not; what is important is how groundwater use influences the seasonal duration and quality of surface water and, by extension, instream habitat.

The mechanism by which stream-dwelling organisms are impacted by groundwater pumping is habitat degradation caused by the draw-down of surface flows (Barlow and Leake 2012), and can occur in both "gaining" and "losing" stream reaches. The impacts can be both physical (e.g., pool volume shrinks as water surface elevation declines) and physicochemical (e.g., water quality can suffer as pools and riffles lose connectivity). Thus, the appropriate method to determine whether pumping is having "significant and unreasonable adverse impacts" on beneficial uses of surface water is to understand the level of impact (i.e., volume of streamflow depletion) and how habitat quality and functionality change because of that impact. Further data is required throughout the 180/400-foot sub-basin to establish localized relationships between streamflow depletion and the resulting instream habitat characteristics.

The final GSP should address this data gap by including studies that develop an appropriate threshold preventing significant and unreasonable impacts to beneficial users of surface water. The final GSP should also elaborate sufficiently as to when, where, and how this data will be collected during the first few years of GSP implementation, or at the very least, clearly commit to developing a detailed data collection plan with interested stakeholders at a later date.

NMFS recommends the final GSP follow guidance from California Department of Fish and Wildlife (2019) and develop conservative streamflow depletion thresholds as a precautionary approach until the surface flow/groundwater dynamic in the 180/400 foot sub-basin is better studied and understood.

Page 30 of the draft chapter 5 states "*…s*ince, as presented in the discussion of hydrographs in the San Luis Valley in Section 5.2, there has been no long- term water level declines in this area, there is no evidence of long-term depletion of interconnected surface water in this area.*"*

This statement is not consistent with basic principles of groundwater hydrology or SGMA regulations. First, as noted above, several of the groundwater elevation plots referenced in Section 5.2 do not contain full records, and are thus inappropriate for discerning recent trends and concluding water levels have not been declining in the area. Second, whether or not groundwater levels are steady over time has no probative value informing streamflow depletion impacts – the proper method for determining potential streamflow depletion is developing and using an analytical groundwater/surface water, as required by SGMA regulations.

Page 31 of the draft Chapter 5 notes that:

> "Observations of stream conditions indicate a perennial reach of Pismo Creek that flows through Price Canyon and supports year-round critical habitat for threatened steelhead just south of the Basin Boundary."

A recent study of instream flows of Pismo Creek also indicates, "Groundwater discharge into the channel (gaining reaches) tends to occur within localized areas in the steep Franciscan Mélange formations, and within localized areas of Price Canyon, while stream reaches tend to lose water as they cross the Quaternary sedimentary deposits of Edna Valley (Stillwater 2016).

Rearing juvenile steelhead (as well a resident O. *mykiss*) respond to changing water conditions (including seasonal desiccation of stream reaches) by moving to areas with more suitable habitat conditions, including surface flow conditions. This behavioral response is common in streams that naturally exhibit diverse flow regimes such as ephemeral, intermittent, or interrupted flow (i.e., alternating reaches of surface and non-surface flow). In some situations, *this* situation can create enhanced feeding and growing conditions for juvenile *O. mykiss when they re-occupy previously desiccated stream reaches.* See, Boughton, et al. 2009. Spatial patterning of habitat for *Oncorhynchus mykiss* in a system of intermittent and perennial stream. *Ecology of Freshwater Fishes* 18:92-105.

Page 47 of the draft Chapter 5 provides references, which appear incomplete. For instance, Bennett (2015) does not appear in the reference list.

Finally, DWR's analysis suggests streamflow depletion are potentially influencing GDEs in the SLO Valley Basin, as evidenced by their updated basin prioritization work (DWR 2018). The SLO Valley Basin received extra priority points for water quality and streamflow/habitat impacts during the 2018 basin prioritization process[1]. The DWR prioritization handbook (DWR 2018) makes clear that those points reflect potential impacts to GDEs and their habitat, noting that:

> "…habitat and/or streamflow point(s) were not applied to basin prioritization until it was determined that one or more of the habitats and/or streamflows were potentially being adversely impacted."

NMFS suggests that the final GSP develop conclusions regarding streamflow depletion impacts based on reliably estimating streamflow-depletion rates or volumes using the required groundwater/surface water model, and relating those depletions to instream habitat impacts that limit steelhead survival. See for example, Sophocleous 2002, Mercer and Faust 1980.

---

[1] See the SGMA Basin Prioritization Dashboard tool at https://gis.water.ca.gov/app/bp-dashboard/final/ Also, The Nature Conservancy. 2018. Groundwater Dependent Ecosystems under the Sustainable Groundwater Management Act. Guidance for Preparing Groundwater Sustainability Plans.

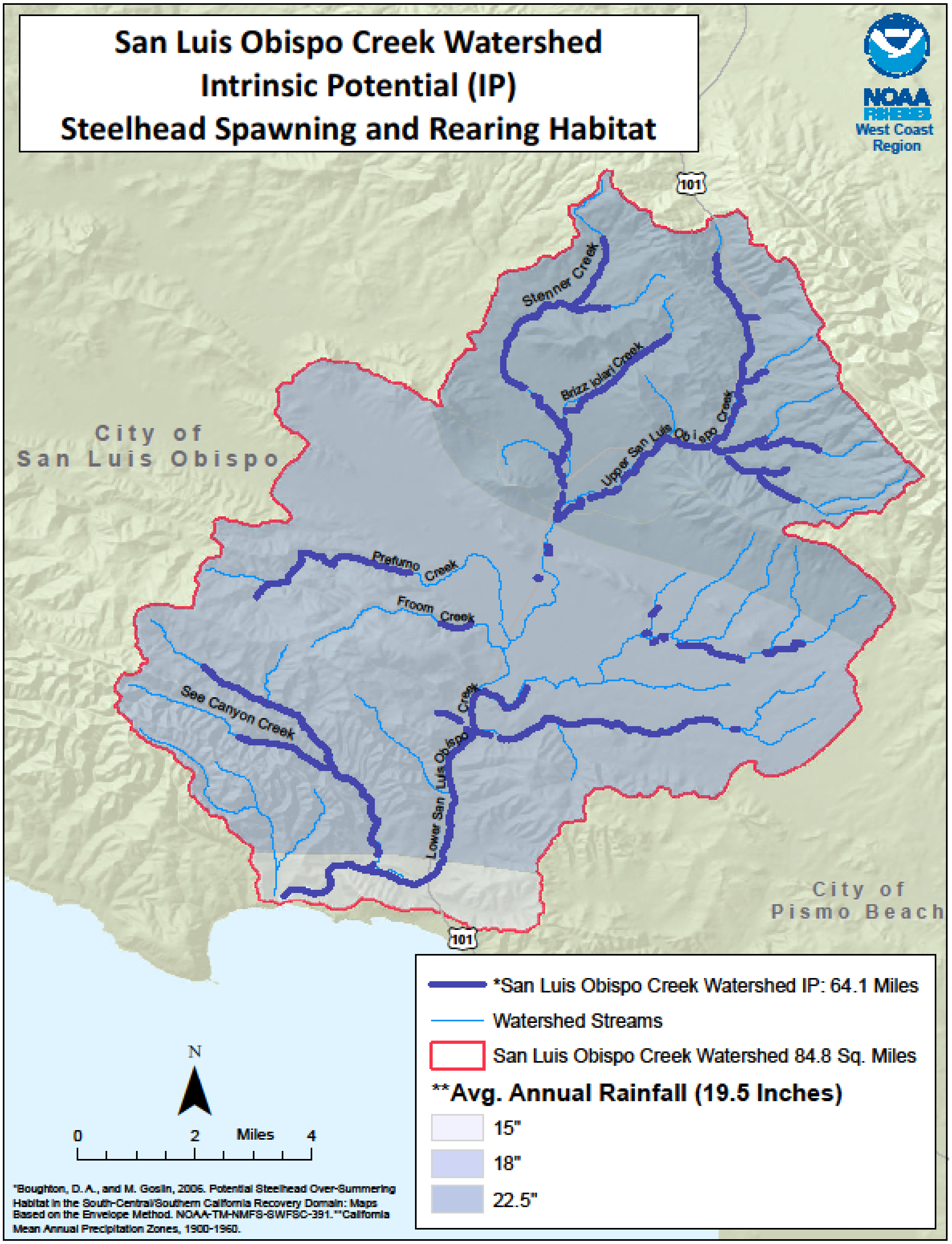

Figure 1. San Luis Obispo Creek Intrinsic Potential Steelhead Spawning and Rearing Habitat.

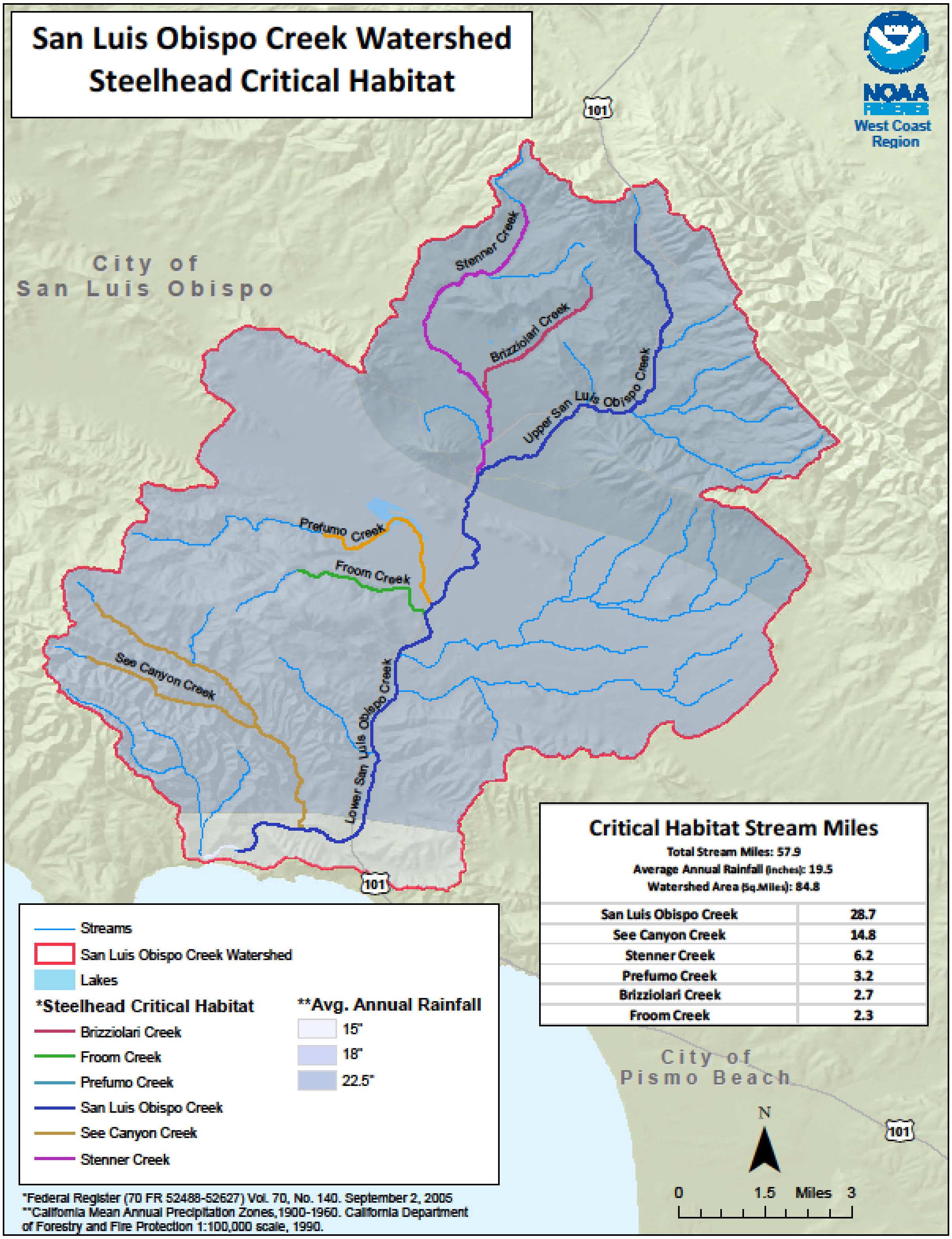

Figure 2. San Luis Obispo Creek Critical Steelhead Habitat.

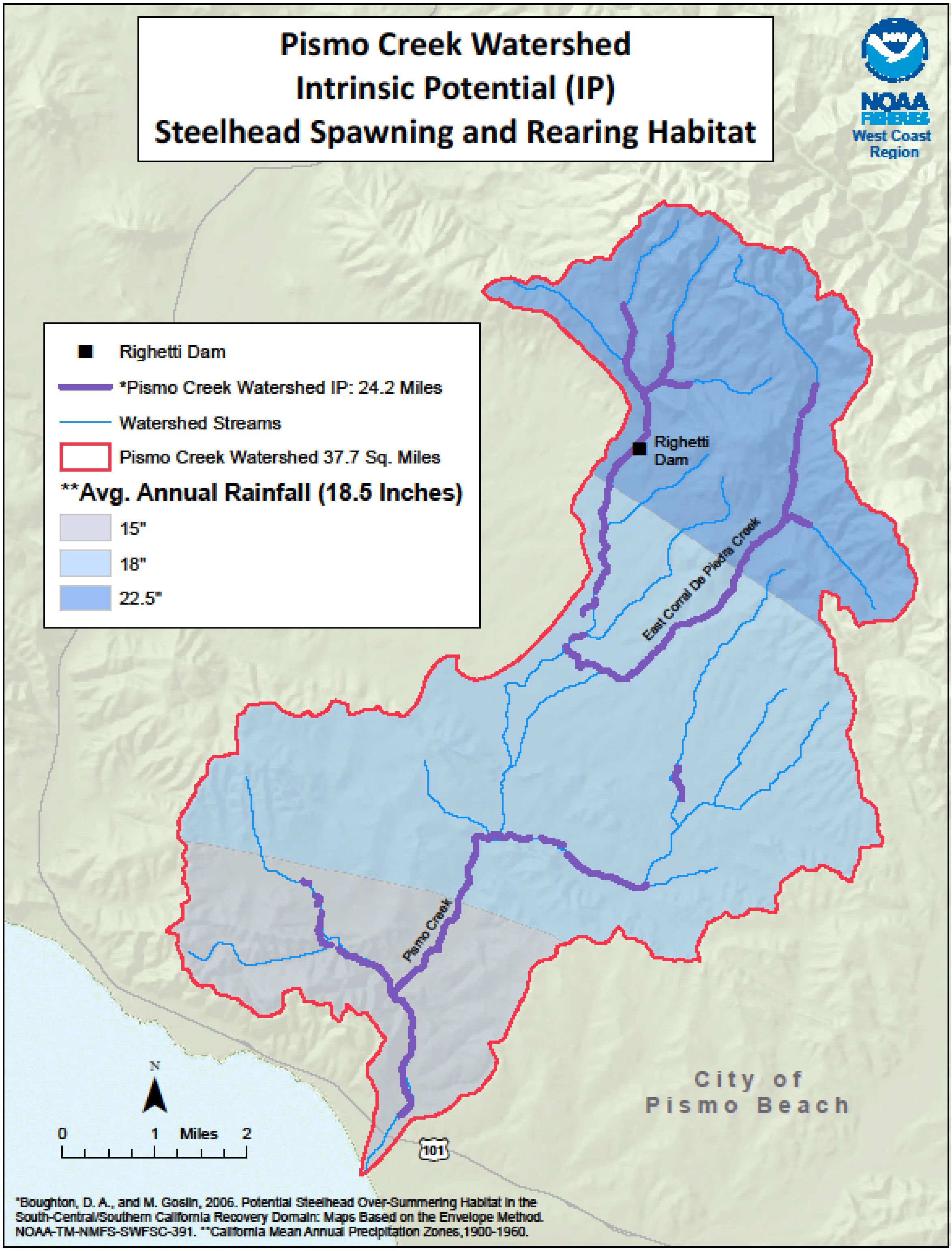

Figure 3.Pismo Creek Intrinsic Potential Steelhead Spawning and Rearing Habitat.

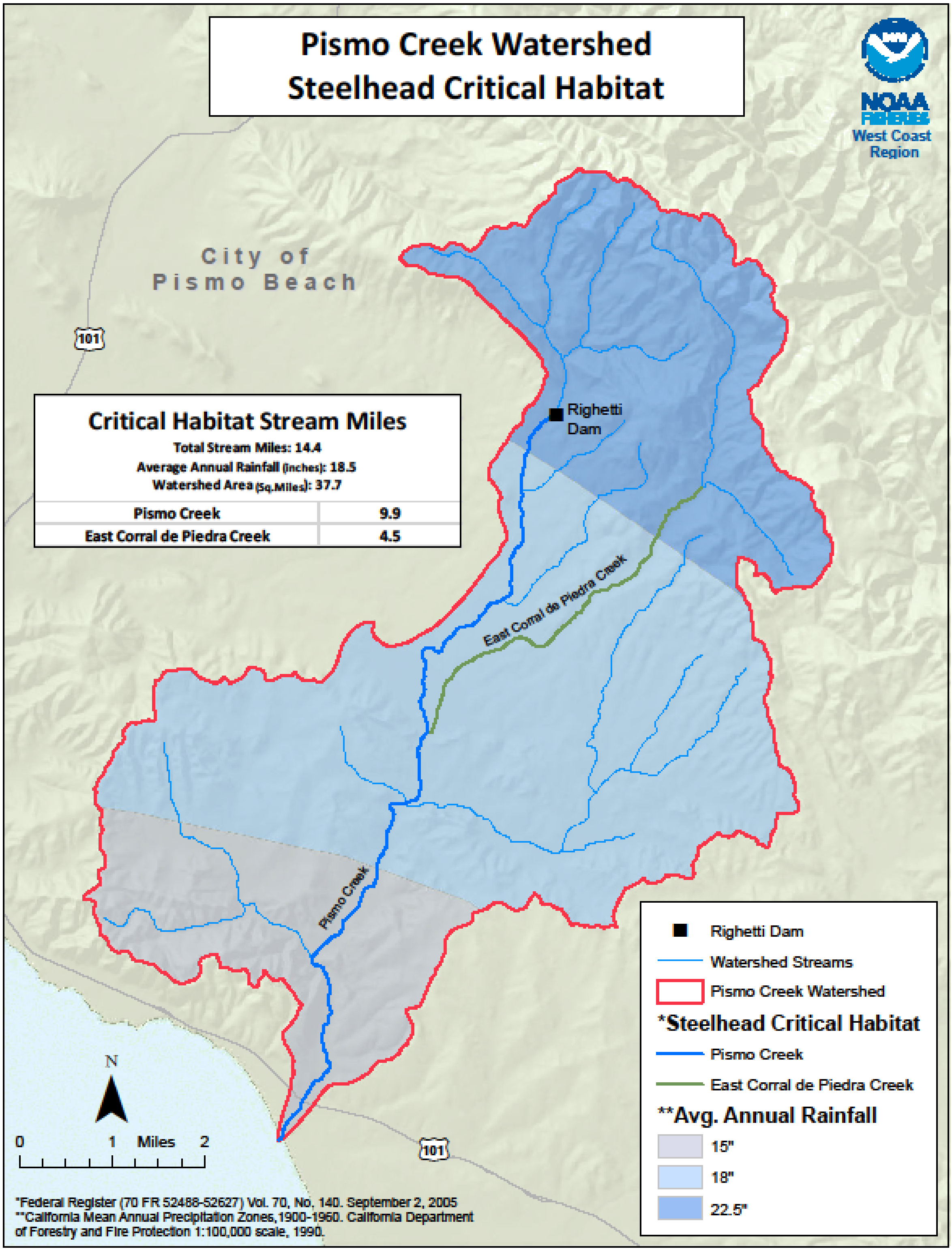

Figure 4. Pismo Creek Critical Steelhead Habitat.

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MEMORANDUM

Date: November 11, 2020

To: San Luis Obispo Valley Groundwater Sustainability Commission

From: Board of Directors
Varian Ranch Mutual Water Company
Edna Ranch East Mutual Water Company

Via: Rob Miller, PE

REGISTERED PROFESSIONAL ENGINEER
ROBERT S. MILLER
No. 57474
CIVIL
STATE OF CALIFORNIA

Subject: Policy Considerations for Groundwater Sustainability Plan

Edna Ranch East and Varian Ranch Mutual Water Companies (Companies) are currently participating in the preparation of a Groundwater Sustainability Plan (GSP) for the San Luis Obispo Valley Groundwater Basin (Basin). Based on information provided in June 2020 by the consultant team, the Edna Subarea of the Basin may be in overdraft by an estimated deficit of 1,100 acre feet per year (AFY). As a result, one of the strategies that may be suggested in the coming months is the mandatory reduction of pumping within the Edna Subarea.

Over the last six years, the Companies have implemented aggressive conservation measures in response to Basin conditions and severe drought. These measures represent a permanent shift in water policies, technology, and customer demands. Key conservation measures and metrics are summarized in this memorandum, resulting in the following findings:

- New monitoring technology, combined with conservation policies, have resulted in a reduction in well water production of 35% compared to the 2013 baseline year, and 26% compared to the 10-year period of 2005 through 2014.
- Given that some customer growth has occurred during the analysis period, the extent of the conservation is even greater when analyzed on a per customer basis. In the Edna Ranch East area, the customer base has increased by approximately 10% since 2009, and the average use per connection has dropped by approximately 40%.
- The combined well production of the Companies represents approximately 2% of the overall basin production/yield for the Edna Valley Subarea.

Table 1 below summarizes the conservation measures implemented by the Companies. Of particular note is the use of technology to drive both management and customer decision making. Both systems have installed the Beacon Automated Meter Reading (AMR) system. This system provides hourly customer used data to Company management and to each connected customer, including customizable text alerts and automated leak detection. The typical customer interface is shown in Figure 1 below. Combined with enforceable penalties, the AMR system has resulted in substantial demand reductions as noted above. In addition to customer meters, water supply wells and water tanks are remotely monitored by management.

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Figure 1 - AMR Customer Portal

Table 1: Summary of Conservation Measures Implemented (2014 to Present)		
Calendar Year	**Varian Ranch Mutual Water Company**	**Edna Ranch East Mutual Water Company**
2014	Enforced historical per lot maximum water use of 1,500 gallons per day on bi-monthly basis, with penalty charge of 4 times normal water rate.	Enforced historical per lot maximum water use of 1,161 gallons per day (424,000 gal/year), with penalty charge
2015	Reduced allowable usage to 1,200 gallons per day with continued penalties, enforced bi-monthly.	Continued enforcement
2016	Enforced previously approved policies	Implemented Automated Meter Reading with continuous customer access to data and leak notification
2017	Implemented Automated Meter Reading with continuous customer access to data and leak notification	Continued enforcement of maximum use, with real time customer data
2018	Amended bylaws to allow for tiered rates and continued enforcement	Continued enforcement of maximum use, with real time customer data. Board increased penalty charges.
2019	Previous measures remain in effect post drought. Continued enforcement of maximum use, with real time data.	Continued enforcement of maximum use, with real time data
Results Summary	Significant reductions began in 2015. Production reduced by 31% based on current 5-year average.	Significant reductions began in 2015 and accelerated in 2016. Production reduced by 23% based on current 4-year average.

Water production data from the time period of 2005 through 2019 has been compiled and analyzed. Figures 2 through 4 have been assembled to illustrate the water production trends that have resulted from the recent conservation measures. The attached figures are described below:

- Figure 2 displays the annual well production for both Varian and Edna East as separate entities.
- Figure 3 provides a summary of the combined production of both Companies
- Figure 4 illustrates the combined production of the Companies in comparison to the Edna Valley Subarea estimated yield.

Given the substantial reductions in groundwater production that have already been achieved by the Companies, the following management principles are recommended for consideration in the stakeholder discussion for the preparation of the GSP:

1. The recent reductions in groundwater production documented by the Edna Ranch East and Varian Ranch Mutual Water Companies, if maintained over time, satisfy the adjustments required to achieve Basin sustainability.
2. Periodic monitoring and reporting should be implemented to confirm continued adherence to the average well production from the period of 2015 through 2019, and no further reductions are contemplated at this time.
3. The total production of the Companies represents approximately 2% of the estimated Edna Valley Subarea yield, and therefore the continued implementation of recent conservation strategies is a sufficient contribution to overall Basin management.

Please let me know if you have any questions, or if you need more information.

Figure 2
Annual Production by Year - Edna Ranch East and Varian Mutual Water Companies

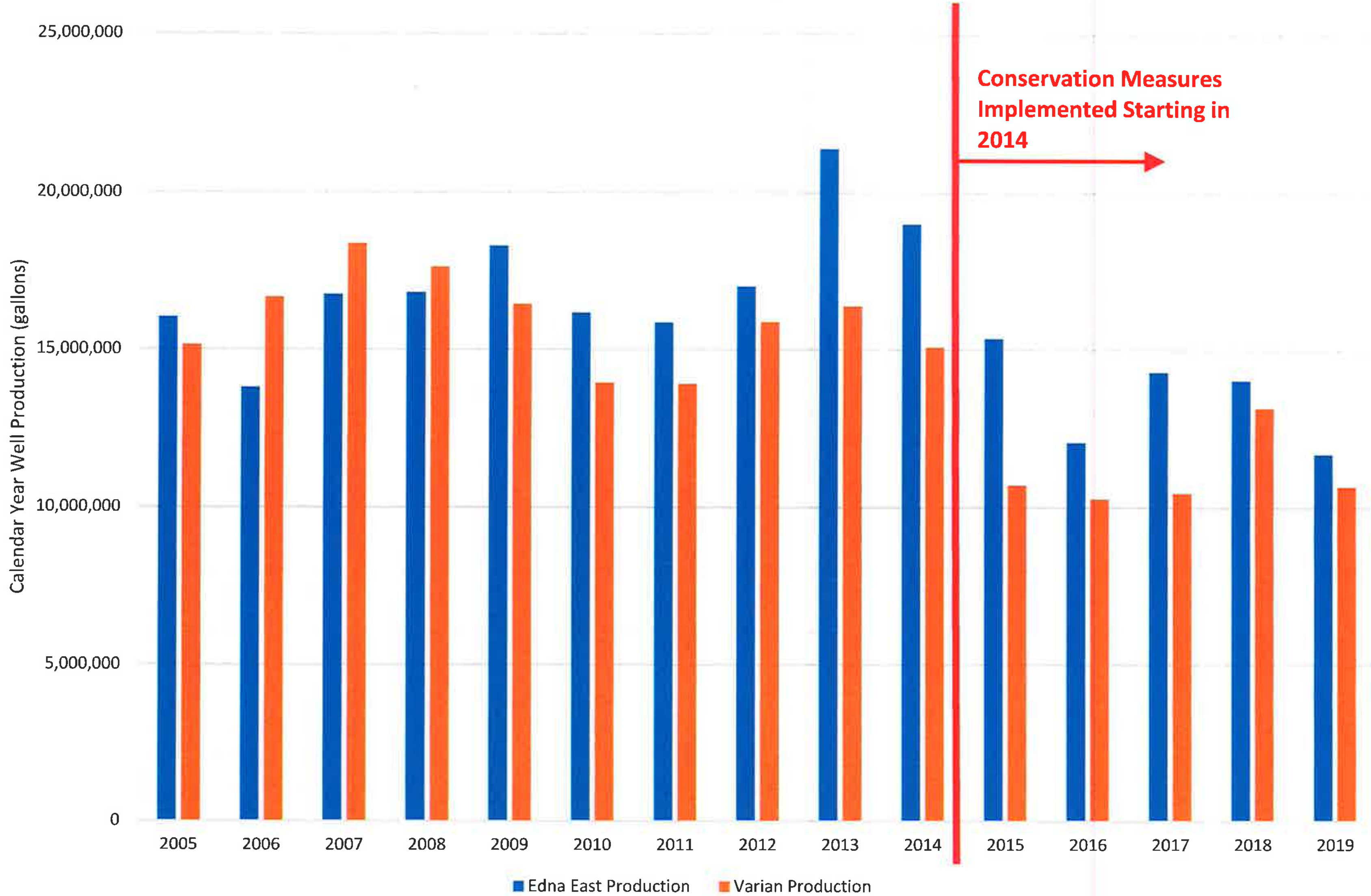


Figure 3: Combined Annual Production by Year - Edna Ranch East and Varian Mutual Water Companies

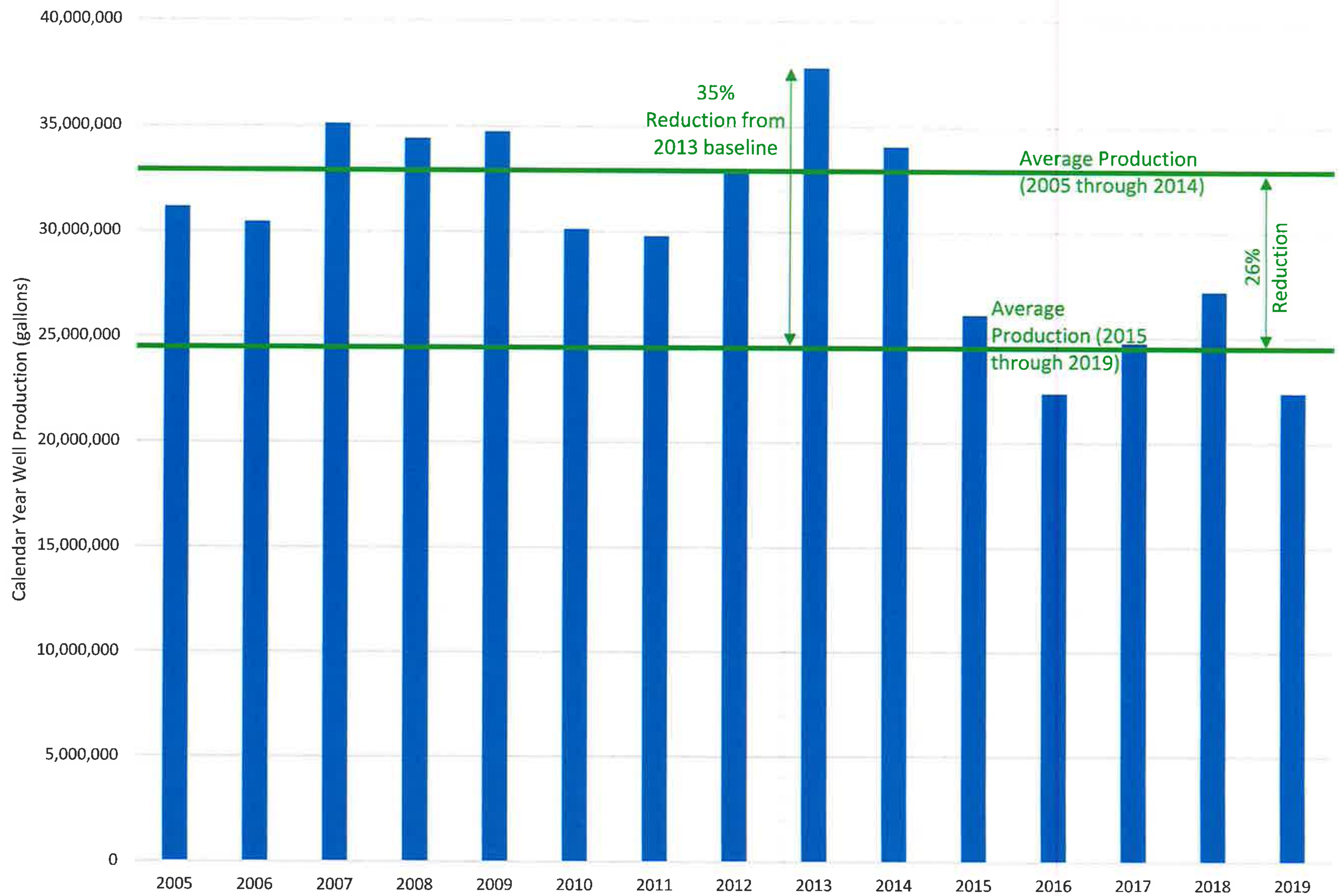
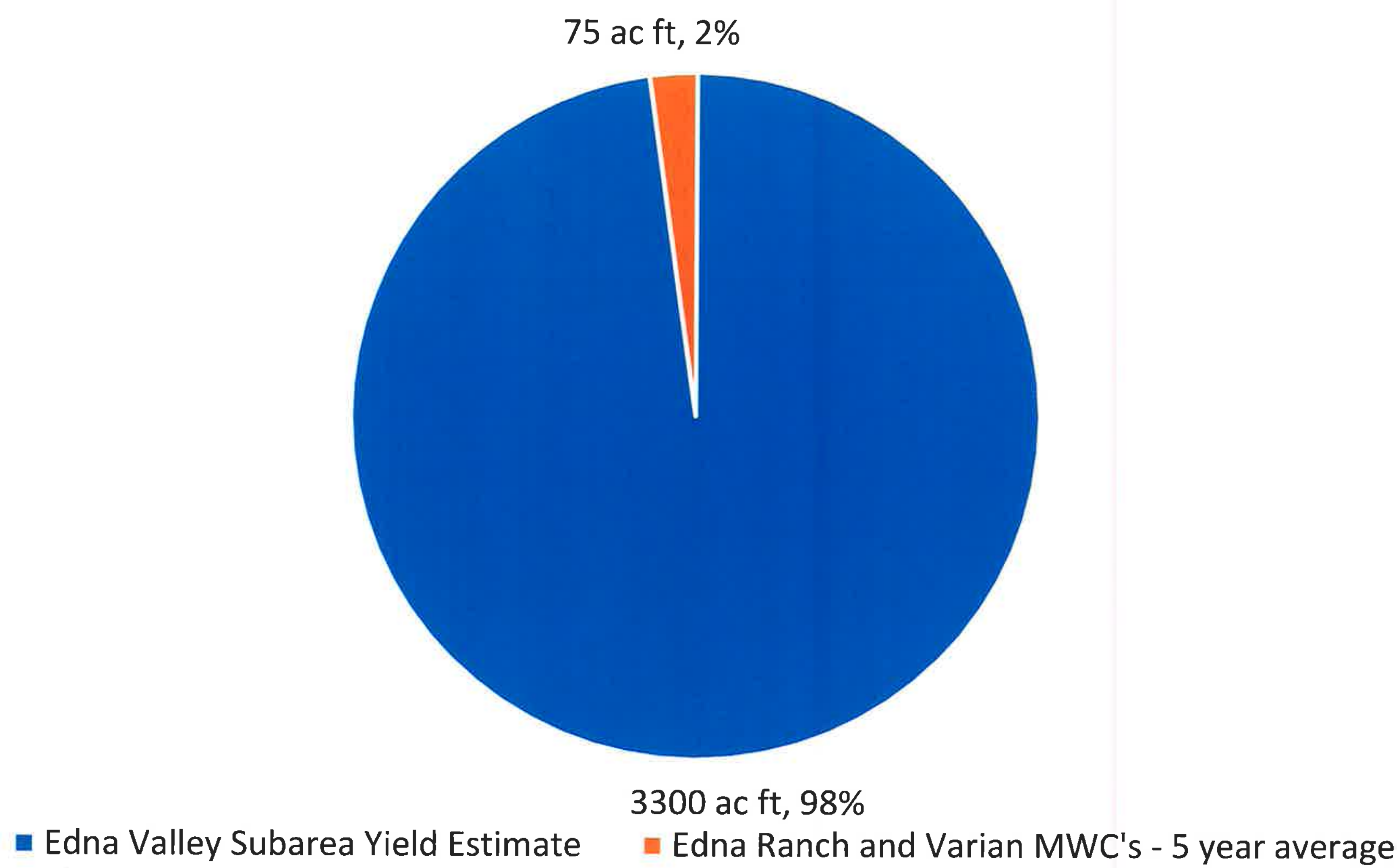


Figure 4: Basin Yield vs Edna/Varian Annual Well Production



Public Utilities
879 Morro Street, San Luis Obispo, CA 93401-2710
805.781.7215
slocity.org

DATE: 2/7/2021

TO: The Groundwater Sustainability Commission

FROM: Mychal Boerman, Utilities Deputy Director - Water

SUBJECT: City of San Luis Obispo Recycled Water Limitations

The City of San Luis Obispo has been utilizing recycled water as a component of its multi-source water supply since 2006. The City's goal is to use this water source to the highest and most beneficial use. The City is committed to the expansion of its non-potable recycled water programs and to the development of a potable reuse program to supplement groundwater supplies.

The cumulation of past groundwater usage has resulted in an imbalance in the Edna Valley area's groundwater elevation. The delivery of the City's recycled water to parties within the Edna Valley area has been identified as a potential short-term augmentation project to offset further lowering of groundwater levels.

The purpose of this memo is to provide the Commission with a clear understanding of the City's long-term intent to put recycled water to the greatest beneficial use. While not conclusively detailing all constraints of future recycled water availability, this memo should serve to document the nature of the City's concerns regarding physical constraints on recycled water availability and delivery, as well as the City's intention of prioritizing the needs of in-City users above those of outside-City users. This memo does not discuss other topics such as pricing, contract terms, permitting, water rights, etc.

Seasonal Availability

The quantity of recycled water available for use to City customers is dependent on the quantity of untreated wastewater flowing into the City's Water Resource Recovery Facility (WRRF). Unlike most cities that experience relatively uniform recycled water availability throughout the year, the City of San Luis Obispo's availability is drastically impacted by the students from Cal Poly vacating the community during the summer months and thus decreasing the wastewater influent into the WRRF. This decrease in wastewater influent occurs during the summer months when the City's 50+ recycled water accounts increase irrigation to combat the warm, dry conditions. This decrease in availability, coupled with a substantial increase in demand, abnormally limits the recycled water available during the summer months.

Long-Term Versus Short-Term Availability

While there is currently surplus recycled water available year-round, with over 150 acre-feet per month available in some winter and spring months, it is anticipated that the City will not have a significant volume of recycled water supply available to sell to any outside users from June-October once the internal City demands increase to support new residential and commercial developments.

Recycled water demands from Avila Ranch, San Luis Ranch, Righetti Ranch, and other future in-City developments are expected to result in increased recycled water demand of roughly 400-500 acre-feet per year with most of this demand occurring during the summer. These developments are currently being constructed with many of the Orcutt Area developments already receiving recycled water deliveries. The City continues to update its recycled delivery projections as any amounts obligated for delivery beyond availability would need to be made up by use of City potable water supplies. This concern will continue to increase as both in-City and Cal Poly users continue to improve in their conservation of water.

As the City continues to develop its groundwater pumping program, it has been identified that there is significant recharge potential (upwards of 400 acre-feet per year) within the City's portion of the SLO Valley Groundwater Basin adjacent to the WRRF. Recharge projects in other areas of the City have not yet been studied but are anticipated to increase the amount of water that could be recharged within the basin. As the City resumes its groundwater pumping, additional capacity will likely be created within the basin, increasing the City's need for recycled water for recharge projects that may ultimately be used for a potable reuse project. As surface water supplies are adversely impacted by climate change, augmentation of the groundwater basin will be the City's major water supply expansion strategy and will limit water availability for outside-City interests as augmentation projects come online. Potable reuse through storage in the groundwater basin may also address the issues with seasonal availability by creating a prolonged time lag between highly treated wastewater injection and its withdrawal for use.

Physical Delivery Constraints

The City's recycled water storage and distribution system was designed to provide intermittent in-City deliveries within the southern half of the City. The City's storage tank, pumps, telemetry, and pipelines were not designed to provide recycled water to outside-City customers and may require upgrades in order to accommodate continuous 24/7 delivery. Additionally, the two potential pipeline alignments that could be utilized to deliver water to the Edna Valley area are undersized and limit the ability to deliver recycled water during the winter and spring months when it is most abundantly available. One pipeline located within Broad Street near the airport is 6" diameter C900 pipe. The other, located within Tank Farm road, is 8" diameter ductile iron pipe. It is estimated that the larger of the two pipelines could deliver approximately 100/acre-feet of recycled water per month if operated 24-hours per day for a full month. This undersized pipeline significantly restricts the amount of water that could be delivered to outside City customers during the winter and spring months.

Summary

While the City is actively pursuing opportunities to sell recycled water in the short-term, it must be conveyed that the long-term prioritization of recycled water is for irrigation of in-City uses where it can offset current potable supplies, and for use as a potable reuse project. When examining available basin augmentation projects, the City's recycled water supply should not be assumed to be available as a permanent augmentation project that will provide a consistent amount of water for basin augmentation through 2042 and beyond. With current in-City recycled water demands and influent, it is anticipated that the City could provide 500-800 acre-feet of recycled water annually with quantities decreasing as new in-City users come online and as the City develops potable reuse projects to supplement its supplies. In-City groundwater basin augmentation efforts, new regulations, drought, additional in-City customers, and the like could reduce the quantity available to outside users by several hundred acre-feet in the foreseeable future.

Please contact me with any questions related to the City's use of recycled water.

Mychal Boerman
mboerman@slocity.org
(805)781-7237

UNITED STATES DEPARTMENT OF COMMERCE
National Oceanic and Atmospheric Administration
NATIONAL MARINE FISHERIES SERVICE
West Coast Region
501 West Ocean Boulevard, Suite 4200
Long Beach, California 90802-4213

June 3, 2021

John Diodati
Interim Director, Public Works Department
County of San Luis Obispo
976 Osos St #207
San Luis Obispo, California 93408

Re: NOAA's National Marine Fisheries Service comments on the May 6, 2021, draft Groundwater Sustainability Plan for the San Luis Obispo Valley Groundwater Basin

Dear Mr. Diodati:

Enclosed with this letter are NOAA's National Marine Fisheries Service's (NMFS) comments on "Chapter 8: Groundwater Conditions" of the draft Groundwater Sustainability Plan (GSP) for the San Luis Obispo (SLO) Valley Groundwater Basin.

The GSP is intended to meet the requirements of the California Sustainability Groundwater Management Act (SGMA). The SMGA includes specific requirements to identify and consider impacts to Groundwater Dependent Ecosystems (GDE) that have significant and unreasonable adverse impacts on all recognized beneficial uses of groundwater and related surface waters (Water Section 10720), including fish and wildlife and botanical resources.

As explained more fully in the enclosed comments, the draft Chapter 8 does not adequately address the recognized instream beneficial uses of the SLO Valley Basin, which underlies San Luis Obispo Creek and Pismo Creek, or other GDE, potentially affected by the management of groundwater within the SLO Valley Basin. In particular, the draft Chapter 8 does not adequately analyze or identify Sustainable Management Criteria that have the potential to affect the federally threatened South-Central California Coast steelhead (*Oncorhynchus mykiss*). This information is necessary because management of the SLO Valley Basin has consequences for the amount and extent of surface flows in San Luis Obispo Creek and Pismo Creek, both of which support populations of threatened steelhead.

Our enclosed comments include recommendations for revisions that are intended to assist the County of San Luis Obispo develop a final GSP that meets the requirements of the SGMA. To this end, NMFS recommends that the revised draft Chapter 8 be re-circulated to give interested parties an opportunity to review and comment before it is finalized.

NMFS appreciates the opportunity to provide the enclosed comments on the draft Chapter 8. If you have a question regarding this letter or enclosure, please contact Mr. Mark H. Capelli in our Santa Barbara Office (805) 963-6478 or mark.capelli@noaa.gov, or Mr. Andres Ticlavilca in our Santa Rosa Office (707-575-6054) andres.ticlavilca@noaa.gov.

Sincerely,

Anthony P. Spina
Chief, Southern California Branch
California Coastal Office

cc:

Natalie Stork, Chief, DWR, Groundwater Management Program
James Nachbaur, SWRCB
Annette Tenneboe, Region 4, CDFW
Julie Vance, Regional Manager, Region 4, CDFW
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Suzanne De Leon, Region 4, CDFW
Don Baldwin, Region 4, CDFW
Christopher Diel, Ventura Field Office, USFWS
Ronnie Glick, CDP&R
Fred Otte, City of San Luis Obispo

Enclosure

NOAA's National Marine Fisheries Service's Comments on the draft Groundwater Sustainability Plan (Chapter 8: Sustainable Management Criteria) for the San Luis Obispo Valley Groundwater Basin (May 6, 2021)

June 3, 2021

Background

NOAA's National Marine Fisheries Service (NMFS) is responsible for protecting and conserving anadromous fish species listed under the U.S. Endangered Species Act (ESA), including the federally threatened South-Central California Coast (SCCC) Distinct Population Segment (DPS) of Steelhead (*Oncorhynchus mykiss*), which utilize San Luis Obispo Creek and Pismo Creek. NMFS listed SCCC, including the populations in the San Luis Obispo Creek and Pismo Creek watersheds (which overlies a portion of the SLO Valley Basin), as "threatened" in 1997 (62 FR 43937), and reaffirmed the threatened status of the species in 2006 (71 FR 5248).

On March 12, 2020, the California Department of Water Resources (DWR) designated the SLO Valley Basin a "Medium" priority for groundwater management, requiring the development of a final Groundwater Sustainability Plan (GSP) by January 31, 2022, pursuant to the 2014 SGMA. Several watercourses that overlie portions of the SLO Valley Basin, including San Luis Obispo Creek and the headwaters of Pismo Creek, support federally threatened steelhead.

The available information establishes that surface water and groundwater are hydraulically linked in the SLO Valley Basin, and this linkage is critically important in creating seasonal habitat for threatened SCCC steelhead. Where the groundwater aquifer supplements streamflow, the influx of cold, clean water is essential for maintaining suitable water temperature and surface flow (Brunke and Gosmer 1997). Pumping from these aquifer-stream complexes can adversely affect freshwater rearing areas for juvenile steelhead by lowering groundwater levels and interrupting the hyporheic flow between the aquifer and the stream, particularly during summer and fall months when streamflow is already low. Thus, groundwater extraction in the SLO Valley Basin has the potential to adversely affect threatened SCCC steelhead through a reduction in the amount and extent of freshwater rearing sites for this species.

NMFS has previously commented on Chapter 5: Groundwater Conditions of the SLO Valley Basin GSP and provided background information on steelhead life history habitat requirements, and the role of both Pismo Creek and San Luis Obispo Creek in NMFS' South-Central Steelhead Recovery Plan (2013). See NMFS' May 29, 2020 letter to John Diodati, Interim Director, Public Works Department County of San Luis Obispo County).

Specific Comments

Page 29: The draft Chapter 8 indicates the basin will be considered to have experienced undesirable results if any of the monitoring wells exceed the minimum threshold for two consecutive fall measurements. The standard of failing two consecutive fall measurements is not explained, and thus appears arbitrarily. Steelhead migration, spawning and rearing (beneficial uses of surface water as set by the Regional Water Quality Control Board[1]) are biological processes that can be impacted by a single streamflow depletion event. SGMA regulations require a minimum threshold be used to define an undesirable result, in this case streamflow depletion resulting in significant and unreasonable impact to beneficial uses of surface water. For a beneficial use such as steelhead rearing, a depletion of adequate streamflow can result in steelhead mortality, and is therefore irreversible. We therefore recommend that the standard for determining undesirable results be expressed in terms of minimum pool depth and/or surface flow during the summer and fall base flow periods.

Page 29: Groundwater elevations may be necessary as a proxy for streamflow depletion due to a lack of data gathered to this point. However, there appears to be no attempt at correlating groundwater elevation thresholds with impacts to beneficial uses of surface water. In fact, many of the groundwater elevation minimum thresholds are set at the lowest (or below the lowest) groundwater elevations ever recorded within the basin. These thresholds are likely associated with severe groundwater over-pumping during dry periods, when groundwater depletion was greatest, and surface water discharge the lowest. Managing streamflow depletion conditions comparable with the severest drought conditions is not protective of surface water beneficial uses that support ESA-listed steelhead, and likely would result in adversely affecting steelhead and its identified critical habitat (see enclosed steelhead critical habitat and intrinsic potential maps for San Luis Obispo Creek and Pismo Creek). If the GSAs uses groundwater levels as a proxy for streamflow depletion, it should explain how the chosen minimum thresholds and measurable objectives adequately avoid adversely impacting surface water beneficial uses that support steelhead survival throughout the SLO Basin. If that effort proves problematic due to a lack of data at the present time, the GSAs should follow guidance by the California Department of Fish and Wildlife that recommends a conservative approach to groundwater dependent ecosystem protection in those situations (CDFW 2019).

Page 29, Section 8.9.2: The draft includes the following statement:

> *To avoid management conditions that allow for lower groundwater elevations than those historically observed, MTs* [Minimum Thresholds]f*or these wells were set at the historic low water levels indicated on the hydrographs, which occur with regularity during every extended dry period evident in the record (Figures 8-9, 8-10).*

As noted above, managing to perpetuate historically low groundwater elevations is not appropriate as a management threshold, since it does not adequately define the undesirable result of streamflow depletion on aquatic biological resources such as federally threatened South-Central Coast steelhead. Based upon fundamental hydrogeologic principles where the depletion rate is proportional to the difference between the water table and surface water, the amount of streamflow depletion associated with the proposed minimum thresholds would be the greatest on record (Sophocleous 2002, Bruner *et al*. 2011, Barlow and Leake 2012). This level of streamflow depletion would likely impact surface water beneficial uses to the extent that threatened steelhead would experience "harm" under the ESA as well as result in adverse impacts to Groundwater Dependent Ecosystems (GDE) supporting a variety of native aquatic species.

Page 30: Following the discussion on the relation between flow conditions in San Luis Obispo Creek and the underlying aquifer, the draft Chapter 8 asserts, "in both cases the amount of flux between the surface water and the groundwater system is small compared to the volume of water flowing down the creek." The point of this statement is unclear but seems to suggest that groundwater levels are not significantly influenced by the volume (including duration) of stream flow. However, this implication is contradicted by the statement, "In wetter years, when flows in the San Luis Obispo Creek are high there is [sic] greater amounts of discharge from the creek to the groundwater system." In general, higher and longer the duration flows in SLO Creek will increase the area of wetted stream bottom (i.e., the area of infiltration) as well as the duration of the infiltration of surface flows to the underlying groundwater basin. Furthermore, the assertion that stable groundwater levels at a specific well "suggest that the mechanisms of surface water/groundwater interaction have not been negatively impacted since the early 1990's" does not address the question of whether these stable conditions have had and are resulting in streamflow depletion impacts as defined under SGMA. Currently stable groundwater levels are not an indicator of sustainable groundwater conditions, or, more specifically, avoidance of significant and unreasonable effects on streamflow. The revised draft Chapter 8 should address this issue and clearly indicate how existing stable groundwater conditions are protective of GDE, such as rearing habitat for juvenile steelhead.

Page 31: The draft Chapter 8 states that, "by defining minimum thresholds in terms of groundwater elevations….the GSA will….manage potential changes in depletion of interconnected surface (sic [flows?])." The draft Chapter 8, however, has not established the required correlation between groundwater elevations and surface flows that would justify groundwater levels as a proxy for streamflow depletion, and has not quantified what level of streamflow depletion represents significant and unreasonable impacts to GDE, including but not limited to rearing habitat for juvenile steelhead. The draft Chapter 8 should identify the data needed to analyze the relationship of groundwater levels, streamflow depletion rates, and impacts to GDE, specifically spawning, rearing and migration of ESA-listed steelhead.

Page 31: The draft Chapter 8 establishes minimum thresholds for streamflow depletions as "the lowest water levels observed in the period of record" for the chosen monitoring wells. As noted earlier, according to SGMA regulations a minimum threshold is used to define an undesirable result, in this case streamflow depletion resulting in significant and unreasonable impact to GDE, including, but not limited to rearing juvenile steelhead. The use of a streamflow depletion thresholds associated with the lowest recorded groundwater levels are inappropriate because they will not avoid significant and unreasonable impacts to GDE. The thresholds are inappropriate for avoiding impacts to ESA-listed steelhead resulting from streamflow depletion. To be consistent with the requirements of SGMA, the GSAs must develop thresholds that are likely to avoid adversely impacting steelhead, as well as other GDE.

Page 32: The draft Chapter 8 includes no information or analysis that supports the assertion that "maintaining groundwater levels close to historically observed ranges will continue to support groundwater dependent ecosystems." As noted above, there is an assumption embedded within the assertion that current groundwater levels support groundwater dependent ecosystems; this has not been supported by any data or analysis because such information is not presented in the draft document. Managing groundwater levels at historical lows is likely to adversely affect ESA-listed steelhead, and designated critical habitat for this species. To be consistent with the requirements of SGMA, the GSAs must develop minimum thresholds that are likely to avoid adversely impacting steelhead, as well as other GDE.

Finally, it is unclear if the reference in the draft Chapter 8 to the Water Budget is to Chapter 5 and/or Chapter 6. If the draft Chapter 8 is referring to Table 6-20 (Current Water Budget – Basin Total), the comparison between the annual groundwater/ surface water interaction with an annual outflow volume of the watershed does not provide an indication of aquatic habitat conditions during low flow periods. We would note that intermittent stream reaches can provide seasonally important rearing habitat for juvenile steelhead. Reaches that temporarily lose surface flow through the natural seasonal reduction in groundwater levels can be re-occupied by fish rearing in other parts of the stream system as groundwater levels rebound and surface flows are reinitiated in the temporarily desiccated reaches (Boughton *et al.* 2009). However, artificially reduced groundwater levels can accelerate the temporary cessation of surface flows, and then delay the re-initiation of surface flows, thus reducing the amount and quality of rearing habitat with the stream system and adversely affect GDE.

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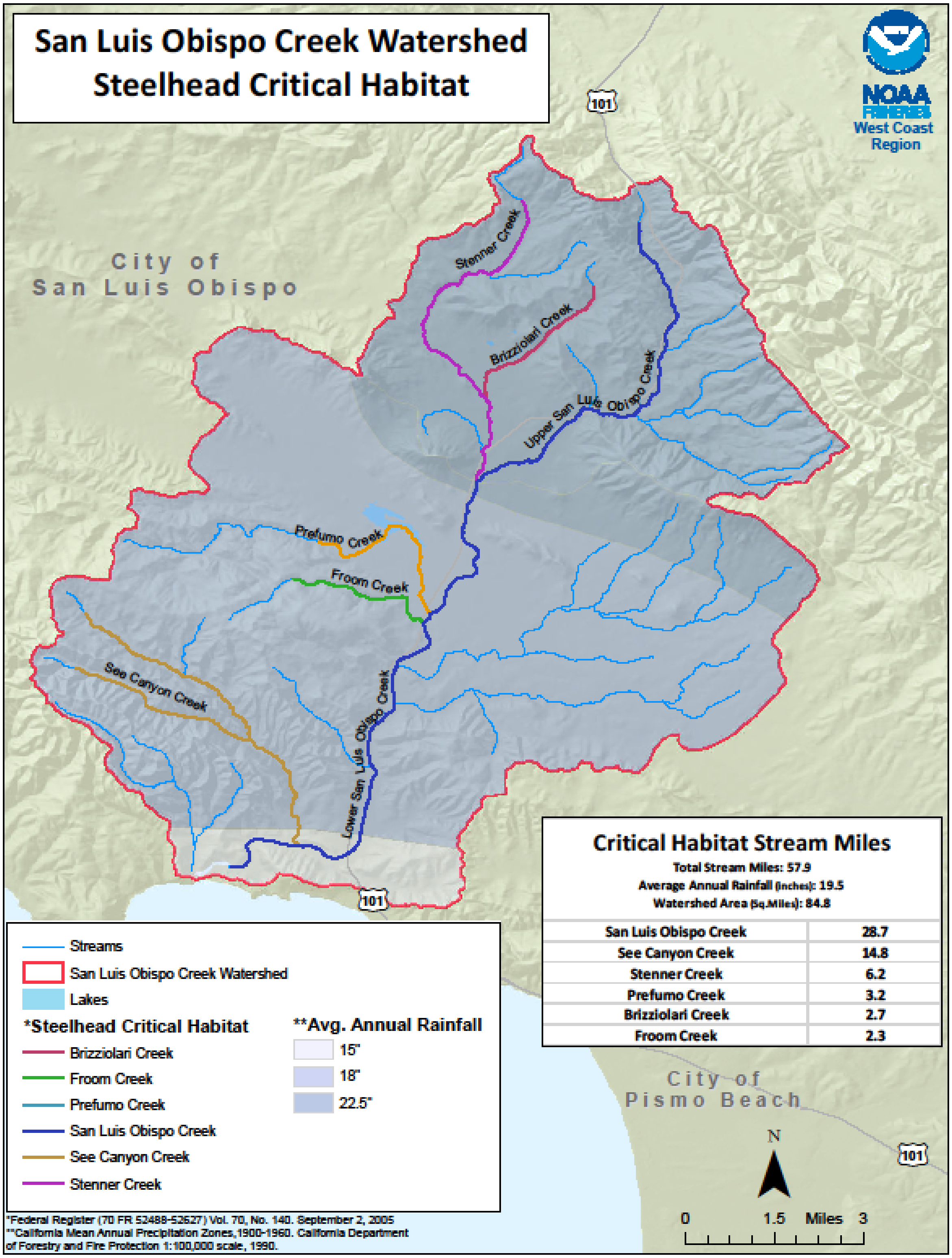
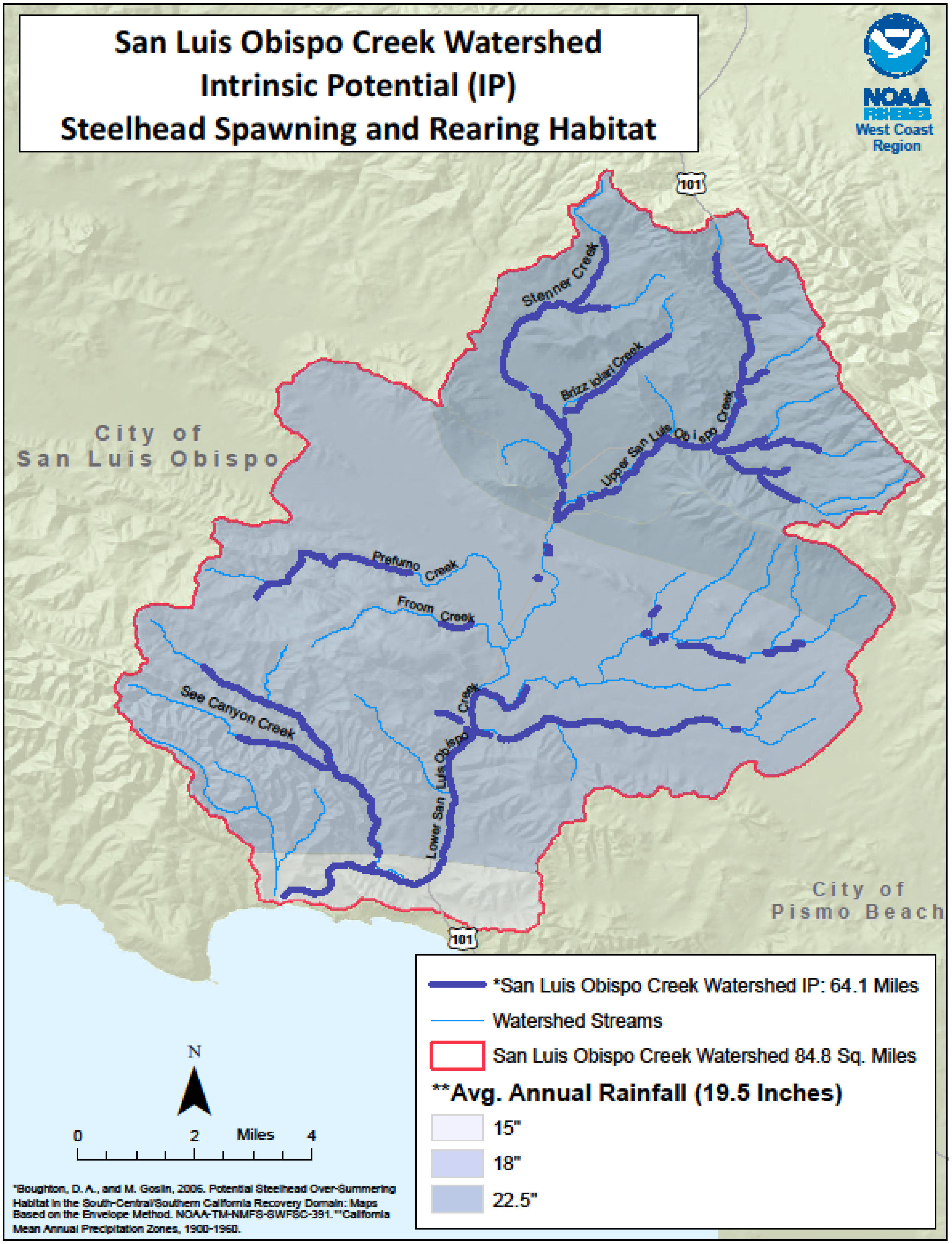
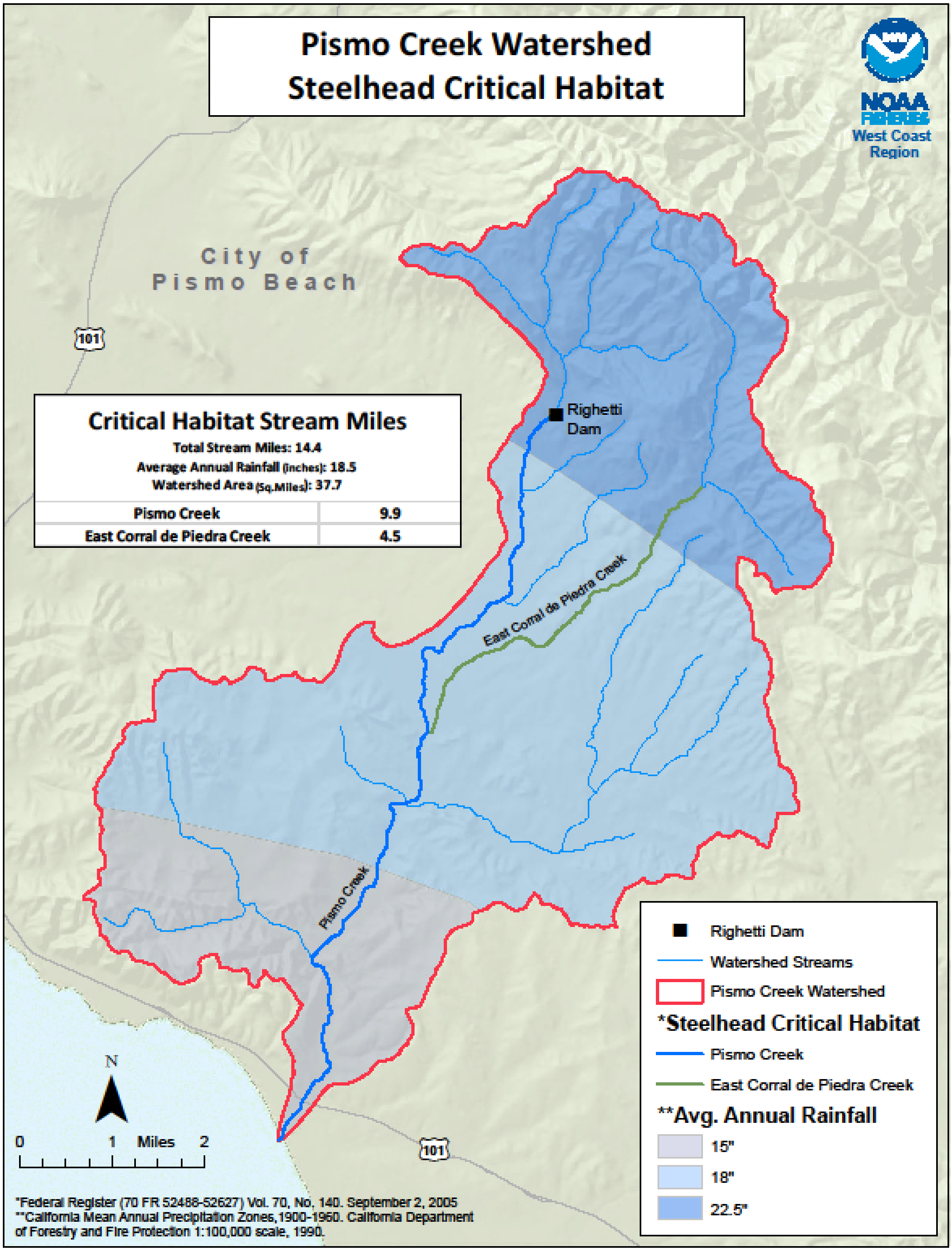
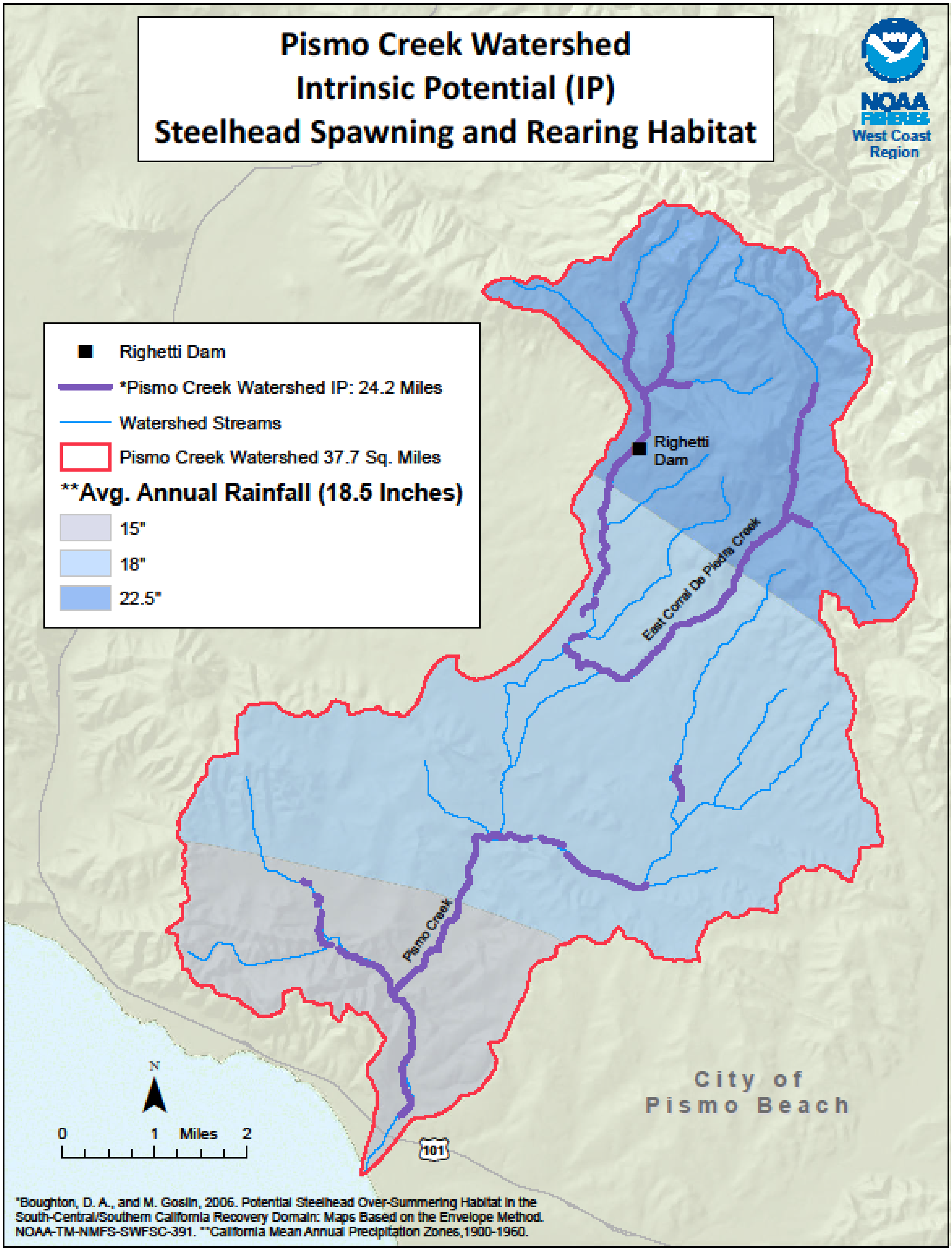

San Luis Obispo Creek Watershed
Steelhead Critical Habitat
NOAA FISHERIES
West Coast Region
City of San Luis Obispo
101
Stenner Creek
Brizziolari Creek
Upper San Luis Obispo Creek
Prefumo Creek
Froom Creek
See Canyon Creek
Lower San Luis Obispo Creek
Critical Habitat Stream Miles
Total Stream Miles: 57.9
Average Annual Rainfall (inches): 19.5
Watershed Area (Sq.Miles): 84.8
San Luis Obispo Creek 28.7
See Canyon Creek 14.8
Stenner Creek 6.2
Prefumo Creek 3.2
Brizziolari Creek 2.7
Froom Creek 2.3
Streams
San Luis Obispo Creek Watershed
Lakes
*Steelhead Critical Habitat
Brizziolari Creek
Froom Creek
Prefumo Creek
San Luis Obispo Creek
See Canyon Creek
Stenner Creek
**Avg. Annual Rainfall
15"
18"
22.5"
City of Pismo Beach
N
0 1.5 Miles 3
*Federal Register (70 FR 52488-52627) Vol. 70, No. 140. September 2, 2005
**California Mean Annual Precipitation Zones,1900-1960. California Department of Forestry and Fire Protection 1:100,000 scale, 1990.



San Luis Obispo Creek Watershed
Intrinsic Potential (IP)
Steelhead Spawning and Rearing Habitat
NOAA FISHERIES
West Coast Region
101
City of San Luis Obispo
City of Pismo Beach
Stenner Creek
Brizziolari Creek
Upper San Luis Obispo Creek
Prefumo Creek
Froom Creek
See Canyon Creek
Lower San Luis Obispo Creek
*San Luis Obispo Creek Watershed IP: 64.1 Miles
Watershed Streams
San Luis Obispo Creek Watershed 84.8 Sq. Miles
**Avg. Annual Rainfall (19.5 Inches)
15"
18"
22.5"
N
0
2
Miles
4
*Boughton, D. A., and M. Goslin, 2006. Potential Steelhead Over-Summering Habitat in the South-Central/Southern California Recovery Domain: Maps Based on the Envelope Method. NOAA-TM-NMFS-SWFSC-391. **California Mean Annual Precipitation Zones, 1900-1960.


Pismo Creek Watershed
Steelhead Critical Habitat
NOAA FISHERIES
West Coast Region
City of Pismo Beach
101
Critical Habitat Stream Miles
Total Stream Miles: 14.4
Average Annual Rainfall (inches): 18.5
Watershed Area (Sq.Miles): 37.7
Pismo Creek 9.9
East Corral de Piedra Creek 4.5
Righetti Dam
East Corral de Piedra Creek
Pismo Creek
N
0 1 Miles 2
Righetti Dam
Watershed Streams
Pismo Creek Watershed
*Steelhead Critical Habitat
Pismo Creek
East Corral de Piedra Creek
**Avg. Annual Rainfall
15"
18"
22.5"
*Federal Register (70 FR 52488-52627) Vol. 70, No. 140. September 2, 2005
**California Mean Annual Precipitation Zones,1900-1960. California Department of Forestry and Fire Protection 1:100,000 scale, 1990.



Pismo Creek Watershed
Intrinsic Potential (IP)
Steelhead Spawning and Rearing Habitat
NOAA FISHERIES
West Coast Region
Righetti Dam
*Pismo Creek Watershed IP: 24.2 Miles
Watershed Streams
Pismo Creek Watershed 37.7 Sq. Miles
**Avg. Annual Rainfall (18.5 Inches)
15"
18"
22.5"
Righetti Dam
East Corral De Piedra Creek
Pismo Creek
City of Pismo Beach
N
0
1
Miles
2
101
*Boughton, D. A., and M. Goslin, 2006. Potential Steelhead Over-Summering Habitat in the South-Central/Southern California Recovery Domain: Maps Based on the Envelope Method. NOAA-TM-NMFS-SWFSC-391. **California Mean Annual Precipitation Zones,1900-1960.

NewCurrent
WATER AND LAND

July 21, 2021

San Luis Valley Groundwater Sustainability Agency

Re: Comments to Chapter 9 and 10

Dear GSA:

These comments are submitted by New Current Water and Land, LLC (NCWL) on behalf of Edna Ranch East and the Edna Ranch East Mutual Water Company (collectively "Edna Ranch East").

NCWL is an experienced water consulting company composed of 4 principals with a combined experience in California water matters of over 140 years. Some of the principals were engaged on behalf of the Association of California Water Agencies and the Governor's Office in negotiating the language of the Sustainable Groundwater Management Act (SGMA).

These comments cover three critical issues. First, they address the question of de minimis use. Second, they address the baseline period and the conservation of groundwater that has occurred since. Finally, they address the question of sustainable yield and how the Groundwater Sustainability Agency (GSA) intends to allocate management actions among various groundwater uses within the basin.

Edna Ranch East is located in the Edna Valley portion of the San Luis Obispo subbasin. It is comprised of a number of homesites with stock in a mutual water company for the purpose of providing domestic water to the homesites. In other words, each homeowner owns an interest in the mutual water company for the purpose of providing water to their home. No homesite extracts more than 2 acre feet of water per year through the mutual water company. California Water Code section 10721(e) defines a De minimis extractor as a person who extracts, for domestic purposes, two acre-feet or less per year. California Water Code section 10725.8 authorizes GSAs to require measuring methodologies of groundwater extractions for the purpose of achieving groundwater sustainability. Section 10725.8(e) states that the provisions of the section do not apply to de minimis extractors. Thus, Edna Ranch East asserts that SGMA does not apply to the homeowners at Edna Ranch East.

California Water Code section 10720.5(a) states that extractions after January 1, 2015 cannot be used as evidence of any claim of prescription. The effect of this section is to establish a base line of rights on January 1, 2015. In the case of Edna Ranch East, several actions have been taken since that date, which have had the effect of reducing homeowner water use. Such actions have included installation of an automated water metering system, tripling of excessive water use penalties, providing water audits to homeowners to reduce water use, installation of an enhanced water leak detection system, and direct engagement of the Board of Directors of the mutual water company with homeowners with high usage (on a weekly basis). Edna Ranch East asserts that the GSA should credit it with the efficiencies achieved through these and other measures undertaken by the mutual water company.

As noted above, Edna Ranch East believes homeowner extractions are de minimis and that it has undertaken several actions that have reduced average homeowner use. Further, we can find no determination that existing uses exceed the sustainable yield. If they do not, further management actions should not be necessary. Legally, the mutual is extracting water for use by homeowners on land overlying the subbasin. Their rights should be based upon the extraction of water as compared to sustainable yield. If the mutual water company extraction for homeowners is not determined to be as an overlying right holder, then they have prescribed against overlying right holders and could have a senior right.

Edna Ranch East is submitting these comments for the record. It fully intends to stay actively engaged in the process and support reasonable and equitable solutions to achieve a sustainably managed groundwater basin. In doing so, it requests the GSA recognize the nature of its rights, actions it has taken to more efficiently manage water.

Sincerely

Daniel M. Dooley

DMD:dt

Central Coast Salmon Enhancement, Inc. dba Creek Lands Conservation

7-22-2021

To whom it may concern:

Thank you for accepting my comments regarding the document titled “Groundwater-Dependent Ecosystems in the San Luis Obispo Valley Groundwater Basin Technical Memorandum” (SLO Valley GDE Technical Memo), as well as chapters from the Draft San Luis Obispo Valley Basin Groundwater Sustainability Plan. Creek Lands Conservation (CLC) works collaboratively with non-profits and local agencies to protect and enhance groundwater dependent ecosystems (GDEs) in SLO County on behalf of all freshwater aquatic species including but not limited to federally threatened steelhead trout (*Onchorychus mykiss*). GDEs are those ecosystems that rely on groundwater to supply surface water. When groundwater is in an overdraft condition, these systems suffer. Overdraft can result in the loss of plants and animals in a basin, or in the worst case, extinction. Groundwater dependent ecosystems in the San Luis Obispo Valley Basin include San Luis Obispo Creek and all its tributaries, Pismo Creek and all its tributaries, Laguna Lake, and various seeps, springs, and wetlands associated with these systems.

The Sustainable Groundwater Management Act (SGMA) contains numerous provisions to consider and address the environment in groundwater sustainability plans and actions. SGMA requires that all beneficial uses and users be considered in the development and implementation of Groundwater Sustainability Plans. GDE’s are one type of beneficial user of groundwater. CLC hopes to continue to work with other non-profits, local, and state agencies to ensure that GDE’s are clearly identified and mapped, to improve our understanding of surface-groundwater interactions, to identify potential adverse impacts on GDE’s, and to help set appropriate minimum thresholds and measurable objectives for GDE’s under SGMA.

The comments on the SLO Valley GDE Technical Memo and applicable Draft GSP Chapters herein are provided with the understanding that the SLO Valley GDE Technical Memo provides the most recent and most detailed study of GDEs within the groundwater basin as they relate to the SGMA process. With that understanding, CLC is commenting not only on the recently released SLO Valley GDE Technical Memo but also on Draft GSP Chapters 7 and 8, Monitoring Networks and Sustainable Management Criteria, respectively. Because the SLO Valley GDE Technical Memo was referenced in Chapter 7 prior to its release, and because sustainable management criteria (SMC) described in Chapter 8 rely on the monitoring network described in Chapter 7, CLC finds that the content of the GDE Memo is fundamentally tied to language within Chapter’s 7 and 8. Thus, to provide meaningful comments on the GDE memo, CLC also provides comments on these draft chapters within this comment period.

General Comments

1. Using the best available science and expert review that includes water agencies, state agencies, academics, technical consultants, and NGO's, a framework on how to address GDE's under SGMA has been developed. This framework is titled "Groundwater Dependent Ecosystems under the Sustainable Groundwater Management Act (TNC 2018)". The framework is based on the structure provided by the Department of Water Resources (DWR) and proposes seven steps as follows:

1. Identify Groundwater Dependent Ecosystems (GDEs)
2. Determine Potential Effects on GDEs
3. Determine the Sustainability Goal
4. Set Minimum Thresholds
5. Establish Measurable Objectives and 5-year Interim Milestones
6. Incorporate GDEs into the Monitoring Network
7. Identify Projects and Management Actions

In the context of this framework, we interpret the SLO Valley GDE Technical Memo to be a supporting document for the achievement of these steps. We respectfully request that the information and recommendations provided within the SLO Valley GDE Technical Memo be consistently incorporated into the Draft GSP Chapters to a greater degree than currently exists. To our knowledge, there are no other publicly available studies on GDEs in the San Luis Obispo Valley Groundwater Basin that identify sustainable GDE indicators, nor any studies other than the technical memo that describe a monitoring network specifically suited to tracking GDE indicators and indicator target values. Therefore, we find that the SLO Valley GDE Technical Memo is a part of the best available science that the GSC has at its disposal for creating a GSP that describes both a monitoring network and SMC that sufficiently protects GDEs under SGMA.

Specific Comments on Chapter 7

2. Chapter 7, Page 3, Paragraph 2 and bulleted list, under heading 7.1.2 Representative Monitoring Sites

> *"Representative monitoring sites are the locations at which sustainability indicators are monitored, and for which quantitative values for minimum thresholds, measurable objectives, and interim milestones are defined. The criteria that were used to determine which wells to utilize are as follows:*
>
> - *A minimum 10-year period of record of historical measurements spanning wet and dry periods.*
> - *Available well information (well depth, screened interval).*
> - *Access considerations.*
> - *Proximity and frequency of nearby pumping wells.*
> - *Spatial distribution relative to the applicable sustainability indicators.*
> - *Groundwater use.*
> - *Impacts on beneficial uses and Basin users."*

Groundwater levels and GDEs should have different representative monitoring site (RMS) selection criteria. Whereas groundwater RMSs require a longer historical record to establish the definition for undesirable results, GDE undesirable results are straight-forward and actionable without 10 prior years of data for whatever given SMC and MT that is defined. For example, if a relationship between groundwater pumping at Well "A" can be correlated with critical habitat impairment using a nearby stream gage at Site "X", There is no need for Site X to have multiple years of data to establish a trend. Rather, undesirable effects correlated with Site X can be sufficiently defined using a relatively short data record. To expand on this example: we can know the stage at which Site X goes dry (an undesirable result) and, to the extent that this can be correlated to groundwater extraction, the stage or discharge data at Site X can be used immediately to set MTs for the interconnected surface flows.

Another limitation of the Draft GSP can be highlighted here. The RMSs do not appear to anticipate the eventual inclusion of the stream gage network in future revisions of the GSP. Although the exact criteria for determining undesirable results for interconnected surface water and GDEs has yet to be determined through scientific analysis, the Draft GSP should already be considering which surface water monitoring network components will become RMSs. If separate RMS selection criteria for interconnected surface water indicators are not developed now, groundwater managers will be delayed in properly protecting GDEs because the GSP will not provide a framework for the future studies that are referenced in chapters 7 and 8.

Specific Comments on Chapter 8

3. Chapter 8, Page 28, Paragraph 3 under heading 8.9 DEPLETION OF INTERCONNECTED SURFACE WATER SUSTAINABILITY INDICATOR § 354.28(C)(6)

> *"Direct measurement of flux between an aquifer and an interconnected stream is not feasible using currently available data."*

We find no explanation earlier in Chapter 8, nor in Chapter 7, for why the flux between the aquifer and the interconnected stream must be measured to create a minimum threshold that is protective of GDEs. Language cited under section 8.9.2 Minimum Thresholds (page 29) restates the following SGMA regulation language:

> *"…'The minimum threshold for depletions of interconnected surface water shall be the* ***rate or volume*** *of surface water depletions caused by groundwater use that has adverse impacts on beneficial uses of the surface water and may lead to undesirable results.'"* (emphasis added)

The next paragraph then continues:

> *"Current data are insufficient to determine the* ***rate or volume*** *of surface water [depletions] in the creeks. Therefore, groundwater elevations in the RMSs intended to monitor surface water/groundwater interaction (SLV-12, EV-01, EV-11) are used as a proxy for the Depletion of Interconnected Surface Water Sustainability Indicator."* (emphasis added)

The rate or volume of surface water depletions do not need to be synonymous with the flux measurement presently described in Chapter 8. A rate of flow depletion can be correlated with changes in stage and does not necessarily require a rating curve to draw a correlation between groundwater and surface water fluctuations. We do agree that the eventual development of rating curves for all existing and proposed stream gages is a wise step in creating the monitoring network, however.

Although the precise fluxes of groundwater in a given interconnected reach of these creeks have not yet been determined, the existing stream stage monitoring network, combined with existing low flow measurements (e.g. Stillwater Sciences 2014, Creek Lands Conservation 2019) and/or additional manual flow measurements in the dry season that could be collected in a few days of work effort would provide a basic, minimum supplement to the groundwater level indicator that is currently proposed.

4. Chapter 8, Page 28, Paragraph 1 under heading 8.9.1 Undesirable Results § 354.26(a)-(d)

> *"The undesirable result for Depletions of Interconnected Surface Water is a result that causes significant and unreasonable adverse effects on beneficial uses of interconnected surface water within the Basin over the planning and implementation horizon of this GSP. As discussed in Section 8.9, measurement of the fluxes between the aquifer and Basin creeks is not feasible with currently available data. Therefore, water level measurements at the RMSs designated for the Depletion of Interconnected Surface Water Sustainability Indicator will be used as the basis MTs and Undesirable Results until better data becomes available under future monitoring activities."*

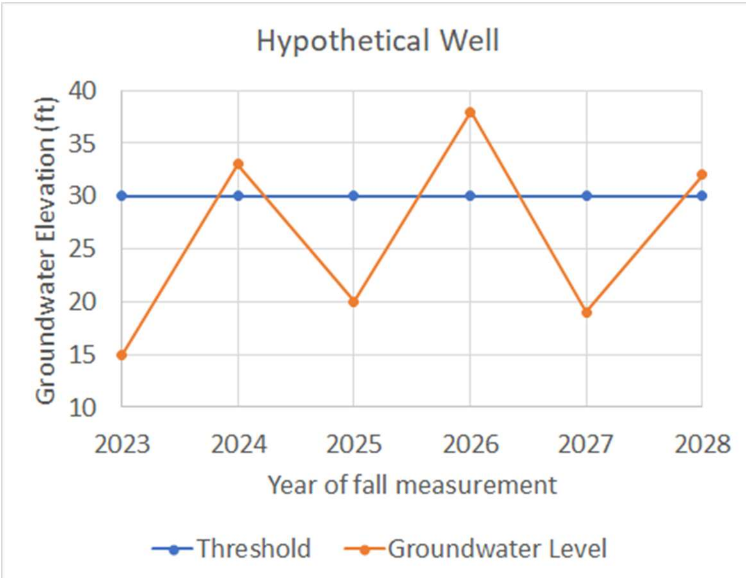
This section does not adequately address how groundwater level measurements at the RMSs will be indicative of undesirable results to depletions of interconnected surface water. In other words, there is no language that qualifies well level measurements at the selected RMSs as useful indicators for harm that could be done to GDEs that rely on interconnected surface water or groundwater.

5. Chapter 8, Page 29, Paragraph 2 under heading 8.9.1 Undesirable Results § 354.26(a)-(d)

> *"The Basin will be considered to have undesirable results if any of the representative wells monitoring groundwater/surface water interaction display exceedances of the minimum threshold values for two consecutive Fall measurements."*

Groundwater levels intermittently measured at the proposed wells (SLV-12, EV-01, EV-11) will not necessarily alert groundwater managers to imminent risks to instream habitat that is reliant on interconnected streamflow. As stated in the quoted section above, at least two sequential years of exceedances will be required to generate an undesirable result. However, this does not properly address the life cycle constraints of organisms that make up our local GDEs.

For example, if the selected representative wells exceeded the minimum threshold value in the fall of year 1, leading to the stranding of some steelhead trout or desiccation of some California red-legged frog (CRLF) eggs, but then was not exceeding this threshold in the fall of year 2, the MT would indicate no problems with the groundwater extraction regime. Furthermore, we could see some hypothetical cycle such as this:



Where the indicator well oscillates around the minimum threshold value, but never triggers the two consecutive fall measurements rule for the MT. If the years where fall measurements fell below the minimum threshold value caused greater GDE species mortality, this MT would never correct for that. This is, of course, a hypothetical situation, but nonetheless shows a potential blind spot that could be mitigated with simple surface water monitoring that is less rigorous than the measurement of groundwater flux into the interconnected stream.

To expand on why this MT type is a weak indicator for the protection of GDEs, please consider this excerpt from Stanford's Water in the West document titled "Guide to Compliance with California's Sustainable Groundwater Management Act" by Alleta Belin:

> **1. Federal and/or State Endangered Species Act (ESA) surface flow or other surface water-dependent requirements are currently not being met at least partially due to groundwater diversions**
>
> - If it is determined that groundwater diversions are causing or contributing to unauthorized "take"[46] of listed species, that is an explicit violation of the ESA that needs to be addressed;
> - Even where there is no direct violation of the ESA, the following situations are problematic because of the high likelihood of unlawful take of the species:
>   - Where a federal Biological Opinion specifies minimum instream flows that are currently not being met;[47] or
>   - Where critical habitat[48] has been designated for a listed species[49] and features in the critical habitat considered essential for survival of the species are currently being destroyed or adversely modified; or
>   - Where groundwater diversions are causing or contributing to low instream flows that are likely to jeopardize the continued existence of listed species. This should be assumed to be a problem even where violations may be rare, or very sporadic.[50]
>
> 50 Even a single day of river-drying or mortally high water temperatures can kill a large number of fish, thereby causing longterm harm to the survivability of the species.

Source: Belin 2018, excerpt from page 9.

It is our opinion that the current SMCs will create a risk that groundwater managers will inadvertently cause or contribute to take of listed species or adversely affect critical habitat. As noted in footnote #50 from the excerpt above, even a single day of drying or mortally high water temperatures in our creeks can harm the long term survivability of listed species. The current MT for undesirable results defined in Section 8.9.1 relies solely on a metric that is only monitored once each year and is only actionable after a minimum of two years. The MT in this draft of Chapter 8 will not provide the appropriate temporal resolution for protecting listed species.

Although future revisions of the GSP might include better indicators that use a higher temporal resolution, the protection of endangered and threatened species cannot be subordinated to the timelines that govern those future revisions. Those administrative timelines are even slower to respond to the immediate needs of GDEs than the currently proposed MT. This should be especially salient when there is an opportunity in the current process to avoid that.

General Comments on Chapter 7 and Chapter 8

- Although the importance of monitoring the gaining and losing reaches of streams within the groundwater basin is highlighted in Chapter 7, and referenced in Chapter 8, neither of these chapters give concrete or consequential future steps toward integrating the monitoring of these features with SMCs or MTs.

  Furthermore, none of the SMCs or MTs properly address GDEs that may be directly reliant on groundwater. The SLO Valley GDE Technical Memo highlights riparian and oak woodland GDEs in Table 2 of that document and suggests that groundwater levels could be used to determine sustainability indicators for them. More work will need to be done to find the appropriate thresholds for GDEs that are directly reliant on groundwater levels, but the current draft only discusses GDEs in the context of interconnected surface water and does not lay the foundation for GDEs that do not rely directly on surface water depletion.

- The authors of the SLO Valley GDE Technical Memo note (on page 5, paragraph 2) that several monitoring wells are screened at unknown depths.

  "...however, the screening depth is known only for 6 of the 17 wells. Wells where the screened depth is unknown may be measuring groundwater levels for deeper aquifers that are unconnected to the shallow groundwater system and thus ***groundwater deeper than 30 ft for a given well may not reflect the absence of shallow groundwater, but instead reflects the absence of data.****"* (emphasis added)

  Creek Lands has not evaluated the veracity of this particular statement but, if it is true, the potential use of these wells for establishing an indicator of interconnected surface water SMCs or other GDE indicators is cast in doubt until the exact screening depths are determined.

- Although they may not be able to establish numerical MTs for particular interconnected surface water undesirable results or GDE impacts, what is preventing the GSP from incorporating tentative or placeholder MTs? It would be much more promising to have an interconnected surface water MT that stated how the monitoring network would be used to monitor GDE impacts, without necessarily committing to a numerical value.
  - For example: "Discharge changes between the Andrews Street Gage and the Marsh Street Gage will be used to establish a minimum threshold when better data becomes available"

- or “Minimum surface water elevations dependent on interconnected groundwater in Stenner Creek will be established when a correlation between near-stream groundwater elevations and the stream gage monitoring network are established.”
- These examples do not hold groundwater managers accountable to any thresholds that are not supported by good science, but create the necessary impetus for future research to address data gaps that are directly applicable to creating MTs that meet SGMA requirements for the proper consideration of GDEs. More specificity at this stage of the GSP development will benefit everyone in the future.

- As it stands, the current Draft GSP does not create a catalyst for future research or GSP revisions that achieve the proper level of protection for GDEs. The current drafts only list the types of data and analyses that may be sought in the future, without enough actionable language that will hold the GSC accountable for implementing effective research in pursuit of a monitoring network that protects GDEs.

Creek Lands Conservation appreciates the opportunity to comment on this document and participate in the SGMA process. We also value the public process and the willingness of the other participants to consider our comments. We hope that these comments will inspire more conversation about how our groundwater resources support critical habitat within the SLO Valley Groundwater Basin. Responses or questions about these comments are welcome, and you may reach out to us using the contact information below.

Sincerely,

Timothy Delany
Hydrologist
tim@creeklands.org
Office: (805) 473-8221

Cited Works

Belin, Alleta. 2018. Guide to Compliance with California's Sustainable Groundwater Management Act. Stanford: Water in the West. Stanford, CA.

Creek Lands Conservation (CLC). 2019. Upper San Luis Obispo Creek Instream Flow Monitoring Report (2016-2018). Report to WCB Streamflow Enhancement Program (Grant #2016041)

Creek Lands Conservation (CLC). 2020. San Luis Obispo County Low Flow Monitoring Report (2015-2018). Report to WCB Streamflow Enhancement Program (Grant #2016041).

Stillwater Sciences. 2014. San Luis Obispo County regional instream flow assessment. Prepared by Stillwater Sciences, Morro Bay, California for Coastal San Luis Resource Conservation District, Morro Bay, California.

Allan Cooper's comments on draft Chapters 9 and 10 of the GSP submitted to the SLO City Council on July 20, 2021:

The Current Water Crisis Will Negatively Impact Paso Robles, Atascadero and Templeton - But Not the City of San Luis Obispo

When considering whether SLO can risk selling City Recycled Water to the Edna Valley Growers, I revisited our current reliance on Nacimiento, Whale Rock and Salinas reservoir water. What seems interesting when checking the acre feet of water stored in our three reservoirs is that SLO appears to be drawing water exclusively out of the Nacimiento Reservoir. As of today Nacimiento has dropped down to 18% capacity. This while Whale Rock has remained steady at around 76% capacity and Salinas has remained steady at 63% capacity. Compare this with March 11, 2016 where Nacimiento was at 28% but Whale Rock had slipped down to 36% and Salinas had slipped down to 13% capacity. So it appears to me that SLO is doing a better job holding a reserve of water in both Whale Rock and Salinas. Also bear in mind that Nacimiento lost 86,375 cubic feet of water over the last four months. At this rate Nacimiento will be below "dead pool", perhaps even empty, 4 months from now when the rains might eventually return. SLO County has rights to 15,750 acre feet per year of Nacimiento water and it's hard to tell if that allocation has already been exhausted (our City has a contractual entitlement to 5,482 AFY of Nacimiento water). Although Morro Bay, Pismo Beach, Oceano and Avila Beach are reliant on the State Water Project, Paso Robles (which is entitled to 17,500 acre feet per year), Templeton and Atascadero depend on both well water and Nacimiento Reservoir water.

When the Nacimiento water runs out, SLO will be switching over to what water remains in Whale Rock and Salinas. This will give SLO - at a consumption rate of 4,700 acre-feet per year - a supply sufficient to see us through next winter. The City's capacity rights to Whale Rock water is 55.5% which is currently 14,403 acre feet. Salinas will currently provide us with 13,164 acre feet of water. This totals an ample 29,567 acre feet (or 6 years worth) of water for our own use.

Sept. 17, 2021

Submitted by: Peg Pinard

Former Mayor, City of San Luis Obispo and Chairperson, San Luis Obispo County Board of Supervisors

I am very please to see that the SLO Basin was designated by the State as a high-priority basin "which means the basin's management agencies are required to develop a groundwater sustainability plan".

With this as the goal, there are a number of points I would like to make regarding this San Luis Obispo Valley Basin (SLO Basin) Groundwater Sustainability Plan (GSP)

1. Limited Input
2. SLO City's Water Supply
3. Definition of the Basin
4. The Model Used
5. Nature of Local Agriculture
6. Environmental Relationship between "Above Ground" and "Below Ground"

Limited Input

The list of people who gave input to this plan appears to have been garnered from primarily one sector of the basin, ie; Edna Valley. There was a reference to a forum from some of the respondents but, although I have been very involved in the city's water management plan (ever since the city, literally, hit rock bottom with our available water supply when I was on the city council), I did not hear of any meeting about this plan (nor did any of the usually informed residents, that I know). This is unfortunate because there were a lot of statements made that would have benefitted from a wider discussion had the focus been on the needs of the entire basin as well as the farmers in the Edna Valley.

SLO City’s Water Supply

Based on dozens of previous comments, one thing in particular needs to be clarified. There is no excess SLO City water that is being "wasted going down the creek to the ocean”. When SLO residents’ water was being rationed, down to how many gallons they could use a day, there was a demand for the city to get new water sources any way they could. The most obvious one available at that crises time was to recycle the water that we already had. In order to achieve this, residents agreed to raise their own water (and sewer) rates to make this happen. We even negotiated a pipe-line-exchange deal with an oil companiy so that we could use the lines they didn’t need anymore in order to get our recycled water to our largest users…mainly our parks and schools.

Imagine our surprise and, yes, dismay, when the regulatory agencies decided that, even though this was NOT WATER FROM THE CREEK, that we would be required to take our recycled water and release a good portion of it to the creek. In other words, the amount of water naturally coming down the creek was going to be artificially augmented from the water residents had planned (and paid for!) to use from recycling. While the regulatory agency’s goal was noble, ie, to augment water for downstream fishery needs (and yes, that release also helped recharge aquifers) the main justification for requiring the additional release was not what we had planned on when we agreed to the higher level of treatment. Residents had planned to use that recycled water! So, believe me, that, if that water was ever to be designated as “extra” the residents of the city would be demanding that it be available for their use….as they had planned and paid for!

Definition of the Basin

It was very surprising to see the definition of the basin pretty much end at Laguna Lake. That is not what we learned during the drought (in the late 80’s) when we did multiple "well studies" in our efforts to get whatever water we could from our wells. The most surprising information was when a dye-test was done to try and understand the basin under the Dalidio property The city wanted to know where it came from and where it went. Actually, it shouldn’t have been surprising because once we got the information, the topography all made sense.

Historically, it was called Marsh Street for a reason! Water collected there, seeped into the ground, and was a primary recharge collection area for water that traveled down the Los Osos Valley. This aquifer was important for the wells that served Los Osos. This understanding was so important that, when we were originally having discussions with the Dalidios about the development for their property, the plans included a new lake that would still allow for the function of being a primary recharge area for Los Osos. Those original plans tried to acknowledge what was needed environmentally while still being able to accommodate appropriate development. Since the sewer plant was nearby, we even discussed how we could augment that lake by bringing the high tertiary-level-treated, recycled water across the freeway. The “lake" could then function as an asset for everyone. This concept for the use of recycled water was later put into practice at Cypress Ridge in Arroyo Grande where the homes are even sold as “Lakeside Homes”!

One of the main “take aways” from that whole discussion was the need to identify where the major recharge areas were so that we could make sure that we consciously aided the ability to recharge our precious aquifers. The city, and county, were supposed to ‘red line’ these areas so that we didn’t lose them. This was supposed to be a priority! We could accommodate development without having to destroy the very environment we depended on! As mentioned above, they could even become a selling point!

As I see this plan, there does not appear to be any recognition or designation of important recharge areas that must be kept as sacrosanct. While I’m not a soil scientist, I doubt that there is much recharge ability through concrete. And, where is the accountability for the part of this aquifer that serves Los Osos?

<u>The Model Used</u>

There were a lot of comments about what years were used for the calculations. Apparently, the year 2016 caused alot of discussion. But I can’t help thinking that the whole focus is wrong…no matter what years are used. The past is no longer a reliable indicator for the future! That’s what the whole issue is about in recognizing Global Warming…and, as we are seeing, it’s happening a lot faster than was originally thought.

We aren’t talking about seasonal differences any more — differences where taking multiple years and averaging them would bring us a fairly reasonable plan.

It's now a whole different ball game! I haven't heard of any climate projection that says that things are going to get better - or even stay the same.
In fact, it's just the opposite. The west is getting hotter and drier - not just here but all over. Green house gasses and carbon emissions, continue to accelerate.

Where is this current reality taken into consideration? This is not a time for the proverbial "burying one's head in the sand" and pretend it isn't real. If people don't plan for what is already knowable then people have to realize that they will be deliberately creating very severe conflicts….much more severe than the ones that already exist.

<u>The Nature of Local Agriculture</u>

One property owner described the situation very accurately when she said that her previously reliable well had gone dry and that she had doubts about how her new, much deeper (and costlier) well would last. In the past, the valley had been mostly dry land farming. At first, I remember that businesses like Talley Farms were doing amazing things with their existing crops utilizing innovative irrigation practices that reflected, and respected, the diminishing water availability. But then, the valley changed with the influx of more intensive water uses. This is exactly the situation that old-timers from the north county, told me happened in Paso Robles. The aquifers could handle some increase in production, but not all that had been allowed to happen. "Big business" could afford to dig deeper, while regular folks were watching their wells go dry. This is probably a "sacred cow" for the Edna Valley farmers, but the ever-growing level of agriculture apears to be going beyond the sustainable capacity of the basin. People who have inhabited this land for decades, shouldn't be having to bear the cost of having to dig deeper and deeper for their water while others, who can simply write-off any of these expenses as a business deduction are allowed to take so much.

A Basin Plan cannot have undiscussed 'sacred cows". It needs "to put everything on the table," including what level of agriculture the valley can reasonably sustain for ALL the residents in the valley. The City of San Luis Obispo's water is not up for grabs - and, truth be told, the city has its own issues with regard to "putting everything on the table" in being honest and responsible regarding sustainability for its residents.

Environmental Relationship between "Above Ground" and "Below Ground"

Rick Rogers (NOAA's National Marine Fisheries) really tried to get the discussion of a Basin Plan on a reasonable and responsible track. There is an interrelationship between what happens above ground and what happens below it. Ignore that relationship at one's own peril. We are seeing the effects, and, if we don't change course, the effects are going to be even greater when combined with other global warming factors. The exponential curve that we see with regard to carbon emissions holds true for other factors like deforestation - no matter what chart one uses, the reality is the same.

Trees are the bridge between the two ecosystems…above and below the ground. Yet we are cutting them down with total disregard for the effects. Besides being the cheapest, most effective and reliable carbon sequesters that we have, they have multiple other functions that are seldom discussed. They slow the rain down as it hits the ground, allowing for more time to percolate the soil. The roots hold that water in the soil, again, allowing for the water to slow down as it nourishes and sustains the quality of the soil through its mycorrhizal networks. The leaves not only capture water but they are key for the tree's transpiration of moisture into the atmosphere - thus feeding the atmospheric 'river' and attracting rain clouds for our own areas. This doesn't even begin to talk about all the biological benefits of trees. Crops of all kinds need pollinators and beneficial insects and birds to keep the bad bugs under control.
Where do you think our beneficials and birds live?

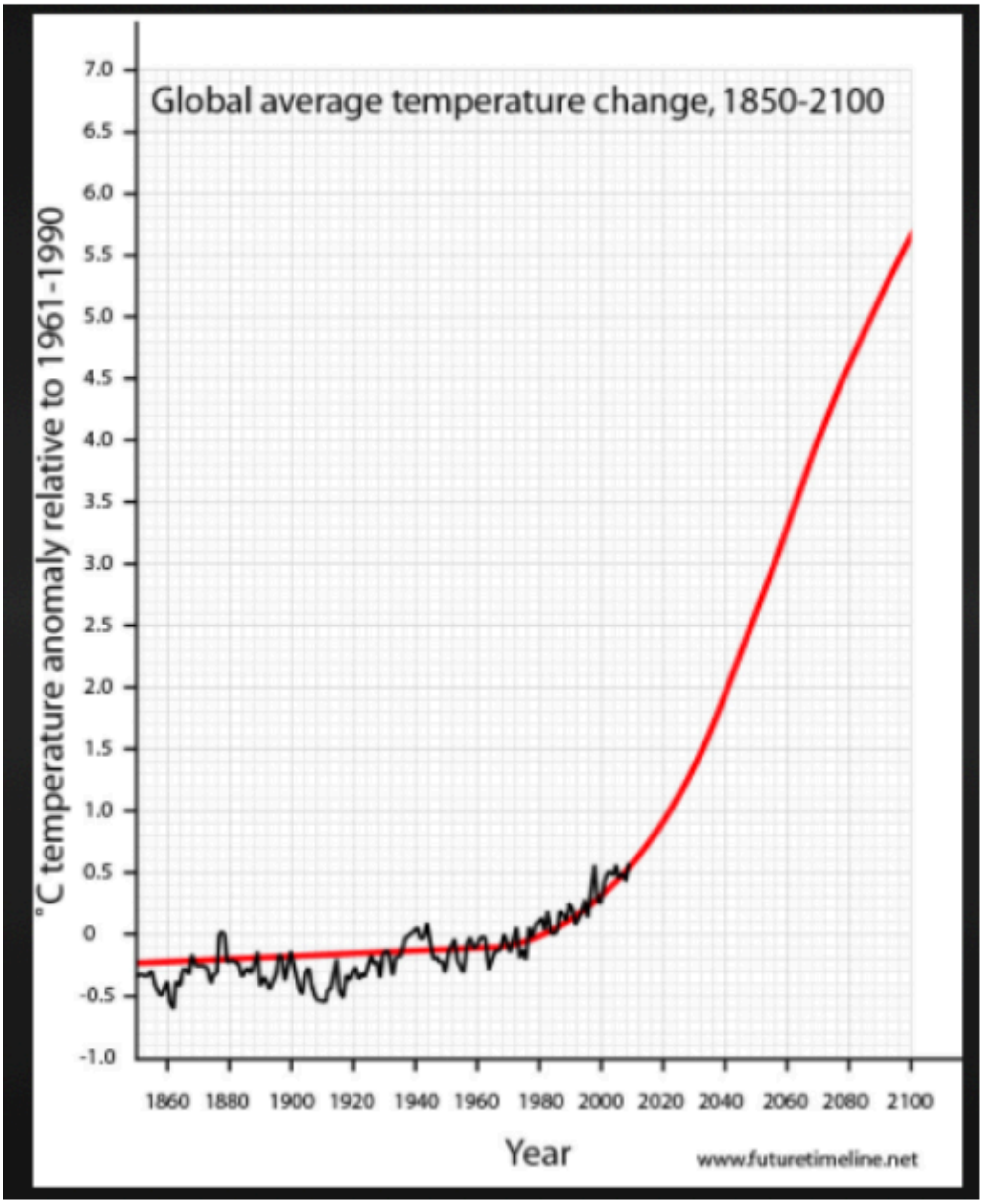
Many farmers know this, but are silent regarding the relationship between the trees' benefits to farmers and the negative effect of cutting the trees down. As we have experienced in this county, some business investors (I really can't call them farmers, sorry) don't care at all and just cut down thousands of trees that are 'in their way' for making every last buck that they can. The result is that we all pay the cost for such disregard for this interrelationship. It's been very short-term thinking!

Lest anyone think it's just the agricultural interests that have been destructive with the land by destroying the benefits that trees naturally bring to all of us, just know that the City of San Luis Obispo, a supposedly environmentally-conscious city has done no better. One of the impacts of cutting down over 560 mature trees with the San Luis Ranch project (and a couple of other major projects) is that the city just agreed to put about 22,400 more pounds of carbon into the atmosphere EVERY YEAR. The city itself added to the amount of carbon being put into the atmosphere since they cut down even more trees to make room for a new entrance to the project.

It takes a sense of responsibility for a developer to plan building around the mature, existing trees. It takes a willingness to not push for every dollar that one can make by simply clearcutting the land. And, when that sense is missing, it takes a city council or Board of Supervisors willing to stand up to the pressure from the monied interests. That isn't happening.

This isn't a comment about not building or not having a farm, it's about being truly conscious of what we are doing and taking responsibility for the factors that will affect all of us, and future generations, in the long run.

A "Basin Plan" needs to account for all of these significant factors that affect the capacity and sustainability of the basin.


Global average temperature change, 1850-2100
°C temperature anomaly relative to 1961-1990
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Year
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UNITED STATES DEPARTMENT OF COMMERCE
National Oceanic and Atmospheric Administration
NATIONAL MARINE FISHERIES SERVICE
West Coast Region
501 West Ocean Boulevard, Suite 4200
Long Beach, California 90802-4213

September 9, 2021

John Diodati, Director
County of San Luis Obispo GSA - San Luis Obispo Valley
976 Osos Street, Room 206
San Luis Obispo, California 93408

Re: NOAA's National Marine Fisheries Service comments on the draft Groundwater Sustainability Plan for the San Luis Obispo Valley Groundwater Basin

Dear Mr. Diodati:

NOAA's National Marine Fisheries Service (NMFS) is the federal agency responsible for managing, conserving, and protecting living marine resources in inland, coastal, and offshore waters of the United States. We derive our mandates from numerous statutes, including the Federal Endangered Species Act (ESA). The purpose of the ESA is to conserve threatened and endangered species and their ecosystems.

On August 19, 2021, the San Luis Obispo Valley Groundwater Basin Groundwater Sustainability Agencies (hereafter, "GSAs") released the draft Groundwater Sustainability Plan (GSP) for the San Luis Obispo Valley Groundwater Basin (SLO Valley Basin). The California Department of Water Resources has designated the SLO Valley Basin a "high" priority for groundwater management, necessitating the development of a final GSP by January 31, 2022, as required under California's Sustainable Groundwater Management Act of 2014 (SGMA). Several waterways that overlie portions of the SLO Valley Basin, including San Luis Obispo Creek and the headwaters of Pismo Creek, support federally threatened South-Central California Coast (S-CCC) steelhead (*Oncorhynchus mykiss*).

Surface water and groundwater are hydraulically linked in the SLO Valley Basin, and this linkage is critically important in creating seasonal habitat for S-CCC steelhead. Where the groundwater aquifer supplements streamflow, the influx of cold, clean water is critically important for maintaining temperature and flow volume. Pumping from these aquifer-stream complexes can adversely affect juvenile salmon and steelhead habitat by lowering groundwater levels and interrupting the hyporheic flow between the aquifer and stream. Low groundwater elevations caused by unsustainable groundwater pumping can combine with low surface flow discharge to impact instream aquatic habitat, as was demonstrated during California's protracted 2012-2016 drought when the above two factors led to desiccation of streams throughout the SLO Valley Basin (CDFW 2019a). Based upon these past results and the return of dry conditions beginning with the 2020 water year, NMFS believes that groundwater extraction in the SLO Valley Basin is currently compromising S-CCC steelhead instream habitat. This letter transmits NMFS' comments regarding the draft GSP.

NMFS previously commented on the draft Chapter 8 of the draft GSP via letter dated June 3, 2021, and the GSAs responded to our comments as part of the Appendices of the draft GSP. We first offer comment on those responses.

NMFS June 3, 2021 comment #1 (p. 29): "The draft Chapter 8 indicates the basin will be considered to have experienced undesirable results if any of the monitoring wells exceed the minimum threshold for two consecutive fall measurements. The standard of failing two consecutive fall measurements is not explained, and thus appears arbitrarily. Steelhead migration, spawning and rearing (beneficial uses of surface water as set by the Regional Water Quality Control Board) are biological processes that can be impacted by a single streamflow depletion event. SGMA regulations require a minimum threshold be used to define an undesirable result, in this case streamflow depletion resulting in significant and unreasonable impact to beneficial uses of surface water. For a beneficial use such as steelhead rearing, a depletion of adequate streamflow can result in steelhead mortality, and is therefore irreversible. We therefore recommend that the standard for determining undesirable results be expressed in terms of minimum pool depth and/or surface flow during the summer and fall base flow periods."

<u>GSA Response to Comment #1:</u> *"The standard of two consecutive fall measurements was adopted to avoid triggering any far reaching management actions such as pumping reductions on the basis of a single dry season. As has been discussed, groundwater systems react very slowly to changed conditions, and it was judged appropriate by the GSC and GSA members to utilize two consecutive measurements to avoid triggering any actions based on temporary conditions. Additionally, in the future more wells in the network will be equipped with transducers to gather continuous monitoring data. It may be appropriate to prioritize monitoring wells designated for depletion of ISW for transducers. At that point, the definition of the MT may need to be revised, as continuous data will be available. This text will be updated for clarification in Chapter 8.*

The GSP is intended to be a groundwater monitoring plan. Because there are numerous factors that affect instream flow conditions (rainfall, temperature, ET, etc.), it is not within the ability of this GSP to mandate instream flow conditions such as pool depth as an MT. The objective of the plan with respect to interconnected groundwater such that there is no significant or unreasonable increase in depletion of ISW. As such, MTs are defined to disallow water levels from declining lower than recently historically observed conditions. Stillwater Sciences has prepared a TM on GDEs in the Basin that will be included as an appendix to the GSP."

<u>NMFS Final Draft GSP response:</u> While the GSA response explains the reasoning and origin of the proposed "two consecutive fall measurements" standard, the GSA fails to explain how the minimum threshold will avoid adversely affecting ESA-listed steelhead, or satisfy the following requirement stated within the SGMA regulations:

> "The relationship between the minimum thresholds for each sustainability indicator, including an explanation of how the Agency has determined that basin conditions at each minimum threshold will avoid undesirable results for each of the sustainability indicators". (CCR §354.28(b)(2))

The GSA has failed to adequately explain how the proposed minimum threshold for streamflow depletion will avoid significant and unreasonable impacts to surface water beneficial uses, including ESA-listed steelhead. NMFS has noted in the past that historically low minimum thresholds and measurable objectives proposed for the streamflow depletion correspond with historically high streamflow depletion rates. Historically high depletion rates consistent with, or worse than, those experienced during the California drought of record (2011-2016) will likely adversely impact ESA-listed steelhead and their critical habitat, as well as significantly impact surface water beneficial uses. If the GSA has information that would contradict this assumption, they should present it within the final GSP.

SGMA language and its associated regulatory requirements clearly indicate that, despite the GSA's assertion, GSPs are not intended to just "monitor groundwater." While monitoring groundwater conditions is an important component of a GSP, the clear intent of SGMA is to achieve sustainable groundwater management through setting sustainable management criteria and undertaking actions that ensure the basin is sustainably managed[1] by 2042. Furthermore, SGMA requires significant and unreasonable impacts to surface water beneficial uses be <u>avoided</u>. Thus, a plan objective of "no significant or unreasonable increase in depletion of ISW (interconnected surface water)" is inconsistent with SGMA regulations and the basic purposes of SGMA

NMFS June 3, 2021 comment #2 (p. 29): "Groundwater elevations may be necessary as a proxy for streamflow depletion due to a lack of data gathered to this point. However, there appears to be no attempt at correlating groundwater elevation thresholds with impacts to instream beneficial uses of surface water. In fact, many of the groundwater elevation minimum thresholds are set at the lowest (or below the lowest) groundwater elevations ever recorded within the basin. These thresholds are likely associated with severe groundwater over-pumping during dry periods, when groundwater depletion was greatest, and surface water discharge the lowest. Managing streamflow depletion conditions comparable with the severest drought conditions is not protective of surface water beneficial uses that support ESA-listed steelhead, and likely would result in adversely affecting steelhead and its identified critical habitat (see enclosed steelhead critical habitat and intrinsic potential maps for San Luis Obispo Creek and Pismo Creek). If the GSAs uses groundwater levels as a proxy for streamflow depletion, it should explain how the chosen minimum thresholds and measurable objectives adequately avoid adversely impacting surface water beneficial uses that support steelhead survival throughout the SLO Basin. If that effort proves problematic due to a lack of data at the present time, the GSAs

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[1] From the Department of Water Resources' "Sustainable Management Criteria – Best Management Practices (DWR 2017):

"SGMA defines sustainable groundwater management as the management and use of groundwater in a manner that can be maintained during the planning and implementation horizon without causing undesirable results."

"The GSP Regulations focus the development of GSPs on locally-defined, quantitative criteria, including undesirable results, minimum thresholds, and measurable objectives. Undesirable results must be eliminated through the implementation of projects and management actions, and progress toward their elimination will be demonstrated with empirical data (e.g., measurements of groundwater levels or subsidence)."

should follow guidance by the California Department of Fish and Wildlife that recommends a conservative approach to groundwater dependent ecosystem protection in those situations (CDFW 2019b)."

<u>GSA Response to comment #2:</u> *"The primary rationale for the selection of the MTs is protection of domestic water wells. Initially MTs were proposed that would be no lower than the observed low point in 2015, under the rationale that the stakeholders had managed to obtain household supplies and proceed with their operations under those extreme conditions, and so could do it again. See text on evaluating reduced water levels compared to domestic well depths. Ultimately the GSC members agreed that an additional 10 feet below observed low GW elevations would help protect agricultural businesses in the Edna Valley. For now, in the lack of data collection outlined in Chapter 7 (Monitoring Network) and Stillwater Sciences TM on GDEs, three existing wells located adjacent to streams are selected to monitor, and groundwater elevations will go no lower than observed seasonal low water levels, and by extension, surface water/groundwater will not be negatively impacted in these areas. The MTs associated with the observed severe droughts is proposed as the MT, which should not be exceeded (I.e., water levels lower) under normal operating conditions. The MTs are not proposed to be the normal operating conditions of the aquifer."*

<u>NMFS Final Draft GSP response:</u> The explanation offered above only clarifies that domestic and agricultural groundwater production were considered when developing streamflow depletion criteria. How the criteria actually avoid significant and unreasonable impacts to instream beneficial uses of surface water is not explained within the draft Final GSP. The statement "groundwater elevations will go no lower than observed seasonal low water levels, and by extension, surface water/groundwater will not be negatively impacted in these areas" ignores the adverse effects on surface flows resulting from "observed seasonal low [ground]water levels".. The necessary reasoning of how a minimum threshold consistent with historically high streamflow depletion avoids impacts to surface water beneficial uses is absent within the draft Final GSP. Finally, although the proposed minimum thresholds are not "proposed to be the normal operating conditions of the aquifer", that is essentially what will occur during the initial several years of plan implementation when further data for refining the threshold is gathered. If groundwater management actions will engage at groundwater elevations above the identified minimum thresholds to reduce the possibility of undesirable results, the GSP should thoroughly explain this engagement plan. Without that engagement or action by the GSA at groundwater elevations above the minimum thresholds, the GSP is in essence managing to those minimum threshold elevations as normal operating conditions.

NMFS June 3, 2021 comment #3 (p. 29): "The draft includes the following statement:

> To avoid management conditions that allow for lower groundwater elevations than those historically observed, MTs [Minimum Thresholds] for these wells were set at the historic low water levels indicated on the hydrographs, which occur with regularity during every extended dry period evident in the record (Figures 8-9, 8-10).

As noted above, managing to perpetuate historically low groundwater elevations is not appropriate as a management threshold, since it does not adequately define the undesirable result of streamflow depletion on aquatic biological resources such as federally threatened South-Central Coast steelhead. Based upon fundamental hydrogeologic principles where the depletion rate is proportional to the difference between the water table and surface water, the amount of streamflow depletion associated with the proposed minimum thresholds would be the greatest on record (Sophocleous 2002, Bruner et al. 2011, Barlow and Leake 2012). This level of streamflow depletion would likely impact surface water beneficial uses to the extent that threatened steelhead would experience "harm" under the ESA as well as result in adverse impacts to Groundwater Dependent Ecosystems (GDE) supporting a variety of native aquatic species."

<u>GSA Response to comment #3</u>**:** *"It is not the intent that the MTs are to "perpetuate historically low groundwater conditions." It is the intent that the basin should be managed such that water levels do not go lower than the MTs. And for the MTs associated with GW/SW interaction, these MTs have been commonly observed in the historical period of record of water levels, and so are assumed to be appropriate to local conditions. Projects and supplemental water sources in Edna Valley are intended to improve streamflow conditions."*

<u>NMFS Final Draft GSP response</u>: A minimum threshold identifies when groundwater conditions may cause an undesirable result in the basin (DWR 2017). NMFS maintains that the historically high streamflow depletion rates that would result from the proposed groundwater elevation thresholds do not delineate the point where conditions "may" cause unreasonable and significant impacts to surface water beneficial uses (including ESA-listed salmonids), but instead very likely represent conditions where severe impacts are expected to occur.

The GSA response also notes, "MTs have been commonly observed in the historical period of record of water levels, and so are assumed to be appropriate to local conditions." The reference to "appropriate conditions" is confusing -- SGMA does not include any requirement concerning appropriate conditions, nor does the term even appear within the SGMA regulations. SGMA regulations require an explanation of how the Agency has determined that basin conditions at each minimum threshold will avoid undesirable results for each of the sustainability indicators[2]. The Final Draft GSP should clearly explain how this requirement is met now, or describe a proposed course of action to meet the requirement in the future.

NMFS June 3, 2021 comment #4 (p. 30): " Following the discussion on the relation between flow conditions in San Luis Obispo Creek and the underlying aquifer, the draft Chapter 8 asserts, "in both cases the amount of flux between the surface water and the groundwater system is small compared to the volume of water flowing down the creek." The point of this statement is unclear but seems to suggest that groundwater levels are not significantly influenced by the volume (including duration) of stream flow. However, this implication is contradicted by the statement, "In wetter years, when flows in the San Luis Obispo Creek are high there is [sic] greater amounts of discharge from the creek to the groundwater system." In general, higher and longer the duration flows in SLO Creek will increase the area of wetted stream bottom (i.e., the area of infiltration) as well as the duration of the infiltration of surface flows to the underlying groundwater basin. Furthermore, the assertion that stable groundwater levels at a specific well

[2] 23 CCR §354.28(b)(2)

“suggest that the mechanisms of surface water/groundwater interaction have not been negatively impacted since the early 1990’s” does not address the question of whether these stable conditions have had, or are currently resulting in, streamflow depletion impacts as defined under SGMA. Currently stable groundwater levels are not an indicator of sustainable groundwater conditions, or, more specifically, avoidance of significant and unreasonable effects on streamflow. The revised draft Chapter 8 should address this issue and clearly indicate how existing stable groundwater conditions are protective of GDE, such as rearing habitat for juvenile steelhead.”

*GSA Response to comment #4***:** *“The text in this chapter has been revised to address these issues in greater detail, including discussion of Darcy’s law and flow direction between stream and aquifer, more detailed hydrograph analysis of SLO Creek and Corral de Piedras Creeks, and a conceptual modeling evaluation of surface water/groundwater interaction. It is important to recognize that many factors contribute to instream flow conditions that are beyond the ability of a groundwater management plan to control (rainfall, temperature, etc.). The objective with respect to interconnected surface water (ISW) is to avoid groundwater conditions that result in significant or unreasonable increase(sic) in ISW depletion.”*

NMFS Final Draft GSP response: The GSA includes modeling results evaluating surface water/groundwater interaction in the Final Draft GSP that suggest significant streamflow depletion occurred during the summer seasons of 2014-2016. While the modeling exercise was unavoidably imprecise due to a basin-wide dearth of groundwater and streamflow data, the modeling results presented in the Final Draft GSP likely underestimate historical surface water depletion and the potential degree to which it could impact surface water beneficial uses. The modeling analysis was focused on “groundwater pumping in the San Luis Valley watershed”, and estimated average streamflow over July, August and September. Given the varied spatial diversity of potential gaining and losing stream reaches across the watershed, the current analysis is inappropriate for discerning streamflow depletion impacts at the spatial scale where groundwater dependent ecosystems (GDE) experience them. Future studies should refine the modeling analysis based upon stream reaches defined by their hydrologic and geologic characteristics, and not generalize impacts at a spatial scale with little relevance to GDE impacts. Likewise, averaging the three summer months minimizes the potential effect of streamflow depletion, since depletion impact likely progressively worsen over the summer and typically reach their peak just prior to the onset of fall rains (i.e., early October). Future analysis should avoid “averaging” when analyzing streamflow depletion impacts, but should instead focus on the period when the impact is expected to be most significant.

Finally, with regard to the final sentence of the GSA response referring to avoiding “groundwater conditions that result in significant or unreasonable increases in ISW depletion”, please see NMFS comment #1 above.

NMFS June 3, 2021 comment #5 (p. 31): “The draft Chapter 8 states that, “by defining minimum thresholds in terms of groundwater elevations….the GSA will….manage potential changes in depletion of interconnected surface (sic [flows?]).” The draft Chapter 8, however, has not established the required correlation between groundwater elevations and surface flows that could justify groundwater levels as a proxy for streamflow depletion, and has not quantified what level of streamflow depletion represents significant and unreasonable impacts to GDE, including but not limited to rearing habitat for juvenile steelhead. The draft Chapter 8 should identify the data needed to analyze the relationship of groundwater levels, streamflow depletion rates, and impacts to GDE, specifically spawning, rearing and migration of ESA-listed steelhead."

<u>GSA Response:</u> ***"****There is no technology or field method to directly measure depletions in surface water flow attributable to groundwater development. Estimates must be made using interpretation, modeling, and other methods of analysis. A discussion of Darcy's Law and direction of flow between the stream and aquifer has been added to the text of this section, as well as additional well hydrograph analysis, and a conceptual modeling exercise. However, it is a commonly accepted hydrologic principle that correlates groundwater elevations higher than the stream elevation and aquifer discharge to the stream. Survey data must be collected on stream channels and groundwater elevations to confirm this relationship. Proposed improvements to the monitoring network discussed in Chapter 7 and the Stillwater TM will improve the understanding of this dynamic.*

<u>NMFS Final Draft GSP response:</u> We reiterate that the GSA has not "quantified what level of streamflow depletion represents significant and unreasonable impacts to GDE, including but not limited to rearing habitat for juvenile steelhead", nor has the GSA proposed any plan for addressing this data gap within the Final Draft GSP. Although the data may not be readily available to specify the precise groundwater elevations that avoid streamflow depletion undesirable results, the GSA can and should nevertheless outline the general concept of how the threshold will be set in the future. For example, if the GSA wishes to use groundwater elevation as a proxy metric for avoiding the streamflow depletion undesirable result, the relationship between groundwater elevations, the resulting streamflow depletion at those elevations, and ultimately the impact on spawning, migration, and rearing habitat condition in the stream should analyzed. The Draft Final GSP makes no mention of their intent to carry out these necessary studies, and we recommend DWR not accept the document until this commitment is included.

NMFS June 3, 2021 comment #6 (p. 31): "The draft Chapter 8 establishes minimum thresholds for streamflow depletions as "the lowest water levels observed in the period of record" for the chosen monitoring wells. As noted earlier, according to SGMA regulations a minimum threshold is used to define an undesirable result, in this case streamflow depletion resulting in significant and unreasonable impact to GDE, including, but not limited to rearing juvenile steelhead. The use of streamflow depletion thresholds associated with the lowest recorded groundwater levels are inappropriate because they will not avoid significant and unreasonable impacts to GDE. The thresholds are inappropriate for avoiding impacts to ESA-listed steelhead resulting from streamflow depletion. To be consistent with the requirements of SGMA, the GSAs must develop thresholds that are likely to avoid adversely impacting steelhead, as well as other GDE."

<u>GSA Response:</u> ***"****If groundwater elevations have not been observed to decline below historical levels in the vicinity of a stream, as is the case along SLO Creek, this is an indicator that anthropogenic activities have not impacted stream conditions in this area in the period of record. The objective of the GSP with respect to ISW is to avoid groundwater conditions that will significantly or unreasonably increase depletion of ISW. Hydrograph analysis of wells along corral de Piedras Creeks indicate that this creek is seasonally disconnected from the aquifer; additional monitoring data can confirm or deny this assumption. Additional stream corridor*

characterization and monitoring is recommended in Chapter 7, Monitoring Networks, and in the Stillwater TM on GDEs that will be included as an appendix to the GSP."

<u>NMFS Final Draft GSP response:</u> Groundwater elevations remaining above historical low levels is not an indicator that "anthropogenic activities have not resulted in lowered water levels." Anthropogenic activities can (and likely have been) lowering groundwater levels during wet, average, and even dry years without those levels approaching "historical levels." Groundwater pumping during an above average water year which depress groundwater elevations down to those characteristic of a below average water year in the past is but one example that contradicts the above reasoning. Likewise, consistent groundwater levels do not "imply that stream conditions have not been impacted…due to groundwater usage" without further elaboration. For instance, how is "impacted" defined—does it refer to less flow in the creek, or degraded water quality? What are the specific "stream conditions" being referred to? Furthermore, the well readings presented in the hydrographs appear to be twice yearly measurements; were they measured on the same day every year? If not, how was this discrepancy accounted for in the GSA's comparison of groundwater elevation between different years? How was climatic variability between years accounted for? As mentioned above, streamflow depletions don't manifest as an "annual" impact, nor does groundwater usage remain constant throughout a whole water year – how did the analysis account for impacts to stream conditions that occur on a daily, weekly or monthly time-step. Finally, please explain the analysis method from which you conclude groundwater elevations have been "consistent" over the past thirty years. Wells 31S/12E-03P01, 31S/12E-10F03, 31S/13E-17Q04, as well as others appear to show trends of lower spring high elevations and/or lower fall low elevations for groundwater elevation over time, or at best appear inconclusive with regard to historical trends.

NMFS June 3, 2021 comment #7 (p. 32): "The draft Chapter 8 includes no information or analysis that supports the assertion that "maintaining groundwater levels close to historically observed ranges will continue to support groundwater dependent ecosystems." As noted above, there is an assumption embedded within the assertion that current groundwater levels support groundwater dependent ecosystems; this has not been supported by any data or analysis because such information is not presented in the draft document. Managing groundwater levels at historical lows is likely to adversely affect ESA-listed steelhead, and designated critical habitat for this species. To be consistent with the requirements of SGMA, the GSAs must develop minimum thresholds that are likely to avoid adversely impacting steelhead, as well as other GDE."

GSA Response: *"The statement "maintaining groundwater levels close to historically observed ranges will continue to support groundwater dependent ecosystems." is intended to apply to SLO Creek, where there have been no trends of declining GW levels. If WLs have not declined, and fish populations have existed during the period of record, it is argued that by extension, if GW levels continue at levels approximately equal to those observed in the past 30 years, then groundwater management will not have allowed conditions that lead to significant or unreasonable deletion of interconnected surface water. Conditions in Corral de Piedras Creek will be better characterized after the implementation of the proposed monitoring plan discussed in Chapter 7 and in the Stillwater TM on GDEs."*

NMFS Final Draft GSP response: As noted earlier, the assertion that groundwater levels have not declined during the period of record is suspect without further explanation, especially when several groundwater hydrographs appear to show the opposite. In addition, the GSA response maintains that GDEs have been supported in the past and are currently supported by historically observed groundwater levels. What information supports this assertion? Were past studies conducted? Past monitoring? Finally, the argument that since fish populations have "existed" during periods of low groundwater elevation, therefore low groundwater levels "will not have allowed conditions that lead to significant or unreasonable deletion of interconnected surface water" is absurd. CCC steelhead populations throughout central and southern California have collapsed during the last several decades due largely to instream habitat degradation caused by, among other things, groundwater pumping (NMFS 2013). The argument offered in the GSA response is not supported by data and inconsistent with basic principles of salmonid population dynamics.

Additional Comments on the Draft Final GSP

Page 8-34: The draft plan states the following:

> "It is not within the scope or capability of this plan to mandate specific instream flow requirements deemed necessary for the recovery of native steelhead populations, such as minimum instream flows or minimum pool depths. Rather, it is the objective to plan for management of groundwater resources such that depletion of interconnected surface water is not significantly increased due to projects or management actions proposed in the plan."

Establishing instream flow requirements deemed necessary for the full *recovery* of CCC steelhead is not within the scope of a GSP. However, SGMA requires that GSAs achieve sustainable groundwater management in their groundwater basins by 2042, with sustainable groundwater management defined as the "management and use of groundwater in a manner that can be maintained during the planning and implementation horizon without causing undesirable results."[3] Thus, the objective of the GSP, all SGMA-related groundwater management activities, should be to achieve sustainable groundwater management, not to manage groundwater resources "such that depletion of interconnected surface water is not significantly increased due to projects or management actions proposed in the plan" as described above. For the purpose of meeting SGMA requirements, the important consideration is whether significant and unreasonable impacts to beneficial uses of surface water that result from groundwater extraction will be avoided during the planning and implementation horizon. Protecting identified surface water beneficial uses (e.g., spawning and early development, migration, and cold-water fisheries) within the SLO Valley Basin is critically important to CCC steelhead survival, and we recommend the final GSP establish minimum thresholds and measurable objectives that appropriately protect them.

A similarly problematic sentence appears at the bottom of page 8-34:

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[3] https://water.ca.gov/-/media/DWR-Website/Web-Pages/Programs/Groundwater-Management/Sustainable-Groundwater-Management/Best-Management-Practices-and-Guidance-Documents/Files/BMP-6-Sustainable-Management-Criteria-DRAFT_ay_19.pdf

> “If groundwater elevations in the vicinity of a stream are maintained such that the direction and magnitude of hydraulic gradient between the creek and the aquifer are not significantly changed, it follows that the flux between stream and aquifer will not be significantly impacted.”

This sentence again misconstrues the requirement of SGMA regulations that undesirable results must be avoided in order to achieve sustainable groundwater management. Whether the groundwater/surface water hydraulic gradient are not significantly changed does not inform whether groundwater pumping is impacting beneficial uses of surface water, nor does any conclusion that the stream/aquifer flux will not be impacted. The GSP should clarify how this statement relates to avoiding significant and unreasonable impacts to surface water beneficial uses caused by groundwater pumping.

If you have any questions or concerns regarding this letter, please contact Mr. Mark Capelli (805) 963-6478 in our Santa Barbara office, or Mr. Rick Rogers (707) 578-8552; rick.rogers@noaa.gov) our Santa Rosa Office.

Sincerely,

Anthony P. Spina
South Coast Branch Chief
California Coastal Office

Cc:

Kristie Klose, USFS, Fisheries Biologist, Los Padres National Forest (kristieaklose@fs.fed.us)
Angela Murvine, CDFW Statewide SGMA Coordinator (Angela.Murvine@wildlife.ca.gov)
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Ronnie Glick, Resource Ecologist, California Department of Parks and Recreation (Ronnie.Glick@parks.ca.gov)

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Central Coast Salmon Enhancement, Inc. dba Creek Lands Conservation

9-19-2021

To whom it may concern:

Creek Lands Conservation (CLC) previously submitted comments on July 22, 2021 for drafts of GSP chapters. We have reviewed responses to those comments, as well as subsequent revisions that are in the Public Draft GSP. We are pleased to see some of the comments have resulted in changes, but there are concerns that have still not been addressed to our satisfaction.

Creek Lands has also reviewed new comments from NMFS, dated September 9, 2021 for this Draft GSP. We generally concur with the concerns expressed in that letter and would like to see responses to those comments.

<u>Comments</u>

There appears to be some disagreement about whether the GSP should include surface water sustainability indicators in a groundwater sustainability plan. CLC's position is that there is a place for surface water indicators in the GSP, or at least the GSP should include a more detailed defense of how Sustainability Indicators (SI) will adequately protect Interconnected Surface Water (ISW) and Groundwater Dependent Ecosystems (GDEs) from impacts caused by groundwater management actions, especially near the Minimum Thresholds (MT).

The nexus between groundwater and surface water is clearly acknowledged by SGMA and groundwater management can have a direct influence on ISW depletion. Therefore, Sustainability Indicators should capture the impacts of groundwater management actions on the beneficial uses of ISW, including GDEs. Unless a clear relationship between the SLO Basin's groundwater levels and ISW depletion is established, the GSA will not have a GSP that can prevent groundwater management actions from unreasonably impacting GDEs or the beneficial uses of ISW. As it is currently written, the Public Draft GSP does not provide an ISW Sustainability Indicator that will perform well enough to prevent ISW depletion that produces undesirable results.

Comment 1

The statement defining undesirable results for the depletion of ISW is still inadequate:

> "*The Basin will be considered to have undesirable results if any of the representative wells monitoring interconnected surface water display exceedances of the minimum threshold values for two consecutive Fall measurements.*"

Creek Lands addressed this statement in our previous comments, including a detailed description of the ways in which this indicator could fail to detect undesirable results. Two consecutive fall measurements will not necessarily detect the changes in ISW depletion that can result in impacts to GDEs or threatened species in the creeks. The time and spatial scales of the Sustainability Indicator need to be similar to the time and spatial scales of the potential impacts. A single day of creek drying, if attributable to groundwater management actions, could lead to undesirable results but would not necessarily be detected using the definition above. A definition that uses a higher resolution groundwater measurement is requested if a surface water flow indicator cannot be used.

Comment 2 (Follow-up for response to Comment 4 in CLC's July 22, 2021 letter)

Creek Lands understands the concept of Darcy's Law and its implications for the creeks in the SLO Basin. There are certainly groundwater levels at which the gradient from the groundwater elevation to the surface water elevation in the creeks is sufficient to support GDEs. However, the GSP does not provide enough evidence that the hydraulic gradient at the historically low groundwater levels is a level that will avoid undesirable results. The MTs should be set higher until the GSA has more confidence about the relationship between the hydraulic gradient and ISW depletion.

Creek Lands Conservation appreciates the time and effort that has gone into preparing this draft of the GSP, as well as the time taken to engage with comments and accept feedback. We hope that our comments have been useful to the GSA and to stakeholders in this process. Responses to or questions about out comments are welcome, and you may reach out to us using the contact information below.

Sincerely,

Timothy Delany
Hydrologist
tim@creeklands.org
Office: (805) 473-8221

September 19, 2021

San Luis Obispo Valley Groundwater Basin Groundwater Sustainability Agencies

Submitted via web: https://portal.slowaterbasin.com/comment/new

Re: Public Comment Letter for San Luis Obispo Valley Basin Draft GSP

Dear Chung-te "Dick" Tzou,

On behalf of the above-listed organizations, we appreciate the opportunity to comment on the Draft Groundwater Sustainability Plan (GSP) for the San Luis Obispo Valley Basin being prepared under the Sustainable Groundwater Management Act (SGMA). Our organizations are deeply engaged in and committed to the successful implementation of SGMA because we understand that groundwater is critical for the resilience of California's water portfolio, particularly in light of changing climate. Under the requirements of SGMA, Groundwater Sustainability Agencies (GSAs) must consider the interests of all beneficial uses and users of groundwater, such as domestic well owners, environmental users, surface water users, federal government, California Native American tribes and disadvantaged communities (Water Code 10723.2).

As stakeholder representatives for beneficial users of groundwater, our GSP review focuses on how well disadvantaged communities, tribes, climate change, and the environment were addressed in the GSP. While we appreciate that some basins have consulted us directly via focus groups, workshops, and working groups, we are providing public comment letters to all GSAs as a means to engage in the development of 2022 GSPs across the state. Recognizing that GSPs are complicated and resource intensive to develop, the intention of this letter is to provide constructive stakeholder feedback that can improve the GSP prior to submission to the State.

Based on our review, we have significant concerns regarding the treatment of key beneficial users in the Draft GSP and consider the GSP to be **insufficient** under SGMA. We highlight the following findings:

1. Beneficial uses and users **are not sufficiently** considered in GSP development.
    a. Human Right to Water considerations **are not sufficiently** incorporated.
    b. Public trust resources **are not sufficiently** considered.
    c. Impacts of Minimum Thresholds, Measurable Objectives and Undesirable Results on beneficial uses and users **are not sufficiently** analyzed.
2. Climate change **is not sufficiently** considered.

3. Data gaps **are not sufficiently** identified and the GSP **needs additional plans** to eliminate them.
4. Projects and Management Actions **do not sufficiently consider** potential impacts or benefits to beneficial uses and users.

Our specific comments related to the deficiencies of the San Luis Obispo Valley Basin Draft GSP along with recommendations on how to reconcile them, are provided in detail in **Attachment A.**

Please refer to the enclosed list of attachments for additional technical recommendations:

Attachment A	GSP Specific Comments
Attachment B	SGMA Tools to address DAC, drinking water, and environmental beneficial uses and users
Attachment C	Freshwater species located in the basin
Attachment D	The Nature Conservancy's "Identifying GDEs under SGMA: Best Practices for using the NC Dataset"

Thank you for fully considering our comments as you finalize your GSP.

Best Regards,

Ngodoo Atume
Water Policy Analyst
Clean Water Action/Clean Water Fund

J. Pablo Ortiz-Partida, Ph.D.
Western States Climate and Water Scientist
Union of Concerned Scientists

Samantha Arthur
Working Lands Program Director
Audubon California

Danielle V. Dolan
Water Program Director
Local Government Commission

E.J. Remson
Senior Project Director, California Water Program
The Nature Conservancy

Melissa M. Rohde
Groundwater Scientist
The Nature Conservancy

Attachment A

Specific Comments on the San Luis Obispo Valley Basin Draft Groundwater Sustainability Plan

1. Consideration of Beneficial Uses and Users in GSP development

Consideration of beneficial uses and users in GSP development is contingent upon adequate identification and engagement of the appropriate stakeholders. The (A) identification, (B) engagement, and (C) consideration of disadvantaged communities, drinking water users, tribes, groundwater dependent ecosystems, streams, wetlands, and freshwater species are essential for ensuring the GSP integrates existing state policies on the Human Right to Water and the Public Trust Doctrine.

A. Identification of Key Beneficial Uses and Users

Disadvantaged Communities, Drinking Water Users, and Tribes

The identification of Disadvantaged Communities (DACs), drinking water users, and tribes is **insufficient**. We note the following deficiencies with the identification of these key beneficial users.

- The GSP states in the Communication and Engagement Plan (Appendix E) that the city of San Luis Obispo is recognized as a DAC and references the DWR Disadvantaged Communities Mapping Tool. The GSP however does not show the city boundaries on a map or give the population of the DAC area.

- The GSP provides a map of domestic well density in Figure 3-5 but fails to provide depth of these wells (such as minimum well depth, average well depth, or depth range) within the basin.

- The GSP fails to identify the population dependent on groundwater as their source of drinking water in the basin. Specifics are not provided on how much the DAC community relies on a particular water supply (e.g., what percentage is supplied by groundwater).

These missing elements are required for the GSA to fully understand the specific interests and water demands of these beneficial users, to support the development of water budgets using the best available information, and to support the development of sustainable management criteria and projects and management actions that are protective of these users.

RECOMMENDATIONS
• Provide a map of the boundaries of San Luis Obispo, the recognized DAC in the basin. Provide the population of the DAC. • Include a map showing domestic well locations and average well depth across the basin.

- Identify the sources of drinking water for DAC members, including an estimate of how many people rely on groundwater (e.g., domestic wells, state small water systems, and public water systems).

Interconnected Surface Waters

The identification of Interconnected Surface Waters (ISW) is **insufficient**, due to lack of clarity around the monitoring well data (spatial and temporal) used to map interconnected stream reaches.

The GSP states that the groundwater and surface water are generally connected in the San Luis Valley and generally disconnected in the Edna Valley, but only two wells and stream gauges are mentioned in the assessment in that area. More data is needed to make these claims. The plan concludes that no surface water depletion has been caused by groundwater decline in the basin. This statement is not supported by sufficient spatial and temporal data based on the location of groundwater wells and stream gauges in the basin and the frequency with which they have been sampled.

The GSP states (p. 5-26): "In cases where average springtime water levels were greater than the elevation of the adjacent San Luis Obispo Creek channel, the stream reach was considered as potentially 'gaining'. In cases where average springtime water levels were below the adjacent channel elevation, the stream reach was considered 'losing' and potentially 'disconnected'." The GSP implies with this statement that losing streams equate to disconnected streams, but this is not true because losing reaches are still connected with the saturated zone. The regulations [23 CCR §351(o)] define ISW as "surface water that is hydraulically connected at any point by a continuous saturated zone to the underlying aquifer and the overlying surface water is not completely depleted". "At any point" has both a spatial and temporal component. Even short durations of interconnections of groundwater and surface water can be crucial for surface water flow and supporting environmental users of groundwater and surface water.

RECOMMENDATIONS

- Provide more discussion in the GSP about the groundwater elevation data used to verify interconnected reaches. Include a map of the interpolated groundwater elevations and spatial extent of groundwater monitoring wells used to produce the map.
- On Figure 5-16 (Losing and Gaining Reaches Within the Basin), also denote interconnected and disconnected reaches within the basin. Clarify in the text that losing reaches do not equate to disconnected reaches.
- On Figure 5-16, clearly label the areas with data gaps. While the GSP identifies data gaps in the text, we recommend that the GSP considers any segments with data gaps as potential ISWs and clearly marks them as such on maps provided in the GSP.

Groundwater Dependent Ecosystems

The identification of Groundwater Dependent Ecosystems (GDEs) is **insufficient**, due to a lack of comprehensive, systematic analysis of the basin's GDEs.

The GSP took initial steps to identify and map GDEs using the Natural Communities Commonly Associated with Groundwater dataset (NC dataset) and other sources. However, we found that some mapped features in the NC dataset were improperly disregarded, as described below.

- NC dataset polygons were incorrectly removed based on groundwater levels that were greater than 30-ft in 2019, a single point in time. This is a technically incorrect approach since groundwater levels fluctuate over seasonal and interannual time scales due to California's Mediterranean climate and intensifying flood and drought events due to climate change. Justifying the removal of NC dataset polygons solely based on this criterion does not acknowledge that groundwater levels temporally vary and the fact that many plant species within GDEs can access groundwater depths beyond 30-feet or have adapted water stress strategies to deal with intermittent periods of deep groundwater levels. Using this methodology disregards groundwater fluctuations and may result in the omission of ecosystems that are groundwater dependent.
- The GSP is not clear on its use of depth thresholds to analyze GDEs. The GSP states (p. 5-32): "Oak woodlands were considered potentially groundwater dependent due to their deep rooting depths (up to 70 feet (Lewis, 1964))." However, the next sentence is: "Potential vegetation and wetland GDEs were retained if the underlying depth to water in 2019 was inferred to be 30 feet or shallower based on the existing well network (Figure 5-17)."

We commend the GSA for listing special-status species and sensitive natural communities (Appendix F, Table 1) and a summary of GDE types in the basin (Appendix F, Table 2) using TNC's freshwater species list and Critical Species Lookbook, among other sources.

RECOMMENDATIONS
• Develop and describe a systematic approach for analyzing the basin's GDEs. For example, provide a map of the NC Dataset. On the map, label polygons retained, removed, or added to/from the NC dataset (include the removal reason if polygons are not considered potential GDEs, or include the data source if polygons are added). Discuss how local groundwater data was used to verify whether polygons in the NC Dataset are supported by groundwater in an aquifer. Refer to Attachment D of this letter for best practices for using local groundwater data to verify whether polygons in the NC Dataset are supported by groundwater in an aquifer. • Clarify the use of depth thresholds in the GDE analysis. Refer to Attachment B for more information on TNC's plant rooting depth database. Deeper thresholds are necessary for plants that have reported maximum root depths that exceed the averaged 30-ft threshold, such as valley oak (*Quercus lobata*). We recommend that the reported max rooting depth for these deeper-rooted plants be used. For example, a depth-to-groundwater threshold of 80 feet should be used instead of the 30-ft threshold, when verifying whether valley oak polygons from the NC Dataset are connected to groundwater. It is important to re-emphasize that actual rooting depth data are limited and will depend on the plant species and site-specific conditions such as soil and aquifer types, and availability to other water sources.

- Use depth-to-groundwater data from multiple seasons and water year types (e.g., wet, dry, average, drought) to determine the range of depth to groundwater around NC dataset polygons. We recommend that a baseline period (10 years from 2005 to 2015) be established to characterize groundwater conditions over multiple water year types. Refer to Attachment D of this letter for best practices for using local groundwater data to verify whether polygons in the NC Dataset are supported by groundwater in an aquifer.

- Provide depth-to-groundwater contour maps, noting the best practices presented in Attachment D. Specifically, ensure that the first step is contouring groundwater elevations, and then subtracting this layer from land surface elevations from a digital elevation model (DEM) to estimate depth-to-groundwater contours across the landscape.

- If insufficient data are available to describe groundwater conditions within or near polygons from the NC dataset, include those polygons as "Potential GDEs" in the GSP until data gaps are reconciled in the monitoring network.

Native Vegetation and Managed Wetlands

Native vegetation and managed wetlands are water use sectors that are required[1,2] to be included in the water budget. The integration of native vegetation into the water budget is **insufficient**. The GSP states that native vegetation is one of the land use types included in developing the water budget. However, the water budget did not include a separate item for the current, historical, and projected demands of native vegetation. The omission of explicit water demands for native vegetation is problematic because key environmental uses of groundwater are not being accounted for as water supply decisions are made using this budget, nor will they likely be considered in project and management actions. Managed wetlands are not mentioned in the GSP, so it is not known whether or not they are present in the basin.

RECOMMENDATIONS

- Quantify and present all water use sector demands in the historical, current, and projected water budgets with individual line items for each water use sector, including native vegetation.

- State whether or not there are managed wetlands in the basin. If there are, ensure that their groundwater demands are included as separate line items in the historical, current, and projected water budgets.

[1] "'Water use sector' refers to categories of water demand based on the general land uses to which the water is applied, including urban, industrial, agricultural, managed wetlands, managed recharge, and native vegetation." [23 CCR §351(al)]

[2] "The water budget shall quantify the following, either through direct measurements or estimates based on data: (3) Outflows from the groundwater system by water use sector, including evapotranspiration, groundwater extraction, groundwater discharge to surface water sources, and subsurface groundwater outflow." [23 CCR §354.18]

B. Engaging Stakeholders

Stakeholder Engagement during GSP development

Stakeholder engagement during GSP development is **insufficient**, based on lack of targeted engagement and outreach to environmental stakeholders. The Communication and Engagement Plan (Appendix E) identifies environmental users as stakeholders but does not include targeted engagement opportunities for them, and only provides details on engagement opportunities for *all* stakeholders listed. Therefore, SGMA's requirement for public notice and engagement of stakeholders[3] is not fully met by the description in the Stakeholder Communication and Engagement Plan.

We commend the GSAs for targeted outreach and engagement to DACs in the basin. These opportunities include hosting informational events at local Farmers Markets, promoting meetings and updates around city kiosks and places where utility bills are paid, the parks and recreation departments where after school programs take place, and the senior citizens center. The Communication and Engagement Plan also includes general stakeholder engagement such as access to public meetings, access to SGMA-related material and GSP development notifications in non-English languages, surveys and workshops.

We also commend the GSAs for engaging with the Northern Chumash Tribe, which encompasses the County area. The Communication and Engagement Plan refers to DWR's Engagement with Tribal Governments Guidance Document.

The Communication and Engagement Plan does not include a plan for continued opportunities for engagement through the *implementation* phase of the GSP targeted to DACs, domestic well owners, tribes, and environmental stakeholders.

RECOMMENDATIONS

- In the Communication and Engagement Plan, describe outreach and engagement targeted specifically to environmental stakeholders.
- In the Communication and Engagement Plan, describe active and targeted outreach to engage DAC members, domestic well owners, tribes, and environmental stakeholders throughout the GSP *implementation* phase. Refer to Attachment B for specific recommendations on how to actively engage stakeholders during all phases of the GSP process.
- Include a map showing the jurisdictional boundaries of tribal lands within the basin.

[3] "A communication section of the Plan shall include a requirement that the GSP identify how it encourages the active involvement of diverse social, cultural, and economic elements of the population within the basin." [23 CCR §354.10(d)(3)]

C. Considering Beneficial Uses and Users When Establishing Sustainable Management Criteria and Analyzing Impacts on Beneficial Uses and Users

The consideration of beneficial uses and users when establishing sustainable management criteria (SMC) is **insufficient**. The consideration of potential impacts on all beneficial users of groundwater in the basin are required when defining undesirable results[4] and establishing minimum thresholds.[5,6]

Disadvantaged Communities and Drinking Water Users

For chronic lowering of groundwater levels, the GSP describes impacts to domestic drinking water wells when defining undesirable results, and the GSP describes how the existing minimum threshold groundwater levels are consistent with avoiding undesirable results in the basin. These are described through an analysis presented in the GSP (p. 8-15) to evaluate potential water level of minimum thresholds compared to the depths of private domestic wells identified in County data. The basin-wide fall 2015 groundwater elevations were mapped and compared to the total depths of domestic wells in the County's well permitting database.

The GSP does not however, specifically analyze direct and indirect impacts on DACs, drinking water users and tribes when defining undesirable results or evaluate the cumulative or indirect impacts of proposed minimum thresholds on these stakeholders.

The GSP states that the constituents of concern (COCs) in the basin are total dissolved solids (TDS), nitrate, arsenic, boron, and volatile organic compounds tetrachloroethylene (PCE) and trichloroethylene (TCE). The minimum thresholds for TDS, nitrate, arsenic, boron, PCE and TCE are presented in Table 8-3 and are based on the primary or secondary maximum contaminant limit (MCL). No minimum threshold is set for boron.

For degraded water quality, the GSP only includes a very general discussion of indirect impacts to drinking water users when defining undesirable results and evaluating the cumulative or indirect impacts of proposed minimum thresholds. The GSP does not, however, mention or discuss impacts to DACs, drinking water users or tribes, or otherwise consider these stakeholders, when discussing SMC for degraded water quality.

The GSP states that for water quality SMCs, minimum thresholds are equal to measurable objectives. The plan also states that sustainability indicator constituents selected for groundwater quality are total dissolved solids (TDS), nitrate, and arsenic; the GSP excludes the PCE plume, also known as the South San Luis Obispo (SLO) PCE Plume, and a TCE plume, also known as the Buckley Road Area plume. It also excludes selenium which has been observed at concentrations that affect well operations at individual wells in the basin.

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[4] "The description of undesirable results shall include [...] potential effects on the beneficial uses and users of groundwater, on land uses and property interests, and other potential effects that may occur or are occurring from undesirable results." [23 CCR §354.26(b)(3)]

[5] "The description of minimum thresholds shall include [...] how minimum thresholds may affect the interests of beneficial uses and users of groundwater or land uses and property interests." [23 CCR §354.28(b)(4)]

[6] "The description of minimum thresholds shall include [...] how state, federal, or local standards relate to the relevant sustainability indicator. If the minimum threshold differs from other regulatory standards, the agency shall explain the nature of and the basis for the difference." [23 CCR §354.28(b)(5)]

RECOMMENDATIONS
Chronic Lowering of Groundwater Levels ● Describe direct and indirect impacts on DACs and tribes when describing undesirable results and defining minimum thresholds for chronic lowering of groundwater levels (in addition to describing impacts to drinking water users). **Degraded Water Quality** ● Describe direct and indirect impacts on drinking water users, DACs and tribes when defining undesirable results for degraded water quality. For specific guidance on how to consider these users, refer to "Guide to Protecting Water Quality Under the Sustainable Groundwater Management Act."[7] ● Evaluate the cumulative or indirect impacts of proposed minimum thresholds for degraded water quality on drinking water users, DACs, and tribes. ● In Table 8-3, state explicitly what value the minimum thresholds listed are based on (e.g., primary or secondary MCL). ● Select lower values for groundwater quality measurable objectives. ● Include SMC for all constituents of concern within the basin. Ensure they align with federal, state or local drinking water standards[8].

Groundwater Dependent Ecosystems and Interconnected Surface Waters

The GSP only considers GDEs with respect to the depletion of interconnected surface water sustainability indicator, but not the chronic lowering of groundwater levels sustainability indicator. No analysis is done to set SMC that consider GDEs directly dependent on groundwater.

The GSP states the following with respect to the depletion of interconnected surface water SMC (p. 8-37): "The Basin will be considered to have undesirable results if any of the representative wells monitoring interconnected surface water display exceedances of the minimum threshold values for two consecutive Fall measurements." The GSP states further (p. 8-38): "Because there have been no historical groundwater level declines in the ISW RMS [Representative Monitoring Site] wells, the MTs are defined at these three RMSs as the lowest historically observed water level in the period of record."

Establishing minimum thresholds based on the lowest historically observed water level does not consider any impacts on beneficial users and can result in 'significant and unreasonable' impacts. This is especially problematic for GDEs and ISW habitats, since managing the basin to historically low (drought) conditions can result in irreparable harm to these sensitive ecosystems. Groundwater conditions that deplete streamflow and lower groundwater elevations such that GDEs, particularly those with listed species, experience mortality and are unable to perform key life processes (e.g., reproduction, migration) are 'significant and unreasonable'. The GSP does not explain how the chosen minimum thresholds and measurable objectives avoid significant and

[7] Guide to Protecting Water Quality under the Sustainable Groundwater Management Act https://d3n8a8pro7vhmx.cloudfront.net/communitywatercenter/pages/293/attachments/original/1559328858/Guide_to_Protecting_Drinking_Water_Quality_Under_the_Sustainable_Groundwater_Management_Act.pdf?1559328858.

[8] "Degraded Water Quality [...] collect sufficient spatial and temporal data from each applicable principal aquifer to determine groundwater quality trends for water quality indicators, as determined by the Agency, to address known water quality issues." [23 CCR §354.34(c)(4)]

unreasonable effects on surface water beneficial users in the basin, such as the federally threatened South-Central California Coast steelhead.

RECOMMENDATIONS
• When defining undesirable results for chronic lowering of groundwater levels, provide specifics on what biological responses (e.g., extent of habitat, growth, recruitment rates) would best characterize a significant and unreasonable impact to GDEs. Undesirable results to environmental users occur when 'significant and unreasonable' effects on beneficial users are caused by one of the sustainability indicators (i.e., chronic lowering of groundwater levels, degraded water quality, or depletion of interconnected surface water). Thus, potential impacts on environmental beneficial uses and users need to be considered when defining undesirable results[9] in the basin. Defining undesirable results is the crucial first step before the minimum thresholds[10] can be determined. • When defining undesirable results for depletion of interconnected surface water, include a description of potential impacts on instream habitats within ISWs when defining minimum thresholds in the basin[11]. The GSP should confirm that minimum thresholds for ISWs avoid adverse impacts to environmental beneficial users of interconnected surface waters as these environmental users could be left unprotected by the GSP. These recommendations apply especially to environmental beneficial users that are already protected under pre-existing state or federal law[6,12].

2. Climate Change

The SGMA statute identifies climate change as a significant threat to groundwater resources and one that must be examined and incorporated in the GSPs. The GSP Regulations[13] require integration of climate change into the projected water budget to ensure that projects and management actions sufficiently account for the range of potential climate futures.

The integration of climate change into the projected water budget is **insufficient**. The GSP does incorporate climate change into the projected water budget using DWR change factors for 2070. However, the GSP did not consider multiple climate scenarios (e.g., the 2070 extremely wet and extremely dry climate scenarios) in the projected water budget. The GSP should clearly and transparently incorporate the extremely wet and dry scenarios provided by DWR into projected water budgets or select

[9] "The description of undesirable results shall include [...] potential effects on the beneficial uses and users of groundwater, on land uses and property interests, and other potential effects that may occur or are occurring from undesirable results". [23 CCR §354.26(b)(3)]

[10] The description of minimum thresholds shall include [...] how minimum thresholds may affect the interests of beneficial uses and users of groundwater or land uses and property interests." [23 CCR §354.28(b)(4)]

[11] "The minimum threshold for depletions of interconnected surface water shall be the rate or volume of surface water depletions caused by groundwater use that has adverse impacts on beneficial uses of the surface water and may lead to undesirable results." [23 CCR §354.28(c)(6)]

[12] Rohde MM, Seapy B, Rogers R, Castañeda X, editors. 2019. Critical Species LookBook: A compendium of California's threatened and endangered species for sustainable groundwater management. The Nature Conservancy, San Francisco, California. Available at: https://groundwaterresourcehub.org/public/uploads/pdfs/Critical_Species_LookBook_91819.pdf

[13] "Each Plan shall rely on the best available information and best available science to quantify the water budget for the basin in order to provide an understanding of historical and projected hydrology, water demand, water supply, land use, population, climate change, sea level rise, groundwater and surface water interaction, and subsurface groundwater flow." [23 CCR §354.18(e)]

more appropriate extreme scenarios for their basins. While these extreme scenarios may have a lower likelihood of occurring, their consequences could be significant, therefore they should be included in groundwater planning.

The GSP includes climate change into precipitation, evapotranspiration, and surface water flow terms of the projected water budget. However, the GSP does not calculate a sustainable yield based on the projected water budget with climate change incorporated. If the water budgets are incomplete, including the omission of extremely wet and dry scenarios, and sustainable yield is not calculated based on climate change projections, then there is increased uncertainty in virtually every subsequent calculation used to plan for projects, derive measurable objectives, and set minimum thresholds. Plans that do not adequately include climate change projections may underestimate future impacts on vulnerable beneficial users of groundwater such as ecosystems, DACs, and domestic well owners.

RECOMMENDATIONS

- Integrate climate change, including extremely wet and dry scenarios, into all elements of the projected water budget to form the basis for development of sustainable management criteria and projects and management actions.
- Calculate sustainable yield based on the projected water budget with climate change incorporated.
- Incorporate climate change scenarios into projects and management actions.

3. Data Gaps

The consideration of beneficial users when establishing monitoring networks is **insufficient**, due to lack of RMSs in the monitoring network that represent water quality conditions and shallow groundwater elevations around DACs and domestic wells in the basin. These beneficial users of groundwater may remain unprotected by the GSP without adequate monitoring and identification of data gaps in the shallow aquifer. The Plan therefore fails to meet SGMA's requirements for the monitoring network[14].

The six groundwater level monitoring sites and five surface water flow monitoring sites appear sufficient to fill shallow monitoring well data gaps around GDEs and ISWs in the monitoring network. The GDE Technical Memo (Appendix F) states: "Wells where the screened depth is unknown may be measuring groundwater levels for deeper aquifers that are unconnected to the shallow groundwater system and thus groundwater deeper than 30 ft for a given well may not reflect the absence of shallow groundwater, but instead reflects the absence of data. To determine the hydraulic connectivity between potential perched aquifers to the regional aquifer, additional monitoring with nested piezometers could be utilized." This noted data gap appears to be filled by the additional monitoring sites, but the GSP does not explicitly state this.

[14] "The monitoring network objectives shall be implemented to accomplish the following: [...] (2) Monitor impacts to the beneficial uses or users of groundwater." [23 CCR §354.34(b)(2)]

RECOMMENDATIONS

- Provide maps that overlay monitoring well locations with the locations of DACs, domestic wells, and GDEs to clearly identify potentially impacted areas. Increase the number of RMSs across the subbasin for all groundwater condition indicators. Prioritize proximity to DACs and drinking water users when identifying new RMSs.
- State in the GSP whether the additional six groundwater level monitoring sites and five surface water flow monitoring sites will fill the data gap noted in Appendix F.
- Determine what biological monitoring can be used to assess the potential for significant and unreasonable impacts to GDEs or ISWs due to groundwater conditions in the subbasin. The GSP states (p. 5-29): "Additional field reconnaissance is necessary to verify the existence and extent of these potential GDEs and may be considered as part of the monitoring effort for future planning efforts." No further detail, however, is provided.
- Clarify the symbols used on Figure 7-1 (Water Level Monitoring Network). Many wells are shown on this map but only a few have the teal box representing chronic water level decline monitoring well locations.

4. Addressing Beneficial Users in Projects and Management Actions

The consideration of beneficial users when developing projects and management actions is **insufficient**, due to the failure to completely identify benefits or impacts of identified projects and management actions to beneficial users of groundwater such as DACs and drinking water users.

We commend the GSAs for including projects and management actions with explicit benefits to the environment, particularly the Price Canyon Discharge Relocation. The GSP does not discuss the manner in which DACs and drinking water users may be benefitted or impacted by identified projects and management actions. Therefore, potential project and management actions may not protect these beneficial users. Groundwater sustainability under SGMA is defined not just by sustainable yield, but by the avoidance of undesirable results for *all* beneficial users.

RECOMMENDATIONS

- For DACs and domestic well owners, include discussion of a drinking water well impact mitigation program to proactively monitor and protect drinking water wells through GSP implementation. Refer to Attachment B for specific recommendations on how to implement a drinking water well mitigation program.
- For DACs and domestic well owners, include a discussion of whether potential impacts to water quality from projects and management actions could occur and how the GSA plans to mitigate such impacts.

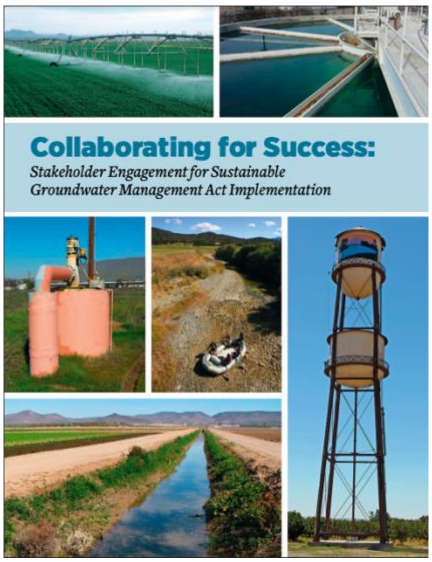
- Recharge ponds, reservoirs, and facilities for managed stormwater recharge can be designed as multiple-benefit projects to include elements that act functionally as wetlands and provide a benefit for wildlife and aquatic species. For guidance on how to integrate multi-benefit recharge projects into your GSP, refer to the "Multi-Benefit Recharge Project Methodology Guidance Document"[15].
- Develop management actions that incorporate climate and water delivery uncertainties to address future water demand and prevent future undesirable results.

[15] The Nature Conservancy. 2021. Multi-Benefit Recharge Project Methodology for Inclusion in Groundwater Sustainability Plans. Sacramento. Available at: https://groundwaterresourcehub.org/sgma-tools/multi-benefit-recharge-project-methodology-guidance/

Attachment B

SGMA Tools to address DAC, drinking water, and environmental beneficial uses and users

Stakeholder Engagement and Outreach



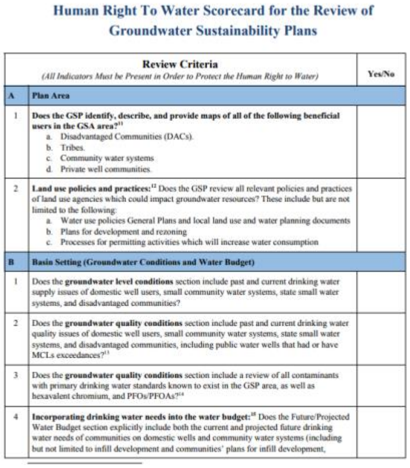
Clean Water Action, Community Water Center and Union of Concerned Scientists developed a guidance document called Collaborating for success: Stakeholder engagement for Sustainable Groundwater Management Act Implementation. It provides details on how to conduct targeted and broad outreach and engagement during Groundwater Sustainability Plan (GSP) development and implementation. Conducting a targeted outreach involves:

- Developing a robust Stakeholder Communication and Engagement plan that includes outreach at frequented locations (schools, farmers markets, religious settings, events) across the plan area to increase the involvement and participation of disadvantaged communities, drinking water users and the environmental stakeholders.

- Providing translation services during meetings and technical assistance to enable easy participation for non-English speaking stakeholders.

- GSP should adequately describe the process for requesting input from beneficial users and provide details on how input is incorporated into the GSP.

The Human Right to Water

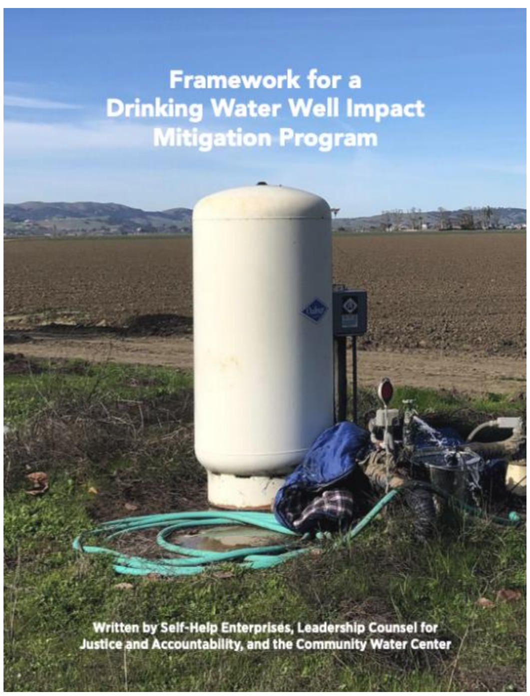


Human Right To Water Scorecard for the Review of Groundwater Sustainability Plans

	Review Criteria *(All Indicators Must be Present in Order to Protect the Human Right to Water)*	Yes/No
A	**Plan Area**	
1	**Does the GSP identify, describe, and provide maps of all of the following beneficial users in the GSA area?**[11] a. Disadvantaged Communities (DACs). b. Tribes. c. Community water systems d. Private well communities.	
2	**Land use policies and practices:**[12] Does the GSP review all relevant policies and practices of land use agencies which could impact groundwater resources? These include but are not limited to the following: a. Water use policies General Plans and local land use and water planning documents b. Plans for development and rezoning c. Processes for permitting activities which will increase water consumption	
B	**Basin Setting (Groundwater Conditions and Water Budget)**	
1	Does the **groundwater level conditions** section include past and current drinking water supply issues of domestic well users, small community water systems, state small water systems, and disadvantaged communities?	
2	Does the **groundwater quality conditions** section include past and current drinking water quality issues of domestic well users, small community water systems, state small water systems, and disadvantaged communities, including public water wells that had or have MCLs exceedances?[13]	
3	Does the **groundwater quality conditions** section include a review of all contaminants with primary drinking water standards known to exist in the GSP area, as well as hexavalent chromium, and PFOs/PFOAs?[14]	
4	**Incorporating drinking water needs into the water budget:**[15] Does the Future/Projected Water Budget section explicitly include both the current and projected future drinking water needs of communities on domestic wells and community water systems (including but not limited to infill development and communities' plans for infill development,	

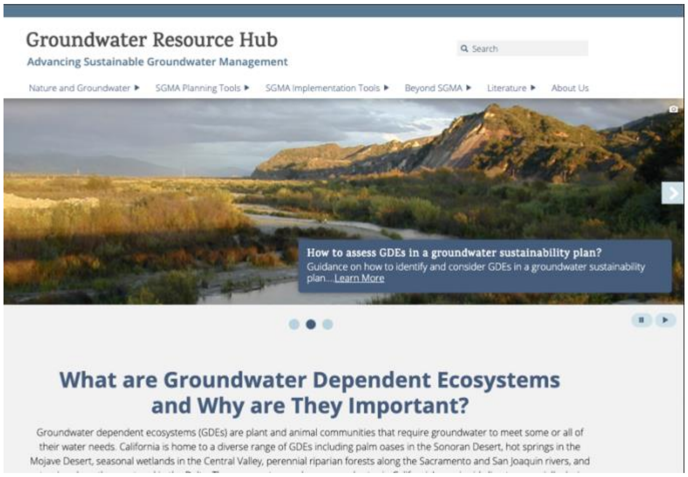
The Human Right to Water Scorecard was developed by Community Water Center, Leadership Counsel for Justice and Accountability and Self Help Enterprises to aid Groundwater Sustainability Agencies (GSAs) in prioritizing drinking water needs in SGMA. The scorecard identifies elements that must exist in GSPs to adequately protect the Human Right to Drinking water.

Drinking Water Well Impact Mitigation Framework



The Drinking Water Well Impact Mitigation Framework was developed by Community Water Center, Leadership Counsel for Justice and Accountability and Self Help Enterprises to aid GSAs in the development and implementation of their GSPs. The framework provides a clear roadmap for how a GSA can best structure its data gathering, monitoring network and management actions to proactively monitor and protect drinking water wells and mitigate impacts should they occur.

Groundwater Resource Hub



The Nature Conservancy has developed a suite of tools based on best available science to help GSAs, consultants, and stakeholders efficiently incorporate nature into GSPs. These tools and resources are available online at GroundwaterResourceHub.org. The Nature Conservancy's tools and resources are intended to reduce costs, shorten timelines, and increase benefits for both people and nature.

Rooting Depth Database

The Plant Rooting Depth Database provides information that can help assess whether groundwater-dependent vegetation are accessing groundwater. Actual rooting depths will depend on the plant species and site-specific conditions, such as soil type and availability of other water sources. Site-specific knowledge of depth to groundwater combined with rooting depths will help provide an understanding of the potential groundwater levels are needed to sustain GDEs.

How to use the database

The maximum rooting depth information in the Plant Rooting Depth Database is useful when verifying whether vegetation in the Natural Communities Commonly Associated with Groundwater (NC Dataset) are connected to groundwater. A 30 ft depth-to-groundwater threshold, which is based on averaged global rooting depth data for phreatophytes[1], is relevant for most plants identified in the NC Dataset since most plants have a max rooting depth of less than 30 feet. However, it is important to note that deeper thresholds are necessary for other plants that have reported maximum root depths that exceed the averaged 30 feet threshold, such as valley oak (*Quercus lobata*), Euphrates poplar (*Populus euphratica*), salt cedar (*Tamarix spp.*), and shadescale (*Atriplex confertifolia*). The Nature Conservancy advises that the reported max rooting depth for these deeper-rooted plants be used. For example, a depth-to groundwater threshold of 80 feet should be used instead of the 30 ft threshold, when verifying whether valley oak polygons from the NC Dataset are connected to groundwater. It is important to re-emphasize that actual rooting depth data are limited and will depend on the plant species and site-specific conditions such as soil and aquifer types, and availability to other water sources.

The Plant Rooting Depth Database is an Excel workbook composed of four worksheets:

1. California phreatophyte rooting depth data (included in the NC Dataset)
2. Global phreatophyte rooting depth data
3. Metadata
4. References

How the database was compiled

The Plant Rooting Depth Database is a compilation of rooting depth information for the groundwater-dependent plant species identified in the NC Dataset. Rooting depth data were compiled from published scientific literature and expert opinion through a crowdsourcing campaign. As more information becomes available, the database of rooting depths will be updated. Please Contact Us if you have additional rooting depth data for California phreatophytes.

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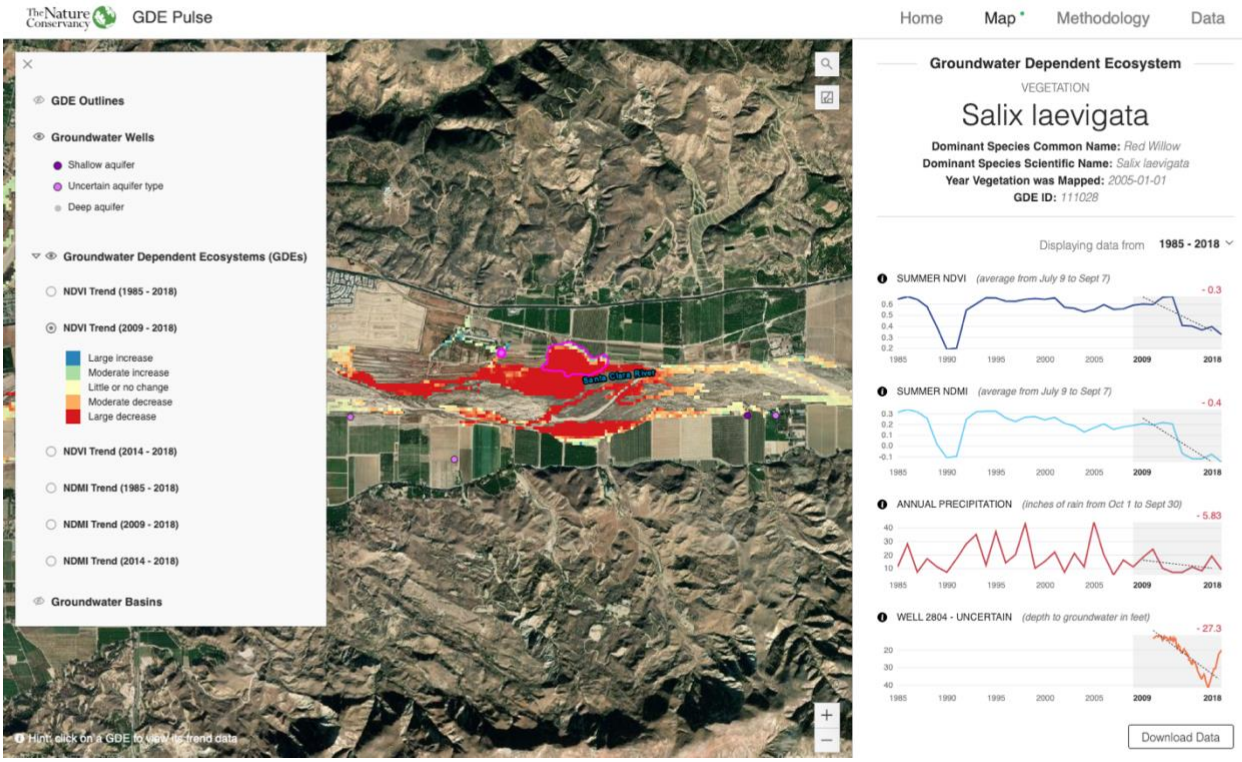
[1] Canadell, J., Jackson, R.B., Ehleringer, J.B. et al. 1996. Maximum rooting depth of vegetation types at the global scale. Oecologia 108, 583–595. https://doi.org/10.1007/BF00329030

GDE Pulse



[GDE Pulse](#) is a free online tool that allows Groundwater Sustainability Agencies to assess changes in groundwater dependent ecosystem (GDE) health using satellite, rainfall, and groundwater data. Remote sensing data from satellites has been used to monitor the health of vegetation all over the planet. GDE pulse has compiled 35 years of satellite imagery from NASA's Landsat mission for every polygon in the Natural Communities Commonly Associated with Groundwater Dataset. The following datasets are available for downloading:

Normalized Difference Vegetation Index (NDVI) is a satellite-derived index that represents the greenness of vegetation. Healthy green vegetation tends to have a higher NDVI, while dead leaves have a lower NDVI. We calculated the average NDVI during the driest part of the year (July - Sept) to estimate vegetation health when the plants are most likely dependent on groundwater.

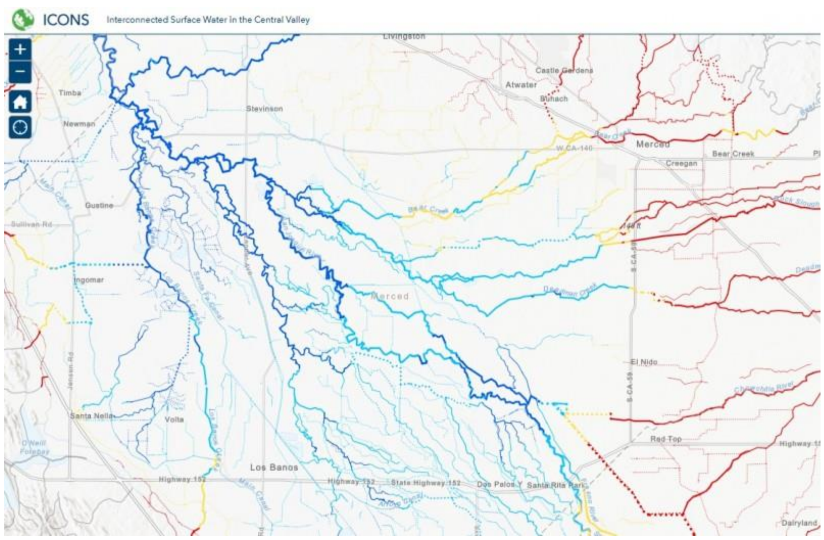
Normalized Difference Moisture Index (NDMI) is a satellite-derived index that represents water content in vegetation. NDMI is derived from the Near-Infrared (NIR) and Short-Wave Infrared (SWIR) channels. Vegetation with adequate access to water tends to have higher NDMI, while vegetation that is water stressed tends to have lower NDMI. We calculated the average NDVI during the driest part of the year (July–September) to estimate vegetation health when the plants are most likely dependent on groundwater.

Annual Precipitation is the total precipitation for the water year (October 1st – September 30th) from the PRISM dataset. The amount of local precipitation can affect vegetation with more precipitation generally leading to higher NDVI and NDMI.

Depth to Groundwater measurements provide an indication of the groundwater levels and changes over time for the surrounding area. We used groundwater well measurements from nearby (<1km) wells to estimate the depth to groundwater below the GDE based on the average elevation of the GDE (using a digital elevation model) minus the measured groundwater surface elevation.

ICONOS Mapper

Interconnected Surface Water in the Central Valley



ICONS maps the likely presence of interconnected surface water (ISW) in the Central Valley using depth to groundwater data. Using data from 2011-2018, the ISW dataset represents the likely connection between surface water and groundwater for rivers and streams in California's Central Valley. It includes information on the mean, maximum, and minimum depth to groundwater for each stream segment over the years with available data, as well as the likely presence of ISW based on the minimum depth to groundwater. The Nature Conservancy developed this database, with guidance and input from expert academics, consultants, and state agencies.

We developed this dataset using groundwater elevation data available online from the California Department of Water Resources (DWR). DWR only provides this data for the Central Valley. For GSAs outside of the valley, who have groundwater well measurements, we recommend following our methods to determine likely ISW in your region. The Nature Conservancy's ISW dataset should be used as a first step in reviewing ISW and should be supplemented with local or more recent groundwater depth data.

Attachment C

Freshwater Species Located in the San Luis Obispo Valley

To assist in identifying the beneficial users of surface water necessary to assess the undesirable result "depletion of interconnected surface waters", Attachment C provides a list of freshwater species located in the San Luis Obispo Valley Basin. To produce the freshwater species list, we used ArcGIS to select features within the California Freshwater Species Database version 2.0.9 within the basin boundary. This database contains information on ~4,000 vertebrates, macroinvertebrates and vascular plants that depend on fresh water for at least one stage of their life cycle. The methods used to compile the California Freshwater Species Database can be found in Howard et al. 2015[1]. The spatial database contains locality observations and/or distribution information from ~400 data sources. The database is housed in the California Department of Fish and Wildlife's BIOS[2] as well as on The Nature Conservancy's science website[3].

Scientific Name	Common Name	Legal Protected Status		
		Federal	State	Other
BIRDS				
Actitis macularius	Spotted Sandpiper			
Actitis macularius	Spotted Sandpiper			
Aechmophorus clarkii	Clark's Grebe			
Aechmophorus clarkii	Clark's Grebe			
Aechmophorus occidentalis	Western Grebe			
Aechmophorus occidentalis	Western Grebe			
Agelaius tricolor	Tricolored Blackbird	Bird of Conservation Concern	Special Concern	BSSC - First priority
Agelaius tricolor	Tricolored Blackbird	Bird of Conservation Concern	Special Concern	BSSC - First priority
Aix sponsa	Wood Duck			
Anas acuta	Northern Pintail			
Anas acuta	Northern Pintail			
Anas americana	American Wigeon			
Anas americana	American Wigeon			
Anas clypeata	Northern Shoveler			
Anas clypeata	Northern Shoveler			
Anas crecca	Green-winged Teal			
Anas crecca	Green-winged Teal			
Anas cyanoptera	Cinnamon Teal			
Anas cyanoptera	Cinnamon Teal			

[1] Howard, J.K. et al. 2015. Patterns of Freshwater Species Richness, Endemism, and Vulnerability in California. PLoSONE, 11(7). Available at: https://journals.plos.org/plosone/article?id=10.1371/journal.pone.0130710

[2] California Department of Fish and Wildlife BIOS: https://www.wildlife.ca.gov/data/BIOS

[3] Science for Conservation: https://www.scienceforconservation.org/products/california-freshwater-species-database

Anas discors	Blue-winged Teal			
Anas discors	Blue-winged Teal			
Anas platyrhynchos	Mallard			
Anas platyrhynchos	Mallard			
Anas platyrhynchos	Mallard			
Anas platyrhynchos	Mallard			
Anas strepera	Gadwall			
Anas strepera	Gadwall			
Anser albifrons	Greater White-fronted Goose			
Anser albifrons	Greater White-fronted Goose			
Ardea alba	Great Egret			
Ardea alba	Great Egret			
Ardea alba	Great Egret			
Ardea herodias	Great Blue Heron			
Ardea herodias	Great Blue Heron			
Aythya affinis	Lesser Scaup			
Aythya affinis	Lesser Scaup			
Aythya americana	Redhead		Special Concern	BSSC - Third priority
Aythya collaris	Ring-necked Duck			
Aythya marila	Greater Scaup			
Botaurus lentiginosus	American Bittern			
Botaurus lentiginosus	American Bittern			
Bucephala albeola	Bufflehead			
Bucephala albeola	Bufflehead			
Bucephala clangula	Common Goldeneye			
Butorides virescens	Green Heron			
Calidris alpina	Dunlin			
Calidris mauri	Western Sandpiper			
Calidris mauri	Western Sandpiper			
Calidris minutilla	Least Sandpiper			
Calidris minutilla	Least Sandpiper			
Chen caerulescens	Snow Goose			
Chen caerulescens	Snow Goose			
Chen rossii	Ross's Goose			
Chen rossii	Ross's Goose			
Chen rossii	Ross's Goose			
Chroicocephalus philadelphia	Bonaparte's Gull			
Chroicocephalus philadelphia	Bonaparte's Gull			
Cistothorus palustris palustris	Marsh Wren			
Cistothorus palustris palustris	Marsh Wren			
Egretta thula	Snowy Egret			

Egretta thula	Snowy Egret			
Egretta thula	Snowy Egret			
Fulica americana	American Coot			
Fulica americana	American Coot			
Fulica americana	American Coot			
Gallinago delicata	Wilson's Snipe			
Gallinago delicata	Wilson's Snipe			
Grus canadensis	Sandhill Crane			
Himantopus mexicanus	Black-necked Stilt			
Himantopus mexicanus	Black-necked Stilt			
Ixobrychus exilis hesperis	Western Least Bittern		Special Concern	BSSC - Second priority
Limnodromus scolopaceus	Long-billed Dowitcher			
Limnodromus scolopaceus	Long-billed Dowitcher			
Lophodytes cucullatus	Hooded Merganser			
Lophodytes cucullatus	Hooded Merganser			
Megaceryle alcyon	Belted Kingfisher			
Megaceryle alcyon	Belted Kingfisher			
Mergus merganser	Common Merganser			
Mergus merganser	Common Merganser			
Numenius americanus	Long-billed Curlew			
Numenius americanus	Long-billed Curlew			
Nycticorax nycticorax	Black-crowned Night-Heron			
Nycticorax nycticorax	Black-crowned Night-Heron			
Oxyura jamaicensis	Ruddy Duck			
Oxyura jamaicensis	Ruddy Duck			
Pelecanus erythrorhynchos	American White Pelican		Special Concern	BSSC - First priority
Pelecanus erythrorhynchos	American White Pelican		Special Concern	BSSC - First priority
Phalacrocorax auritus	Double-crested Cormorant			
Phalacrocorax auritus	Double-crested Cormorant			
Phalacrocorax auritus	Double-crested Cormorant			
Piranga rubra	Summer Tanager		Special Concern	BSSC - First priority
Plegadis chihi	White-faced Ibis		Watch list	
Plegadis chihi	White-faced Ibis		Watch list	

Pluvialis squatarola	Black-bellied Plover			
Pluvialis squatarola	Black-bellied Plover			
Podiceps nigricollis	Eared Grebe			
Podiceps nigricollis	Eared Grebe			
Podilymbus podiceps	Pied-billed Grebe			
Podilymbus podiceps	Pied-billed Grebe			
Porzana carolina	Sora			
Rallus limicola	Virginia Rail			
Rallus limicola	Virginia Rail			
Recurvirostra americana	American Avocet			
Recurvirostra americana	American Avocet			
Setophaga petechia	Yellow Warbler			BSSC - Second priority
Tachycineta bicolor	Tree Swallow			
Tachycineta bicolor	Tree Swallow			
Tringa melanoleuca	Greater Yellowlegs			
Tringa melanoleuca	Greater Yellowlegs			
Tringa semipalmata	Willet			
CRUSTACEANS				
Branchinecta lynchi	Vernal Pool Fairy Shrimp	Threatened	Special	IUCN - Vulnerable
Branchinecta lynchi	Vernal Pool Fairy Shrimp	Threatened	Special	IUCN - Vulnerable
Crangonyx spp.	Crangonyx spp.			
Cyprididae fam.	Cyprididae fam.			
Gammarus spp.	Gammarus spp.			
Hyalella spp.	Hyalella spp.			
FISH				
Oncorhynchus mykiss irideus	Coastal rainbow trout			Least Concern - Moyle 2013
Oncorhynchus mykiss irideus	Coastal rainbow trout			Least Concern - Moyle 2013
Oncorhynchus mykiss - SCCC	South Central California coast steelhead	Threatened	Special Concern	Vulnerable - Moyle 2013
HERPS				
Actinemys marmorata marmorata	Western Pond Turtle		Special Concern	ARSSC
Actinemys marmorata marmorata	Western Pond Turtle		Special Concern	ARSSC
Actinemys marmorata marmorata	Western Pond Turtle		Special Concern	ARSSC

Ambystoma californiense californiense	California Tiger Salamander	Threatened	Threatened	ARSSC
Anaxyrus boreas boreas	Boreal Toad			
Rana boylii	Foothill Yellow-legged Frog	Under Review in the Candidate or Petition Process	Special Concern	ARSSC
Rana draytonii	California Red-legged Frog	Threatened	Special Concern	ARSSC
Rana draytonii	California Red-legged Frog	Threatened	Special Concern	ARSSC
Taricha torosa	Coast Range Newt		Special Concern	ARSSC
Thamnophis hammondii hammondii	Two-striped Gartersnake		Special Concern	ARSSC
Thamnophis sirtalis sirtalis	Common Gartersnake			
Actinemys marmorata marmorata	Western Pond Turtle		Special Concern	ARSSC
Pseudacris regilla	Northern Pacific Chorus Frog			
Rana draytonii	California Red-legged Frog	Threatened	Special Concern	ARSSC
INSECTS & OTHER INVERTS				
Agabus spp.	Agabus spp.			
Antocha spp.	Antocha spp.			
Apedilum spp.	Apedilum spp.			
Atractelmis wawona	Wawona Riffle Beetle		Special	
Baetis spp.	Baetis spp.			
Baetis tricaudatus	A Mayfly			
Blephariceria spp.	Blephariceria spp.			
Brillia spp.	Brillia spp.			
Cheumatopsyche spp.	Cheumatopsyche spp.			
Chironomidae fam.	Chironomidae fam.			
Chironomus spp.	Chironomus spp.			
Corixidae fam.	Corixidae fam.			
Cricotopus spp.	Cricotopus spp.			
Cryptochironomus spp.	Cryptochironomus spp.			
Ephydridae fam.	Ephydridae fam.			
Eubrianax edwardsii				Not on any status lists
Eukiefferiella spp.	Eukiefferiella spp.			
Helochares normatus				Not on any status lists
Hydropsyche spp.	Hydropsyche spp.			
Hydropsychidae fam.	Hydropsychidae fam.			

Hydroptila spp.	Hydroptila spp.			
Laccobius spp.	Laccobius spp.			
Lepidostoma spp.	Lepidostoma spp.			
Marilia flexuosa	A Caddisfly			
Maruina lanceolata				Not on any status lists
Micrasema spp.	Micrasema spp.			
Micropsectra spp.	Micropsectra spp.			
Microtendipes spp.	Microtendipes spp.			
Narpus angustus				Not on any status lists
Ochthebius spp.	Ochthebius spp.			
Optioservus spp.	Optioservus spp.			
Ordobrevia nubifera				Not on any status lists
Parametriocnemus spp.	Parametriocnemus spp.			
Paraphaenocladius spp.	Paraphaenocladius spp.			
Paratanytarsus spp.	Paratanytarsus spp.			
Phaenopsectra spp.	Phaenopsectra spp.			
Polypedilum spp.	Polypedilum spp.			
Rheotanytarsus spp.	Rheotanytarsus spp.			
Simuliidae fam.	Simuliidae fam.			
Simulium spp.	Simulium spp.			
Sperchon spp.	Sperchon spp.			
Sperchontidae fam.	Sperchontidae fam.			
Sympetrum madidum	Red-veined Meadowhawk			
Tanytarsus spp.	Tanytarsus spp.			
Tinodes spp.	Tinodes spp.			
Tricorythodes spp.	Tricorythodes spp.			
Tvetenia spp.	Tvetenia spp.			
MAMMALS				
Castor canadensis	American Beaver			Not on any status lists
Ondatra zibethicus	Common Muskrat			Not on any status lists
MOLLUSKS				
Ferrissia spp.	Ferrissia spp.			
Hydrobiidae fam.	Hydrobiidae fam.			
Menetus opercularis	Button Sprite			CS
Physa spp.	Physa spp.			
Pisidium spp.	Pisidium spp.			
Valvata spp.	Valvata spp.			
PLANTS				
Cirsium fontinale obispoense	Chorro Creek Bog Thistle	Endangered	Endangered	CRPR - 1B.2

Eryngium aristulatum hooveri	Hoover's Coyote-thistle		Special	CRPR - 1B.1
Cirsium fontinale obispoense	Chorro Creek Bog Thistle	Endangered	Endangered	CRPR - 1B.2
Cotula coronopifolia	NA			
Eryngium aristulatum hooveri	Hoover's Coyote-thistle		Special	CRPR - 1B.1
Eryngium aristulatum hooveri	Hoover's Coyote-thistle		Special	CRPR - 1B.1
Persicaria punctata	NA			Not on any status lists
Persicaria punctata	NA			Not on any status lists
Psilocarphus tenellus	NA			
Psilocarphus tenellus	NA			
Salix breweri	Brewer's Willow			
Schoenoplectus acutus occidentalis	Hardstem Bulrush			
Schoenoplectus acutus occidentalis	Hardstem Bulrush			
Veronica anagallis-aquatica	NA			
Veronica anagallis-aquatica	NA			
Veronica anagallis-aquatica	NA			

Attachment D

The Nature Conservancy

July 2019

IDENTIFYING GDEs UNDER SGMA

Best Practices for using the NC Dataset

The Sustainable Groundwater Management Act (SGMA) requires that groundwater dependent ecosystems (GDEs) be identified in Groundwater Sustainability Plans (GSPs). As a starting point, the Department of Water Resources (DWR) is providing the Natural Communities Commonly Associated with Groundwater Dataset (NC Dataset) online[1] to help Groundwater Sustainability Agencies (GSAs), consultants, and stakeholders identify GDEs within individual groundwater basins. To apply information from the NC Dataset to local areas, GSAs should combine it with the best available science on local hydrology, geology, and groundwater levels to verify whether polygons in the NC dataset are likely supported by groundwater in an aquifer (Figure 1)[2]. This document highlights six best practices for using local groundwater data to confirm whether mapped features in the NC dataset are supported by groundwater.

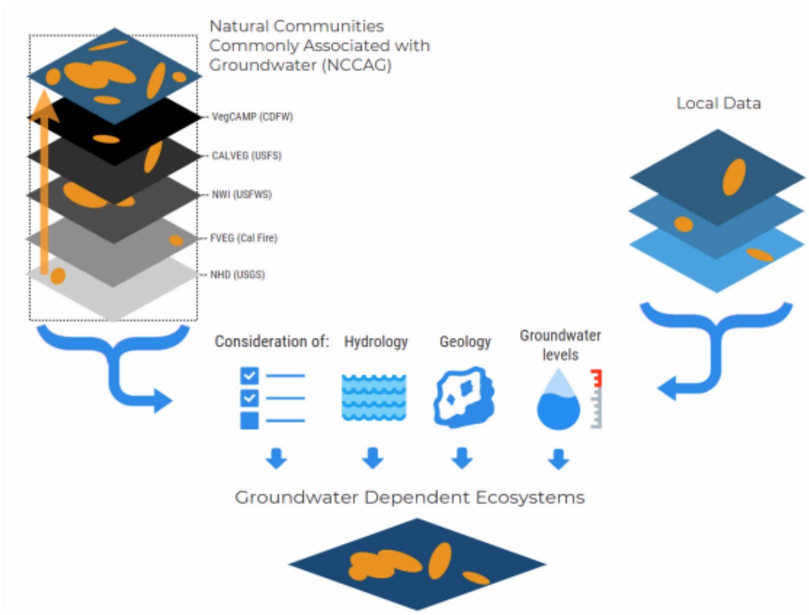


Figure 1. Considerations for GDE identification.
Source: DWR[2]

[1] NC Dataset Online Viewer: https://gis.water.ca.gov/app/NCDatasetViewer/
[2] California Department of Water Resources (DWR). 2018. Summary of the "Natural Communities Commonly Associated with Groundwater" Dataset and Online Web Viewer. Available at: https://water.ca.gov/-/media/DWR-Website/Web-Pages/Programs/Groundwater-Management/Data-and-Tools/Files/Statewide-Reports/Natural-Communities-Dataset-Summary-Document.pdf

The NC Dataset identifies vegetation and wetland features that are good indicators of a GDE. The dataset is comprised of 48 publicly available state and federal datasets that map vegetation, wetlands, springs, and seeps commonly associated with groundwater in California[3]. It was developed through a collaboration between DWR, the Department of Fish and Wildlife, and The Nature Conservancy (TNC). TNC has also provided detailed guidance on identifying GDEs from the NC dataset[4] on the Groundwater Resource Hub[5], a website dedicated to GDEs.

BEST PRACTICE #1. Establishing a Connection to Groundwater

Groundwater basins can be comprised of one continuous aquifer (Figure 2a) or multiple aquifers stacked on top of each other (Figure 2b). In unconfined aquifers (Figure 2a), using the depth-to-groundwater and the rooting depth of the vegetation is a reasonable method to infer groundwater dependence for GDEs. If groundwater is well below the rooting (and capillary) zone of the plants and any wetland features, the ecosystem is considered disconnected and groundwater management is not likely to affect the ecosystem (Figure 2d). However, it is important to consider local conditions (e.g., soil type, groundwater flow gradients, and aquifer parameters) and to review groundwater depth data from multiple seasons and water year types (wet and dry) because intermittent periods of high groundwater levels can replenish perched clay lenses that serve as the water source for GDEs (Figure 2c). Maintaining these natural groundwater fluctuations are important to sustaining GDE health.

Basins with a stacked series of aquifers (Figure 2b) may have varying levels of pumping across aquifers in the basin, depending on the production capacity or water quality associated with each aquifer. If pumping is concentrated in deeper aquifers, SGMA still requires GSAs to sustainably manage groundwater resources in shallow aquifers, such as perched aquifers, that support springs, surface water, domestic wells, and GDEs (Figure 2). This is because vertical groundwater gradients across aquifers may result in pumping from deeper aquifers to cause adverse impacts onto beneficial users reliant on shallow aquifers or interconnected surface water. The goal of SGMA is to sustainably manage groundwater resources for current and future social, economic, and environmental benefits. While groundwater pumping may not be currently occurring in a shallower aquifer, use of this water may become more appealing and economically viable in future years as pumping restrictions are placed on the deeper production aquifers in the basin to meet the sustainable yield and criteria. Thus, identifying GDEs in the basin should done irrespective to the amount of current pumping occurring in a particular aquifer, so that future impacts on GDEs due to new production can be avoided. A good rule of thumb to follow is: *if groundwater can be pumped from a well - it's an aquifer*.

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[3] For more details on the mapping methods, refer to: Klausmeyer, K., J. Howard, T. Keeler-Wolf, K. Davis-Fadtke, R. Hull, A. Lyons. 2018. Mapping Indicators of Groundwater Dependent Ecosystems in California: Methods Report. San Francisco, California. Available at: https://groundwaterresourcehub.org/public/uploads/pdfs/iGDE_data_paper_20180423.pdf
[4] "Groundwater Dependent Ecosystems under the Sustainable Groundwater Management Act: Guidance for Preparing Groundwater Sustainability Plans" is available at: https://groundwaterresourcehub.org/gde-tools/gsp-guidance-document/
[5] The Groundwater Resource Hub: www.GroundwaterResourceHub.org

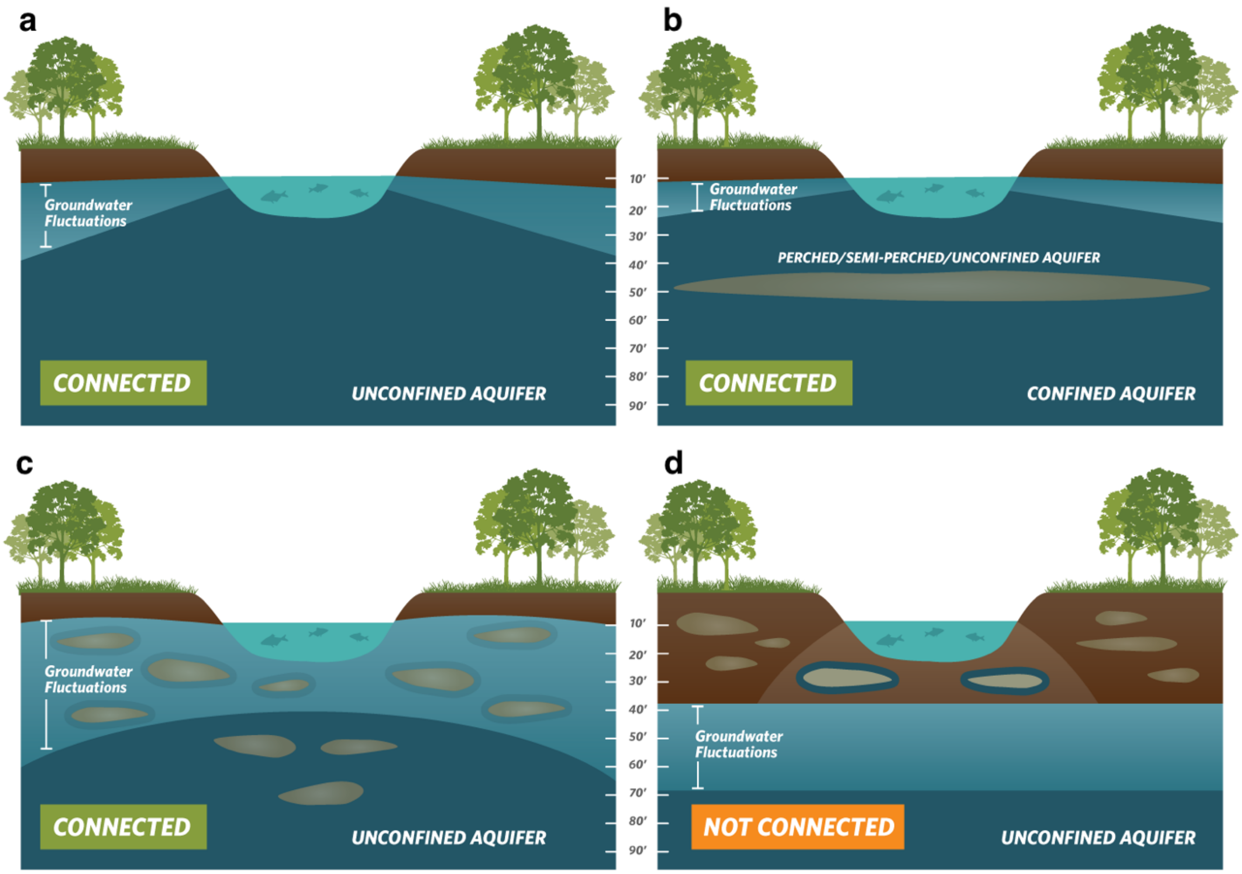

Figure 2. Confirming whether an ecosystem is connected to groundwater. Top: (a) Under the ecosystem is an unconfined aquifer with depth-to-groundwater fluctuating seasonally and interannually within 30 feet from land surface. **(b)** Depth-to-groundwater in the shallow aquifer is connected to overlying ecosystem. Pumping predominately occurs in the confined aquifer, but pumping is possible in the shallow aquifer. **Bottom: (c)** Depth-to-groundwater fluctuations are seasonally and interannually large, however, clay layers in the near surface prolong the ecosystem's connection to groundwater. **(d)** Groundwater is disconnected from surface water, and any water in the vadose (unsaturated) zone is due to direct recharge from precipitation and indirect recharge under the surface water feature. These areas are not connected to groundwater and typically support species that do not require access to groundwater to survive.

BEST PRACTICE #2. Characterize Seasonal and Interannual Groundwater Conditions

SGMA requires GSAs to describe current and historical groundwater conditions when identifying GDEs [23 CCR §354.16(g)]. Relying solely on the SGMA benchmark date (January 1, 2015) or any other single point in time to characterize groundwater conditions (e.g., depth-to-groundwater) is inadequate because managing groundwater conditions with data from one time point fails to capture the seasonal and interannual variability typical of California's climate. DWR's Best Management Practices document on water budgets[6] recommends using 10 years of water supply and water budget information to describe how historical conditions have impacted the operation of the basin within sustainable yield, implying that a baseline[7] could be determined based on data between 2005 and 2015. Using this or a similar time period, depending on data availability, is recommended for determining the depth-to-groundwater.

GDEs depend on groundwater levels being close enough to the land surface to interconnect with surface water systems or plant rooting networks. The most practical approach[8] for a GSA to assess whether polygons in the NC dataset are connected to groundwater is to rely on groundwater elevation data. As detailed in TNC's GDE guidance document[4], one of the key factors to consider when mapping GDEs is to contour depth-to-groundwater in the aquifer that is supporting the ecosystem (see Best Practice #5).

Groundwater levels fluctuate over time and space due to California's Mediterranean climate (dry summers and wet winters), climate change (flood and drought years), and subsurface heterogeneity in the subsurface (Figure 3). Many of California's GDEs have adapted to dealing with intermittent periods of water stress, however if these groundwater conditions are prolonged, adverse impacts to GDEs can result. While depth-to-groundwater levels within 30 feet[4] of the land surface are generally accepted as being a proxy for confirming that polygons in the NC dataset are supported by groundwater, it is highly advised that fluctuations in the groundwater regime be characterized to understand the seasonal and interannual groundwater variability in GDEs. Utilizing groundwater data from one point in time can misrepresent groundwater levels required by GDEs, and inadvertently result in adverse impacts to the GDEs. Time series data on groundwater elevations and depths are available on the SGMA Data Viewer[9]. However, if insufficient data are available to describe groundwater conditions within or near polygons from the NC dataset, include those polygons in the GSP until data gaps are reconciled in the monitoring network (see Best Practice #6).

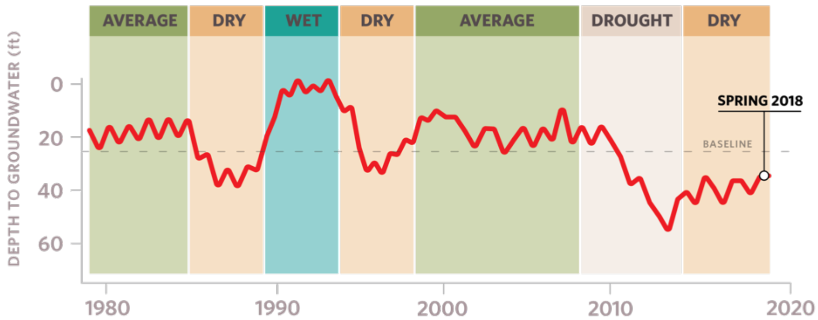

Figure 3. Example seasonality and interannual variability in depth-to-groundwater over time. Selecting one point in time, such as Spring 2018, to characterize groundwater conditions in GDEs fails to capture what groundwater conditions are necessary to maintain the ecosystem status into the future so adverse impacts are avoided.

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[6] DWR. 2016. Water Budget Best Management Practice. Available at: https://water.ca.gov/LegacyFiles/groundwater/sgm/pdfs/BMP_Water_Budget_Final_2016-12-23.pdf

[7] Baseline is defined under the GSP regulations as "historic information used to project future conditions for hydrology, water demand, and availability of surface water and to evaluate potential sustainable management practices of a basin." [23 CCR §351(e)]

[8] Groundwater reliance can also be confirmed via stable isotope analysis and geophysical surveys. For more information see The GDE Assessment Toolbox (Appendix IV, GDE Guidance Document for GSPs[4]).

[9] SGMA Data Viewer: https://sgma.water.ca.gov/webgis/?appid=SGMADataViewer

BEST PRACTICE #3. Ecosystems Often Rely on Both Groundwater and Surface Water

GDEs are plants and animals that rely on groundwater for all or some of its water needs, and thus can be supported by multiple water sources. The presence of non-groundwater sources (e.g., surface water, soil moisture in the vadose zone, applied water, treated wastewater effluent, urban stormwater, irrigated return flow) within and around a GDE does not preclude the possibility that it is supported by groundwater, too. SGMA defines GDEs as "ecological communities and species that depend on groundwater emerging from aquifers or on groundwater occurring near the ground surface" [23 CCR §351(m)]. Hence, depth-to-groundwater data should be used to identify whether NC polygons are supported by groundwater and should be considered GDEs. In addition, SGMA requires that significant and undesirable adverse impacts to beneficial users of surface water be avoided. Beneficial users of surface water include environmental users such as plants or animals[10], which therefore must be considered when developing minimum thresholds for depletions of interconnected surface water.

GSAs are only responsible for impacts to GDEs resulting from groundwater conditions in the basin, so if adverse impacts to GDEs result from the diversion of applied water, treated wastewater, or irrigation return flow away from the GDE, then those impacts will be evaluated by other permitting requirements (e.g., CEQA) and may not be the responsibility of the GSA. However, if adverse impacts occur to the GDE due to changing groundwater conditions resulting from pumping or groundwater management activities, then the GSA would be responsible (Figure 4).

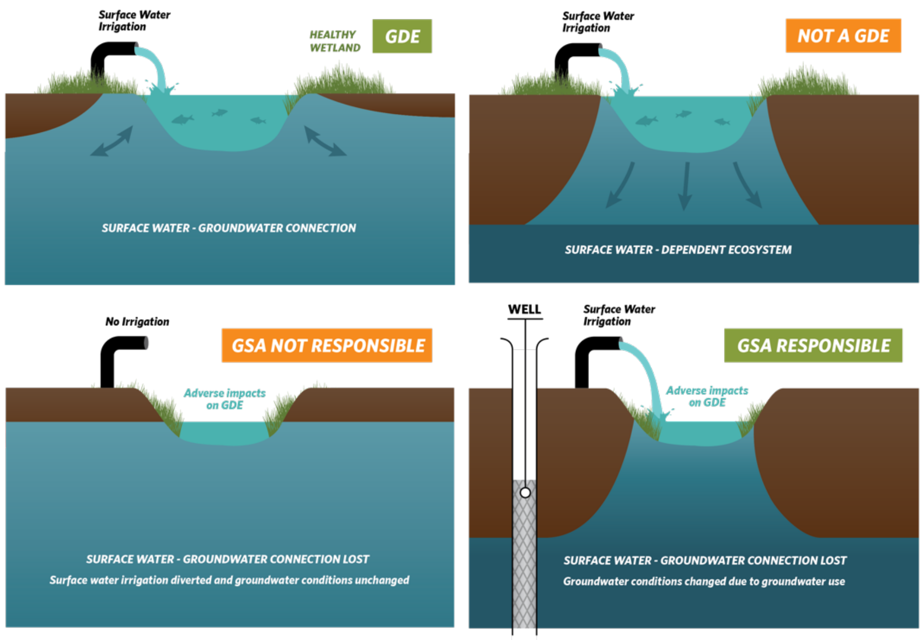

Figure 4. Ecosystems often depend on multiple sources of water. Top: (Left) Surface water and groundwater are interconnected, meaning that the GDE is supported by both groundwater and surface water. **(Right)** Ecosystems that are only reliant on non-groundwater sources are not groundwater-dependent. **Bottom: (Left)** An ecosystem that was once dependent on an interconnected surface water, but loses access to groundwater solely due to surface water diversions may not be the GSA's responsibility. **(Right)** Groundwater dependent ecosystems once dependent on an interconnected surface water system, but loses that access due to groundwater pumping is the GSA's responsibility.

[10] For a list of environmental beneficial users of surface water by basin, visit: https://groundwaterresourcehub.org/gde-tools/environmental-surface-water-beneficiaries/

BEST PRACTICE #4. Select Representative Groundwater Wells

Identifying GDEs in a basin requires that groundwater conditions are characterized to confirm whether polygons in the NC dataset are supported by the underlying aquifer. To do this, proximate groundwater wells should be identified to characterize groundwater conditions (Figure 5). When selecting representative wells, it is particularly important to consider the subsurface heterogeneity around NC polygons, especially near surface water features where groundwater and surface water interactions occur around heterogeneous stratigraphic units or aquitards formed by fluvial deposits. The following selection criteria can help ensure groundwater levels are representative of conditions within the GDE area:

- Choose wells that are within 5 kilometers (3.1 miles) of each NC Dataset polygons because they are more likely to reflect the local conditions relevant to the ecosystem. If there are no wells within 5km of the center of a NC dataset polygon, then there is insufficient information to remove the polygon based on groundwater depth. Instead, it should be retained as a potential GDE until there are sufficient data to determine whether or not the NC Dataset polygon is supported by groundwater.

- Choose wells that are screened within the surficial unconfined aquifer and capable of measuring the true water table.

- Avoid relying on wells that have insufficient information on the screened well depth interval for excluding GDEs because they could be providing data on the wrong aquifer. This type of well data should not be used to remove any NC polygons.

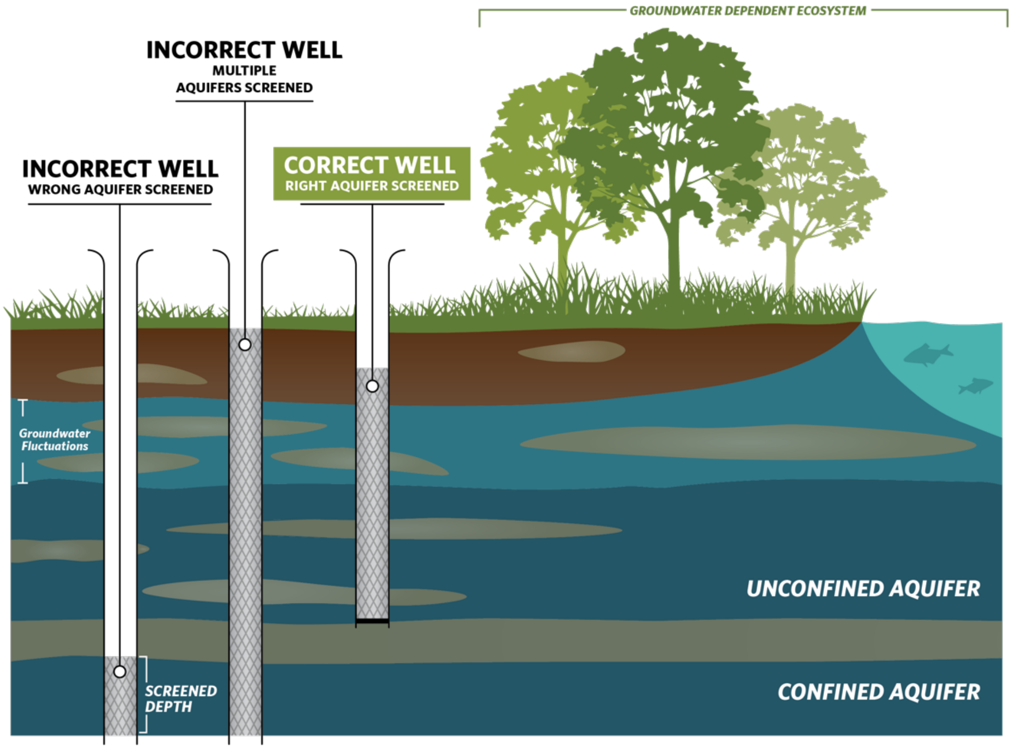

Figure 5. Selecting representative wells to characterize groundwater conditions near GDEs.

BEST PRACTICE #5. Contouring Groundwater Elevations

The common practice to contour depth-to-groundwater over a large area by interpolating measurements at monitoring wells is unsuitable for assessing whether an ecosystem is supported by groundwater. This practice causes errors when the land surface contains features like stream and wetland depressions because it assumes the land surface is constant across the landscape and depth-to-groundwater is constant below these low-lying areas (Figure 6a). A more accurate approach is to interpolate **groundwater elevations** at monitoring wells to get groundwater elevation contours across the landscape. This layer can then be subtracted from land surface elevations from a Digital Elevation Model (DEM)[11] to estimate depth-to-groundwater contours across the landscape (Figure b; Figure 7). This will provide a much more accurate contours of depth-to-groundwater along streams and other land surface depressions where GDEs are commonly found.

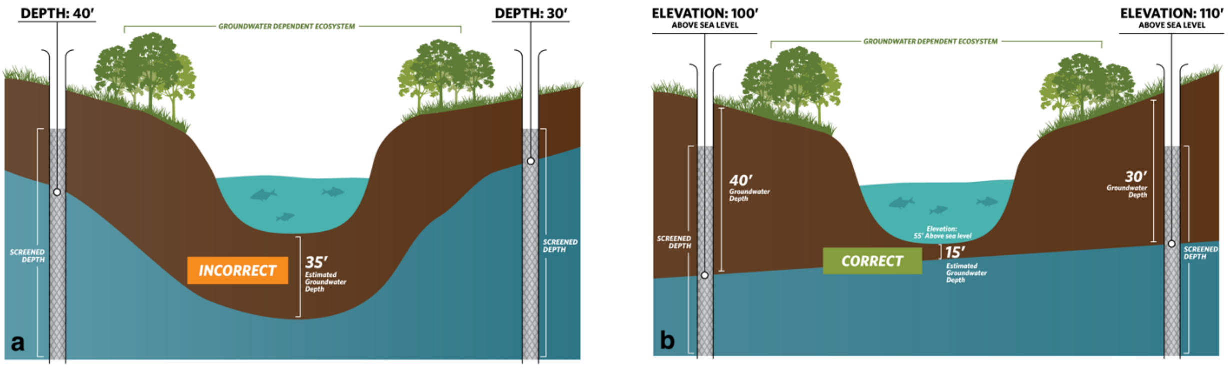

Figure 6. Contouring depth-to-groundwater around surface water features and GDEs. (a) Groundwater level interpolation using depth-to-groundwater data from monitoring wells. **(b)** Groundwater level interpolation using groundwater elevation data from monitoring wells and DEM data.

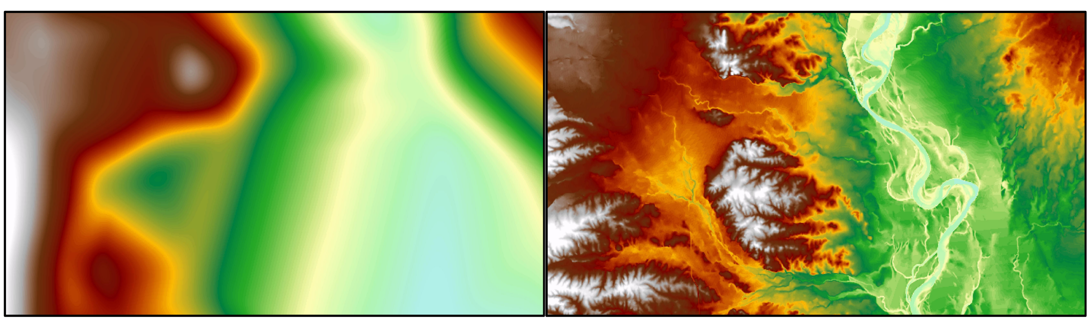

Figure 7. Depth-to-groundwater contours in Northern California. (Left) Contours were interpolated using depth-to-groundwater measurements determined at each well. **(Right)** Contours were determined by interpolating groundwater elevation measurements at each well and superimposing ground surface elevation from DEM spatial data to generate depth-to-groundwater contours. The image on the right shows a more accurate depth-to-groundwater estimate because it takes the local topography and elevation changes into account.

[11] USGS Digital Elevation Model data products are described at: https://www.usgs.gov/core-science-systems/ngp/3dep/about-3dep-products-services and can be downloaded at: https://iewer.nationalmap.gov/basic/

BEST PRACTICE #6. Best Available Science

Adaptive management is embedded within SGMA and provides a process to work toward sustainability over time by beginning with the best available information to make initial decisions, monitoring the results of those decisions, and using the data collected through monitoring programs to revise decisions in the future. In many situations, the hydrologic connection of NC dataset polygons will not initially be clearly understood if site-specific groundwater monitoring data are not available. If sufficient data are not available in time for the 2020/2022 plan, **The Nature Conservancy strongly advises that questionable polygons from the NC dataset be included in the GSP until data gaps are reconciled in the monitoring network.** Erring on the side of caution will help minimize inadvertent impacts to GDEs as a result of groundwater use and management actions during SGMA implementation.

KEY DEFINITIONS

Groundwater basin is an aquifer or stacked series of aquifers with reasonably well-defined boundaries in a lateral direction, based on features that significantly impede groundwater flow, and a definable bottom. *23 CCR §341(g)(1)*

Groundwater dependent ecosystem (GDE) are ecological communities or species that depend on groundwater emerging from aquifers or on groundwater occurring near the ground surface. *23 CCR §351(m)*

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

Principal aquifers are aquifers or aquifer systems that store, transmit, and yield significant or economic quantities of groundwater to wells, springs, or surface water systems. *23 CCR §351(aa)*

ABOUT US

The Nature Conservancy is a science-based nonprofit organization whose mission is *to conserve the lands and waters on which all life depends*. To support successful SGMA implementation that meets the future needs of people, the economy, and the environment, TNC has developed tools and resources (www.groundwaterresourcehub.org) intended to reduce costs, shorten timelines, and increase benefits for both people and nature.