



SPADRA BASIN GROUNDWATER SUSTAINABILITY AGENCY

GROUNDWATER SUSTAINABILITY PLAN FOR THE SPADRA BASIN

Final Report | January 2022



Groundwater Sustainability Plan for the Spadra Basin

PREPARED FOR



PREPARED BY

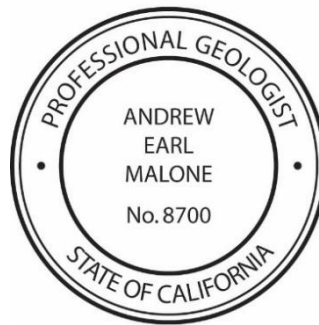


Groundwater Sustainability Plan for the Spadra Basin

Prepared for

Spadra Basin Groundwater Sustainability Agency

Project No. 954-80-20-01



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LIST OF ACRONYMS AND ABBREVIATIONS

µg/kg	Micrograms per Kilogram
µg/l	Micrograms per Liter
1,1,1-TCA	1,1,1-Trichloroethane
1,1-DCE	1,1-Dichloroethene
1,2,3-TCP	1,2,3-Trichloropropane
af	Acre-Feet
afy	Acre-Feet Per Year
AGR	Agricultural Supply
AMP	Adaptive Monitoring Plan
application	Application for Well/Exploration Hole Permit
CASGEM	California Statewide Groundwater Elevation Monitoring
CBWM	Chino Basin Watermaster
CCR	California Code of Regulations
CDFM	Cumulative Departure from the Mean
CDFW	California Department of Fish and Wildlife
CDPH	California Department of Public Health
CFI	Consolidated Foundries Incorporated
CIMIS	California Irrigation Management Information System
cis-1,2 DCE	cis-1,2 Dichloroethene
CIWQS	California Integrated Water Quality System Project
CPP	California State Polytechnic University of Pomona
CRA	Colorado River Aqueduct

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CVM	Chino Valley Model
DCA	1,1-Dichloroethane
DDW	State Water Resources Control Board Division of Drinking Water
DEM	Digital Elevation Model
DIPAW	Deep Infiltration of Precipitation and Applied Water
DLR	Detection Limit for The Purposes of Reporting
DTSC	California Department of Toxic Substances
DWR	California Department of Water Resources
EDDs	Electronic Data Deliverables
EPA	Environmental Protection Agency
ET	Evapotranspiration
FEIR	Environmental Impact Report
ft	Foot or Feet
ft/d	Feet per Day
ft-amsl	Feet Above Mean Sea Level
ft-bgs	Feet Below Ground Surface
GAMA	Groundwater Ambient Monitoring and Assessment
GDEs	Groundwater-Dependent Ecosystems
gpm	Gallons per Minute
GSA	Groundwater Sustainability Agency
GSP	Groundwater Sustainability Plan
HSPF	Hydrological Simulation Program-FORTRAN
IND	Industrial Services Supply
InSAR	Interferometric Synthetic-Aperture Radar
LA Basin Plan	Water Quality Control Plan Los Angeles Region
LA Regional Board	California Regional Water Quality Control Board Los Angeles Region
LACPWD	Los Angeles County Public Works Department
LACSD	Los Angeles County Sanitation Districts
LADPH	Los Angeles County Department of Public Health
M&RP	Monitoring and Reporting Program
MCL	Maximum Contaminant Level
Metropolitan	Metropolitan Water District of Southern California
mgd	Million Gallons per Day
mg/l	Milligrams per Liter
Miramar WTP	Miramar Water Treatment Plant
MOA	Memorandum of Agreement
MS4 Permit	Municipal Separate Storm Sewer System Order No. R4-2012-0175
MTBE	Methyl Tert-Butyl Ether
MUN	Municipal and Domestic Supply
NCCAG	Natural Communities Commonly Associated with Groundwater
ND	Non Detect Concentration
NEXRAD	Next-Generation Radar
NL	Notification Level

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NOAA	National Oceanic and Atmospheric Administration
NPDES	National Pollutant Discharge Elimination System
NTU	Nephelometric Turbidity Unit
OEHHA	California Office of Environmental Health Hazard Assessment
OSY	Operating Safe Yield
PBWA	Puente Basin Water Agency
PCE	Tetrachloroethene
PFAS	Polyfluoroalkyl Substances
PHG	Public Health Goal
Pomona	City of Pomona
Pomona WRP	Pomona Water Reclamation Plant
PRISM	PRISM Climate Group
PROC	Industrial Process Supply
PVPA	Pomona Valley Protective Agency
QA/QC	Quality Assurance and Quality Control
Recycled Water Policy	Policy for Water Quality Control for Recycled Water
RO	Reverse Osmosis
San Gabriel SNMP	The San Gabriel Valley Basin SNMP
SASG	San Antonio Spreading Grounds
SAWCo	San Antonio Water Company
SCADA	Supervisory Control and Data Acquisition
SCAG	Southern California Association of Governments
SGMA	Sustainable Groundwater Management Act
SNMP	Salt and Nutrient Management Plan
State Water Board	State Water Resources Control Board
SVE	Soil Vapor Extraction
SWP	State Water Project
TCE	Trichloroethene
TDS	Total Dissolved Solids
TM	Technical Memorandum
TVMWD	Three Valleys Municipal Water District
µmhos/cm	Micromhos Per Centimeter
USACE	United States Army Corps of Engineers
USBR	United State Bureau of Reclamation
USGS	United States Geological Survey
VIC	Variable Infiltration Capacity
VOC	Volatile Organic Compound
WDR	Waste Discharge Requirement
WEI	Wildermuth Environmental, Inc.
Weymouth WTP	Weymouth Water Treatment Plant
WQS	Water-Quality Standard
WRD	Water Replenishment District
WRP	Water Reclamation Plant

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WRR	Water Reclamation Requirement
WTP	Water Treatment Plant
WVWD	Walnut Valley Water District

Executive Summary

INTRODUCTION

In 2014 the California legislature enacted the Sustainable Groundwater Management Act (SGMA)—the primary purpose of which is to achieve and/or maintain sustainability within the State’s groundwater basins. SGMA called for the formation of one or more Groundwater Sustainability Agencies (GSA) to fully cover a basin; development of one or more Groundwater Sustainability Plans (GSP) for a basin; implement the GSP to achieve sustainability and avoid undesirable results; and periodic reporting to the California Department of Water Resources (DWR).

The Spadra Basin is a small, non-adjudicated subbasin of the San Gabriel Valley Basin (Basin 4-013 as defined by DWR). The DWR designated the San Gabriel Valley Basin as a “very low-priority” basin mainly because groundwater pumping rights across most of the basin have been adjudicated. SGMA does not require that a GSP be prepared for the basin, however the legislation “encourages and authorizes” basins designated as very low priority to be managed under a GSP.

The Walnut Valley Water District (WVWD) and the City of Pomona (Pomona) collectively formed the Spadra Basin GSA in February 2017 through a Memorandum of Understanding (MOU) and elected to prepare and adopt a GSP for the Spadra Basin with the main objective of encouraging collaborative management of the Basin between all pumpers and maximizing beneficial use of the basin in a sustainable fashion. The MOA between the WVWD and Pomona established an Executive Committee, Implementation Team, and Advisory Committee with roles to support both the development and implementation of the Spadra Basin GSP.

The Spadra Basin GSP was developed using a process that encouraged all interested stakeholders and the public to participate in its development. The Advisory Committee was formed of representatives from interested Spadra Basin stakeholders to oversee and provide guidance on the GSP development and implementation. The Advisory Committee meetings were the forum to present all content used to prepare the GSP in an open and transparent process, and to receive feedback from all interested stakeholders and the public. Five technical memorandums (TMs) that were interim milestones in the development of the GSP were prepared in sequence with input from interested stakeholders and the public along the way. The contents of the draft TMs were presented at Advisory Committee meetings, and stakeholders and the public had a review period to provide comments and suggested edits. All draft and final TMs were published on the [GSA website documents page](#).

PLAN AREA AND BASIN SETTING

Plan Area

The Spadra Basin is approximately seven square miles (4,200 acres) located in eastern Los Angeles County in Southern California. The Spadra Basin is a non-adjudicated groundwater basin and there is no formal basin management plan and no defined restrictions on groundwater pumping. The Spadra Basin is surrounded by four adjudicated groundwater basins: Puente Basin to the southwest; Main San Gabriel Basin to the northwest; Six Basins to the north; and Chino Basin to the east. Pomona, WVWD, and California State Polytechnic University of Pomona (CPP) are the local water purveyors with service area boundaries overlying the Spadra Basin. The water purveyors obtain water supplies from multiple sources including groundwater from Spadra Basin, groundwater from other basins, local surface water, treated

imported water from the State Water Project and Colorado River, and recycled water. There are nine wells owned and operated by Pomona, WVWD, and CPP that pump groundwater from the Spadra Basin.

Current land use in the Spadra Basin is predominantly urban (93 percent urban and six percent irrigated agriculture). Because most of the land surface is impervious, most of the rainfall exists the Basin as stormwater runoff in concrete-lined flood-control channels. The main channels that drain the Spadra Basin are the San Jose Creek and South San Jose Creek which merge, and then ultimately discharge to the San Gabriel River downstream from the Spadra Basin. The surface water runoff that exits the Spadra Basin in these channels is put to beneficial use by the downstream entities mainly for groundwater recharge, is consumptively used by riparian vegetation in unlined stream reaches, or flows to the ocean. Wastewater generated in the Spadra Basin is treated at the Pomona Water Reclamation Plant (WRP) located in the Spadra Basin, which is a regional facility that receives wastewater originating from an 82 square-mile area in the eastern portion of Los Angeles County. The Pomona WRP is owned and operated by the Los Angeles County Sanitation Districts (LACSD). Tertiary-treated wastewater from the Pomona WRP is either discharged to the South San Jose Creek where it exists the Spadra Basin or is reused for irrigation or commercial processes at sites within the Spadra Basin and Puente Basin.

Basin Setting

The Spadra Basin is a relatively narrow, alluvial-filled valley located between the San Jose Hills and Puente Hills. Basin stratigraphy consists of two main units: (i) unconsolidated water-bearing sediments, which are alluvial sediments consisting of interconnected layers of pervious gravels and sands, and less pervious silts and clay, and (ii) consolidated bedrock, which are older impermeable (non-water bearing) formations. Hydrogeologic cross-sections depict a narrow aquifer system along the central axis of the basin that has a saturated thickness of about 100-200 feet (ft) and thickens to about 400 ft to the east.

Groundwater Pumping, Groundwater Levels, and Groundwater in Storage

Historic groundwater conditions were evaluated from 1977 to 2018 using all available monitoring data from existing production wells. Historically, groundwater pumping ranged from a high of about 2,200 acre-feet per year (afy) in 1986 to a low of about 700 afy in 1991, and averaged 1,280 afy. Groundwater pumping declined over the last 10 years, with an average annual pumping of about 970 afy. Long-term trends in groundwater elevation are consistent at all wells across the basin suggesting that all wells are being influence by the same regional stresses of recharge and pumping. Groundwater levels appear to rise in response to hydrologic wet periods and fall in response to hydrologic dry periods. Over the study period, the lowest groundwater levels across the basin occurred in 1977 and the highest groundwater levels occurred around 2008. Changes in groundwater levels result in changes in groundwater storage. Over the historical period from 1977 to 2018, groundwater levels increased by about 25 to 35 ft across most the basin. The net change in groundwater elevation and estimates of the specific yield and aquifer thickness were used to estimate a total change in storage from 1977 to 2018 of + 9,278 acre-feet (af). An analysis of the change in storage for over this historical period was also performed through the development and calibration of a groundwater-flow model for the Spadra Basin, which computed a similar change in storage of 7,089 afy.

Groundwater Quality

Spadra Basin groundwater is generally of poor quality. Pumped groundwater is used primarily for non-potable uses. Constituents of concern include total dissolved solids (TDS), nitrate, trichloroethene (TCE), tetrachloroethene (PCE), 1,1-dichloroethene (1,1-DCE), and perchlorate. Groundwater from Spadra

Executive Summary

Basin that is used for potable supply often requires treatment or blending prior to use to comply with State Water Board's Division of Drinking Water (DDW) drinking-water standards.

Land Subsidence

The analysis of historical Interferometric Synthetic Aperture Radar (InSAR) estimates of vertical ground motion for portions of the Spadra Basin demonstrated that very little permanent land subsidence occurred within the Spadra Basin since the mid-1990s. It appears from these InSAR estimates that recent vertical ground motion is small in magnitude (e.g., less than +/- 0.1 ft) and elastic in nature. Vertical ground motion in the adjacent Chino Basin over this same period is much greater and is currently being studied and managed by the Chino Basin Watermaster. The aquifer systems of the Chino Basin and Spadra Basin are connected across their common boundary and changes in groundwater levels within one basin could cause changes in groundwater levels in the other, which could lead to aquitard compaction and associated land subsidence. Therefore, land subsidence is a potential undesirable result in the Spadra Basin and the Chino Basin from groundwater management activities in either basin.

Water Budget and Developed Yield

A water budget of the Spadra Basin over the 1977 to 2018 period was prepared through the development and calibration of a groundwater-flow model for the Spadra Basin. Groundwater inflows are primarily subsurface inflow from the saturated alluvium and fractures within the bordering bedrock of the San Jose and Puente Hills, and deep infiltration of precipitation and applied water. Groundwater discharge occurs primarily through groundwater pumping and subsurface outflow to the Puente Basin and the Chino Basin.

The "developed yield" of the Spadra Basin over the historical period (1977-2018), which is the annual average pumped from the groundwater basin, corrected for the change in storage, was estimated to be 1,432 afy from the water budget. The developed yield for the historical period was also estimated using the calculated change in storage from the change in water levels over this period and computed a similar developed yield estimate of 1,498 afy.

SUSTAINABLE MANAGEMENT CRITERIA

SGMA introduces several terms to measure sustainability including Undesirable Results, Sustainability Indicators, Minimum Thresholds, Measurable Objectives, and the Sustainability Goal.

The 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. Under the SGMA, Undesirable Results occur when the effects caused by groundwater conditions occurring throughout the basin cause significant and unreasonable impacts to any of the following six Sustainability Indicators:

- Chronic lowering of groundwater levels
- Reduction of groundwater storage
- Seawater intrusion
- Degraded water quality
- Land subsidence
- Depletions of interconnected surface water

The Sustainability Indicators of seawater intrusion and depletions of interconnected surface water are not relevant to the Spadra Basin. The applicable Sustainability Indicators to the Spadra Basin are: (1) chronic lowering of groundwater levels; (2) reduction of groundwater storage; (3) degraded water quality; and (4) land subsidence. The GSP describes the Undesirable Results for each of these Sustainability Indicators, and then established Minimum Thresholds and Measure Objectives that are the operating band of quantitative metrics for groundwater conditions that will achieve and maintain sustainability and avoid Undesirable Results.

Chronic Lowering of Groundwater Levels, Reduction of Groundwater Storage, and Land Subsidence

Seven wells located throughout the Spadra Basin were selected as representative sites to establish the Minimum Thresholds and Measurable Objectives for the chronic lowering of groundwater levels. The Minimum Thresholds were set as the lowest historical groundwater elevations at each well between the 1978 to 2018 period. These Minimum Thresholds are preliminary estimates based on the analysis of historical data from 1978 to 2018 and are based on the belief that Undesirable Results did not occur over this historical period. An Undesirable Result would occur if static groundwater elevations decline below a Minimum Threshold for an entire year at any well. The Measurable Objectives were set as the highest historical groundwater elevations at each well between 1978 to 2018. These Measurable Objectives establish a reasonable margin of operational flexibility between the Measurable Objectives and the Minimum Thresholds and will promote sustainable groundwater management by accommodating wet and dry periods, levels of uncertainty, and potential projects that the GSA may pursue to maximize the beneficial use of the Spadra Basin. Tables 3-1 and 3-2 in Section 3 of the GSP summarize the Minimum Thresholds and Measurable Objectives for chronic lowering of groundwater levels for each representative monitoring well.

By proxy, the Minimum Thresholds defined for chronic lowering of groundwater levels at the wells throughout the basin will be used to assess the Sustainability Indicators of reduction of groundwater storage and land subsidence. The assessment of these proxy Minimum Thresholds can be compared to the storage calculations performed annually (for storage), and available data of vertical ground motion evaluated periodically as needed (for land subsidence).

Degraded Water Quality

Seven wells located throughout the Spadra Basin were selected as representative sites to establish the Minimum Thresholds and Measurable Objectives for degraded water quality. The Minimum Thresholds and Measurable Objectives were established for each contaminant of concern (total dissolved solids [TDS], nitrate, trichloroethene [TCE], tetrachloroethene [PCE], 1,1-dichloroethene [1,1-DCE], and perchlorate) and can differ at each well depending on multiple factors. The Minimum Thresholds are set dependent on the contaminant type and are protective of each well's beneficial use. The Measurable Objectives are set on the contaminant type, and if the current concentrations exceeded the proposed Minimum Thresholds. Tables 3-3 and 3-4 in Section 3 of the GSP summarize the Minimum Thresholds and Measurable Objectives for each representative monitoring well for degraded water quality.

Table ES-1. Summary Table of the Minimum Thresholds and Measurable Objectives Set for the Sustainability Indicators for the Spadra Basin

Sustainability Indicator	Minimum Threshold	Measurable Objective
<i>Chronic Lowering of Groundwater Levels</i>	Lowest historical groundwater elevation at representative wells over the period of 1978-2018	Highest historical groundwater elevation at representative wells over the period of 1978-2018
<i>Reduction of Storage</i>	By proxy, Minimum Thresholds set for Groundwater Levels	By proxy, Measurable Objectives set for Groundwater Levels
<i>Degraded Water Quality</i>	Potable Wells: TDS = 800 milligrams per liter (mg/l) Nitrate-Nitrogen = 10 mg/l Perchlorate = 6 micrograms per liter (µg/l) TCE & PCE = 5 µg/l 1,1-DCE = 6 µg/l Non-Potable Wells: TDS = 1,500 mg/l Nitrate-Nitrogen = 20 mg/l Perchlorate = 12 µg/l TCE & PCE = 5 µg/l 1,1-DCE = 6 µg/l	TDS, Nitrate & Perchlorate: lowest detected concentration historically at all representative sites in the basin, or better. TCE, PCE, and 1,1-DCE: 2015 concentration or better for wells where the current concentration is above the Primary MCL; and non-detect concentration at the wells where the current concentration is below the Primary MCL.
<i>Land Subsidence</i>	By proxy, Minimum Thresholds set for Groundwater Levels	By proxy, Measurable Objectives set for Groundwater Levels

Sustainability Goal of the Spadra Basin: In a collaborative effort between all Spadra Basin water purveyors, conjunctively use all water supplies available to the Spadra Basin to achieve and maintain groundwater sustainability, avoid Undesirable Results, maximize the beneficial use of the basin, and minimize cost.

MONITORING NETWORK

The Monitoring Program in Section 4 includes a discussion of the monitoring protocols for each data type and the relation to monitoring required for the assessment of the Sustainable Management Criteria. The monitoring program in the GSP is the first coordinated monitoring effort in the Spadra Basin and addresses data gaps described in the Basin Setting.

The GSP monitoring program is designed to collect data of sufficient quality, frequency, and distribution to characterize conditions in the basin and evaluate sustainability during GSP implementation. The monitoring program will allow the GSA to track short-term, seasonal, and long-term trends in groundwater conditions; evaluate conditions relative to Minimum Thresholds, Measurable Objectives, and Interim Milestones; update to the groundwater-flow model to evaluate groundwater conditions; and quantify changes in water budget.

The Spadra Basin monitoring program includes monitoring of groundwater (production, levels, and quality), surface water, and land subsidence. Groundwater monitoring is the primary component of the monitoring

program and includes collecting groundwater data at all existing wells in the basin, including a newly constructed monitoring well to fill a data gap.

The GSA will monitor for groundwater levels and production at 12 wells, which includes the seven wells established as representative monitoring sites for the Sustainability Indicators of chronic lowering of groundwater levels, reduced groundwater storage and land subsidence. The GSA will collect metered production data from the well owners. The GSA will monitor groundwater levels using a pressure transducer (if possible) that measures and records water levels once every 15 minutes. The GSA will monitor for groundwater quality at the seven wells established as representative monitoring sites for the Sustainability Indicator of degraded water quality. Any additional groundwater data for the remaining wells in the basin will be collected annually from the well owners by the GSA.

The effluent discharge and quality data measured at the Pomona WRP will be collected from the LACSD by the GSA annually. Monitoring of land subsidence will be conducted at a minimum of once every five years by the GSA via InSAR data made available by the DWR to verify that permanent land subsidence is not occurring.

All data collected will be compiled, checked for QA/QC to ensure data quality, and uploaded to the GSA's data management system.

PROJECTS AND MANAGEMENT ACTIONS TO ACHIEVE SUSTAINABILITY

Section 5 of the GSP identifies projects and management actions that the GSA identified to help avoid Undesirable Results and achieve the Sustainability Goal for the Spadra Basin. To do this, the GSA first developed and evaluated a Baseline Scenario that included the future expected water demands, water-supply plans, and groundwater management plans of the Spadra Basin water purveyors to understand the sustainability of expected future groundwater conditions in the absence of projects or management actions. The Spadra Basin Groundwater Model was used to simulate the Baseline Scenario and estimate the response of the groundwater basin over a 60-year planning period. The model results of the Baseline Scenario indicated that groundwater levels are projected to decline over the planning horizon by 20-25 ft, which would be below the Minimum Thresholds, and was therefore not considered sustainable.

Spadra Basin stakeholders used the model results of the Baseline Scenario to guide the development of several projects and management actions to achieve sustainability. Combinations of the proposed projects were included in three "Basin Optimization Scenarios" to achieve sustainability in the Spadra Basin over the planning period and/or maximize the beneficial use of the Basin. All three Basin Optimization Scenarios include the use of surplus recycled water from the Pomona WRP to achieve the objectives of the scenarios. Surplus recycled water is tertiary-treated effluent from the Pomona WRP that is not delivered for direct reuse to existing customers in the Spadra Basin and Puente Basin for irrigation or commercial purposes. The Basin Optimization Scenarios are:

- **Basin Optimization Scenario 1 - Sustainability through Substitution.** This scenario includes reduced groundwater pumping and additional recycled water reuse.
- **Basin Optimization Scenario 2 - Sustainability through Recharge.** This scenario includes artificial recharge of 500 afy of recycled water.

- **Basin Optimization Scenario 3 - Maximum Beneficial Use.** This scenario includes artificial recharge of 3,500 afy of recycled water, increasing production by a similar amount, and expansion of the CPP reverse osmosis (RO) plant. The pumped groundwater will be treated at the RO plant and used for potable water supplies, which reduces the demands for imported water and increases potable water-supply reliability.

The Spadra Basin Groundwater Model was used to simulate the Basin Optimization Scenarios to estimate the response of the groundwater basin over a 60-year planning period and evaluate sustainability. The conclusions of this analysis were that all Basin Optimization Scenarios are hydrologically feasible, and compared to the Baseline Scenario, all are expected to result in: (i) higher groundwater levels that do not decline below Minimum Thresholds or pumping sustainability metrics; (ii) no significant and unreasonable land subsidence or reductions of groundwater storage; (iii) higher Sustainable Yield; and (iv) no reductions in subsurface outflow to the neighboring groundwater basins. In other words, the Basin Optimization Scenarios will avoid Undesirable Results and achieve and maintain sustainability.

Cost models for the Baseline Scenario and the three Basin Optimization Scenarios were developed to estimate and evaluate the cost of the aggregate water-supply of the water purveyors in the Spadra Basin for each scenario. The aggregate melded unit cost of water for the three Basin Optimization Scenarios were compared to each other and to the Baseline Scenario; however, the Baseline Scenario cannot be directly compared to the Basin Optimization Scenarios because the Baseline Scenario is not sustainable like the Basin Optimization Scenarios. The aggregate melded unit cost of water for Basin Optimization Scenarios 1 and 2 are slightly more expensive than the aggregate melded unit cost of water for the Baseline Scenario. And the aggregate melded unit cost of water for Basin Optimization Scenario 3 averages about \$150/af more than the aggregate melded unit cost of water for the Baseline Scenario and Basin Optimization Scenarios 1 and 2 from 2030-2059, and then declines to about \$400/af less than these other scenarios after the loans for capital improvements are paid off. Basin Optimization Scenario 3 is less expensive in the long run because of the investment in facilities that produce a local, more reliable, and less expensive water supply as an alternative to imported water supplies.

Basin Optimization Scenario 3 is the recommended scenario for GSP implementation. It results in the highest Sustainable Yield for the Spadra Basin by recharging surplus recycled water from the Pomona WRP and increasing groundwater production by similar volumes. Through groundwater treatment, it increases local, reliable, potable water supplies as an alternative to the use of less reliable imported waters.

GSP IMPLEMENTATION

The implementation of the GSP for the Spadra Basin includes five main categories:

- **Administration and legal support** – The GSA will perform all administrative activities and legal services to implement the GSP.
- **Monitoring** – The GSA will conduct the monitoring program for the Spadra Basin GSP described in Section 4 Monitoring Program.
- **Annual reporting** – Annual reports for the Spadra Basin GSP are required to be prepared every year that is inclusive of all requirements in California Code of Regulations (CCR) §356.2 of the GSP Regulations. By April 1 of every year the GSA will prepared and submit the annual report and required electronic data deliverables to the DWR.

- **Five-year evaluation reporting** – Assessments of the Spadra Basin GSP will be prepared at least every five years and documented in a report. The five-year assessments shall describe whether the implementation of the GSP is meeting the Sustainability Goal and include all the information in CCR §356.4 of the GSP Regulations. These assessments could coincide with periodic updates and recalibration of the Spadra Basin Groundwater-flow Model (planned model updates occur at a minimum of every ten years) that will be used to evaluate sustainability of current and future conditions under GSP implementation.
- **Planning and implementation of projects and management actions** – The GSA will implement the projects and management actions in Basin Optimization Scenario 3 from the concepts described in this GSP to final design and then through construction and operation. These phases include: Phase 1 – Identify Project Alternatives; Phase 2 – Project Screening Assessment; Phase 3 – Feasibility Assessment; and Phase 4 – Project Implementation.

Conceptual cost estimates for implementation of the GSP were developed for the categories of Administrative, Monitoring/Reporting, and Project and Management Actions:

- **Administrative** - Costs are estimated to be about \$53,000 annually.
- **Monitoring/Reporting** - Costs are estimated to range between \$137,000 to \$612,000. Cost for the first year of GSP implementation is \$186,000, and subsequent years are \$137,000. The costs for the years when a five-year evaluation of the GSP is performed is expected to be about \$612,000.
- **Projects and Management Actions** - The annual cost for the planning and implementation of projects in preferred Basin Optimization Scenario 3 ranges from \$5.3 to \$ 5.8 million per year. This range is for the first 30 years when loans for capital improvements are being paid off.

The GSA will develop a funding structure to pay for the costs to implement the GSP upon adoption of the GSP. Additionally, the GSA may pursue other financing sources for capital projects, repayment of debt, operations and maintenance (O&M), and other ongoing expenses for the projects and management actions. Section 6 of the GSP includes an estimated schedule for the major categories of GSP implementation for the first 20 years.

SECTION 1

Introduction

1.1 PURPOSE OF THE GROUNDWATER SUSTAINABILITY PLAN

The Sustainable Groundwater Management Act (SGMA) was enacted in 2014 via a three-bill legislative package consisting of Assembly Bill 1739 (Dickinson), Senate Bill 1168 (Pavley), and Senate Bill 1319 (Pavley) (Part 2.74 of Division 6 of the California Water Code, beginning with § 10720). The SGMA and its associated regulations call for four main activities:

- Formation of one or more Groundwater Sustainability Agencies (GSA) to fully cover a basin
- Development of one or more Groundwater Sustainability Plans (GSP) for the basin
- Implement the GSP to achieve quantifiable objectives
- Periodic reporting to the California Department of Water Resources (DWR)

The Spadra Basin is a small, non-adjudicated subbasin of the San Gabriel Valley Basin (Basin No. 4-013) as defined by the California Department of Water Resources [DWR]. The DWR designated the San Gabriel Valley Basin as a “very low-priority” basin mainly because groundwater pumping rights across most of the basin have been adjudicated; and as such, the SGMA does not require that a GSP be prepared for the basin. However, the SGMA Legislation “encourages and authorizes” basins designated as very low priority to be managed under a GSP (Water Code § 10720.7(b)).

The Walnut Valley Water District (WVWD) and the City of Pomona (Pomona) collectively formed the Spadra Basin GSA in February 2017 and elected to prepare and adopt a GSP for the Spadra Basin. The main objectives for this decision were to encourage collaborative management of the Spadra Basin between all pumpers and make maximum beneficial use of the basin in a sustainable fashion. In 2018, the newly formed Spadra Basin GSA secured a Proposition 1 Sustainable Groundwater Planning Grant to support the preparation of the GSP (Appendix A).

1.2 AGENCY INFORMATION

The Spadra Basin GSA was formed on February 28, 2017 by the WVWD and Pomona under a Memorandum of Agreement (MOA) to establish the Spadra Basin GSA (Appendix B). The WVWD and Pomona are two of the public agencies the produce groundwater from the Spadra Basin. Pomona has land use responsibilities for most of the basin. On March 29, 2017, the Spadra Basin GSA completed its filing of the notice to the DWR of its formation and intent to prepare a GSP for the Spadra Basin. The Spadra Basin GSA was officially formed as the exclusive GSA for the Spadra Basin on June 27, 2017, 90 days after the filing.

The Spadra Basin GSA contact information is:

[Spadra Basin Groundwater Sustainability Agency](#)
c/o Walnut Valley Water District
Attention: Sherry Shaw
271 South Brea Canyon Road
Walnut, CA 91789

1.2.1 Organization and Management Structure of the GSA

The MOA between the WVWD and Pomona to form the Spadra Basin GSA established an Executive Committee, Implementation Team, and an Advisory Committee with roles to support the development and implementation of the Spadra Basin GSP:

- **The Executive Committee** is the governing body for the Spadra Basin GSA and is comprised of one member and one alternate from both the WVWD and Pomona. The Executive Committee is responsible for directing and providing guidance to the Implementation Team and consultants working with the Spadra Basin GSA on matters such as: a) developing a GSP that achieves the goals and objectives of SGMA; b) implementing actions undertaken pursuant to the MOA and resolving issues related to these actions; c) implementing measures in the event of insufficient or unsatisfactory progress is being made in development or implementation of the GSP; and d) establishing an Advisory Committee and developing a stakeholder participation plan. The Executive Committee appoints an Administrative Officer and Legal Counsel for the Spadra Basin GSA. Executive Committee meetings are required to be held annually. During the GSP development process, meetings were held bi-monthly.
- **The Implementation Team** is selected by the Executive Committee and is comprised of staff from WVWD and Pomona. The Implementation Team oversees and coordinates the activities to develop and implement the GSP. In coordination with the Executive Committee, the Implementation Team developed and implemented a stakeholder participation plan and related outreach.
- **The Advisory Committee** consists of representatives from interested Spadra Basin stakeholders. The Advisory Committee members include representatives from: California State Polytechnic University, Pomona (CPP) who is a groundwater producer in the Spadra Basin along with ~~the~~ Pomona and WVWD; Rowland Water District; Three Valleys Municipal Water District (TVMWD); and Forest Lawn [Memorial Park](#). An Advisory Committee chair and vice chair are appointed to assist with organizing the committee and leading the committee meetings. The Advisory Committee reviews and provides feedback on the technical memoranda prepared during the development of the GSP and provides input to the Implementation Team regarding issues addressed in the GSP, and the eventual actions to implement the GSP.

The MOA established the WVWD as the treasurer for the Spadra Basin GSA who shall hold all monies contributed by the parties to the MOA, and with approval of the Executive Committee, pay all invoices and bills relating to services rendered in connection with the MOA.

Bylaws for the Spadra Basin GSA organization and management structure are in Appendix C of this GSP.

The contact information for the Plan Manager for this GSP is:

[Sherry Shaw](#)
Director of Engineering, Walnut Valley Water District
271 S. Brea Canyon Road
Walnut, CA 91789
(909) 595-1268 x.234

1.2.2 Legal Authority of the GSA

The SGMA provides legal authority to local public agencies that have water supply, water management, or land uses responsibilities in a basin to become a GSA and develop and implement a GSP. Pomona and WVWD formed the Spadra Basin GSA through a February 27, 2017 MOU in accordance with Water Code [§ 10723.6\(a\)](#) as the exclusive GSA for the entire Spadra Basin. In accordance with the SGMA, the Spadra Basin GSA has all the powers and authorities available to ~~them-it~~ outlined in ~~the~~ Chapters 5, 8, and 9 of the SGMA legislation, which provides the necessary legal authority for the Spadra Basin GSA to carry out the preparation and implementation of the GSP. The following SGMA statutes provide the powers and authorities to the GSA:

- Chapter 5 (Water Code § 10725 ~~Et-et~~ seq.) provides certain powers and authorities to the Spadra Basin GSA to perform duties, exercise powers, and accept responsibility for managing groundwater sustainability in the Spadra Basin. Some of these duties and powers are: adopting rules, regulations, ordinances, ~~and~~ resolutions policies and procedures to support GSP implementation and sustainable groundwater management; conduct investigations to support sustainable groundwater management and implementation of the GSP; require the registration of groundwater extraction facilities; and require the measurement and reporting of groundwater extraction at every extraction facility except for *de minimis* extractors who pump two acre-feet per year (afy) or less for domestic purposes.
- Chapter 8 (Water Code § 10730 ~~Et-et~~ seq.) provides the financial authorities to the Spadra Basin GSA to propose and collect fees on groundwater production to fund the costs of the GSP development, implementation and management.
- Chapter 9 (Water Code § 10732 ~~Et-et~~ seq.) provides enforcement powers to the Spadra Basin GSA to impose penalties and bring actions in the Superior Court against persons who extract groundwater in excess of an authorized amount or who violate a rule, regulation, ordinance, or resolution of the GSA.

1.3 NOTICE AND COMMUNICATION WITH STAKEHOLDERS

The GSP Regulations [Title 23 \(23\) California Code of Regulations \(CCR\)](#) § 354.10, requires a summary of information related to the notification and communication with stakeholders by the GSA during the process to develop the GSP. This includes:

- Description of beneficial uses and users of groundwater in the basin, including land uses and property interest affected by the use, the persons or entities representing those interests, and the nature of consultation with those interests.
- Summary of public meetings at which the GSP was discussed or considered by the GSA.
- All comments regarding the GSP received by the GSA and a summary of responses.
- Description of communication including: the GSA decision making process; identification of opportunities for public engagement and how public input is used; and encouragement of active involvement of diverse social, cultural, and economic elements of the population within the basin.

1.3.1 Beneficial Uses and Users of Groundwater

The SGMA requires that a GSA consider the interest of all beneficial uses and users of groundwater in the development of the GSP. Pursuant to SGMA, [in](#) Water Code § 10723.2, the beneficial uses and users of groundwater to [be](#) [considered](#) in the GSP development include but are not limited to the following: holders of overlying groundwater rights (including agricultural users and domestic well owners); municipal well operators; public water systems; local land use planning agencies; environmental users of groundwater; surface water users; the federal government; Native American tribes; disadvantaged communities; and other local agencies that are monitoring and managing groundwater usage in the GSP area.

The beneficial uses in the Spadra Basin are potable municipal supply (sometimes after treatment or blending); non-potable water supply for municipal, industrial, and agricultural uses; and domestic supply.

The Spadra Basin GSA prepared and submitted to the DWR a list of all beneficial uses and users of groundwater in the Spadra Basin (Appendix D). The beneficial users of the Spadra Basin include the following holders of overlying ~~and~~ groundwater rights for agricultural [users](#) and domestic water well owners: WVWD, Pomona, CPP, and Walnut Hills Mobile Home Community. WVWD, Pomona, and CPP are municipal well operators for public water systems, and Walnut Hills Mobile Home Community is a private well operator for domestic use. Pomona and WVWD are parties to the MOA that formed the Spadra GSA. The Walnut Hills Mobile Home Community and CPP are not parties of the Spadra Basin GSA, but the GSA has engaged with these [agencies-entities](#) to encourage their participation in the preparation of the GSP. CPP is currently the largest groundwater producer in the Spadra Basin but is statutorily prohibited from becoming a member of the GSA. The CPP is a key stakeholder and member of the Spadra Basin Advisory Committee that provides input on the development of the GSP and its implementation (see Section 1.2.1).

Pomona is also the local land use planning agency. Portions of the Spadra Basin in the City of Pomona are considered Disadvantaged Communities by the DWR.

There are none of the following beneficial users in the Spadra Basin listed in Water Code § 10723.2: environmental users of groundwater, surface water users, federal government, and Native American tribes.

1.3.2 Notice

Prior to the official formation of the Spadra Basin GSA, public notices were published in local newspapers in February 2017 by the WVWD and Pomona to provide notice of a public hearing on the formation of the GSA. Copies of these notices are in Appendix E.

A [Spadra Basin GSA website](#) was established as the central repository for all information related to the Spadra Basin GSA and the GSP process. The Spadra Basin GSA website includes information on the Spadra Basin, the SGMA, the Spadra Basin, GSA organization structure, stakeholder engagement, and a calendar of meetings. All meeting agendas, meeting minutes, presentations, notices, press releases, project reports and other related information is made available on the website. In addition, the website provides options for contacting the Spadra Basin GSA and interested parties can sign-up to receive all GSA and GSP related notifications.

The Spadra Basin GSA compiled an initial list of stakeholders and interested persons for the development of the Spadra Basin GSP. The initial list is included in an appendix of the Stakeholder Engagement Plan described in Section 1.3.3.1 below. These interested persons were included in an email list of persons and

interested stakeholders as required in Water Code §10723.4 to receive notices regarding plan preparation, meeting announcements, availability of draft plans and other relevant documents. Regular mail was used for any person(s) that did not have access to email.

Information about the Spadra Basin GSA and GSP development was distributed to the stakeholder list via email or mail, including notification of all meetings. The Spadra Basin GSA Executive Committee and Advisory Committee meetings are open to the public and were noticed at least 72 hours prior to ~~the~~each meeting.

1.3.3 Communication and Stakeholder Involvement

The Spadra Basin GSA is committed to an open, transparent, and inclusive public outreach and education process that supports the development and implementation of the GSP for the Spadra Basin. All interested ~~party~~parties or stakeholders are encouraged to participate.

1.3.3.1 Stakeholder Identification and Engagement

The Spadra Basin Implementation Team₂ with oversight ~~of~~from the Executive Committee prepared a Spadra Basin GSA Stakeholder Engagement Plan (Appendix F) to encourage engagement with the public and stakeholders of diverse social, cultural, and economic elements of the population within the basin, and describe the ways that the public and interested stakeholders can participate in the development and implementation of the Spadra Basin GSP. The Stakeholder Engagement Plan for the Spadra Basin GSA describes the GSA's program to:

- Identify stakeholder who have an interest in the Spadra Basin.
- Understand and involve stakeholders and their concerns in the decision-making process, including the anticipated schedule for providing information to the stakeholders and receiving feedback during the GSP development and its implementation.
- Evaluate the success of stakeholder engagement methods.

An initial list of the Spadra Basin stakeholders was developed and included as an appendix to the Spadra Basin GSA Stakeholder Engagement Plan in Appendix F of this GSP. The GSA maintained and modified this list through the GSP development process and will continue to do so during GSP implementation.

1.3.3.2 Opportunity for Public and Stakeholder Participation

The Spadra Basin GSA Advisory Committee was formed of representatives from interested Spadra Basin stakeholders to oversee and provide guidance on the GSP development and implementation. The Advisory Committee meetings are the forum to present all content used to prepare the GSP in an open and transparent process, and to receive feedback from all interested parties and stakeholders. All meetings of the Spadra Basin GSA Advisory Committee (and the Executive Committee) include an opportunity for public comments.

The schedule and process to develop the GSP was done in five phases:

- **Phase I** – Develop Hydrogeologic Conceptual Model and Groundwater Model for the Spadra Basin
- **Phase II** – Develop Sustainable Management Criteria for the Spadra Basin
- **Phase III** – Evaluate the Sustainability of Future Baseline Conditions

- **Phase IV** – Evaluate Basin Optimization Scenarios to Achieve Sustainability
- **Phase V** - Develop GSP

Five technical memoranda were prepared in sequence with input from interested stakeholders and the public along the way. Each technical memorandum (TM) represents an interim milestone in the development of the GSP and ultimately became sections in this GSP and were used to help prepare the GSP monitoring and implementation plans. The five technical memoranda were:

- **Technical Memorandum 1 (TM 1)** – Conceptual Model of the Spadra Basin
- **Technical Memorandum 2 (TM 2)** – Construction and Calibration of the Spadra Basin Groundwater Model
- **Technical Memorandum 3 (TM 3)** – Sustainable Management Criteria for the Spadra Basin
- **Technical Memorandum 4 (TM 4)** – Sustainability of Future Baseline Conditions
- **Technical Memorandum 5 (TM 5)** – Basin Optimization Scenarios to Achieve Sustainability

The contents of each draft TM were presented at one or more Advisory Committee meetings, and stakeholders and the public had a four-week review period to provide comments and suggested edits. All draft TMs were published on the [GSA website documents page](#):

The comments received and the responses to comments were documented in an appendix to the final TM, along with edits based on the comments. Appendix G of this GSP includes all the comments and responses for each of the TMs. The final TMs were posted to the GSA website documents page.

The same review process ~~will happen~~[applies with to](#) this GSP. All public and stakeholder comments received on the draft GSP and response to those comments ~~will be~~[is](#) included in Appendix H.

1.3.3.3 Decision-making process

The Advisory Committee provides guidance, input, and advice in connection with the development and implementation of the GSP, and reviews and provides feedback on the draft technical memoranda and the GSP. The Executive Committee is responsible for the overall management of the GSA and if needed will implement measures if insufficient or unsatisfactory progress is being made in the development and implementation of the GSP. The Executive Committee approves all interim technical memoranda and other items related to the GSP development and implementation, including the final GSP.

1.3.4 Meetings

The Executive Committee and Advisory Committee meetings were held regularly. Executive Committee and Advisory Committee meetings were held bi-monthly (every two months) throughout the GSP development process. All meeting agendas and minutes are located on the Meetings/Agendas page on the Spadra Basin [website](#). All meeting presentations are available on the Resources page on the Spadra Basin [website](#).

The table below ~~Table 1-1~~ provides a complete list of all Executive Committee meetings held during the GSA formation and the GSP development process.

Table 1-1. Spadra Basin GSA Executive Committee Meetings			
2018	2019	2020	2021
June 7, 2018	January 7, 2019	January 6, 2020	January 4, 2021
July 2, 2018	March 4, 2019	March 2, 2020	March 1, 2021
August 6, 2018	May 6, 2019	May 4, 2020	May 3, 2021
September 4, 2018	July 1, 2019	July 6, 2020	July 6, 2021
October 1, 2018	August 5, 2019	September 8, 2020	September 7, 2021
November 5, 2018	September 3, 2019	November 2, 2020	November 16, 2021
-	November 4, 2019	-	-

The table below ~~Table 1-2~~ provides a complete list of all Advisory Committee meetings held during the GSP development process.

Table 1-2. Spadra Basin GSA Advisory Committee Meetings	
2019 and 2020	2021
November 19, 2019	February 4, 2021
February 3, 2020	April 1, 2021
June 1, 2020	June 3, 2021
August 3, 2020	July 6, 2021
October 5, 2020	August 7, 2021
December 7, 2020	September 15, 2021
-	November 10, 2021
	December 15, 2021

1.3.5 Comments

The Executive Committee and Advisory Committee meetings included a scheduled time for public comments. There were no public comments offered during these designated comment periods.

As described in *Section 1.3.3.2 Opportunity for Public and Stakeholder Participation* above, the interested public and stakeholders of the Spadra Basin had the opportunity to provide comments on the draft technical memoranda prepared in the development of the GSP. All comments received and the responses to comments were documented in an appendix of each final TM. Appendix G of this GSP includes all Comments and Responses for each of the TMs. The five final TMs are available on the Resources page on the Spadra Basin [website](#).

1.4 GSP ORGANIZATION

This GSP meets the minimum requirements of the DWR's GSP Regulations and statutory provisions of SGMA as described in *Article 5—Plan Contents* ~~of the (as described in California Code of Regulations, 23 CCR)~~, [Title 23, Division 2, Chapter 1.5, Subchapter 2](#)). The Spadra Basin GSP is organized based on the recommended outline in the DWR's guidance document *GSP Annotated Outline* (DWR, 2016). The *Preparation Checklist for the GSP* in Table 1-3 maps the GSP requirements in accordance with the DWR's GSP Regulations to the corresponding sections of this GSP. The GSP is organized as follows:

- **Section 1.0 Introduction.** This section summarizes the purpose of the GSP, information about the Spadra Basin GSA and its organizational structure, the beneficial uses and users of groundwater, the notice and communication with stakeholders, and the organization of the GSP.
- **Section 2.0 Plan Area and Basin Setting.** This section presents a description of the Plan Area and Basin Setting of the Spadra Basin. The Plan Area is a general description of the GSP area including jurisdictional boundaries, existing monitoring and management plans, and the overlying land uses, water uses and water disposal. The Basin Setting includes a detailed description of the hydrogeologic conceptual model of the Spadra Basin, its surface-water and groundwater hydrology over a long-term historical period to current conditions, the historical and current water budget, and the data gaps and levels of uncertainty in the description of the Basin Setting.
- **Section 3.0 Sustainable Management Criteria.** This section presents the conditions that constitute sustainable groundwater management in the Spadra Basin in accordance with the GSP Regulations, [23 CCR § 354.22](#) through [§ 354.30](#). This section defines the Sustainability Indicators relevant to the Spadra Basin, and a description of the Undesirable Results, Minimum Thresholds, Measurable Objectives, and Interim Milestones for each Sustainability Indicator. This section also includes a description of the Sustainability Goal for the Spadra Basin.
- **Section 4.0 Monitoring Network.** This section describes the monitoring network and monitoring procedures for GSP implementation designed to assess the conditions in the basin necessary to evaluate progress towards achieving Measurable Objectives and avoiding exceedance of Minimum Thresholds and Undesirable Results. This section also describes the process to fill data gaps that were identified during GSP preparation.
- **Section 5.0 Projects and Management Actions to Achieve Sustainability.** This section describes the development and evaluation of future projects and management actions necessary to achieve the Sustainability Goal. The section begins with a description and evaluation of a future Baseline Scenario that was used to guide the need for and the development of three Basin Optimization Scenarios. The Basin Optimization Scenarios are modifications of the Baseline Scenario that include projects and management actions to achieve sustainability and/or maximize the beneficial use of the basin. This section includes a recommendation for the preferred Basin Optimization Scenario for GSP implementation.
- **Section 6.0 Plan Implementation.** This section describes the plan to implement the GSP, including a schedule and cost estimates. This section also outlines the procedure for annual reporting and the periodic (5-year) evaluations of the GSP.
- **Section 7.0 References.** This section lists the references and publications used to prepare this GSP.

Table 1-3. Preparation Checklist for Spadra Basin GSP			
GSP Regulations Section	Requirement	Description	Section Number, or other location in the GSP
Article 3. Technical and Reporting Standards			
352.2	Monitoring Protocols	Monitoring protocols adopted by the GSA for data collection and management	Section 4.1
		Monitoring protocols that are designed to detect changes in groundwater levels, groundwater quality, inelastic surface subsidence for basins for which subsidence has been identified as a potential problem, and flow and quality of surface water that directly affect groundwater levels or quality or are caused by groundwater extraction in the basin	Section 4.1
Article 5. Plan Contents, Subarticle 1. Administrative Information			
354.4	General Information	Executive Summary	Executive Summary
		List of references and technical studies	Section 7
354.6	Agency Information	GSA mailing address	Section 1.2
		Organization and management structure	Section 1.2.1
		Contact information of Plan Manager	
		Legal authority of GSA	Section 1.2.2
		Estimate of implementation costs	Section 6.2
354.8(a)	Map(s)	Area covered by GSP	Section 2.1.1
		Adjudicated areas, other agencies within the basin, and areas covered by an Alternative	
		Jurisdictional boundaries of federal or State land	
		Existing land use designations	Section 2.1.3.1
		Density of wells per square mile	Section 2.1.2.3
354.8(b)	Description of the Plan Area	Summary of jurisdictional areas and other features	Section 2.1.1
354.8(c) 354.8(d) 354.8(e)	Water Resource Monitoring and Management Programs	Description of water resources monitoring and management programs	Section 2.1.2
		Description of how the monitoring networks of those plans will be incorporated into the GSP	Section 4.0
		Description of how those plans may limit operational flexibility in the basin	Not applicable
		Description of conjunctive use programs	
354.8(f)	Land Use Elements or Topic Categories of Applicable General Plans	Summary of general plans and other land use plans	Section 2.1.3
		Description of how implementation of the GSP may change water demands or affect achievement of sustainability and how the GSP addresses those effects	
		Description of how implementation of the GSP may affect the water supply assumptions of relevant land use plans	
		Summary of the process for permitting new or replacement wells in the basin	Section 2.1.3.4
		Information regarding the implementation of land use plans outside the basin that could affect the ability of the Agency to achieve sustainable groundwater management	Not applicable (optional)
354.8(g)	Additional GSP Contents (optional items)	Description of Actions related to: Control of saline water intrusion	Not applicable (optional)
		Wellhead protection	Section 2.2.3.7
		Migration of contaminated groundwater	
		Well abandonment and well destruction program	Section 2.1.3.4
		Replenishment of groundwater extractions	Not applicable (optional)
		Conjunctive use and underground storage	
		Well construction policies	Sections: 5.3, 5.4
		Addressing groundwater contamination cleanup, recharge, diversions to storage, conservation, water recycling, conveyance, and extraction projects	
		Efficient water management practices	
		Relationships with State and federal regulatory agencies	
		Review of land use plans and efforts to coordinate with land use planning agencies to assess activities that potentially create risks to groundwater quality or quantity	
		Impacts on groundwater dependent ecosystems	
354.10	Notice and Communication	Description of beneficial uses and users	Section 1.3.1
		List of public meetings	Section 1.3.4
		GSP comments and responses	Section 1.3.5
		Decision-making process	Section 1.3.3.3
		Public engagement	Section 1.3.3.2
		Encouraging active involvement	Sections 1.3.3.2, 1.3.3.3
		Informing the public on GSP implementation progress	Section 1.3.2
Article 5. Plan Contents, Subarticle 2. Basin Setting			
354.14	Hydrogeological Conceptual Model	Description of the Hydrogeologic Conceptual Model	Section 2.2.2
		Two scaled cross-sections	Section 2.2.2.5 and Figures 2-15 a, b, c, d, e
		Map(s) of physical characteristics: topographic information, surficial geology, soil characteristics, surface water bodies, source and point of delivery for imported water supplies	Figures 2-11, 2-12, and 5-15

Table 1-3. Preparation Checklist for Spadra Basin GSP			
GSP Regulations Section	Requirement	Description	Section Number, or other location in the GSP
354.14(c)(4)	Map of Recharge Areas	Map delineating existing recharge areas that substantially contribute to the replenishment of the basin, potential recharge areas, and discharge areas	Figures 2-8, and Figure 5-16
	Recharge Areas	Description of how recharge areas identified in the plan substantially contribute to the replenishment of the basin	Section 2.2.2.7
354.16	Current and Historical Groundwater Conditions	Groundwater elevation data	Section 2.2.2.11 and Figures 2-18 a, b, c, d
		Estimate of groundwater storage	Section 2.2.2.11
		Seawater intrusion conditions	Not applicable; this is described Section 3.2
		Groundwater quality issues	Section 2.2.3
		Land subsidence conditions	Section 2.2.4
		Identification of interconnected surface water systems	Not applicable; this is described Sections 2.2.5 and 3.2
		Identification of groundwater-dependent ecosystems	
354.18	Water Budget Information	Description of inflows, outflows, and change in storage	Section 2.2.6
		Quantification of overdraft	Sections 2.2.6.1.3 and 2.2.3.1.4
		Estimate of sustainable yield	Section 2.2.6.1.4
		Quantification of current, historical, and projected water budgets	Section 2.2.6
	Surface Water Supply	Description of surface water supply used or available for use for groundwater recharge or in-lieu use	Section 2.1.3.3
354.20	Management Areas	Reason for creation of each management area	Not applicable
		Minimum thresholds and measurable objectives for each management area	
		Level of monitoring and analysis	
		Explanation of how management of management areas will not cause undesirable results outside the management area	
		Description of management areas	
Article 5. Plan Contents, Subarticle 3. Sustainable Management Criteria			
354.24	Sustainability Goal	Description of the sustainability goal	Section 3.4
354.26	Undesirable Results	Description of undesirable results	Section 3.3
		Cause of groundwater conditions that would lead to undesirable results	
		Criteria used to define undesirable results for each sustainability indicator	
		Potential effects of undesirable results on beneficial uses and users of groundwater	
354.28	Minimum Thresholds	Description of each minimum threshold and how they were established for each sustainability indicator	Section 3.3
		Relationship for each sustainability indicator	
		Description of how selection of the minimum threshold may affect beneficial uses and users of groundwater	
		Standards related to sustainability indicators	
		How each minimum threshold will be quantitatively measured	
354.30	Measurable Objectives	Description of establishment of the measurable objectives for each sustainability indicator	Section 3.3
		Description of how a reasonable margin of safety was established for each measurable objective	
		Description of a reasonable path to achieve and maintain the sustainability goal, including a description of interim milestones	Section 3.5
Article 5. Plan Contents, Subarticle 4. Monitoring Networks			
354.34	Monitoring Networks	Description of monitoring network	Section 4.0
		Description of monitoring network objectives	Section 4.0
		Description of how the monitoring network is designed to: demonstrate groundwater occurrence, flow directions, and hydraulic gradients between principal aquifers and surface water features; estimate the change in annual groundwater in storage; monitor seawater intrusion; determine groundwater quality trends; identify the rate and extent of land subsidence; and calculate depletions of surface water caused by groundwater extractions	Section 4.1
		Description of how the monitoring network provides adequate coverage of Sustainability Indicators	Section 4.1
		Density of monitoring sites and frequency of measurements required to demonstrate short-term, seasonal, and long-term trends	Section 4.1

Table 1-3. Preparation Checklist for Spadra Basin GSP			
GSP Regulations Section	Requirement	Description	Section Number, or other location in the GSP
		Scientific rational (or reason) for site selection	Sections 4.1 and 3.3
		Consistency with data and reporting standards	Section 4.1
		Corresponding sustainability indicator, minimum threshold, measurable objective, and interim milestone	Sections 4.1 and 3.3
		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 Description of technical standards, data collection methods, and other procedures or protocols to ensure comparable data and methodologies	Section 4.1, Table 4-1, and Figure 4-1
354.36	Assessment and Improvement of Monitoring Network	Description of representative sites	Sections 4.1 and 3.3
		Demonstration of adequacy of using groundwater elevations as proxy for other sustainability indicators	Sections 4.1.1.1.1, 3.3.2, and 3.3.4
		Adequate evidence demonstrating site reflects general conditions in the area	Sections 4.1, and 4.3
354.38		Review and evaluation of the monitoring network	Sections 4.3 and 6.1.4
		Identification and description of data gaps	Section 4.3
		Description of steps to fill data gaps	Section 4.3
		Description of monitoring frequency and density of sites	Sections 4.1 and 4.3
Article 5. Plan Contents, Subarticle 5. Projects and Management Actions			
354.44	Projects and Management Actions	Description of projects and management actions that will help achieve the basin’s sustainability goal	Sections 5.3 and 5.4
		Measurable objective that is expected to benefit from each project and management action	
		Circumstances for implementation	
		Public noticing	
		Permitting and regulatory process	
354.44(b)(2)		Timetable for initiation and completion, and the accrual of expected benefits	Sections 5.4, 6.2, and 6.3
		Expected benefits and how they will be evaluated	
		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.	
		Legal authority required	
		Estimated costs and plans to meet those costs	Section 5.3
		Management of groundwater extractions and recharge	

SECTION 2

Plan Area and Basin Setting

2.1 PLAN AREA

The Plan Area is a description of the geographic area for the GSP and the interaction of the GSP with existing jurisdictions, monitoring and management plans, and land uses. The Plan Area description addresses the requirements of GSP Regulations [23](#) CCR § 354.8 of the GSP Regulations and includes the following descriptions:

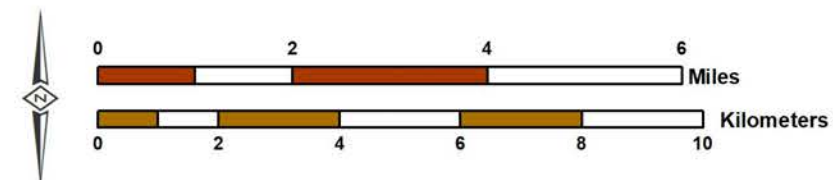
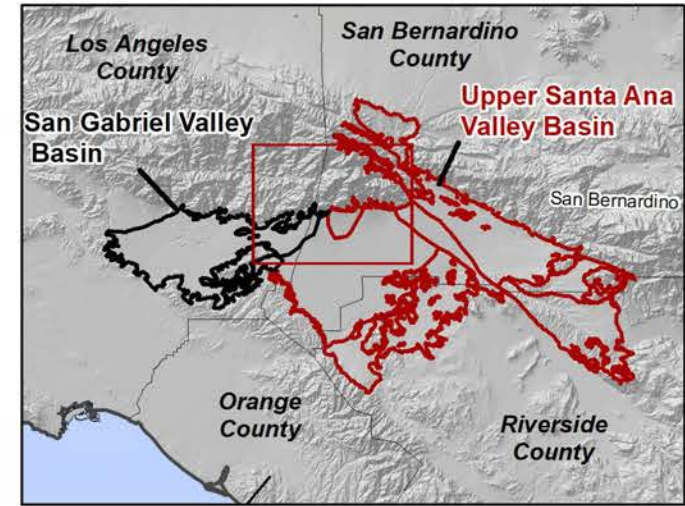
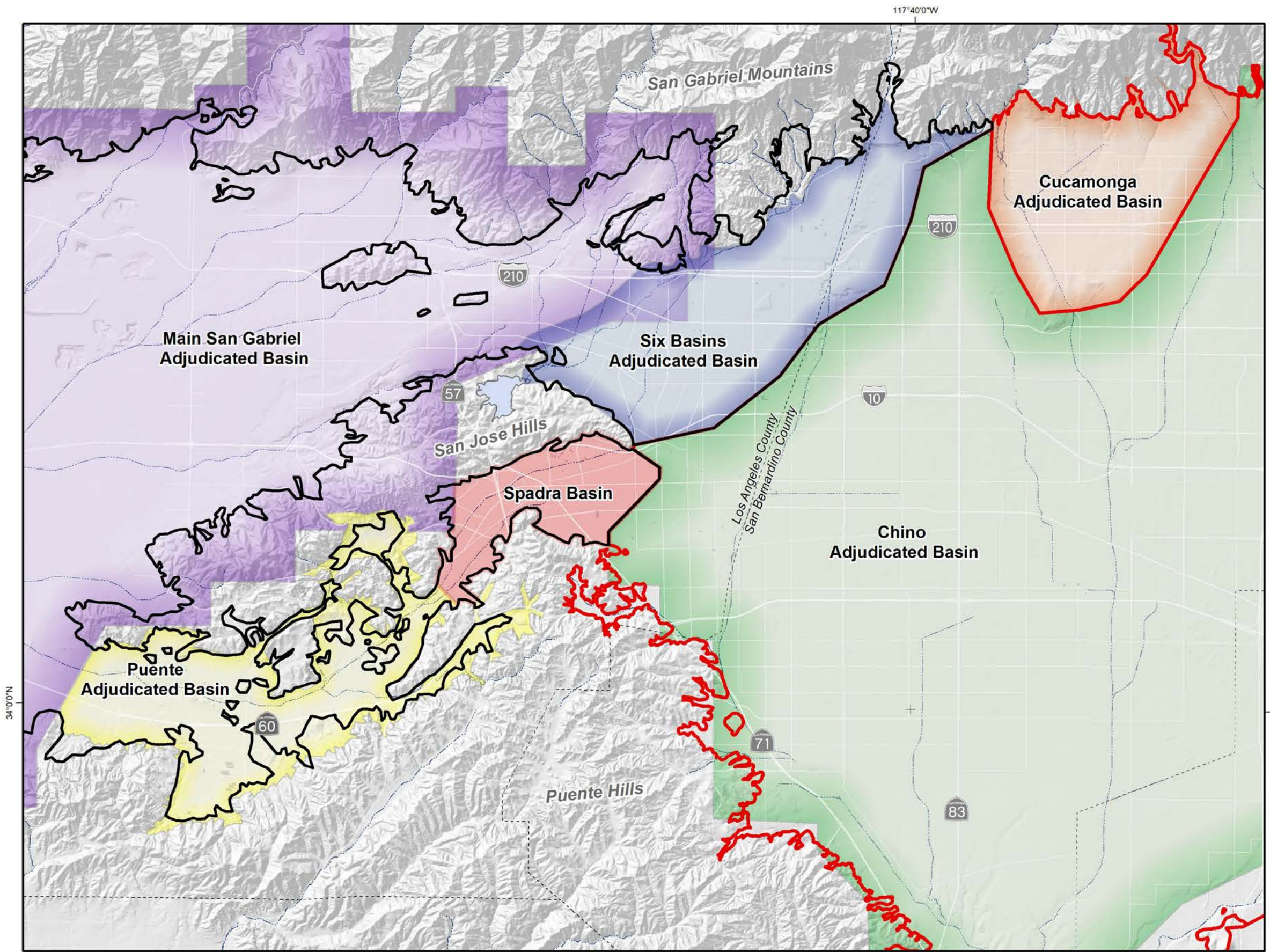
- Jurisdictional areas and other features
- Existing monitoring and groundwater management programs
- Historical and current land use, water use, and water disposal

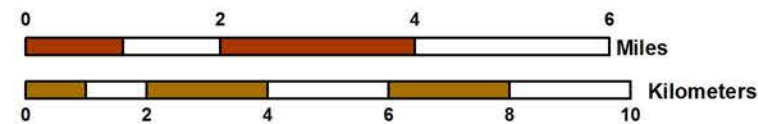
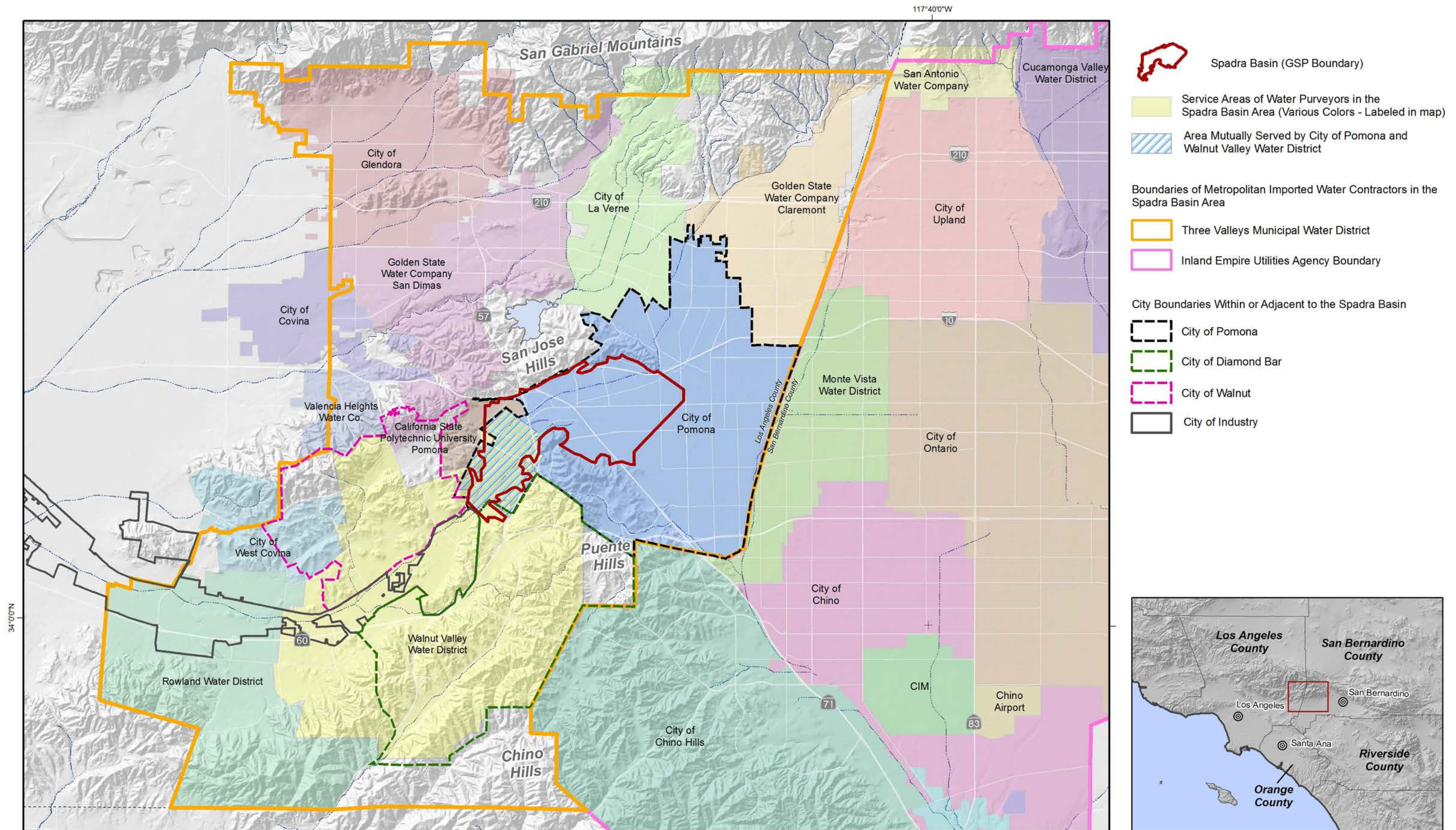
2.1.1 Jurisdictional Area and Other Features

The Spadra Basin is a relatively small groundwater basin, about seven square miles (4,200 acres), in eastern Los Angeles County in Southern California. It sits at the eastern end of the northeast-southwest trending San Jose Valley between the San Jose Hills and Puente Hills. Figure 2-1 shows the location of the Spadra Basin and nearby groundwater basins. The Spadra Basin boundary shown on Figure 2-1 is the Spadra Basin GSA boundary, which is defined as the unadjudicated portion of the San Gabriel Valley Groundwater Basin as defined in the DWR's *Bulletin 118 California's Groundwater Update 2003* (Basin No. 4-013) exclusive of the adjudicated boundaries of the Main San Gabriel and Puente Basins. The eastern boundary of the Spadra Basin is the western boundary of the Chino subbasin of the Upper Santa Ana Valley Groundwater Basin (Basin No. 8-002.01 as defined in Bulletin 118). The Spadra Basin is surrounded by four adjudicated groundwater basins: the Puente Basin to the southwest, the Main San Gabriel Basin to the northwest, the Six Basins to the north, and Chino Basin to the east.

Figure 2-2 shows the location of the Spadra Basin and the water purveyors in the area. Pomona, the WVWD, and CPP are the local water purveyors with service area boundaries overlying the Spadra Basin. The water purveyors obtain water supplies from multiple sources including groundwater, local surface water, treated imported water from the State Water Project and Colorado River, and recycled water. The water purveyors purchase imported water from the Three Valleys Municipal Water District (TVMWD), a sub-agency of the Metropolitan Water District of Southern California (Metropolitan). The Spadra Basin lies within the TVMWD's service area. Pomona's service area overlies the majority of the Spadra Basin. WVWD's service area overlies a smaller portion of the Spadra Basin to the west and CPP's service area overlies a small portion in the north. In the western portion of the Spadra Basin, there is an overlap of the Pomona and WVWD service areas where water is served by both purveyors.

Figure 2-2 also shows the location of cities within and immediately adjacent to the Spadra Basin. The City of Pomona boundary overlies the majority of the Spadra Basin and is the same boundary as the Pomona water service area boundary. The City of Diamond Bar overlies a very small corner of the Spadra Basin to the south, and the Cities of Walnut and Industry are located just west of the Spadra Basin; all three cities are served by the WVWD.





2.1.2 Existing Water Resources Monitoring and Management Programs

The Spadra Basin is an unadjudicated portion of the San Gabriel Valley Basin (Basin No. 4-013). There is no formal basin management plan for the water resources in the Spadra Basin and there are no defined restrictions on groundwater pumping. The Spadra Basin GSA agencies are parties to the Judgments for the adjacent adjudicated groundwater basins: Six Basins, Puente Basin, and Chino Basin. Pomona is a party to the Six Basins Judgment (*Southern California Water Company vs. City of La Verne, et al.*) and Chino Basin Judgment (*Chino Basin Municipal Water District vs. City of Chino et al.*); the WVWD is a party to the Puente Basin Judgment (*Puente Basin Water Agency et al. vs. The City of Industry et al.*).

There are some regional water management plans that include Spadra Basin groundwater, including Urban Water Management Plans prepared by water purveyors in the Spadra Basin area and the *Water Quality Control Plan, Los Angeles Region* (LA Basin Plan) prepared by the California Regional Water Quality Control Board, Los Angeles Region (LA Regional Board). These water management plans are described in more detail below.

Monitoring of water resources in the Spadra Basin generally consists of uncoordinated efforts by water purveyors to measure and record groundwater pumping, groundwater quality, and groundwater levels. Surface-water monitoring is conducted by the Los Angeles County Sanitation Districts (LACSD) at the Pomona Water Reclamation Plant (Pomona WRP) for discharge and water quality.

2.1.2.1 Urban Water Management Plans

Urban Water Management Plans are prepared every five years pursuant to requirements in the California Water Code (§_10610-10656 and §_10608), by urban water purveyors who serve more than [3,000 customers or supply more than 3,000 afy of water](#). These plans support the water purveyors' long-term resource planning to ensure that adequate water supplies are available to meet existing and future water needs. Spadra Basin groundwater is described primarily as a non-potable water supply in several 2015 Urban Water Management Plans, including:

- **City of Pomona 2015 Urban Water Management Plan** (Pomona, 2016). Pomona pumps groundwater from three wells in the Spadra Basin primarily to supplement the City's non-potable water system. One of the wells can supply water to the City's potable water system on a limited basis.
- **Walnut Valley Water District 2015 Urban Water Management Plan** (Civiltec Engineering, 2016). The WVWD pumps groundwater from one well in the Spadra Basin to supplement the District's non-potable water system.
- **Rowland Water District 2015 Urban Water Management Plan** (RMC Water and Environment, 2016). Spadra Basin groundwater pumped by the WVWD and used to supplement its non-potable water system can be delivered to Rowland Water District via an emergency recycled water connection.

2.1.2.2 LA Basin Plan

The responsibility for protecting water quality in California rests with the State Water Resources Control Board (State Water Board) and its nine Regional Water Quality Control Boards, who set policies and develop water quality control plans for their respective regions. The Spadra Basin is within the jurisdiction of the LA Regional Board who has developed the LA Basin Plan pursuant to state and federal water quality statutes and regulations to preserve and enhance water quality and protect beneficial uses of all regional waters in the Los Angeles Region (LA Regional Board, 2019). Specifically, the Basin Plan (i) designates beneficial uses for surface and groundwaters, (ii) sets objectives that must be attained or maintained to protect the designated beneficial uses and conform to the State's Antidegradation Policy, and (iii) describes implementation programs and other actions that are necessary to achieve the water quality objectives established in the Basin Plan. The Spadra Basin is part of the Bulletin 118 San Gabriel Valley Basin which has the following designated beneficial uses for groundwater indicated in Section 2, Table 2-2 of the Basin Plan:

- Municipal and Domestic Supply (MUN)
- Industrial Service Supply (IND)
- Industrial Process Supply (PROC)
- Agricultural Supply (AGR)

The State's policies and plans are based on the State Water Board's Antidegradation Policy (Resolution 68-16), which restricts the degradation of surface water or groundwater quality to protect their beneficial uses. Section 3 of the LA Basin Plan includes narrative water-quality objectives for regional groundwaters and specific numerical objectives for sub-basins in the region. The LA Basin Plan of the LA Regional Board contains numeric water-quality objectives for the Spadra Basin to maintain or protect the designated beneficial uses and conform to the State's Antidegradation Policy. When the existing water quality of a groundwater basin is better than its Basin Plan objective, then the water body has "assimilative capacity" for degradation. The Antidegradation Policy is implemented, in part, through Waste Discharge Requirements (WDRs) issued by the Regional Boards. In the Spadra Basin, this includes the reclamation requirements for discharges to groundwater from recycled water reuse from the LACSD's Pomona Water Reclamation Plant (Pomona WRP).

The LA Basin Plan also includes salt and nutrient management plans (SNMPs) for groundwater basins in the Los Angeles Region, that were developed pursuant to the State Water Board's 2009 *Policy for Water Quality Control for Recycled Water* (Recycled Water Policy). The Recycled Water Policy requires that a SNMP be prepared for all high priority¹ groundwater basins in the State to address: the potential for salt and nutrient degradation in groundwater from all sources, the potential impairment of beneficial uses, and to support recycled water reuse programs. Pursuant to this requirement, the Main San Gabriel Basin Watermaster in conjunction with other primary stakeholders² prepared *The San Gabriel Valley Basin SNMP* ([San Gabriel SNMP] Stetson Engineers Inc., 2016) to provide a framework for water management practices in the San Gabriel Valley Groundwater Basin to ensure beneficial uses and sustainability of groundwater resources, consistent with the LA Regional Board's water quality objectives. The San Gabriel SNMP was adopted by the LA Regional Board on December 8, 2016, the State Water Board on

¹ The basin priority designation for the Recycled Water Policy is different than that used by DWR for the SGMA.

² Upper San Gabriel Valley Municipal Water District, San Gabriel Valley Municipal Water District, Three Valley's Municipal Water District, County of Los Angeles Department of Public Works, Metropolitan Water District, and Los Angeles County Sanitation Districts.

May 16, 2017, and the Office of Administrative Law on December 19, 2018, and was subsequently included in Section 8 of the LA Basin Plan. The San Gabriel SNMP only incorporates the portions of the Bulletin 118 San Gabriel Valley Basin included in the Main San Gabriel Basin Judgment; the Spadra Basin was excluded from the San Gabriel SNMP. Consequently, there is no SNMP for the Spadra Basin.

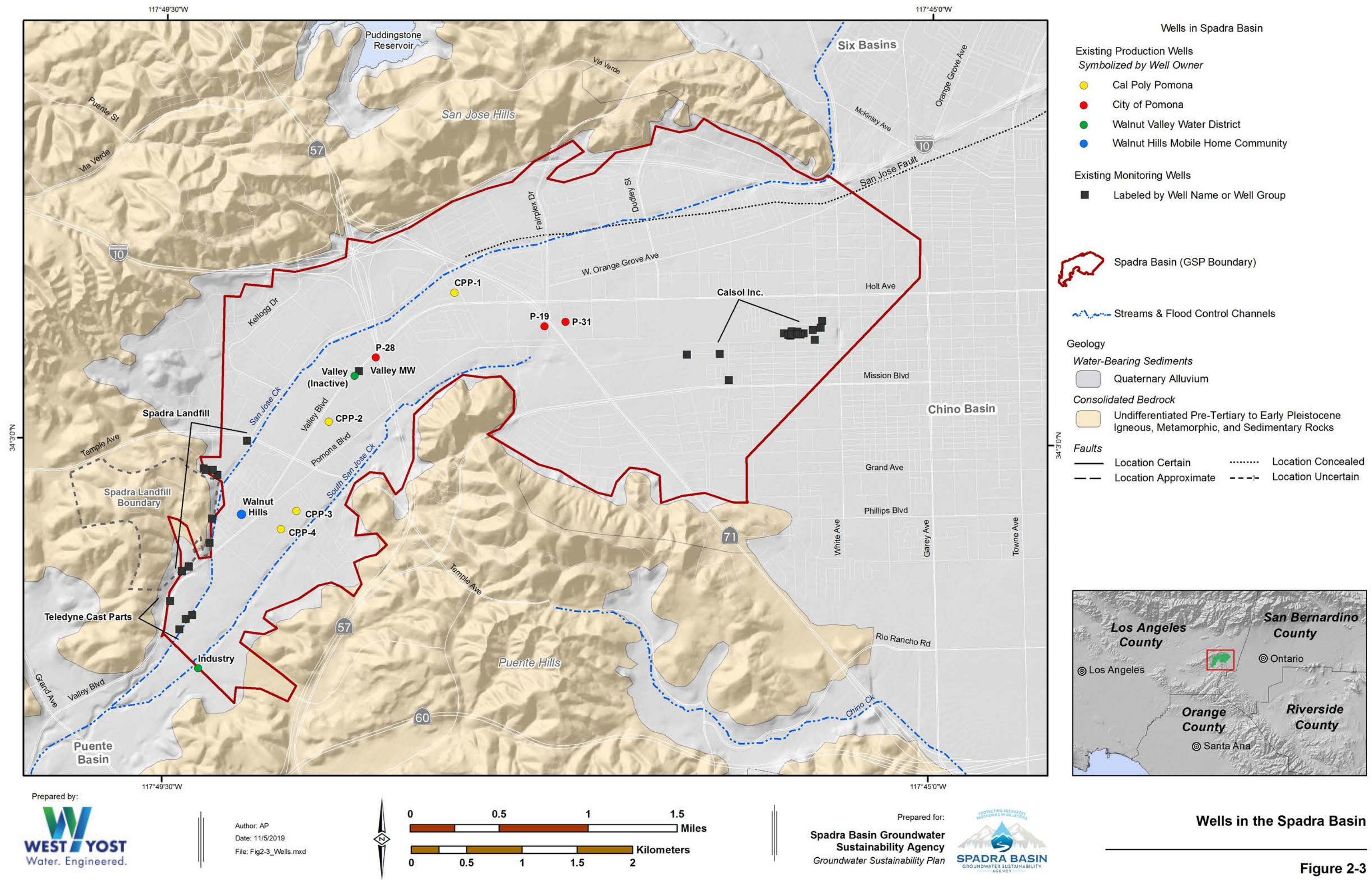
2.1.2.3 Groundwater Monitoring

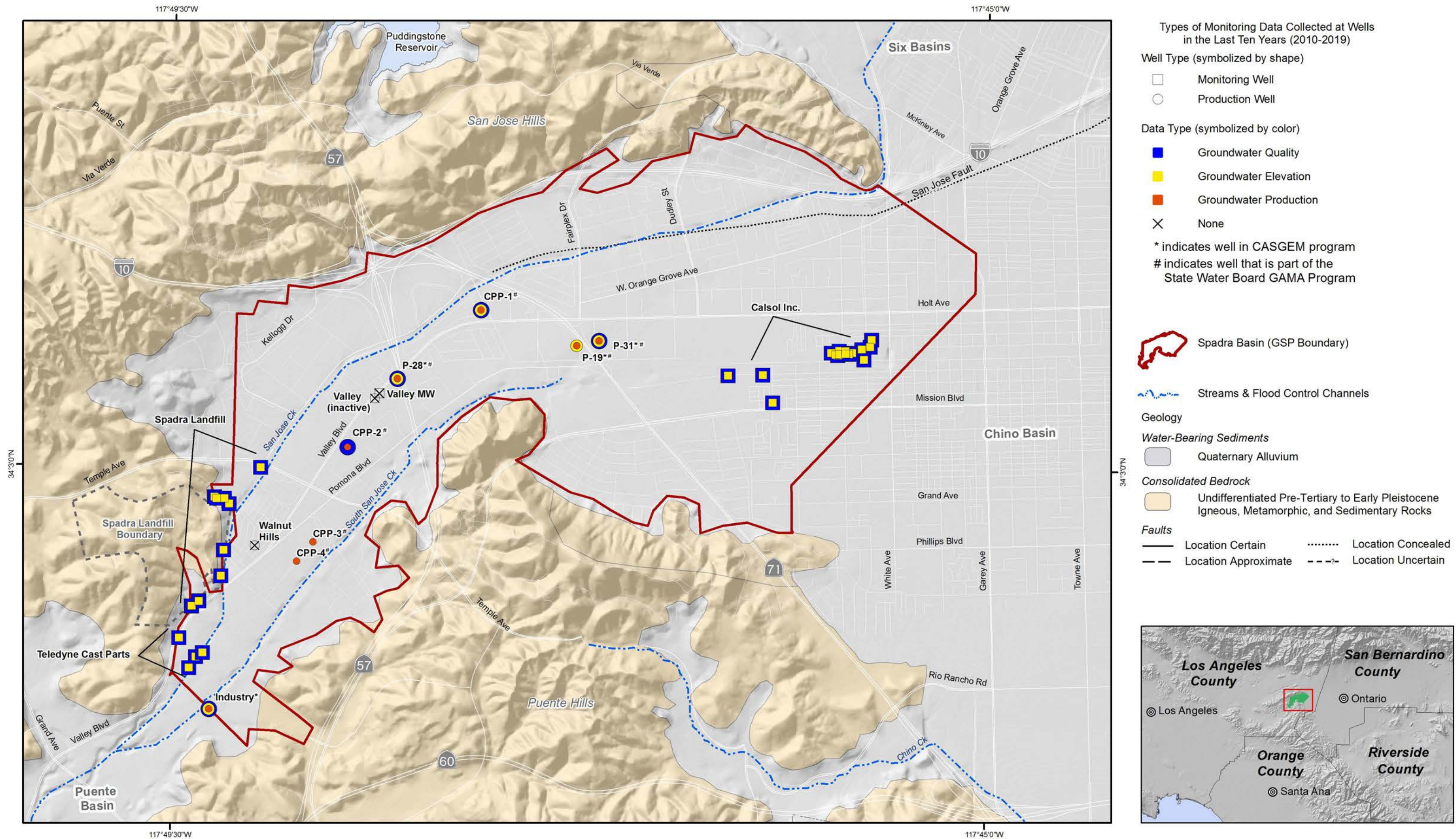
Figure 2-3 shows the locations of all known existing wells in the Spadra Basin. There are 10 known production wells: nine are municipal wells owned and operated by Pomona, WVWD, and CPP; one is owned by the Walnut Hills Mobil Home Park. Groundwater pumped from the municipal wells is primarily used as a supplemental supply source for non-potable uses by these water purveyors. Except for one production well owned by the WVWD, all wells are active (*i.e.*, they are currently used to pump groundwater). The production wells are generally located along the axis of the Spadra Basin, and their spatial density ranges from one to three wells per square mile. There may potentially be additional, privately owned production wells in the Spadra Basin that are yet to be identified.

There are 29 known monitoring wells in the Spadra Basin: 28 are associated with point-source contaminant sites at the Spadra Landfill, Teledyne Cast Parts, and Calsol Inc., one is a WVWD monitoring well located near WVWD's inactive "Valley" well.

Figure 2-4 characterizes the groundwater data that have been collected at wells in the Spadra Basin within the last 10 years, from 2010 to 2019. Currently, groundwater monitoring in the Spadra Basin occurs at the municipal production wells owned by water purveyors, and at wells installed for monitoring at the three point-source contaminant sites. Groundwater-quality samples are collected at most of the active production wells by the well owners for informational and operational purposes or to comply with State Water Resources Control Board Division of Drinking Water (DDW) monitoring schedules for water systems. Table 2-1 summarizes the groundwater monitoring that has occurred at Spadra Basin wells over the last 10 years.

Table 2-1. Summary of Groundwater Data Collected in the Last Ten Years (2010-2019) at Spadra Basin Wells				
Well Type and Status	Total No. of Wells in Spadra Basin	No. of Wells with Production Data	No. of Wells with Groundwater Quality Data	No. of Wells with Groundwater Level Data
Active Municipal Production Well	8	8	5	5
Inactive Municipal Production Well	1	0	0	0
Active Private Production Well	1	0	0	0
Contaminate Site Monitoring Well	29	-	29	29
Other Monitoring Well	1	-	0	0
Total	40	8	34	34





Production data is measured at eight of the active production wells (owned by water purveyors), and groundwater-quality and groundwater-level data are collected at some of these wells. No groundwater data have been collected from the active private production well (owned by Walnut Hills Mobile Home Park) or the inactive municipal production well.

At the 29 monitoring wells associated with the Spadra Landfill, Teledyne Cast Parts, and Calsol Inc. sites, groundwater-quality and groundwater-level data have been collected during the last ten years. There is one monitoring well where no groundwater data have been collected.

Four wells in the Spadra Basin are part of the DWR's California Statewide Groundwater Elevation Monitoring (CASGEM) Program—these wells are annotated with a “*” symbol in Figure 2-4. The Puente Basin Watermaster is the designated CASGEM monitoring entity for the Puente Basin and the Spadra Basin subbasins of the San Gabriel Valley Basin and has been reporting groundwater elevations for the four wells semi-annually since 2011. Five wells in the Spadra Basin are part of the State Water Board's Groundwater Ambient Monitoring and Assessment (GAMA) Program—these wells are annotated with a “#” symbol in Figure 2-4.

2.1.3 Land Use, Water Use, and Disposal in the Spadra Basin

This section describes the historical and current land use, water use, and disposal of water in the Spadra Basin. The overlying land use impacts water demand and supply patterns. For example, outdoor water uses can result in return flows to the groundwater basin. Indoor water uses generate wastewaters that are conveyed to a treatment plant or to a septic system. It is important to understand overlying land use, water use, and disposal together because different land uses have different imperviousness, irrigation practices, and disposal practices that affect the volume of return flows to the groundwater basin. Furthermore, land use, water use, and disposal are an important influence on groundwater quality: the concentration of dissolved constituents in return flows is typically higher relative to groundwater, causing degradation of groundwater quality.

2.1.3.1 Land Use and Source Waters

Figure 2-5 illustrates the overlying land use in the Spadra Basin in 1949, 1975, 1990, and 2017. Figure 2-6 shows the land-use changes in Figure 2-5 quantified by acreage. The land-use maps were developed from DWR land use surveys for 1949 and 1975, and from Southern California Association of Governments (SCAG) surveys for 1990 and 2017. The maps show a change in land use over time from primarily irrigated agriculture (crops, pastures, fruit, nuts, and citrus) and vacant lands in 1949 to urban (residential, commercial, and industrial) land uses by 2017. By 1975, about 78 percent of the overlying land use in the Spadra Basin was urban. By 2017, urban land uses accounted for about 93 percent of overlying land use, while irrigated agriculture accounted for six percent, associated with lands owned by the State of California and utilized by CPP for growing various crops for the university's horticultural program.

Pomona is the primary land use planning agency in the Spadra Basin. The urban and agricultural lands owned by CPP are not covered by Pomona and have a different land use planning process through the state. With the exception of a few vacant properties, the lands overlying the Spadra Basin are completely developed, and land and water use are not projected to change significantly in the future.

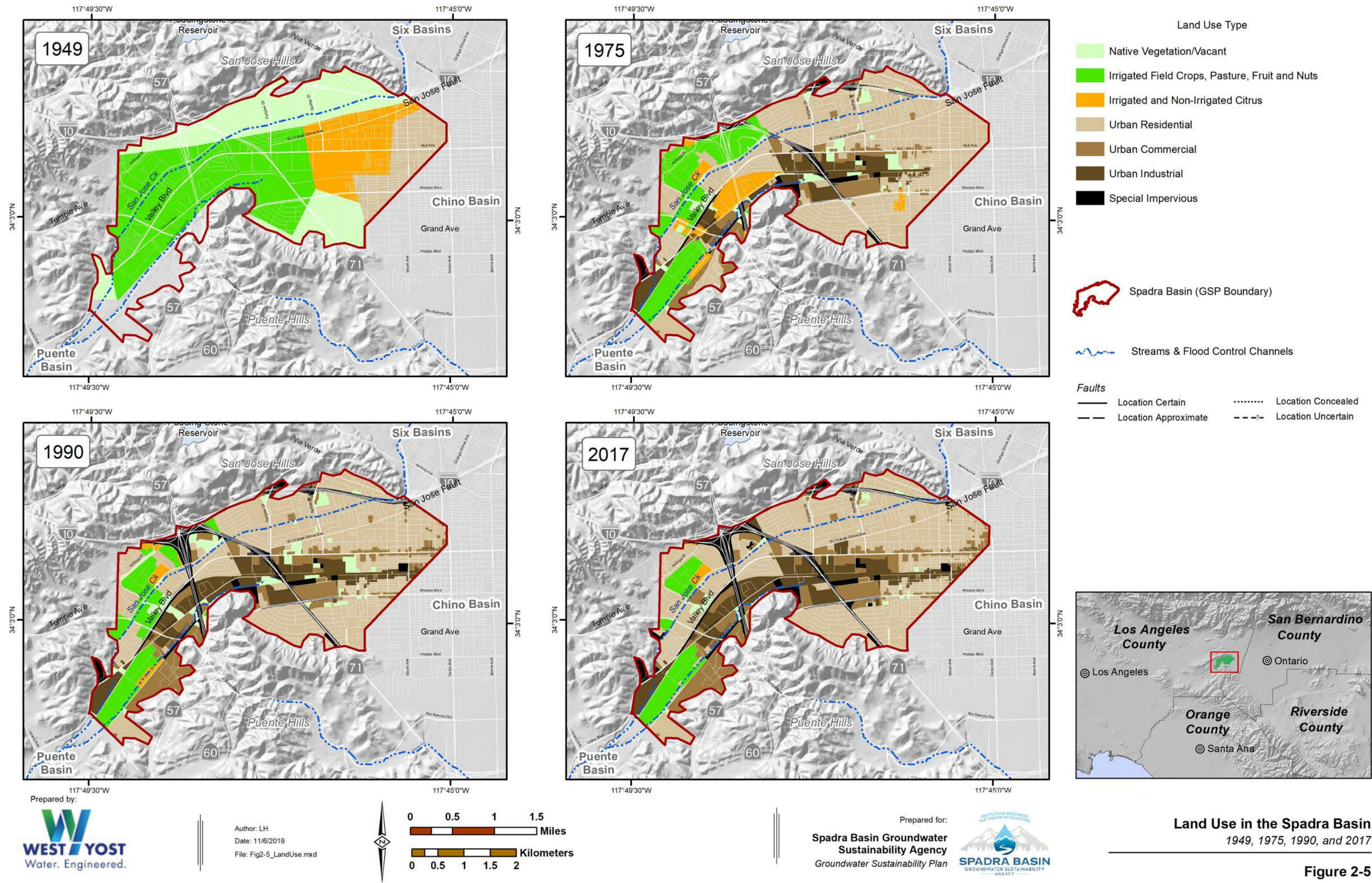
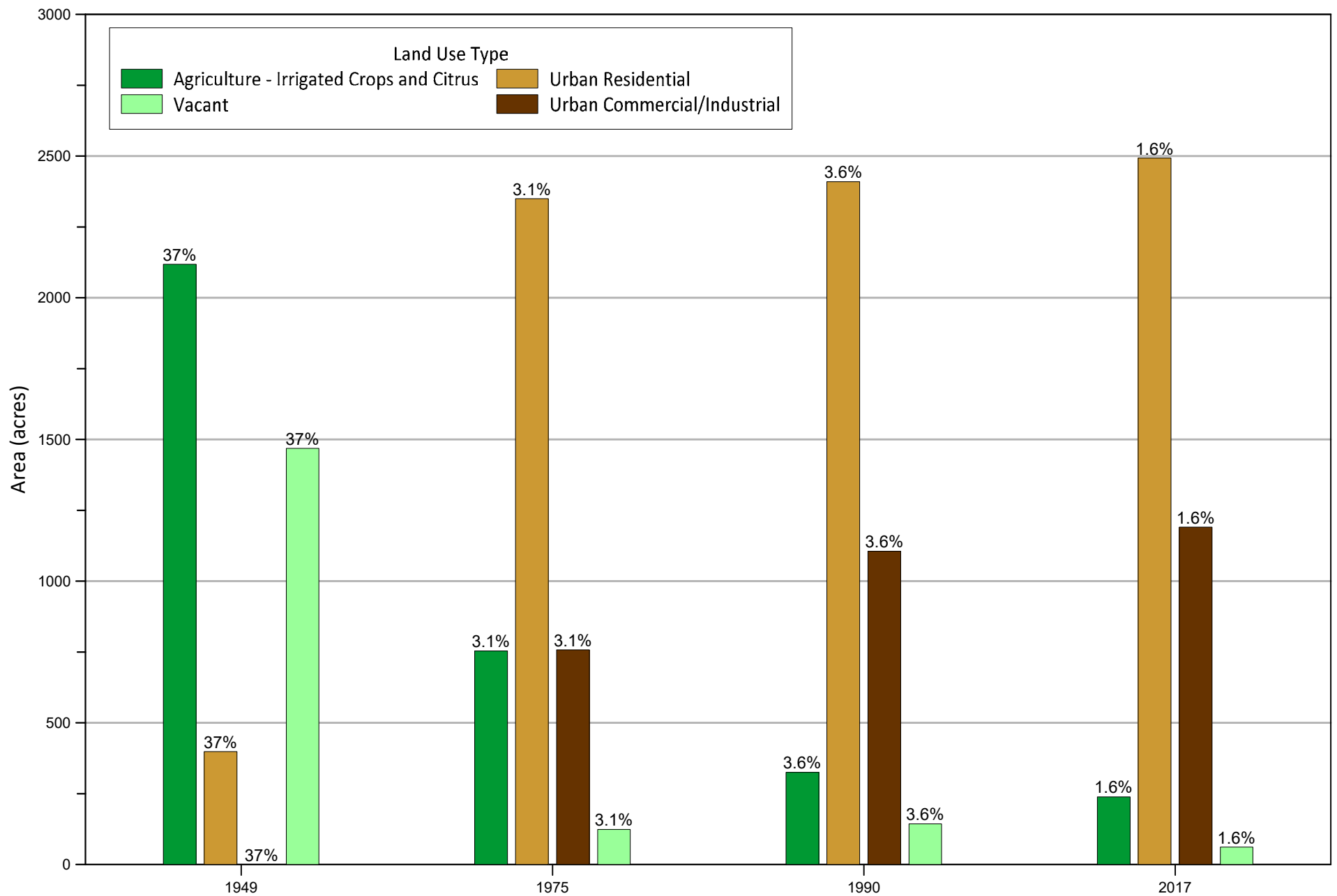


Figure 2-6. Land Use Changes by Type - 1949 to 2017



The water purveyors with Urban Water Management Plans anticipate having sufficient water supplies from their various sources to serve the overlying land uses in the future. The development of the Spadra GSP is intended to maximize the beneficial use and reliability of Spadra Basin groundwater.

2.1.3.2 Outdoor Water Use and Return Flows

Irrigation return flows to groundwater are a function of land imperviousness and irrigation efficiency. When land was converted from vacant or agricultural to urban uses, the imperviousness of the Spadra Basin increased from near zero to between 20 and 100 percent, depending on the specific land use. The Los Angeles County Public Works Department (LACPWD) assumes a two percent impervious area for orchards and vineyards in their hydrology manual (LACPWD, 2006). By contrast, LACPWD assumes urbanized areas have a much higher fraction of imperviousness, typically ranging from about 20 percent for very low-density residential areas to about 90 percent or more for apartments, mobile home courts, and high-rise offices.

Irrigated agriculture and irrigated urban lands have different irrigation efficiencies.³ The lower the efficiency, the more applied water will infiltrate past the root zone to the aquifer system. The typical efficiency of crop irrigation or flood-irrigated citrus groves is 60 percent or less. Modern irrigation methods, such as trickle irrigation, can achieve 90 percent efficiency (Pier, 2006). The combination of higher imperviousness and higher irrigation efficiency associated with urban land uses reduces the return flows of applied water. Thus, the change from agricultural to urban land uses in the Spadra Basin resulted in reduced irrigation return flows, and hence, reduced recharge to the basin.

Additionally, irrigation return flows typically degrade groundwater quality. Agriculture, and to a lesser degree urban landscape irrigation, is associated with the application of fertilizers and pesticides that dissolve in the applied water. Plant uptake of the water concentrates the dissolved constituents within the return flows. The return flows are a non-point source of contaminant loading to the groundwater basin that has affected, and continues to affect, the groundwater quality of the Spadra Basin.

2.1.3.3 Disposal of Water

Surface-water runoff over lands that does not infiltrate, exits the Spadra Basin in concrete-lined storm-drain systems and flood-control channels. The two major concrete-lined channels exiting the Spadra Basin are the San Jose Creek and South San Jose Creek—their locations are shown in Figure 2-7. The surface-water runoff that exits the Spadra Basin in these channels is put to beneficial use by downstream entities mainly for groundwater recharge, is consumptively used by riparian vegetation in unlined stream reaches or flows to the ocean.

The land use agencies overlying the Spadra Basin are regulated by National Pollutant Discharge Elimination System (NPDES) Municipal Separate Storm Sewer System Order No. R4-2012-0175 (MS4 Permit). As part of the MS4 Permit, new development and redevelopment projects are required to control pollutants, pollutant loads, and runoff volumes from development sites.

³ Irrigation efficiency is defined as the ratio of the use of the applied water by the plants to the total water applied (UCCE, 2000).

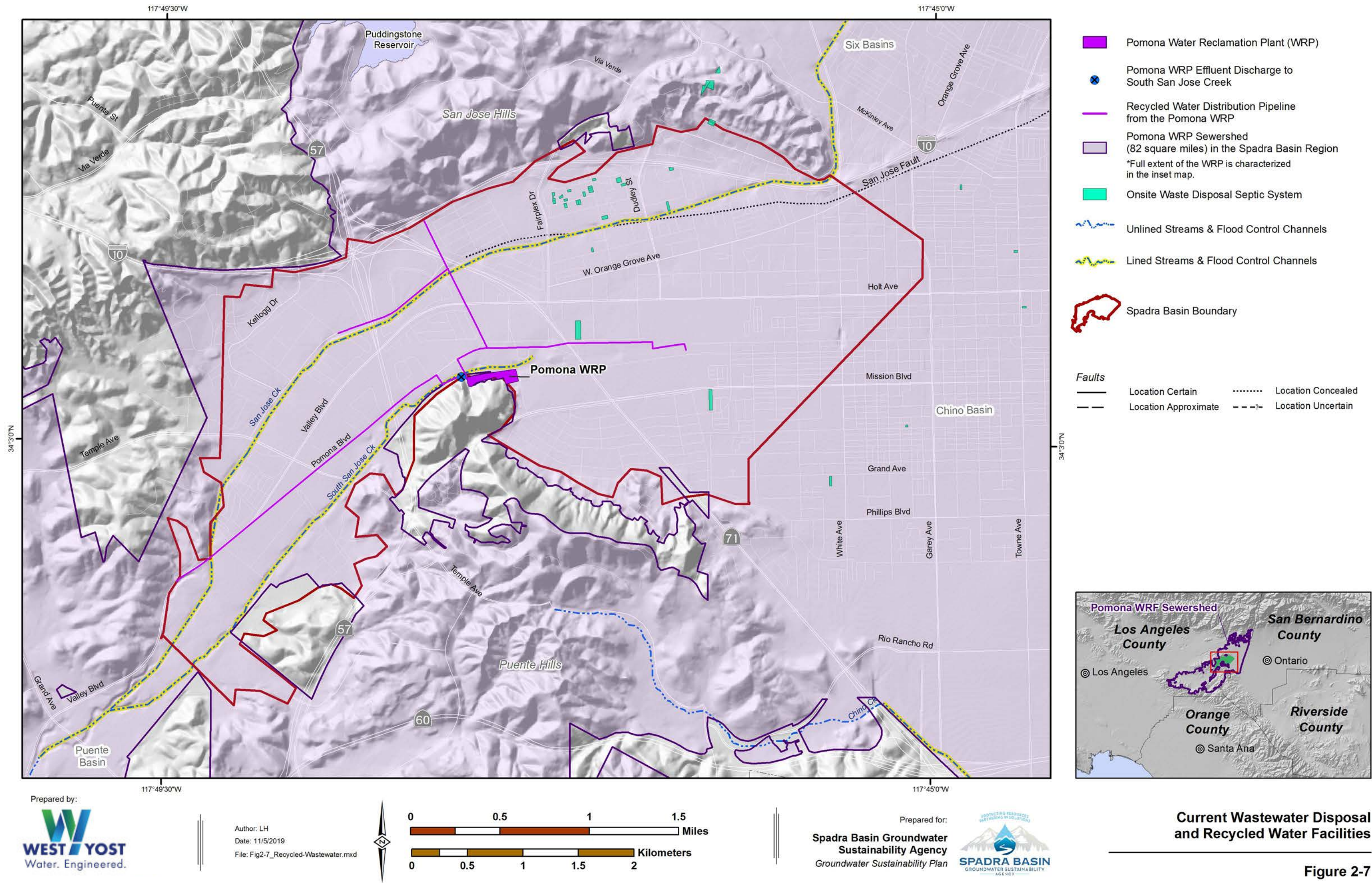


Figure 2-7

Section 2

Plan Area and Basin Setting



Figure 2-7 shows the current wastewater disposal and recycling facilities in the Spadra Basin. The Pomona WRP, located in the Spadra Basin, is a regional facility that receives and treats wastewater originating from indoor residential, commercial, and industrial uses within an 82 square-mile area in the eastern portion of Los Angeles County. It is owned and operated by the Joint Outfall System⁴ of the LACSD. The tertiary-treated recycled water from the Pomona WRP is either discharged to South San Jose Creek, used for irrigation or commercial processes, or recharged outside the Spadra Basin, subject to the following permits:

- NPDES No. CA0053619 Order No. R4-2014-0212 and WDRs for the Joint Outfall System Pomona Water Reclamation Plant Discharge to the South Fork San Jose Creek Via Outfall 001
- Water Reclamation Requirements (WRRs) for County Sanitation Districts of Los Angeles County and others, 1981 Order No. 81-24; readopted in 1997 Order No. 97-072
- Monitoring and Reporting Program (M&RP) No. 6241, ordered July 27, 1981
- WRRs for Groundwater Recharge at the Montebello Forebay Order No. 91-100

Currently, recycled water from the Pomona WRP is reused by Pomona and the WVWD at approximately ~~210-211~~ sites over 2,393 acres in the Spadra Basin and Puente Basin ~~over approximately 2,300 acres~~ (LACSDHartling, E., personal communication, 2018/2022). Recycled water that is not delivered for direct reuse is discharged to the concrete-lined South San Jose Creek where it flows into the San Gabriel River about 15 miles downstream and recharged at spreading grounds in the Montebello Forebay overlying the Central Basin. In ~~2018/2020~~, approximately ~~45-50~~ percent of the recycled water from Pomona WRP was reused within the Spadra Basin and Puente Basin (3,124 af), and ~~55-50~~ percent was used for recharge at the Montebello Forebay (3,122 af) (LACSD, 2019Hartling, E., personal communication, 2022).

In 2019, the LACSD filed a wastewater change petition with the State Water Board to reduce the discharge of treated wastewater to South San Jose Creek from the Pomona WRP to zero during all months of the year based on recycled water demand. A notice of the wastewater change petition (WW0104) was published on October 15, 2019 by the State Water Board with a public protest period through November 14, 2019. This change petition was granted in October 2020 allowing for the potential utilization of this surplus recycled water in the Spadra Basin (State Water Board and California EPA, 2020).

Figure 2-7 also shows that some urbanized areas without sewer, and the disposal of wastewater occurs via on-site waste disposal (septic) systems. These areas are mainly located in northern portion of the Spadra Basin along the San Jose Hills. This wastewater has the potential for adverse impact on groundwater quality in downgradient areas—particularly regarding nitrate. Studies have indicated that return flows from septic systems have a nitrate-nitrogen concentration ranging from 30-40 milligrams per liter (mg/l) (Environmental Protection Agency [EPA], 2002; Wildermuth Environmental [WEI], 2007; Kennedy/Jenks Consultants, 2013).

⁴ Signatory parties to the amended Joint Outfall Agreement effective July 1, 1995 includes County Sanitation Districts of Los Angeles County Nos 1, 2, 3, 5, 8, 15, 16, 17, 18, 19, 22, 22, 23, 28, 29, and 34, and South Bay Cities Sanitation District of Los Angeles County.

2.1.3.4 Permitting of New Wells and Destruction of Wells

The well permitting agencies in the Spadra Basin include the California Department of Public Health (CDPH) and the Los Angeles County Department of Public Health (LADPH). The CDPH regulates production well construction for municipal water purveyors with service connections of 200 or more.

The LADPH is responsible for reviewing plans and approving private residential water wells and small water systems that serve fewer than 200 service connections and for production well construction for municipal water purveyors with service connections of 200 or more after approval from the CDPH. The LADPH requires an *Application for Well/Exploration Hole Permit*⁵ ~~(application)~~ be submitted for the construction, reconstruction, or destruction of a well. The LADPH is required to respond to an application within ten days after receiving it. For newly constructed or reconstructed wells, the LADPH requires site visits to evaluate the location and the installation of the well seal, the submittal of the well log, and the submittal of required water-quality testing results.

2.2 BASIN SETTING

The Basin Setting is a detailed description of the surface-water and groundwater hydrology of the Spadra Basin over a long-term historical period through current conditions, including the identification of data gaps and the level of uncertainty in the description. The Basin Setting addresses the requirements of Article 5, Sub article 2 of the GSP Regulations, and will serve as the basis for the construction and calibration of the numerical groundwater-flow model and the development of Sustainable Management Criteria for the Spadra Basin.

2.2.1 Surface-Water Hydrology

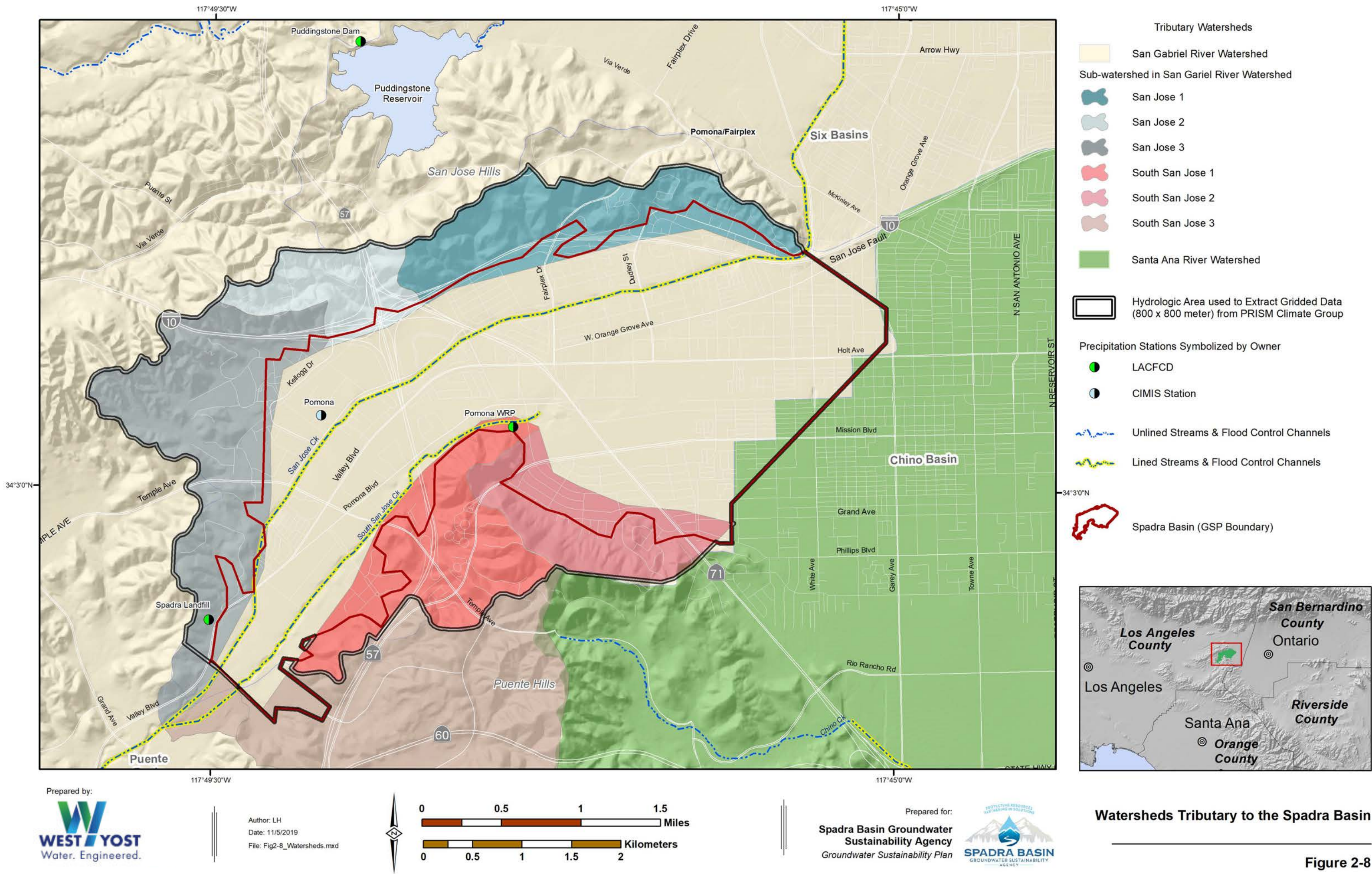
The following subsections describe the surface water resources tributary to the Spadra Basin.

2.2.1.1 Tributary Sub-watersheds

Figure 2-8 shows the primary watersheds and sub-watersheds that are tributary to the Spadra Basin. Along the northern margin of the basin, there are three sub-watersheds in the San Jose Hills (San Jose 1, 2, and 3) which generally flow from north to south. Along the northern margin of the basin, there are three sub-watersheds in the Puente Hills (South San Jose 1, 2, and 3) which generally flow from south to north. These six sub-watersheds in the surrounding hills are part of the San Gabriel River watershed.

Precipitation falling on pervious areas within the sub-watersheds in the hills can combine with any applied water in the soils, infiltrate past the root zone, and recharge the Spadra Basin as underflow from the San Jose Hills and Puente Hills. Precipitation falling on pervious areas overlying the basin can combine with any applied water in the soils, infiltrate past the root zone, and recharge the Spadra Basin directly. Stormwater and dry-weather runoff in the basin and from the sub-watersheds in the hills typically enter concrete-lined flood-control storm drains and channels that exit the Spadra Basin via the San Jose Creek and South San Jose Creek and flow about 13 miles downstream into the San Gabriel River. Currently, there are no artificial recharge facilities in the Spadra Basin that can divert and recharge surface-water runoff. A small area in the eastern portion of the Spadra Basin is part of the Santa Ana River watershed. Runoff generated in the Santa Ana River watershed flows south into the Prado Flood Control Basin in the southern portion of the Chino Basin.

⁵ [Public Health LA County](#)



2.2.1.2 Precipitation

The climate in the Spadra Basin area is characteristic of a semi-arid Mediterranean climate with generally dry summers and comparatively wet winters. Precipitation is a natural source of recharge to the Spadra Basin and can be characterized by looking at long-term records. Figure 2-8 shows the locations of active precipitation stations that have varying historical records dating as far back as the ~~1940s~~1930s. Table 2-2 below summarizes the active stations, their owner/operator, elevation, and period of record.

Table 2-2. Active Daily-Precipitation Gages in the Spadra Basin				
Station ID	Owner/Operator	Surface Elevation, ft-amsl	Period of Record	
			Date Range	Length of Record, years
Spadra Landfill (1260)	Los Angeles County Flood Control District	700	1988 - present	32
Pomona WRP	Los Angeles County Flood Control District	786	1981 - Present	39
Puddingstone Dam	Los Angeles County Flood Control District	1,030	1931 – Present	89
Pomona (78)	California Irrigation Management Information System (CIMIS)	730	1985 – present	35

Gridded data sets of precipitation data are also available including the National Oceanic and Atmospheric Administration (NOAA) Next-Generation Radar⁶ (NEXRAD), and the PRISM Climate Group (PRISM).⁷ Monthly precipitation estimates from the PRISM gridded data (an 800-meter by 800-meter grid) were computed as a spatial average across the hydrologic area of Spadra Basin shown in Figure 2-8 to characterize precipitation in the Spadra Basin. Figure 2-9 shows the annual precipitation time-history, the long-term average annual precipitation, and the cumulative departure from mean (CDFM) precipitation for this hydrologic area of Spadra Basin for the 124-year period from 1895 to 2018. The CDFM plot is a useful way to characterize the occurrence and magnitude of wet and dry periods. When the slope of the CDFM plot trends downward from left to right, the annual precipitation is less than the average precipitation, and when the slope continues downward for more than one year, the CDFM indicates a dry period. When the slope of the CDFM plot trends upward from left to right, annual precipitation is greater than average precipitation, and when the slope continues upward for more than one year, the CDFM is indicates a wet period. Based on Figure 2-9, the precipitation trends in the region have been:

- 8-year dry period from 1896 through 1903
- 18-year wet period from 1904 through 1921
- 14-year dry period from 1922 through 1935
- 9-year wet period from 1936 through 1944

⁶ [NCDC NOAA Radar-Data Nexrad](#)

⁷ [Prism Oregon State Education](#)

- 32-year dry period from 1945 through 1976
- 9-year wet period from 1977 through 1982
- 8-year dry period from 1983 through 1990
- 7-year wet period from 1991 through 1997
- 21-year dry period from 1998 through 2018

Figure 2-9 shows that precipitation is highly variable, and that there are generally three to five years of consecutive, below-average precipitation before an average or above-average year occurs. The last 21 years constitute a long dry period.

The monthly variation in precipitation is also important to understand the availability of storm water throughout the year. Figure 2-10 is a statistical characterization of monthly precipitation in Spadra Basin in the form of a Box and Whisker Plot based on the monthly precipitation estimates from PRISM Climate Group. The Box and Whisker Plot shows the minimum, lower quartile, median, upper quartile, and maximum, precipitation values. Over the period of record, the median monthly precipitation ranges from 0 to 2.7 and the minimum monthly precipitation total was zero inches in every month of the year. The plot shows that most of the annual precipitation occurs during the period of November through March (the median greater than about two inches per month in these months), with the highest monthly precipitation occurring in January and February. A minor amount of precipitation (median less than one-half an inch per month) occurs during the period of May through October.

2.2.2 Hydrogeologic Conceptual Model

This section describes the evolution, structure, and composition of the Spadra Basin aquifer system and the occurrence and movement of groundwater. The section concludes with an initial estimate of the long-term yield that has been developed from the Spadra Basin and a discussion of data gaps.

The hydrogeology of the Spadra Basin area has been studied by various entities and authors in the past, including Mendenhall (1908), Eckis (1934), California DWR (1947, 1966, 1970), Ecological Systems Corporation (1975), Donald R. Howard Consulting Engineers (1999), Fox/Roberts (2001), and Worley Parsons Resources and Energy (2009). The hydrogeologic description below was prepared from a review of prior studies and from original work performed for this effort.

2.2.2.1 Geologic Setting

Figure 2-11 is a geologic map of the Spadra Basin and the surrounding area (Morton and Miller, 2006). The Spadra Basin is a relatively narrow, alluvial-filled valley located between the San Jose Hills and Puente Hills at the northern end of the Peninsular Ranges. The Spadra Basin was formed as tectonic compression and faulting uplifted the Tertiary and pre-Tertiary consolidated bedrock formations of the San Jose Hills and Puente Hills. An eastward-flowing ancestral stream carved a narrow canyon into the bedrock formations that deepens to the east. In Quaternary time, as the San Gabriel Mountains to the north were elevated, sediments were eroded and washed out of the mountains by San Antonio Creek, depositing a broad alluvial fan that emanates from the mouth of San Antonio Canyon. The progradation of the alluvial fan began to fill the valley between the San Jose Hills and Puente Hills with unconsolidated sediments, as San Antonio Creek may have flowed through this valley towards the west. Sediments were also eroded and deposited in the valley from local tributaries flowing out of the San Jose Hills and Puente Hills. The interconnected pore spaces within the Quaternary sediments are today's groundwater reservoirs of the Spadra Basin.

Figure 2-9. Annual Precipitation and CDFM - Spadra Basin and Tributary Watersheds - Water Year 1896 to 2019

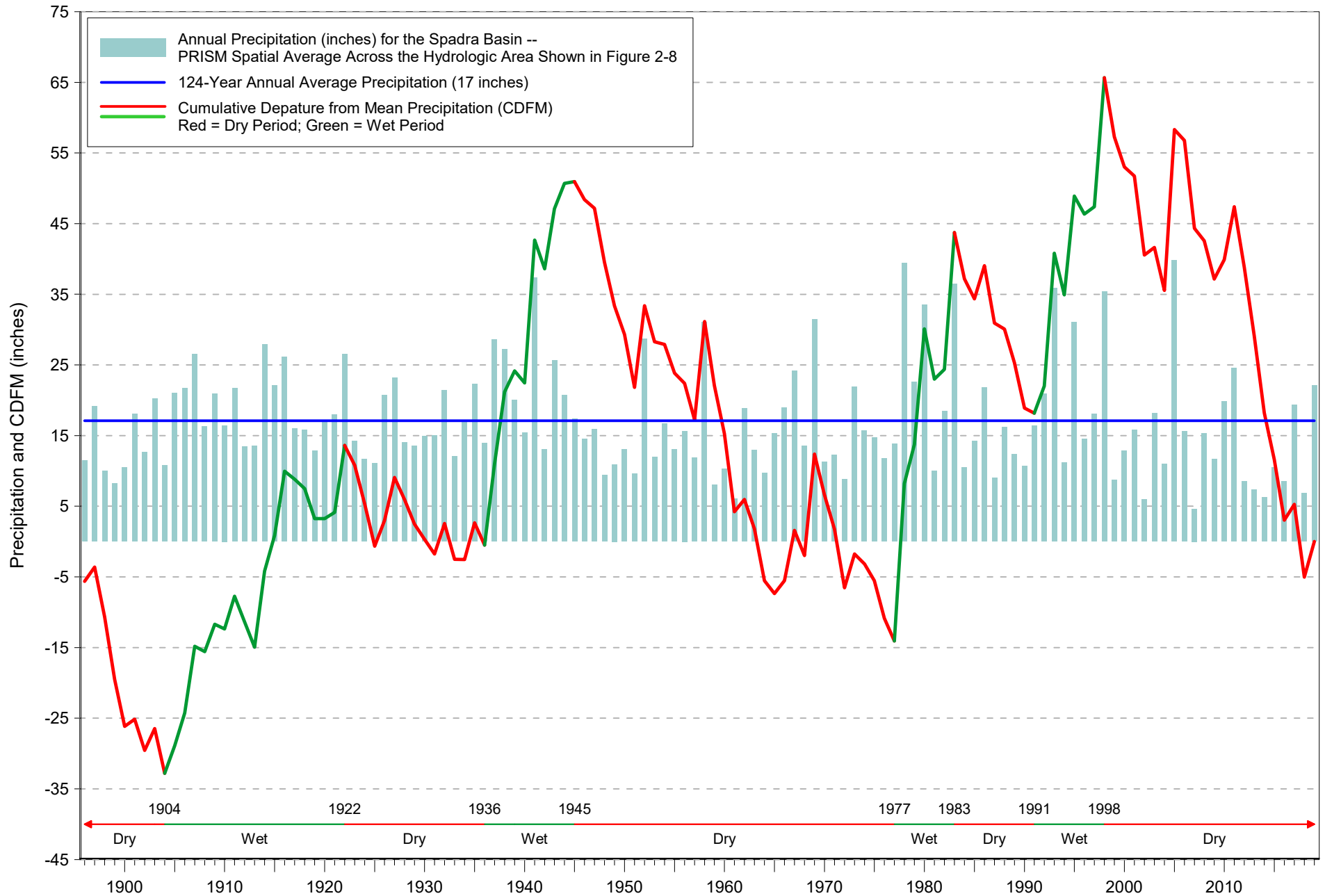
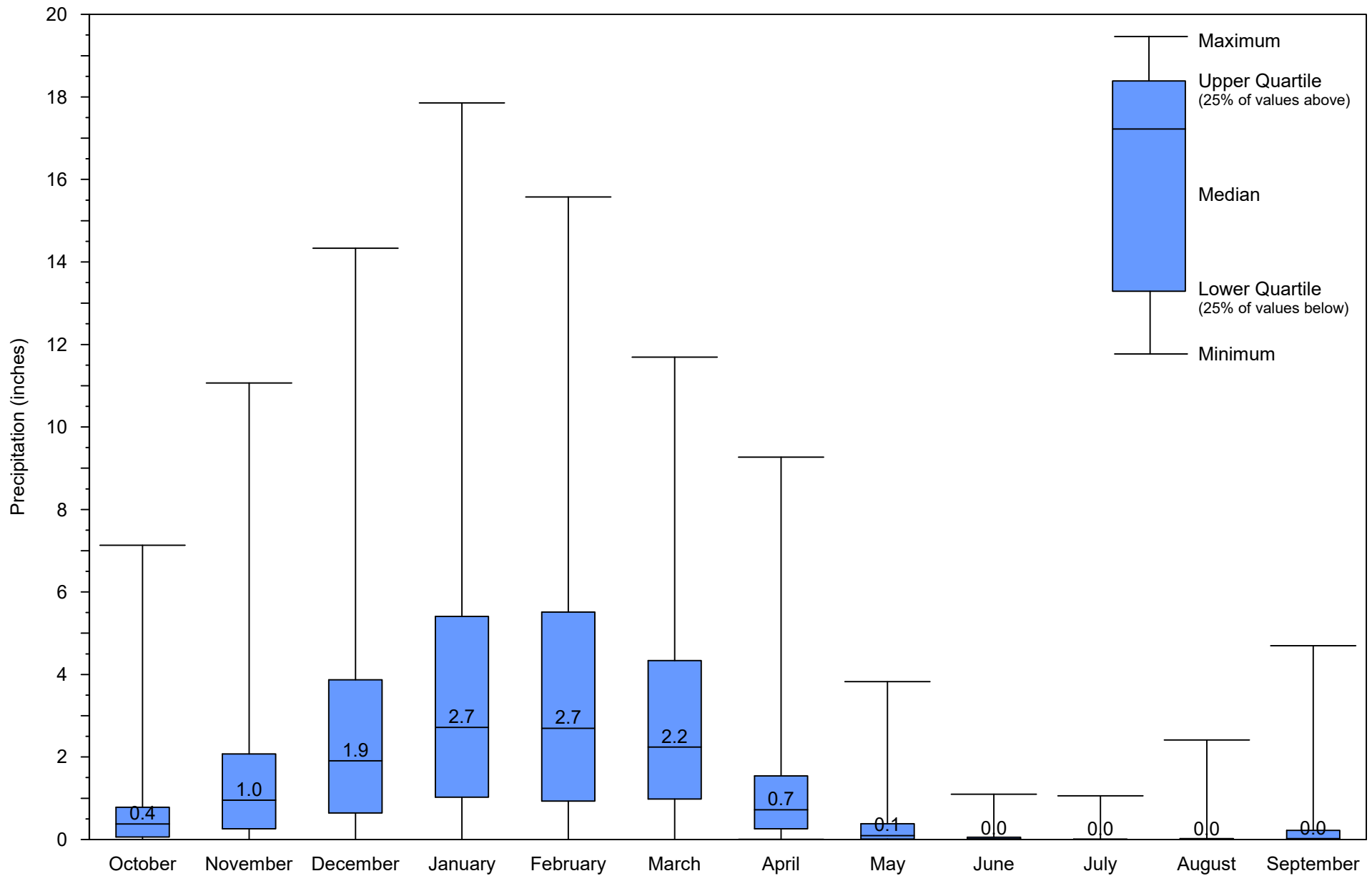
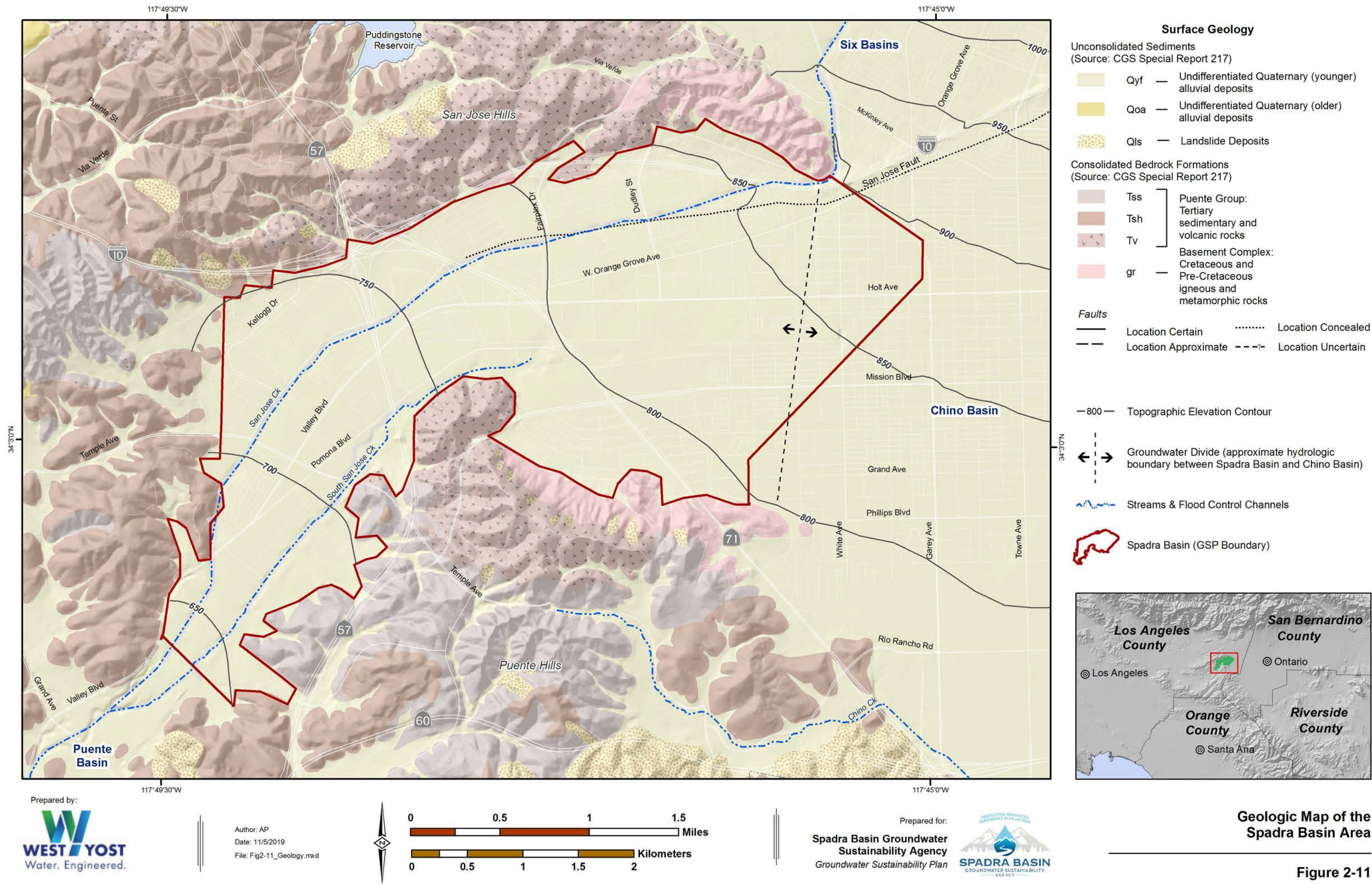


Figure 2-10. Box and Whisker Plot of Average Monthly Precipitation - Spadra Basin and Tributary Watersheds - Water Year 1896 to 2019





At present, San Antonio Creek flows south to the Santa Ana River. The main streams that drain the Spadra Basin ~~is-are~~ San Jose Creek and South San Jose Creek, which flows to the west and merge, and ultimately ~~merges-discharge with-to~~ the San Gabriel River.

2.2.2.2 Basin Boundaries

The physical boundaries of the Spadra Basin are described below and are shown in Figure 2-11. The physical boundaries do not coincide exactly with the SGMA boundaries as defined by the Spadra Basin GSA, which are also shown in Figure 2-11.

San Jose Hills. The northern boundary of the Spadra Basin is the contact with impermeable Basement Complex and the Puente Group that outcrops along the southern front of the San Jose Hills.

San Jose Fault. The northeastern boundary of the Spadra Basin is the San Jose Fault, which separates the upgradient Six Basins from the Spadra Basin. The San Jose Fault is a known barrier to groundwater flow from the Six Basins into the Spadra Basin and the Chino Basin. The barrier effect is demonstrated by groundwater elevations that are hundreds of ft higher in the Six Basins compared to the Spadra Basin and Chino Basin.

Groundwater Divide. The eastern boundary of the Spadra Basin is a natural groundwater divide that extends from the eastern tip of the San Jose Hills southward to the Puente Hills. The groundwater divide is evidenced by groundwater-elevations measured at wells in the Six Basins, Chino Basin and Spadra Basin (described in *Section 2.2.2.9 Groundwater Flow*). Eckis (1934) speculated that the origin of the groundwater divide is underflow from the Six Basins across the San Jose Fault. Groundwater flowing westward from the divide enters the Spadra Basin; groundwater flowing eastward from the mound enters the Chino Basin. The location of the groundwater divide is transient and can shift east or west depending on the rate of groundwater flow from the Six Basins and changes in groundwater levels in the Spadra Basin and/or Chino Basin.

Puente Hills. The southern boundary of the Spadra Basin is the contact with impermeable Basement Complex and the Puente Group that outcrops along the northern front of the Puente Hills.

Puente Basin. The western boundary of the Spadra Basin is a bedrock narrows that separates the Spadra Basin from the Puente Basin. Groundwater flows through the bedrock narrows as underflow from the Spadra Basin into the Puente Basin.

2.2.2.3 Stratigraphy

In this report, the stratigraphy of the Spadra Basin is divided into two generalized geologic formations: (i) the pervious formations that comprise the groundwater reservoir are termed *water-bearing sediments* and (ii) the impermeable formations that enclose the groundwater reservoirs are termed *consolidated bedrock*. Water-bearing sediments overlie the consolidated bedrock, with the bedrock formations coming to the surface in the surrounding hills and highlands. Below, these geologic formations are described in stratigraphic order, with the oldest formations first.

The terms used in this report to describe bedrock, such as “consolidated,” “non-water-bearing,” and “impermeable,” are used in a relative sense. The water content and permeability of these bedrock formations, in fact, is not zero. However, the primary point is that the permeability of the geologic formations in the areas flanking the groundwater basin is much less than the aquifer sediments within the basin.

2.2.2.3.1 Consolidated Bedrock

The consolidated bedrock formations that flank and underlie the Spadra Basin consist of very old crystalline rocks of the Basement Complex and younger sedimentary and volcanic rocks of the Puente Group.

The Basement Complex consists of deformed and recrystallized metamorphic rocks (e.g., banded gneisses) that have been intruded by masses of igneous rocks (e.g., granite). As shown in Figure 2-11, the Basement Complex outcrops in the eastern margins of the San Jose Hills and Puente Hills. Weathering and erosion of the Basement Complex in the San Gabriel Mountains is the major sediment source for the younger sedimentary formations—in particular, the water-bearing sediments of Spadra Basin.

The Puente Group, where present, overlies the Basement Complex and consists of interbedded shales, sandstones, conglomerates, lava flows, volcanic ash, and volcanic breccia (English, 1926). As shown in Figure 2-11, the Puente Group outcrops in the western San Jose Hills and Puente Hills.

2.2.2.3.2 Water-Bearing Sediments

During the Quaternary Period, sediments that eroded from the surrounding and distant mountains and hills were transported to the Spadra Basin by flooding and deposited atop the consolidated bedrock formations as interbedded, discontinuous layers of gravel, sand, silt, and clay to form the water-bearing sediments.

The water-bearing sediments are over 600 ft thick in places, but pinch-out to zero thickness along the northern and southern basin boundaries at the surface contact with the consolidated bedrock. Most water wells have their screens completed within the water-bearing sediments. Some of these wells in the Spadra Basin can pump over 400 gallons per minute (gpm).

The water-bearing sediments are typically composed of gneissic and granitic debris from the San Gabriel Mountains and can be differentiated into the Older Alluvium of Pleistocene age and Younger Alluvium of Holocene age. The general character of these formations is known from driller's logs and surface outcrops.

The Older Alluvium was deposited on top of the bedrock formations under conditions similar to today's depositional environments. The Older Alluvium is commonly distinguishable in surface outcrop by its red-brown or brick-red color. The red color comes from secondary clays that formed from the weathering and oxidation of sediments that were deposited in areas where the water table was deep and where sediments were not disturbed by stream erosion over long periods. The Older Alluvium contains many local unconformities because of the nature of the alluvial fan deposition process. The Older Alluvium is the main source of groundwater for today's wells.

The Younger Alluvium was deposited on top of the Older Alluvium after a period of weathering and erosion of the Older Alluvium. The Younger Alluvium is typically a fresh, un-weathered, grey or brown color, and exists in outcrop only along the recent streambed channels of San Jose Creek. The Younger Alluvium is absent in most places and is typically thin compared to the Older Alluvium. Where it exists, it is commonly unsaturated and lies above the regional water table. The Younger Alluvium is typically more permeable than the Older Alluvium.

Figure 2-12 is a map of the hydrologic soil types across the Spadra Basin area, as mapped by the Soil Conservation Service:

- **Type A soils** - have high infiltration rates, even when thoroughly wetted. Typically composed of sands and gravels.
- **Type B soils** - have moderate infiltration rates when thoroughly wetted. Typically composed of moderately fine to moderately coarse texture.
- **Type C soils** - have slow infiltration rates when thoroughly wetted. Typically include a layer that impedes downward movement of water and/or moderately fine to fine texture.
- **Type D soils** - have very slow infiltration rates when thoroughly wetted and a high runoff potential. Typically, are of fine texture and/or a thin soil over a nearly impervious material.

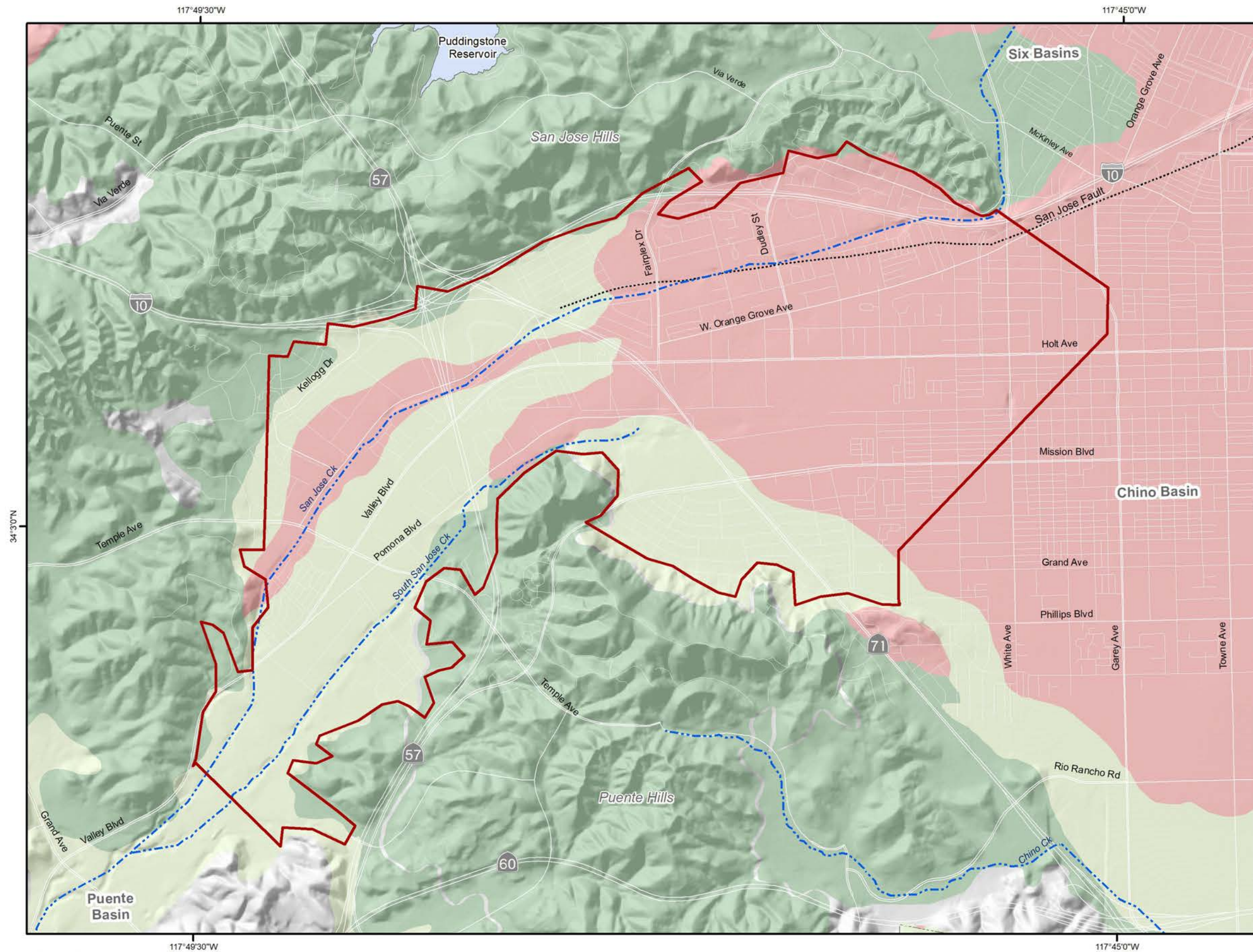
Note the absence of Type A soils across the Spadra Basin, which is consistent with the near absence of Younger Alluvium. Type B soils cover most of the eastern Spadra Basin and the older stream channels of San Jose Creek. Type C soils occur across most of the narrow western portion of the basin and along the basin fringes, likely representing the deposition of sediments eroded from the flanking San Jose Hills and Puente Hills. Type D soils occur across most of the San Jose Hills and Puente Hills, which are composed of the consolidated bedrock formations.

2.2.2.4 Bottom of the Aquifer

The consolidated bedrock formations underlying the water-bearing sediments of the Spadra Basin act as the effective base of the freshwater aquifer. Herein, the effective base of the freshwater aquifer is referred to as the “bottom of the aquifer.”

Figure 2-13 is a contour map of equal depth to the bottom of the aquifer (i.e., the buried contact between the water-bearing sediments and consolidated bedrock). The units of depth are in feet below ground surface (ft-bgs). These contours were drawn from lithologic descriptions of borehole cuttings that were recorded on well driller’s reports that were collected and reviewed for this study. Each well driller’s report was reviewed, and best efforts were made to identify the driller’s interpretation of depth to borehole penetration of the consolidated bedrock. The interpretations by the well drillers are often subjective and poorly described on the well driller’s reports. The typical terminology used to describe bedrock on the reports were: “hill formation,” “rock,” or “decomposed granite,” among others.

Depth to bedrock at each well-borehole location, which represents the bottom of the aquifer, were plotted on a map. Zero depth to bedrock was defined by the surface contact between the water-bearing sediments and the consolidated bedrock. Contours of the bottom of the aquifer were hand drawn and digitized in ArcGIS.



Hydrologic Soil Types

-  **A** Low runoff potential. Soils having high infiltration rates even when thoroughly wetted and consisting chiefly of deep, well to excessively drained sands or gravels. These soils have a high rate of water transmission.
-  **B** Soils having moderate infiltration rates when thoroughly wetted and consisting chiefly of moderately deep to deep, moderately well to well drained soils with moderately fine to moderately coarse textures. These soils have a moderate rate of water transmission.
-  **C** Soils having slow infiltration rates when thoroughly wetted and consisting chiefly of soils with a layer that impedes downward movement of water, or soils with moderately fine to fine texture. These soils have a slow rate of water transmission.
-  **D** High runoff potential. Soils having very slow infiltration rates when thoroughly wetted and consisting chiefly of clay soils with a high swelling potential, soils with a permanent high water table, soils with a claypan or clay layer at or near the surface, and shallow soils over nearly impervious material. These soils have a very slow rate of water transmission.

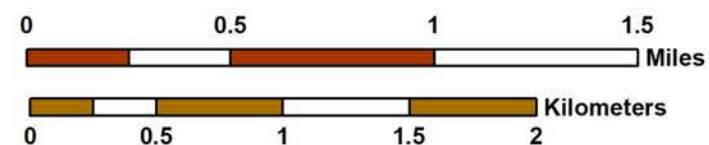
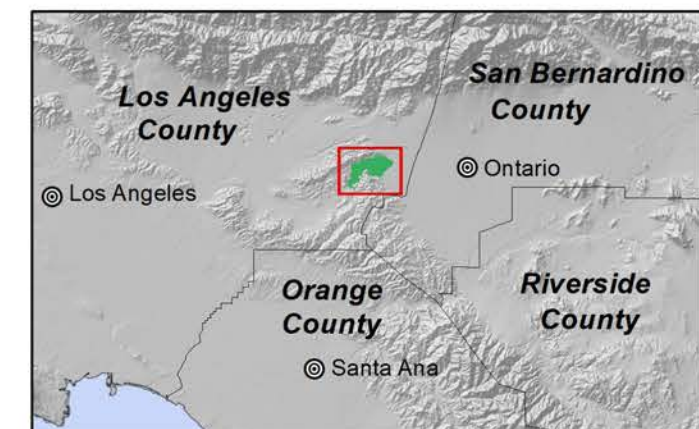
Source: Los Angeles County: United States Agriculture Dept
Soils Bureau, 1917
San Bernardino County: National Cooperative Soil Survey

 Spadra Basin (GSP Boundary)

 Streams & Flood Control Channels

Faults

-  Location Certain
-  Location Concealed
-  Location Approximate
-  Location Uncertain



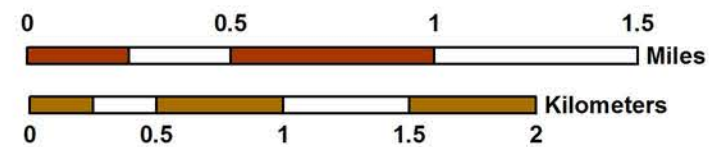
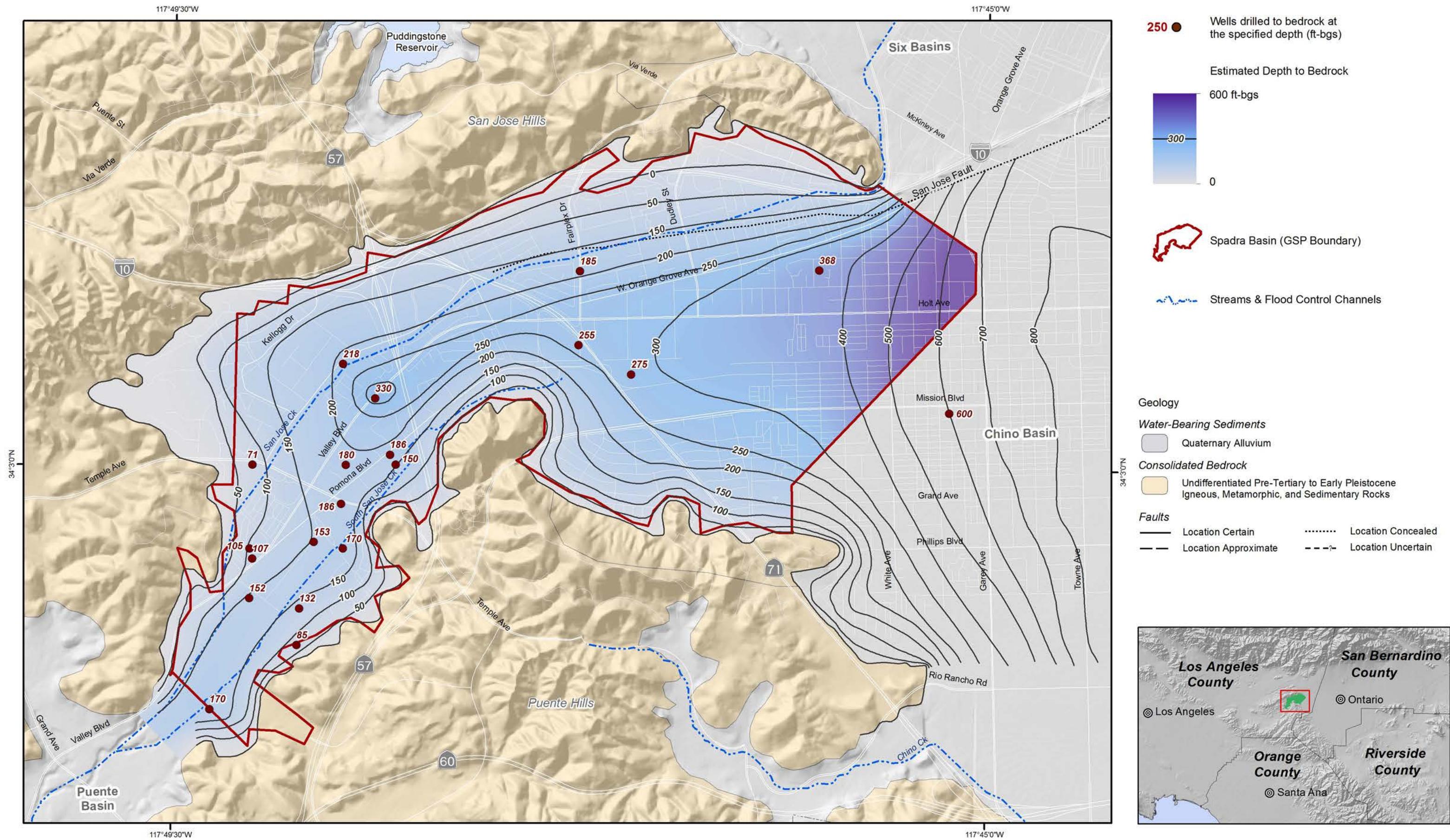
The contours on Figure 2-13 show that the bottom of the aquifer is a narrow trough aligned along the axis of the Spadra Basin. A bedrock “narrows” is located at the southwestern end of Spadra Basin (i.e., the boundary with the Puente Basin), where the bottom of the aquifer appears to be less than 200 ft-bgs. The bedrock trough deepens to the east, where at the eastern margins of the Spadra Basin (i.e., the boundary with the Chino Basin), the bottom of the aquifer is greatest at over 600 ft-bgs. The eastward-sloping bedrock trough appears to be related to erosion by ancestral streams that flowed from west to east as the San Jose Hills and Puente Hills were uplifted. Eckis (1934) speculated that the contact between the consolidated bedrock and the water-bearing sediments is unconformable, as indicated by an ever-present weathered zone in the consolidated bedrock directly underlying the contact with the water-bearing sediments. This observed relationship suggests that the consolidated bedrock in the Spadra Basin area was undergoing erosion prior to deposition of the water-bearing sediments. Eckis (1934) reported that the weathered zone is about 50 ft thick, and that beneath the weathered zone the bedrock is hard. Fractured and weathered zones in the bedrock formations may yield water to wells locally, but the storage capacity is typically inadequate for sustained production.

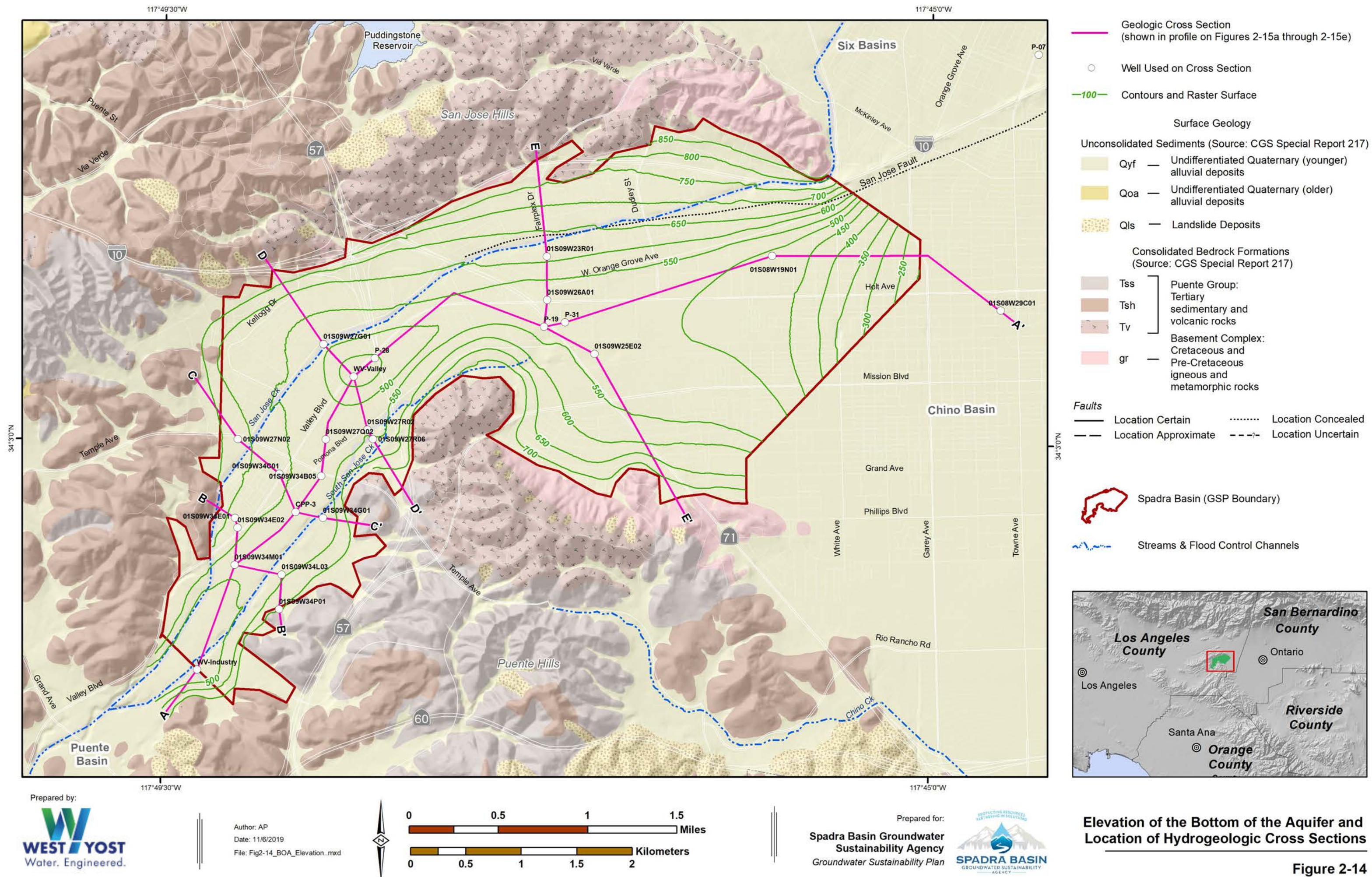
Like Figure 2-13, Figure 2-14 is a map of the bottom of the aquifer; however, depth of the bottom of the aquifer has been converted to elevation in feet above mean sea level (ft-amsl). The following steps were executed in ArcGIS Geostatistical Analyst to complete this conversion: (i) create a raster of the depth to the bottom of the aquifer from the contours and data shown on Figure 2-13; (ii) subtract the depth raster from the [United State Geological Survey \(USGS\)](#) 10-meter digital elevation model of the ground-surface elevation to create a raster of the elevation of the bottom of the aquifer; and (iii) create contours from the elevation raster.

2.2.2.5 Hydrostratigraphy and Aquifer Systems

As described above, the water-bearing sediments are composed of interbedded layers of gravel, sand, silt and clay, or layers that are a combination of one or more of these sediment types. The layers composed mainly of gravel and sand are permeable and groundwater flows through the interconnected pore space within these layers towards pumping wells. These layers of gravel and sand are referred to as “aquifers.” The layers composed mainly of silt and clay are poorly permeable and impede groundwater flow to pumping wells. Layers of silt and clay are referred to as “aquitards.” Aquitards store groundwater and can transmit appreciable amounts of groundwater to the adjacent aquifers through vertical drainage. Together, the aquifers and aquitards are herein referred to as the “aquifer system.”

Groundwater can exist within an aquifer system under two different hydraulic conditions: unconfined and confined. Where the groundwater table is exposed to the atmosphere through the overlying unsaturated zone, the aquifer system is unconfined, and the groundwater table can rise and fall freely under the stresses of recharge and pumping. Where deeper groundwater is separated from the atmosphere by significant thicknesses of aquitards, the aquifer system is confined, and the groundwater can be under a pressure head that is higher than the top of the aquifer. Depending on the spatial distribution of the aquitards, and their effectiveness as “confining layers,” a groundwater reservoir can be vertically stratified into multiple aquifer systems that have different physical and chemical characteristics.





The aquifer and aquitard layers and their geometries are numerous and complex in the Spadra Basin and must be simplified into a hydrogeologic conceptual model that represents the three-dimensional distribution of the water-bearing sediments and their hydrogeologic properties. This conceptual model is described below and will be used as input to a numerical groundwater-flow model ([Spadra Basin Groundwater Model](#)) to support the development of the Spadra Basin GSP.

In order to depict the hydrogeologic conceptual model, five hydrogeologic cross-sections were constructed across the Spadra Basin. The plan-view locations of these cross-sections are shown on Figure 2-14 and the profile-view cross-sections are shown in Figure 2-15a through Figure 2-15e. Plotted on these cross-sections are well and borehole data, including: borehole lithology, well casing perforations, recent estimates of groundwater elevation (Fall 2018), specific capacities of the wells, and estimates of horizontal hydraulic conductivity of the saturated sediments (see *Section 2.2.2.6 Initial Estimates of Aquifer Properties*).

The hydrogeologic cross-sections depict a narrow, channel-like aquifer system that consists of about 100-200 ft of saturated sediments along the axis of the basin that thicken to about 400 ft near the western boundary with the Chino Basin. Along the northern and southern edges of the basin, the depth to bedrock becomes shallow and the saturated sediments pinch out against the buried contact with bedrock.

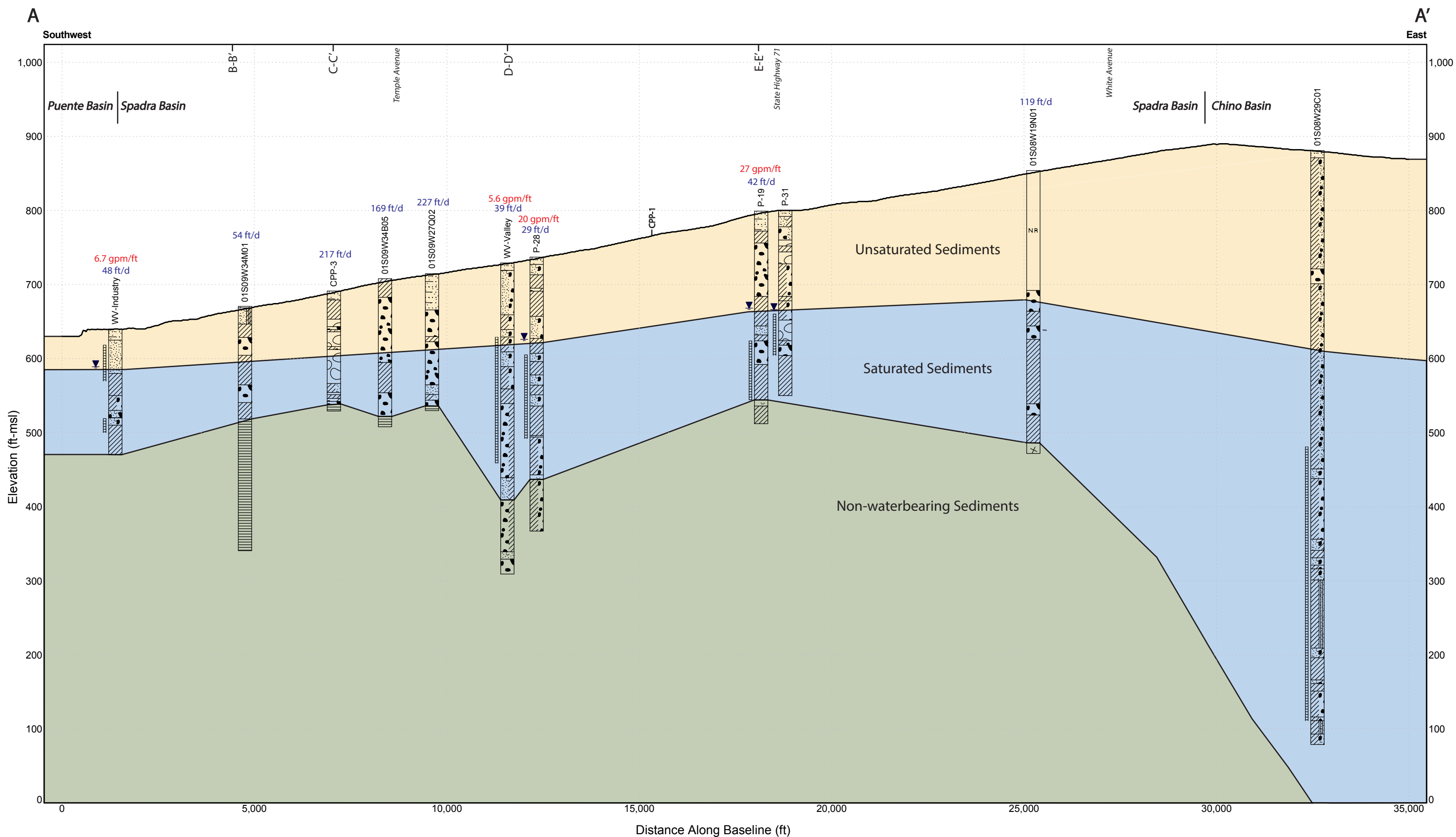
The thickness of the unsaturated zone along the axis of the basin varies from about 40 ft at the western boundary of the basin to about 250 ft at the eastern boundary of the basin.

There are no data to support a multiple-layer aquifer system within Spadra Basin. The saturated sediments are a relatively thin unit (typically less than about 200 ft thick) of interbedded, discontinuous layers of gravel, sand, silt, and clay mixtures. There are no thick, regionally extensive, fine-grained layers (aquitards) that could create conditions for deeper confined aquifers. Flowing-artesian wells—an indication of confined aquifer conditions—have never been observed or mapped in the basin. The Spadra Basin is best characterized as a relatively thin, unconfined, alluvial aquifer system.

2.2.2.6 Initial Estimates of Aquifer Properties

The properties that characterize the ability of the water-bearing sediments of the Spadra Basin to store and transmit groundwater are specific yield (effective porosity) and hydraulic conductivity. The specific yield of the water-bearing sediments is a measure of its capacity to store water. Specific yield is the ratio of the volume of water that a given mass of saturated sediments will yield by gravity drainage to the volume of that mass. The ratio is typically stated as a percentage. The hydraulic conductivity of the water-bearing sediments is a measure of its capacity to transmit water. Hydraulic conductivity is the rate of flow of groundwater in gallons per day through a cross section of one square foot of sediment under a unit hydraulic gradient. The English units for hydraulic conductivity are feet per day (ft/d).

This section describes the initial estimation of specific yield and hydraulic conductivity for the saturated water-bearing sediments within the Spadra Basin. These estimates will be refined during the calibration of the ~~numerical groundwater-flow model~~ [Spadra Basin Groundwater Model](#).



Prepared by:



Vertical Scale: 1" = 120'
Horizontal Scale: 1" = 2310'
Vertical Exaggeration = 19:1

- NR No Sample
- Gravel
- Clay
- Crystalline Bedrock
- Topsoil

- Sand
- Decomposed Granite
- Sand with Gravel
- Gravel with Clay
- Clay with Gravel

- Clay with Gravel and Sand
- Sand with Gravel and Clay
- Clay with Sand and Silt
- Clay with Sand
- Shale

- Well Screen Interval
- Groundwater Elevation (Fall 2018)

Vertical Scale: 1" = 120'
Horizontal Scale: 1" = 2310'
Vertical Exaggeration = 19:1

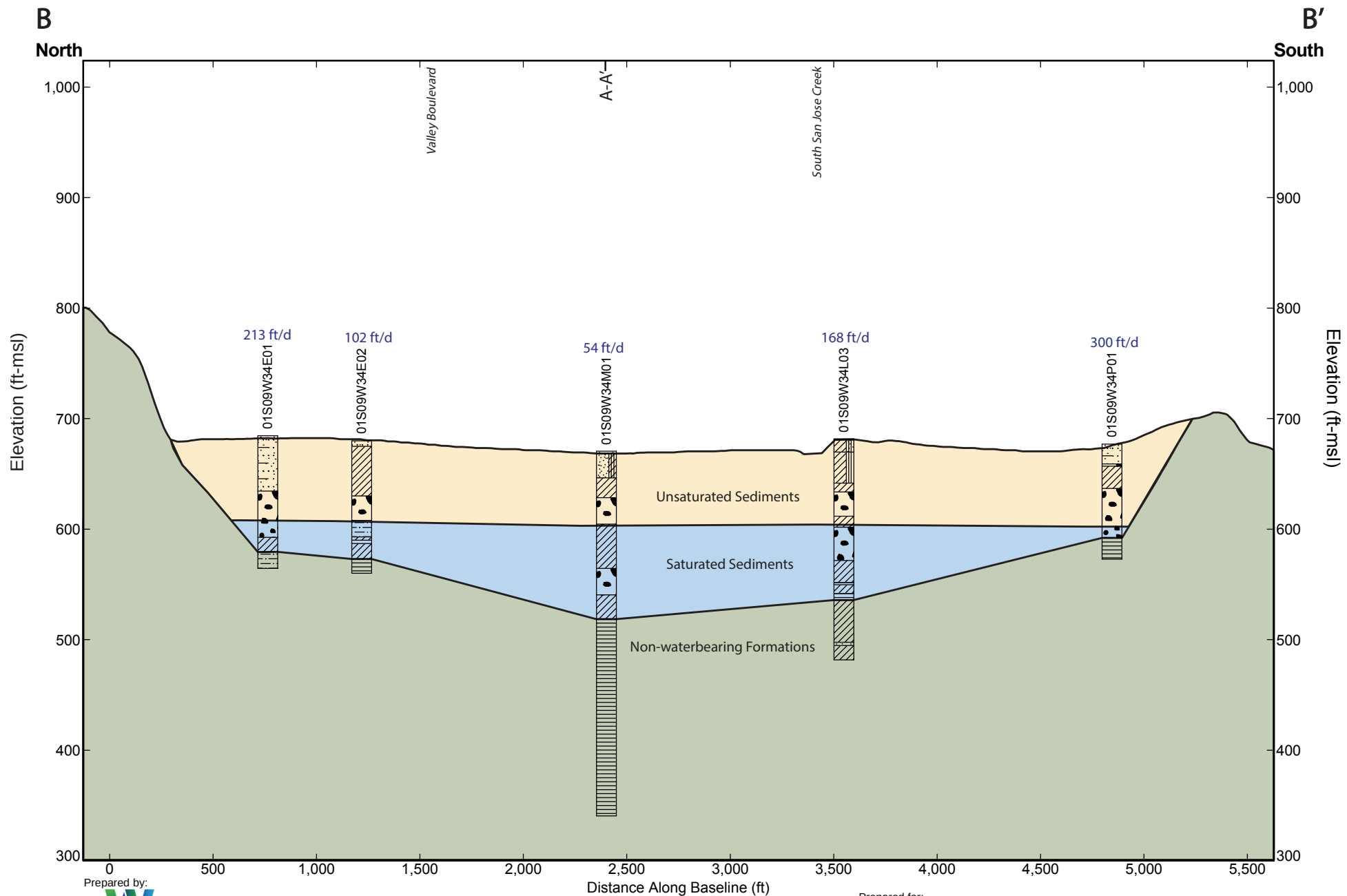
- gpm/ft Specific Yield
- ft/d Estimated Hydraulic Conductivity

Prepared for:



Hydrogeologic Cross Section A-A'

Figure 2-15a



Prepared by:

WEST YOST
Water. Engineered.

Vertical Scale: 1" = 119'

Horizontal Scale: 1" = '667

Vertical Exaggeration = 5.6:1

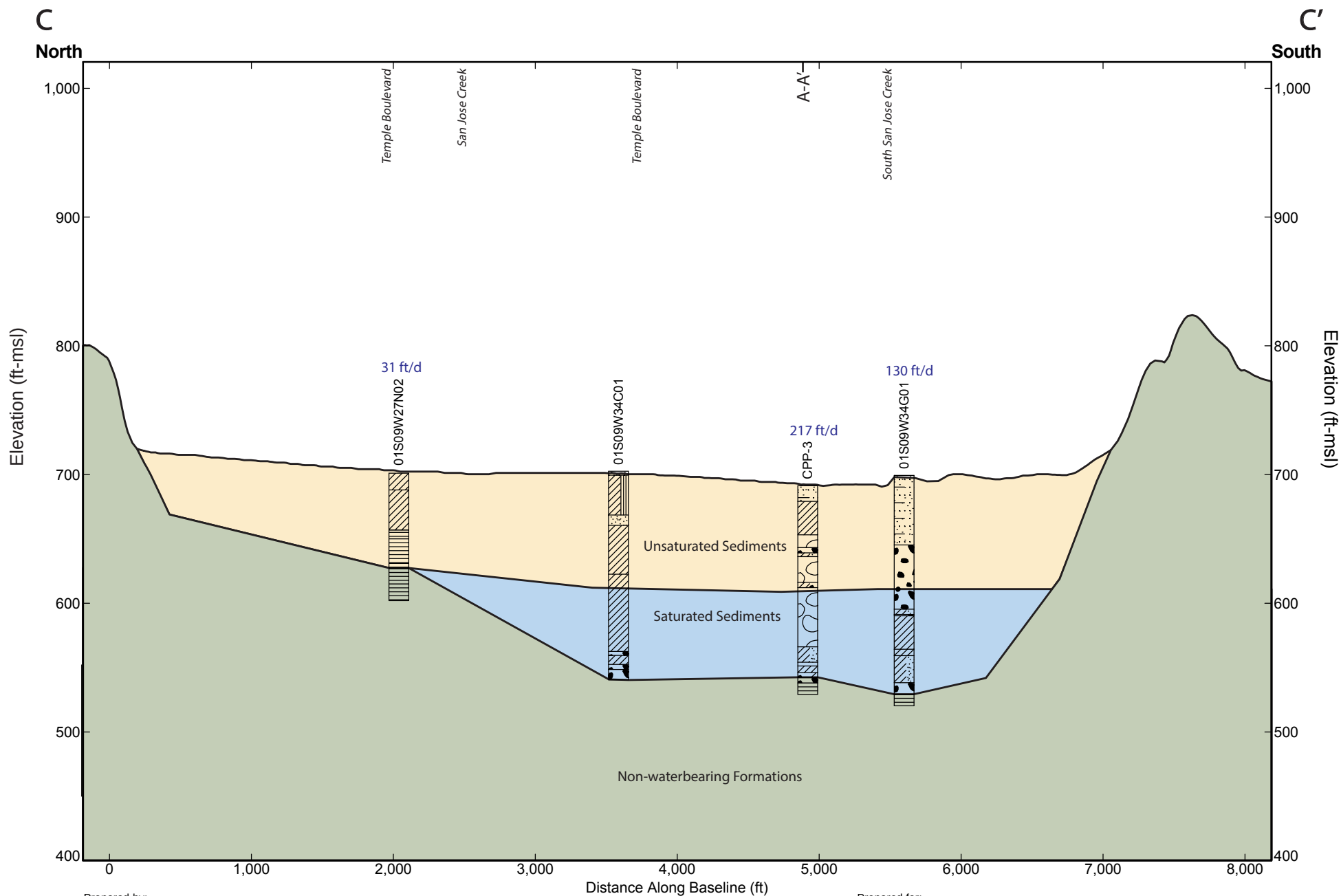
- | | | |
|---------------------|-------------------------|----------------------------------|
| Topsoil | Shale | Sand |
| Clay | Clay with Sand and Silt | Sand with Silt and Clay |
| Gravel | Clay with Silt | Estimated Hydraulic Conductivity |
| Sedimentary Bedrock | | |



Hydrogeologic Cross Section

B-B'

Figure 2-15b



Prepared by:

WEST YOST
Water. Engineered.

Vertical Scale: 1" = '102
Horizontal Scale: 1" = '929
Vertical Exaggeration = 9:1

Clay

Shale

Topsoil

Clay with Silt

Sand

Gravel

Clay with Sand

Cobbles and/or Boulders

Clay with Gravel

Gravel with Clay

ft/d Estimated Hydraulic Conductivity

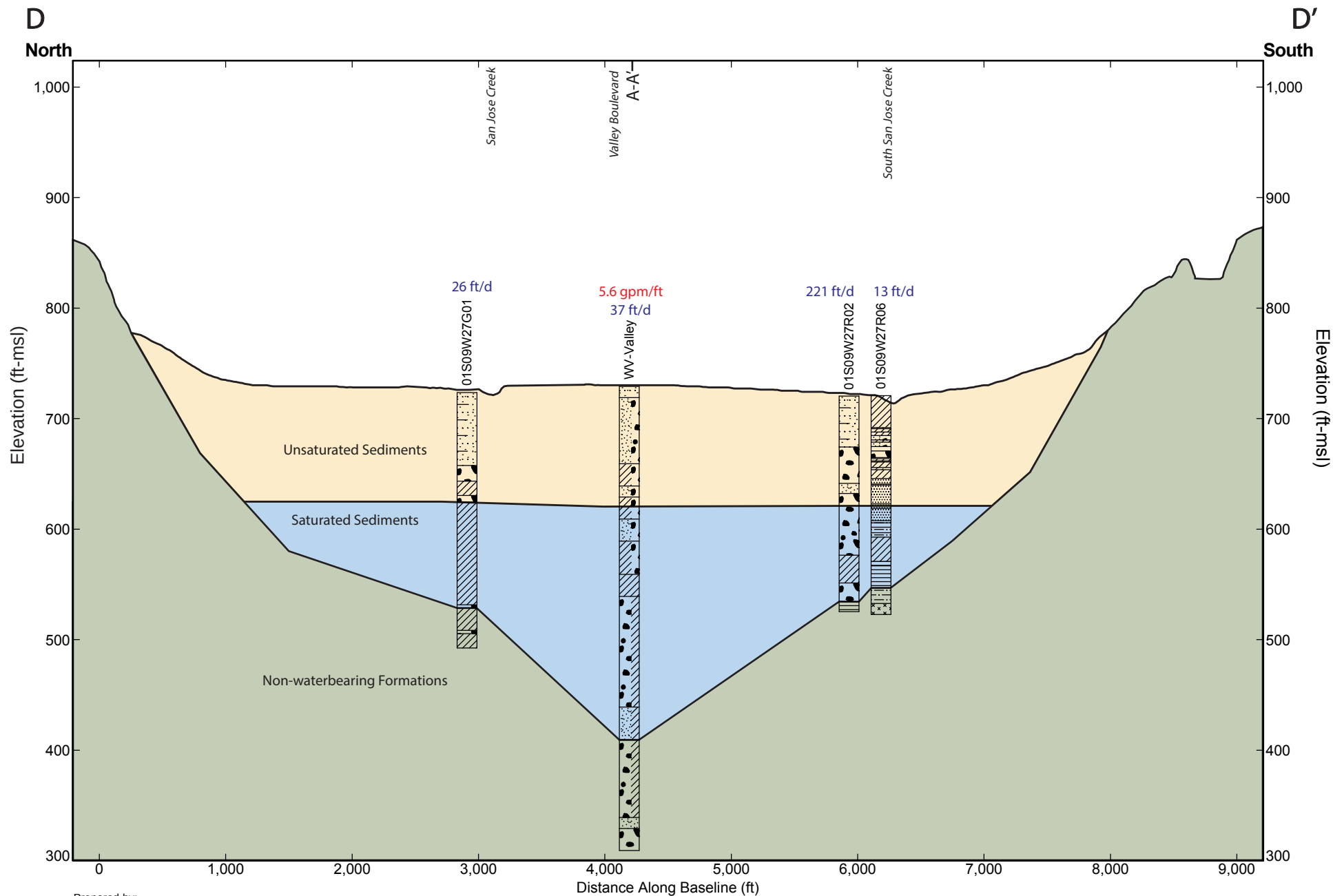
Prepared for:

SPADRA BASIN
GROUNDWATER SUSTAINABILITY
AGENCY

Hydrogeologic Cross Section

C-C'

Figure 2-15c

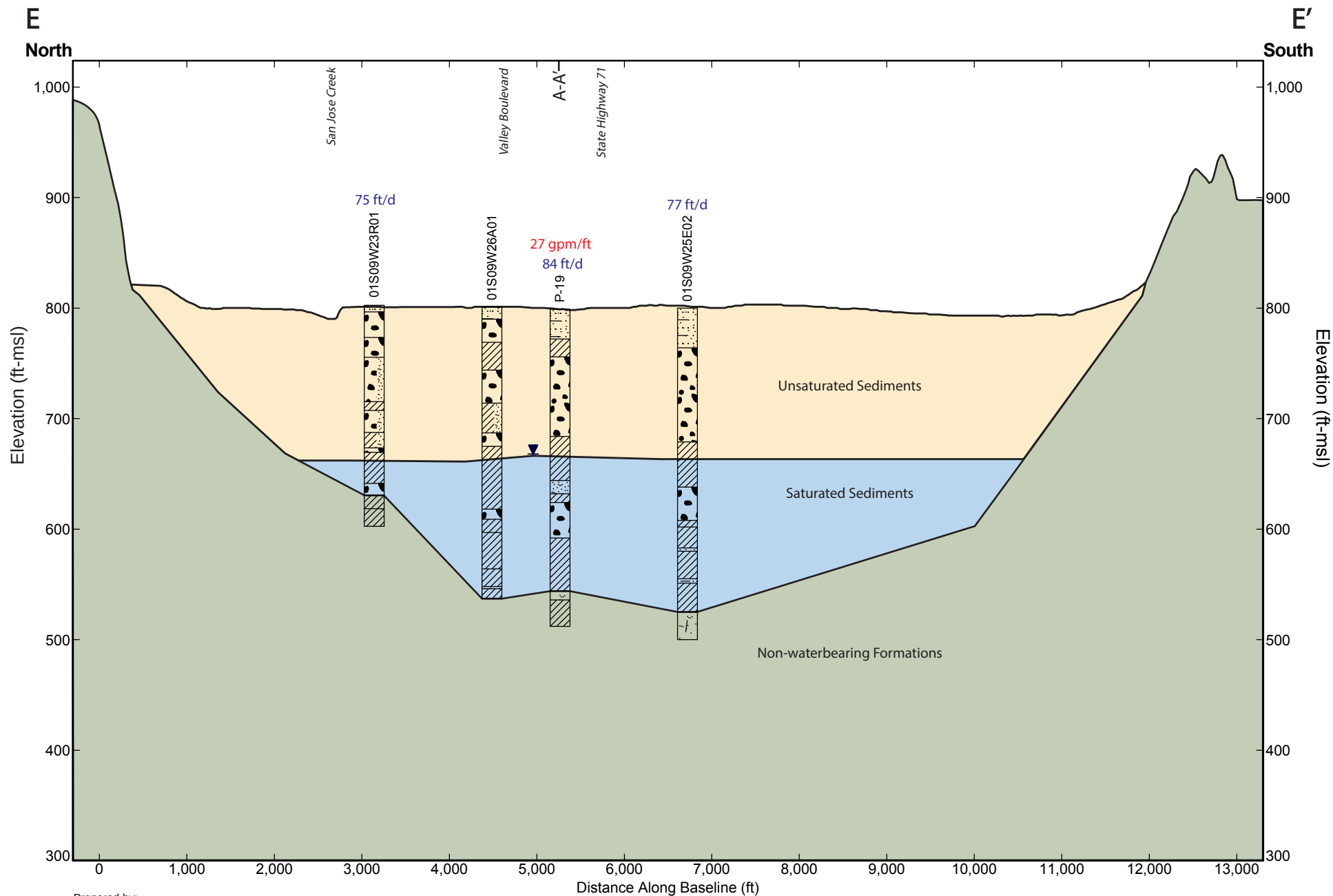


Prepared by:
WEST YOST
 Water. Engineered.
 Vertical Scale: 1" = '118
 Horizontal Scale: 1" = '1043
 Vertical Exaggeration = 9:1

Hydrogeologic Cross Section

D-D'

Figure 2-15d



Prepared by:
WEST YOST
 Water. Engineered.
 Vertical Scale: 1" = '120
 Horizontal Scale: 1" = '1508
 Vertical Exaggeration = 12.5:1

- | | | | |
|--|---------|--|---------------------|
| | Topsoil | | Sedimentary Bedrock |
| | Gravel | | Decomposed Granite |
| | Clay | | Clay with Sand |
| | Sand | | Gravel with Sand |

gpm/ft Specific Yield
 ft/d Estimated Hydraulic Conductivity



Hydrogeologic Cross Section

E-E'

Figure 2-15e

Hydraulic conductivity and specific yield are closely related to the texture of the sediments (McCuen et al., 1981). For example, the values of hydraulic conductivity and specific yield are generally higher in sands and gravels as compared to silts and clays. Several databases and publications have estimated values of hydraulic conductivity and specific yield based on sediment texture (Rawls et al., 1982; Schaap and Leij, 1998; Carsel and Parrish, 1988; Bouwer, 1978; Prudic, 1991; Reese and Cunningham, 2000; Kuniansky and Hamrick, 1998; Domenico and Schwartz, 1990; Freeze and Cherry, 1979; and Johnson, 1967). These estimates were used to assign hydraulic conductivity and specific yield to each sediment description on every available well driller's report for boreholes drilled in the Spadra Basin. Using the following formulas, thickness-weighted estimates of horizontal hydraulic conductivity and specific yield were computed for each borehole across the saturated thickness based on 2008 water level conditions, a time of relatively high groundwater elevations:

$$K_h = \sum_{i=1}^n \frac{K_i b_i}{b}$$

$$S_y = \sum_{i=1}^n \frac{S_{yi} b_i}{b}$$

Where:

K_h is the average horizontal hydraulic conductivity of the saturated sediments

K_i is the hydraulic conductivity of i bed

b_i is the saturated thickness of bed i

b is the total thickness of the of the saturated sediments

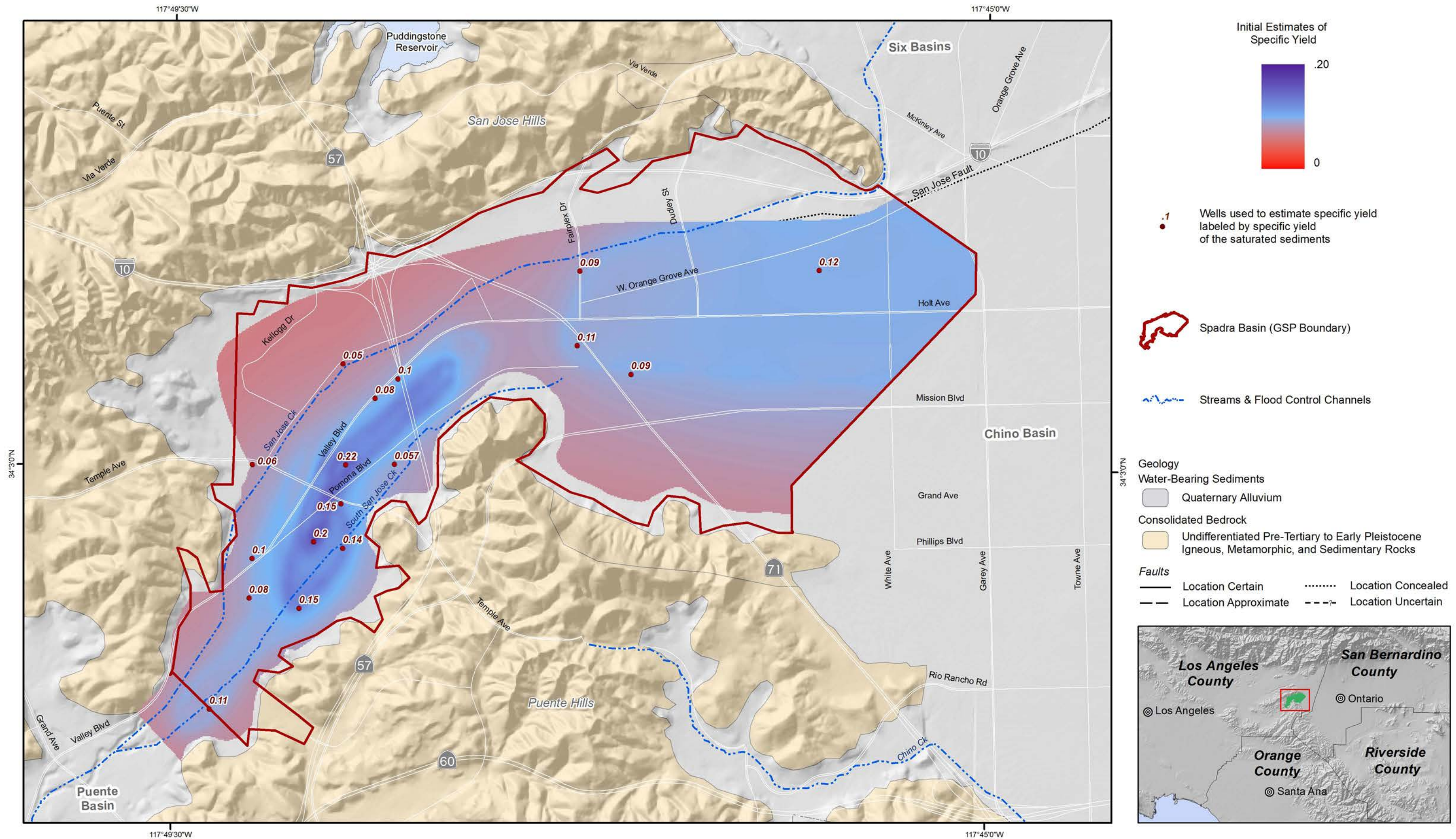
S_y is average specific yield of the saturated sediments

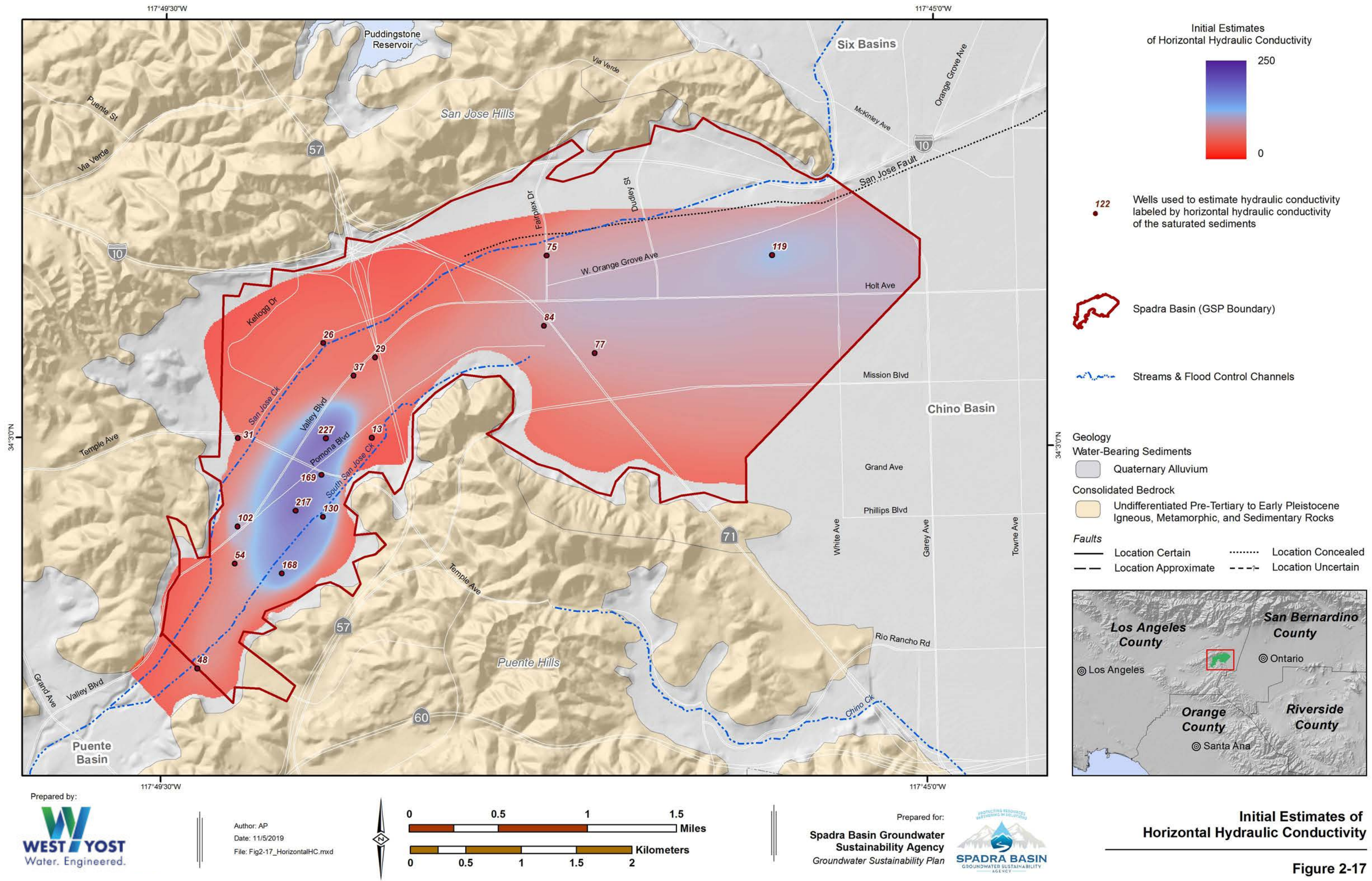
S_{yi} is the specific yield for bed i

Figure 2-16 shows the thickness-weighted, initial estimates for specific yield at 16 boreholes that penetrated the entire thickness of the water-bearing sediments. The figure also shows interpolated estimates of specific yield between boreholes to depict its spatial distribution. The interpolated surface is clipped to the area of the saturated sediments (i.e., the water-bearing sediments are thin and unsaturated along the margins of the basin, hence, estimates of aquifer properties are not needed). Specific yield of the saturate sediments is relatively low across the basin and ranges from about 5 percent to 22 percent. Generally, specific yield is higher along the basin axis and lower along the edges of the basin. There is a localized area of higher specific yield in the western portion of the basin, and in the east, specific yield appears to increase toward the Chino Basin.

Figure 2-17 shows the thickness-weighted, initial estimates for horizontal hydraulic conductivity at boreholes that penetrate the entire thickness of the water-bearing sediments. The figure also shows interpolated estimates of horizontal hydraulic conductivity between boreholes to depict its spatial distribution. Horizontal hydraulic conductivity of the saturated sediments ranges from about 30 to 230 ft/d. As with specific yield, hydraulic conductivities are higher along the basin axis and lower along the edges of the basin. There is a localized area of higher hydraulic conductivities in the western portion of the basin, and in the east hydraulic conductivity appears to increase toward the Chino Basin.

The initial estimates of vertical hydraulic conductivity are assumed to be ten percent of the horizontal hydraulic conductivity.





2.2.2.7 Groundwater Recharge

Groundwater recharge to the Spadra Basin primarily occurs by the following general mechanisms:

- **Subsurface inflow from the Six Basins across the San Jose Fault.** The San Jose Fault is a known barrier to groundwater flow from the Six Basins into the Spadra Basin; however, Eckis (1934) speculated that groundwater flows from the Six Basins into the Spadra Basin as underflow across the San Jose Fault near the eastern tip of the San Jose Hills.
- Subsurface inflow from the saturated alluvium and fractures within the bordering bedrock hills (San Jose Hills and Puente Hills).
- **Deep infiltration of precipitation and applied water (DIPAW).** DIPAW includes the combination of precipitation that falls directly on a pervious land surface, precipitation that falls on impermeable land surface that subsequently flows onto pervious surfaces, and irrigation water applied to the land surface; all of which when combined is surplus to the evapotranspiration (ET) demand and soil water storage capacity. DIPAW migrates through the root zone and subsequently reaches the underlying groundwater reservoir. DIPAW is an important source of recharge from a water quality standpoint because it is typically high in total dissolved solids (TDS) and nitrogen from land application of fertilizers and from consumptive use by vegetation.
- Deep infiltration of septic tank discharge and leakage from water mains.

2.2.2.8 Groundwater Discharge

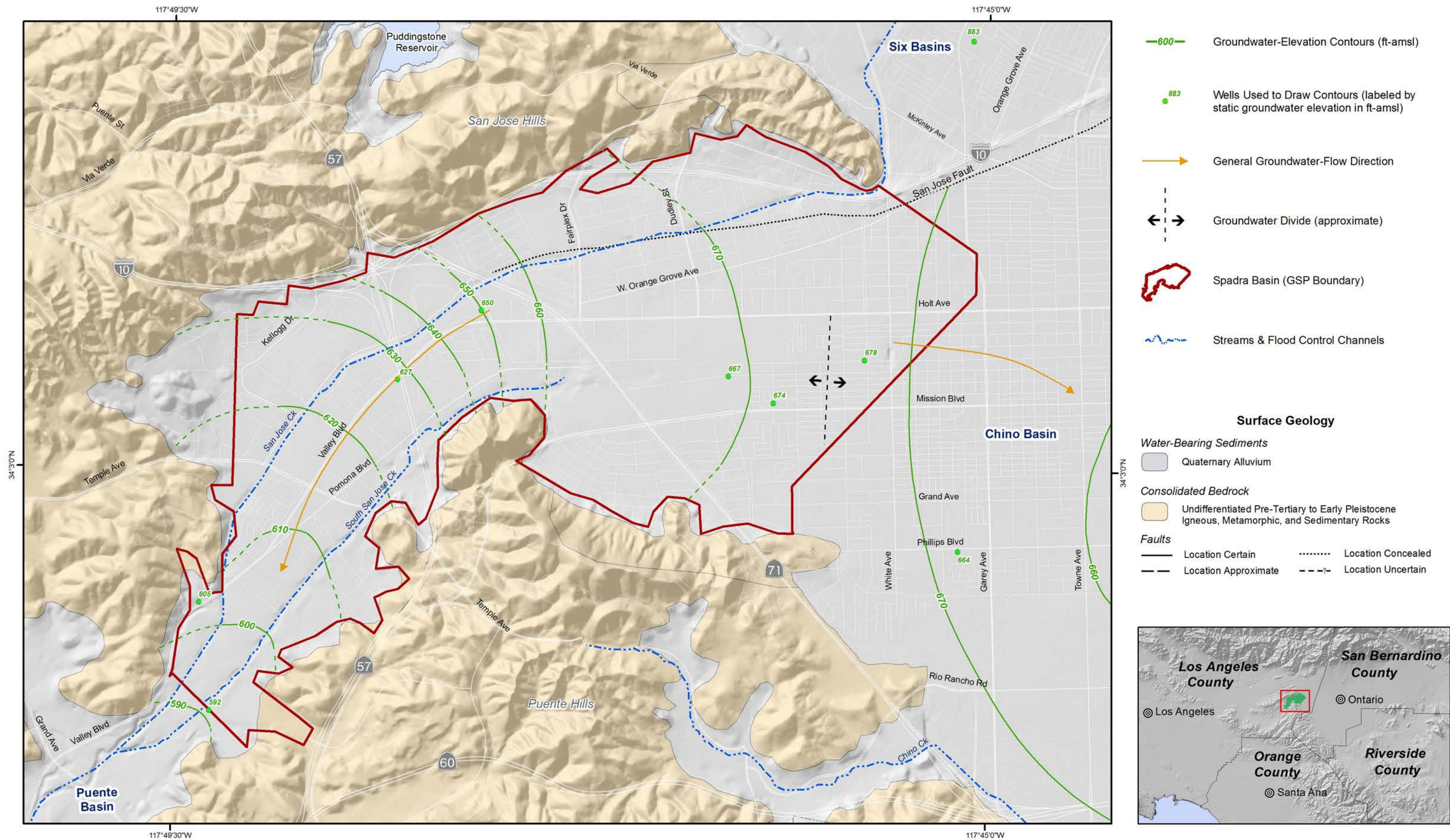
Groundwater discharge from the Spadra Basin occurs primarily as:

- Groundwater production from wells.
- **Sub-surface outflow to the Puente Basin.** This component of discharge occurs as underflow through the saturated sediments in the narrow bedrock gap that connects the Spadra Basin to the Puente Basin. The rate of underflow is dependent on the hydraulic gradient and the hydraulic conductivity of the saturated sediments.
- **Sub-surface outflow to the Chino Basin.** This component of discharge occurs as underflow through the saturated sediments when the groundwater divide is located west of the boundary with the Chino Basin. The rate of underflow is dependent on the hydraulic gradient and the hydraulic conductivity of the saturated sediments.

2.2.2.9 Groundwater Flow

Figure 2-18a is an equal groundwater-elevation contour map for fall 2018. Figures 2-18b, 2-18c, and 2-18d are groundwater-elevation contour maps for: fall 1977, which represents a period of low groundwater elevations; fall 2008, which represents a period of relatively high groundwater elevations; and fall 2015, which represents the start of SGMA implementation. The procedure for constructing groundwater elevation contour maps follows:

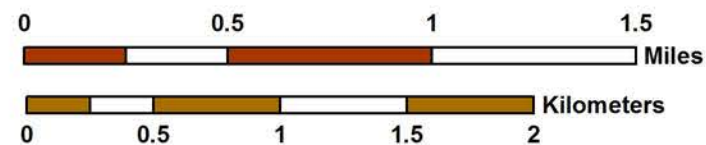
- **Collect historical groundwater-elevation data for wells within the basin.** Main data sources included files from the Pomona, WVWD, [CCPCPP](#), DWR, Chino Basin Watermaster ([CBWM](#)), and Six Basins Watermaster.
- **Prepare and analyze time-series charts of groundwater elevations for all wells.** The time-series charts can be used to distinguish between static and pumping groundwater levels. Groundwater-elevation data that were collected while the well was under the influence of pumping were not used in the preparation of the groundwater-elevation contour maps.
- **Extract groundwater-elevation data for specific time periods.** For example, for the Fall 2018 groundwater-elevation contour map, we extracted groundwater elevation data for wells with data between September 1 and December 31, 2018. After “pumping” data were discarded, we chose one groundwater-elevation data point for each well in the following order of priority: November, October, December, September.
- **Prepare maps of the groundwater-elevation data.** The maps included background hydrogeologic layers, such as surface geology, faults, and stream channels.
- **Prepare contours of equal groundwater elevation.** Groundwater elevation contours were hand drawn based on the plotted groundwater elevation point (well) data. The groundwater elevation contours were digitized and imported into the project GIS. The contours are dashed where groundwater-elevation data are sparse or absent, and hence, groundwater-elevations contours are uncertain.



Prepared by:



Author: AP
Date: 11/5/2019
File: Fig2-18a_GWE_2018.mxd



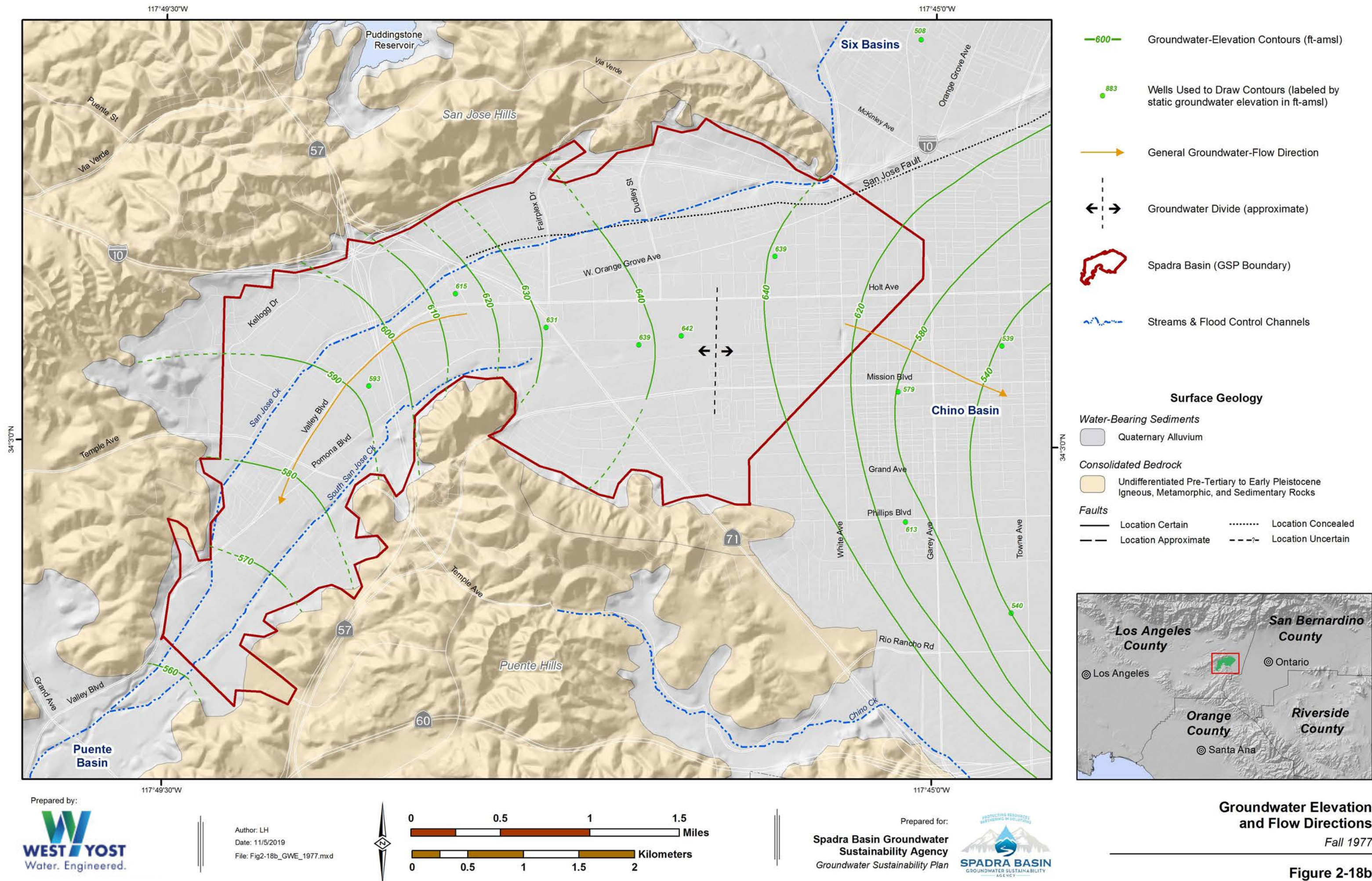
Prepared for:
Spadra Basin Groundwater Sustainability Agency
Groundwater Sustainability Plan

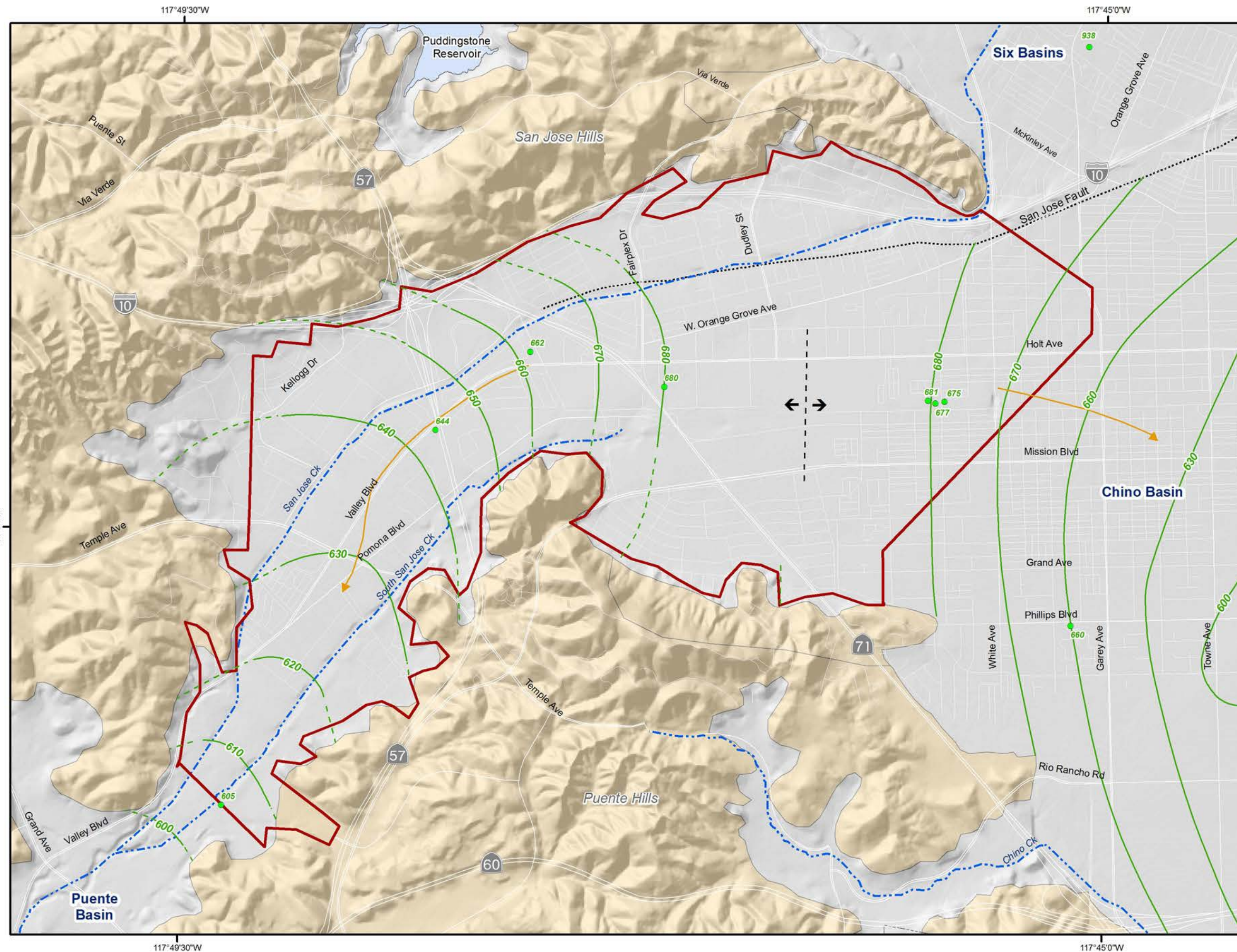


Groundwater Elevation and Flow Directions

Fall 2018

Figure 2-18a





- 600— Groundwater-Elevation Contours (ft-amsl)
- 883 Wells Used to Draw Contours (labeled by static groundwater elevation in ft-amsl)
- General Groundwater-Flow Direction
- ↔ Groundwater Divide (approximate)
- Spadra Basin (GSP Boundary)
- Streams & Flood Control Channels

Surface Geology

Water-Bearing Sediments

Quaternary Alluvium

Consolidated Bedrock

Undifferentiated Pre-Tertiary to Early Pleistocene Igneous, Metamorphic, and Sedimentary Rocks

Faults

Location Certain

Location Approximate

Location Concealed

Location Uncertain



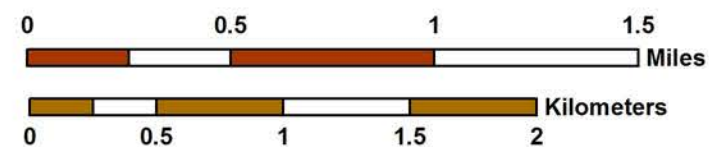
Prepared by:



Author: AP

Date: 11/5/2019

File: Fig2-18C_GWE_2008.mxd



Prepared for:
Spadra Basin Groundwater Sustainability Agency
 Groundwater Sustainability Plan



Groundwater Elevation and Flow Directions

Fall 2008

Figure 2-18c



The groundwater elevation contour maps were used to analyze and interpret groundwater flow directions (perpendicular to the groundwater elevation contours). Groundwater-flow directions are perpendicular to the contours from higher elevation to lower elevation. Although groundwater elevations are different on these maps, the shape and orientation of the contours are similar, demonstrating that the groundwater-flow patterns within the Spadra Basin have been generally consistent over time and under different hydrologic conditions. The maps and interpretations from this report were compared to maps and interpretations published in past literature. The main observations and interpretations from Figures 2-18a through 2-18d are:

- Groundwater elevations in the Six Basins may influence groundwater levels and groundwater-flow directions in the Spadra Basin. For example, when groundwater elevations in the Six Basins are higher than groundwater elevations in the Spadra Basin, the underflow across the San Jose Fault may help to create and maintain the groundwater divide that extends from the eastern tip of the San Jose Hills to the eastern Puente Hills. Note on the map figures the groundwater elevation at the P-3 well in the Six Basins, which helps to describe the head difference across the San Jose Fault. Consider the differences between Figure 2-18a and 2-18b which demonstrates the differences in groundwater levels and flow directions between 2018 and 1977:
 - Figure 2-18a is a map of groundwater elevations in 2018. The map shows that groundwater elevations were higher in the Six Basins compared to the Spadra Basin, which likely resulted in subsurface flow from the Six Basins across the San Jose Fault as a source of recharge to the Spadra Basin. Groundwater levels were relatively high in the Spadra Basin, and the groundwater divide was located just south of the eastern tip of the San Jose Hills (where the subsurface inflow from the Six Basins is most likely to occur).
 - Figure 2-18b is a map of groundwater elevations in 1977. The map shows that groundwater elevations were lower in the Six Basins compared to the Spadra Basin, which likely resulted in no subsurface flow from the Six Basins. Groundwater levels were relatively low in the Spadra Basin, and the groundwater divide was located further west of the tip of the San Jose Hills, likely because of the lack of subsurface flow from the Six Basins.
- From the groundwater divide, the main directions of groundwater flow within the Spadra Basin are: (i) eastward into the Chino Basin or (ii) westward and southwestward along the axis of the Spadra Basin toward the Puente Basin. The southwestward flowing groundwater that is not pumped ultimately migrates as underflow through the bedrock narrows into the Puente Basin.
- The hydraulic gradients shown by the groundwater-elevation contours on the figures are relatively constant in the eastward and westward directions, and hence, do not suggest the existence of internal barriers that interrupt or impede the flow of groundwater. The only mapped fault within the Spadra Basin is the extension of the San Jose Fault along the northern margin of the basin. There are no wells (or groundwater data) in the Spadra Basin that are located north of the San Jose Fault that would help determine if the San Jose Fault is a barrier to groundwater flow within the Spadra Basin.

2.2.2.10 Groundwater Pumping

Groundwater pumping is the extraction of groundwater from the aquifer system by a well. In 2018, there were approximately 10 active production wells in the Spadra Basin. Pumping capacities at these wells are relatively low ranging between 200 to 400 gpm. Specific capacities at the pumping wells are also typically low (<25 gpm/ft-drawdown). The low pumping capacities and specific capacities at wells are likely due to the saturated sediments in the Spadra Basin being relatively thin and of low hydraulic conductivity.

Annual groundwater pumping from 1977-2018 is listed by well in Table 2-3 and shown graphically in Figure 2-19. The maximum discharge by pumping occurred in 1986 at about 2,200 afy; the minimum pumping occurred in 1991 at about 700 afy. The average annual pumping over the entire 1977-2018 period was about 1,280 afy. Average annual pumping over the last 10 years was about 970 afy—about 310 afy less than the long-term average. The percentage of the total pumping in the Spadra Basin between the three water purveyors during 1977-2018 was 51 percent by Pomona, 46 percent by CPP, and 3 percent by the WVWD.

2.2.2.11 Groundwater Levels and Storage

This section describes how groundwater levels and storage have changed over time across the Spadra Basin, and why those changes occurred.

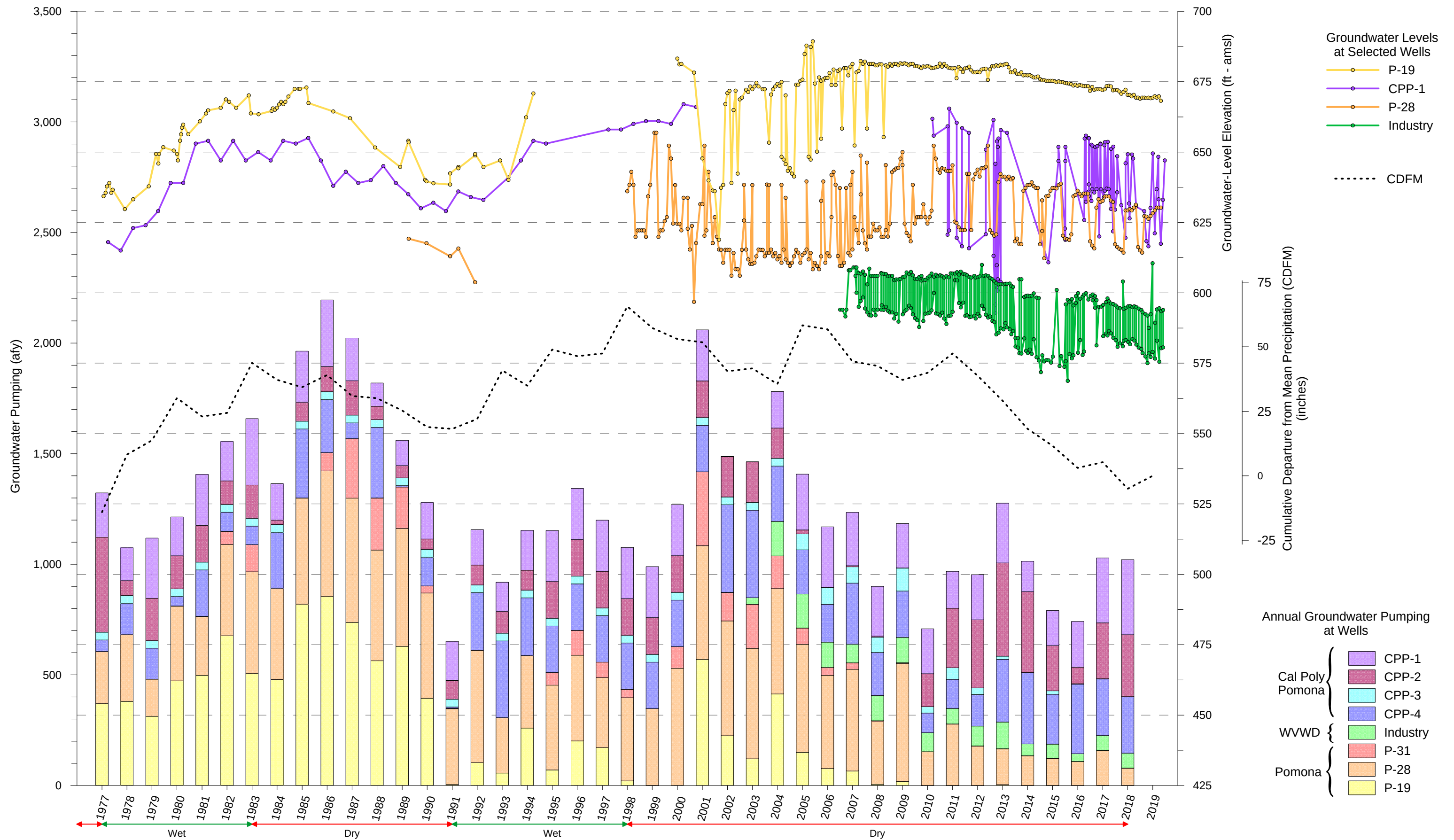
Figure 2-19 shows time-series charts of groundwater elevation at four wells located across the Spadra Basin. The time-series charts indicate:

- At some wells, the short-term groundwater-level fluctuations are caused by including pumping and non-pumping measurements on the time series charts.
- Seasonal changes in groundwater levels at all wells are minimal, and do not exceed a few ft of seasonal change.
- The long-term trends in groundwater levels appear to be consistent at all wells across the basin, suggesting that all wells are being influenced by the same regional stresses of recharge and pumping.

Table 2-3. Groundwater Pumping in the Spadra Basin 1977-2018 (afy)

Year	City of Pomona				Walnut Valley Water District			California State Polytechnic University of Pomona					Other	Total
	P-19	P-28	P-31	Total	Industry	Valley	Total	CPP-1	CPP-2	CPP-3	CPP-4	Total	Walnut Hills	
1977	370	235	1	605	0	0	0	201	430	35	52	718		1,323
1978	380	304	0	684	0	0	0	149	67	35	140	391		1,075
1979	312	168	0	480	0	0	0	273	190	35	140	638		1,119
1980	473	339	0	811	0	0	0	176	150	35	43	403		1,214
1981	498	267	0	764	0	0	0	231	166	35	210	642		1,407
1982	677	413	59	1,149	0	0	0	178	107	35	86	406		1,555
1983	506	460	123	1,089	0	0	0	300	151	35	83	569		1,658
1984	479	413	0	891	0	0	0	165	20	35	253	473		1,364
1985	820	480	0	1,300	0	0	0	231	86	35	312	664		1,964
1986	854	568	83	1,505	0	0	0	302	113	35	240	690		2,195
1987	737	562	269	1,568	0	0	0	193	155	35	2038	2422		3,989
1988	563	501	235	1,299	0	0	0	105	60	35	319	520		1,820
1989	629	533	188	1,349	0	0	0	114	56	35	6	211		1,560
1990	394	476	32	902	0	0	0	165	47	35	130	377		1,279
1991	4	343	2	348	0	0	0	177	85	35	6	303		651
1992	103	507	0	611	0	0	0	160	90	35	261	546		1,157
1993	56	251	0	307	0	0	0	132	99	35	346	611		919
1994	259	329	0	588	0	0	0	180	90	35	260	565		1,153
1995	70	383	57	511	0	0	0	231	166	35	210	642		1,153
1996	201	387	112	701	0	0	0	231	166	35	210	642		1,343
1997	171	316	70	557	0	0	0	231	166	35	210	642		1,199
1998	20	376	37	434	0	0	0	231	166	35	210	642		1,076
1999	0	347	0	347	0	0	0	231	166	35	210	642		989
2000	0	529	98	628	0	0	0	231	166	35	210	642	no data	1,270
2001	570	514	334	1,418	0	0	0	231	166	35	210	642		2,060
2002	225	519	129	873	0	0	0	0	182	35	396	614		1,487
2003	120	499	199	818	30	0	30	0	183	35	396	614		1,463
2004	414	476	148	1,038	156	0	156	165	137	35	250	587		1,781
2005	149	489	74	711	154	0	154	252	18	72	200	542		1,407
2006	76	422	35	533	115	0	115	274	2	75	171	521		1,169
2007	65	460		525	84	0	84	240	5	74	276	595		1,205
2008	5	286	2	293	114	0	114	225	5	69	195	494		900
2009	18	534	3	555	115	0	115	201	0	104	209	515		1,184
2010	0	155	0	155	85	0	85	203	149	29	88	468		708
2011	0	278	0	278	70	0	70	167	269	52	132	620		968
2012	0	178	0	178	90	0	90	204	308	30	143	685		953
2013	4	162	0	166	121	0	121	270	422	14	283	990		1,276
2014	0	134	0	134	53	0	53	137	366	0	323	826		1,013
2015	0	123	0	123	63	0	63	159	204	15	226	604		790
2016	0	108	0	108	35	0	35	207	74	2	314	598		741
2017	0	158	0	158	68	0	68	293	253	0	256	803		1,028
2018	0	78	0	78	67	0	67	339	280	0	256	875		1,021
Minimum	0	78	0	78	0	0	0	0	0	0	6	211		289
Average	243	359	56	657	34	0	34	200	147	36	250	633		1,323
Maximum	854	568	334	1568	156	0	156	339	430	104	2038	2422		4,145
Total	10,222	15,061	2,291	27,574	1,419	0	1,419	8,384	6,182	1,518	10,509	26,594		55,587
Percent of Total	-	-	-	50%	-	-	3%	-	-	-	-	48%		100%

* Numbers in *italics* are estimated volumes of pumping. These estimates were prepared based on confirmation that the well was active and were determined using the average of the measured and recorded annual pumping volumes.



Prepared by:



Author: LH
Date: 20191021
Filename: Fig2-23_Production_GWE

Spadra Basin Groundwater
Sustainability Agency
Groundwater Sustainability Plan



Precipitation, Groundwater Pumping, and
Groundwater Levels in the Spadra Basin

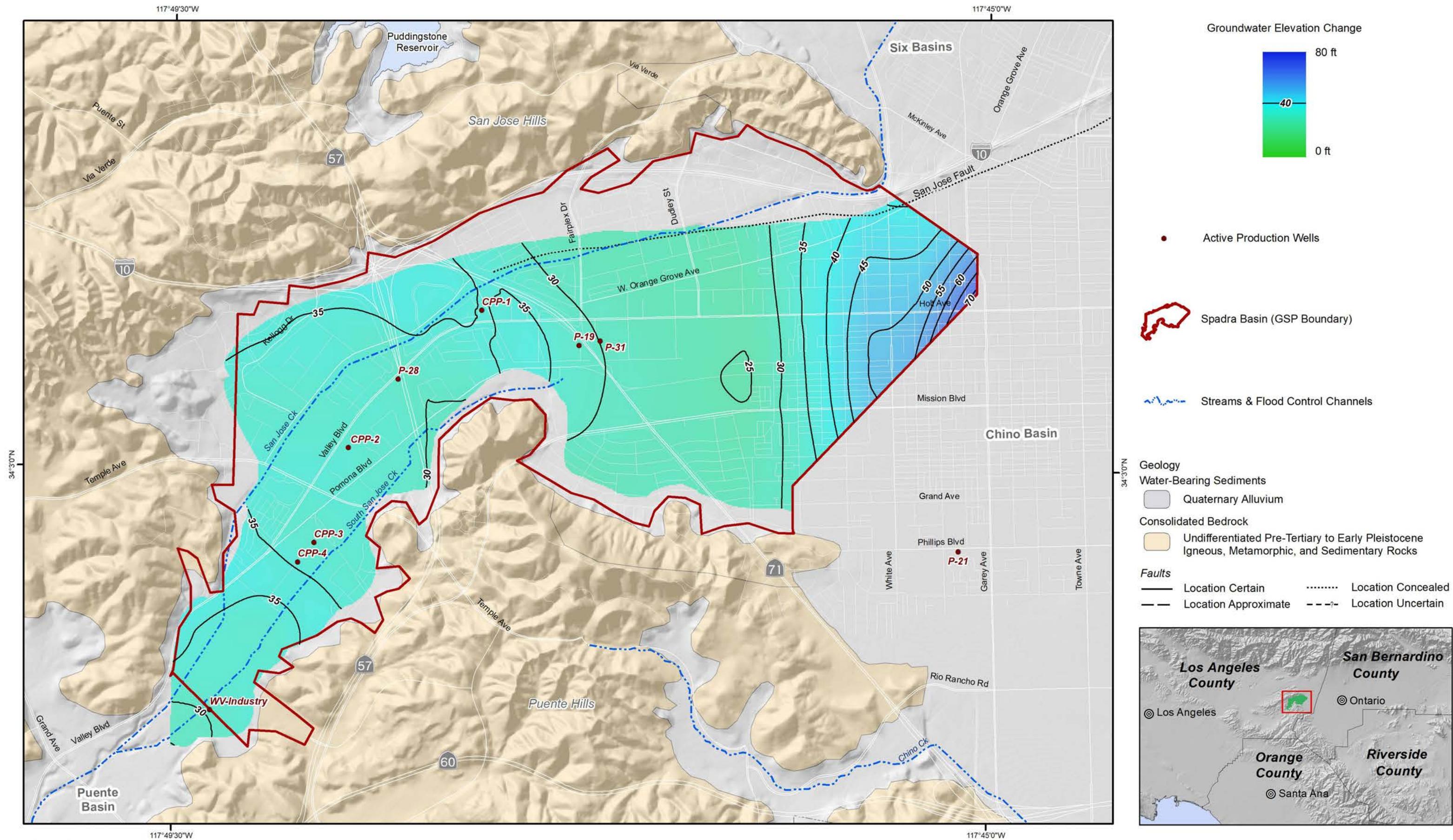
Figure 2-19

On Figure 2-19, the behavior of groundwater levels is compared to precipitation patterns and groundwater pumping to help describe why the changes in groundwater levels have occurred. Precipitation patterns are illustrated by the CDFM curve. The following describes the observations and interpretations from Figure 2-19 and Figures 2-18a through 2-18d:

- In 1977, groundwater elevations were relatively low in the Spadra Basin. This was true for two main reasons: (i) the period from 1945 through 1977 was a long-term drought and (ii) groundwater elevations in the Six Basins were near all-time lows (and in fact, lower than groundwater elevations in the Spadra Basin) (WEI, 2017) which likely resulted in cutting off subsurface inflow from the Six Basins.
- From 1978 to 1985, groundwater elevations increased in the Spadra Basin by 30-40 ft, even though groundwater pumping increased from about 1,200 afy to over 2,000 afy. This increase in groundwater levels was likely due to: (i) increased recharge from precipitation associated with the 1978-83 wet period and (ii) rapidly increasing groundwater levels in the Six Basins in the early 1980s (WEI, 2017) that likely resulted in increased recharge by subsurface flow across the San Jose Fault.
- From 1985 to 1992, groundwater elevations decreased by about 25-30 ft, even though groundwater pumping progressively decreased from over 2,000 afy in 1986 to about 700 afy in 1991. This decrease in groundwater levels was likely due to the 1984 to 1991 dry hydrologic period.
- From 1992 to 2008, groundwater elevations increased by about 40 ft. Groundwater pumping was variable over this period, but generally averaged about 1,200 afy. The increase was likely due to the 1991-98 wet hydrologic period which likely increased the recharge via DIPAW and subsurface inflow from the surrounding hills. Also, during this period, groundwater levels in the Six Basins had increased by at least 300 ft compared to the late 1970s which likely resulted in increased subsurface inflow to the Spadra Basin across the San Jose Fault.
- From 2009 to 2018, groundwater elevations in the Spadra Basin gradually decreased by about 10-20 ft even though groundwater pumping decreased to an average annual rate of about 970 afy for the period. The decrease in groundwater levels was likely due to the 1999- 2018 dry period from and a 50-ft decrease in groundwater levels in the Six Basins, both of which reduced the recharge to the Spadra Basin.

The changes in groundwater levels described above resulted in changes in groundwater storage. Figure 2-20 is a map that shows changes in groundwater levels from 1977 to 2018. Groundwater levels were about 25-35 ft higher in 2018 compared to 1977 across most of the Spadra Basin and were up to 70 ft higher near the boundary with the Chino Basin.

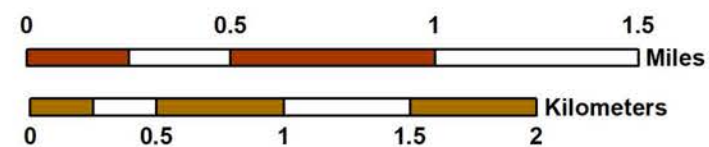
The data used to estimate groundwater in storage for a specific year included: bedrock elevation (shown on Figure 2-14); groundwater elevation (Figure 2-18b for 1977 and Figure 2-18a for 2018); and the thickness-weighted average specific yield of the saturated sediments (Figure 2-16). In ArcGIS, bedrock elevation, groundwater-level elevation, and specific yield were assigned to each cell of a 60 x 60-meter grid (196 x 196-ft) superimposed over the Spadra Basin. In Microsoft Excel, the volume of groundwater in storage within each grid cell was calculated and summed to estimate the total storage in acre-feet (af).



Prepared by:



Author: AP
Date: 11/6/2019
File: Fig2-20_1977-2018_Change.mxd



Prepared for:
Spadra Basin Groundwater Sustainability Agency
Groundwater Sustainability Plan



Change in Groundwater Levels
Fall 1977 - Fall 2018

Figure 2-20

Table 2-4 summarizes the estimated water in storage in 1977 and 2018, and the change in storage over this period.

Table 2-4. Groundwater in Storage and Change in Storage in the Spadra Basin (1977-2018)	
Year	Storage, af
1977	23,678
2018	32,956
Storage 1977-2018	+9,278

2.2.2.12 Initial Estimate of Developed Yield: 1977-2018

As defined herein, the “developed yield” is the annual average yield that was pumped from the groundwater basin over a finite period of time but is corrected for the change in groundwater storage (described above) and the volume of supplemental-water recharge that occurred during the period of interest. The developed yield is reflective of the hydrology and water management practices of that period. It can be considered an estimate of the sustainable yield of a basin if: (i) it is computed over a long enough period to include both wet and dry hydrologic periods and (ii) there were no obvious undesirable results that occurred, such as chronic lowering of groundwater levels and reduction of storage.

Herein, the period of interest for computing an initial estimate of developed yield is 1977 to 2018. This period included wet periods (1978-83 and 1991-98) and dry periods (1984-90 and 1999-2018) and groundwater levels increased across the basin. No supplemental water recharge occurred in the Spadra Basin during 1977 to 2018.

The developed yield can be estimated using a pragmatic approach:

$$\text{Developed Yield} = (O_p - I_{ar} + \Delta S) / \Delta t$$

Where:

Δt is the time period over which the developed yield is being estimated

O_p is the total groundwater pumped from the basin(s) during Δt

I_{ar} is the total supplemental water recharged to the basin(s) during Δt

ΔS is the change in groundwater storage within the basin(s) during Δt

$$\text{Developed Yield} = (53,649 \text{ af} - 0 \text{ af} + 9,278 \text{ af}) / 42 \text{ yr} = 1,498 \text{ afy}$$

In *Section 2.2.6 Water Budget*, a more rigorous analysis of the water budget and the developed yield of the Spadra Basin over the 1977 to 2018 time period was performed through the development and calibration of [the Spadra Basin Groundwater-flow Model](#).

2.2.3 Groundwater Quality

Spadra Basin groundwater is used primarily for non-potable uses by the overlying water purveyors because of the general poor quality of groundwater. Groundwater from Spadra Basin that is used for potable supply often requires treatment or blending prior to use to comply with DDW drinking-water standards.

In the Spadra Basin, groundwater-quality data are available for production wells and monitoring wells. Groundwater-quality samples from production wells are sampled by well owners and are generally sampled for constituents required by the DDW monitoring schedules for municipal water systems. The frequency of water-quality sampling depends on the well use; some production wells in the Spadra Basin are rarely or never sampled because they are used for agricultural or other non-potable uses where water-quality monitoring is performed elsewhere in the distribution system. Groundwater-quality samples from monitoring wells in the Spadra Basin are collected by public entities, private companies and their consultants to characterize point-source contamination for which they are potentially responsible as determined by the LA Regional Board. The constituents and sampling frequency vary by contamination site.

All available groundwater-quality data from wells in the Spadra Basin over the last twenty years (2000-2019) was analyzed for exceedances of regulatory standards including: primary or secondary California maximum contaminant levels (MCLs) for drinking water; State notification levels (NLs) set by the DDW as advisory levels for potential negative health effects; and the numerical groundwater-quality objectives for the Spadra Basin as defined in the LA Basin Plan. There were 39 wells with available groundwater quality data during this period; the frequency of monitoring and constituents sampled for varies by well. Table 2-5 summarizes the number of wells in the Spadra Basin with constituent concentrations that exceed an MCL, NL, or a numerical Basin Plan objective. In one or more wells, there are 17 constituents that exceed a primary MCL, five constituents that exceed a secondary MCL, three constituents that exceed a NL, and four constituents that exceed a Basin Plan objective.

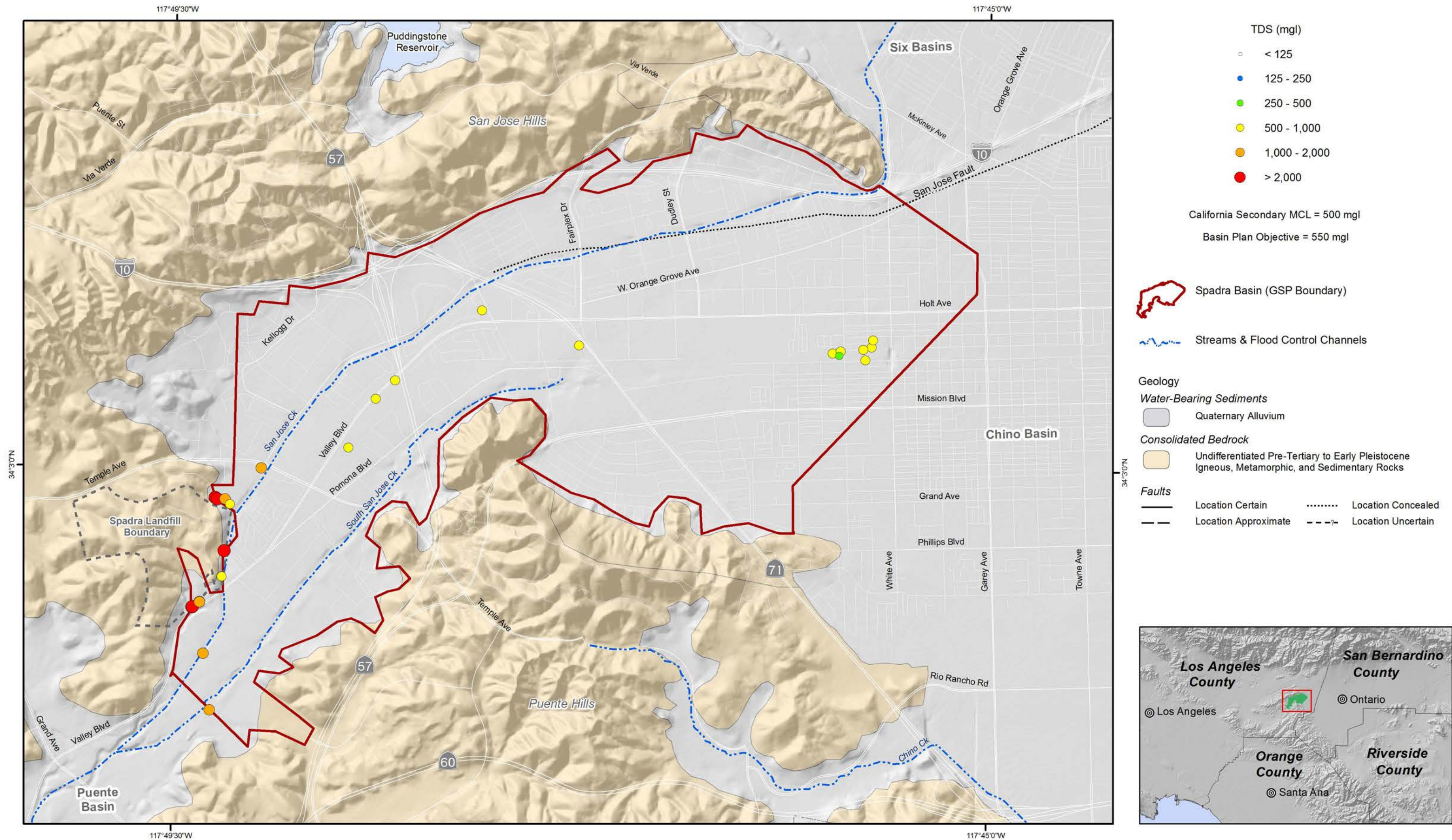
Section 2

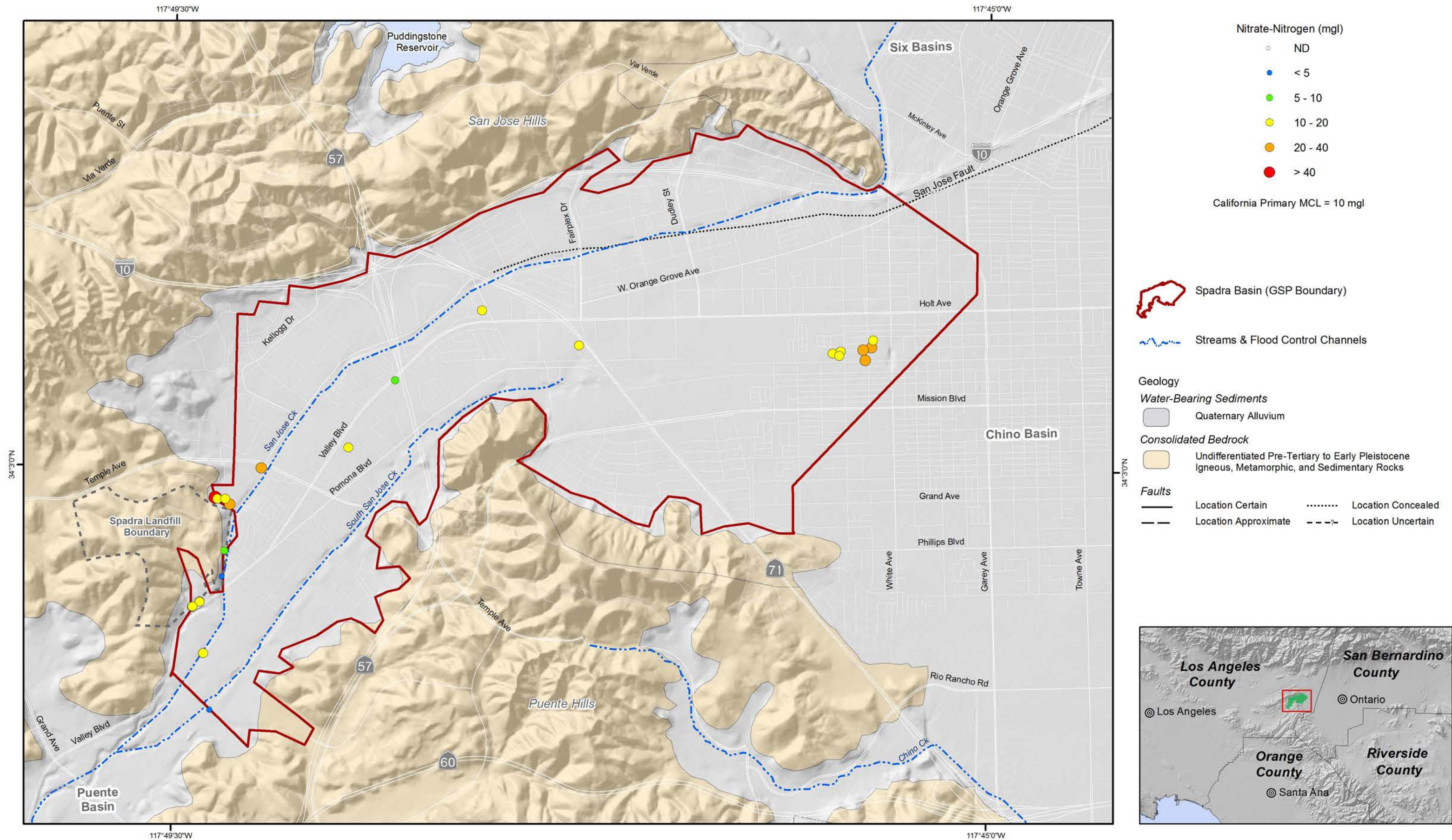
Plan Area and Basin Setting

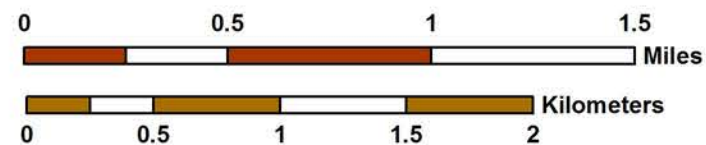
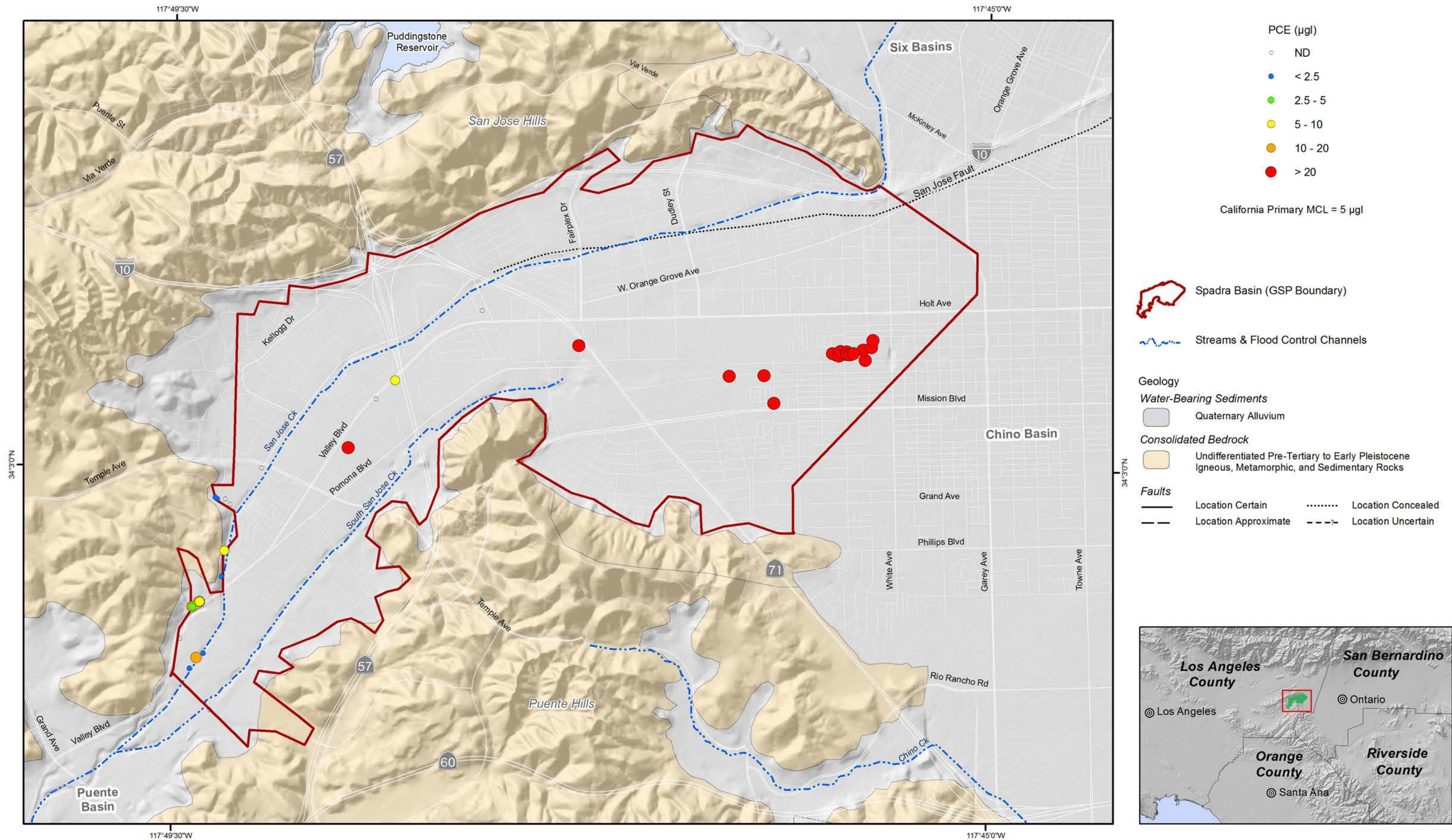


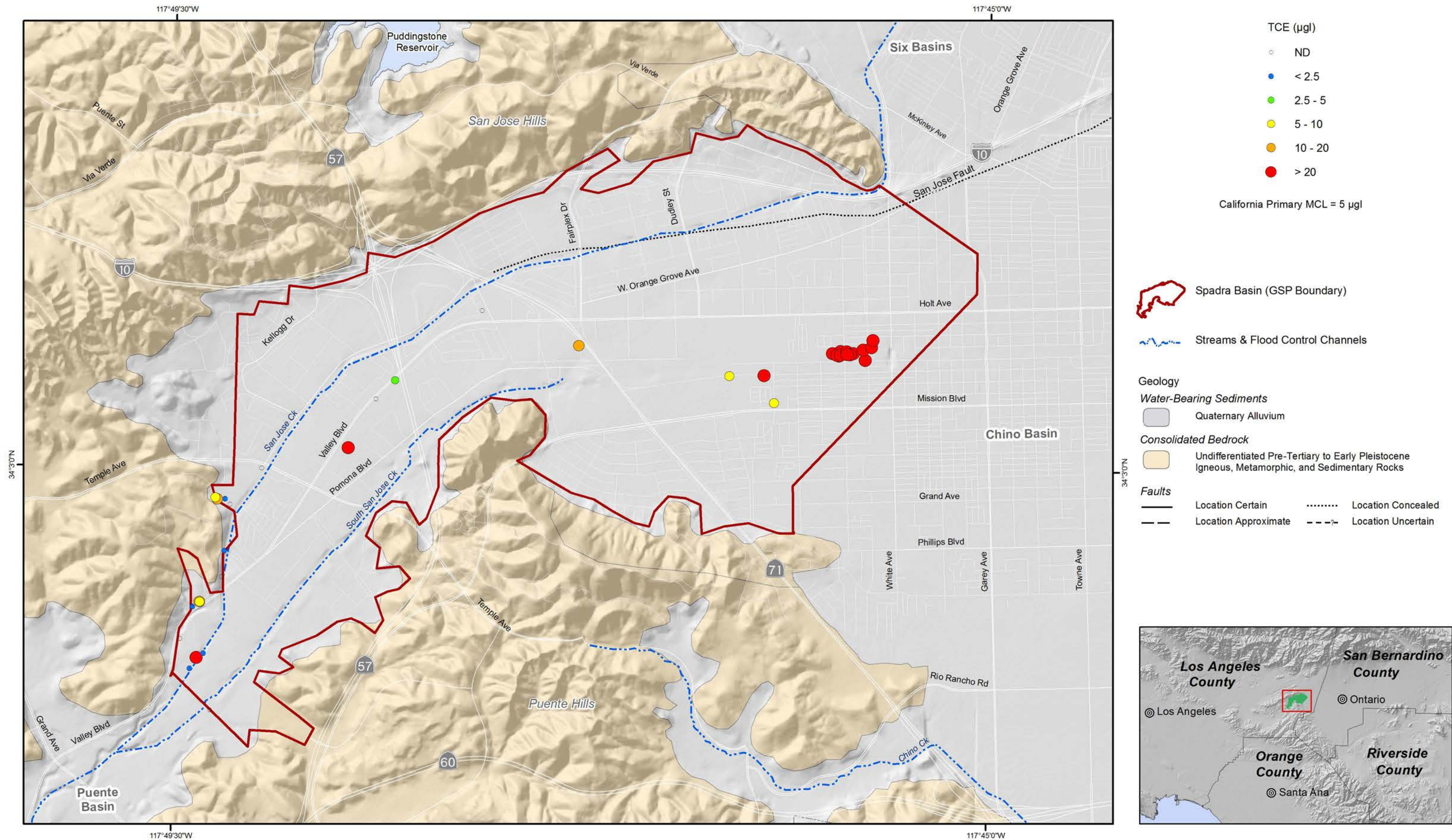
Table 2-5. Exceedances of Groundwater Quality Standards in the Spadra Basin 2000-2019

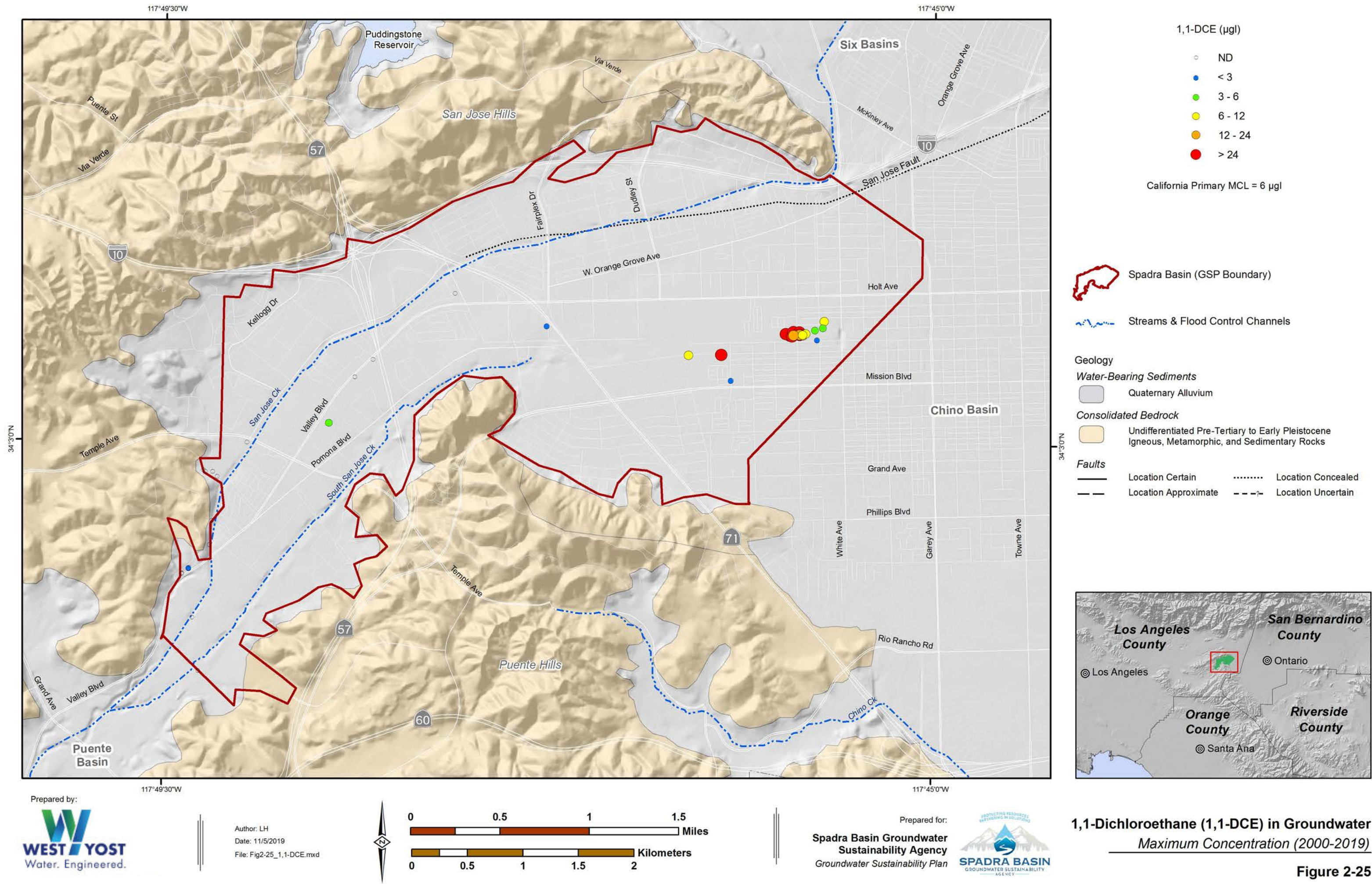
Analyte	Standard ^(a)	Number of Wells Sampled	Number of Wells with Exceedances	Percent of wells with Exceedance
Contaminant with Primary MCL				
1,1-Dichloroethene (1,1-DCE)	6 µg/l	39	14	36%
1,2-Dibromo-3-chloropropane	0.2	27	1	4%
1,2-Dichloroethane	0.5 µg/l	39	8	21%
Arsenic	0.01 µg/l	17	4	24%
Benzene	1 µg/l	36	4	11%
Cadmium	0.005 µg/l	17	1	6%
Chromium	50 µg/l	16	5	31%
cis-1,2-Dichloroethene (cis-1,2-DCE)	6 µg/l	38	3	8%
Di(2-ethylhexyl)phthalate	4 µg/l	14	1	7%
Methyl Tert-Butyl Ether (MTBE)	13 µg/l	36	9	25%
Nickel	0.1 µg/l	15	5	33%
Nitrate-Nitrogen	10 µg/l	23	20	87%
Perchlorate	6 µg/l	15	4	27%
Selenium	50 µg/l	17	5	29%
Tetrachloroethene (PCE)	5 µg/l	39	26	67%
Trichloroethylene (TCE)	5 µg/l	39	25	64%
Vinyl Chloride	0.5 µg/l	29	2	7%
Contaminant with Secondary MCL				
Chloride	500 mg/l	25	1	4%
Manganese	0.05 mg/l	7	1	14%
Methyl Tert-Butyl Ether (MTBE)	5 µg/l	36	16	44%
Sulfate	250 mg/l	25	11	44%
TDS	500 mg/l	25	24	96%
Contaminant with California NL				
1,4-Dioxane	1 µg/l	12	2	17%
Tert-Butyl Alcohol	120 µg/l	33	1	3%
Vanadium	50 µg/l	12	6	50%
Contaminant with Basin Plan Objective ^(b)				
TDS	550 mg/l	25	24	96%
Nitrate-Nitrogen	10 mg/l	23	20	#DIV/0!87%
Sulfate	200 mg/l	25	15	60%
Chloride	120 mg/l	25	12	48%
(a) All MCL standards used for this analysis are California Primary MCL standards; the Federal EPA MCL standards are either higher than, equivalent to, or non-existent for all the contaminants detected in Spadra Basin wells with a MCL exceedance.				
(b) There are no wells in the Spadra Basin that exceed the Basin Plan objective of 1 mg/l for Boron.				

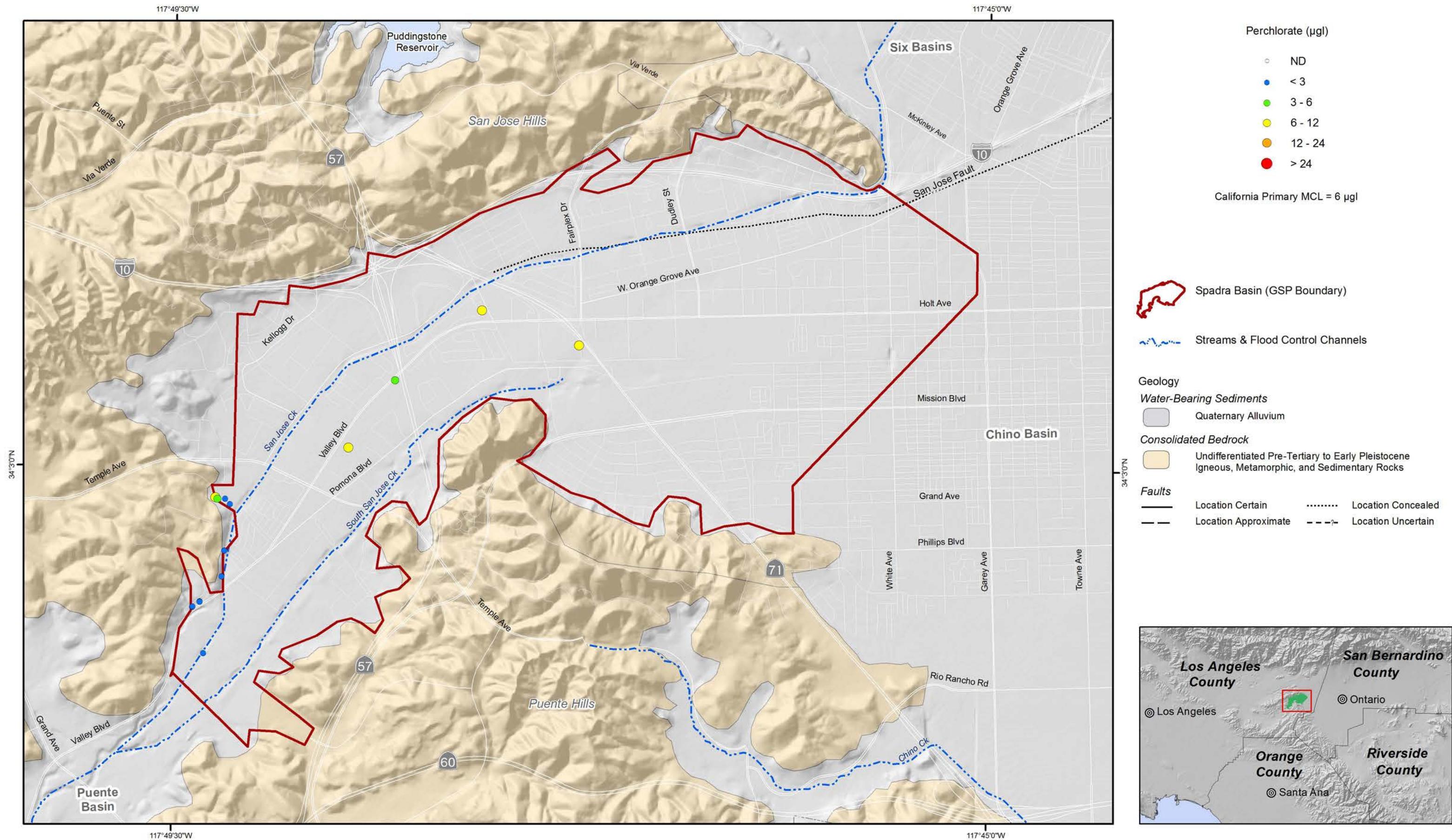












2.2.3.2 Nitrate

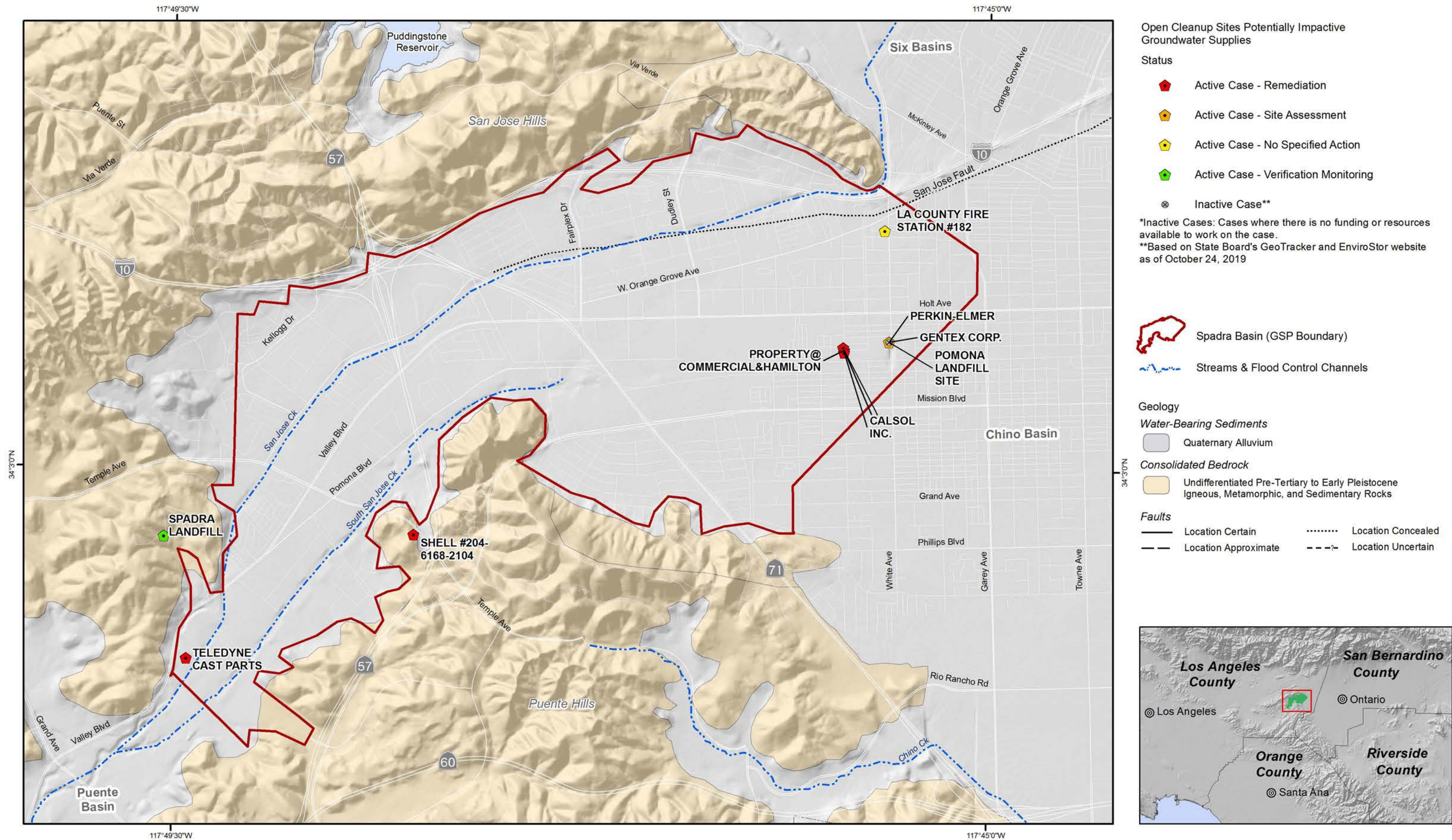
The California primary MCL for nitrate (as nitrogen) in drinking water is 10 mg/l. By convention all nitrate values are expressed in this GSP as nitrate as nitrogen. The Basin Plan also has a nitrate objective of 10 mg/l. Figure 2-22 displays the areal distribution of the maximum nitrate concentration at wells in the Spadra Basin from 2000 through 2019. During this period, 24 of the 39 wells with water-quality data were sampled for nitrate, and nitrate exceeded the primary MCL at 20 (87 percent) of the wells sampled. The maximum nitrate concentrations ranged from 0.8 to 43.4 mg/l and averaged 17 mg/l. The historical land use in the Spadra Basin included irrigated crops, pastures, and citrus where nitrate fertilizers were regularly applied to citrus and other crops. Furthermore, typical irrigation practices for citrus have low irrigation efficiencies, about 60 percent. The lower the irrigation efficiency of the practice, the more applied water percolates to groundwater. There are still portions of the Spadra Basin with irrigated citrus and other crops. These historical and current agricultural practices can result in high nitrate concentrations in groundwater.

2.2.3.3 PCE and TCE

PCE and TCE are regulated drinking water contaminants in California each with a primary MCL of 5 micrograms per liter (µg/l). Figure 2-23 and Figure 2-24 display the areal distribution of the maximum PCE and TCE concentrations at wells in the Spadra Basin from 2000 to 2019, respectively. During this period, 39 out of 39 wells with water quality data were sampled for both PCE and TCE, and PCE concentrations exceeded the primary MCL at 26 (67 percent) of the wells sampled, and TCE concentrations exceeded the primary MCL at 25 (64 percent) of the wells sampled. PCE and TCE are common industrial solvents used as degreasers in metal-working industries. Wells with detectable levels of PCE and TCE occur predominantly in monitoring well clusters associated with known point-sources of contamination (see Figure 2-27) or in wells downgradient of these contamination sites. However, PCE and TCE are detected in some pumping wells in the Spadra Basin that are not located in proximity to these contamination sites and potential sources and responsible parties are yet to be identified. The known point-source contamination sites in the Spadra Basin will be discussed further in *Section 2.2.3.7*

2.2.3.4 1,1-DCE

1,1-DCE is a regulated drinking-water contaminant in California with a primary MCL of 6 µg/l. Figure 2-25 displays the areal distribution of the maximum 1,1 DCE concentration at wells in the Spadra Basin from 2000 to 2019. During this period, 39 of the 39 wells with water quality were sampled for 1,1-DCE and, 1,1-DCE concentrations exceeded the primary MCL at 14 (39 percent) of the wells sampled. 1,1-DCE is a degradation by-product of TCE, PCE, and 1,1,1-trichloroethane (1,1,1-TCA) that is formed by reductive dehalogenation. Wells with detectable levels of 1,1-DCE occur predominantly in monitoring well clusters associated with the known point-sources of contamination (see Figure 2-27) or in wells downgradient of these contamination sites. However, 1,1-DCE is detected in a few wells that are not located in proximity to these contamination sites and potential sources and responsible parties are yet to be identified. The known point-source contamination sites in the Spadra Basin will be discussed further in *Section 2.2.3.7*.



2.2.3.5 Perchlorate

Perchlorate is a regulated drinking-water contaminant in California with a primary MCL of 6 µgl. Figure 2-26 displays the areal distribution of the maximum perchlorate concentration at wells in the Spadra Basin from 2000 to 2019. During this period, 15 of the 39 wells with water-quality data were sampled for perchlorate, and perchlorate concentrations exceeded the primary MCL at 4 (27 percent) of the wells sampled. Perchlorate sources in groundwater can include: (i) synthetic perchlorate, such as ammonium perchlorate used in the manufacturing of solid propellants used for rockets, missiles, and fireworks and (ii) natural perchlorate, such as that derived from Chilean caliche that was used as a fertilizer. It is known that Chilean nitrate fertilizer was used in Southern California in the early 1900s for the citrus industry, which covered the eastern and western portions of the Spadra Basin as shown in Figure 2-5. While Chilean nitrate fertilizer is no longer used, and citrus farming is almost non-existent today in the Spadra Basin, like nitrate, the legacy of perchlorate contamination in groundwater still exists⁸.

In 2015, the California Office of Environmental Health Hazard Assessment (OEHHA) lowered the public health goal (PHG) for perchlorate from 6 to 1 µgl, which prompted the DDW to initiate a process to evaluate the current MCL of 6 µgl. The State Water Board approved a July 2017 DDW recommendation to lower the detection limit for the purposes of reporting (DLR) to 1 µgl to gather state-wide occurrence data and use this to support a potential MCL revision. Perchlorate data has not been collected in every pumping well in Spadra Basin, and at the pumping wells that have been sampled the perchlorate concentrations are above the new PHG, and most are above the MCL. Because of the historical citrus farming in the Spadra Basin and a potential lowering of the MCL by the DDW, perchlorate is a contaminant of concern in the Spadra Basin that could impact the beneficial uses of the groundwater.

2.2.3.6 1,2,3-Trichloropropane

1,2,3-Trichloropropane (1,2,3-TCP) is a newly regulated contaminant in California with a Primary MCL of 0.005 µgl, which was adopted and immediately effective in December 2017. 1,2,3-TCP was used historically as a solvent, an extractive agent, a paint remover, a cleaning and degreasing agent, and in the manufacturing of soil fumigants used for agriculture including citrus farming. During the period of 2000 to 2019, all of the 29 wells sampled for 1,2,3-TCP were non-detect for the contaminant, however all but two of the wells were sampled using laboratory methods with a DLR equivalent to, or lower than, the MCL of 0.005 µgl. The range in the DLR of the laboratory methods used to test for 1,2,3-TCP ranged from 0.5 to 100 µgl, equivalent to 100 to 20,000 µgl times the MCL – thus the occurrence of 1,2,3-TCP relative to the regulatory standard cannot be characterized. Because of the history of citrus and crop farming, and the existence of point-source contaminant sites related to solvent use, 1,2,3-TCP is a potential contaminant of concern in the Spadra Basin that could impact the beneficial uses of the groundwater.

2.2.3.7 Point-Source Contamination in the Spadra Basin

The [State Water Board's GeoTracker](#) databases and California Department of Toxic Substances [Control](#) (DTSC) [EnviroStor](#) database were queried to determine if there are any point-source contaminant sites with open cases for the monitoring and cleanup of groundwater within and adjacent to the Spadra Basin. Sites listed on GeoTracker and EnviroStor that contained no information about the contamination source,

⁸ The [CBWM Chino Basin Watermaster](#) conducted a study analyzing the stable isotopes of oxygen and chlorine from perchlorate in samples from groundwater wells in west and central Chino Basin. This study concluded that Chilean fertilizer was the source of perchlorate in those portions of Chino Basin. The results of the study were not published by the [CBWM Chino Basin Watermaster](#).

contaminants of concern, or contaminated media, were not further investigated, as well as sites where the contaminated media is only soil. Figure 2-27 shows the general location of the point-source contaminant sites identified, categorized by investigation status. Three sites within the Spadra Basin were identified on GeoTracker and EnviroStor that have monitoring data and information indicating a potential impact to groundwater quality: the Teledyne Cast Parts, the Spadra Landfill, and Calsol Inc. These three sites are described below using the resources available on GeoTracker and EnviroStor for these sites.⁹

2.2.3.7.1 Teledyne Cast Parts

The Teledyne Cast Parts site (GeoTracker Case ID: SL0603791177), located at 4200 West Valley Boulevard in Pomona, is an approximately 12-acre facility operated by Consolidated Foundries Incorporated (CFI) for the manufacturing of aluminum and magnesium casting parts for the commercial and military aircraft industries. In 2000, CFI acquired the site from Teledyne Cast Parts who operated the facility since 1971. Teledyne Cast Parts documented the stockpiling of casting sands generated during casting processes. At the request of the LA Regional Board, the stockpiles were removed between 1994 and 1997 and initial site investigations began in 1990 with soil sampling. PCE and TCE were detected in soil samples at concentrations up to 630 to 11,000 micrograms per kilogram ($\mu\text{g}/\text{kg}$). In 1992, groundwater sampling was required in the investigation, including the installation of four on-site monitoring wells. Groundwater quality monitoring was conducted from 1994 to 2013. PCE and TCE were the primary volatile organic compound (VOC) contaminants detected in one of the four monitoring wells at concentrations up to 64.2 and 28.6 $\mu\text{g}/\text{l}$, respectively. Additionally, cis-1,2 dichloroethene (cis-1,2 DCE) and vinyl chloride were detected in one of the four monitoring wells at concentrations up to 12 $\mu\text{g}/\text{l}$ and 6.4 $\mu\text{g}/\text{l}$, respectively. A soil vapor extraction (SVE) system pilot study was conducted by PES Environmental in 2000 and by Environ in 2012. A full-scale SVE system was operated from December 2012 through September 2013.

In August 2014, CFI requested closure of the site by the LA Regional Board, and in 2017 submitted additional monitoring documentation as requested by the LA Regional Board to prepare for closure. According to the 2017 report, TCE and cis-1,2 DCE were detected at one of the four monitoring wells at concentrations of 3.8 and 3.5 $\mu\text{g}/\text{l}$, respectively, both of which are below their respective MCLs. There have been no updates from the LA Regional Board or CFI regarding the potential site closure since 2017.

2.2.3.7.2 Spadra Landfill

The Spadra Landfill (GeoTracker Case ID: L10001382782) is about 300 acres in size and is located at 4125 West Valley Boulevard in Pomona adjacent to the Spadra Basin. The site is owned and operated by the LACSD. The landfill opened as a Class II municipal solid waste disposal facility in 1957 and was certified as closed in 2002. Post-closure monitoring includes collecting groundwater-quality samples from 17 monitoring wells constructed adjacent to and within the Spadra Basin.

Groundwater monitoring began in 1994. VOCs were detected at three of the monitoring wells, and in 2000 it was concluded that the VOCs entered the groundwater due to contact with gas from the landfill, and that groundwater outside of the landfill had not been impacted. VOCs detected included: benzene, chlorobenzene, chloroform, o-dichlorobenzene, p-dichlorobenzene, 1,1-dichloroethane (DCA), 1,2-dichloroethane, 1,1-dichloroethylene, cis-1,2-dichloroethylene, trans-1,2-dichloroethylene, 1,2-dichloropropane, ethylbenzene, Freon-11, methylene chloride, PCE, TCE, toluene, and vinyl chloride. To address these detections, in 2001 the LACSD began operating groundwater extraction wells to capture contaminated groundwater from

⁹ Teledyne Cast Parts at [Geotracker](#); Spadra Landfill at [Geotracker](#); Calsol Inc. at [Envirostor](#)

beneath the site. Pumped groundwater is treated at an air-stripper treatment facility onsite and discharged to the sewer system under an industrial wastewater discharge permit.

Post-closure monitoring includes collecting groundwater-quality samples from 17 monitoring wells constructed adjacent to and within the Spadra Basin. During the May 2019 sampling event, the following VOCs were detected in monitoring wells: cis-1,2-dichloroethene, 1,4-dioxane, DCA, PCE, TCE, chloroform, and vinyl chloride.

In May 2019, the LACSD submitted a work plan for assessing per- and polyfluoroalkyl substances (PFAS) at the landfill. This sampling is planned to occur concurrently with the existing semi-annual sampling (May and November of each year).

2.2.3.7.3 Calsol Inc.

The former Calsol Inc. facility (Envirostor Site Code: 60000137) is a 1.2-acre lot located at the southwest corner of the intersection of Hamilton Boulevard and Commercial Street in Pomona. Calsol Inc. was a solvent distributor and hazardous waste generator of waste oil, mixed oil, and liquids with halogenated VOCs. In 1997, initial investigations identified that soil, soil vapor, and groundwater were impacted with VOCs, specifically PCE and TCE. This was attributed to an accident that occurred in 1976 between a city refuse truck and a train, that resulted in damage to an above-ground storage tank and subsequent release of up to 5,300 gallons of PCE. Secondary sources have also been identified on the site as a result of site operations, which included 23 fuel and solvent storage tanks (above- and below-ground).

A removal action workplan was submitted to and approved by the California Department of Toxic Substances (DTSC) in 2016. The workplan recommended the operation of an SVE system after the successful implementation of two SVE pilots from 2015-2016. At the time the workplan was submitted, groundwater sampling had been minimal and the workplan required quarterly monitoring for a year to better understand the impacts of VOCs in groundwater and the connection between a perched aquifer and a “basal” aquifer. The quarterly groundwater monitoring conducted from 2016-2017, and subsequent semi-annual sampling show elevated concentrations of PCE, TCE, and 1,1-DCE at onsite and offsite monitoring wells. During the latest sampling event in March 2019, the following constituents were detected (maximum concentration detected): PCE (1,400 µg/l), TCE (1,900 µg/l), 1,1-DCE (51 µg/l), and methyl tert-butyl ether (MTBE) (21 µg/l).

As of March 2019, the SVE system is still in operation and quarterly groundwater sampling continues. To date, an estimated total of 6,800 pounds of VOCs have been removed by the SVE system.

2.2.4 Ground Levels

Vertical ground motion, in the form of subsidence and rebound of the land surface, occurs in all groundwater basins as groundwater levels change within the underlying aquifer system. This process has occurred in the Spadra Basin, as well as in the adjacent groundwater basins, such as well-documented occurrences in the Chino Basin (WEI, 2019). It is important to understand and monitor vertical ground motion because land subsidence can cause damage to vulnerable infrastructure at the surface.

Although drawdown of groundwater levels is the driving force that causes land subsidence due to groundwater pumping, the geology of a groundwater basin also plays an important role in this process. Clay layers within the aquifer-system are relatively compressible materials. Therefore, aquifer-systems

that contain thick and/or numerous clay layers are most susceptible to land subsidence or rebound when groundwater is extracted or recharged.

The process that describes pumping-induced land subsidence is termed the “aquitard-drainage model.” Simply stated, an aquifer system consists of permeable sand and gravel layers interbedded with less-permeable silt and clay layers. The sand and gravel layers are the “aquifers” and groundwater flows through the aquifers toward pumping wells. The silt and clay layers are the “aquitards.” Pumping wells cause groundwater-level drawdown in the aquifers which, in turn, cause the aquitards to slowly drain into the aquifers. The draining allows aquitard pore pressures to decay toward equilibrium with the reduced pore pressures in the adjacent aquifers. Since the pressure of the pore water provides some internal support for the sedimentary structure of the aquitards, this loss of internal support causes the aquitards to compress, resulting in subsidence at the land surface. When the pumping wells turn off, and groundwater levels recover in the aquifers, groundwater migrates back into the aquitards and they expand, resulting in rebound at the land surface. Over a limited range of seasonal groundwater-level fluctuations, this process can occur in a purely elastic fashion. That is, a recovery of groundwater levels to their original values causes the land surface to rebound to its original elevation. However, when drawdown falls below a certain “threshold” level, elastic compression transitions to a non-recoverable inelastic compaction of the aquitards, resulting in permanent land subsidence. The “threshold” level, referred to as the “preconsolidation stress,” is taken to be the maximum past stress to which the sedimentary structure had previously equilibrated under the gradually increasing load of accumulating sediments.

The hydrogeologic cross-sections in Figures 2-15a–~~ed~~ show that the aquifer system in Spadra Basin contains numerous aquitard lenses of varying thickness that could be susceptible to compaction via the aquitard-drainage model. However, the Spadra Basin is a relatively thin aquifer system which limits the potential magnitude of aquitard compaction and land subsidence that could occur.

Aquitard drainage, and the resultant deformation of the ground surface, has been well documented in the Chino Basin where ground fissures damaged overlying infrastructure in the City of Chino in the early 1990s (WEI, 2006). The [Chino Basin Watermaster \(CBWM\)](#) has conducted extensive studies of the process, and based on those studies, developed a subsidence management plan to minimize or abate the occurrence of subsidence and ground fissuring in the Chino Basin (CBWM, 2015). Currently, the [CBWM Watermaster](#)’s efforts are focused on developing a specific subsidence management plan for “Northwest MZ-1 Area”, which is the area of the Chino Basin directly adjacent to the Spadra Basin.

Part of the Chino Basin [CBWM Watermaster](#)’s subsidence management plan is to conduct ongoing monitoring of ground motion by Synthetic Aperture Radar Interferometry (InSAR), which is a method that utilizes radar imagery from an Earth-orbiting satellite to map ground motion over time. The [CBWM Watermaster](#) determines the scope of its monitoring efforts annually. The InSAR data collected and utilized in the subsidence studies in Chino Basin cover portions of the Spadra Basin as well. These InSAR estimates are the most complete and accurate record of vertical ground motion available for the Spadra Basin.

Figure 2-28 includes a series of maps that display the InSAR estimates of vertical ground motion across the Spadra Basin for the periods 1992-1995, 1996-1999, 2005-2010, and 2011-2018. The maps indicate that downward ground motion has occurred across the Spadra Basin over the period of record, even though groundwater levels have remained relatively stable over the same period (see Figure 2-19).

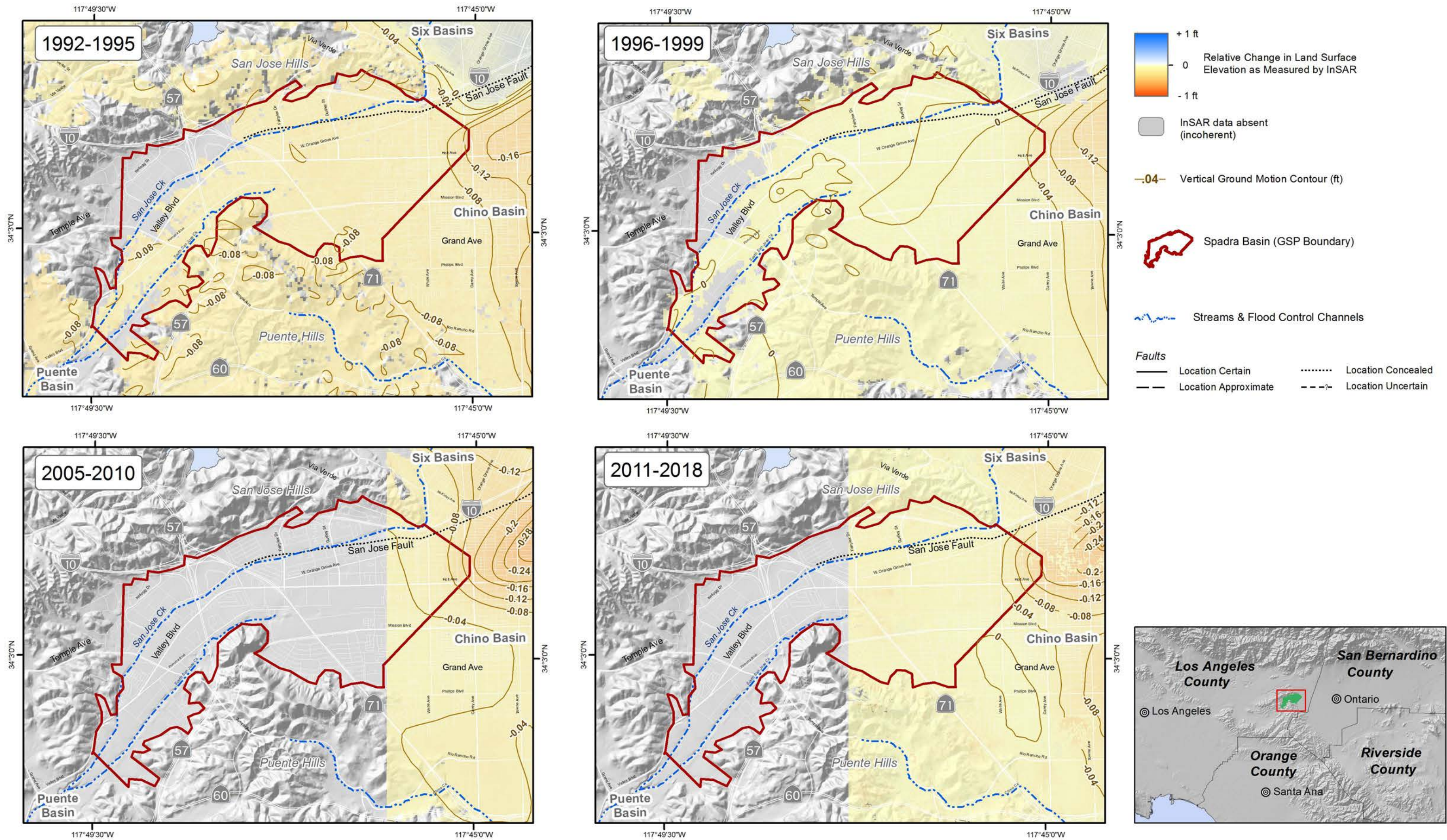


Figure 2-28 shows that the same gradual and persistent downward ground motion has occurred in the adjacent areas of the Chino Basin, although the magnitude of downward ground motion has been comparatively much less in the Spadra Basin. As in the Spadra Basin, groundwater levels in this part of the Chino Basin have been relatively stable or increasing during the 1992-2018 period. The [CBWM Chino-Basin Watermaster](#) (2019) states that a plausible explanation for the gradual and persistent downward ground motion is that thick, slow-draining aquitards are permanently compacting in response to the historical declines in groundwater levels that occurred between 1930 and 1978. This same process could explain the downward ground motion observed in the Spadra Basin from 1992 to 2018, but not enough data and information are available to confirm.

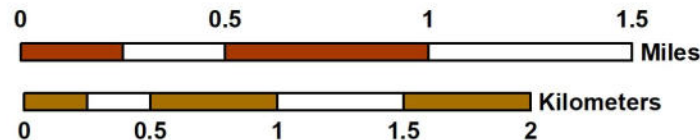
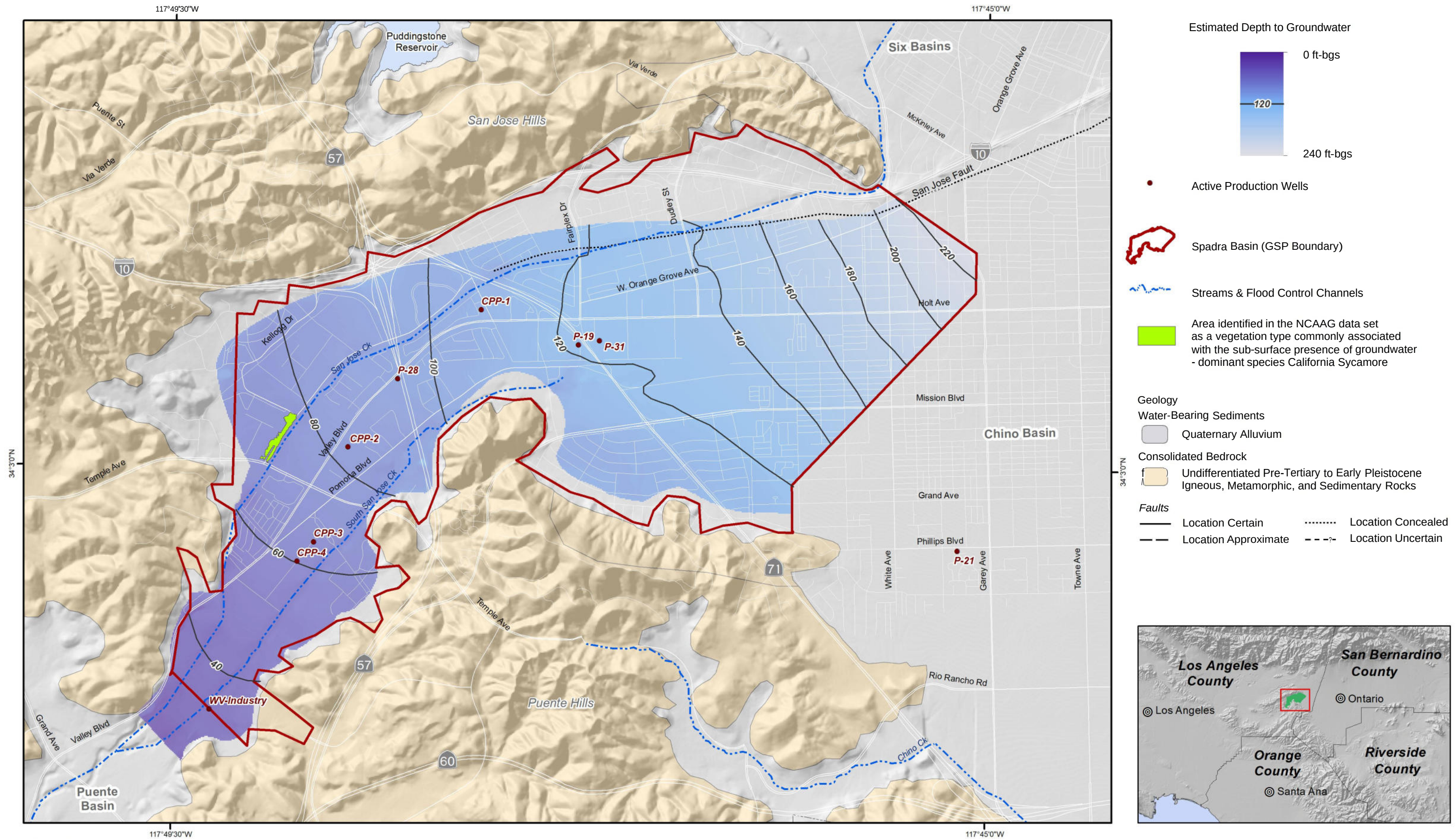
The aquifer systems of the Chino Basin and Spadra Basin are connected across their common boundary. Changes in groundwater levels within one basin could cause changes in groundwater levels in the other, which could lead to aquitard drainage and associated land subsidence. Therefore, land subsidence is a potential undesirable result of groundwater management practices in both basins and should be a factor of consideration in the development and implementation of groundwater management plans in both basins.

2.2.5 Surface Water and Groundwater Dependent Ecosystems

The GSP Regulations require that GSPs identify Groundwater Dependent Ecosystems (GDEs), and where appropriate, consider the potential impacts on GDEs. GDEs are defined in the GSP Regulations as “ecological communities of species that depend on groundwater emerging from aquifers or on groundwater occurring near the ground surface.” Figure 2-29 is a map of depth-to-groundwater in the Spadra Basin in 2008, a period of highest recorded groundwater levels. Depth-to-groundwater in 2008 ranged from a maximum of about 220 ft-bgs in the eastern portion of the Spadra Basin to a minimum of about 40 ft-bgs at the western margin of the basin. Maximum rooting depths for vegetation in GDEs is typically less than 30 ft-bgs. Because depth-to-groundwater is greater than 40 ft-bgs, and because all stream channels in Spadra Basin are concrete-lined, there appears to be no areas of interconnected groundwater and surface-water or swallow groundwater in the Spadra Basin that are supporting GDEs in the Spadra Basin.

On the DWR’s Natural Communities Commonly Associated with Groundwater (NCCAG) dataset map viewer of GDEs¹⁰ there is one small area mapped as a vegetation type commonly associated with the sub-surface presence of groundwater (mapped vegetated area). The mapped vegetated area is shown on Figure 2-29 and includes the dominant species California Sycamore (*Platanus racemose*) The NCCAG data set is to be used as a starting point to identify GDEs with a groundwater basin and should be researched and verified using local knowledge.

¹⁰ The NCCAG data set [NC Dataset Viewer](#) is a compilation of 48 publicly available State and federal agency datasets that map vegetation, wetlands, springs, and seeps in California, developed through a screening process by a working group comprised of DWR, California Department of Fish and Wildlife (CDFW), and The Nature Conservancy.



The Sycamore trees in mapped vegetated area are located on the northern side of the concrete-lined San Jose Creek and appear to be part of the irrigated urban landscaping along both sides of Campus Drive between Temple Avenue and Kellogg Drive. The estimated depth to groundwater in this mapped vegetated area is greater than 40 ft-bgs, which is likely too deep to support the Sycamores that typically have rooting depths of less than 10 ft-bgs. Additionally, San Jose Creek is concrete lined along its entire reach within the Spadra Basin and therefore cannot provide recharge to support riparian vegetation. These observations indicate that the mapped vegetative area is not a GDE.

Notwithstanding the above observations, the Spadra GSA will continue to refer to additional resources and local knowledge to identify potential GDEs in the Spadra Basin, and if appropriate, consider the impacts to GDEs in the final GSP

2.2.6 Water Budget

[23](#) CCR § 354.18 of the GSP Regulations requires that each GSP include a water budget for the basin, reported in tabular and graphical form, for historical, current, and projected conditions. The water budget is the annual accounting of specific components of recharge to and discharge from the groundwater system and the resultant changes of groundwater in storage. When total recharge is equal to total discharge, there is no change in groundwater storage, indicating that the aquifer system is at equilibrium or steady state. When total recharge does not equal the total discharge, there is either an increase in storage or a decrease in storage, which results in a change in groundwater levels. The water budget is transient over time, and can be affected by short-term weather events, long-term climatic trends, overlying land uses, outdoor water uses, water disposal practices, groundwater pumping, groundwater management activities in adjacent basins, and artificial recharge activities. Understanding of the water budget for a groundwater basin is key to the development of sustainable management criteria and management practices.

Water budgets for the Spadra Basin were estimated using the numerical Spadra Basin [Groundwater-flow Model](#) that was developed from the hydrogeologic information described in this *Basin Setting* section of this GSP and then calibrated to refine the aquifer-system properties. The construction and calibration of the Spadra Basin [Groundwater-flow Model](#) is described in a technical memorandum that went through the stakeholder review process and is included as Appendix I of this GSP. The historical and current water budget spans the model calibration period of 1978-2018. The “current” water budget conditions are considered to be 2018 conditions. Future water budgets were estimated from subsequent model-simulations over the 60-year planning horizon of 2019-2079 for baseline conditions and for the three planning scenarios that were evaluated in the development of this GSP. (see *Section 5 Projects and Management Actions to Achieve Sustainability*).

2.2.6.1 Historical and Current Water Budget

This section describes the historical water budget for the Spadra Basin for the period of 1978-2018, [prepared on](#) the calibration period for the Spadra Basin [Groundwater-flow Model](#) (see Appendix I). Table 2-6 lists the various methods that were used to estimate the historical water budget for the Spadra Basin, which include measured data, model estimates, information from prior investigations, or a combination of these methods. Table 2-7 lists the annual volumes of each water-budget component and the annual change in groundwater storage. The measured data that were used to estimate certain water-budget components, such as groundwater pumping, are described in previous sections of the Basin Setting. The models used to estimate other water-budget components are described in Appendix I.

Table 2-6. Methods, Data, and Information Used to Estimate the Water Budget for the Spadra Basin

	Method Used to Estimate Water Budget Component (Measurement, Model, or Both)	Data/Information Used in the Development of Recharge and Discharge Components							
		Land use	Hydrologic Soil Type	Surface Water Drainage System	Measured Surface Water Discharge	Measured Precipitation	Measured ET and Evaporation	Metered Groundwater Pumping	Measured Water Level at Wells
Recharge Component									
Subsurface inflow from adjacent hills and mountains	Model	◆	◆	◆	◆	◆	◆		
Deep infiltration of precipitation and applied water	Model	◆	◆	◆	◆	◆	◆		
Discharge Component									
Subsurface outflow to adjacent groundwater basins	Both, and prior information ^(a)								◆
Groundwater pumping	Measurement							◆	
Evapotranspiration (ET)	Both	◆	◆			◆	◆		

(a) Prior information is derived from prior investigations.

Table 2-7. Water Budget for the Spadra Basin -- Fiscal Year 1978-2018

Fiscal Year	Recharge			Discharge				Change in Storage (Recharge - Discharge)		Annual Developed Yield
	DIPAW ^(a)	Subsurface Inflow from San Jose and Puente Hills	Total Recharge	Pumping	Outflow to Puente Basin	Outflow to Chino Basin	Total Discharge	Annual	Cumulative	
				<i>a</i>				<i>b</i>		<i>a + b</i>
1978	2,961	1,504	4,465	1,402	1,336	950	3,689	777	777	2,179
1979	3,076	1,527	4,604	937	1,769	446	3,151	1,452	2,229	2,389
1980	3,161	1,636	4,797	1,188	1,819	293	3,300	1,497	3,726	2,685
1981	3,114	1,665	4,779	1,544	1,786	384	3,714	1,066	4,792	2,610
1982	3,107	1,657	4,764	1,344	1,871	434	3,649	1,115	5,907	2,460
1983	3,430	1,621	5,051	1,752	2,019	482	4,253	798	6,706	2,550
1984	3,353	1,545	4,898	1,189	2,000	529	3,718	1,179	7,885	2,369
1985	2,984	1,367	4,351	1,805	1,899	648	4,352	0	7,884	1,804
1986	2,992	1,451	4,442	2,133	1,827	699	4,658	-216	7,668	1,917
1987	2,722	1,337	4,059	2,159	1,774	685	4,617	-559	7,110	1,600
1988	2,827	1,142	3,969	1,934	1,746	655	4,335	-366	6,744	1,568
1989	2,791	1,140	3,931	1,615	1,768	677	4,060	-129	6,615	1,486
1990	2,412	1,085	3,496	1,388	1,785	639	3,812	-316	6,299	1,073
1991	2,315	955	3,270	999	1,721	520	3,240	31	6,330	1,029
1992	2,386	1,078	3,464	910	1,740	449	3,099	365	6,694	1,274
1993	2,429	1,126	3,555	1,129	1,578	434	3,141	414	7,108	1,543
1994	2,374	1,048	3,422	872	1,599	483	2,953	469	7,578	1,341
1995	2,323	1,163	3,485	1,175	1,491	504	3,171	314	7,892	1,490
1996	2,272	1,195	3,467	1,266	1,499	661	3,426	41	7,933	1,307
1997	2,375	1,151	3,527	1,351	1,481	684	3,516	11	7,944	1,362
1998	2,602	1,178	3,780	1,101	1,584	699	3,384	396	8,340	1,497
1999	2,445	1,172	3,617	1,025	1,560	600	3,185	432	8,772	1,457
2000	2,292	1,114	3,406	1,106	1,483	727	3,316	90	8,862	1,196
2001	2,366	1,127	3,493	2,096	1,431	730	4,257	-765	8,097	1,332
2002	2,201	996	3,197	1,735	1,202	633	3,569	-372	7,725	1,362
2003	2,204	823	3,027	1,409	1,062	616	3,086	-59	7,665	1,350
2004	2,087	842	2,929	1,552	1,065	616	3,233	-304	7,361	1,248
2005	2,096	997	3,093	1,496	1,124	554	3,174	-82	7,280	1,415
2006	2,113	950	3,063	1,039	1,271	481	2,791	272	7,551	1,311
2007	1,974	940		1,177	1,159	238	2,573	341	7,892	1,517
2008	1,938	935	2,873	1,082	1,182	398	2,662	211	8,103	1,293
2009	1,974	940	2,914	834	1,335	558	2,726	188	8,291	1,021
2010	1,977	802	2,779	887	1,272	630	2,789	-10	8,281	877
2011	2,073	884	2,958	788	1,457	561	2,806	151	8,432	939
2012	1,789	891	2,680	764	1,368	459	2,591	90	8,522	854
2013	1,712	819	2,531	1,001	1,253	496	2,750	-218	8,303	783
2014	1,721	766	2,487	1,180	1,060	590	2,829	-342	7,961	838
2015	1,663	669	2,332	865	1,100	609	2,574	-242	7,719	623
2016	1,613	549	2,163	602	1,215	560	2,377	-214	7,505	387
2017	1,625	659	2,284	809	1,208	425	2,442	-158	7,347	651
2018	1,475	653	2,128	986	1,065	335	2,386	-258	7,089	728
Statistics for the Calibration Period 1978 through 2018										
Minimum	1,475	549	2,128	602	1,060	238	2,377	-765		387
Average	2,374	1,100	3,474	1,259	1,487	555	3,301	173		1,432
Maximum	3,430	1,665	5,051	2,159	2,019	950	4,658	1,497		2,685
Total	97,345	45,100	142,445	51,624	60,959	22,774	135,356	7,089		58,713

2.2.6.1.1 Recharge Components

The recharge components for the Spadra Basin are listed in Table 2-7 for the calibration period and are characterized below:

Deep infiltration of precipitation and applied water (DIPAW). The Hydrological Simulation Program-FORTRAN (HSPF) and R4 watershed models were used to estimate surface water discharge from precipitation throughout the Spadra Basin watershed and the DIPAW from the soil (root) zone. The data requirements of these models include the following: land use and associated properties (imperviousness, irrigation practices), hydrologic soil type, topography, surface water drainage system (channel alignment, hydraulic properties and operating schemes), surface water discharge measurements (boundary inflows), precipitation, and evapotranspiration (ET) and evaporation. Recharge from DIPAW ranged from about 1,475 to 3,430 afy and averaged about 2,374 afy over the calibration period.

Subsurface inflow from the saturated alluvium and fractures within the bordering bedrock hills (San Jose and Puente Hills). The model estimated DIPAW for watersheds that are tributary to and not overlying the groundwater basin was assumed to be the subsurface inflow from these areas to the Spadra Basin proximate to the discharge point of the watershed to the groundwater basin. Surface water discharges estimated by these models were routed through the stream systems that overlie the active Spadra Basin domain. Subsurface inflow from the saturated alluvium and fractures within the bordering bedrock hills ranged from about 549 to 1,665 afy and averaged about 1,100 afy over the calibration period.

Subsurface inflow from the Six Basins across the San Jose Fault. Subsurface inflow from the Six Basins across the San Jose Fault is a possible source of recharge to the Spadra Basin. Eckis (1933) speculated that this inflow could be, at least in part, responsible for the existence of the groundwater divide that separates the Spadra Basin from the Chino Basin. However, the gap between the San Jose Fault and San Jose Hills, where such subsurface inflow could occur, is small, and there is a paucity of hydrogeologic data in this area to characterize how such inflow occurs. For these reasons, subsurface inflow from the Six Basins was assumed to be negligible in this modeling effort.

Deep infiltration of septic tank discharge. Wastewaters generated within the Spadra Basin are almost entirely conveyed to the Pomona Water Reclamation Plant for treatment. Therefore, the deep infiltration of septic tank discharge was assumed to be negligible in this modeling effort.

Table 2-7 shows that average recharge to the Spadra Basin was estimated to be about 3,474 afy over the period of 1978-2018.

2.2.6.1.2 Discharge Components

The discharge components for the Spadra Basin are listed in Table 2-7 for the calibration period and are characterized below:

- **Groundwater pumping from wells.** This discharge component was estimated based on the records of major groundwater producers in the Spadra Basin (Pomona, WVWD, and the CPP). Groundwater pumping ranged from about 602 to 2,159 afy and averaged about 1,259 afy over the calibration period.

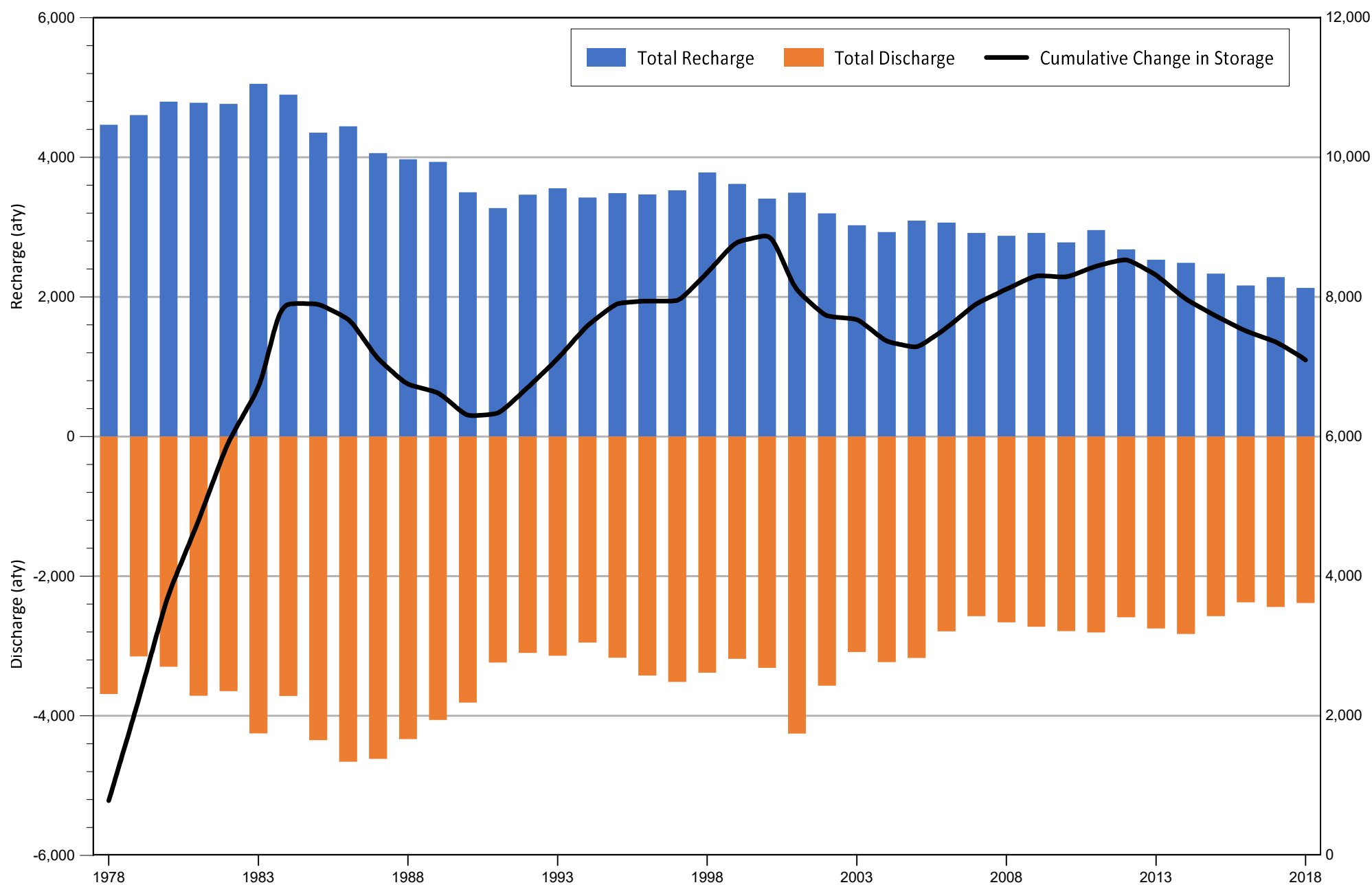
- **Subsurface outflow to the Puente Basin.** Subsurface outflow to the Puente Basin occurs through the saturated sediments in the bedrock narrows at the southwestern boundary of the Spadra Basin. The outflows were estimated by the Spadra Basin [Gg](#)groundwater-[flow](#) [Mm](#)model based on a historical time series of groundwater elevations at a well located near the boundary and the calibrated hydraulic conductivities in the Spadra Basin adjacent to the boundary as described in Appendix I. The boundary was treated as a variable-head boundary during model calibration. Subsurface outflow to the Puente Basin ranged from about 1,060 to 2,019 afy and averaged about 1,487 afy over the calibration period.
- **Subsurface outflow to the Chino Basin.** Subsurface outflow to the Chino Basin occurs within the saturated sediments across the eastern boundary of the Spadra Basin, which is the adjudicated Chino Basin boundary. The outflows were estimated by the Spadra Basin [Gg](#)groundwater-[flow](#) [Mm](#)model during model calibration. Subsurface outflow to the Chino Basin ranged from about 238 to 950 afy and averaged about 555 afy over the calibration period.
- **Rising Groundwater Outflow and Evapotranspiration.** Measured groundwater levels and model-simulated groundwater levels during model calibration never rise to closer than 30 ft from the ground surface in the Spadra Basin, so there is no discharge due to rising groundwater outflow. In addition, there are no Groundwater Dependent Ecosystems (GDEs) within the Spadra Basin, so there is no discharge due to evapotranspiration.

Table 2-7 shows that average discharge from the Spadra Basin was estimated to be about 3,300 afy over the calibration period 1978-2018.

2.2.6.1.3 Change in Groundwater Storage

Table 2-7 lists the annual and cumulative change in groundwater storage over the calibration period as estimated from the water budget. Figure 2-30 is a time-history chart that shows annual recharge, annual discharge, and the cumulative change in storage for 1978-2018. The cumulative change in storage over this period was +7,089 af. This table and figure indicate that the water budget, and hence the changes in storage, were primarily driven by climatic conditions and changes in groundwater production. For example, groundwater storage increased by about 8,000 af during the 1978-83 wet period, primarily because recharge (DIPAW and subsurface inflow from the surrounding mountains and hills) was higher than discharge (pumping and subsurface outflow). From 1984 to 2018, recharge was approximately equal to discharge, annual changes in storage were relatively small, and total groundwater in storage remained relatively stable. This relative balance persisted even during the long-term dry period from 1999-2018, primarily because of reduced groundwater pumping. These model-estimated changes in storage are consistent with the measured changes in groundwater elevations across the Spadra Basin as described in *Section 2.2.2.11 Groundwater Level and Storage* (see Figure 2-19 and 2-20).

Figure 2-30. Total Recharge, Discharge, and Change in Storage in the Spadra Basin During the Calibration Period (1978-2018)



2.2.6.1.4 Sustainable Yield

The term Sustainable Yield is central to SGMA and is defined as the maximum quantity of water that can be withdrawn annually from a groundwater supply without causing Undesirable Results. The water budget in Table 2-7 shows the annual “developed yield” of the Spadra Basin. Developed yield is equal to groundwater production plus the change in storage. Developed yield is an estimate of net inflow to a basin. Over a representative hydrologic period and under similar conditions of overlying land and water uses, developed yield is an estimate of the Sustainable Yield from the groundwater basin. The average developed yield over the calibration period was about 1,430 afy. This estimate of developed yield is about 170 afy greater than the average pumping from the Spadra Basin over the same period, suggesting that higher Sustainable Yield (sustainable pumping rates) equivalent to the calculated developed yield are possible within the Spadra Basin without causing a decrease in storage or other Undesirable Results that are described in *Section 3 Sustainable Management Criteria*.

2.2.6.2 Future Water Budget

Potential future water budgets over the 60-year planning horizon of 2019-2079 were developed for a Baseline Scenario of future conditions in the Spadra Basin and for three Basin Optimization Scenarios (planning scenarios with combinations of conceptual projects and management plans to achieve long-term sustainability in the Spadra Basin and maximize the beneficial use). The model-evaluation of these future scenarios and the resulting water budgets are described in *Section 5 Projects and Management Actions to Achieve Sustainability*.

2.2.7 Data Gaps

Section §354.12 of the GSP Regulations requires the identification of “data gaps” and levels of uncertainty in the description of the Basin Setting. A “data gap” refers to a lack of information that significantly affects the understanding of the basin setting or the future evaluation of the efficacy of GSP implementation to sustainably manage the basin.

The Basin Setting description above has revealed potential data gaps that may need to be filled as part of GSP implementation to improve the monitoring network. A preliminary list and description of the data gaps is listed below.

- There is a lack of hydrogeologic data and information to describe the groundwater interactions between the Spadra Basin, Six Basins, and Chino Basin. The Basin Setting describes: (i) the important role of the Six Basins as a potential source of recharge to the Spadra Basin just south of the eastern tip of the San Jose Hills and (ii) the transient groundwater divide that separates the Spadra Basin from the Chino Basin from the San Jose Hills to the Puente Hills. Understanding the geologic and current/future groundwater conditions in this area will likely be critical to assessing the long-term sustainable management of the Spadra Basin and the potential impacts of Spadra Basin management on the adjacent groundwater basins, and vice versa. There are very few deep boreholes/wells located in this area to characterize the geologic and current/future groundwater conditions, which represents a gap in the monitoring network. A new monitoring well(s) in this area is needed to fill the data gap.
- Historically, groundwater-pumping and groundwater-level data been collected by well owners in the Spadra Basin in an uncoordinated fashion and at a maximum frequency of once per month. Improved methods to measure and record these data at higher frequency and

- accuracy will: improve the hydrogeologic conceptual understanding of the aquifer system and the fault barriers, which can be used to improve the Spadra Basin Groundwater Model; provide groundwater-pumping and groundwater-level data of high accuracy and resolution which can be used to improve the Spadra Basin Groundwater Model; support the design of capital facilities associated with GSP implementation, such as new wells and treatment facilities; and support any required monitoring and mitigation requirements associated with GSP projects. These data can be acquired by implementing a coordinated monitoring program that includes the installation of transducers in wells that measure and record high-frequency water-level data and utilizes the supervisory control and data acquisition (SCADA) systems of the well owners.
- Historically, groundwater-quality monitoring in the Spadra Basin has been infrequent and limited in scope. The groundwater-quality analysis in *Section 2.2.3 Groundwater Quality* was not based on a robust data set regarding the number of monitoring locations, the frequency of sample collection, the constituents analyzed, and the laboratory detection limits used. Hence, there is a limited understanding of groundwater-quality conditions and their potential impact on the beneficial uses of the groundwater. For example, perchlorate and 1,2,3-TCP are groundwater contaminants that could have originated from various overlying agricultural and/or industrial land uses. However, both constituents have not been commonly analyzed for using laboratory detection limits equivalent to the regulatory standards. A more robust groundwater-quality monitoring program is necessary to characterize TDS, nitrate, regulated contaminants, and emerging contaminants in the Spadra Basin; assist in the identification of the sources of the contaminants; and assist in the development and evaluation of future treatment and cleanup projects.
 - Currently, there is little information on the location and status of private wells in the Spadra Basin, and there is no coordinated monitoring of pumping, groundwater quality, and groundwater levels at the private wells. These data are fundamental to the development and implementation of sustainable groundwater management practices in the Spadra Basin. A private well canvass should be performed, and based on the results of the canvass, a program to collect and compile groundwater data from the private wells may be recommended as part of the GSP monitoring program.
 - Currently, there is no coordinated monitoring program of surface-water discharge from storm or dry-weather runoff. These discharges represent a potential source of artificial recharge to the Spadra Basin. A surface-water monitoring program is needed to better characterize the availability and magnitude of these potential sources of recharge.
 - Land subsidence has occurred in the Spadra Basin, as well as in the adjacent groundwater basins, particularly the northwestern portion of the Chino Basin. It is important to understand and monitor land subsidence and its causes because it can cause damage to vulnerable infrastructure at the land surface. Currently, the only subsidence monitoring that is ongoing is the [CBWM's Chino Basin Watermaster's](#) monitoring of ground motion by InSAR, which is a method that utilizes radar imagery from an Earth-orbiting satellite to map ground motion over time. However, the [CBWM's Watermaster's](#) data sets cover only the eastern portion of the Spadra Basin. The [Watermaster-CBWM](#) determines the scope of its monitoring efforts annually. The Spadra Basin GSA should consider future subsidence monitoring via InSAR that includes the entire basin. Collaboration with the [CBWM's Chino Basin Watermaster's](#) subsidence monitoring program may be the most efficient method to conduct this monitoring effort.

Section 2

Plan Area and Basin Setting



The subsequent development and calibration of the Spadra Basin Groundwater Model (described in Appendix I) also indicated the following areas of uncertainty and data gaps:

- The calibrated model indicates the potential existence of an unmapped hydraulic barrier along the boundary with the Chino Basin which is simulated by very low horizontal hydraulic conductivities. This model conceptualization may not be an accurate representation of the actual hydrogeology of the area. Currently, there is not enough hydrogeologic data in this area to understand the exact location and hydraulic properties of the presumed barrier. Additional hydrogeologic data would need to be acquired in this area to improve the conceptual and numerical models, which may require the construction of new monitoring wells and implementation of a monitoring program.
- The properties of the San Jose Fault and the hydrogeology of the narrow area that separates the Spadra Basin from the Six Basins is not well understood. In addition, there are no wells or water-level observations in this area. This lack of data and hydrogeologic understanding limits the ability to model the subsurface flows between the Six Basins and Spadra Basin with any confidence. Additional hydrogeologic data would need to be acquired in this area to improve the conceptual and numerical models, which may require the construction of new monitoring wells and implementation of a monitoring program.

SECTION 3

Sustainability Management Criteria

3.1 SGMA DEFINITIONS OF SUSTAINABLE MANAGEMENT CRITERIA

SGMA defines sustainable groundwater management as the management and utilization of groundwater in a manner that can be maintained over a 50-year planning horizon without causing “Undesirable Results.” The avoidance of Undesirable Results is key to the success of a GSP. To achieve and demonstrate sustainable groundwater management, the SGMA requires that a GSP establishes “Sustainable Management Criteria” for the groundwater basin. These criteria include:

- **A Sustainability Goal.** The goal of a GSP is to achieve sustainable groundwater management. The “Sustainability Goal” is the detailed characterization of the sustainable conditions for the basin and the specific implementation measures that the GSA will implement to ensure the basin is operated within its Sustainable Yield by 2040. “Sustainable Yield” is the maximum annual quantity of groundwater, calculated over a base period representative of long-term conditions in the basin, that can be withdrawn without causing an Undesirable Result.
- **Undesirable Results.** An Undesirable Result is one or more of the following adverse 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 horizon. A decline in groundwater levels over a period of drought is not sufficient to constitute “chronic lowering” if groundwater pumping and recharge are managed to ensure that the reductions in groundwater levels during the drought are offset by increases during other periods.
 - Significant and unreasonable reduction of groundwater storage. Overdraft (pumping in excess of Sustainable Yield) over a period of drought is not sufficient to constitute a “significant and unreasonable reduction” if groundwater pumping and recharge are managed as necessary to ensure that reductions in storage during the drought are offset by increases in storage during other periods.
 - 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 land uses.
 - Depletions of interconnected surface water that have significant and unreasonable adverse impacts on beneficial uses of the surface water.

Because the avoidance of Undesirable Results is the key indicator of sustainable groundwater management for the SGMA, the DWR defines each of the above effects as “Sustainability Indicators.” When a Sustainability Indicator becomes “significant or unreasonable,” then it is an Undesirable Result. For each Sustainability Indicator, a GSA must describe: (i) the causes that can lead to an Undesirable Result; (ii) the potential effects of the Undesirable Result on the beneficial use and users of groundwater in the basin; and (iii) the criteria used to define when and where the effects of the groundwater conditions cause the Undesirable Result. Undesirable Results must be eliminated or avoided through the implementation of projects and management actions, and the progress toward their elimination or avoidance must be demonstrated with empirical data.

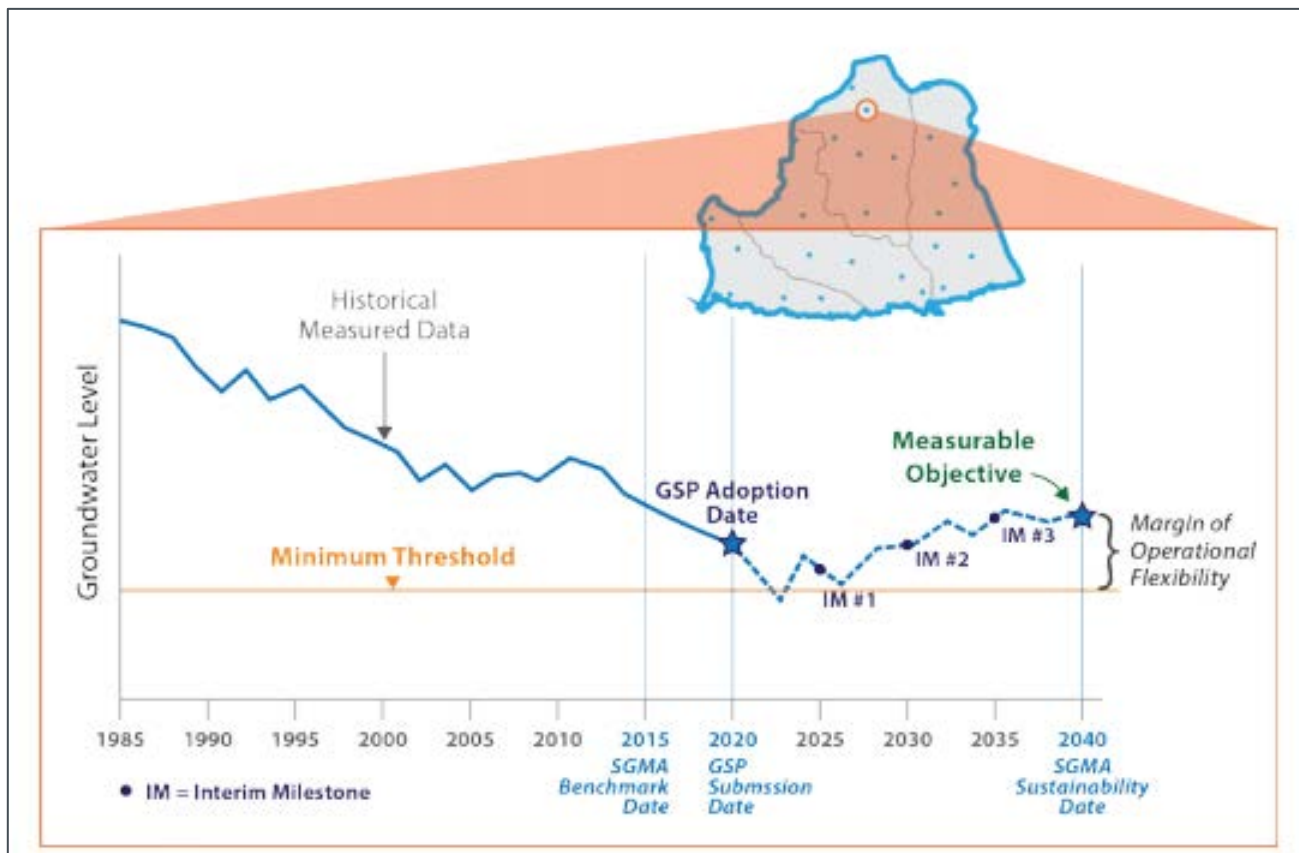
- **Minimum Thresholds.** A “Minimum Threshold” is the quantitative value that represents the groundwater conditions at a representative monitoring site that, when exceeded individually or in combination with Minimum Thresholds at other monitoring sites, may cause an Undesirable Result(s) in the basin. GSAs are required to define Minimum Thresholds at representative monitoring sites for each applicable Sustainability Indicator after considering the interests of beneficial uses and users of groundwater, land uses, and property interests in the basin. Minimum Thresholds should be set at levels that do not impede the ability to meet Minimum Thresholds or Sustainability Goals defined for adjacent basins.
- **Measurable Objectives.** The GSP Regulations define “Measurable Objectives” as specific, quantitative goals for the maintenance or improvement of specified groundwater conditions that have been included in an adopted GSP to achieve the Sustainability Goal for the basin. Measurable Objectives are defined for each Sustainability Indicator at the same set of representative monitoring sites, and using the same metrics, for which Minimum Thresholds have been defined. Measurable Objectives should be set such that there is a reasonable margin of operational flexibility within the operating band between the Minimum Threshold and Measurable Objective that will accommodate droughts, climate change, conjunctive use operations, or other groundwater management activities. There are exceptions to this general rule. For example, if the Minimum Threshold for land subsidence is zero (e.g., no subsidence), the Measurable Objective may also be zero. The diagram below illustrates the relationship between the Minimum Threshold, Measurable Objectives, and margin of operational flexibility within an operating band of sustainable groundwater conditions.

The diagram below [is](#) from the DWR Best Management Practices guidance document for Sustainable Management Criteria (DWR, 2017), ~~showing~~ [shows](#) the relationship between the Minimum Thresholds, Measurable Objectives, Interim Milestones, and margin of operational flexibility for the Sustainability Indicator of chronic lowering of groundwater levels for a representative monitoring site within a theoretical basin.

Projects and management actions included in the GSP should be designed to achieve and maintain groundwater conditions within the operating band between the Measurable Objectives and Minimum Thresholds, with descriptions of how those projects and management actions will enable operations within the margin of operational flexibility.

In addition, quantitative “Interim Milestones” towards meeting the Measurable Objectives must be defined in five-year increments for each of the representative monitoring sites. These Interim Milestones should be established based on the projected groundwater conditions that will result from implementing the projects and management actions proposed by the GSA to achieve sustainability. The milestones are used by the DWR and the GSA to track progress towards meeting the Sustainability Goal.

The Sustainable Management Criteria should be defined based on the hydrogeologic conceptual model, current and historical groundwater conditions, and the water budget. For the Spadra Basin, this information is described in Section 2.2 Basin Setting.



Defining the Sustainable Management Criteria for a Basin can be an iterative process. The initial criteria may need to be adjusted if future monitoring data provide improved information about the basin that suggests different criteria are appropriate to address potential effects on the beneficial uses and users of groundwater, land uses, and property interests. The GSP Regulations ([23 CCR § 356.4\(f\)](#)) require GSAs to evaluate GSPs at least every five years (and whenever amended) to assess groundwater conditions relative to each Sustainability Indicator and its Minimum Thresholds, Measurable Objectives, and Interim Milestones. The evaluation must also assess whether new information obtained since the last GSP update warrants changes to any aspect of the GSP, including the Sustainable Management Criteria. If adjustments to the Sustainable Management Criteria are determined necessary for the Spadra Basin, they will likely occur during future updates to the GSP.

3.2 SUSTAINABILITY INDICATORS APPLICABLE TO THE SPADRA BASIN

The default position for GSAs is that all six Sustainability Indicators apply, unless there is evidence that the indicator is not applicable for the basin. Based on the hydrogeologic conceptual model, current and historical groundwater conditions, and the water budget of the Spadra Basin, only four Sustainability Indicators are applicable to the Spadra Basin. The four applicable Sustainability Indicators are:

- Chronic lowering of groundwater levels indicating a significant and unreasonable depletion of supply
- Significant and unreasonable reduction of groundwater storage

- Significant and unreasonable degraded water quality
- Significant and unreasonable land subsidence

In other words, it is possible that significant and unreasonable occurrence of these Sustainability Indicators could occur within the Spadra Basin and therefore constitute an Undesirable Result(s).

The following two Sustainability Indicators are not applicable, because they cannot occur in the Spadra Basin:

- **Significant and unreasonable seawater intrusion.** Seawater intrusion into the Spadra Basin is impossible because the Spadra Basin is not adjacent to or near the Pacific Ocean or other sea-water sources.
- **Surface water depletions that have significant and unreasonable adverse impacts on beneficial uses of the surface water.** Surface water depletion is not possible because there are no areas in the Spadra Basin where surface waters are directly connected with groundwater. This is demonstrated by the following: (i) all streams that cross the basin are concrete-lined flood-control channels which prohibits groundwater/surface-water interactions; (ii) through recorded history, depth to groundwater has nearly always exceeded 30 feet below the ground surface which is the maximum rooting depth for groundwater dependent ecosystems (GDEs); and (iii) there are no mapped areas of rising groundwater or GDEs in the Spadra Basin.

3.3 UNDESIRABLE RESULTS, MINIMUM THRESHOLDS, AND MEASURABLE OBJECTIVES FOR THE SPADRA BASIN SUSTAINABILITY INDICATORS

This section describes the Undesirable Results, Minimum Thresholds, and Measurable Objectives for each of the four Sustainability Indicators that are applicable to the Spadra Basin. These criteria were established based on currently available data and information, which was presented in the Section 2.2 Basin Setting.

3.3.1 Chronic Lowering of Groundwater Levels

3.3.1.1 Undesirable Results

Spadra Basin groundwater is primarily used by the overlying water purveyors and private well owners for the following beneficial uses: potable municipal supply (sometimes after treatment or blending); non-potable water supply for municipal, industrial, and agricultural uses; and domestic supply. Chronic lowering of groundwater levels within the Spadra Basin could occur if total discharge exceeded the total recharge over a prolonged period and could adversely impact these beneficial uses and users of groundwater.

The components of discharge from the Spadra Basin are:

- Subsurface outflow to the neighboring Chino Basin and Puente Basin. Subsurface outflow is controlled by the hydraulic gradients between the groundwater basins and the hydraulic conductivities of the aquifer sediments at the basin boundaries.
- Groundwater pumping. Groundwater is a source of water supply for the overlying water purveyors and water users and the volume pumped is dependent on the end user demands.

The components of recharge from the Spadra Basin include the deep infiltration of precipitation and applied water (DIPAW) and subsurface inflow from the saturated alluvium and fractures within the bordering bedrock hills (San Jose Hills and Puente Hills). These two recharge terms are mainly controlled by precipitation falling on the tributary watershed and by the application of water for irrigation on the overlying land uses.

The most likely potential causes of chronic lowering of groundwater levels are (i) over pumping; (ii) a prolonged dry period; (iii) reductions in water applied to overlying outdoor land uses; and/or (iv) declining groundwater levels in the adjacent groundwater basins.

If groundwater levels were to decline to elevations such that well owners could no longer pump their wells at the desired rates, this would represent a significant and unreasonable depletion of the groundwater supply and is an Undesirable Result. The Minimum Thresholds established for the chronic lowering of groundwater levels are set to avoid this Undesirable Result.

Other potential adverse effects from the chronic lowering of groundwater levels in the Spadra Basin are: (i) land subsidence that adversely impacts the overlying infrastructure and land uses; (ii) significant and unreasonable reduction of groundwater storage; and (iii) reduced subsurface outflow to the neighboring groundwater basins, which could potentially cause Undesirable Results to occur in those basins.

3.3.1.2 Minimum Thresholds

The Minimum Threshold for the chronic lowering of groundwater levels is the elevation below which an Undesirable Result will occur at a representative monitoring site.

As described in the *Basin Setting* in Section 2.2 of this GSP(TM-1), groundwater levels have fluctuated across the Spadra Basin within a defined range of elevation over the 40-year historical period of 1978 to 2018. During this period, groundwater pumping ranged between 700 and 2,200 afy and averaged 1,280 afy. The long-term trends in groundwater levels appear to be consistent at all wells across the basin, suggesting that all wells were influenced by the same regional stresses of pumping and recharge. Generally, groundwater levels appear to increase in response to hydrologic wet periods and decrease in response to hydrologic dry periods. There are no known records of well owners reporting or describing adverse impacts to pumping rates due to low groundwater levels for this historical period. Based on this, it is reasonable to assume that the range of observed groundwater levels over the historical period are protective against the primary Undesirable Result of a significant and unreasonable depletion of the groundwater supply (i.e., well owners no longer can pump at the desired rates). Hence, the Minimum Threshold will be set as-at the lowest historical elevations across the Spadra Basin.

Section 3

Sustainability Management Criteria



Seven wells were selected as representative sites to establish the Minimum Thresholds based on their location and historical record of groundwater levels. The location of these wells are shown in Figure 3-1. The seven wells include: a well located close to the Chino Basin boundary (MW-5); a well located close to the Puente Basin boundary (Industry Well); and five wells located along the axis of the basin where the majority of groundwater production occurs (OMW-3, P-19, P-28, CPP-1, and CPP-4). These seven wells are spatially distributed throughout the Spadra Basin along the center axis of the basin, which is the thickest and main portion of the aquifer and are dispersed to represent groundwater-level conditions for the entire basin.

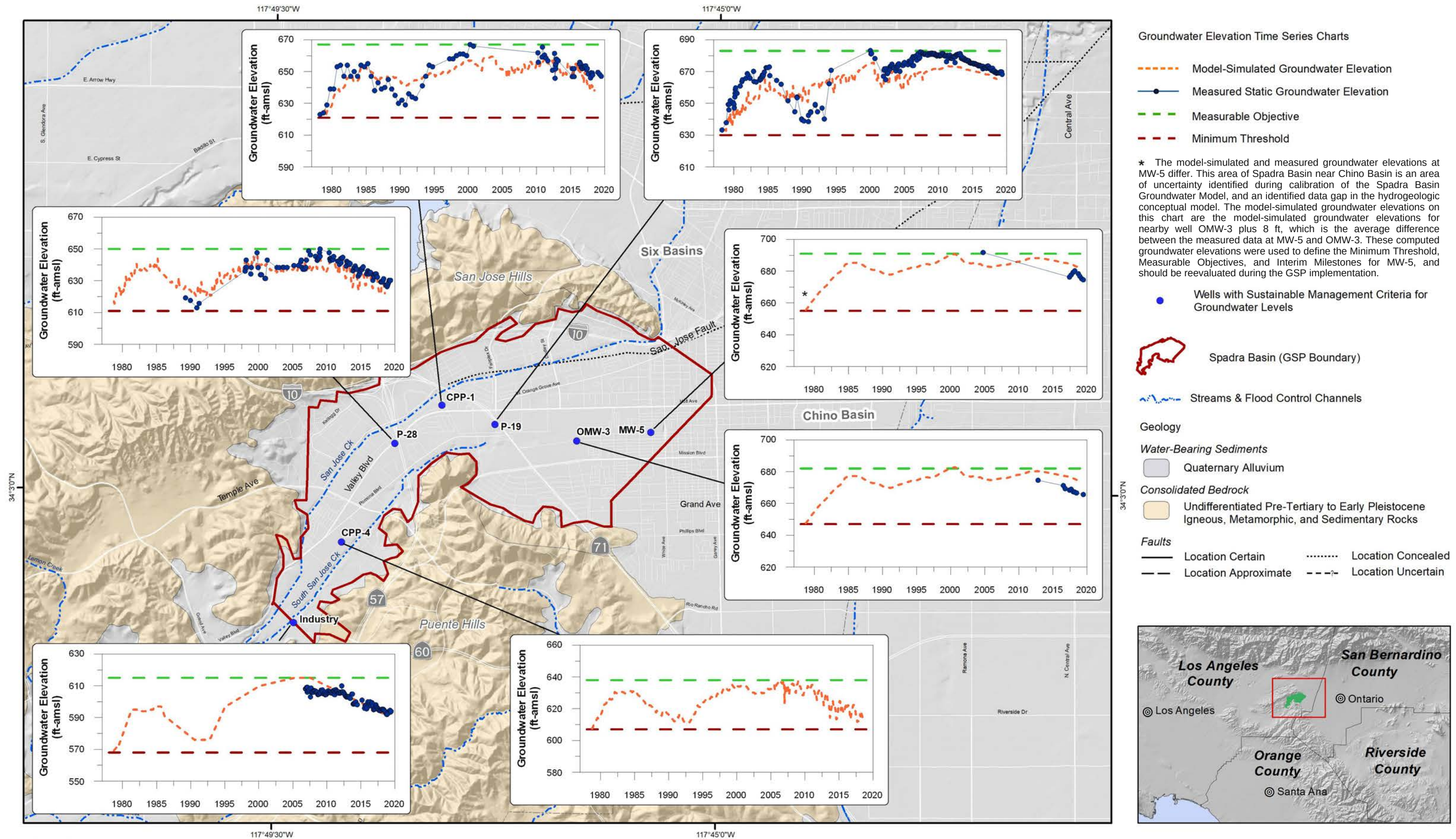
For each well, Figure 3-1 shows a time-series chart of historical groundwater elevations, the model-estimated groundwater elevations from the calibration of the Spadra Basin [groundwater-Groundwater Model](#), and the proposed Minimum Threshold. The Minimum Thresholds are based on the lowest historical groundwater elevations (measured or model estimated), observed across the Spadra Basin which generally occurred in 1978.

To avoid Undesirable Results, groundwater elevations at the representative monitoring sites should remain above the Minimum Thresholds listed in Table 3-1 below:

Table 3-1. Minimum Thresholds for Groundwater Levels in the Spadra Basin		
Well	Well Type and Status	Minimum Threshold, ft-amsl
MW-5	Monitoring Well (Active)	655
OMW-3	Monitoring Well (Active)	647
P-19	Municipal Production Well (Inactive)	630
P-28	Municipal Production Well (Active)	611
CPP-1	Municipal Production Well (Active)	621
CPP-4	Municipal Production Well (Active)	607
Industry	Municipal Production Well (Active)	568

The proposed Minimum Thresholds for groundwater levels are preliminary estimates based on the historical operations from 1978 to 2018 and the belief that there were no Undesirable Results. To justify the proposed Minimum Thresholds for application across the entire basin, the information on the depth of the pump bowls for every active pumping well in the Spadra Basin was collected.¹ These depths were converted to elevations and compared to the Minimum Threshold elevation at the representative monitoring sites, or the lowest historical groundwater elevation if the well is not a representative monitoring site, to ensure that these Minimum Thresholds promote pumping sustainability at all active wells in the Spadra Basin. This analysis confirmed that all the proposed Minimum Thresholds or lowest groundwater elevations are 32 ft or more above the pump bowls.

¹ There is one active pumping well where the depth of the well and depth of the pump bowl is unknown (CPP-3). And there is one active pumping well where the depth of the pump bowl is unknown, and the depth of the well less 100 ft was used to estimate the pump bowl depth (CPP-1).



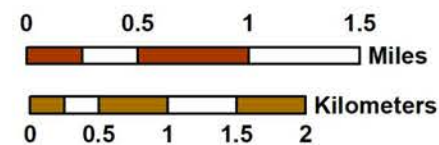
Prepared by:



Author: LH

Date: 7/31/2020

File: Figure 3-1-GWE Time Series.mxd



Prepared for:

Spadra Basin Groundwater Sustainability Agency
Groundwater Sustainability Plan



Sustainable Management Criteria
For Chronic Lowering of Groundwater Levels

Figure 3-1

Monitoring of groundwater levels at the seven representative monitoring sites will be conducted by installing pressure transducers within each well casing (if possible) to measure and record groundwater elevation once every 15 minutes. This high-frequency data is sufficient to fully understand the short-term, seasonal, and long-term trends in the groundwater levels to evaluate the conditions across the Spadra Basin. If static groundwater elevations decline below a Minimum Threshold for an entire year at any well, this constitutes an Undesirable Result. The lowest static groundwater-elevation measurement during fall (September – November) will be used to compare to the Minimum Threshold established at each well to monitor for potential Undesirable Results related to the chronic lowering of groundwater levels. If the lowest static fall groundwater elevation measurement at all of the representative monitoring wells are below respective Minimum Thresholds, for two consecutive years, this may cause an Undesirable Result.

Maintaining groundwater levels above the Minimum Thresholds should also avoid Undesirable Results related to the Sustainability Indicators of groundwater storage and land subsidence, as discussed in the following sections. And maintaining groundwater levels above the Minimum Thresholds is likely to protect against contributing to the occurrence of Undesirable Results in the adjacent groundwater basins. That said, the interaction with adjacent basins is not fully understood. The Spadra Basin [Groundwater Model](#) estimated that over the historical period of 1978 to 2018, subsurface outflow from Spadra Basin to Puente Basin ranged from about 1,000 to 2,000 afy. This may be a significant source of recharge to the Puente Basin that supports its sustainable yield and the beneficial uses and users of groundwater in that basin, and hence, should be investigated in collaboration with the Puente Basin agencies. The Spadra Basin groundwater model estimated that over the historical period, subsurface outflow from Spadra Basin to Chino Basin ranged from about 250 to 950 afy. Although these rates of subsurface inflow are relatively minor compared to the total storage (~12 million af) and the Safe Yield (131,000 afy) of the Chino Basin, the Chino Basin experienced land subsidence during the 1978 to 2018 period in the area near where Spadra Basin discharges into the Chino Basin. The potential impacts of changes in subsurface outflows from the Spadra Basin to the Chino Basin should be monitored in collaboration with the Chino Basin Watermaster.

3.3.1.3 Measurable Objectives

The Measurable Objectives for groundwater levels in the Spadra Basin are defined as the highest historical groundwater elevations across the Spadra Basin over the period of 1978-2018. These Measurable Objectives establish a reasonable margin of operational flexibility between the Measurable Objectives and the Minimum Thresholds and will promote sustainable groundwater management by accommodating wet and dry periods, levels of uncertainty, and potential projects that the GSA may pursue to maximize the beneficial use of the Spadra Basin, including artificial recharge, pump-and-treat, and conjunctive use projects. The time-series charts of historical groundwater elevations on Figure 3-2 show the Measurable Objective along with the Minimum Threshold at each of the seven representative monitoring sites. The highest historical groundwater elevation at each well typically occurred in 2000. The Measurable Objectives for groundwater levels are summarized in the Table 3-2.

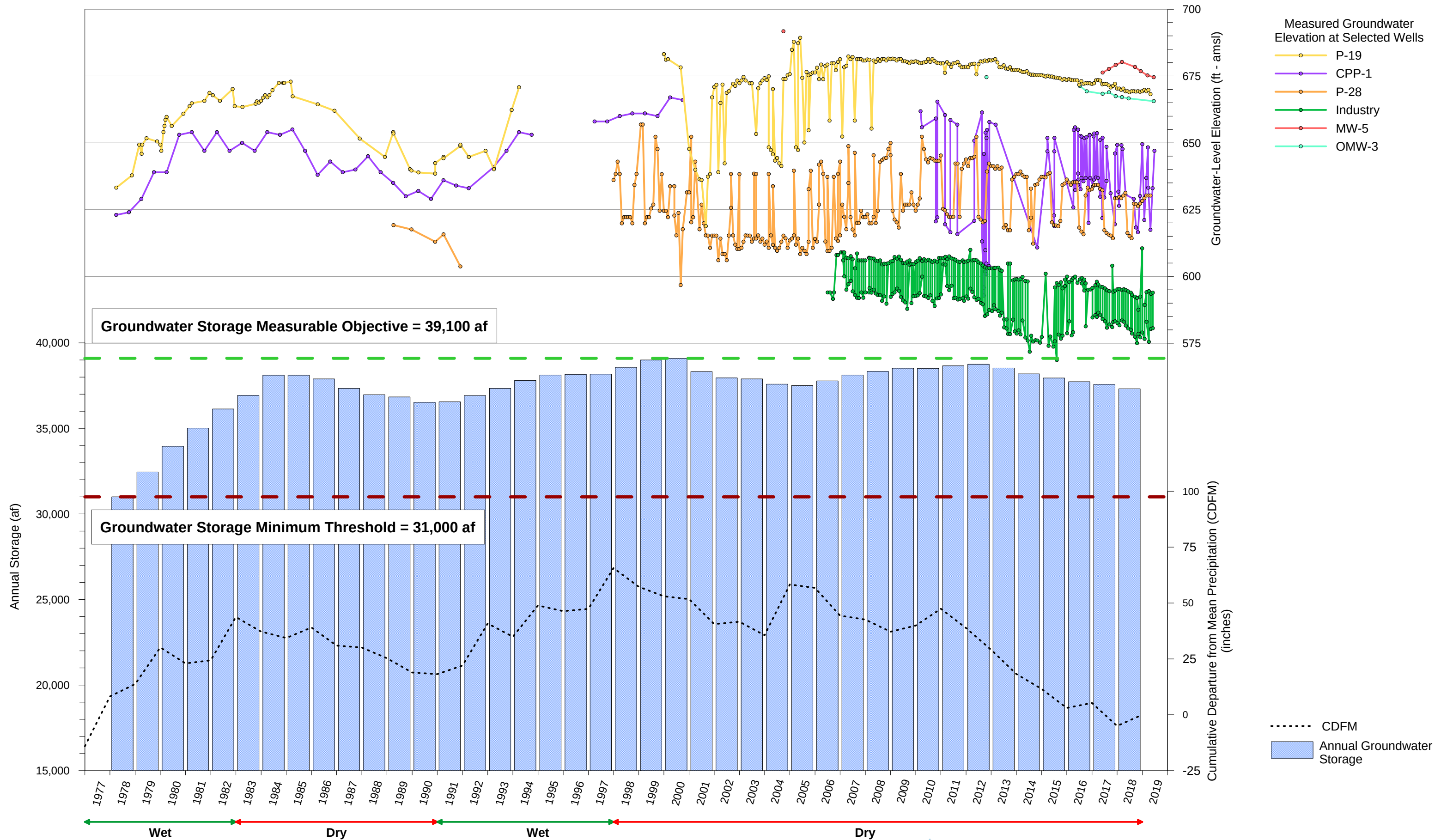


Table 3-2. Measurable Objectives for Groundwater Levels in the Spadra Basin

Well	Well Type and Status	Measurable Objective, ft-amsl
MW-5	Monitoring Well (Active)	691
OMW-3	Monitoring Well (Active)	682
P-19	Municipal Production Well (Inactive)	683
P-28	Municipal Production Well (Active)	650
CPP-1	Municipal Production Well (Active)	667
CPP-4	Municipal Production Well (Active)	638
Industry	Municipal Production Well (Active)	615

3.3.2 Reduction of Groundwater Storage

3.3.2.1 Undesirable Results

Spadra Basin groundwater is primarily used by the overlying water purveyors and private well owners for the following beneficial uses: potable municipal supply (sometimes after treatment or blending); non-potable water supply for municipal, industrial, and agricultural uses; and domestic supply. A significant and unreasonable reduction of groundwater storage within the Spadra Basin could occur if total discharge exceeded the total recharge over a prolonged period and could adversely impact the beneficial uses and users of groundwater.

The components of discharge from the Spadra Basin are:

- Subsurface outflow to the neighboring Chino Basin and Puente Basin. Subsurface outflow is controlled by the hydraulic gradients between the groundwater basins and the hydraulic conductivities of the aquifer sediments at the basin boundaries.
- Groundwater pumping. Groundwater pumping is a source of water supply for the overlying water purveyors and water users and the volume pumped is dependent on the end user demands.

The components of recharge from the Spadra Basin include the deep infiltration of precipitation and applied water (DIPAW) and subsurface inflow from the saturated alluvium and fractures within the bordering bedrock hills (San Jose Hills and Puente Hills). These two recharge terms are mainly controlled by precipitation falling on the tributary watershed and by the application of water for irrigation on the overlying land uses.

The most likely potential causes of a reduction of groundwater storage are (i) over pumping; (ii) a prolonged dry period; (iii) reductions in water applied to overlying outdoor land uses; and/or (iv) declining groundwater levels in the adjacent groundwater basins.

If groundwater storage in the Spadra Basin were to decline to a volume such that wells could no longer pump at the desired rates, this would represent a significant and unreasonable depletion of the groundwater supply and is an Undesirable Result. The Minimum Thresholds established for the reduction of groundwater storage are set to avoid this Undesirable Result.

Other potential adverse effects from a reduction of groundwater storage in the Spadra Basin are: (i) land subsidence that adversely impacts the overlying infrastructure and land uses; (ii) significant and unreasonable lowering of groundwater levels; and (iii) reduced subsurface outflow to the neighboring groundwater basins, which could potentially cause Undesirable Results to occur in those basins.

3.3.2.2 Minimum Thresholds

Figure 3-2 shows the annual groundwater storage in the Spadra Basin during 1978-2018 as estimated during calibration of the Spadra Basin [groundwater](#) [Groundwater-flow Mm](#) model (see water budget in Table 2-7 and Appendix I). Also shown on Figure 3-2 are: the time-series of groundwater elevations at the seven wells that are representative monitoring sites for groundwater levels and the cumulative departure from the mean precipitation curve (CDFM). The annual groundwater in storage in the Spadra Basin fluctuated over the 40-year historical period of 1978 to 2018. During this period, groundwater storage appears to rise in response to hydrologic wet periods and fall in response to hydrologic dry periods. These model-estimated changes in storage are consistent with the trends observed in the measured groundwater elevations at the wells across Spadra Basin. The annual volume of groundwater storage ranged from about 31,000 af to 39,100 af over the 40-year historical period. The lowest groundwater storage of 31,000 af over this period occurred in 1978 which is also the period of the lowest groundwater levels in the Spadra Basin.

By proxy, the Minimum Thresholds for the chronic lowering of groundwater levels defined at representative monitoring sites in Table 3-1 will be used to assess reduced groundwater storage. The Minimum Thresholds for groundwater levels and by proxy groundwater storage are based on the lowest historical elevation between 1978-2018 and the assumption that the range of observed groundwater levels over the historical period are protective against Undesirable Results for groundwater storage, since there were no Undesirable Results over the historical period. Maintaining groundwater levels above the Minimum Thresholds should avoid Undesirable Results for groundwater storage because the Undesirable Results are the same, and because changes in groundwater storage are directly related to changes in groundwater levels.

A secondary Minimum Threshold for groundwater storage will be set at the lowest historical volume of 31,000 af (see Figure 3-2). The analyzes of this Minimum Threshold can be done as a subsidiary analysis during the required GSA annual reporting to the DWR (Water Code § 10728). A requirement of the annual reporting is an estimate of the annual change in storage. This annual estimate will include updating the Spadra Basin [Ggroundwater](#) [Mm](#) model with hydrology, pumping, and recharge through the current year to extend the historical model simulation and produce a water budget for the Spadra Basin through the current year. The water budget will include the estimate of the annual volume and change in groundwater storage through the current year. The annual volume of groundwater storage can be compared to the secondary Minimum Threshold of 31,000 af (see Figure 3-2) that was set as the lowest storage between 1978-2018 and was also the year of the lowest groundwater levels. The analysis can be used and compared to the analysis of the groundwater level Minimum Thresholds used as a proxy.

Maintaining groundwater levels above the Minimum Thresholds is likely to protect against contributing to the occurrence of Undesirable Results in the adjacent groundwater basins. That said, the interaction with adjacent basins is not fully understood. The Spadra Basin [Ggroundwater](#) [Mm](#) model estimated that over the historical period of 1978 to 2018, subsurface outflow from Spadra Basin to Puente Basin ranged from about 1,000 to 2,000 afy. This may be a significant source of recharge to the Puente Basin that supports its sustainable yield and the beneficial uses and users of groundwater in that basin, and hence, should be investigated in collaboration with the Puente Basin Watermaster. The Spadra Basin [Ggroundwater](#) [Mm](#) model

estimated that over the historical period of 1978-2018, subsurface outflow from Spadra Basin to Chino Basin ranged from about 250 to 950 afy. Although these rates of subsurface inflow are relatively minor compared to the total storage (~12 million af) and the Safe Yield of the Chino Basin (131,000 afy), the Chino Basin experienced land subsidence during the 1978 to 2018 period in the area near where Spadra Basin discharges into the Chino Basin. The potential impacts of changes in subsurface outflows from the Spadra Basin to the Chino Basin should be monitored in collaboration with the Chino Basin Watermaster.

3.3.2.3 Measurable Objectives

By proxy, the Measurable Objectives defined for chronic lowering of groundwater levels in Table 3-2 will be used to assess reduced groundwater storage. The Measurable Objectives for groundwater levels and by proxy groundwater storage are based on the highest historical elevation between 1978-2018 and representative of the upper boundary of the operating band for groundwater levels and storage, to achieve and maintain sustainable groundwater management. These Measurable Objectives for groundwater levels can be used as a proxy to evaluate sustainable conditions for groundwater storage because there were no observed Undesirable Results for groundwater storage, and the observed trends in groundwater storage and groundwater levels over the historical 1978-2018 period are related. These Measurable Objectives allow a reasonable margin of operational flexibility between the Measurable Objective and the Minimum Threshold that will accommodate wet and dry periods, levels of uncertainty, and potential projects that the GSA may pursue to maximize the beneficial use of the Spadra Basin, including artificial recharge, pump-and-treat, and conjunctive use projects.

A Measurable Objective for groundwater storage will be set at the highest historical volume of 39,100 af (see Figure 3-2). The analyses of this Measurable Objective can be done as a secondary analysis during the required annual reporting for the GSA to the DWR which includes an annual change in storage estimate and can be compared to the analysis of the proxy Measurable Objective (see Section 4.2.2.).

3.3.3 Degraded Water Quality

3.3.3.1 Undesirable Results

The Spadra Basin is part of the Bulletin 118 San Gabriel Valley Basin which has the following designated beneficial uses for groundwater in the *Water Quality Control Plan, Los Angeles Region* (LA Basin Plan [LA Regional Board], 2019): municipal and domestic supply (MUN), industrial service supply (IND), industrial process supply (PROC), and agricultural supply (AGR). As described in the Basin Setting, groundwater quality in the Spadra Basin is generally poor, many of the supply wells have constituent concentrations that are higher than drinking-water primary and secondary MCLs and the TDS and nitrate concentration objectives within the LA Basin Plan and requires treatment or blending for potable use. The Basin Setting identifies six contaminants of concern in Spadra Basin: TDS, nitrate, TCE, PCE, 1,1-DCE, and perchlorate.

Most of the groundwater pumped in the Spadra Basin is used for agricultural and urban irrigation and other non-potable uses and thus is not required to meet drinking-water standards. There are various point-source contaminant sites in the Spadra Basin, but the extent of the contaminant plumes associated with the individual point-sources have not been mapped. Many of the supply wells in the basin produce water containing similar contaminants as those associated with the point-source contamination sites, such as TCE, PCE, and 1,1-DCE, but the potential source(s) and parties responsible for the contaminants present at any given well have yet to be identified.

The six contaminants of concern in the Spadra Basin can be grouped in two types: the inorganic contaminants of TDS, nitrate, and perchlorate; and the synthetic organic contaminants of TCE, PCE, and 1,1-DCE. The sources and causes of these two types of contaminants in groundwater are different. The inorganic contaminants of TDS, nitrate, and perchlorate are chemicals that enter groundwater from non-point source origins as a result of human activity on the overlying lands. The main sources include: the application of water to the land surface for agriculture and landscape irrigation and the resulting concentrated return flows to groundwater and the application of fertilizers on crops and irrigated landscapes which can dissolve into percolating groundwater. The organic contaminants of TCE, PCE, and 1,1-DCE are man-made chemicals used in industrial solvents that can enter groundwater from the unregulated release or spills of these contaminants at a point source.

Because the sources and causes of these two types of contaminants in groundwater are different, the degraded groundwater quality conditions that are considered an Undesirable Result are different depending on the contaminant type [and the beneficial use of groundwater](#):

- If the concentrations of the inorganic contaminants from non-point sources increase at a well to concentrations that would impact the current beneficial uses of groundwater from that well and the inability to use a well for its current use, this would represent a significant and unreasonable degradation of water quality and an Undesirable Result.
- If the concentrations of the organic contaminants from point-sources are above the Primary MCL at a well, this represents a significant and unreasonable degradation of water quality with an Undesirable Result of preventing all potential beneficial uses in the basin.

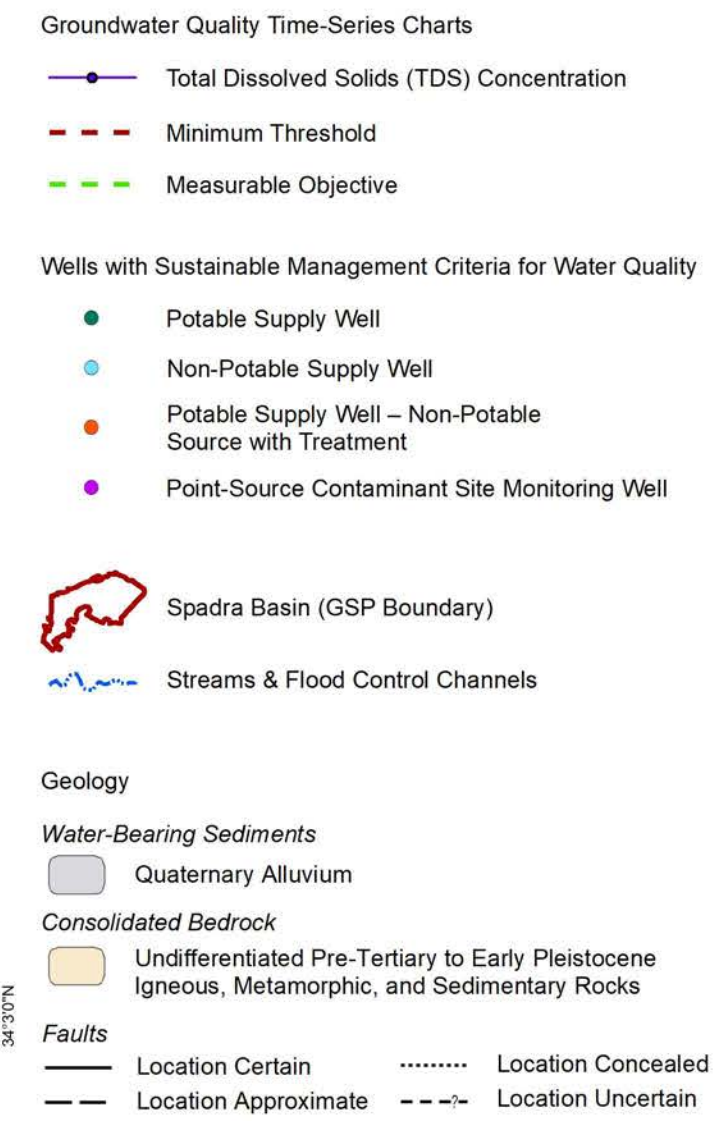
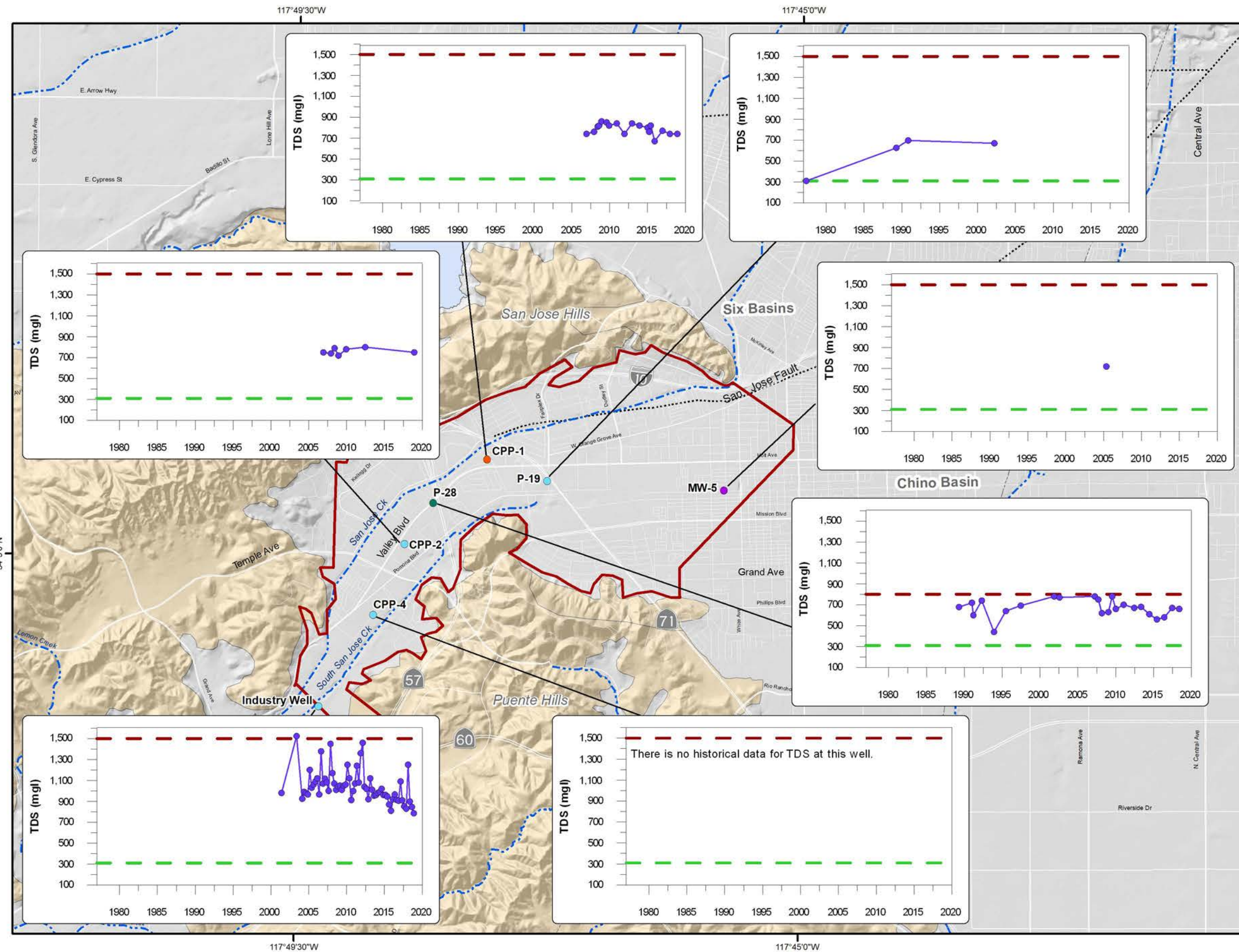
The Minimum Thresholds established for degraded water quality are set to avoid these Undesirable Results.

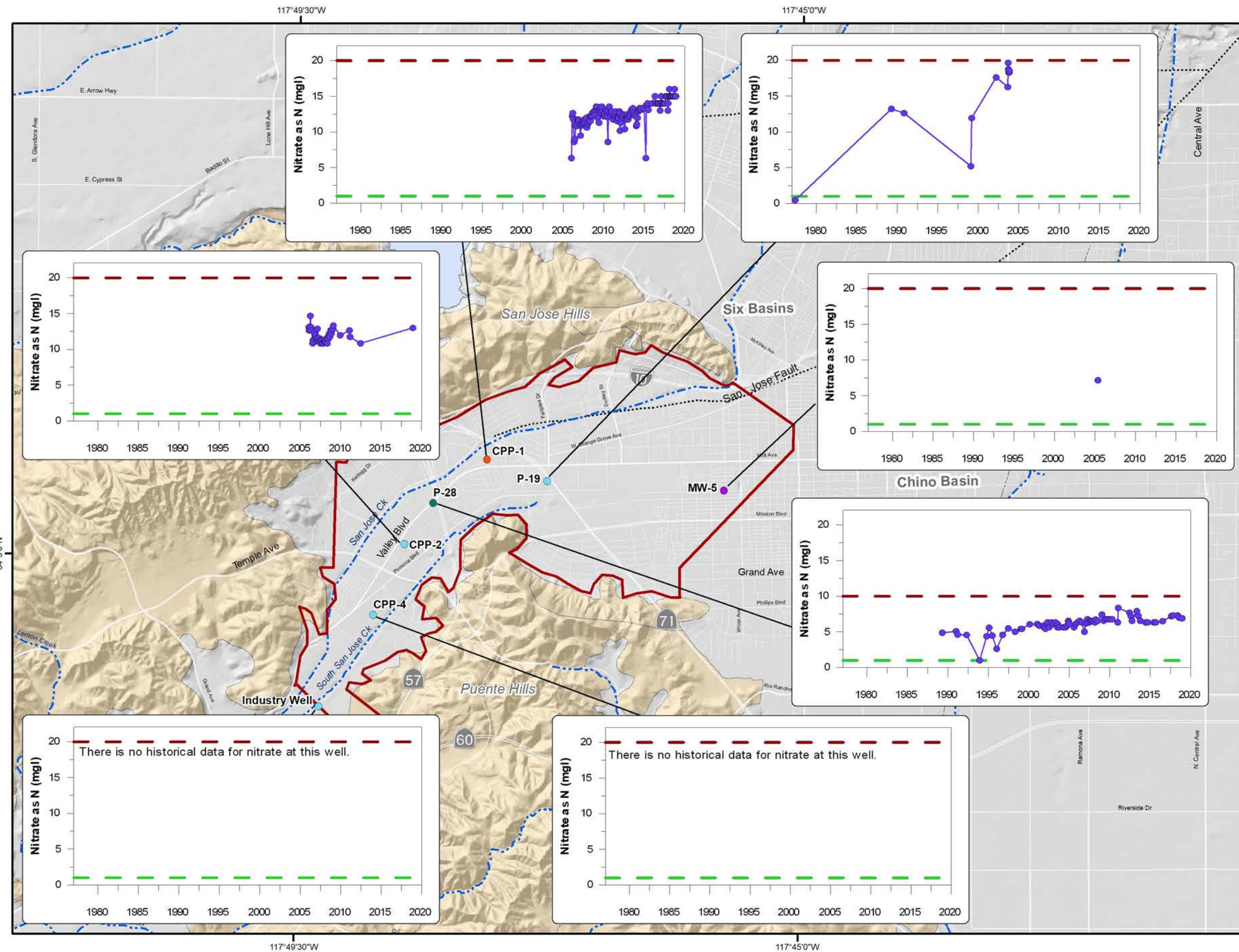
Other potential adverse effects from degraded water quality in the Spadra Basin are increases in operational costs for treatment to enable beneficial use, and water quality degradation of neighboring groundwater basins.

3.3.3.2 Minimum Thresholds

The Minimum Threshold for degraded water quality is the contaminant concentration above which an Undesirable Result will occur at a representative monitoring site.

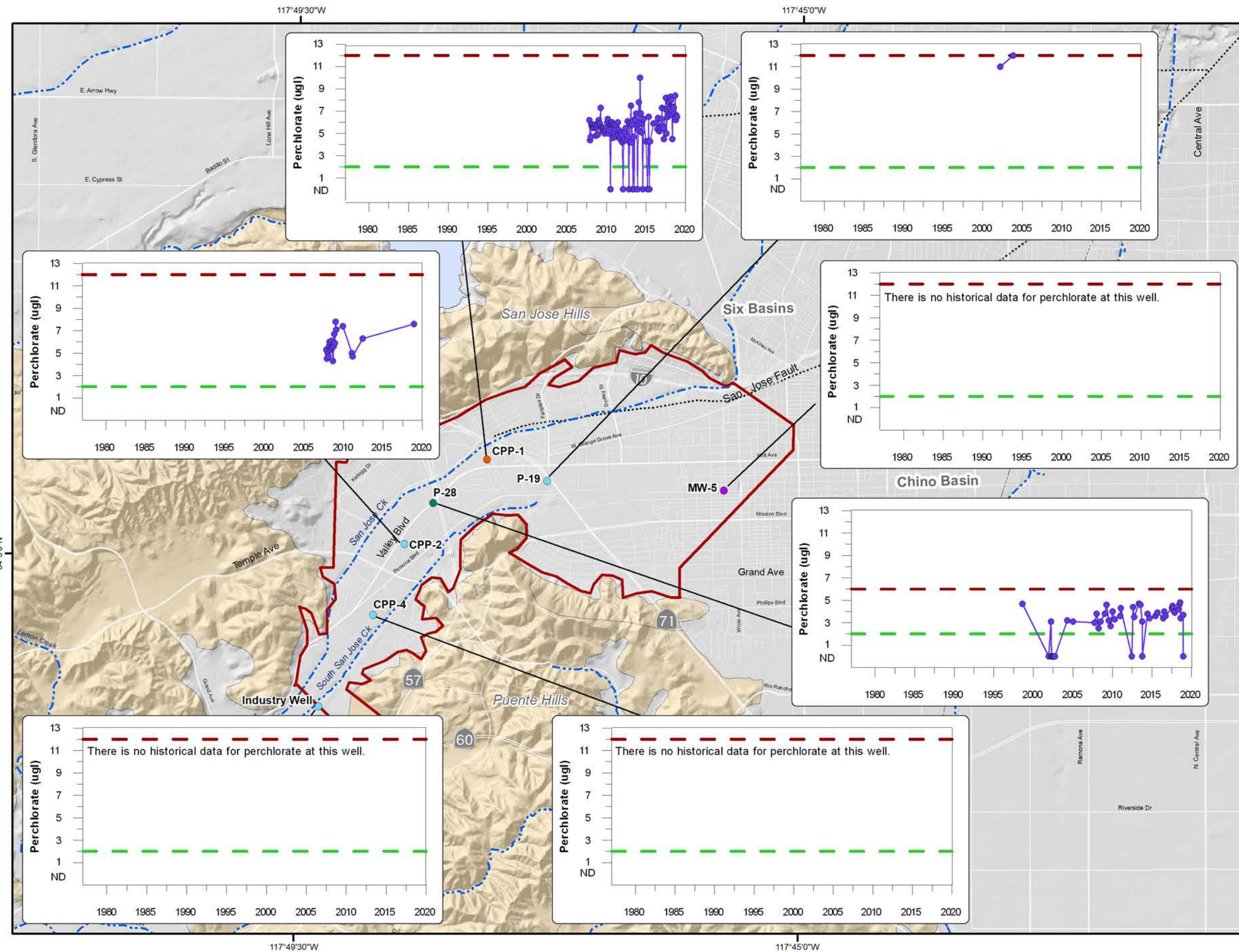
Minimum Thresholds are defined for each of the six contaminants of concern. Seven wells were selected as representative monitoring sites across the basin based on their location, well type, and well use. Figures 3-3a through 3-3f show the locations of the representative monitoring sites. These seven wells selected as are representative monitoring sites spatially distributed throughout the Spadra Basin along the center axis of the basin which is the thickest and main portion of the aquifer and are dispersed to represent groundwater quality conditions for the entire basin. These wells are either production wells with water quality data representative of the different beneficial uses or they are monitoring wells for point-source contamination of groundwater. The wells include: three non-potable supply wells along the central axis of the basin (P-19, CPP-2, and CPP-4); one potable supply well in the center on the basis (P-28); one potable supply well in the center of the basin that is a non-potable source used for potable supply after treatment (CPP-1); one non-potable supply well located along the boundary with the Puente Basin (Industry); and one [non-potable](#) monitoring well associated with the Calsol [Inc.](#) point-source contaminant site located near the Chino Basin boundary (MW-5). Figures 3-3a through 3-3f includes time-series charts of historical groundwater-quality data at each representative monitoring site well for the 1978 to 2018 period and the proposed Minimum Thresholds.





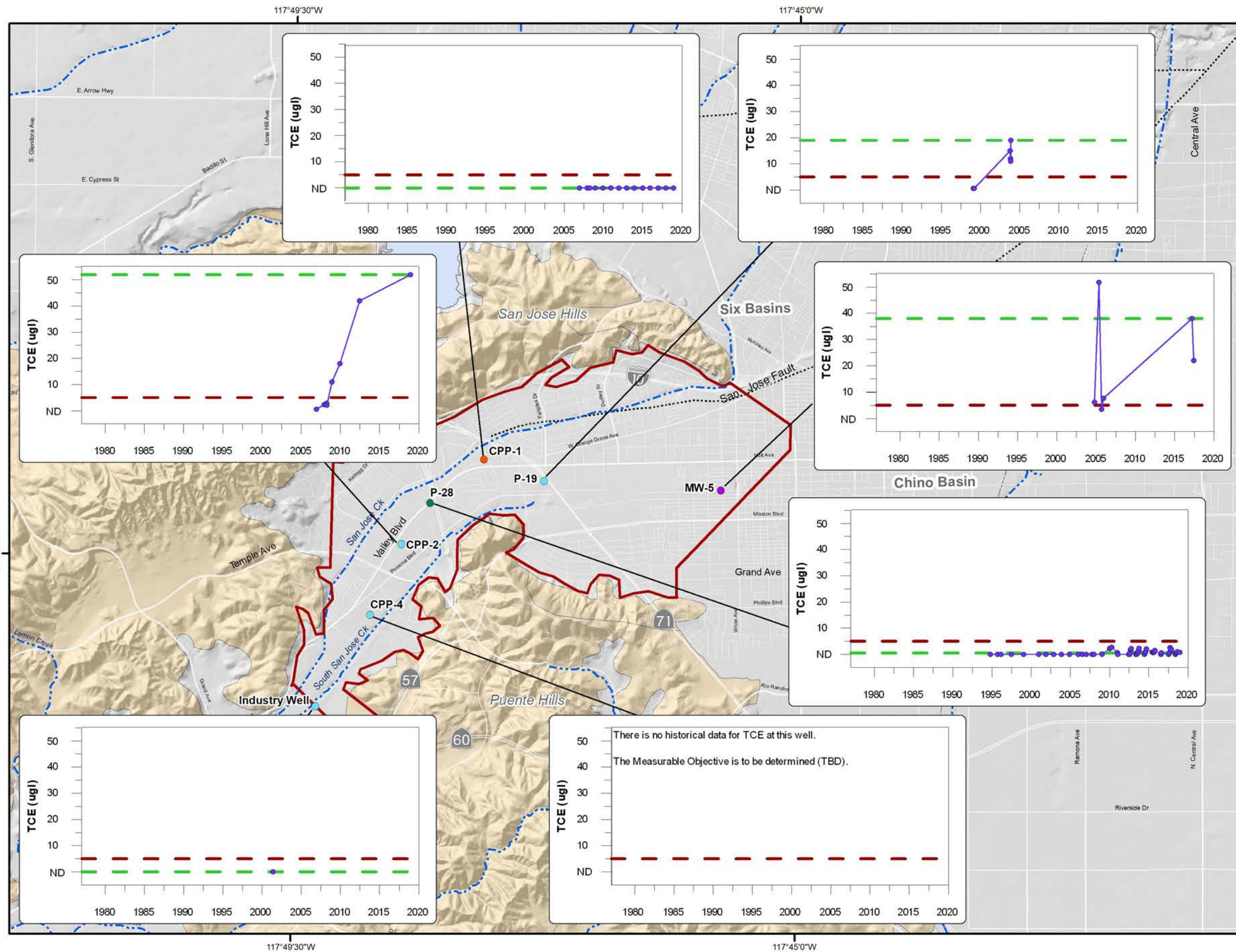
- Groundwater Quality Time-Series Charts**
- Nitrate (as N) Concentration
 - Minimum Threshold
 - Measurable Objective
- Wells with Sustainable Management Criteria for Water Quality**
- Potable Supply Well
 - Non-Potable Supply Well
 - Potable Supply Well – Non-Potable Source with Treatment
 - Point-Source Contaminant Site Monitoring Well
- Geology**
- Water-Bearing Sediments**
- Quaternary Alluvium
- Consolidated Bedrock**
- Undifferentiated Pre-Tertiary to Early Pleistocene Igneous, Metamorphic, and Sedimentary Rocks
- Faults**
- Location Certain
 - Location Concealed
 - Location Approximate
 - Location Uncertain





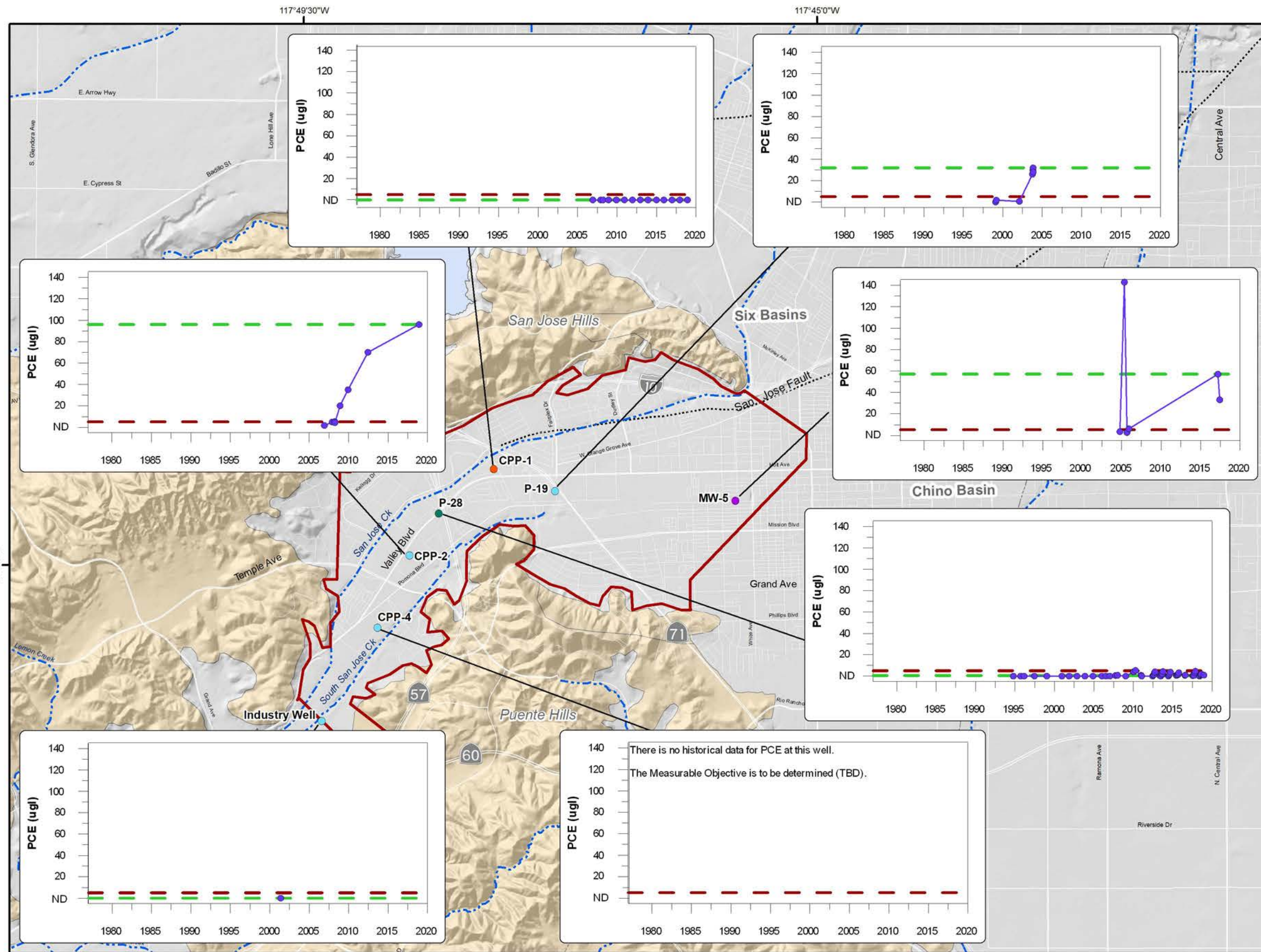
- Groundwater Quality Time-Series Charts**
- Perchlorate Concentration
 - Minimum Threshold
 - Measurable Objective
- Wells with Sustainable Management Criteria for Water Quality**
- Potable Supply Well
 - Non-Potable Supply Well
 - Potable Supply Well – Non-Potable Source with Treatment
 - Point-Source Contaminant Site Monitoring Well
- Geology**
- Water-Bearing Sediments**
- Quaternary Alluvium
- Consolidated Bedrock**
- Undifferentiated Pre-Tertiary to Early Pleistocene Igneous, Metamorphic, and Sedimentary Rocks
- Faults**
- Location Certain
 - Location Concealed
 - Location Approximate
 - Location Uncertain
- Spadra Basin (GSP Boundary)**
- Streams & Flood Control Channels**

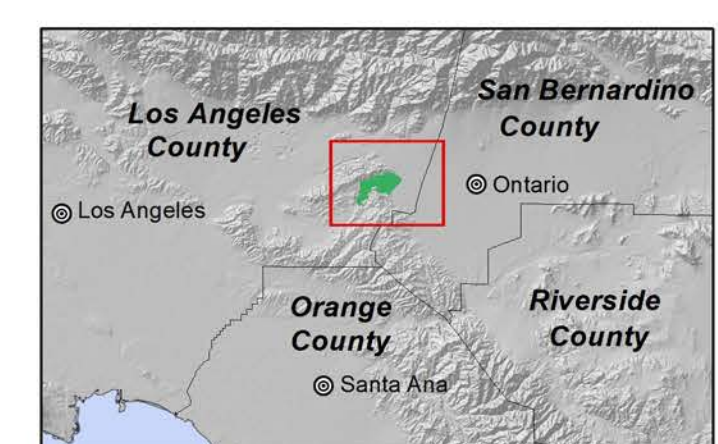
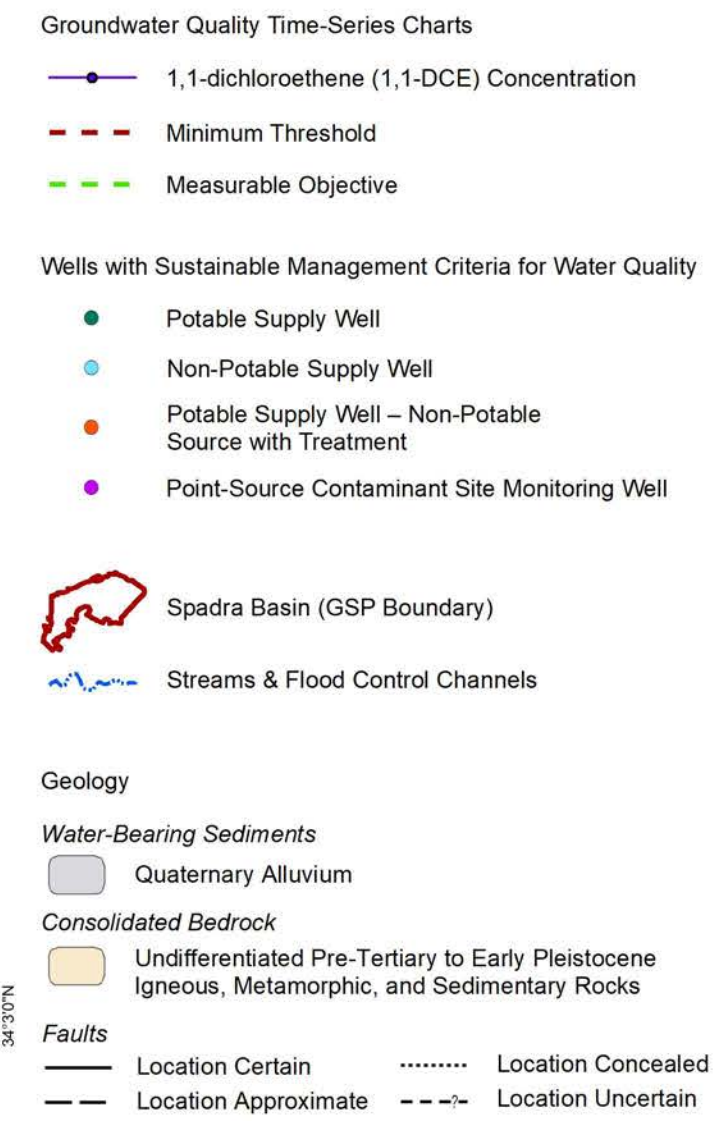
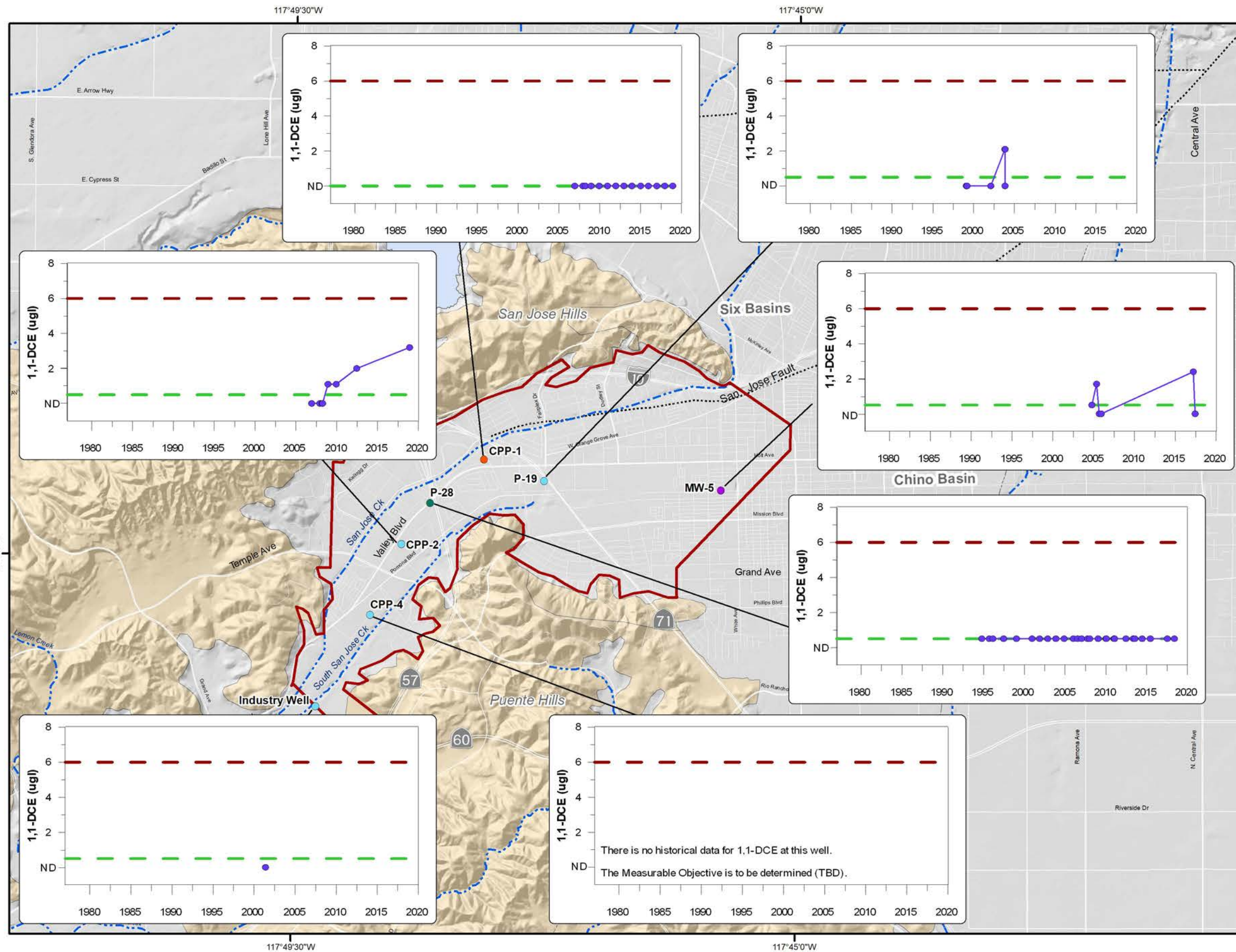




- Groundwater Quality Time-Series Charts
- Trichloroethene (TCE) Concentration
 - Minimum Threshold
 - Measurable Objective
- Wells with Sustainable Management Criteria for Water Quality
- Potable Supply Well
 - Non-Potable Supply Well
 - Potable Supply Well – Non-Potable Source with Treatment
 - Point-Source Contaminant Site Monitoring Well
- Spadra Basin (GSP Boundary)
- Streams & Flood Control Channels
- Geology
- Water-Bearing Sediments
- Quaternary Alluvium
- Consolidated Bedrock
- Undifferentiated Pre-Tertiary to Early Pleistocene Igneous, Metamorphic, and Sedimentary Rocks
- Faults
- Location Certain
 - Location Concealed
 - Location Approximate
 - Location Uncertain







Sustainable Management Criteria
For Degraded Water Quality - 1,1-DCE

Figure 3-3f

Section 3

Sustainability Management Criteria



The Undesirable Results for degraded water quality defined in Section 3.3.3.1 are different based on the type of contaminant and beneficial uses of groundwater, hence, the proposed Minimum Thresholds are dependent on the contaminant type and beneficial use:

- For the inorganic contaminants (TDS, nitrate, and perchlorate), the Minimum Thresholds are set to be protective of the current beneficial uses of groundwater at each well.
 - For the non-potable wells (C-19, CPP-2, CPP-4, Industry, and MW-5), and the well that is non-potable and treated for potable supply (CPP-1), the Minimum Threshold is defined as the highest historical concentration of the contaminant historically at all of the non-potable these representative monitoring wells in the basin. This assumes that concentrations equal to or below historical concentrations are sustainable for the well's beneficial use.
 - For the potable well (P-28), the Minimum Threshold for TDS which has a Secondary MCL, is defined as the highest historical concentration at the eat potable well, and the Minimum Thresholds for nitrate and perchlorate which have Primary MCLs is defined as the MCL.
- For the organic contaminants (TCE, PCE, and 1,1-DCE), the Minimum Thresholds are set so that point-source discharge of contaminants do not impair all potential beneficial uses of groundwater. Hence, the Minimum Thresholds are defined as the Primary MCL.

To avoid Undesirable Results, concentrations of the six contaminants of concern at the representative monitoring sites should remain below the Minimum Thresholds listed below in Table 3-3.

Table 3-3. Minimum Thresholds for Groundwater Quality in the Spadra Basin						
	TDS, mg/l	Nitrate-N, mg/l	Perchlorate, ugl	TC, ugl	PCE, ugl	1,1-DCE , ugl
Primary MCL:	--	10	6	5	5	6
Secondary MCL:	500	--	--	--	--	--
Basin Plan Obj.	550	10	--	--	--	--
Minimum Threshold						
Minimum Thresholds for Non-Potable Wells (Industry, CPP-4, CPP-2, P-19, and MW-5), and Non-Potable Well Treated to Potable (CPP-1)	1,500	20	12	5	5	6
Minimum Threshold for Potable Well (P-28)	800	10	6	5	5	6

The proposed Minimum Thresholds for the inorganic contaminants are preliminary estimates based on the maximum historical concentration of the contaminants at all the representative monitoring sites in the basin. These Minimum Thresholds are intended to represent the concentrations that cause the Undesirable Result that the well could no longer be used for its current beneficial use. Input from the well owners is required to finalize and refine these Minimum Thresholds prior to the preparation of the final GSP, and the final Minimum Thresholds may be set differently at the individual wells.

The proposed Minimum Thresholds for the organic contaminants indicate that Undesirable Results currently exist at three of the representative monitoring sites (MW-5, P-19, CPP-2). Figures 3-3d and 3-3f show that TCE and PCE concentrations at these three wells were above the proposed Minimum Thresholds prior to 2015. The SGMA Regulations (Water Code §10727.2[b][4]) indicate that a GSP “*may, but is not required to, address undesirable results that occurred before, and have not been corrected by January 1, 2015*” and a GSA “*has discretion as to whether to set Measurable Objectives and the timeframes for achieving any objectives for Undesirable Results that occurred before, and have not been corrected by January 1, 2015.*” The DWR Best Management Practices guidance document for Sustainable Management Criteria (DWR, 2017) provides that if an Undesirable Result occurred prior to January 1, 2015, the GSA should set Measurable Objectives to either maintain or improve upon the conditions that were occurring in 2015. The Measurable Objectives were set for these organic contaminants to maintain 2015 conditions, or better, as discussed below for the Measurable Objectives.

Monitoring of groundwater quality at the seven representative monitoring sites will be conducted by collecting triennial samples (at a minimum) for the six contaminants of concern. If a contaminant concentration is above the Minimum Threshold at any well, this may constitute an Undesirable Result. To verify the occurrence of an Undesirable Result, subsequent monitoring will be done within a year to verify the occurrence of an Undesirable Results.

3.3.3.3 Measurable Objectives

The Measurable Objective for degraded water quality is the contaminant concentration at a well that is representative of the lower boundary of the operating band for groundwater quality conditions to achieve and maintain sustainable groundwater management.

Measurable Objectives for groundwater quality are established for the same seven representative sites and six contaminants of concern as [the](#) Minimum Thresholds. [Measurable Objectives are goals for all beneficial uses. Similar to ~~like~~ the Minimum Thresholds, the proposed Measurable Objectives are set dependent on the contaminant type:](#)

- For the inorganic contaminants (TDS, nitrate, and perchlorate), the Measurable Objectives are defined as the lowest detected concentration of the contaminant historically at all representative monitoring sites in the basin, or better. These Measurable Objectives are set as aspirational objectives to promote improving quality and reducing the need for treatment if the well is going to be used for all potential beneficial uses.

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Sustainability Management Criteria

- For the organic contaminants (TCE, PCE, and 1,1-DCE), the Measurable Objectives are [set based on if the current concentration is below or above the Primary MCL. The Measurable Objectives are](#) defined as: the 2015 concentration, or better, for wells where the current concentration is above the Primary MCL, and non-detect concentration at the wells where the current concentration is below the Primary MCL. These Measurable Objectives are set to uphold that point-source discharge of contaminants should not impair all potential beneficial uses of groundwater.

The Measurable Objectives for the six contaminants at each of the seven representative monitoring sites are defined as the following concentrations, or better, shown in Table 3-4:

Table 3-4. Measurable Objectives for Groundwater Quality in the Spadra Basin						
	TDS, mg/l	Nitrate-N, mg/l	Perchlorate, ugl	TCE, ugl	PCE, ugl	1,1-DCE, ugl
Primary MCL:	--	10	6	5	5	6
Secondary MCL:	500	--	--	--	--	--
Basin Plan Obj.	550	10	--	--	--	--
Well	Measurable Objective					
MW-5	310	1	2	38	57	ND (<0.5) ^(a)
P-19	310	1	2	19 ^(a)	32 ^(a)	ND (<0.5) ^(a)
P-28	310	1	2	ND (<0.5)	ND (<0.5)	ND (<0.5)
CPP-1	310	1	2	ND (<0.5)	ND (<0.5)	ND (<0.5)
CPP-2	310	1	2	52	96	ND (<0.5)
CPP-4	310	1	2	TBD	TBD	TBD
Industry	310	1	2	ND (<0.5) ^(a)	ND (<0.5) ^(a)	ND (<0.5) ^(a)
Notes:						
(a) There was no recent (2015-2018) data to develop the measurable objective metric; the measurable objective value is based on historical data from over 15 years ago.						
ND Non-detect concentration						
TBD To be determined. There is no historical data available to establish a measurable objective; the measurable objective value will be determined from sampling in 2022 and 2023.						

Figures 3-3a through 3-3f show the time-series of constituent concentrations and the Measurable Objectives at each of the seven representative sites. The Measurable Objectives defined for the organic contaminants protect against further degradation and promote improvements in groundwater quality from the current concentrations. The Measurable Objectives defined for the inorganic contaminants promote improvements in groundwater quality to the MCL concentrations or better. These Measurable Objectives allow a reasonable margin of operational flexibility between the Measurable Objectives and the Minimum Thresholds that will accommodate levels of uncertainty and potential projects that the GSA may pursue to maximize the beneficial use of the Spadra Basin. The ability to meet these Measurable Objectives will be partly dependent on the projects implemented by the GSA. The projects that could potentially maintain or improve groundwater quality include pumping and treating groundwater, recharging storm water and recycled water, or working with the Regional Board to identify point-source discharges that are impacting the quality at supply wells.

3.3.4 Land Subsidence

3.3.4.1 Undesirable Results

Spadra Basin groundwater is primarily used by the overlying water purveyors and private well owners for the following beneficial uses: potable municipal supply (sometimes after treatment or blending); non-potable water supply for municipal, industrial, and agricultural uses; and domestic supply. Under certain conditions, the pumping of groundwater can cause permanent subsidence of the overlying land surface to occur, which could damage the overlying infrastructure and adversely impact the overlying land uses and property values. The process of pumping, lowering groundwater levels, aquifer-system compaction, and land subsidence within an alluvial aquifer system is described by the *aquitar-drainage model*:

- The aquifer system of the Spadra Basin consists of permeable sand and gravel layers (the aquifers) interbedded with less-permeable silt and clay layers (the aquitards). Pumping wells cause groundwater-level drawdowns in the aquifers which, in turn, cause the aquitards to slowly drain into the aquifers. The draining allows aquitard pore pressures to decay toward equilibrium with the reduced heads in the adjacent aquifers. Since the pressure of the pore water provides some internal support for the sedimentary structure of the aquitards, this loss of internal support causes the aquitards to compress, resulting in a small amount of subsidence at the land surface. When the pumping wells turn off, and water levels recover in the aquifers, groundwater migrates back into the aquitards and they expand, resulting in a small amount of rebound at the land surface. Over a limited range of water-level fluctuations this process can occur in a purely elastic fashion. That is, a recovery of water levels to their original values causes the land surface to rebound to its original elevation. However, when drawdown falls below a certain “threshold” level, elastic compression transitions to a non-recoverable inelastic compaction of the aquitards, resulting in permanent land subsidence. The “threshold” water level, referred to as the *preconsolidation stress*, is taken to be the maximum past stress to which the sedimentary structure had previously equilibrated under the gradually increasing load of accumulating sediments.
- Drawdowns exceeding a previous threshold water level result in an increase in the value of maximum past stress, and thus the establishment of a deeper threshold, accompanied by an increment of inelastic aquitard compaction. Concomitantly, the compaction results in the one-time irreversible mining of groundwater from the aquitards. The benefits of this process include not only the obvious economic value of the water produced but also the often-overlooked fact that, by establishing deeper thresholds, it increases the volume of confined groundwater storage available for cyclical drawdown and replenishment under strictly elastic conditions. The cost, of course, is the resulting deformation of the land surface and its impact on vulnerable infrastructure.

The land uses overlying the Spadra Basin are largely urban and commercial, including but not limited to streets, highways, homes, businesses, industry, flood-control, and gravity/pressurized pipelines. These land uses contain infrastructure that could be adversely impacted by permanent land subsidence. Permanent land subsidence can lead to deformation of the ground surface and ground fissuring that can damage the overlying infrastructure, reduce its capacity to function as designed, and/or lower property values. The most conservative position for the GSA is to deem that any occurrence of permanent land subsidence caused by groundwater basin management is significant and unreasonable, and thereby,

an Undesirable Result. The Minimum Thresholds established for land subsidence are set to avoid this Undesirable Result.

3.3.4.2 Minimum Thresholds

The *aquitar-drainage model*, described above, explained the *preconsolidation stress* as the “threshold” groundwater level, that when and where exceeded, elastic compression of the aquitards transitions to a non-recoverable inelastic compaction, resulting in permanent land subsidence. Hence, the lack of observed permanent land subsidence indicates the current groundwater levels are above the *preconsolidation stress*. The *preconsolidation stress* can be estimated as the deepest historical groundwater level to which the sedimentary structure had previously equilibrated. For these reasons, the Minimum Thresholds for groundwater levels, which are set at the deepest historical groundwater levels, will be used as a proxy for the Minimum Thresholds for land subsidence.

Section 2.2.4 *Ground Levels* in the *Basin Setting* Section of this GSP, demonstrated, through an analysis of InSAR estimates of vertical ground motion, that very little permanent land subsidence, if any, has occurred within the Spadra Basin since the mid-1990s. It appears from these InSAR estimates that recent vertical ground motion is small in magnitude (e.g., less than +/-0.1 ft) and elastic in nature. The objective should be to have negligible downward elastic vertical ground motion (e.g., less than -0.1 ft) across the entire Spadra Basin.

By proxy, the Minimum Thresholds defined for chronic lowering of groundwater levels at the representative monitoring sites in Table 3-1 will be used to assess land subsidence. The Minimum Thresholds for groundwater levels, and by proxy land subsidence, are based on the lowest historical elevation between 1978-2018 and the assumption that the range of observed groundwater levels over the historical period are protective against Undesirable Results for land subsidence, since there were no Undesirable Results over the historical period. Hence, based on these observations and assumptions, maintaining groundwater levels above the Minimum Thresholds should avoid Undesirable Results for land subsidence.

The proposed Minimum Thresholds for groundwater levels are preliminary estimates based on the belief that there will be no Undesirable Results for land subsidence at groundwater levels above these Minimum Thresholds. The assessment of the Minimum Thresholds for groundwater levels, and by proxy land subsidence, can periodically be compared to available data of vertical ground motion measured by InSAR for the Spadra Basin region. This includes: the TRE Altamira InSAR data made available by DWR; and the [Chino Basin Watermaster's CBWM's](#) InSAR data as part of their subsidence management plan in the neighboring Chino Basin that covers a portion of the [Chino-Spadra](#) Basin. The GSA will review these available InSAR data sets periodically (target of annually) to observe if there are any notable downward vertical ground motion in the Spadra Basin and compare to the assessment of the Minimum Thresholds set as the lowest groundwater elevations at the representative monitoring sites. The five-year assessments of the GSP implementation will include an analysis of vertical ground motion from available InSAR, and if there is observed permanent downward vertical ground motion greater than 0.1 ft, then the GSA will re-evaluate the need for expanded land subsidence monitoring and/or updated Minimum Thresholds.

3.3.4.3 Measurable Objectives

By proxy, the Measurable Objectives defined for chronic lowering of groundwater levels in Table 3-2 will be used to assess the land subsidence. The Measurable Objectives for groundwater levels and by proxy land subsidence are based on the highest historical elevation between 1978-2018 and representative of the upper boundary of the operating band for groundwater levels and storage, to achieve and maintain

sustainable groundwater management. These Measurable Objectives for groundwater levels can be used as a proxy to evaluate sustainable conditions for land subsidence because there were no observed Undesirable Results for land subsidence during the historical period at the observed groundwater elevations. These Measurable Objective allows a reasonable margin of operational flexibility between the Measurable Objective and the Minimum Threshold that will accommodate wet and dry periods, levels of uncertainty, and potential projects that the GSA may pursue to maximize the beneficial use of the Spadra Basin, including artificial recharge, pump-and-treat, and conjunctive use projects.

3.4 SUSTAINABILITY GOAL

Per the GSP Regulations [23 CCR § 354.24](#), each GSA shall establish a Sustainability Goal for the basin that culminates in the absence of Undesirable Results within 20 years, and should include:

- A description of the Sustainability Goal, including information from the Basin Setting used to establish the Sustainability Goal.
- An explanation of how the Sustainability Goal is likely to be achieved within 20 years of the GSP implementation and is likely to be maintained through the planning and implementation horizon.
- A discussion of the measures that will be implemented to ensure the basin will be operated within its Sustainable Yield.

The Sustainability Goal of the Spadra Basin: [In a collaborative effort between all Spadra Basin water purveyors, is to](#) conjunctively use all water supplies available to the Spadra Basin [water purveyors](#) to achieve and maintain groundwater sustainability, avoid Undesirable Results, maximize the beneficial use of the basin, and minimize cost.

The Sustainability Goal of the Spadra Basin was refined over the various steps in the GSP development process. The hydrogeologic information described in *Section 2.2 Basin Setting* of this GSP was used to construct and calibrate a numerical groundwater-flow model ([Spadra Basin Groundwater Model](#) documented in Appendix I), which was then used to simulate a Baseline Scenario to determine the long-term sustainability of the basin (see *Sections 5.1 and 5.2 Development and Evaluation of the Baseline Scenario*). The model results of the Baseline Scenario indicated that groundwater levels are projected to decline over the planning horizon by 20-25 [feet](#) throughout the basin, which was determined to be not sustainable when compared to the Sustainable Management Criteria described in this section of the GSP. Three Basin Optimization Scenarios, which included various projects to achieve sustainability and/or maximize the beneficial use of the basin, were then developed and evaluated with the [Spadra Basin Groundwater Model groundwater-flow model](#) and a cost model (see *Sections 5.3 and 5.4 Development and Evaluation of Basin Optimization Scenario*). A preferred Basin Optimization Scenario (Scenario 3) was then identified by the GSA that achieves sustainability and maximizes the beneficial use of the basin, and hence, achieves the Sustainability Goal.

The model evaluation of the Basin Optimization Scenario 3 indicates that the Sustainability Goal will be achieved within 20 years and throughout the rest of the planning horizon through implementation of the projects envisioned in Basin Optimization Scenario 3. These projects include the utilization of local available recycled water for artificial recharge and increasing pumping in the Spadra Basin to about 4,800 afy, which represents the long-term Sustainable Yield. A large portion of the Sustainable Yield will

be treated and used for potable water supplies, which will increase potable water-supply reliability by offsetting the need for less-reliable imported water supplies.

New hydrological data and information obtained through the GSP monitoring program described in Section 4 will be used for periodic updates and recalibration of the Spadra [Basin Groundwater Model groundwater flow model](#), at a minimum of every ten years. The updated model will be used to evaluate sustainability of current and future conditions for the Spadra Basin GSP implementation. The modeling results can inform if updates are required to the GSP to achieve the Sustainability Goal, and what updates are needed including adaptation of pumping and recharge and/or revisions to the Sustainable Management Criteria. These periodic model updates should coincide with the five-year evaluation requirements for a GSP (see Section 6.1.4).

3.5 INTERIM MILESTONES

In accordance with GSP Regulations [23](#) CCR § 354.30(e), a GSP shall develop Interim Milestones in five-year increments for each relevant Sustainability Indicator to describe a reasonable path to achieve the Sustainability Goal for the basin within 20 years of GSP implementation. The Interim Milestones are developed for each of the representative monitoring sites where Measurable Objectives and Minimum Thresholds have been set for each relevant Sustainability Indicator.

As described above in *Section 3.4 Sustainability Goal*, the path to achieve the Sustainability Goal within 20 years is to implement the projects and plans in Basin Optimization Scenario 3 (see Sections 5.3 and 5.4 *Development and Evaluation of Basin Optimization Scenario*). These projects and plans achieve the Sustainability Goal in part by maintaining groundwater levels in the basin above Minimum Thresholds and avoiding Undesirable Results (by proxy, the same applies to groundwater storage and land subsidence). Hence, Interim Milestones were established for chronic lowering of groundwater levels based on the projected groundwater elevations for Basin Optimization Scenario 3 at representative monitoring sites in the Spadra Basin.

Interim Milestones for groundwater levels, and by proxy groundwater storage and land subsidence, are listed in Table 3-5 below.

Table 3-5. Interim Milestones for Groundwater Levels in the Spadra Basin				
Well	2027	2032	2037	2042
	Interim Milestone, ft-amsl			
Industry	579	586	588	588
CPP-4	606	615	616	617
P-28	613	622	623	624
CPP-1	631	636	638	638
P-19	655	644	646	647
OMW-3	671	658	658	659
MW-5	679	671	666	664

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Figures 3-4a through 3-4g are time series charts that show the Interim Milestones graphically for each representative monitoring site, along with measured and modeled groundwater elevations, the Minimum Threshold, and the Measurable Objective. The charts indicate the time of the GSP submittal and the end of the 20-year period to achieve the Sustainability Goal.

Specific Interim Milestones for groundwater quality have not been established because they do not represent a path to achieve the Sustainability Goal for the basin. Interim Milestones for groundwater quality can be considered any concertation between the Minimum Thresholds and Measurables Objectives set at the representative monitoring sites.

Figure 3-4a. Five-Year Interim Milestones at Industry

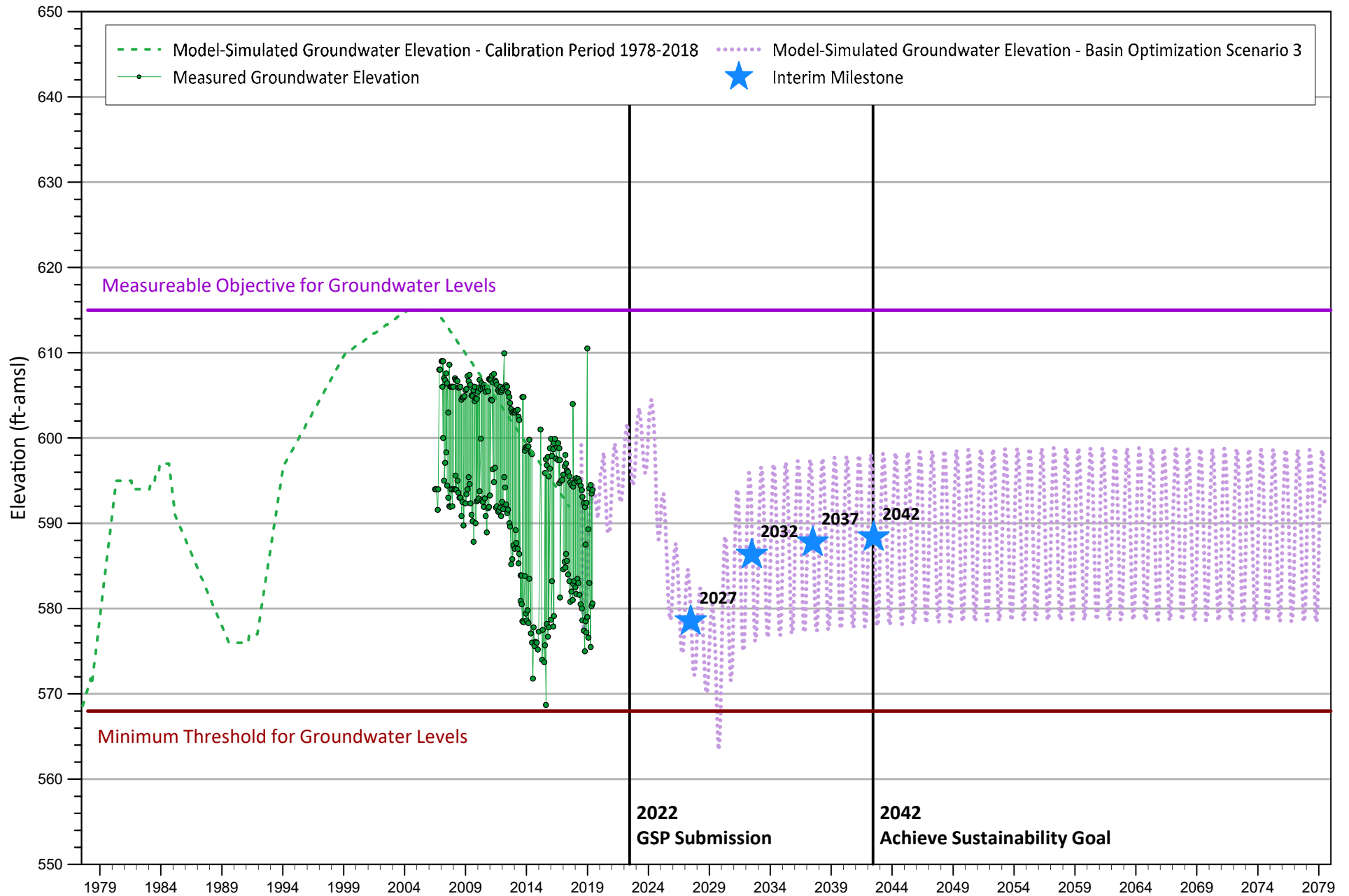


Figure 3-4b. Five-Year Interim Milestones at CPP-4

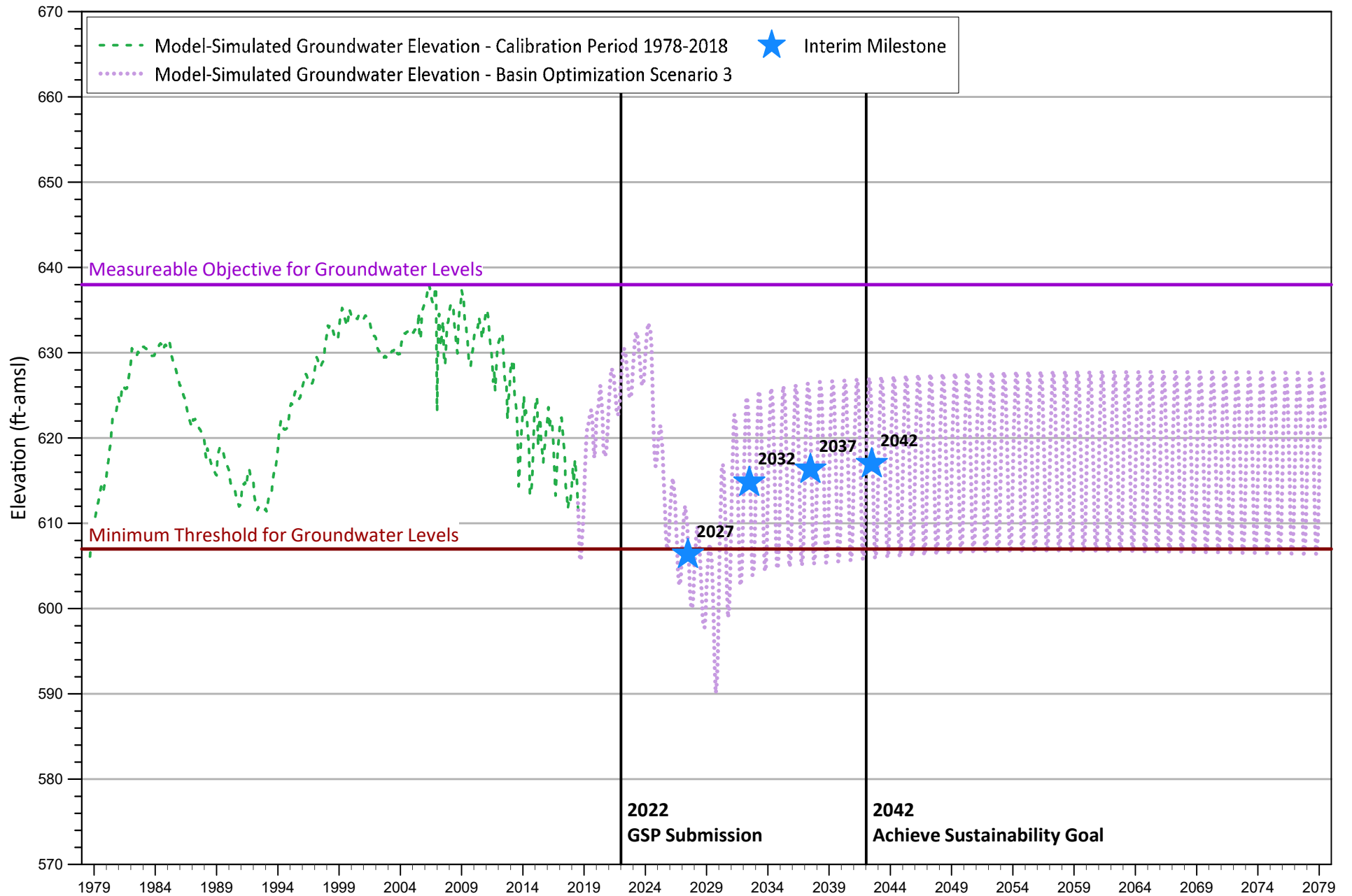


Figure 3-4c. Five-Year Interim Milestones at P-28

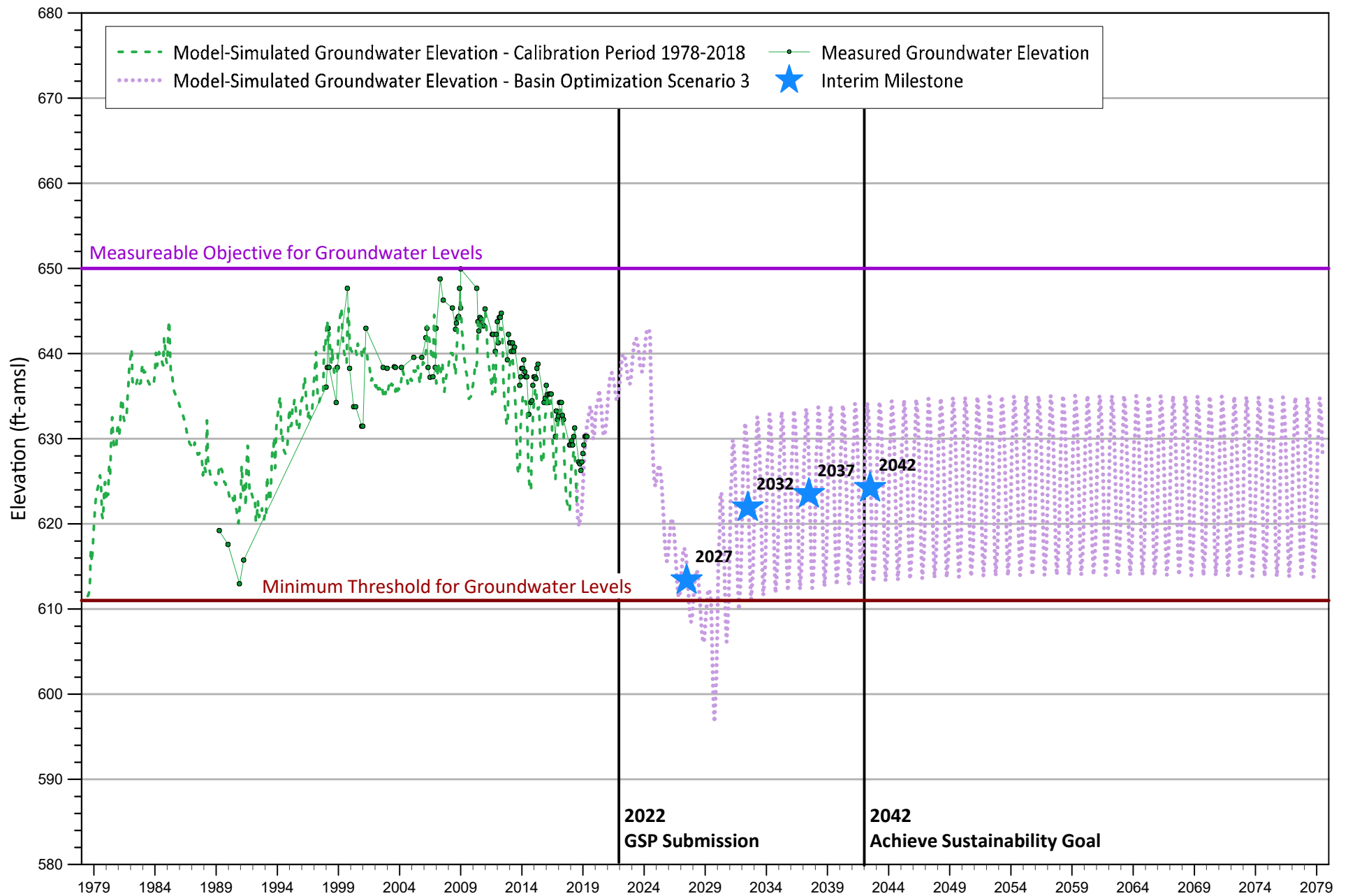


Figure 3-4d. Five-Year Interim Milestones at CPP-1

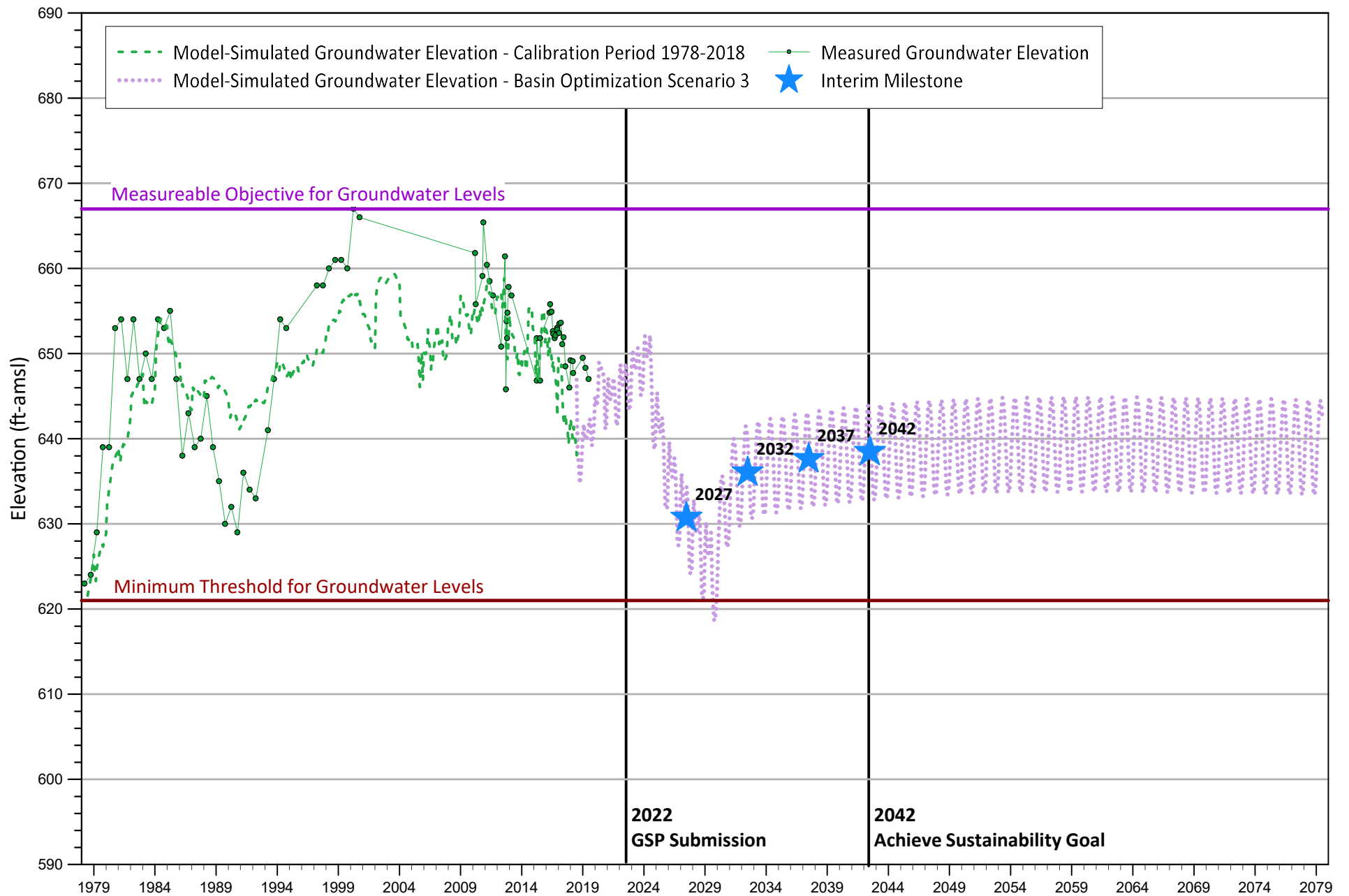


Figure 3-4e. Five-Year Interim Milestones at P-19

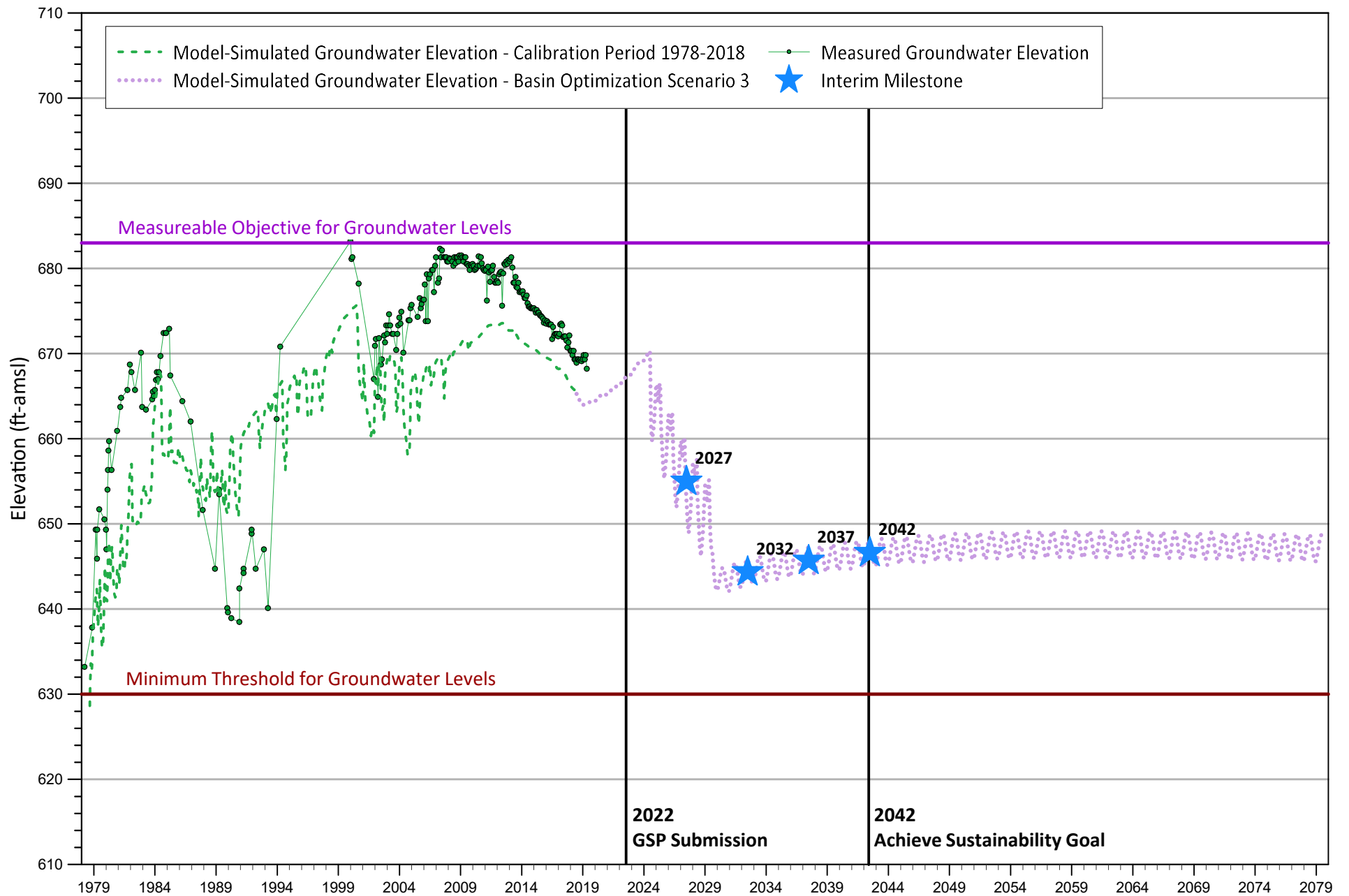


Figure 3-4f. Five-Year Interim Milestones at OMW-3

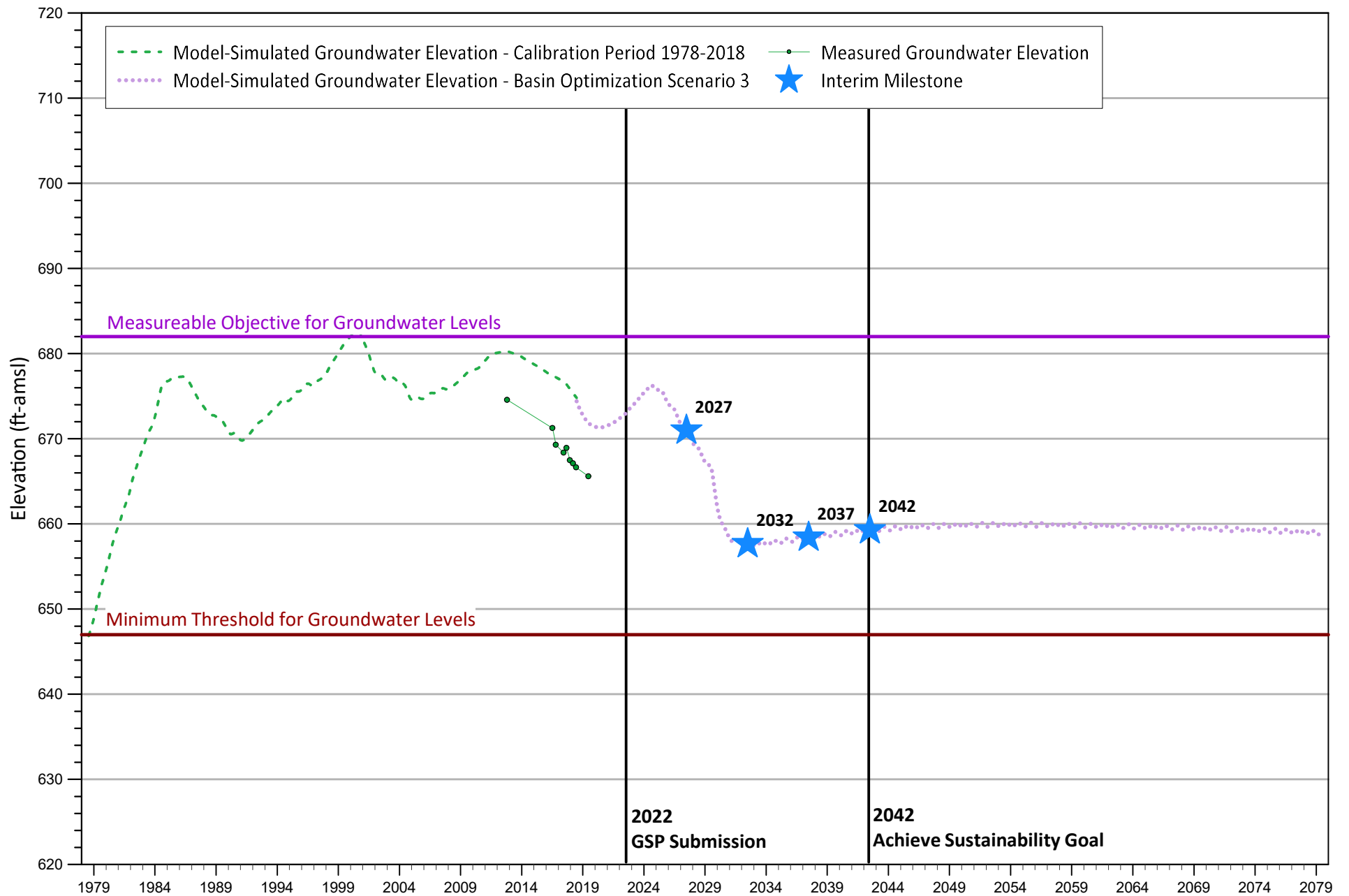
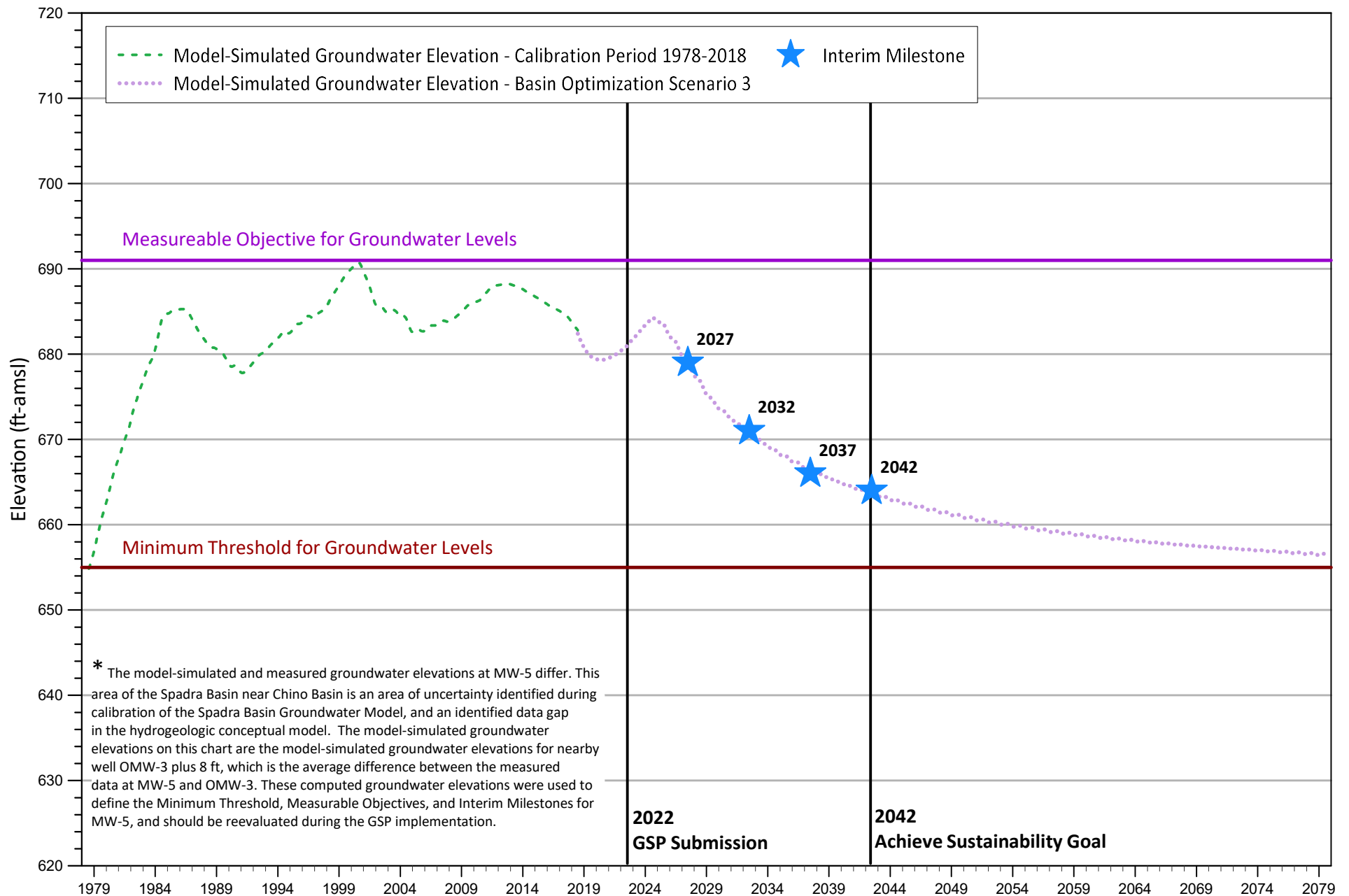


Figure 3-4g. Five-Year Interim Milestones at MW-5



SECTION 4

Monitoring Program

This section describes the GSP monitoring program in accordance with the GSP Regulations for monitoring networks ([23](#) CCR § 354.32 Et seq.). The monitoring program is intended to provide data on the Sustainability Indicators for the Spadra Basin with sufficient accuracy and quantity to demonstrate that the basin is being sustainably managed. The Sustainability Indicators relevant to the Spadra Basin include:

- Chronic lowering of groundwater levels
- Reduction in groundwater storage
- Degraded water quality
- Land subsidence

The objective of the monitoring program is to collect data of sufficient quality, frequency, and distribution to characterize conditions in the basin and evaluate GSP implementation as it relates to:

- Demonstrating short-term, seasonal, and long-term trends in groundwater and related surface conditions.
- Tracking changes in groundwater conditions relative to Minimum Thresholds.
- Detecting impacts to the beneficial uses and users of groundwater.
- Demonstrating progress toward achieving Interim Milestones and Measurable Objectives.
- Collecting data to be used in future updates to the groundwater model that can be used to evaluate groundwater conditions and quantify changes in water budget.

Historically there has been no formal coordinated monitoring effort implemented in the Spadra Basin. Groundwater monitoring was performed by the individual water purveyors and other well owners at various frequency for their own needs. The monitoring program developed for this GSP expands and improves upon the monitoring performed historically in a coordinated effort to achieve the monitoring objectives described above.

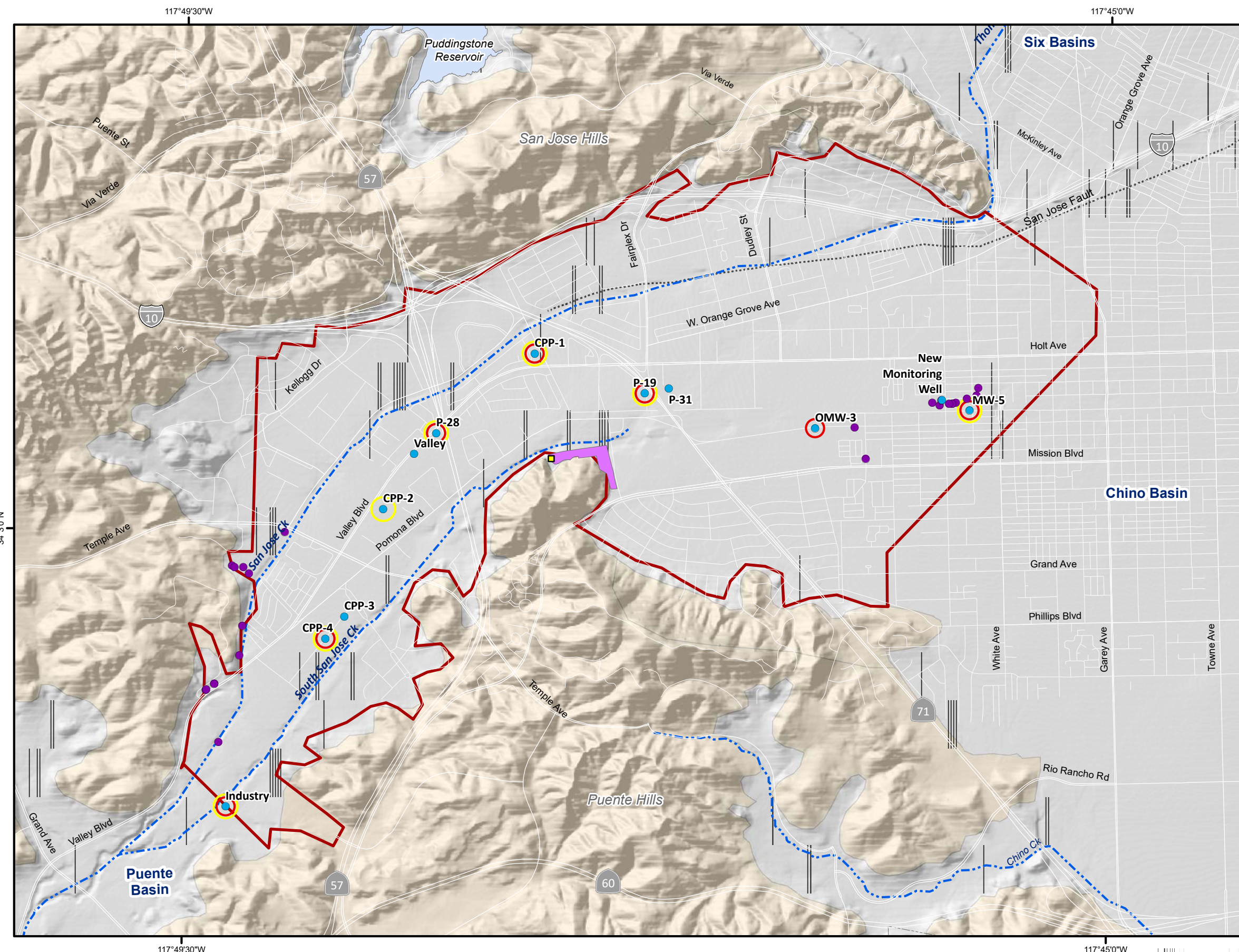
4.1 DESCRIPTION OF THE MONITORING PROGRAM

The Spadra Basin monitoring program includes monitoring of groundwater (levels, quality, and production), surface water, and land subsidence. For each of these data types this section describes:

- Monitoring locations and frequency, and methods of data collection and management.
- Monitoring protocols to ensure that data is collected and managed in a consistent, industry-standard fashion.
- Relation of monitoring program to representative monitoring sites described and established in *Section 3 Substantiable Management Criteria* for the relevant Sustainability Indicators to the Spadra Basin.

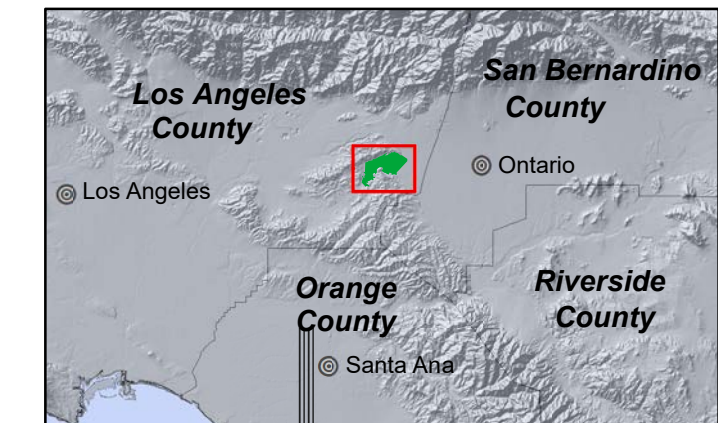
4.1.1 Groundwater Monitoring

Groundwater monitoring is the primary component of the Spadra Basin monitoring program, and includes collecting groundwater level, groundwater quality, and production data at all existing wells in the basin. In addition, a new monitoring well is planned for construction in 2022 to fill a gap in the monitoring network. Figure 4-1 shows the wells in the groundwater monitoring network.



- Wells Monitored by the GSA for Groundwater Levels and Groundwater Quality
- Representative Monitoring Site for Groundwater Levels (by Proxy, Groundwater Storage and Land Subsidence)
- Representative Monitoring Site for Groundwater Quality
- Wells Sampled by Others and Data is Collected by the Spadra Basin GSA
- Pomona WRP
- Pomona WRP Effluent Discharge
- Streams & Flood Control Channels
- Spadra Basin (GSP Boundary)

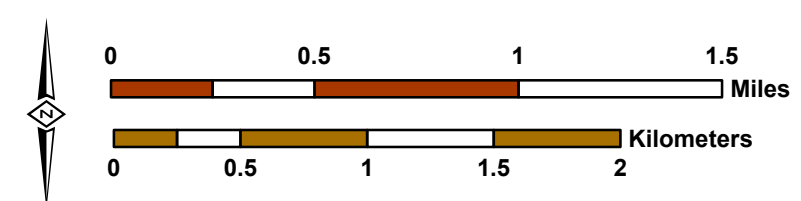
- Geology
- Water-Bearing Sediments
- Quaternary Alluvium
- Consolidated Bedrock
- Undifferentiated Pre-Tertiary to Early Pleistocene Igneous, Metamorphic, and Sedimentary Rocks
- Faults
- Location Certain
 - Location Concealed
 - Location Approximate
 - Location Uncertain



Prepared by:

WEST YOST
Water. Engineered.

Author: VMW
Date: 1/14/2022
File: Figure 4-1.mxd



Prepared for:

Spadra Basin Groundwater Sustainability Agency
Groundwater Sustainability Plan



Spadra Basin GSP Monitoring Network

Figure 4-1

4.1.1.1 Groundwater Levels

Groundwater-level monitoring by the GSA will occur at 12 wells. The 12 wells to be monitoring monitored by the GSA are shown on Figure 4-1 and listed below in Table 4-1.

Table 4-1. Wells to be Monitored by the GSA for Groundwater Levels and Groundwater Quality				
Well	Well Type	Well Owner	Representative Monitoring Site for WL	Representative Monitoring Site for WQ
Industry	Production	WVWD	X	X
CPP-4	Production	CPP	X	X
CPP-3	Production	CPP		
CPP-2	Production	CPP		X
Valley	Monitoring	WVWD		
P-28	Production	Pomona	X	X
CPP-1	Production	CPP	X	X
P-19	Production	Pomona	X	X
P-31	Production	Pomona		
OMW-3	Monitoring	Calsol	X	
MW-5	Monitoring	Calsol	X	X
New Spadra Monitoring Well	Monitoring	Spadra GSA	n/a ^(a)	n/a ^(a)
(a) This monitoring well has not been constructed yet. When the well is constructed and monitoring has been initiated at this well, it will be considered for inclusion as a representative monitoring site.				

These wells are spatially distributed throughout the basin at about every 0.25 mile to 0.75 mile. The wells include all water purveyor production wells in the basin, two monitoring wells at the Calsol Inc. contaminant site, and one future monitoring well that will be constructed by the GSA to fill a gap in the monitoring network.

The GSA will monitor for groundwater levels at these 12 GSP monitoring wells using a pressure transducer (if possible) that measures and records water levels once every 15 minutes. These data will be retrieved in the field on a quarterly basis. If a pressure transducer cannot be installed in the well casing to collect the high-frequency data, then a manual measurement of depth-to-groundwater will be collected monthly. The high-frequency data collected by the transducers is sufficient to fully understand the seasonal and long-term trends in groundwater levels to evaluate the groundwater-level conditions, including the response of the basin to GSP implemented projects and comparison to the Sustainable Management Criteria.

The remaining wells shown in Figure 4-1 are dedicated monitoring wells primarily for the point-source contaminant monitoring at the Spadra Landfill and Calsol Inc. sites. Groundwater-level monitoring at these wells is performed at varying frequencies by the well owners. Annually, the GSA will collect all available groundwater-level data for these wells from the well owners.

4.1.1.1.1 Representative Monitoring

Seven of the 12 wells are representative monitoring sites established and described in Section 3 Sustainable Management Criteria for assessment of the Sustainability Indicators of chronic lowering of groundwater levels, and by proxy, reduced groundwater storage and land subsidence. The wells that are representative monitoring sites are indicated on Figure 4-1 and Table 4-1. Groundwater elevations will be measured and evaluated at the representative monitoring sites to assess sustainability in relation to the Measurable Objectives and Minimum Thresholds for groundwater levels, and by proxy for groundwater storage and land subsidence. The adequacy of using groundwater elevations as a proxy for groundwater storage and land subsidence is described in Sections 3.3.2 and 3.3.4.

4.1.1.1.2 Monitoring Protocols

The goal is for the GSA to install and use pressure transducers with data loggers that measure and record groundwater-elevation measurements every 15-minutes at the 12 wells monitored by the GSA. If it is not possible to install a transducer at a well, then the default measurement method will be manual measurements performed at the well monthly. The GSA will coordinate and conduct the monitoring via transducers or manually at the 12 wells in Table 4-1 using consistent procedures and protocols to ensure comparable data and methodologies. The GSA will utilize the standard operating procedures (SOPs) in Appendix J for groundwater-level monitoring using transducers, and procedures for manual water-level measurements.

To set up the groundwater-level monitoring network, the GSA will need to coordinate and install transducers at the 12 wells in Table 4-1; this includes:

- Coordination with well owners to determine status of well, obtain access to well site and inside of the well.
- Performing a site visit at each well to inspect: the access to the well site; access to the inside of the well; if it is physically possible to install a transducer in the well; proper location to install transducer in well; the depth-to-groundwater, and the proper installation hardware and equipment to purchase.
- Obtain all necessary installation and monitoring equipment.
 - Transducers must be properly specified to have a sufficient measurement range to capture accurate data for each well. Historical groundwater-level data for the well or nearby wells will be used to guide in the selection of the transducer model with applicable range and depth for each well.
 - Direct read cables will be the default installation hardware for the transducers. If a direct read cable cannot be installed, then stainless-steel wire will be used for installation.
- Install transducers in wells via a direct cable or stainless-steel wire. At each well a sketch will be drawn that includes the well location, well construction in relation to the ground surface, location of the designated reference point for measuring depth-to-water, and measured distance from the ground to the designated reference point. Pictures of the well and well site will be taken. These photos and well sketches will be maintained in the data management system for the GSP, for easy access to this well information.

Two weeks after installation the transducers will be tested in the field ~~the~~ to ensure they are working properly to prevent the loss of data due to malfunction or improper installation. At this time, any issues will be addressed immediately if needed. Following this two-week period, quarterly field visits will be conducted to download the 15-minute data from the transducers at the 12 wells. During download,

manual measurements of the depth-to-water in ft will be collected with a precision sounder to ensure accuracy of the 15-minute data from the transducers. Following each quarterly download, the 15-minute data will be checked and processed. The raw data-logger files from the monitoring wells will be converted from pressure to depth-to-water based on the manual water-level measurements collected in the field. The data will be checked for quality assurance and quality control (QA/QC) and uploaded to the data management system for the Spadra Basin GSA.

If needed, manual depth to water measurements using a sounder will be collected monthly by the GSA at a Spadra GSA monitoring well if a transducer is unable to be installed. Manual measurements shall be collected in accordance with the SOP in Appendix J. Following measurement in the field, all data will be processed, reviewed for QA/QC, and uploaded to the data management system for the Spadra Basin GSA.

For the remaining wells in the monitoring network that are not monitored by the Spadra GSA, water-level measurements will be collected by the well owners and/or monitoring entities and the GSA will collect this data. The measurement frequency is dependent on the well owner, but the GSA will encourage monthly measurements at a minimum. All data will be processed, reviewed for QA/QC, and uploaded to the Spadra Basin GSA data management system along with the rest of the data collected by the GSA at the Spadra GSA monitoring wells.

All water level data will be stored in the Spadra GSA data management system as both depth-to-water measurements in ft-bgs and groundwater elevations in ft-amsl. A depth-to-water measurement in ft will be collected via transducer or manual methods and groundwater elevation is calculated using the following equation:

$$GWE = RP - DTW$$

Where:

GWE = groundwater elevation (ft-amsl)

RP – reference point elevation (ft-amsl)

DTW – depth to water (ft-bgs)

All the groundwater elevation measurements will be referenced to a reference point elevation at the well that is determined from a consistent elevation datum. The ground surface elevation at the well will be determined from the 10-meter digital elevation model (DEM) in the National Geodetic Vertical Datum of 1929 (NGVD 29). At each well, a designated well reference point will be identified at the top of the well to manually measure depth-to-water from, and the distance from the ground surface to the reference point will be measured. A reference point elevation will be calculated using the following equation:

$$RP = GSE + (GS \text{ to } RP)$$

Where:

RP – reference point elevation (ft-amsl)

GSE = ground surface elevation (ft-amsl)

GS to RP – the measured distance from the ground surface to the reference point (ft). The distance is a positive number if the distance is above ground, and a negative number if the distance is below ground.

The reference point elevation will be entered into the database and will be used to calculate a groundwater elevation from the depth to water measurement.

For the wells monitored by the GSA, custom field sheets will be made to indicate the designated well reference point to measure depth to water from, and if possible, the well reference point will be permanently marked at its location at the top of the well. Sketches of each GSP monitoring well will be done that include the well reference point and the measured distance from the reference point to the ground surface.

4.1.1.2 Groundwater Quality

Groundwater-quality data will be collected at the 12 wells monitored by the GSA shown in Figure 4-1 and listed in Table 4-1. The 12 GSP monitoring wells are spatially distributed along the axis of the basin, the thickest and main portion of the aquifer, and will represent groundwater-quality conditions for the entire basin. The wells include all water purveyor production wells in the basin, two monitoring wells at the Calsol [Inc.](#) contaminant site, and one future monitoring well that will be constructed by the GSA to fill a gap in the monitoring network.

Groundwater-quality sampling and analyses will occur at a minimum of every three years for the recommended analytes and laboratory analytical methods and detection limits listed in Table 4-2. The recommended analytes include general mineral and physical chemistry, VOCs, and perchlorate, which are necessary to assess current groundwater-quality conditions for contaminants of concern and compare to the Sustainable Management Criteria. These recommended analytes may need to be modified in the future based on the need to monitor for new or emerging contaminants identified by the GSA. Groundwater-quality sampling will be performed by the well owners and the data will be provided to the GSA along with all other groundwater-quality data collected by the well owners. If well owners are unable to monitor for the recommended analytes and frequency desired by the GSA, then the GSA can opt to perform the monitoring.

Table 4-2. Analyte List for Groundwater Quality Monitoring

Analyte	Method Detection Limit	Laboratory Analysis Method
Alkalinity in CaCO ₃ units	2 mg/l	SM 2320B
Ammonia Nitrogen	0.05 mg/l	EPA 350.1
Bicarbonate as HCO ₃	2 mg/l	SM2330B
Calcium	1 mg/l	EPA 200.7
Carbonate as CO ₃	2 mg/l	SM2330B
Chloride	0.5 mg/l	EPA 300.0
Hydroxide as OH	2 mg/l	SM2330B
Magnesium, Total	0.1 mg/l	EPA 200.7
Nitrate as Nitrogen	0.1 mg/l	EPA 300.0
Nitrite as Nitrogen	0.05 mg/l	EPA 300.0
Organic Nitrogen	0.2 mg/l	EPA 351.2
pH	0.1	SM4500
Perchlorate	2 µg/l	EPA 314.0
Potassium Total	1 mg/l	EPA 200.7
Sodium Total	1 mg/l	EPA 200.7
Specific Conductance, 25 C	10 µmhos/cm	SM2510B
Sulfate	0.05 mg/l	EPA 300.0
Total Dissolved Solids (TDS)	10 mg/l	E160.1/SM2540C
Total Hardness as CaCO ₃	3 mg/l	SM 2340B
Total Organic Carbon	0.2 mg/l	SM 5310C
Turbidity	0.1 NTU	EPA 180.1
Volatile Organic Compounds (VOCs)	Variable	EPA 524.2
1,2,3-Trichloropropane (low detection of 0.005 µg/l)	0.005 µg/l	CASRL 524M-TCP ^(a)
(a) Can use this method or a comparable laboratory specific method with a method detection limit of 0.005 µg/l <u>NTU = nephelometric turbidity unit</u> <u>µmhos/cm = micromhos per centimeter</u>		

The remaining wells shown in Figure 4-1 are dedicated monitoring wells primarily for the point-source contaminant monitoring at the Spadra Landfill and Calsol Inc. sites. Groundwater-quality monitoring at these wells is performed at varying frequencies by the well owners. Annually, the GSA will collect all available groundwater-quality data for the past year at these wells from sampling by the well owners.

4.1.1.2.1 Representative Monitoring

Seven of the 12 wells monitored by the GSA are representative monitoring sites for the Sustainable Management Criteria established in Section 3 of this GSP for the Sustainability Indicator of degraded water quality. Monitoring of groundwater quality at the seven representative monitoring sites will be conducted by collecting triennial samples (at a minimum) for the six contaminants of concern. If a contaminant concentration is above the Minimum Threshold set at any well, subsequent monitoring will be done within a year to verify the occurrence of an Undesirable Results.

4.1.1.2.2 Monitoring Protocols

Groundwater-quality monitoring is performed at wells in the Spadra Basin by the well owner. The 12 wells monitored by the GSA (Figure 4-1 and Table 4-1) will be sampled at a minimum for the analytes listed in Table 4-2 on a triennial basis. The groundwater-quality sampling will be performed by the well owners and/or monitoring entities and the data will be provided to the GSA along with all other groundwater-quality data collected by the well owners. If well owners are unable to monitor for the recommended analytes and frequency at the 12 wells in Table 4-1, then the GSA can opt to perform the monitoring. All groundwater-quality analyses are to be performed by laboratories certified under the State Environmental Laboratory Accreditation Program. For consistency that groundwater-quality monitoring at the 12 wells should use the laboratory methods indicated in Table 4-2.

Groundwater will be performed by multiple well owners and/or monitoring entities in the basin, including the GSA and parties to the GSA. The following general data collection protocols should be followed by each sampler:

- Prior to sample collection, order new sample bottles appropriate to each laboratory analysis from the designated laboratory certified under the State Environmental Laboratory Accreditation Program.
- Field forms should be complete for each sample site to document at a minimum: the date/time, sampler, conditions at well, depth-to-water measurement, and field water quality parameters.
- Purge the well casing prior to collecting a sample. Production wells should be sampled while the pump is running. Monitoring wells shall be purge using a submersible pump or bailer.
- Use a water-quality meter with probes that can measure multiple field water quality parameters. Recommended field water quality parameters include TDS, specific conductance, pH, temperature, and turbidity. Collect and log these parameters about every five minutes while purging the well and assure parameter stabilization (within 10 percent) for three consecutive measurements prior to collecting sample. And collect and log one round of field water quality parameters after the sample is collected.
- Based on the sampled constituent, water quality sample collection shall follow specific processing and treatment guidelines per the laboratory method and guidance to assure the accuracy of the data.
- After collection, all sample bottles shall be sealed in zip-closure polyethylene bags that are typically provided by the lab and placed in an insulated cooler with ice for transport to the laboratory. All samples shall be delivered to the laboratory following standard chain-of-custody procedures with these appropriate prescribed holding times.

The GSA will collect that water-quality data from the sampling performed by the multiple well owners/ monitoring entities at a minimum of once per year. Electronic data deliverables (EDDs) prepared by the laboratory, in Microsoft Excel, is the preferred format to the provided to the GSA. All data will be processed, reviewed for QA/QC, and uploaded to the data management system for the Spadra Basin GSA.

4.1.1.3 Groundwater Production

Groundwater production data are analyzed together with groundwater-level data to characterize the influence of pumping on groundwater levels. Groundwater-production data are also used as input to the Spadra Basin **G**roundwater **M**odel that is used to evaluate past and future groundwater conditions, including the annual change in storage calculation that is required for annual reporting to the DWR (23 CCR § 356.2).

Groundwater production data will be collected at all active production wells in the basin. Currently, eight of the 12 wells monitored by the GSA are active or inactive water supply wells, with meters that have been installed by the well owner. The well owners will provide monthly production volumes measured at the water supply wells to the GSA. The data will be collected annually.

4.1.1.3.1 Monitoring Protocols

The DWR requires annual reporting by the GSA of all groundwater production volumes, the measurement method, and accuracy of the method (23 CCR § 356.2[b][2]). All groundwater pumping in the Spadra Basin will be measured via flow meters and reported to the GSA. The individual well owners in the Spadra Basin are responsible for the installation and maintenance of flow meters at their active wells. To ensure accurate reporting of the production volumes, meters **should** be tested and validated routinely. Each well owner is responsible for testing the flow meter **well** every two years by a California-licensed pump contractor for meter accuracy. If test results are not within +/- 5 percent accuracy of 100 percent, follow-up testing can be performed, or the meter should be fixed or replaced. Reports of meter testing should be reported to the GSA within 30 days of completion of the test. Additionally, if a meter is broken, it is up to the well owner to resolve this issue as soon as possible to fix or install a new meter.

Once a year the GSA will collect production data for all active production wells in the Spadra Basin. The measurement frequency is dependent on the well owner, but the GSA will encourage monthly measurements at a minimum. Monthly production data should include the meter model and ID, meter units, a beginning and end meter recording, and the monthly production volumes in af. Data will be processed, reviewed for QA/QC, and uploaded to the data management system for the Spadra Basin GSA.

4.1.1.3.2 Representative Monitoring

There are no representative monitoring sites for production for the *Section 3 Substantiable Management Criteria*.

4.1.2 Surface Water Monitoring

Surface-water discharge in the concrete-lined channels exits the Spadra Basin towards the west via two main channels—San Jose Creek and South San Jose Creek. There are no active surface-water discharge monitoring stations within these two channels across the Spadra Basin.

Surface-water discharge and quality monitoring is performed by LACSD at the Pomona WRP for effluent discharged to the South San Jose Creek (see Figure 4-1 for location). The discharge from the Pomona WRP is a portion of the flow in the South San Jose Creek. The GSA will collect the discharge and water-quality data from the LACSD. The monitoring of the Pomona WRP discharge is important to the GSA to track and understand the volume and quality of water that exits the Spadra Basin from this channel because:

- Surface water that exits the Spadra Basin in the concrete-lined channels serves beneficial uses by downstream entities for groundwater recharge or is consumptively used by riparian vegetation in downstream unlined stream reaches.
- The surplus recycled water from the Pomona WRP that is discharged to South San Jose Creek is the source of water being considered for artificial recharge or expanded reuse in the proposed projects for consideration in this GSP (Sections 5.3 and 5.4) to achieve sustainability and maximize the beneficial use of the basin.

The surface-water discharge and quality monitoring data of the Pomona WRP effluent will be collected from the LACSD by the GSA annually.

4.1.2.1 Representative Monitoring

As described in *Section 2.2.5 Surface Water and Groundwater Dependent Ecosystems*, all streams that cross the Spadra Basin are concrete-lined flood-control channels which prohibits groundwater/surface-water interactions. Therefore, surface water data is not used to evaluate conditions in the Spadra Basin relative to the Sustainable Management Criteria for any relevant Sustainability Indicators of the Spadra Basin.

4.1.2.2 Monitoring Protocols

Monitoring of the Pomona WRP is performed by the LACSD in accordance with monitoring and reporting requirements in the NPDES permit *No. CA0053619 - Order No. R4-2021-0097 and WDRs for the Joint Outfall System Pomona Water Reclamation Plant, Los Angeles County, Discharge to the South Fork San Jose Creek*. Monitoring includes ~~monitoring of~~ daily discharge, and ~~monitoring~~ for specified water quality parameters ~~either~~ daily, weekly, monthly, quarterly, ~~and or~~ semi-annually. The GSA will collect the Pomona WRP discharge and water quality monitoring data that is available online from the State's California Integrated Water Quality System Project (CIWQS) website.¹ This data is important for ~~to~~ the Spadra Basin GSA to track to understand the volume and quality of this water that is exiting the Spadra Basin and that potentially will be used for envisioned projects to achieve sustainability and maximize the beneficial use of the basin. All collected data will be processed, reviewed for QA/QC and uploaded to data management system for the Spadra Basin GSA.

4.1.3 Land Subsidence

As described in *Section 2.2.4 Ground Levels*, available data from the subsidence monitoring program in the neighboring Chino Basin indicates that minor downward ground motion has occurred across the Spadra Basin over the period of 1982-2018. The Minimum Thresholds set for the lowering of groundwater levels will be used as a proxy for the land subsidence Sustainability Indicator. However, monitoring of land subsidence will be conducted periodically (minimum of every five years) by the GSA via available InSAR data to verify that permanent land subsidence is not occurring.

¹ [CA Waterboards/Public Report](#)

4.1.3.1 Representative Monitoring

Monitoring for the Sustainability Indicator of land subsidence will be done by proxy through the groundwater-level monitoring network described in Section 4.1.1.1. The adequacy of using groundwater elevations as a proxy for land subsidence is described in Section 3.3.4.

4.1.3.2 Monitoring Protocols

There are two sources of vertical ground motion data measured by InSAR for the Spadra Basin area that will be periodically reviewed:

- **The TRE Altamira InSAR data made available by DWR.** This dataset is measurements of vertical ground surface displacements in over 200 populated groundwater basins across the State of California. Vertical displacement estimates are derived from InSAR data from the European Space Agency Sentinel-1A satellite and processed by TRE Altamira under contract with the DWR. The DWR provides this data set on the SGMA Data Viewer website² as part of its efforts to provide technical assistance and SGMA-relevant data to the GSAs for GSP development and implementation. The dataset is point or raster grid data for 100 x 100-meter area. The dataset covers the Spadra Basin area and is currently available from 2015 to 2020. As this dataset is continually updated, the GSA will periodically review an InSAR map of vertical ground displacement of the Spadra Basin area through the most available period.
- **The CBWM's InSAR data as part of their subsidence management plan.** The CBWM conducts a subsidence management plan in the neighboring Chino Basin to minimize or abate the occurrence of subsidence and ground fissuring. Currently the ~~Watermaster's~~ CBWM's efforts are focused on developing a specific management plan for the Northwest MZ-1 which is an area directly adjacent to the Spadra Basin. Part of ~~Watermaster's~~ CBWM's subsidence monitoring includes InSAR data that is acquired from the post-processing of land-surface displacement data from the TerraSAR-X satellite operated by the German Aerospace Center. The GSA will periodically review maps of the InSAR data in the annual reports that are prepared for the subsidence management plan which includes a portion of the Spadra Basin (West Yost, 2021).

The GSA will periodically review these InSAR data sets to observe if there is any notable downward vertical ground motion in the Spadra Basin and compare to the assessment of the Sustainable Management Criteria for groundwater levels that will be used as a proxy. Every five years, during the five-year elevations of the GSP described in Section 6.1.4, the GSA will collect and review these available InSAR data sets and provide a discussion of the results and an analysis of the proxy Minimum Thresholds for groundwater levels and the potential need to update any Sustainable Management Criteria for groundwater levels or land subsidence.

4.2 DATA MANAGEMENT

Pursuant to the GSP Regulations (23 CCR §352.6), each GSA shall develop and maintain a data management system capable of storing and reporting information relevant to the development or

² [SGMA CA Water](#)

implementation of the GSP and the monitoring of the basin. During the initial stages of the development of the GSP, ~~that the Spadra Basin~~ GSA utilized a data management system to store all the historical and current data necessary to prepare the GSP. As described throughout this monitoring program all data collected from the GSA monitoring program will be routinely processed, checked for QA/QC to ensure data validity, and uploaded to the GSA's data management system.

4.3 ASSESSMENT AND IMPROVEMENT OF MONITORING PROGRAM

The monitoring program described herein is the first coordinated monitoring effort in the Spadra Basin, and addresses some of the data gaps identified in the *Basin Setting Section 2.2.7* of this GSP. The monitoring program includes either monitoring by the GSA or collecting data at all known existing and accessible wells in the Spadra Basin. The 12 wells that will be monitored by the GSA include a soon to be constructed monitoring well that fills data gaps identified in Section 2.2.7 for hydrogeologic data near the Chino/Spadra Basins boundary. Some additional actions that can be taken by the GSA upon GSP implementation to fill data gaps are:

- Continuing efforts with the owner of the only known private production well in the basin (Walnut Hills Mobile Home Park) for inclusion in the GSP monitoring program.
- Perform a well canvas for any other unknown private wells in the basin, and work with well owners for inclusion in the GSP monitoring program.
- Execute data sharing agreements with the CBWM and Puente Basin Water Agency (PBWA) for sharing data with the neighboring and hydrologically connected Chino and Puente Basins.
- The initiation of a program to collect high-resolution production data at the active production wells to understand how pumping patterns related to observed groundwater levels, better understand aquifer parameters, and improve the hydrogeologic conceptual model. This may include leveraging the water purveyors' existing SCADA systems.
- The addition of surface water gaging stations at upstream and downstream locations along San Jose Creek to monitor storm water and dry-weather runoff to better understand and characterize these potential sources of recharge to the basin.

Per the GSP Regulations (23 CCR § 354.38) the GSP monitoring network will be evaluated in each five-year assessment and update of the GSP, including a determination of uncertainty and if there are monitoring gaps that need to be filled. Future updates and adjustments to the GSP monitoring program could include:

- The addition of any newly constructed wells into the monitoring program.
- The addition of existing wells that are monitored by others to the group of designated GSP wells where frequent and coordinated monitoring is performed by the GSA, to fill spatial data gaps to achieve the objectives of the monitoring program.
- The construction of additional monitoring well/s to fill spatial data gaps in the hydrogeologic conceptual model and/or achieve the objectives of the monitoring program.
- The addition of subsidence monitoring in the basin in addition to the use of available InSAR datasets.

SECTION 5

Projects and Management Actions to Achieve Sustainability

[23](#) CCR § 354.44 of the GSP Regulations requires that a GSP include a description of the projects and management actions that the GSA has determined will achieve the Sustainability Goal for the basin. To do this, the GSA must first understand the sustainability of expected future groundwater conditions in the absence of additional projects or management actions that could be included in the GSP (i.e., a “Baseline Scenario”). Through a stakeholder process, the GSA developed and evaluated a Baseline Scenario that included the future expected water demands, water-supply plans, and groundwater management plans of the Spadra Basin stakeholders, and then used those results to guide the selection of projects and management actions to consider for the GSP to achieve the Sustainability Goal. Various combinations of the proposed projects were included in three “Basin Optimization Scenarios” that were evaluated and compared to the Baseline Scenario and each other. The steps of this effort included:

- Collect the current water demands and supply plans from the stakeholders and describe them as a Baseline Scenario. The Baseline Scenario is a description of how the Spadra Basin is planned to be utilized by the stakeholders absent of a GSP.
- Evaluate the hydrologic response of the Spadra Basin to the Baseline Scenario over a 60-year planning horizon using the Spadra Basin Groundwater Model. Use the model results to quantitatively evaluate and determine sustainability for each Sustainability Indicator.
- Compare the hydrologic response of the Spadra Basin to the Sustainable Management Criteria developed and described in Section 3 Sustainable Management Criteria to determine the long-term sustainability of the Baseline Scenario.
- Develop concepts for projects and management plans with the Spadra Basin stakeholders, identify preferred combinations of these projects and management plans, and describe these combinations as “Basin Optimization Scenarios.”
- Evaluate the hydrologic response of the Spadra Basin to the Basin Optimization Scenarios over a 60-year planning horizon using the Spadra Basin Groundwater Model. Use the groundwater modeling results to quantitatively evaluate and determine sustainability for each Basin Optimization Scenario for each Sustainability Indicator.
- Compare the hydrologic response of the Spadra Basin for the Basin Optimization Scenarios to each other, and to the Baseline Scenario.
- Prepared a cost ~~analyses~~ [analysis](#) of the total melded unit cost of the water supply for the Baseline Scenario and the Basin Optimization Scenarios and compare.
- Recommend a preferred Basin Optimization Scenario for the GSP that achieves the Sustainability Goal.

The results and outcome of this effort are summarized below.

5.1 DEVELOPMENT OF THE BASELINE SCENARIO

This section describes the development of the Baseline Scenario. The Baseline Scenario represents the future water demands and the independent water-supply plans of the water purveyors in the Spadra Basin—in the absence of a GSP. The Baseline Scenario was converted into input files for the Spadra Basin Groundwater Model, which was used to evaluate the physical response of the Spadra Basin to the Baseline Scenario (see *Section 3 Sustainable Management Criteria*).

The development of the Baseline Scenario included: establishing a future planning period; describing the assumptions for future land use and hydrology and using those assumptions to estimate future recharge to the Spadra Basin; and describing the future water demands and water-supply plans of the water purveyors to estimate future pumping and artificial recharge in the Spadra Basin. The development of the Baseline Scenario is described in more detail below.

5.1.1 Planning Period

SGMA legislation defines a “planning and implementation horizon” as a “50-year time period over which a groundwater sustainability agency determines that plans and measures will be implemented in a basin to ensure that the basin is operated within its sustainable yield.” The planning period should be representative of the long-term hydrologic and cultural conditions in the basin. The planning period for the Baseline Scenario is the 60-year period from July 1, 2018 to June 30, 2079. The start date was selected because it follows the end date of the calibration period for the groundwater-flow model (July 1, 1977 to June 30, 2018), and the model is used to evaluate the Baseline Scenario. The 60-year period following July 1, 2018 was selected to comply with the SGMA

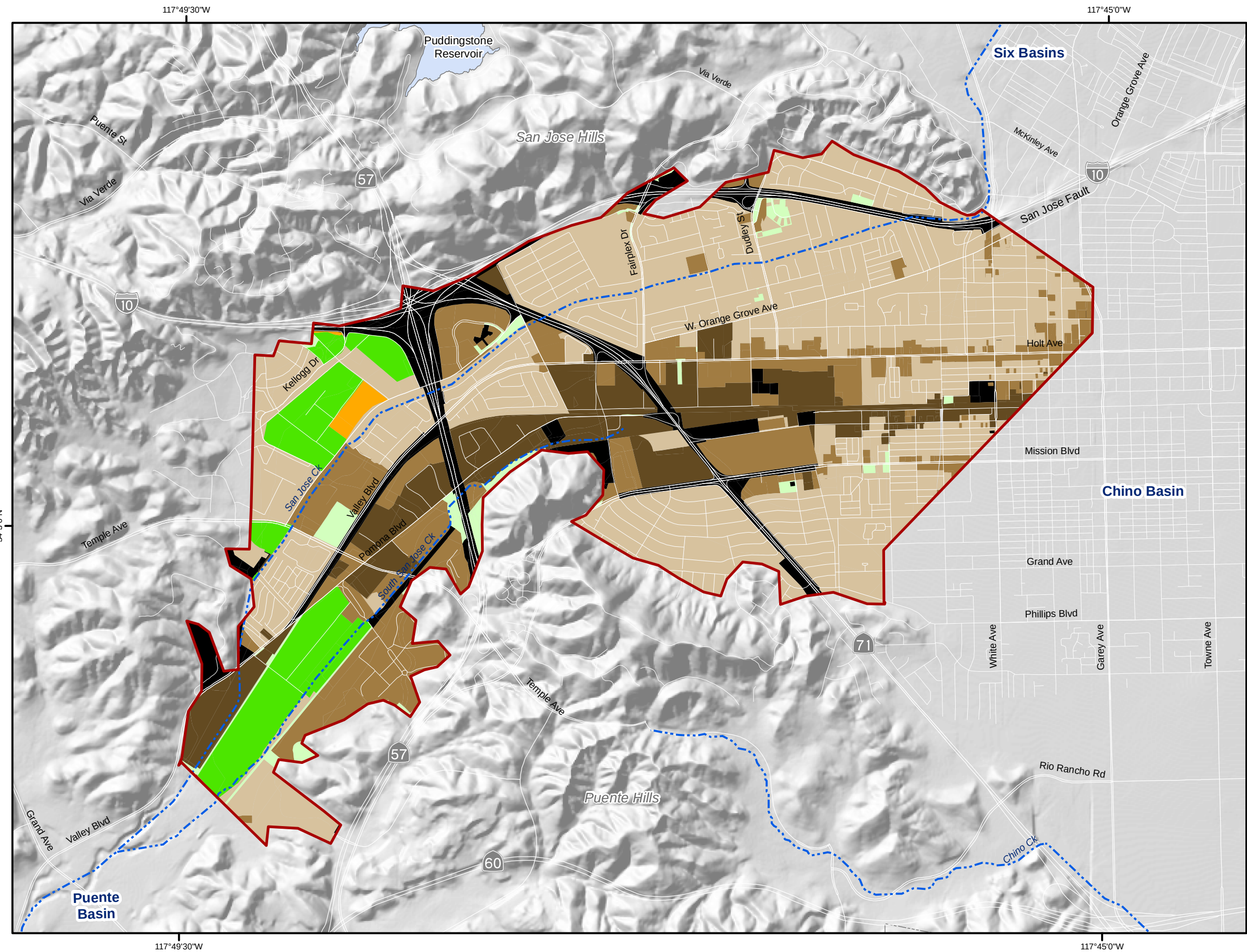
5.1.2 Assumed Land Use and Hydrology for the Planning Period

This section describes how the R4 surface-water model was used to estimate recharge to the Spadra Basin over the planning period for the Baseline Scenario.

5.1.2.1 Land Use

Current (2020) land use information was determined using the land-use map developed from SCAG surveys for 2016 and comparing to current aerial imagery and land use zoning maps for Pomona, who is the primary land use planning agency in the Spadra Basin. Staff from Pomona and CPP (who owns lands for university operations and their agricultural program) were consulted to confirm the 2020 land use map and to review general plans for development and changes to land use over the planning period.

Figure 5-1 is a map that illustrates the land use in the Spadra Basin as of 2020. The lands overlying the Spadra Basin are mostly developed, consisting primarily of urban residential, commercial, and industrial uses, and some irrigated agriculture. Both Pomona and CPP verified that the current land use types are not anticipated to change over the planning period. Therefore, the 2020 land use types and designations are assumed to stay constant over the planning period.



Land Use Type

- Native Vegetation/Vacant
- Irrigated Field Crops, Pasture, Fruit and Nuts
- Irrigated and Non-Irrigated Citrus
- Urban Residential
- Urban Commercial
- Urban Industrial
- Special Impervious

Spadra Basin (GSP Boundary)

Streams & Flood Control Channels

Faults

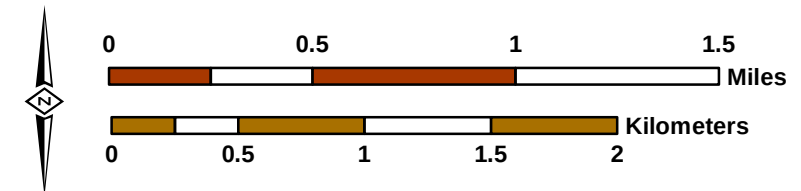
- Location Certain
- Location Approximate
- Location Concealed
- Location Uncertain



Prepared by:

WEST YOST

Author: AP
 Date: 12/22/2020
 File: Fig 2-1_Land_Use.mxd



Prepared for:

Spadra Basin Groundwater Sustainability Agency

Groundwater Sustainability Plan

Current and Projected Land Use in the Spadra Basin

Figure 5-1

5.1.2.2 Hydrology

To support the development of GSPs across California, the DWR has provided climate change datasets in the form of change factors of precipitation, ET, and surface runoff based on 20 global climate projections (DWR, 2018). According to the Guidance for Climate Data Change Use During Groundwater Sustainability Plan Development (DWR, 2018), change factor ratios were calculated as the future scenario (2030 or 2070) divided by the 1995 historical temperature detrended (1995 HTD) scenario. The 1995 HTD scenario represents historical climate conditions where the observed temperature increasing trend is removed.

The change factors are provided as monthly time-series over the period of 1915 to 2011 for each grid cell of the DWR's Variable Infiltration Capacity (VIC) model, which covers the State of California. The DWR provides these change factors for 2030 and 2070 future scenarios. The VIC model grid was overlaid with the R4 model domain – the model used to estimate recharge to the Spadra Basin. Review of these change factors for the VIC model grids for 2030 and 2070 conditions that overly the Spadra Basin model domain indicate that average precipitation is projected to decrease, and average ET is projected to increase.

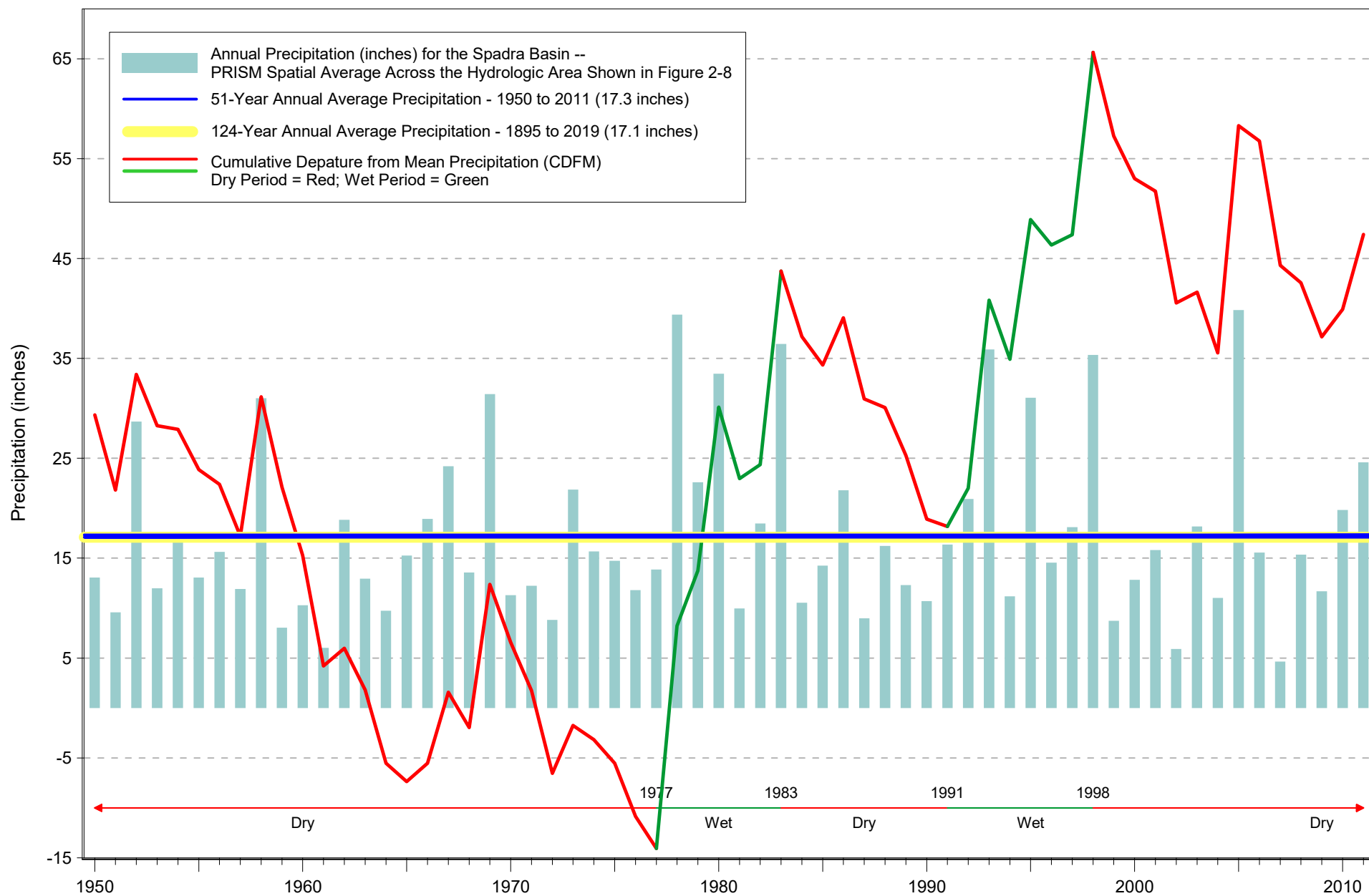
The assumed precipitation and ET over the planning period is based on the historical precipitation and ET for the period 1950 to 2011. Figure 5-2 shows the historical precipitation for the Spadra Basin hydrologic area for the 1950 to 2011 historical period. This is the latest 62-year period that overlaps with the change factor time series provided by the DWR. Note that the average annual precipitation over the Spadra Basin area is equal to long-term precipitation averages (1896 to 2019). Using the historical precipitation record during 1950-2011 for the planning period of 2018-2079 is appropriate because the annual average precipitation (17.3 inches) is virtually equal to the long-term average for 1896 to 2019 (17.1 inches).

5.1.2.2.1 Cultural Conditions, Climate Change, and Estimated Recharge

This section describes how this historical precipitation and ET datasets, along with the climate change factors provided by the DWR, were used to estimate recharge to the Spadra Basin over the planning period for the Baseline Scenario. This process is described below for the Spadra Basin portion of the Chino Valley Model (CVM) domain.

- For the current (2020) cultural condition:
 - The R4 surface-water model is executed using the 2020 land use data and the daily precipitation and ET datasets from 1950 to 2011 with a climate change factor of 1 (no change).
 - The average monthly deep infiltration from precipitation and applied water (DIPAW) is calculated based on the results of the R4 simulation.
- For the 2030 cultural condition:
 - The daily precipitation and ET datasets from 1950 to 2011 are multiplied with the DWR monthly change factors for 2030.
 - The R4 model is executed using the 2030 land use data and the modified precipitation and ET datasets.
 - The average monthly DIPAW is calculated based on the results of the R4 simulation.

**Figure 5-2. Historical Precipitation for Spadra Basin and Tributary Watersheds -
Hydrologic Period 1950-2011 Used for the Baseline Scenario**



- For the 2070 cultural condition:
 - The daily precipitation and ET datasets from 1950 to 2011 are multiplied with the DWR monthly change factors for 2070.
 - The R4 model is executed using the 2070 land use data and the modified precipitation and ET datasets.
 - The average monthly DIPAW is calculated based on the results of the R4 simulation.
- Prepare DIPAW input files for the Spadra Basin Groundwater Model over the planning period.
 - The estimated average monthly DIPAW values are linearly interpolated between the 2020, 2030, and 2070 cultural conditions, and the results are used as input for recharge to the Spadra Basin Groundwater Model.
 - For those portions of the model domain that overly the bordering hills, the DIPAW estimates are translated into estimates of delayed subsurface inflow from the bedrock fractures and sediments in bordering hills.
 - For those portions of the model domain that overly the groundwater basin, the DIPAW estimates are translated into estimates of delayed surface recharge.

5.1.3 Pumping and Artificial Recharge over the Planning Period

5.1.3.1 Sources of Water Supply

To estimate future pumping and artificial recharge in the Spadra Basin over the planning period for the Baseline Scenario, the water purveyors provided planning information on their projected demands and their future water supply plans to meet those demands.

Water-supply sources available to the water purveyors in the Spadra Basin include: groundwater from the Spadra Basin, Six Basins, Chino Basin, Puente Basin, Main San Gabriel Basin, and Central Basin; surface water from the San Antonio Creek watershed; imported water purchased from the TVMWD; and recycled water from the Pomona WRP. It is important to quantify the use of these water supplies in the Baseline Scenario so that cost estimates of the water supply plans can be derived and compared to the costs associated with the water-supply plans for various projects and management actions in the Basin Optimization Scenarios developed and evaluated in *Sections 5.3 and 5.4* of this GSP. The cost estimate for the Baseline Scenario is described in *Section 5.5 Cost analyses of the Baseline and Basin Optimization Scenarios*. Each water-supply source is described below.

5.1.3.1.1 Spadra Basin Groundwater

Section 2.2 Basin Setting describes the physical characteristics of the Spadra Basin. The Spadra Basin is not adjudicated and pumping by the three water purveyors in the basin has averaged 1,280 afy over the long-term historical period of 1977 to 2018. The percentage of the total pumping in the Spadra Basin between the three water purveyors during 1977 to 2018 was 51 percent by Pomona, 46 percent by CPP, and 3 percent by WVWD. Spadra Basin is primarily used as a supplemental non-potable supply by the water purveyors. Some groundwater is used for potable supply but requires pumping strategies or treatment to manage water quality. The historical water budget for the Spadra Basin developed from the calibrated Spadra Basin [Groundwater Model](#) (Table 2-7) estimates a developed yield to be a 1,430 afy. This is about 170 af greater than the average pumping from the Spadra Basin over the same time period, indicating that higher sustainable pumping rates are possible in the Spadra Basin.

5.1.3.1.2 Six Basin Groundwater

The Six Basins are a group of six interconnected groundwater basins, located just south of the San Gabriel Mountains in eastern Los Angeles and western San Bernardino Counties. The Six Basins are one of three sub-basins that make up the DWR Bulletin 118 San Gabriel Groundwater Basin. The Six Basins are located across a major watershed divide that separates the San Gabriel River watershed to the west from the Santa Ana River watershed to the east.

The main source of groundwater replenishment to the Six Basins is surface-water runoff from precipitation that falls on the San Gabriel Mountains and recharges at spreading grounds located along the foot of the mountain range—predominantly at the San Antonio Spreading Grounds (SASG). The water-supply agencies also use imported surface water from the Metropolitan Water District of Southern California (Metropolitan) for artificial recharge at the SASG (and for direct consumptive uses).

The pumping and storage rights for the Six Basins were adjudicated in 1998 through a stipulated judgment titled “Southern California Water Company vs. City of La Verne, et al” in the Superior Court of California for the County of Los Angeles, Case No. KC029152. The Judgment prescribes a physical solution for the coordinated management of the Six Basins with the objective that the Parties to the Judgment can reliably pump their respective rights and maximize the beneficial use of groundwater. The Judgment established the Six Basins Watermaster to implement the physical solution.

The Judgment established the Safe Yield of the Six Basins as 19,300 afy and established a base annual production right for each Party, which is a percentage of the Safe Yield. However, the physical solution states that Watermaster will determine an operating safe yield (OSY) for the Four Basins area (Canyon Basin, Upper Claremont Heights Basin, Lower Claremont Heights Basin, and Pomona Basin), and the Parties can produce their share of the OSY from the Four Basins without incurring a replacement obligation. Each year, the Watermaster determines the OSY based on recent and expected recharge, pumping, and groundwater levels. The OSY is allocated to each Party based on their base annual production right. Production in the Two Basins is reserved for one Party, the City of La Verne, and is not subject to any limitations provided that production does not substantially injure the rights of any other Party.

Replenishment is the Watermaster’s program to augment the recharge of native surface water in the Six Basins and is carried out by the Pomona Valley Protective Association (PVPA) at the direction of Watermaster. Replenishment Water is native surface water spread by the PVPA at the SASG and the Thompson Creek Spreading Grounds. The first 130 afy of native water spread by the City of Pomona and all native water spread by the LA County Flood Control District in the Two Basins is considered Replenishment Water.

In addition to each Party’s share of the OSY, the following additional production rights are provided for in the Judgment:

- The Annual carryover of a Party’s unproduced rights (Carryover Rights) are limited to 25 percent of their share of the OSY.
- Utilization of unused storage capacity in the Four Basins, subject to an approved Storage and Recovery Agreement with Watermaster.
- Transfer of production rights, carryover, or stored water may be transferred, in whole or in part, among the Parties on either a temporary or permanent basis.

- A Party's implementation of a Special Project for controlling groundwater levels or for the remediation of water quality problems in the Four Basins, subject to the Watermaster's approval.
- Access to Temporary Surplus rights declared by the Watermaster during times it is in the Parties' best interest for the control of high groundwater, water quality remediation, or other reasons deemed necessary.

Each year, a Party's total allowable production right is the sum of its share of the OSY, Carryover Rights from the previous year, total recoverable water in storage, transfers from other Parties, water from an approved special project, and Temporary Surplus water. To the extent that any Party's total production exceeds its total allowable production, that Party is obligated to recharge Replacement Water in an amount equal to the excess production. The Parties may obtain Replacement Water by directly purchasing imported water from the TVMWD or the Inland Empire Utilities Agency, arranging for the delivery of a native water supply other than that used for Replenishment, or by paying a Replacement Water assessment to Watermaster so that it may acquire Replacement Water.

The Watermaster is required to operate the Four Basins in a manner that protects against the threat of rising groundwater. In the event that Watermaster determines that Replenishment has to be terminated or curtailed in any year to protect against rising groundwater or that Replenishment Water is rejected due to insufficient storage capacity, some or all of the following rights may be lost, listed in order of priority of loss: other water in storage, imported water in storage, native water in storage, Carryover Water, and Replenishment Water. The amount of water subject to loss is equal to the quantity of Replenishment Water that was curtailed or rejected. [Losses of Carryover](#)

5.1.3.1.3 Chino Basin Groundwater

The Chino Basin is one of the largest groundwater basins in Southern California, containing approximately 12 million ~~acre-feet~~^{af} of water. The Chino Basin covers approximately 220 square miles of the upper Santa Ana River watershed and lies within portions of San Bernardino, Riverside, and Los Angeles Counties. The Chino Basin is bounded by: the Cucamonga Basin and the San Gabriel Mountains to the north; the Rialto/Colton Basins to the east; the Jurupa Hills, the Santa Ana River, and the Temescal Basin to the south; the Chino and Puente Hills to the southwest; and the Spadra Basin, San Jose Hills and the Six Basins to the northwest.

The Chino Basin is administered by the CBWM, which was established under a Judgment entered in the Superior Court of the State of California for the County of San Bernardino, entitled "Chino Basin Municipal Water District v. City of Chino *et al.*" (originally Case No. SCV 164327, the file was transferred August 1989 by order of the Court and assigned Case No. RCV 51010). The CBWM records groundwater production and recharge, collects assessments, assesses over-producers to buy replenishment water and recharges that water into the Chino Basin, accounts for storage and transactions among Parties, performs certain administrative functions, and supervises the implementation of the Optimum Basin Management Program.

The Chino Basin Judgment resulted from studies and discussions that began in the early 1970s and continued for several years. The Judgment numerically defined the Safe Yield of the Chino Basin as 140,000 afy, and it was allocated among the three producer pools: (1) overlying agricultural pool (82,800 afy), (2) overlying non-agricultural pool (7,366 afy), and (3) appropriative pool (49,834 afy). Pursuant to the Chino Basin Optimum Basin Management Program Implementation Plan, CBWM is

required to recalculate the Safe Yield every ten years starting in 2011. The 2021 Safe Yield was recalculated as 131,000 afy (WEI, 2020).

The overlying Agricultural Pool consists of all overlying producers that produce groundwater for uses other than industrial or commercial and the State of California. The Overlying Non-Agricultural Pool consists of overlying producers that produce groundwater for industrial and commercial uses. The Appropriative Pool consists of owners of appropriative rights. All Parties were assigned to a pool when the Judgment was entered. The City of Pomona is an Appropriative Pool party.

A fundamental premise of the Chino Basin Judgment is that it allows all Chino Basin water users to pump sufficient water from the basin to meet their requirements. To the extent that a party's groundwater pumping exceeds its share of the Safe Yield, assessments are levied by the CBWM, and the CBWM uses these assessments to purchase supplemental water to replace overproduction. The Judgment also provides that any subsequent change in the Safe Yield shall be debited or credited to the Appropriative Pool parties, meaning that if the CBWM determines that the Safe Yield has changed, the change would be exclusively debited or credited to members of the Appropriative Pool and the rights allocated to the other pools and their respective parties would remain unchanged.

In addition to each appropriator party's share of the Safe Yield, the following additional production rights are allocated by the CBWM:

- Annual transfers of unproduced water from the overlying Agricultural Pool
- Transfers of rights from an overlying Agricultural Pool when the agricultural land used by a party is converted to another land use, requiring service by an Appropriative Pool party
- New yield from new stormwater recharge
- Recycled water recharged by the Inland Empire Utilities Agency, credited according to each appropriator's percent contribution of total wastewater sent to the Inland Empire Utilities Agency.

Appropriative Pool parties can store unused production rights in the basin, and they may also sell unused water rights and/or water in storage to each other and to the CBWM.

The reliability of Chino Basin groundwater supplies is certain due to the Judgment requirement to replenish production in excess of the Safe Yield.

5.1.3.1.4 Puente Basin Groundwater

The Puente Basin is a small shallow basin that underlies the Puente Valley bound by the San Jose Hills to the north; the Spadra Basin to the east; the Puente Hills to the south; and the Main San Gabriel Basin to the west. The Puente Basin is one of three adjudicated sub-basins (Six Basins, Main San Gabriel Basin, and Puente Basin) that make up the DWR Bulletin 118 San Gabriel Groundwater Basin. Puente Basin groundwater is tributary to the Main San Gabriel Basin. The main sources of recharge to the Puente Basin are infiltration of precipitation and applied water on the valley floor and subsurface inflow from the Spadra Basin and the bounding bedrock hills.

Section 5

Projects and Management Actions to Achieve Sustainability



Groundwater produced from the basin is used primarily by municipalities for non-potables uses including supplemental water for recycled-water distribution systems. Puente Basin groundwater is non-potable due mainly to high concentrations of ~~total dissolved solids (TDS)~~, nitrates, and total ~~volatile organic compounds (VOCs)~~.

There are no barriers to groundwater flow between the Puente Basin and the Main San Gabriel Basin, but both basins are adjudicated and managed separately. In 1972, the Puente Narrows Agreement was developed and adopted between the Upper San Gabriel Valley Municipal Water District and the PBWA, a Joint Powers Authority between the Rowland Water District and WVWD to govern subsurface flow from the Puente Basin to the Main San Gabriel Basin. The agreement requires an average Base Underflow of 580 afy from the Puente Basin to the Main San Gabriel Basin. Any quantity above the Base Underflow is credited to PBWA, and any quantity less than the Base Underflow is a debit from PBWA.

Pumping rights for the Puente Basin were adjudicated in 1986 through a Judgment entered in the Superior Court of the State of California for the County of Los Angeles, entitled "*Puente Basin Water Agency, a joint powers agency, et. al vs. City of Industry, a municipal corporation, et al.*" (Case No. C 369 220). The Judgment prescribes a physical solution for the management of the Puente Basin and provisions of the Judgment are managed and administered by the court-ordered Puente Basin Watermaster which consists of: one appointee nominated by WVWD and Rowland Water District; one appointee nominated by the City of Industry and Industry Urban Development Agency; and one appointee nominated jointly by the first two Watermaster appointees.

The Puente Basin Judgment declares a Safe Yield of 4,400 afy, however the basin is managed on an OSY determined annually by the Puente Basin Watermaster. Pursuant to the Judgment, the Puente Basin Watermaster determines an OSY for the succeeding five years on an annual basis. The OSY is equally divided in an Annual Pumping Right for four Principal Pumpers in the basin, WVWD, Rowland Water District, City of Industry, and the Successor Agency to Industry Urban Development Agency. Pumping in excess of the Annual Pumping Right is categorized two ways:

- Allowable Excess Pumping - which is up to ten percent of the Pumper's share of the OSY.
- Unauthorized Excess Pumping - which is charged against production for the following year and may be subject to remedies as deemed appropriate by the Court.

In addition to each Party's share of the OSY, the following additional production rights are provided by the Judgment:

- Return Flow Credits for imported waters (both imported water from Metropolitan or recycled water from LACSD) delivered and applied for use on lands overlying the Puente Basin. A Return Flow Credit is allocated to the Primary Pumpers who import and apply these waters in the Puente Basin that are in excess of the quantity imported in fiscal year 1984 to 1985. The Primary Pumpers are jointly issued a Return Flow Credit for use in the succeeding year. The Rowland Water District and WVWD are the Primary Pumpers who import and apply these waters in the Puente Basin.
- Carry Over Rights for underproduced rights. The portion of a Primary Pumper's OSY that is not pumped in a year can be carried over to the succeeding year. These Carry Over Rights are intitled to be used first in the succeeding year and will be lost if not used that year.

5.1.3.1.5 Central Basin Groundwater

Central Basin is approximately 227 square miles located in Los Angeles County and is a subbasin in the northeastern half of the DWR Bulletin 118 Coastal Plain of Los Angeles Groundwater Basin in Los Angeles County. The other subbasin of the Coastal Plain of Los Angeles Groundwater Basin is the West Coast Basin which is separated from the Central Basin by the Newport Inglewood fault system. The Elysian, Repetto, Merced, and Puente Hills bound it on the northeast and east. The Orange County Basin is the southeastern boundary along Coyote Creek. The concrete-lined Los Angeles, Rio Hondo, and San Gabriel Rivers flow over the surface of the Central Basin on their way to the Pacific Ocean. Natural replenishment of groundwater in the basin occurs mainly from surface flow and underflow through Whittier Narrows from the San Gabriel Valley. Intentional replenishment is done through the capture and spreading of the Rio Hondo and San Gabriel River Spreading Grounds at the Montebello Forebay. A portion of the surface water that is captured and recharged at these spreading grounds is recycled water from the Pomona Water Reclamation Plant (WRP) discharged to San Jose Creek in the Spadra Basin.

The Water Replenishment District (WRD) was formed in 1959 to manage the artificial recharge in both the Central and West Coast Basins for groundwater replenishment to reduce overdraft that had occurred historically. The Central Basin was adjudicated with the adoption of the Judgment in 1965 (Central and West Basin Water Replenishment District vs. Charles E. Adams et al, Los Angeles County Superior Court Case No. 786,656), and court appointed the DWR as the Watermaster. The 1965 adjudicated pumping rights were set at 267,900 afy, and the amounts of the rights that could be pumped each year were limited to 80 percent of the total adjudicated amount, or 217,367 afy. In the years following adjudication, groundwater levels rebounded, and overdraft was halted. In 2013, a third amendment to the Central Basin Judgment was entered by the Los Angeles Superior Court transferring duties from DWR to a new Watermaster composed of three bodies: the Water Rights Panel, the Administrative Body, and the Storage Panel. The Water Rights Panel is made up of seven Central Basin water rights holders, the Administrative Body consists of WRD, and the Storage Panel consists of the Water Rights Panel and WRD.

There are about 130 Parties to the Central Basin Judgment with Allowed Pumping Allocation in the Central Basin, mostly consisting of public utilities companies, cities and other water public and private water suppliers, but also including school districts, individuals, family trusts, landowners, businesses, religious institutions, cemeteries, nurseries, country clubs, and golf courses. In addition to each Party's Allowed Pumping Allocation, the following provisions are provided for in the Judgment:

- Storage of water in the basin for Parties with water rights upon approval of the Storage Panel.
- Transfer of Allowed Pumping ~~Allowance~~ Allocation and stored water between Parties through sales and leases.
- One-year carryover of unused rights for use in the succeeding year up to the greater of: 1) 60 percent of their Allowed Pumping Allocation plus or minus any leases with flex or 20 af, whichever is more, less the amount of water in a Party's storage account; or 2) 20 percent of a Party's Allowed Pumping Allocation.
- Permitted over extractions up to 20 percent of a Parties Allowed Pumping Allocation.
- Option to purchase more water from an Exchange Pool if a Party estimates that their water requirements exceeds their supply for the year. A request to purchase water from the Exchange Pool must be done by April 1 of each year.

Generally, the groundwater quality in Central Basin is of high quality and suitable for potable uses.

5.1.3.1.6 Main San Gabriel Basin Groundwater

The Main San Gabriel Basin is a large basin bound by the San Gabriel Mountains to the north, the Raymond Basin on the northwest, the Puente Basin on the southeast, and the Central Basin on the south. The Main San Gabriel Basin covers most of the DWR Bulletin 118 San Gabriel Groundwater Basin. The storage capacity in the basin is estimated to be 10,438,000 af (Main San Gabriel Basin Watermaster, 2020). The major sources of natural recharge to the Basin are infiltration of rainfall on the valley floor and runoff from the nearby mountains. The Main San Gabriel Basin is the first of a series of basins to receive the benefit of mountain runoff, and the basin interacts hydrologically and institutionally with adjoining basins, including the Puente, Central, and West Coast Basins. The San Gabriel River and Rio Hondo River flow over the Main San Gabriel Basin and out through the Whitter Narrows to the Central Basin. Recharge of supplemental imported water at spreading basins is managed by the Main San Gabriel Watermaster for intentional replenishment of the basin. Storm water is diverted to spreading basins in coordination with the County of Los Angeles Department of Public Works for groundwater replenishment in coordination with replenishment of ~~the~~ other supplemental water.

The water demand in the Main San Gabriel Basin is satisfied 85 percent by the local groundwater and another 5 percent from other local supplies (recycled and surface water) (Main San Gabriel Watermaster, 2020). Imported water from the State Water Project (SWP) used in the basin is supplied by three member agencies of Metropolitan: TVMWD, Upper San Gabriel Valley Municipal Water District, and San Gabriel Valley Municipal Water District¹.

Due to a need to guarantee a defined amount of water to downstream Central and West Coast Basin, the Main San Gabriel Basin was adjudicated in 1973 through a stipulated Judgment “Upper San Gabriel Valley Municipal Water District vs. City of Alhambra, et al. in the Superior Court of California for the County of Los Angeles, Case No. 924128”. The Main San Gabriel Basin Judgment defined the water rights of 190 original parties, created the Main San Gabriel Basin Watermaster as the governing body, and described a physical solution for the management of water in the basin and adjudicates both groundwater and surface water rights. Since the Judgment was originally entered, there have been subsequent amendments to it that extend and clarify Watermaster's role. Two other Judgments acknowledged in the Main San Gabriel Basin adjudication include: the 1965 Long Beach Judgment which guarantees an average of 98,000 afy of flow through the Whitter Narrows from Main San Gabriel Basin to the Central and West Coasts Basins; and the Puente Narrows Agreement described above that guarantees an average of 580 afy from the Puente Basin to Main San Gabriel Basin.

The Main San Gabriel Watermaster is a nine-person board comprised of six individuals elected by the pumpers and three nominated by the retail water agencies. The Main San Gabriel Watermaster manages and controls the withdrawal of groundwater and surface water, coordinates water deliveries and recharge in the basin, and raises replenishment water revenue by means of assessments and acquires and recharges replacement water.

¹ The San Gabriel Valley Municipal Water District is a direct State Water Project Contractor, and the TVMWD and Upper San Gabriel Valley Municipal Water District are Metropolitan Member Agencies.

The Main San Gabriel Basin Judgment determined the natural safe yield of the basin to be 152,700 af based on the 1967 conditions. The Judgment requires that an OSY be redefined on a yearly basis by the Main San Gabriel Basin Watermaster. The OSY is the amount of groundwater that can be pumped in a year without Replacement Water Assessments. The fiscal year 2019-2020 OSY was 150,000 af. Pumpers can pump in excess of their annual pumping right but must pay. And unproduced groundwater right can be carried over for use in the subsequent year. Any entity that wishes to spread or store supplemental water within the basin for later extraction can do so with a cyclic storage agreement with the Watermaster that has a five-year term. Over the past five years, production in the Main San Gabriel Basin ranged from about 200,000 afy to 189,000 afy (Main San Gabriel Basin Watermaster, 2020).

In 1991 Watermaster was authorized to recharge of up to 30,000 afy of recycled water as supplemental water, and in 2012 was authorized to develop a Resources Development Assessment to purchase about 40,000 afy of untreated imported water to be stored in the Main San Gabriel Basin for an emergency reserve in the event untreated imported water was not available to satisfy a replacement water obligation and to supplement the lack of stormwater replenishment during drought conditions.

5.1.3.1.7 San Antonio Creek Surface Water

The San Antonio Creek Watershed originates in the San Gabriel Mountains and generally flows from north to south towards the Six Basins. The San Antonio Dam at the edge of the mountains was constructed in 1956 by the United States Army Core of Engineers (USACE) for flood control and water conservation purposes. The drainage area behind the dam is about 26 square miles. The SASG resides directly below the dam and is about 980 acres of land where surface water released from the dam can be recharged in the Six Basins. The San Antonio Channel below the Dam is concrete-lined.

The surface water rights of San Antonio Creek from the San Antonio Canyon were assigned in the early 1900s are generally described as:

- About 60 percent of the flow in San Antonio Creek is diverted by San Antonio Water Company (SAWCo).
- About 40 percent of the flow in San Antonio Creek is diverted by the City of Pomona
- All flow in the San Antonio Creek that is not diverted by SAWCo or Pomona is available to the PVPA for diversion and recharge at the SASG.

Most of the surface water runoff generated in the San Antonio Creek watershed enters a “60/40” splitter box where the flow is split and diverted to SAWCo and Pomona conveyance facilities.

Water diverted by SAWCo is used for potable and non-potable uses and is also used for recharge at the SASG and/or at spreading grounds in the Cucamonga Basin. Surface flows diverted at the 60/40 splitter box are directed to the San Antonio Tunnel Ponds or south of the dam to the distribution systems of SAWCo and the City of Upland (the majority shareholder of SAWCo). Water diverted to the Tunnel Ponds percolates into underground “tunnels” that direct flow under the dam and are discharged into the San Antonio’s potable distribution system. Surface flows that bypass the Tunnel Ponds are either sent to SAWCo’s non-potable distribution system or to the San Antonio Canyon Treatment Plant where flows are treated before entering the City of Upland’s potable distribution system. Over the last ten years (2010-2019), SAWCo has diverted about 1,050 to 7,700 afy for potable and non-potable reuse.

Water diverted by Pomona at the 60/40 splitter box is combined with surface-water flows diverted from Evey Canyon and flows by gravity in a shallow underground pipeline called the Canon Pipeline to Pomona's Pedley Treatment Plant, where the water is treated and served for direct potable use. The Pedley Treatment Plant is located adjacent to the Pedley Spreading Grounds. The surface water diverted to the Canon Pipeline generally exceeds the treatment capacity of the Pedley Treatment Plant, so surplus water is recharged at the SASG or the Pedley Spreading Grounds. Over the last ten years (2010-2019) Pomona has diverted between 1,000 to 4,300 afy for direct potable use.

Runoff from the San Antonio Creek watershed that is in excess of what can be used by SAWCo and the City of Pomona is captured behind the San Antonio Dam. The PVPA works with the USACE to coordinate releases from the dam for diversion and recharge at the SASG. Surface water releases from the dam that are not diverted for recharge at the SASG are discharged to the concreted-lined San Antonio Channel where it flows south across Six Basins and Chino Basin. The outflow from San Antonio Dam varies significantly between wet and dry years and range from 0 afy during dry years to up to 60,000 afy in very wet years. On average about 60 percent of the surface water discharged from the dam is diverted for recharge at SASG and about 40 percent is discharged to San Antonio Creek.

5.1.3.1.8 Imported Water

Imported water is available to the Spadra Basin water purveyors from the TVMWD, a member agency of Metropolitan. Metropolitan is a consortium of 26 cities and water districts that provide drinking water to about 19 million people in parts of Los Angeles, Orange, Riverside, San Bernardino, and Ventura Counties—a service area of about 5,200 square miles. Metropolitan currently delivers about two million afy of imported water to its service area from the State Water Project (SWP) and the Colorado River.

The TVMWD was established in 1950 as a wholesale water agency that supplies imported water to the cities and communities in the Pomona, Walnut, and San Gabriel Valleys of Los Angeles County, including the Cities of Claremont, Covina (including the areas of Charter Oak and Covina Knolls), Diamond Bar, Glendora, Industry, La Verne, Pomona, Rowland Heights, San Dimas, Walnut, and West Covina. The TVMWD serves imported water to its member agencies from the Metropolitan's Weymouth Water Treatment Plant (Weymouth WTP) or from its Miramar Water Treatment Plant (Miramar WTP).

The Weymouth WTP can deliver up to 520 million gallons of potable water per day to customers in Los Angeles and Orange Counties. Most of the water treated at Weymouth originates from the Colorado River, with a small amount originating from the SWP. The three water purveyors in the Spadra Basin (Pomona, WVWD, and CPP) are all member agencies of TVMWD and all receive water from the Weymouth WTP via the Pomona-Walnut-Rowland Joint Water Line.

The TVMWD operates the Miramar WTP, which is located at its headquarters in the City of Claremont. The Miramar WTP receives untreated SWP water from the MWDSC's Foothill Feeder and treats it for potable use. Water deliveries from the Miramar WTP are supplemented with Six Basins groundwater produced by the TVMWD. Currently, groundwater makes up about four percent of the total deliveries from the TVMWD's Miramar system. The City of La Verne and Golden State Water Company (for their Claremont and San Dimas systems) have a 50/50 share of the available water from the Miramar WTP, but they currently do not utilize the total water available. Excess water can be delivered to the City of Pomona,

WVWD, and Rowland Water District on an interruptible basis.

The ability of the TVMWD to meet its member agencies' water demands is dependent on Metropolitan's ability to deliver water. Although the Metropolitan continues to face ongoing water-supply challenges for both the SWP and Colorado River systems, through the implementation of programs to increase the reliability of local water supplies in Southern California (e.g. conjunctive use, conservation, water shortage planning, transfer and storage programs, tiered water rates, etc.), Metropolitan predicts it will be able to meet its overall system demands through 2040 (Metropolitan, 2016; TVMWD, 2016; Civiltec Engineering, 2011a; City of Upland, 2011; Kennedy/Jenks, 2011; RMC, 2011a).

From 2002 through 2007, Metropolitan's average rates increased by about six percent per year. From 2007-2012, Metropolitan's average water rates increased by about ten percent per year. And from 2012 through 2016, Metropolitan's average water rates increased by about two or three percent per year. In 2017 Metropolitan's average water rates increased by 11 percent and from 2018 to 2020 increased from three to five percent per year. Metropolitan's full-service untreated Tier 1 rate for 2021 is \$777 per acre-foot. Metropolitan is projecting a rate increase of three percent by 2022 (Metropolitan, 2020).

A brief summary of the imported water supply challenges on the SWP and Colorado River is provided below.

State Water Project. The SWP is owned by the State of California and operated by the DWR. The SWP transports Feather River water, stored in and released from Lake Oroville, and unregulated flows diverted directly from the Delta south via the California Aqueduct to the Metropolitan service area (Metropolitan, 2016). In the Antelope Valley, the California Aqueduct divides into the East and West Branches. The East Branch carries water to Silverwood Lake and Lake Perris. From Silverwood Lake, SWP water is conveyed to the San Bernardino area at the Devil Canyon Afterbay. Metropolitan supplies SWP water to the TVMWD area from its Foothill Feeder Pipeline, which starts at the Devil Canyon Afterbay and traverses westward toward Los Angeles. In a 100-percent allocation year, based on their contract, the DWR will provide Metropolitan with a maximum of 1,911,500 af of SWP water (Table A amount) (DWR, 2020).

In August 2020, the DWR published the Final State Water Project Delivery Capability Report for 2019 (California DWR, 2020). This report updates the DWR's estimate of current (2019) and future (2040) SWP water delivery reliability. The report is produced every two years as part of a settlement agreement that was signed in 2003. The 2019 report shows that current and future SWP deliveries will be impacted by two significant factors: [i1](#) a significant restriction on the SWP and Central Valley Project (CVP) Delta pumping, as required by the biological opinions issued by the United States Fish and Wildlife Service (December 2008) and the National Marine Fisheries Service (June 2009); and [ii2](#) climate change, which is altering hydrologic conditions in Delta and throughout the State. In addition to concerns over climate and environmental issues, the 2019 report indicates that the continued subsidence of Delta islands, many of which that are already below sea level, are a threat to a catastrophic levee failure as water pressure increases on the fragile levee system that is used to convey water from the Sacramento River to the Harvey O. Banks pumping station.

This levee system is also threatened by earthquakes and floods. Should a major levee failure occur, SWP water exports from the Delta could be interrupted for several years (WEI, 2012). The report emphasizes the "need for local agencies to develop resilient and robust water sources and infrastructure to maximize the efficient use of a variable water supply" (California DWR, 2014).

Colorado River. The Colorado River was Metropolitan’s original source of imported water when the agency was established in 1928. Metropolitan constructed the Colorado River Aqueduct (CRA) to transport water from Lake Havasu, located at the border of Arizona and California, to Southern California. The CRA is 242 miles long and terminates at Lake Mathews in Riverside County. The capacity of the CRA is 1.2 million afy. Metropolitan has a legal entitlement to receive water from the Colorado River under a permanent service contract with the United States. Secretary of the Interior (Metropolitan, 2016).

The Colorado River is managed and operated under numerous federal laws, compacts, decrees, contracts, court decisions, and regulatory guidelines that are collectively referred to by the United States Bureau of Reclamation (USBR) as The Law of the River. The Colorado River Compact of 1922 apportioned 15 million afy of water between the seven states: 7.5 million afy was apportioned to the upper basin states of Colorado, New Mexico, Utah, and Wyoming, and 7.5 million afy was apportioned to the lower basin states of Arizona, California and Nevada. The Boulder Canyon Project Act of 1928 divided the lower basin’s 7.5 million afy between the three states, of which 4.4 million afy was allocated to California (USBR, 2008). The California Seven Party Agreement of 1931 set the basis for priorities among California contractors to utilize the State’s 4.4 million afy allocation. Of this, Metropolitan has a fourth priority right to 550,000 afy, a fifth priority right to an additional 662,000 afy and a right of up to 180,000 afy when surplus flows are available (Metropolitan, 2016). For many years, California contractors utilized more than their 4.4 million afy limit, but as population and water demands began to grow in Arizona and Nevada, California was eventually required to cut back use to the agreed upon 4.4 million afy apportionment (USBR, 2008). Many years of court battles, some of which are still not resolved, ensued within California as contractors struggled to secure their respective rights that were not all clearly defined in the 1931 Seven Party Agreement. Metropolitan now has a firm supply of 550,000 afy of Colorado River water. To increase its allocation, Metropolitan has developed a multitude of conservation, storage, and transfer programs with various parties inside and outside of California (Metropolitan, 2016).

Metropolitan’s Colorado River supplies also face other threats to reliability, including a long-term drought that has greatly reduced storage on the river system; costly pest control programs and a loss of operational flexibility due to the spread of invasive quagga mussels throughout the CRA distribution system; the management of high salinity levels, which require that river water be blended with lower-salinity SWP water to meet regulatory limitations for TDS concentrations in many of the Metropolitan service areas; other water quality concerns related to uranium, perchlorate, and hexavalent chromium; and climate change (Metropolitan, 2016).

5.1.3.1.9 Recycled Water

Domestic and commercial wastewater originating in the Spadra Basin and a portion of the Six Basins is treated by the LACSD at the Pomona WRP. Recycled water from the Pomona WRP is the available source of recycled water for reuse in the Spadra Basin. The Pomona WRP has a treatment capacity of up to 15 million gallons per day (mgd). Currently, flows vary from 4 mgd to 15 mgd and average about 9 mgd. The LACSD has agreements to deliver up to one-third of its recycled water available from the Pomona WRP to the WVWD² and the remaining two-thirds to the City of Pomona (Carollo Engineers, 2009). Based on this agreement and the average plant production, the amount of recycled water available to the WVWD is about 3,360 afy and the amount available to Pomona is 6,720 afy. A portion of Pomona’s

² A small portion of the one-third of recycled water flow sent to WVWD is used at the LACSD Spadra Landfill and purchased directly by CPP for use at the university Land Lab located at the landfill.

recycled water is purchased directly by CPP Pomona for use at the university campus, the Forest Lawn Cemetery located just outside the City of Pomona boundary, and on agricultural lands.

Recycled water that is not utilized by the WVWD and Pomona is discharged to the concrete-lined South San Jose Creek channel. It flows in the channel to the San Gabriel River about 15 miles downstream where it is diverted for groundwater recharge at spreading grounds in the Montebello Forebay overlying the Central Basin. In ~~2018~~2020, approximately ~~45-50~~ percent of the recycled water from Pomona WRP was reused within the Spadra Basin and Puente Basin, and ~~55-50~~ percent was discharged to the South San Jose Creek channel ([Hartling, E., personal communication, 2022](#)~~LACSD, 2019~~).

5.1.3.2 Water Demands and Water-Supply Plans

A comprehensive data request was submitted to the three water purveyors in the Spadra Basin (Pomona, WVWD, and CPP) to collect water supply and demand plans for 2020 to 2070, including the well pumping plans for their Spadra Basin wells. The water purveyors were asked to provide projections of their demands and various water supplies to meet those demands for years: 2020, 2025, 2030, 2035, 2040, 2050, 2060, and 2070. These projections were reviewed, and follow-up with each water purveyor was done as necessary. For each water purveyor, their total demands must equal the sum of their various water supplies.

Table 5-1 summarizes the current (2019) and projected (2020 through 2070) total water demand and the water supplies for Pomona, WVWD, and CPP. The plans for each water purveyor are described below in more detail.

5.1.3.2.1 City of Pomona

Figure 5-3 is a stacked bar chart showing Pomona's historical (2010-2019) and projected (2020-2070) total water demands and water supplies by source. The water supplies available to Pomona include: groundwater from the Spadra Basin, Chino Basin, and Six Basins; imported water purchased from the TVMWD; recycled water from the Pomona WRP; and native surface water from San Antonio Creek.

Pomona's historical water demand from 2010 to 2019 averaged about 21,900 afy. During the last five years of that historical period (2015-2019), the total water demand declined to about 20,500 afy due to

water conservation measures required by the State of California to reduced urban water consumption 20 percent by 2020. Pomona expects water demands to increase to about 23,500 ~~acre-feet (af)~~ in 2020, and average about 23,700 afy over the planning period.

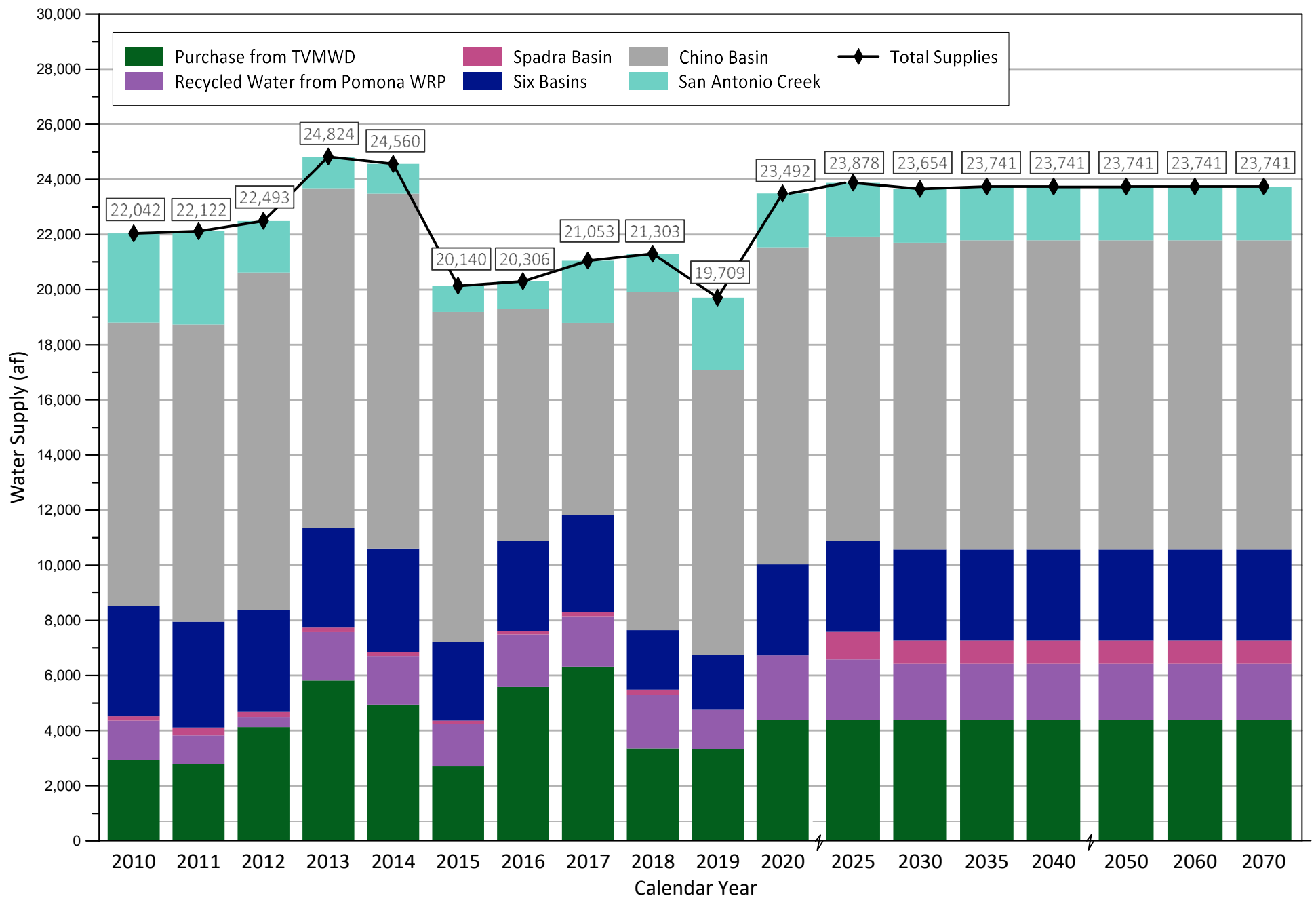
Historically, Pomona's water-supply plan has been to maximize the use of local potable supplies (Six Basins, Chino Basin, Spadra Basin, and surface water from San Antonio Creek) and local non-potable supplies (Spada Basin and recycled water), and purchase the balance from the TVMWD. Figure 5-3 shows that from 2010 to 2019, local water supplies satisfied about 81 percent of the total demand, and Pomona pumped an average of 150 afy of groundwater from the Spadra Basin as part of the local supplies.

Over the planning period, Pomona plans to continue to maximize the use of local supplies and purchase the balance from TVMWD to meet total demands. Figure 5-3 shows that from 2020-2070, local water supplies are projected to satisfy about 82 percent of the total demand, and that Pomona will pump about 850 afy of groundwater from the Spadra Basin as part of the local supplies.

Table 5-1. 2019 and Projected (2020-2070) Water Demand and Supply Plans of the Water Purveyors in the Spadra Basin

Agency	Year	Total Water Demand	Water Supply Sources Available to the Spadra Basin Agencies									
			Groundwater						Imported Water	Recycled Water	San Antonio Creek	Total Supply
			Spadra Basin	Other					Purchased from TVMWD	From the Pomona WRP		
				Six Basins	Chino Basin	Puente Basin	Main San Gabriel Basin	Central Basin				
City of Pomona	2019	19,708	0	1,984	10,348	-	-	-	3,331	1,431	2,614	19,708
	2020	23,492	0	3,300	11,509	-	-	-	4,390	2,343	1,950	23,492
	2025	23,878	1,000	3,300	11,045	-	-	-	4,390	2,193	1,950	23,878
	2030	23,654	845	3,300	11,131	-	-	-	4,390	2,038	1,950	23,654
	2035	23,741	845	3,300	11,218	-	-	-	4,390	2,038	1,950	23,741
	2040	23,741	845	3,300	11,218	-	-	-	4,390	2,038	1,950	23,741
	2050	23,741	845	3,300	11,218	-	-	-	4,390	2,038	1,950	23,741
	2060	23,741	845	3,300	11,218	-	-	-	4,390	2,038	1,950	23,741
	2070	23,741	845	3,300	11,218	-	-	-	4,390	2,038	1,950	23,741
Walnut Valley Water District	2019	17,595	53	0	-	662	0	0	15,795	1,085	-	17,595
	2020	21,191	110	0	-	1,359	0	0	17,518	2,204	-	21,191
	2025	21,007	105	625	-	1,291	2,500	2,000	12,393	2,093	-	21,007
	2030	21,007	105	625	-	1,291	2,500	2,000	12,393	2,093	-	21,007
	2035	21,007	105	625	-	1,291	2,500	2,000	12,393	2,093	-	21,007
	2040	21,007	105	625	-	1,291	2,500	2,000	12,393	2,093	-	21,007
	2050	21,007	105	625	-	1,291	2,500	2,000	12,393	2,093	-	21,007
	2060	21,007	105	625	-	1,291	2,500	2,000	12,393	2,093	-	21,007
	2070	21,007	105	625	-	1,291	2,500	2,000	12,393	2,093	-	21,007
Cal Poly Pomona	2019	1,824	735	-	-	-	-	-	105	984	-	1,824
	2020	1,621	591	-	-	-	-	-	118	911	-	1,621
	2025	1,860	817	-	-	-	-	-	43	1,000	-	1,860
	2030	1,865	856	-	-	-	-	-	9	1,000	-	1,865
	2035	1,865	856	-	-	-	-	-	9	1,000	-	1,865
	2040	1,865	856	-	-	-	-	-	9	1,000	-	1,865
	2050	1,865	856	-	-	-	-	-	9	1,000	-	1,865
	2060	1,865	856	-	-	-	-	-	9	1,000	-	1,865
	2070	1,865	856	-	-	-	-	-	9	1,000	-	1,865
Aggregate for all Agencies	2019	39,127	788	1,984	10,348	662	0	0	19,231	3,500	2,614	39,127
	2020	46,304	701	3,300	11,509	1,359	0	0	22,026	5,458	1,950	46,304
	2025	46,745	1,922	3,925	11,045	1,291	2,500	2,000	16,826	5,286	1,950	46,745
	2030	46,526	1,806	3,925	11,131	1,291	2,500	2,000	16,792	5,131	1,950	46,526
	2035	46,613	1,806	3,925	11,218	1,291	2,500	2,000	16,792	5,131	1,950	46,613
	2040	46,613	1,806	3,925	11,218	1,291	2,500	2,000	16,792	5,131	1,950	46,613
	2050	46,613	1,806	3,925	11,218	1,291	2,500	2,000	16,792	5,131	1,950	46,613
	2060	46,613	1,806	3,925	11,218	1,291	2,500	2,000	16,792	5,131	1,950	46,613
	2070	46,613	1,806	3,925	11,218	1,291	2,500	2,000	16,792	5,131	1,950	46,613

Figure 5-3. Historical and Projected Water Supplies for the City of Pomona



5.1.3.2.2 Walnut Valley Water District

Figure 5-4 is a stacked bar chart showing WVWD's historical (2010-2019) and projected (2020-2070) total water demands and water supplies by source. The water-supply sources available to the WVWD include: imported water purchased from the TVMWD; groundwater from the Spadra Basin, Puente Basin, Main San Gabriel Basin, Central Basin, and Six Basins; and recycled water from the Pomona WRP.

WVWD's historical water demand from 2010 to 2019 averaged about 20,800 afy. During the last five years of that historical period (2015-2019), the total water demand declined to about 19,200 afy due to water conservation measures required by the State of California to reduced urban water consumption 20 percent by 2020. WVWD expects water demands to increase to about 21,200 af in 2020, and average about 21,000 afy over the planning period.

Historically, WVWD's water-supply plan has been to use imported water purchased from TVMWD as the primary water supply for all the potable demands. Figure 5-4 shows that from 2010 to 2019, the imported water was on average 90 percent of the total water supply to meet all demands. The remaining ten percent are the local supplies of recycled water from Pomona WRP, Puente Basin groundwater, and Spadra Basin groundwater to meet non-potable demands. WVWD pumped an average of 71 afy of groundwater from the Spadra Basin as part of the local supplies.

Over the planning period, WVWD plans to diversity its local water-supply portfolio and increase its use of local supplies to decrease its reliance on imported water. To achieve this objective, WVWD has formed partnerships with neighboring water agencies to implement three different projects that will be operational before 2025:

- The Pomona Basin Regional Groundwater Project to deliver groundwater from the Six Basins via the Pomona-Walnut-Rowland Joint feeder line that delivers imported water to the region.
- The La Habra Heights County Water District project to deliver groundwater from Central Basin via a connection to the La Habra Heights County Water District distribution system.
- The California Domestic Water Company Pipeline and Pump Station Project to deliver stored imported water from the Main San Gabriel Basin via a connection to the California Domestic Water Company distribution system. Water delivered from this project comes from water acquired and stored by Puente Basin Water Agency PBWA and not additional groundwater pumping from in the Main San Gabriel Basin that is extracted by California Domestic Water Company on PBWA's behalf.

Figure 5-4 shows that from 2025-2070, local water supplies are projected to satisfy about 31 percent of the total demand, and that WVWD will pump about 105 afy of groundwater from the Spadra Basin as part of the local supplies.

5.1.3.2.3 California Polytechnic University Pomona

Figure 5-5 is a stacked bar chart showing CPP's historical (2010-2019) and projected (2020-2070) total water demands and water supplies by source. The CPP water demands include the potable and non-potable needs of the university and their agricultural lands on and off campus, and the needs of Forest Lawn Cemetery adjacent to the university. The water-supply sources available to CPP include: imported water purchased from the TVMWD; groundwater from the Spadra Basin; and recycled water from the Pomona WRP.

Figure 5-4. Historical and Projected Water Supplies for the City of Pomona for the Walnut Valley Water District

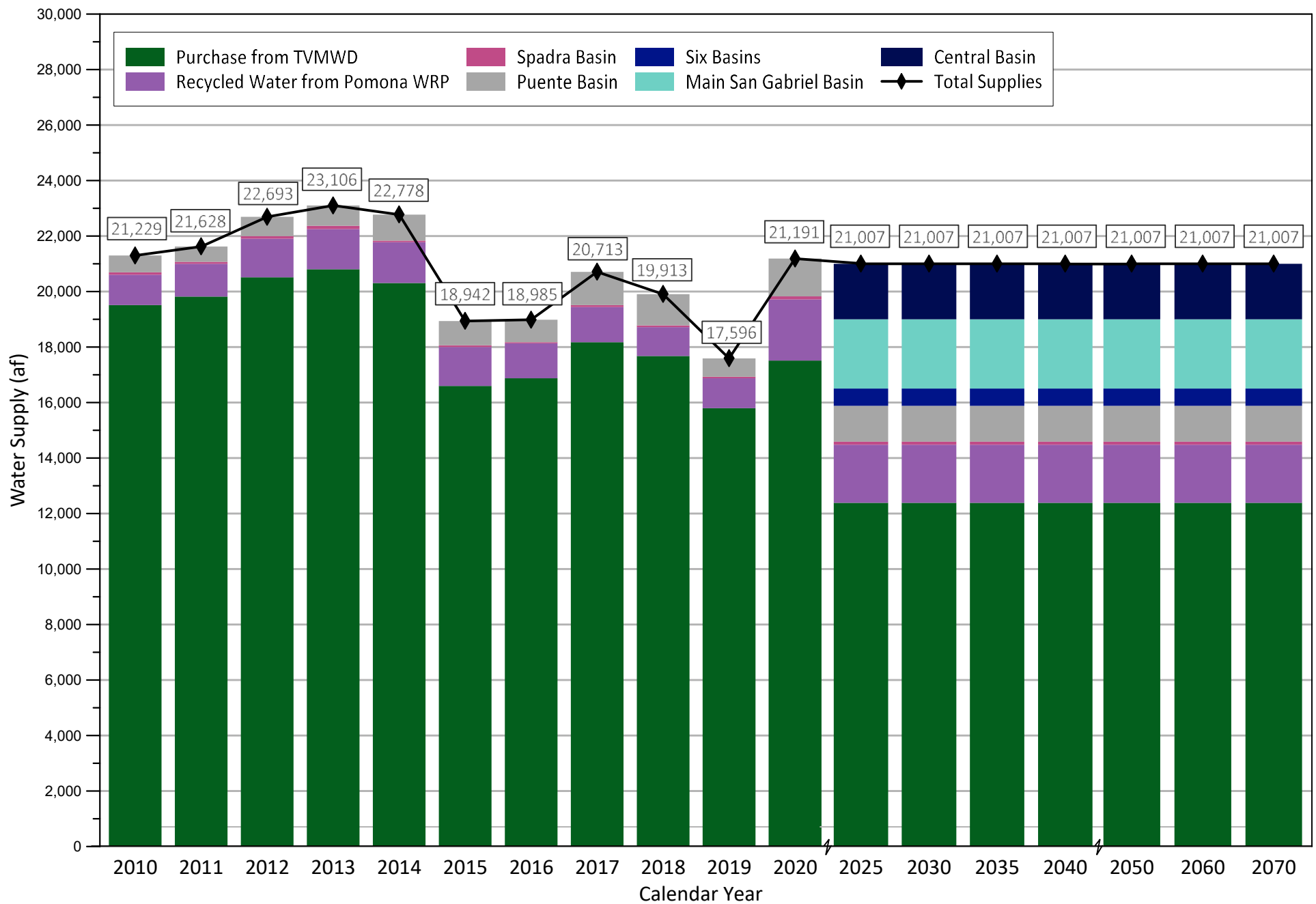
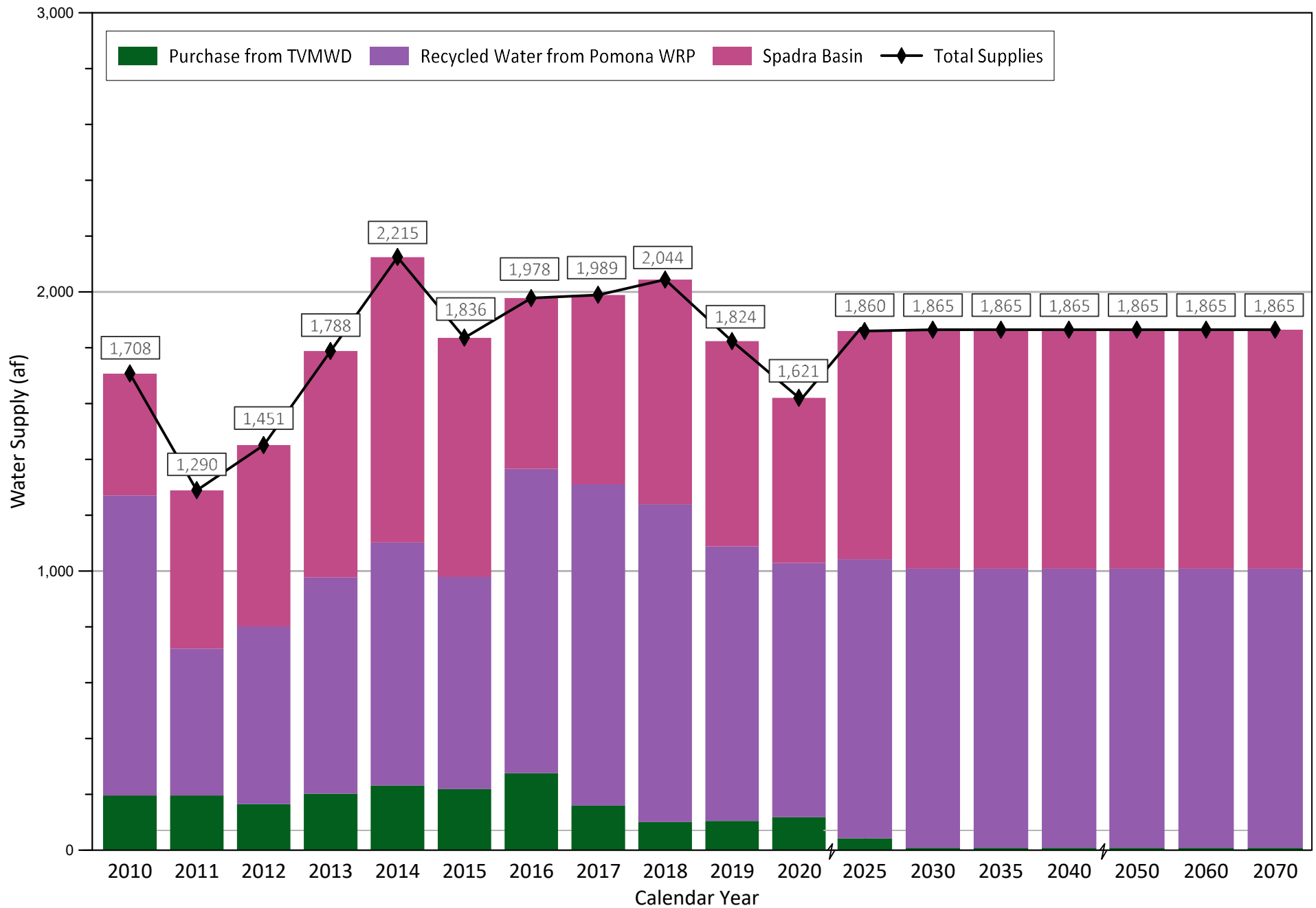


Figure 5-5. Historical and Projected Water Supplies for California State Polytechnic University of Pomona



CPP's historical water demand from 2010 to 2019 averaged 1,800 afy. CPP expects water demands to remain relatively stable at about 1,800 afy over the planning period.

Historically, CPP's water-supply plan has been to meet non-potable demands with recycled water from Pomona WRP and Spadra Basin groundwater. Potable demands have been met with imported water from TVMWD and Spadra Basin groundwater treated at an on-campus reverse osmosis plant. Figure 5-5 shows that from 2010 to 2019, local water supplies satisfied about 90 percent of the total demand, and CPP pumped an average of 700 afy of groundwater from the Spadra Basin as part of the local supplies.

Over the planning period, CPP plans to continue to maximize the use of recycled water and Spadra Basin groundwater and minimize its use of imported water from TVMWD. Figure 5-5 shows that from 2020- 2070, local water supplies are projected to satisfy about 99 percent of the total demand, and that CPP will pump about 850 afy of groundwater from the Spadra Basin as part of the local supplies.

5.1.3.3 Aggregate Water-Supply Plan for the Spadra Basin Pumping

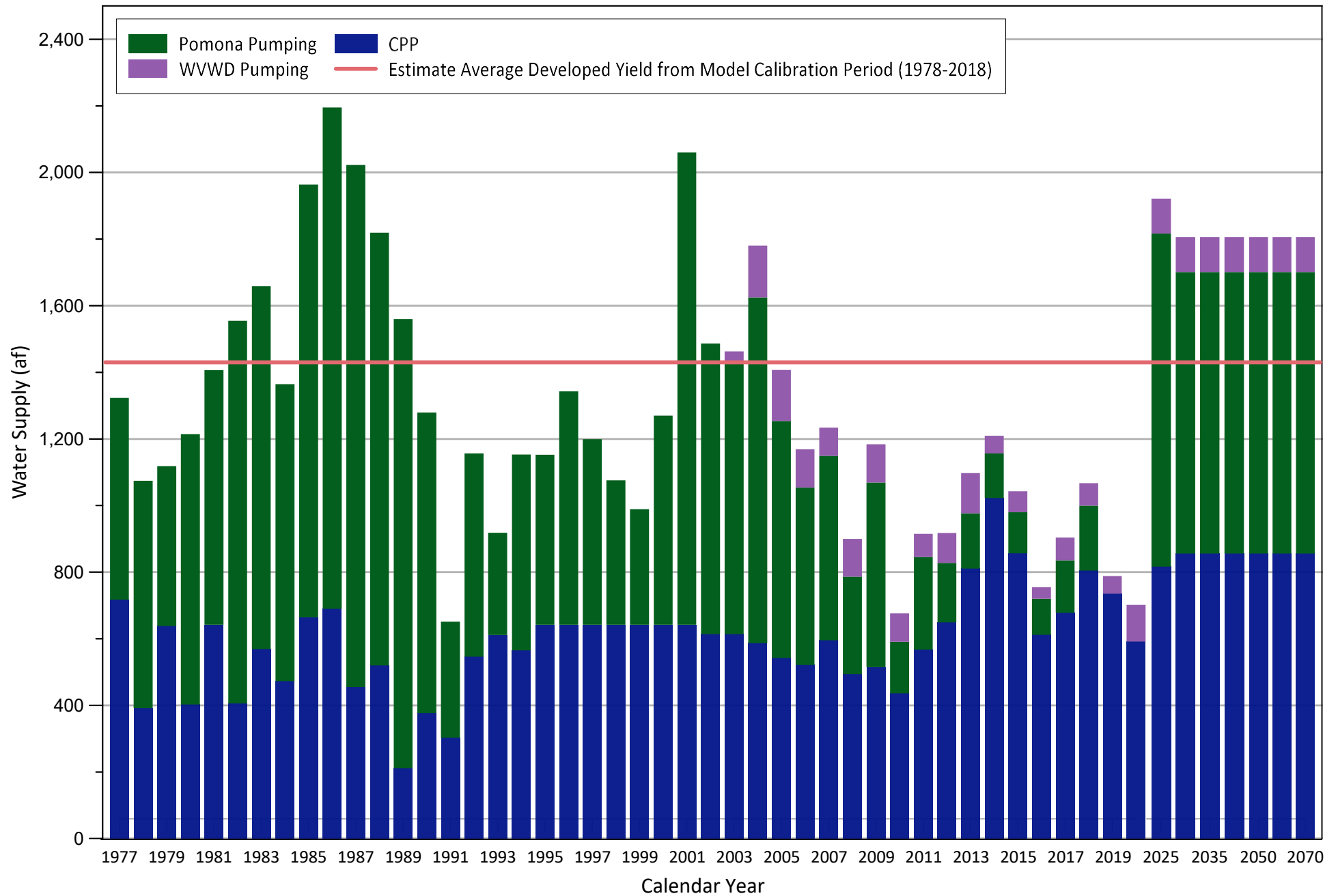
Table 5-1 summarizes the current (2019) and projected (2020 through 2070) total water demands and supplies for the Spadra Basin water purveyors, individually and in aggregate. Collectively, the total water demands of the Spadra Basin purveyors are projected to increase from 39,100 afy in 2019 to about 46,600 afy by 2035 and remain constant thereafter to 2070. The purveyors plan to meet the increase in demands with an increase in groundwater pumping from Spadra Basin and other local groundwater basins (Puente, Chino, Main San Gabriel, Central, and Six Basins). In aggregate, the Spadra Basin water purveyors plan to increase pumping from the Spadra Basin from about 800 afy in 2019 to about 1,800 afy by 2030, and that pumping will remain constant through 2070. While all purveyors plan to increase pumping from the Spadra Basin over the planning period, the City of Pomona's planned increase is the greatest because it plans to reactivate two production wells that pumped very little over the last ten years (2010-2019) compared to pumping during 1977-2009.

Figure 5-6 is a stacked bar chart showing the historical (1978-2019) and planned (2020-2070) groundwater pumping from the Spadra Basin for the water purveyors in the Spadra Basin. Also shown on this figure is the model-estimated average developed yield of 1,430 afy from 1978 to 2018 determined during calibration of the Spadra Basin groundwater-flow model (Table 2-7 and Appendix I). Pumping during the historical period (1978-2019) was on average about 160 afy less than the developed yield of the Basin. The planned pumping of about 1,800 afy from 2030 to 2070 is about 375 afy greater than the estimated developed yield for the historical period.

5.1.3.4 Groundwater Pumping

Figure 5-6 illustrates that total annual pumping from Spadra Basin during the Baseline Scenario begins at about 700 afy in 2020, increases to about 1,900 afy in 2025, and remains at about 1,800 afy from 2030 to 2070. These pumping projections compare to about 1,280 afy of average-annual pumping in the Spadra Basin that occurred over the long-term historical period of 1977-2018. The distribution of pumping by water purveyor in the Baseline Scenario is about: 50 percent by Pomona; 47 percent by CPP; and 3 percent by WVWD.

Figure 5-6. Historical and Projected Groundwater Pumping from the Spadra Basin - Baseline Scenario



The water supply and demand information collected from the Spadra Basin water purveyors included information on well utilization rates and schedules and the percentage of total potable and non-potable demands by month. This planning information, along with the planned pumping volumes by purveyor, were used to develop monthly estimates of pumping for the Baseline Scenario for the seven wells presumed active for the planning period.

For active wells outside of the Spadra Basin but within the CVM domain, the most recent planning projections for pumping in the Chino Basin, Six Basins, and Cucamonga Basin that was used in the 2020 recalculation of Safe Yield in the Chino Basin were assumed for the Baseline Scenario (WEI, 2020).

5.1.3.5 Artificial Recharge

There are no plans for artificial recharge in the Spadra Basin, and therefore, there is no artificial recharge included in the Baseline Scenario.

For artificial recharge that is planned to occur outside of the Spadra Basin but within the CVM domain, the most recent planning projections for artificial recharge in the Chino Basin, Six Basins, and Cucamonga Basin that were used in the 2020 recalculation of Safe Yield in the Chino Basin were assumed for the Baseline Scenario (WEI, 2020).

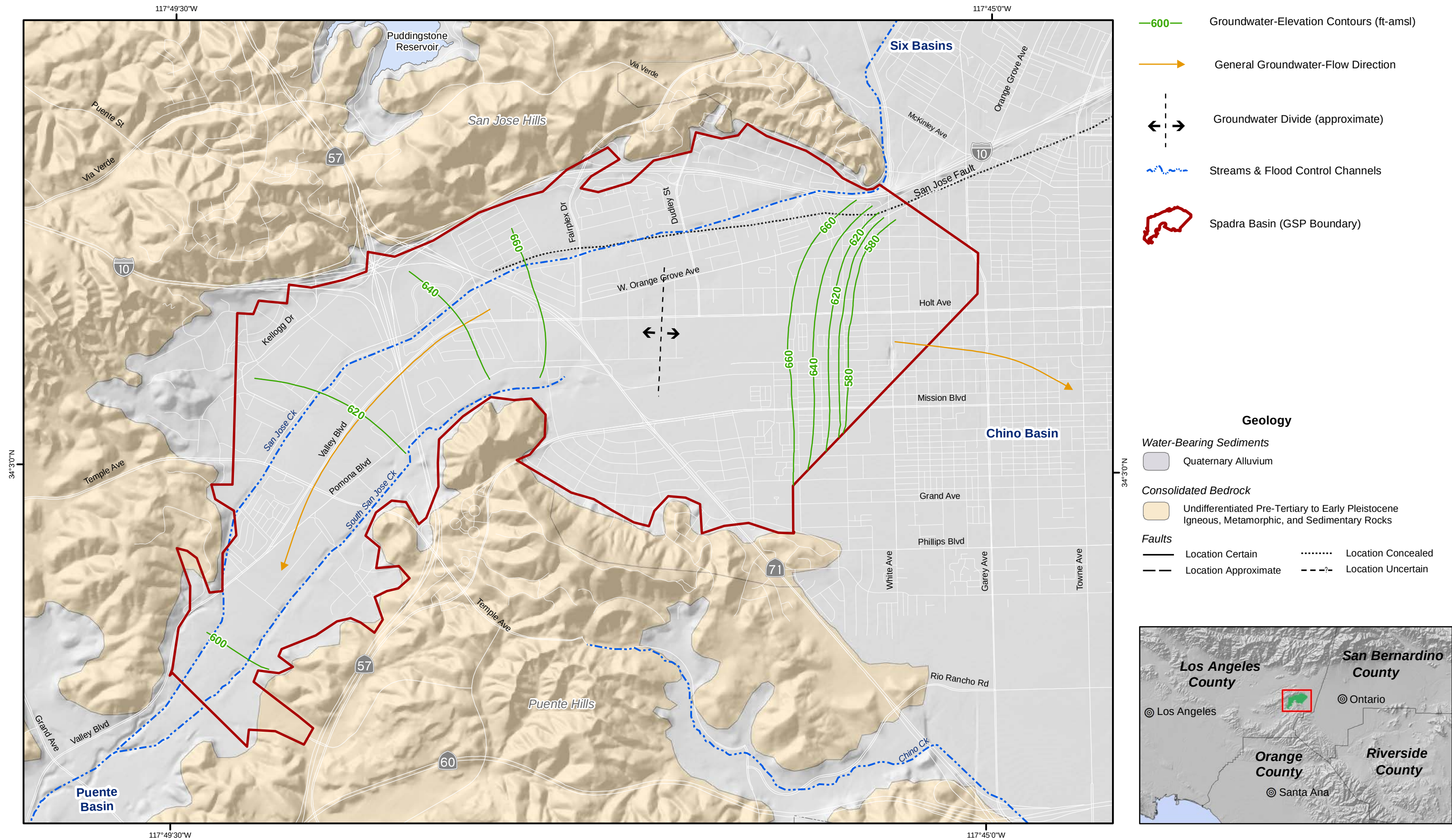
5.2 EVALUATION OF THE BASELINE SCENARIO

The Spadra Basin Groundwater Model was used to simulate the Baseline Scenario and estimate the response of the groundwater basin over the planning period, including: groundwater elevation and flow directions; pumping sustainability at wells; the water budget; basin storage; land subsidence; and the developed yield of the basin. The groundwater level Minimum Thresholds established for wells throughout the Basin in *Section 3 Sustainable Management Criteria* are used as a metric to assess the sustainability of the Baseline Scenario for the Sustainability Indicators of chronic lowering of groundwater levels, reduction of groundwater storage, and land subsidence.

5.2.1 Groundwater-Level Response

5.2.1.1 Groundwater Elevations and Groundwater-Flow Directions

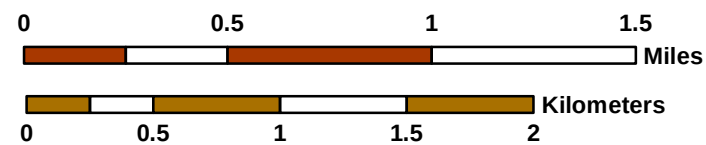
Figure 5-7 is a map showing model-predicted groundwater-elevation contours for July 2018, which represents the initial condition for groundwater elevations at the start of the planning period. The arrows on the map depict the general groundwater-flow directions across the Spadra Basin. There is a groundwater divide in the eastern portion of the basin where groundwater either flows east towards the Chino Basin or west towards the center of the Basin then to the southwest towards the Puente Basin. The location of the groundwater divide is transient and can shift depending on changes in groundwater levels in the Spadra Basin and/or the Chino Basin.



Prepared by:



Author: AP
Date: 12/22/2020
File: Figure 5-7_GWE_201807.mxd



Prepared for:
Spadra Basin Groundwater Sustainability Agency
Groundwater Sustainability Plan



Groundwater Elevation for Initial Conditions - July 2018

Figure 5-7

Section 5

Projects and Management Actions to Achieve Sustainability



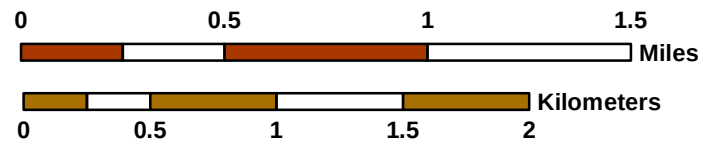
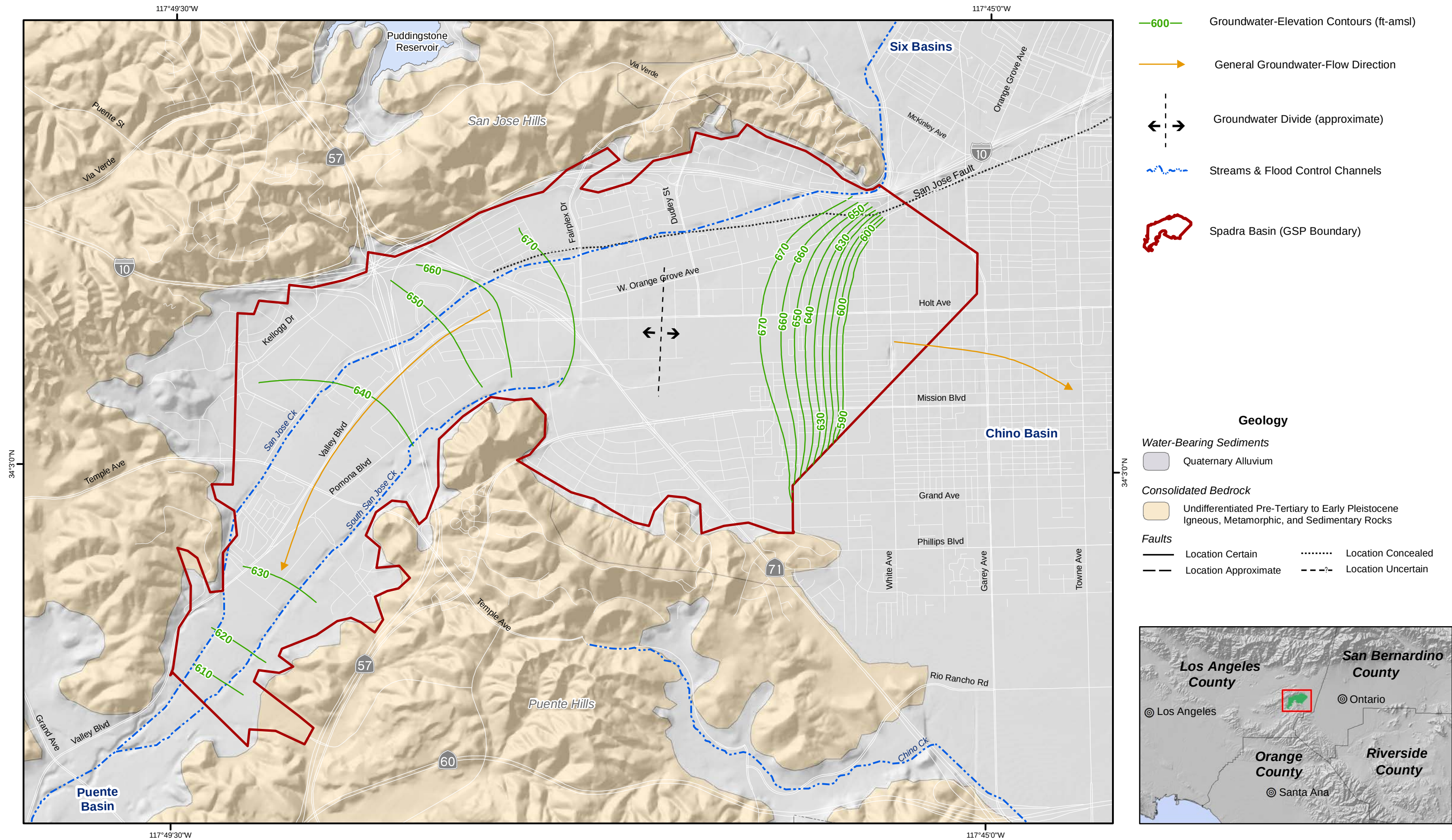
Model-predicted groundwater elevations were also mapped for the following years/conditions during the planning period for the Baseline Scenario:

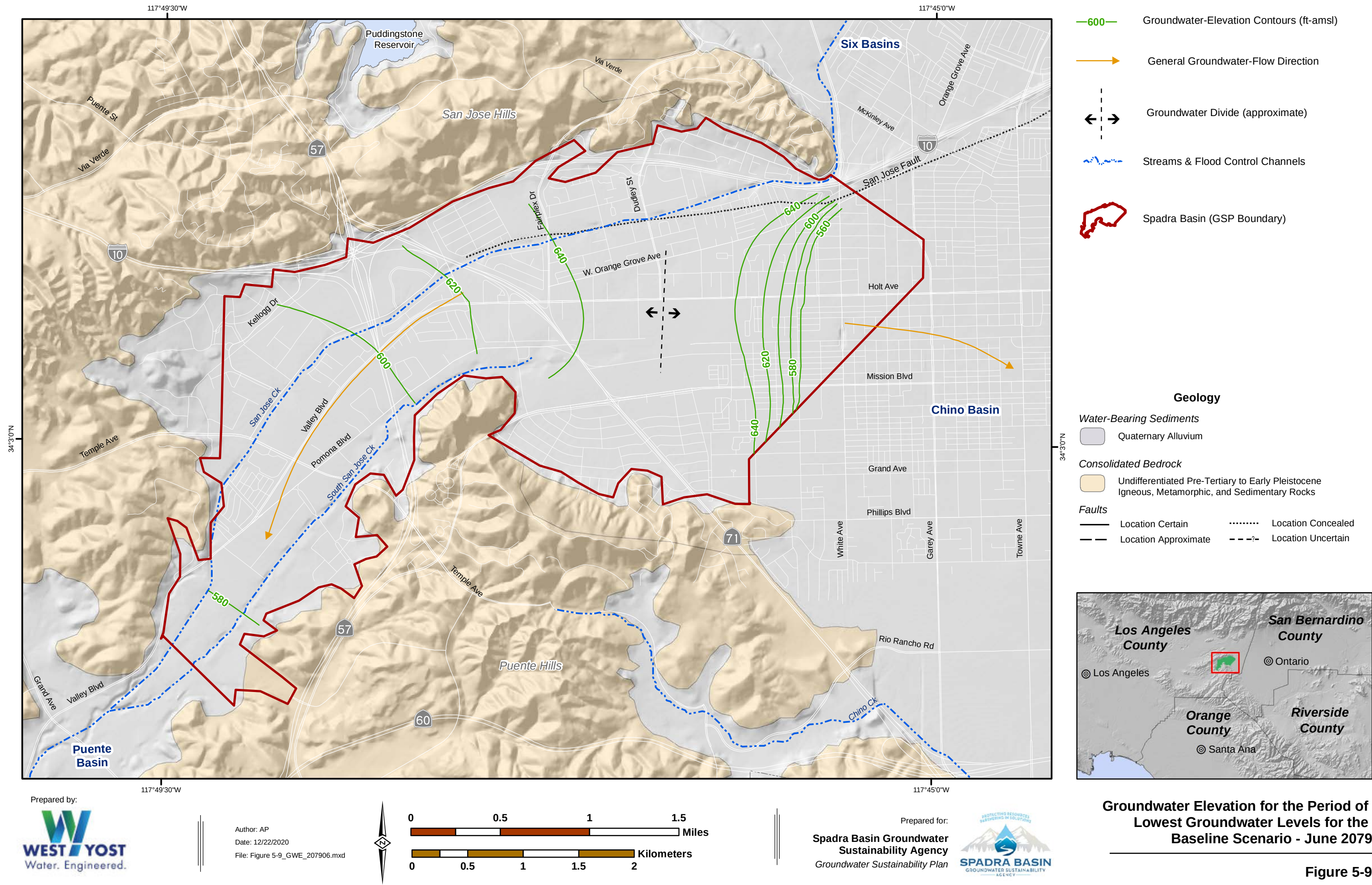
- July 2024 (Figure 5-8). The groundwater elevations shown in this figure represent the time during the planning period of the highest groundwater elevations across the Spadra Basin. Groundwater elevations across most of the Spadra Basin are about 15 ft higher compared to the initial condition (2018).
- June 2079 (Figure 5-9). The groundwater elevations shown in this figure represent the time during the planning period of lowest groundwater elevations in the Spadra Basin. This occurs at the end of the planning period. Groundwater elevations across the Spadra Basin are about 20 ft lower compared to the initial condition (2018).

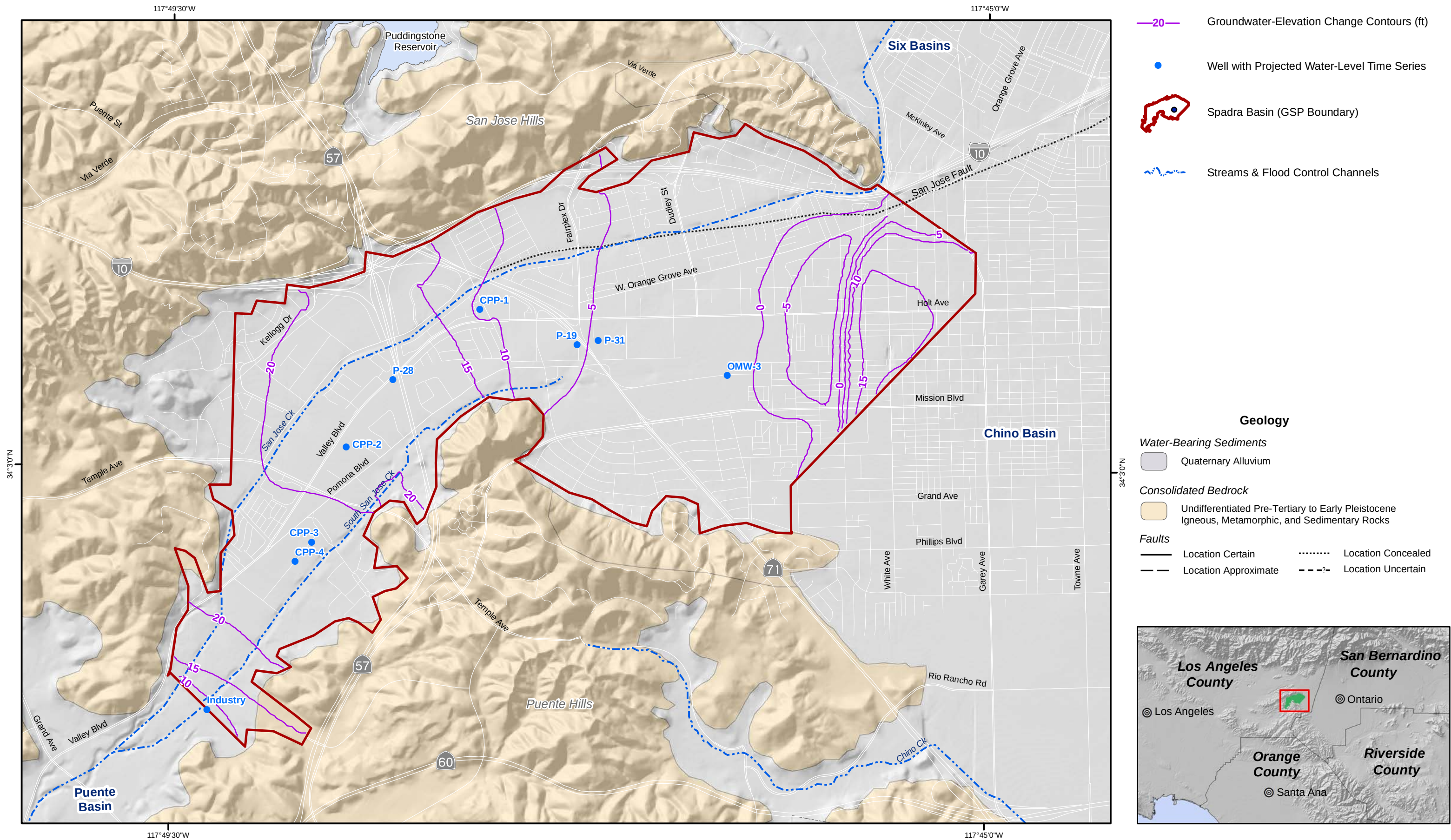
These figures show that in general, groundwater elevations are projected to change across the Spadra Basin over the planning period, but the shape and orientation of the groundwater-elevation contours and the location of the groundwater divide will not change, which indicates that the groundwater-flow patterns within the Spadra Basin are expected to remain consistent over time in the Baseline Scenario.

Figures 5-10 and 5-11 are maps that show the model-predicted change in groundwater elevations for the Baseline Scenario over two time periods:

- Figure 5-10 shows the model-predicted change in groundwater elevations for the initial condition (July 2018) to the time of highest groundwater elevations (July 2024). The map shows that groundwater elevations increased from 5-20 ft across most of the Spadra Basin.
- Figure 5-11 shows the model-projected change in groundwater elevations for the initial condition (July 2018) to the time of lowest groundwater elevations at the end of the planning period (July 2079). This figure shows that groundwater elevations declined during the planning period by about 20-25 ft across most of the basin.



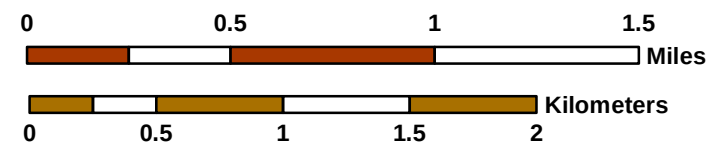




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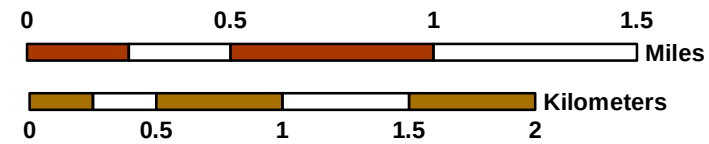
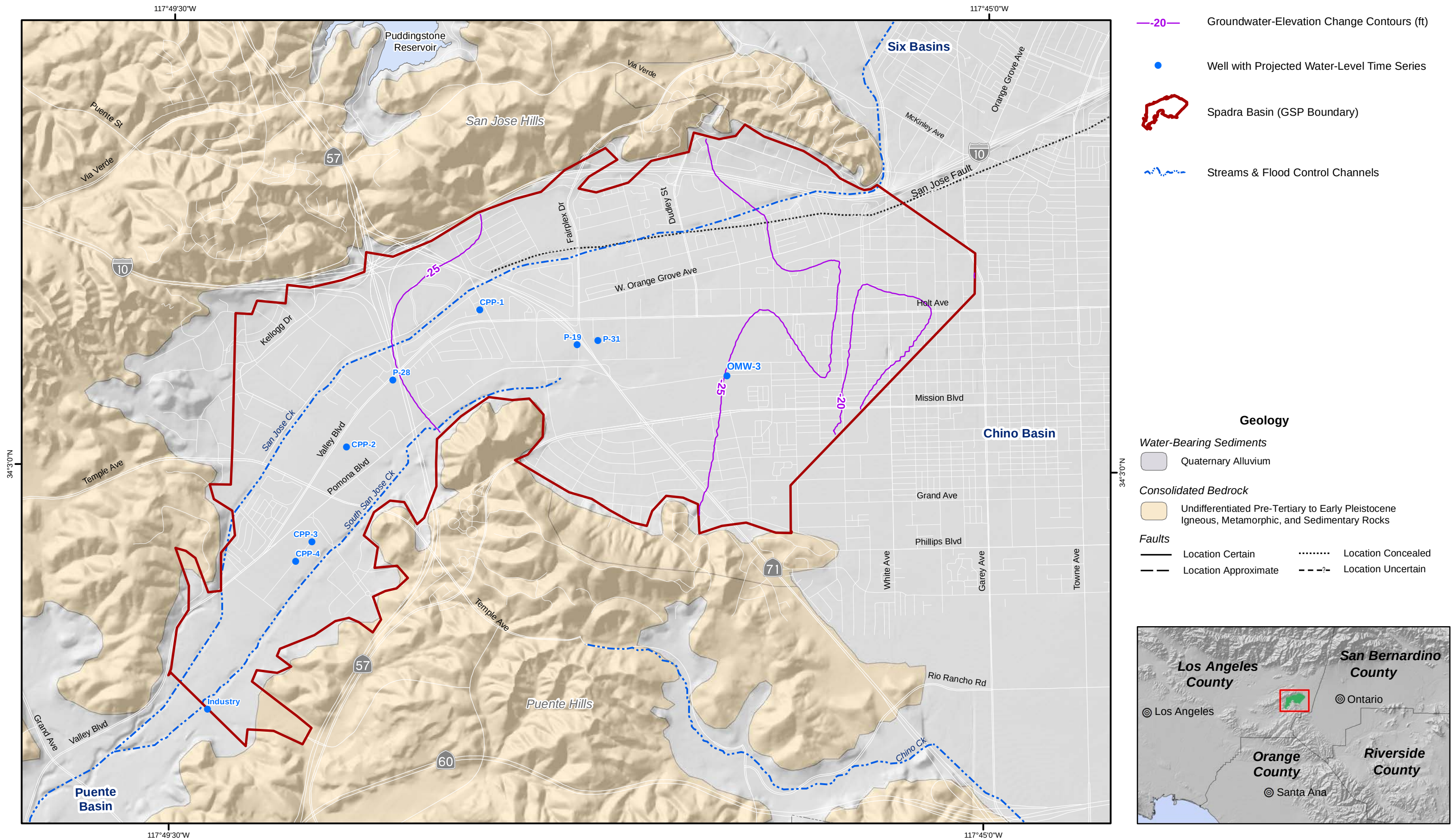


Prepared for:
Spadra Basin Groundwater Sustainability Agency
Groundwater Sustainability Plan



Groundwater-Level Change: Initial Condition vs. Highest Groundwater Levels - Baseline Scenario (July 2018 - June 2024)

Figure 5-10



5.2.1.2 Groundwater Elevations at Wells

Figures 5-10 and 5-11 also show the location of nine wells where time-series of the model-predicted groundwater elevations are analyzed in this section to evaluate the sustainability of the Baseline Scenario.

Figures 5-12a through 5-12i are time-series charts of projected groundwater elevations for the Baseline Scenario for nine wells in the Spadra Basin (see Figures 2-10 and 2-11). These nine wells are located throughout the Basin and include all active municipal pumping wells and/or representative monitoring wells where Sustainable Management Criteria have been established in *Section 3 Sustainable Management Criteria*. These time-series charts also show the: measured groundwater elevations; model-simulated groundwater elevations for the historical period 1978-2018; the Minimum Thresholds and Measurable Objectives for groundwater levels established in *Section 3 Sustainable Management Criteria* at representative wells; and the elevation of the top of the pump-bowl assembly and the “pumping sustainability metric” if applicable.

Figures 5-12a through 5-12i show that groundwater levels at all wells are predicted to increase from 2019 to 2024, and then decrease at declining rates through 2070. These trends in groundwater levels correspond to the relatively low rates of pumping during 2019-2024 followed by relatively high rates of pumping from 2025 through 2070. The sustainability of groundwater levels at wells is evaluated in two ways: comparison of groundwater elevations to the pumping sustainability metric for active pumping wells; and comparison of groundwater elevations to Minimum Thresholds and Measurable Objectives for groundwater levels for representative monitoring wells identified in *Section 3 Sustainable Management Criteria*.

5.2.1.2.1 Pumping Sustainability

The time-series charts in Figures 5-12a through 5-12i include a “pumping sustainability metric” for the active pumping wells. The pumping sustainability metric is the lowest water-level elevation that enables the well owner to produce groundwater at a desired pumping rate, given the well construction and pumping equipment. Groundwater pumping at a well is presumed to be sustainable if the water level at that well remains above the pumping sustainability metric. Information on the elevation of the pump-bowl assembly and the pumping sustainability metric was provided by the well owners for each well. The active pumping wells where these pumping sustainability metrics have been established include: Industry, CPP-4, CPP-2, P-28, CPP-1, and P-19. The pumping sustainability metric for one active well (CPP-3) is undetermined at this time.

Figures 5-12a through 5-12i show that groundwater levels for the Baseline Scenario decline to levels below the pumping sustainability metrics at three wells: Industry, CPP-4, and CPP-2. This indicates that pumping sustainability may be a challenge in the western half of the Spadra Basin for the Baseline Scenario.

5.2.1.2.2 Sustainable Management Criteria

Figures 5-12a through 5-12i include the Minimum Thresholds and Measurable Objectives established as Sustainable Management Criteria for groundwater levels at representative monitoring wells throughout the Spadra Basin. The Minimum Thresholds represent the groundwater level at a representative monitoring well that, when exceeded individually or in combination with Minimum Thresholds at other monitoring wells, may cause Undesirable Results in the basin. The avoidance of Undesirable Results is key to the success of a GSP. The Measurable Objectives are quantitative goals for the maintenance or improvement of groundwater conditions to achieve or maintain sustainability in the basin. These Minimum Thresholds and Measurable Objectives are also used as a proxy to assess the Sustainability Indicators of groundwater storage and land

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subsidence. The wells in Figure 2-12a through 2-12i where ~~the~~ The Minimum Thresholds and Measurable Objectives have been established are: Industry, CPP-4, P-28, CPP-1, P-19, and OMW-3.³

³ Well OMW-3 has Minimum Thresholds and Measurable Objectives but ~~has~~ was been excluded from this analysis because the model-predicted groundwater elevations cannot be used as this is an area of uncertainty identified during calibration of the Spadra Basin Groundwater Model.

Figure 5-12a. Historical and Projected Groundwater Elevations for the Baseline Scenario at Industry

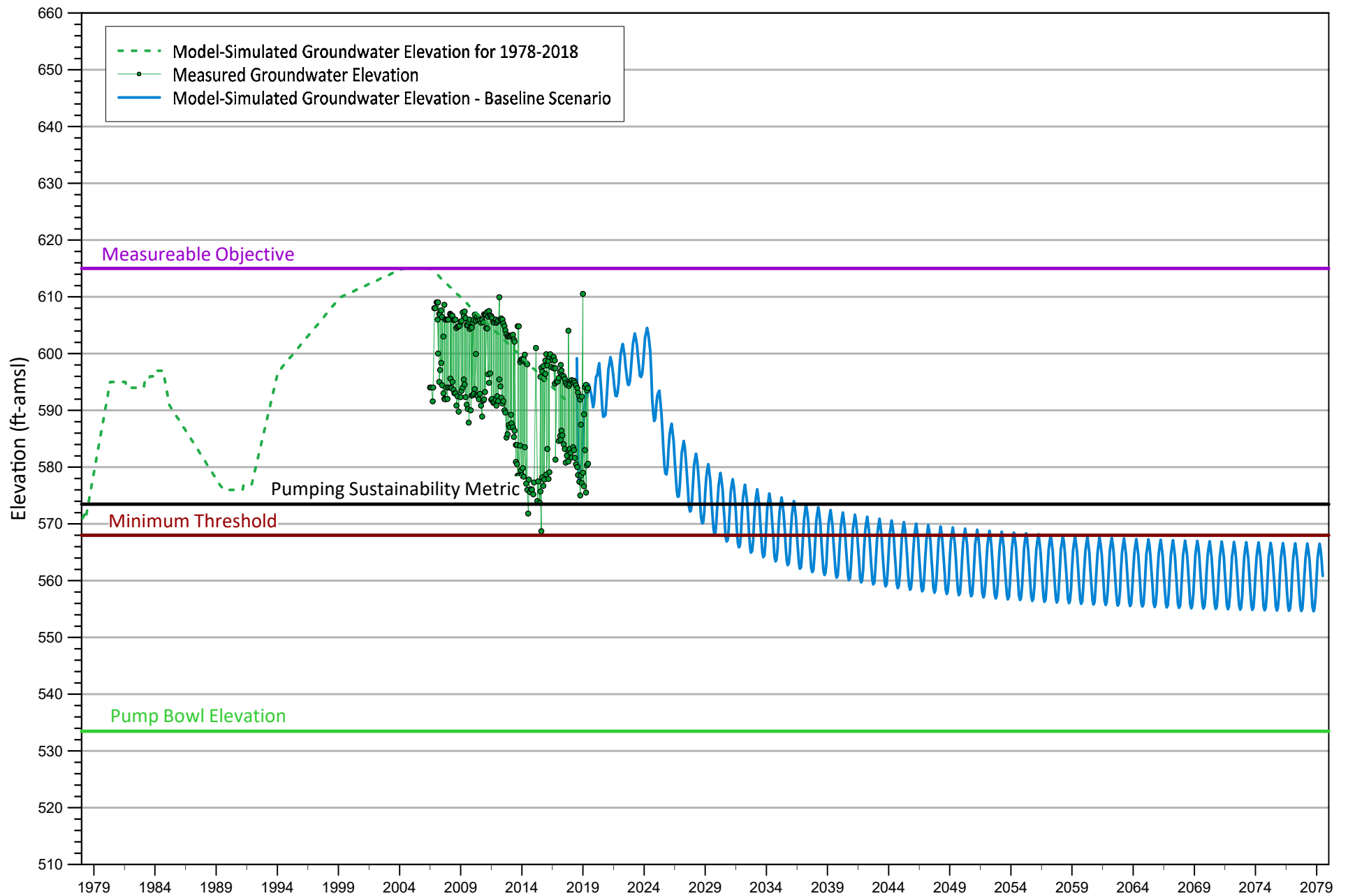


Figure 5-12b. Historical and Projected Groundwater Elevations for the Baseline Scenario at CPP-4

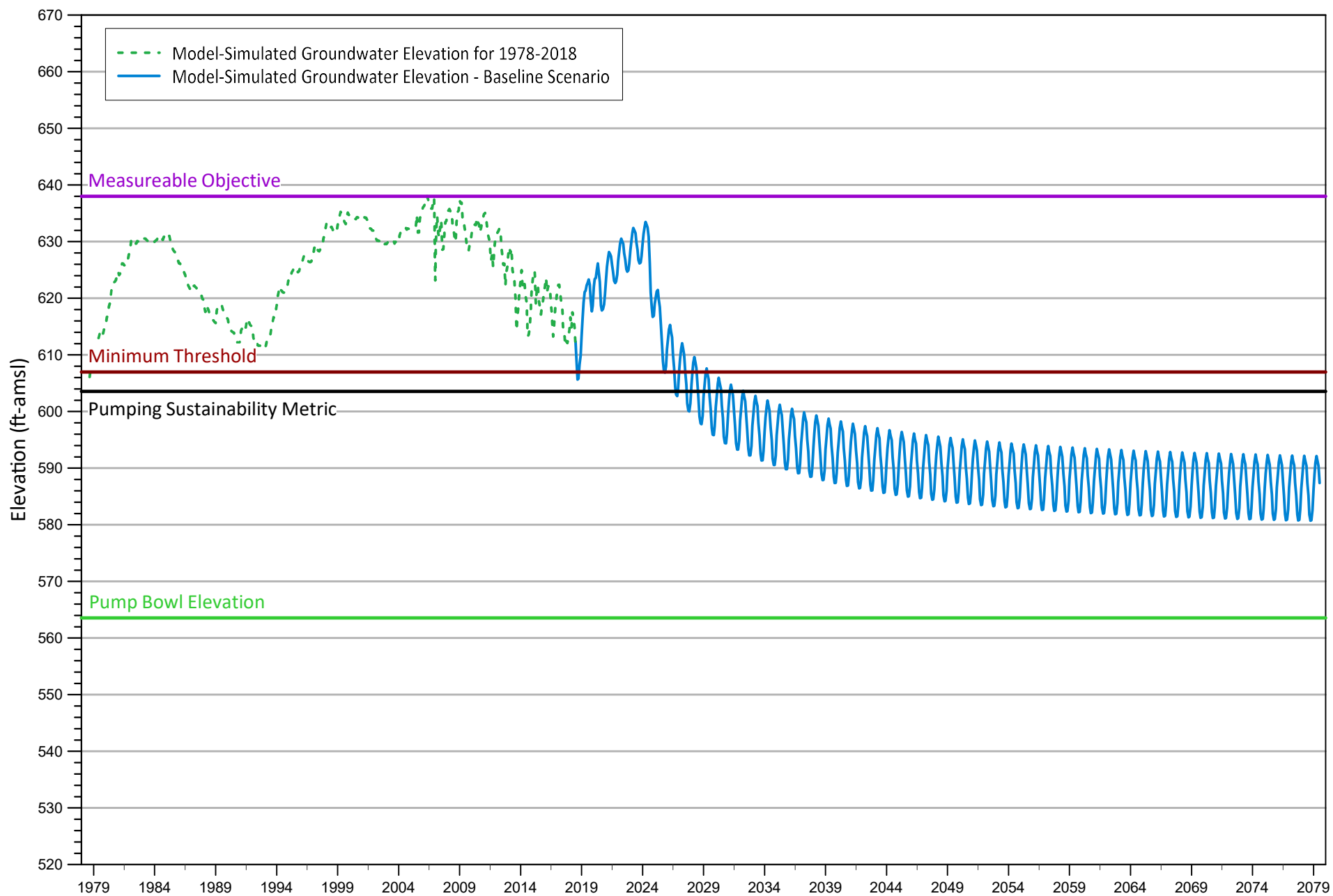


Figure 5-12c. Historical and Projected Groundwater Elevations for the Baseline Scenario at CPP- 3

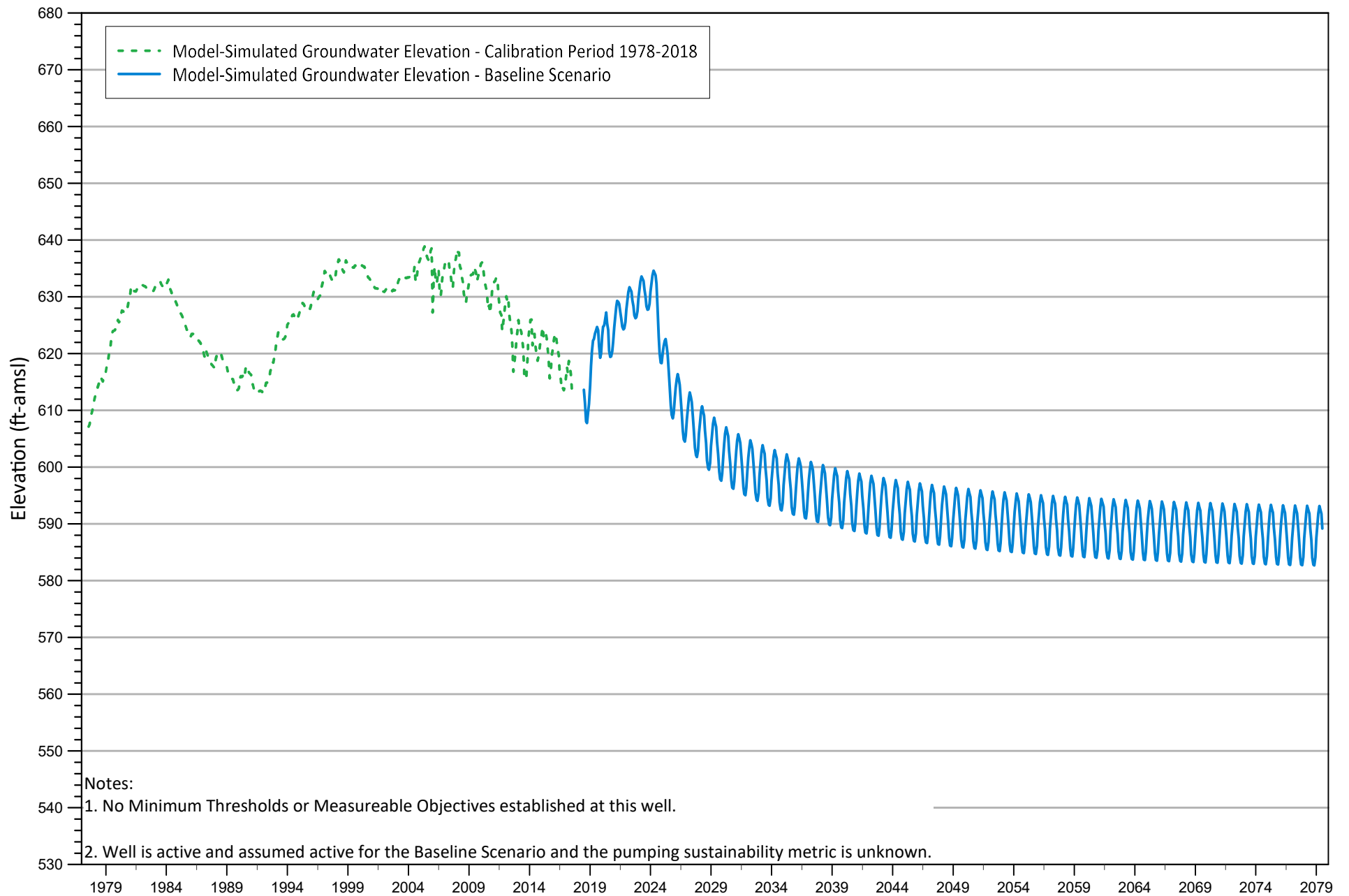


Figure 5-12d. Historical and Projected Groundwater Elevations for the Baseline Scenario at CPP-2

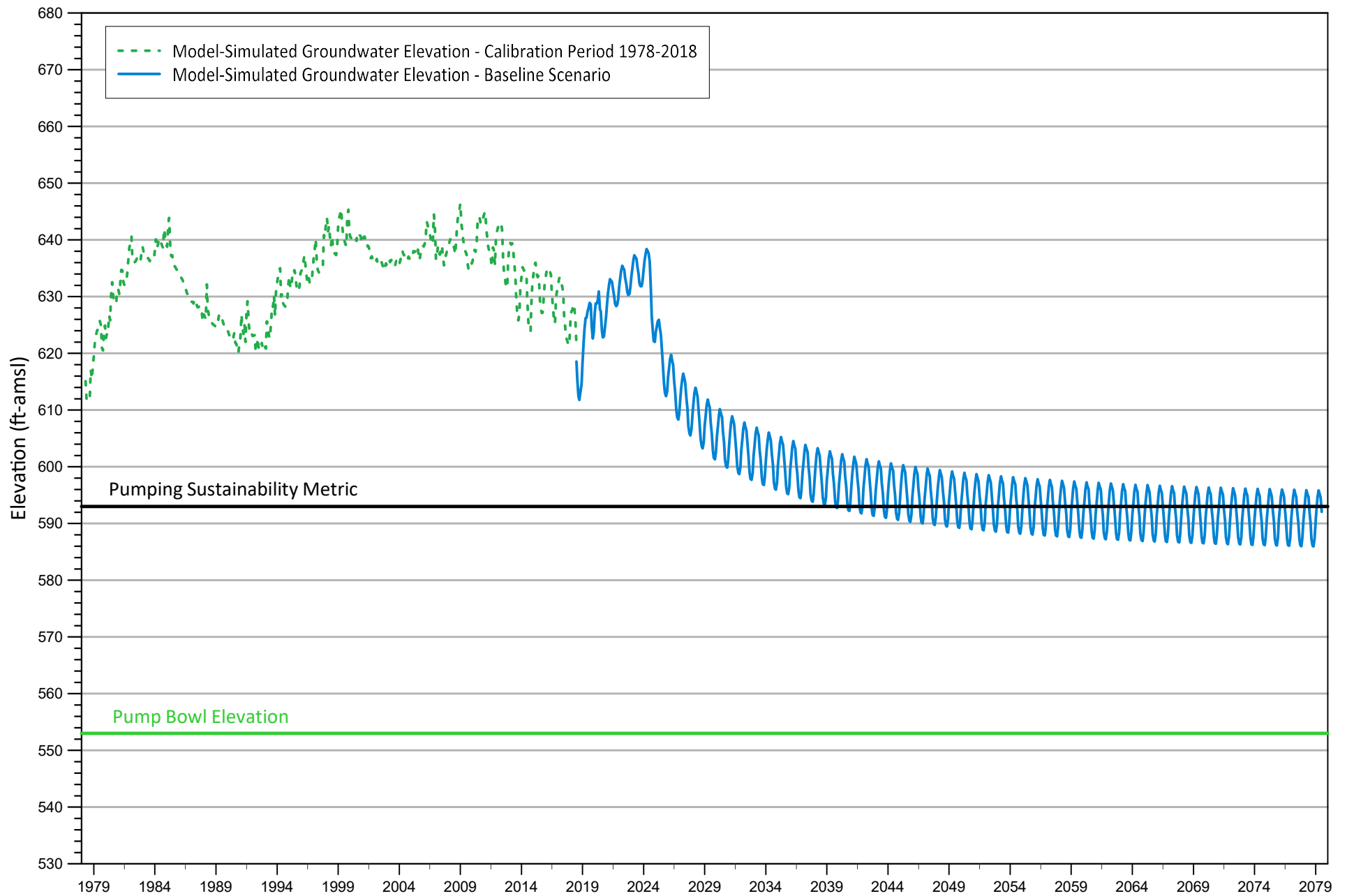


Figure 5-12e. Historical and Projected Groundwater Elevations for the Baseline Scenario at P-28

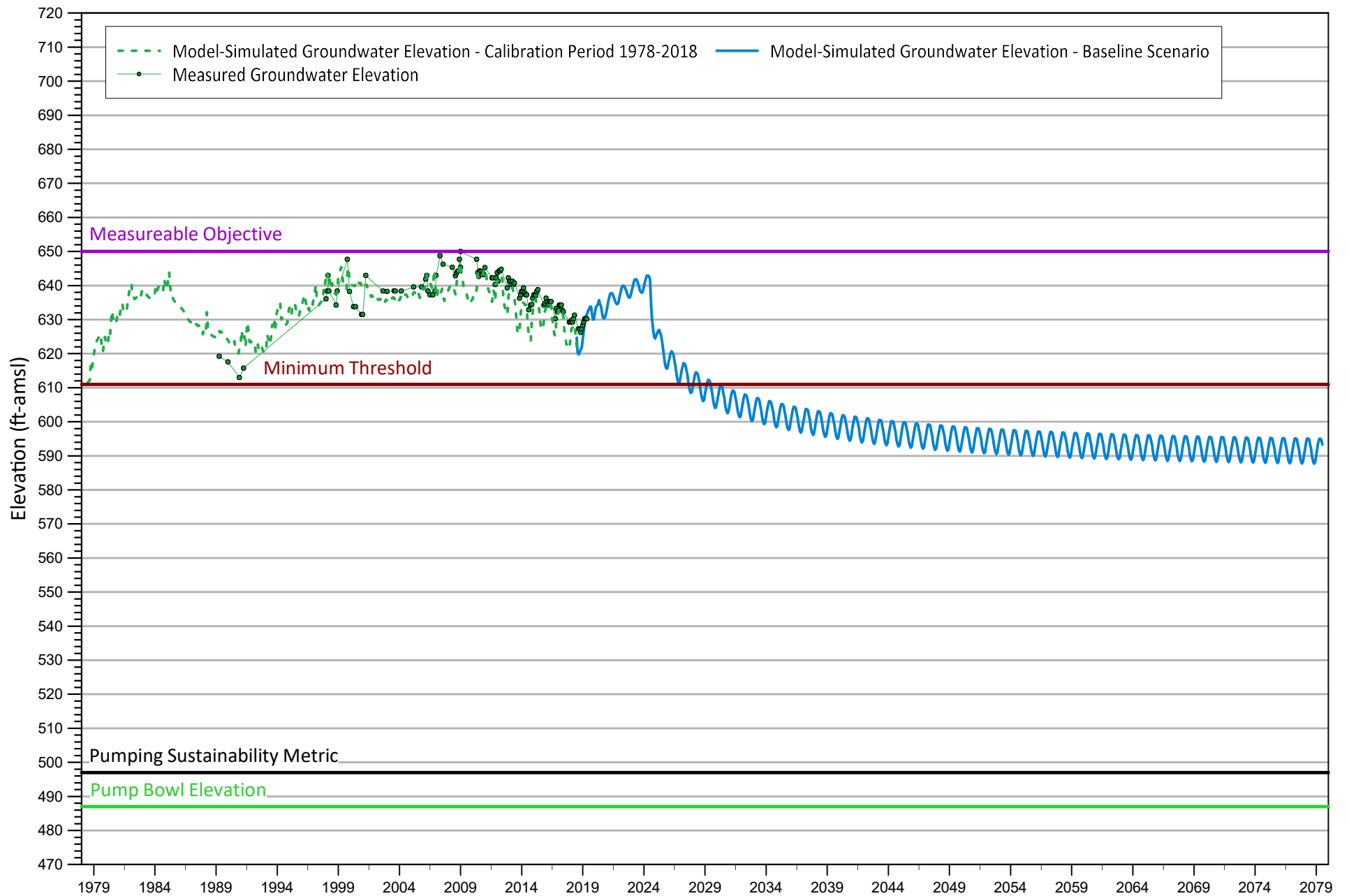


Figure 5-12f. Historical and Projected Groundwater Elevations for the Baseline Scenario at CPP-1

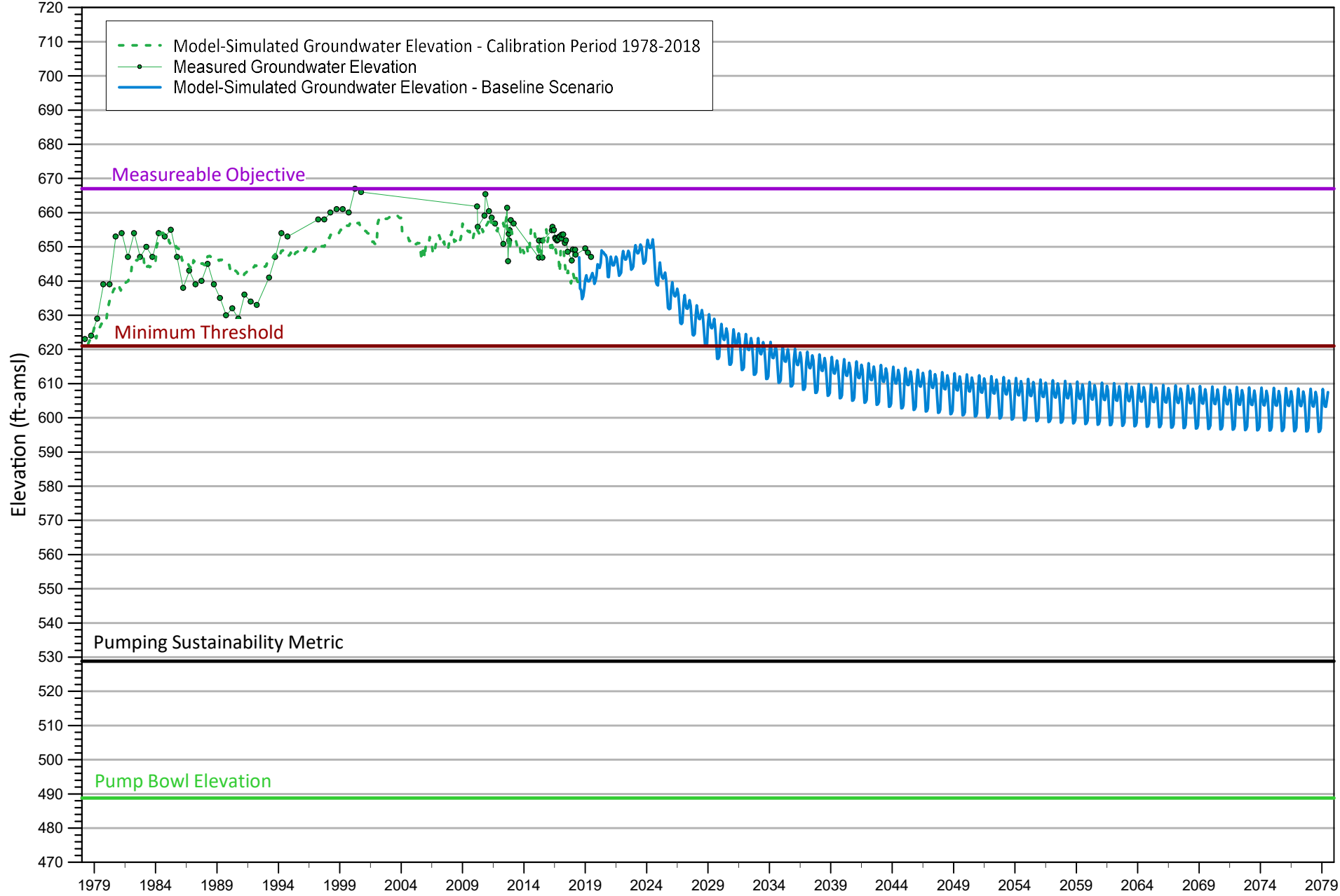


Figure 5-12g. Historical and Projected Groundwater Elevations for the Baseline Scenario at P-19

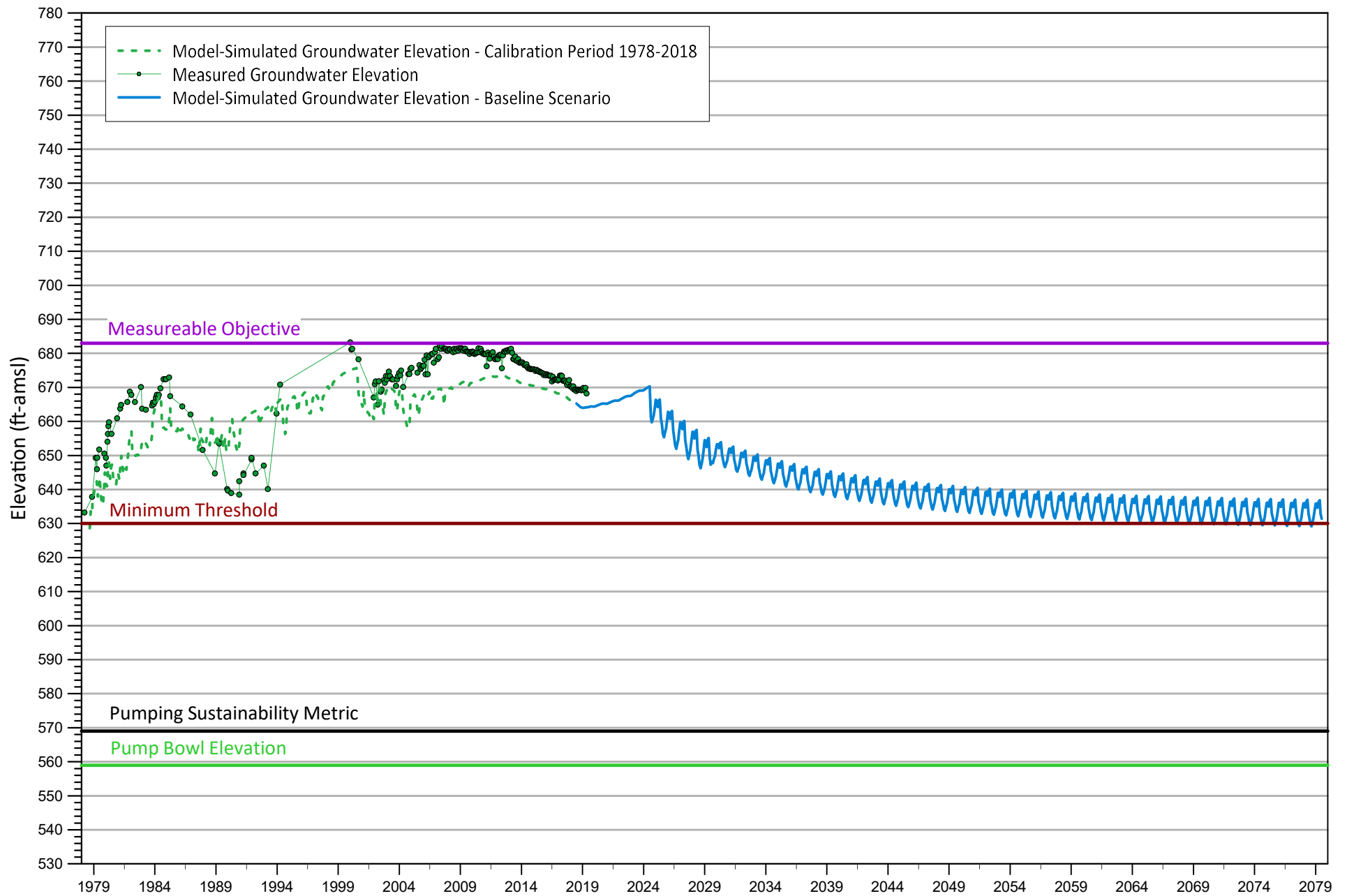


Figure 5-12h. Historical and Projected Groundwater Elevations for the Baseline Scenario at P-31

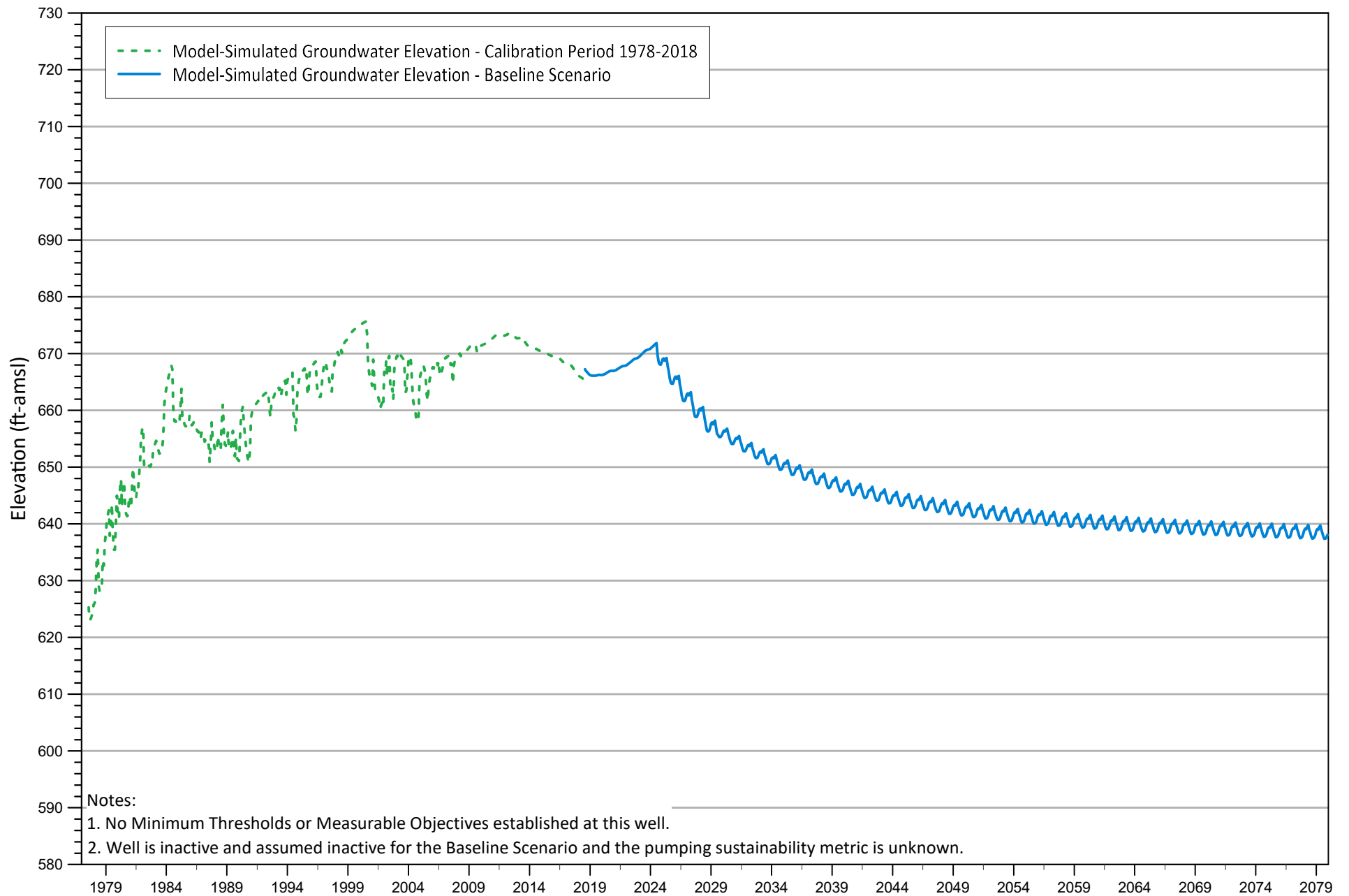
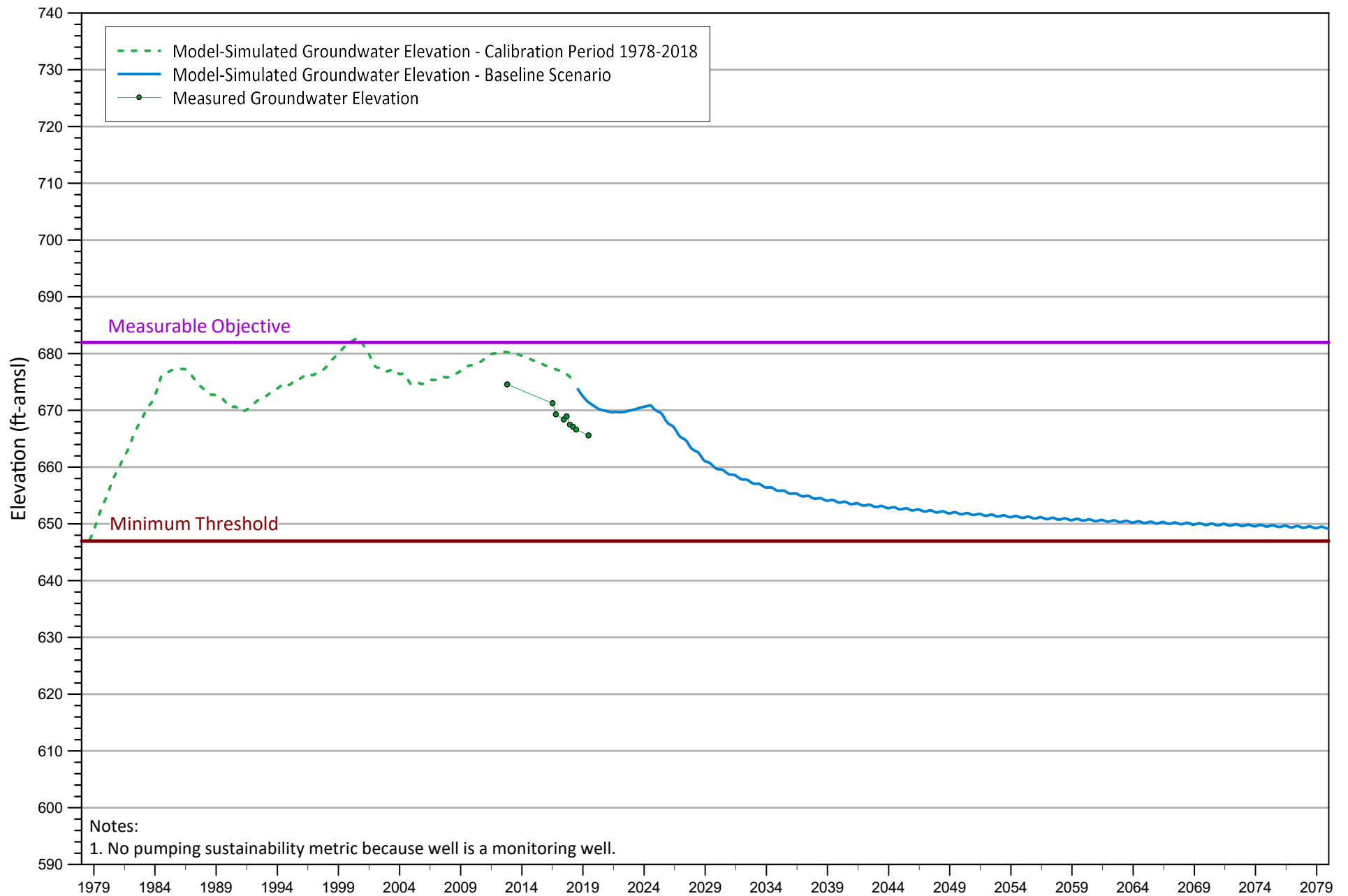


Figure 5-12i. Historical and Projected Groundwater Elevations for the Baseline Scenario at OMW-3



Figures 5-12a through 5-12i show that groundwater levels for the Baseline Scenario decline to levels below the Minimum Thresholds after 2027 and stay below through the end of the planning period in 2079, at five of the six wells: Industry, CPP-4, P-28, CPP-1, and P-19. The decline of groundwater levels below the Minimum Thresholds is predicted to occur around 2027-2030 for the wells in the western portion of the Basin (Industry, CPP-4, P-28, and CPP-1), and around 2060 for the well in the eastern portion of the Basin (OMW-3). This indicates that the Baseline Scenario is not sustainable relative to the Minimum Thresholds defined for these wells in *Section 3 Sustainable Management Criteria*.

5.2.2 Water Budget

Table 5-2 shows the water budget for the Baseline Scenario over the planning period 2019-2079 and contains the components of recharge and discharge, change in storage, and annual developed yield estimates. This water budget fulfills the requirement from Section 354.18 of the GSP Regulations for a projected water budget to estimate future baseline conditions of supply, demand, and aquifer response.

Recharge occurs in the Spadra Basin from DIPAW and subsurface inflow from the saturated alluvium and fractures within the bordering bedrock hills (San Jose and Puente Hills).

- **Deep infiltration of precipitation and applied water (DIPAW).** Over the planning period, annual recharge from DIPAW ranged between about 1,600-2,200 afy and averaged 2,167 afy.
- **Subsurface inflow.** Annual subsurface inflow from the saturated alluvium and fractures within the bordering bedrock hills ranged from about 1,030 to 1,040 afy and averaged 1,036 afy over.
- **Total recharge.** Total annual recharge to the Spadra Basin over the planning period averaged about 3,200 afy.

The discharge components for the Spadra Basin are groundwater pumping and subsurface outflow to the Chino Basin and Puente Basin.

- **Groundwater pumping.** Over the planning period, annual groundwater pumping ranged from about 700 to 1,900 afy and averaged about 1,700 afy.
- **Subsurface outflow to the Chino Basin.** Annual subsurface outflow to the Chino Basin ranged from about 400 to 600 afy and averaged 586 afy.
- **Subsurface outflow to the Puente Basin.** Annual subsurface outflow to the Puente Basin ranged from about 900 to 1,500 afy and averaged about 1,000 afy.
- **Total discharge.** The annual discharge over the planning period averaged 3,300 afy.

Table 5-2. Water Budget for Spadra Basin - Baseline Scenario Fiscal Year 2019-2079 (acre-feet)										
Fiscal Year	Recharge			Discharge				Change in Storage		Annual Developed Yield
	DIPAW	Side Inflows	Total Recharge	Subsurface Outflow to Puente Basin	Groundwater Pumping	Subsurface Outflow to Chino Basin	Total Discharge	Recharge minus Total	Cumulative	
2019	1,581	1,038	2,619	1,310	843	537	2,690	-71	-71	772
2020	1,705	1,035	2,741	1,437	707	389	2,533	207	136	914
2021	1,820	1,039	2,859	1,440	727	446	2,612	247	383	973
2022	1,921	1,039	2,960	1,491	702	492	2,685	275	658	977
2023	2,033	1,039	3,072	1,523	702	535	2,760	313	971	1,015
2024	2,037	1,036	3,073	1,543	702	557	2,802	271	1,241	973
2025	2,164	1,040	3,204	1,388	1,922	580	3,890	-686	556	1,236
2026	2,168	1,040	3,208	1,254	1,922	590	3,766	-558	-2	1,364
2027	2,172	1,040	3,212	1,195	1,922	593	3,710	-498	-500	1,424
2028	2,175	1,038	3,212	1,155	1,922	592	3,669	-457	-957	1,465
2029	2,178	1,041	3,219	1,122	1,922	591	3,635	-416	-1,373	1,506
2030	2,181	1,041	3,222	1,094	1,806	585	3,485	-263	-1,637	1,543
2031	2,185	1,040	3,226	1,073	1,806	579	3,458	-233	-1,870	1,573
2032	2,188	1,037	3,225	1,057	1,806	575	3,438	-212	-2,082	1,594
2033	2,191	1,040	3,231	1,042	1,806	570	3,419	-187	-2,269	1,619
2034	2,194	1,040	3,234	1,029	1,806	565	3,400	-166	-2,435	1,640
2035	2,195	1,040	3,235	1,017	1,806	563	3,386	-151	-2,586	1,655
2036	2,197	1,037	3,234	1,006	1,806	559	3,371	-137	-2,724	1,669
2037	2,197	1,040	3,237	996	1,806	559	3,361	-124	-2,848	1,682
2038	2,198	1,040	3,238	987	1,806	561	3,354	-116	-2,964	1,690
2039	2,199	1,040	3,238	979	1,806	563	3,348	-109	-3,073	1,697
2040	2,199	1,037	3,235	971	1,806	565	3,342	-107	-3,180	1,699
2041	2,199	1,039	3,239	964	1,806	570	3,340	-102	-3,281	1,704
2042	2,200	1,039	3,239	958	1,806	577	3,341	-102	-3,383	1,704
2043	2,200	1,039	3,239	952	1,806	581	3,340	-100	-3,483	1,706
2044	2,201	1,036	3,237	946	1,806	584	3,336	-100	-3,583	1,706
2045	2,201	1,039	3,240	942	1,806	586	3,333	-93	-3,676	1,713
2046	2,202	1,038	3,240	937	1,806	587	3,330	-90	-3,766	1,716
2047	2,203	1,038	3,241	933	1,806	587	3,325	-84	-3,850	1,722
2048	2,203	1,035	3,237	929	1,806	586	3,321	-83	-3,934	1,723
2049	2,203	1,038	3,241	925	1,806	586	3,317	-77	-4,010	1,729
2050	2,204	1,037	3,241	922	1,806	586	3,314	-73	-4,083	1,733
2051	2,204	1,037	3,241	918	1,806	586	3,310	-69	-4,152	1,737
2052	2,204	1,034	3,238	915	1,806	586	3,307	-69	-4,221	1,737
2053	2,205	1,037	3,241	912	1,806	586	3,305	-63	-4,285	1,743
2054	2,205	1,036	3,242	910	1,806	586	3,302	-61	-4,345	1,745
2055	2,206	1,036	3,242	907	1,806	586	3,300	-58	-4,403	1,748
2056	2,206	1,033	3,239	905	1,806	586	3,297	-59	-4,462	1,747
2057	2,206	1,036	3,242	903	1,806	587	3,295	-53	-4,515	1,753
2058	2,207	1,035	3,242	901	1,806	587	3,294	-51	-4,567	1,755
2059	2,207	1,035	3,243	899	1,806	587	3,292	-49	-4,616	1,757
2060	2,208	1,032	3,239	897	1,806	587	3,290	-50	-4,666	1,756
2061	2,208	1,035	3,243	895	1,806	587	3,288	-46	-4,712	1,760
2062	2,208	1,034	3,243	894	1,806	587	3,287	-44	-4,756	1,762
2063	2,209	1,034	3,243	892	1,806	587	3,286	-42	-4,798	1,764
2064	2,209	1,031	3,240	890	1,806	587	3,284	-44	-4,842	1,762
2065	2,210	1,034	3,244	889	1,806	587	3,283	-39	-4,881	1,767
2066	2,210	1,034	3,244	888	1,806	587	3,281	-38	-4,919	1,768
2067	2,211	1,033	3,244	887	1,806	588	3,280	-36	-4,955	1,770
2068	2,211	1,030	3,241	885	1,806	588	3,279	-38	-4,994	1,768
2069	2,211	1,033	3,244	884	1,806	588	3,278	-34	-5,028	1,772
2070	2,212	1,033	3,244	883	1,806	588	3,277	-33	-5,061	1,773
2071	2,212	1,033	3,244	882	1,806	588	3,276	-32	-5,092	1,774
2072	2,212	1,029	3,242	881	1,806	591	3,278	-37	-5,129	1,769
2073	2,212	1,033	3,245	880	1,806	597	3,284	-39	-5,168	1,767
2074	2,213	1,033	3,245	880	1,806	600	3,286	-41	-5,208	1,765
2075	2,213	1,033	3,245	879	1,806	601	3,286	-41	-5,249	1,765
2076	2,213	1,029	3,242	878	1,806	602	3,285	-43	-5,293	1,763
2077	2,213	1,033	3,245	877	1,806	600	3,283	-38	-5,330	1,768
2078	2,213	1,033	3,245	876	1,806	587	3,270	-24	-5,355	1,782
2079	2,213	1,033	3,245	876	1,806	567	3,249	-4	-5,358	1,802
Statistics for the Calibration Period 2019 through 2079										
Total	132,163	63,203	195,366	61,382	104,293	35,050	200,724	-5,358		98,934
Average	2,167	1,036	3,203	1,006	1,710	575	3,291	-88		1,622
Median	2,203	1,036	3,240	925	1,806	586	3,300	-61		1,729
Maximum	2,213	1,041	3,245	1,543	1,922	602	3,890	313		1,802
Minimum	1,581	1,029	2,619	876	702	389	2,533	-686		772

5.2.3 Storage

Table 5-2 includes the model estimates of the annual change in storage over the Baseline Scenario planning period which ranged from about -700 to +300 afy and averaged about -90 afy. The cumulative change in storage over the planning period is about -5,400 af. The decline in storage over the planning period appears to be due to the higher rates of groundwater pumping in the Baseline Scenario (~1,700 afy) compared to the average annual rates of pumping during the historical period 1978-2018 (~1,300 afy).

Figures 3-1 and 3-2 are time series charts that show the relationship between the groundwater storage and subsurface outflow to the neighboring Chino Basin and Puente Basin over the planning period for the Baseline Scenario. These time series charts are plotting the cumulative change in storage for the Baseline Scenario planning period as shown the water budget in Table 5-2. Changes in groundwater storage can be used as a proxy for groundwater levels. The cumulative change in groundwater storage of the Spadra Basin increases about 1,300 af from 2019 to 2024, then continuously decreases from 2025 through 2079 by about -5,000 af, following the same trend in model-projected groundwater levels at wells in Figure 5-12a through 5-12i. The Minimum Thresholds for lowering of groundwater levels can be used as a proxy for groundwater storage. Groundwater levels for the Baseline Scenario are predicted to decline to levels below the Minimum Thresholds set at five of the six wells analyzed (Figures 5-12a through 5-12i) after 2027 and remain below these thresholds through the end of the planning period in 2079. Hence, this indicates that the Baseline Scenario is likely not sustainable for groundwater storage in the Basin.

Figure 5-13 shows the cumulative change in groundwater storage versus subsurface outflow to the Chino Basin for the Baseline Scenario. Subsurface outflow to the Chino Basin occurs within the saturated sediments across the eastern boundary of the Spadra Basin. This figure shows that subsurface outflow to Chino Basin is predicted to be relatively stable during the planning period, even as groundwater storage declines through 2079. This is because the calibration of the Spadra Basin Groundwater Model indicated the existence of an unmapped hydraulic barrier along the boundary with the Chino Basin, and this area is simulated as having very low hydraulic conductivity (see *Section 2.2.7 Data Gaps*). The low hydraulic conductivity in this area of the model domain appears to govern the subsurface outflow to Chino Basin, keeping it relatively constant even as storage declines across the Spadra Basin.

Figure 5-14 shows the cumulative change in groundwater storage versus subsurface outflow to the Puente Basin for the Baseline Scenario. Subsurface outflow to Puente Basin occurs within the saturated sediments through the bedrock narrows at the western boundary of Spadra Basin. This figure shows that subsurface outflow to the Puente Basin is directly related to storage in the Spadra Basin. As storage decreases in the Spadra Basin over the planning period, the subsurface outflow to Puente Basin follows the same trend and rate of change from about 1,500 afy to 875 afy. The rate of change in storage and subsurface outflow to the Puente Basin gradually decline toward the end of the planning period, which indicates that the water budget of the Spadra Basin is approaching a new level of dynamic equilibrium at the lower rates of subsurface outflow.

Figure 5-13. Cumulative Change in Storage and Subsurface Outflow to Chino Basin - Baseline Alternative

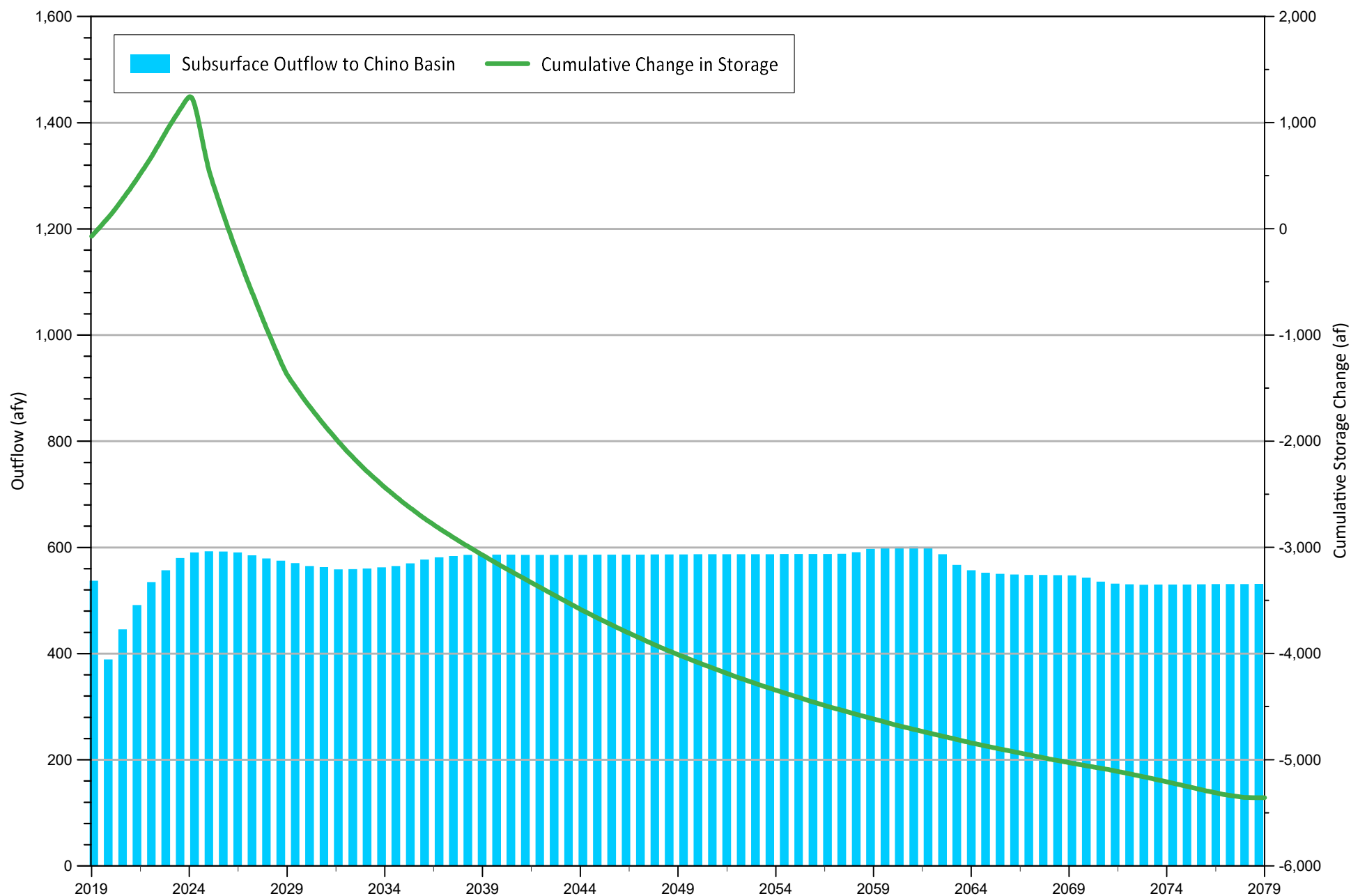
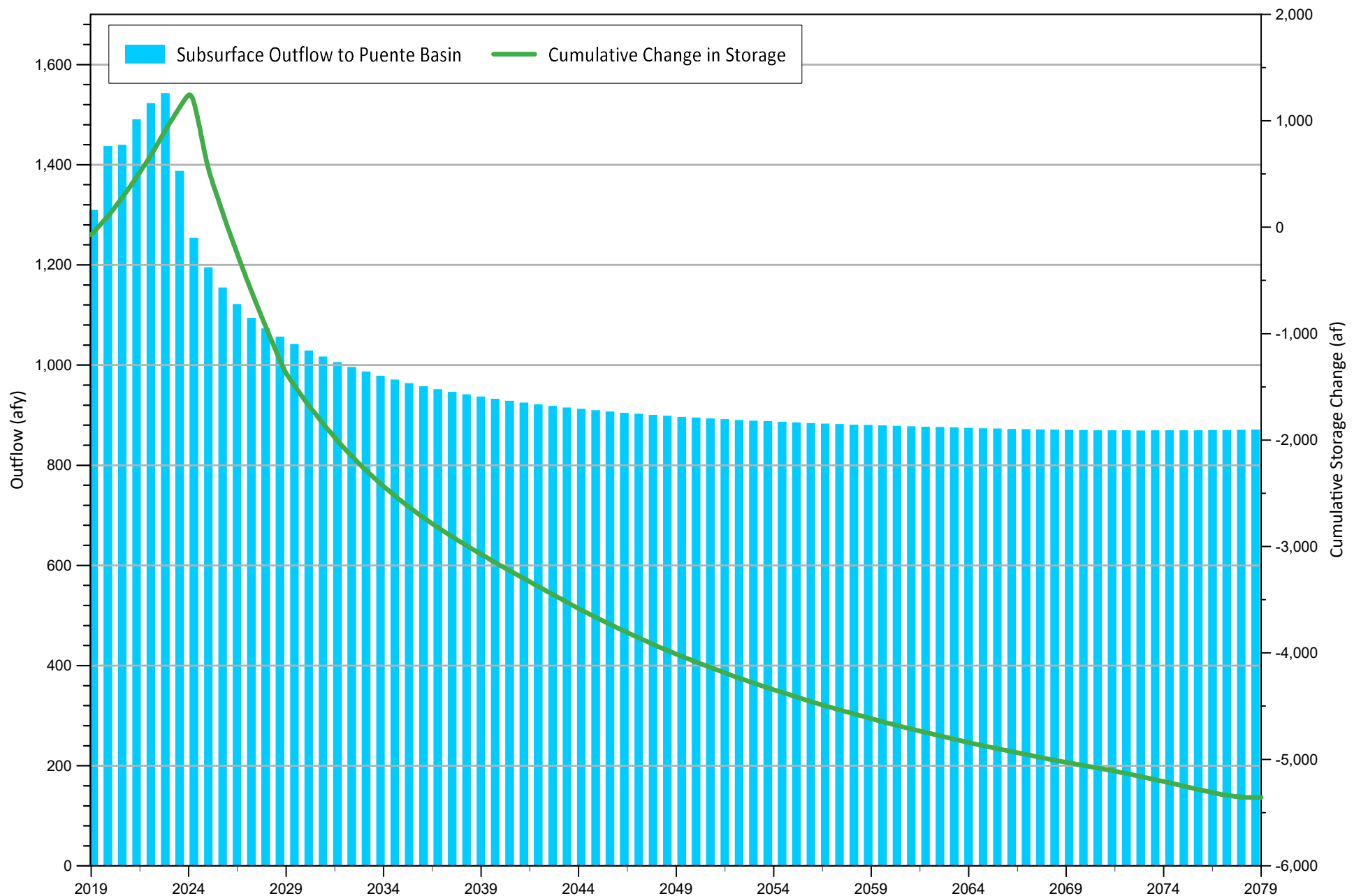


Figure 5-14. Cumulative Change in Storage and Subsurface Outflow to Puente Basin - Baseline Alternative



5.2.4 Land Subsidence

Section 2.2 Basin Setting demonstrated that very little permeant land subsidence, if any, has occurred historically within the Spadra Basin. And as described in *Section 3 Sustainable Management Criteria*, maintaining water levels above the Minimum Thresholds established at representative monitoring wells that are based on the lowest water levels historically is likely to protect against the occurrence of Undesirable Results for land subsidence in the Basin. Therefore, the Minimum Thresholds for lowering of groundwater levels can be used as a proxy for land subsidence. The groundwater levels for the Baseline Scenario are predicted to decline to levels below these Minimum Thresholds set at five of the six wells analyzed (Figures 5-12a through 5-12i) after 2027 and remain below these thresholds through the end of the planning period in 2079. Hence, this indicates that the Baseline Scenario is likely not sustainable for land subsidence in the Basin.

5.2.5 Developed Yield

The “annual developed yield” is the annual volume of groundwater pumping from the Spadra Basin plus the annual change in storage volume calculated in the water budget. Table 5-2 shows that the annual developed yield increased over the planning period from 772 af in 2019 to 1,802 af in 2079, and averaged 1,622 af, which is 190 af more than the estimated annual developed yield of 1,430 afy for the historical 1978 to 2018 period.

The increasing trend in developed yield is caused by increased pumping and declining groundwater levels, which in turn, reduces subsurface outflow to the Puente Basin. As shown in Figures 5-12a through 5-12i, 5-13, and 5-14, the rate of decline in groundwater levels and storage approaches zero toward the end of the planning period. This indicates that the water budget of the Basin is establishing a new dynamic equilibrium at these lower groundwater levels, where recharge and discharge are approximately equal. This observation demonstrates that the Spadra Basin can be operated at these lower groundwater and storage levels to increase the developed yield of the Basin; however, the adverse effects are projected to be exceedances of groundwater level Minimum Thresholds, pumping sustainability challenges at some wells, the potential for land subsidence, and reduced subsurface outflow to the Puente Basin.

5.2.6 Conclusions and Recommendations

The following are the main conclusions and recommendations derived from the evaluation of the Baseline Scenario.

Conclusions:

- The model results of the Baseline Scenario indicate that groundwater levels are projected to decline over the planning period by 20-25 ft throughout the Basin to levels below the groundwater level Minimum Thresholds at most of the representative monitoring wells. The Minimum Thresholds for groundwater levels were set to protect against the occurrence of Undesirable Results including chronic lowering of groundwater levels, significant depletions in storage, land subsidence, and impacts to the beneficial uses of downgradient groundwater basins. This indicates that the Baseline Scenario is not sustainable over the planning period, and projects and programs are needed to achieve long-term sustainability and avoid Undesirable Results.

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- The groundwater levels are predicted to decline to levels below the pumping sustainability metrics at three of the pumping wells in the western portion of the Basin. This indicates that the Baseline Scenario may cause pumping sustainability challenges for some water purveyors.
- The model results of the Baseline Scenario indicate that the annual developed yield of the Basin can be increased with more pumping and lower groundwater levels in the Basin. Under these conditions, the Basin appears to reach a new dynamic equilibrium with less subsurface outflow to the Puente Basin. However, the effects of operating at these lower groundwater levels are, groundwater elevations below Minimum Thresholds; pumping sustainability challenges at wells in the western portion of the Basin; and decreased subsurface outflow to Puente Basin.

Recommendations:

- Develop and evaluate up to four Basin Optimization Scenarios. These scenarios will represent potential plans and projects to: (i) achieve sustainability in the Spadra Basin over the planning period and (ii) maximize the beneficial use of the Basin.
- The Basin Optimization Scenarios should include projects that increase recharge to the basin, such as artificial recharge of storm water and/or supplemental waters. Increased recharge will have the effect of increasing groundwater levels, which could avoid exceedances of Minimum Thresholds and the occurrence of Undesirable Results.
- The projects and plans in the Basin Optimization Scenarios could be implemented in a coordinated fashion to conduct a conjunctive use program—the coordinated use and management of all surface water and groundwater resources available to the water purveyors to enhance basin yield and improve water-supply reliability. The operational concept is to use and/or store surface waters in the Spadra Basin during wet periods when these supplies are more available, so that Spadra Basin groundwater is more available for use during dry periods.

5.3 DEVELOPMENT OF THE BASIN OPTIMIZATION SCENARIOS

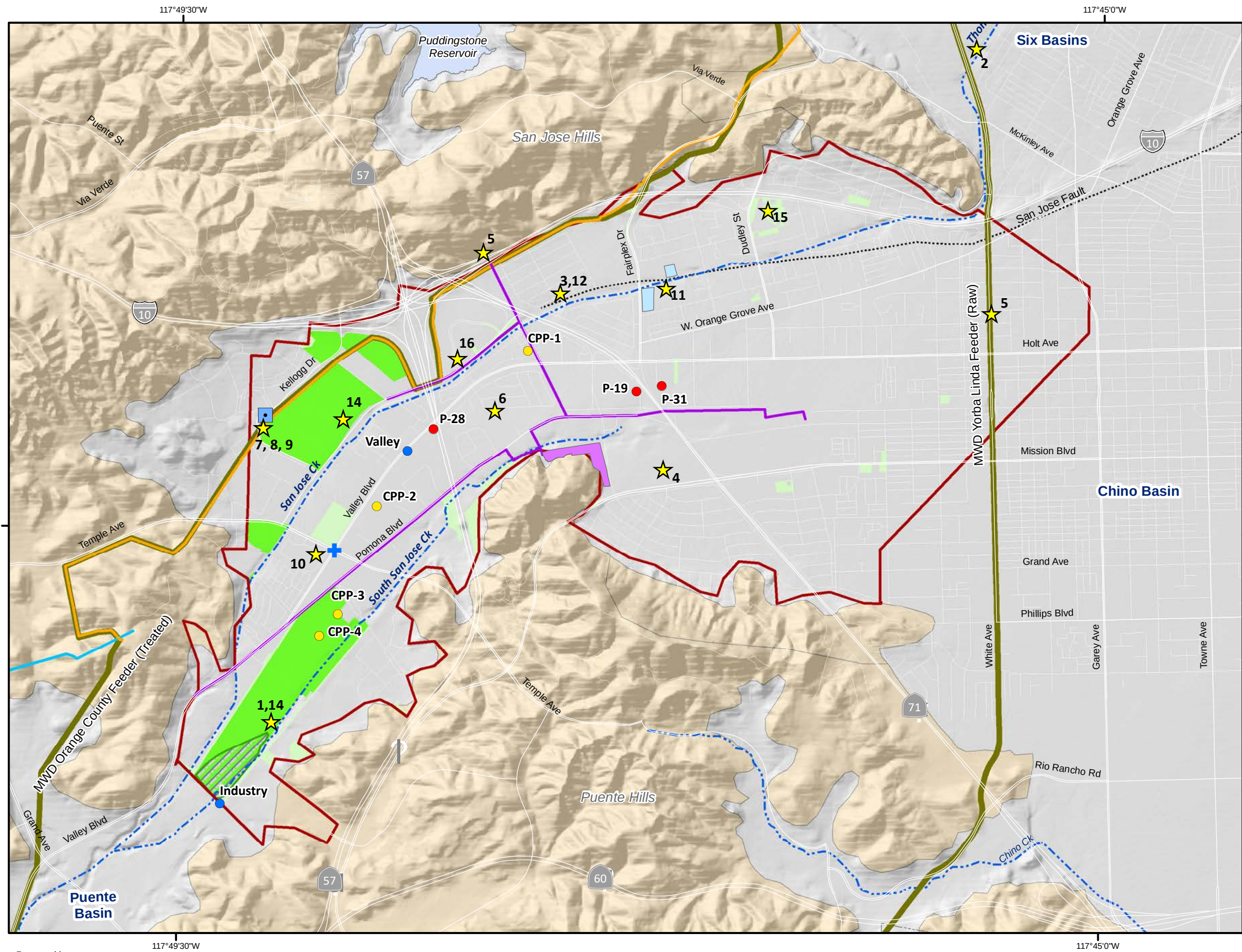
This section describes the accumulation of data and information from Spadra Basin stakeholders on potential projects and management actions in the Spadra Basin, and the combination of some of these projects and management actions into Basin Optimization Scenarios that are intended to achieve long-term sustainability and maximize the beneficial use of the Spadra Basin.

5.3.1 Potential Projects and Management Plan Concepts

The GSA conducted a call for projects from all Spadra Basin stakeholders via email in January 2021. Feedback on potential projects and management actions was received from California State Polytechnic University, Pomona (CPP), WVWD, City of Pomona (Pomona), and Forest Lawn Memorial Parks. This feedback was compiled and presented at a Spadra Basin Advisory Committee meeting on February 25, 2021 for discussion amongst the stakeholders and to solicit additional feedback. Table 5-3 lists the various projects and plans with stakeholder attribution. Figure 5-15 is a map that shows the locations of the projects in the Spadra Basin.

Table 5-3 . Proposed Projects and Management Actions for the Spadra Basin

Map ID	Project Description	Proposing Agency
Recharge Projects		
1	Convert CPP agricultural land at the confluence of San Jose Creek and South San Jose Creek into spreading grounds	CPP, Pomona
2	Develop a spreading connection off of the MWD Foothill Feeder - Rialto Pipeline at Thompson Creek Channel	CPP, WVWD
3	Redirect storm water flows in the area to new spreading grounds	CPP, Forest Lawn
4	Recharge surplus recycled water from the Pomona WRP after contractual obligations are met, via spreading or injection	CPP, Pomona, Forest Lawn, WVWD
5	Utilize three large diameter pipelines for imported water that run through the Spadra Basin as sources for artificial recharge; 1) The MWD's Orange County Feeder treated water pipeline, 2) The Pomona Walnut Rowland Joint Water Line (JWL) treated water pipeline, and 3) The MWD's Yorba Linda Feeder raw water pipeline.	WVWD
11	Selecting recharge locations where there is easy connection to different types of recharge waters (storm water, recycled water, and imported water) - Example shown in map for Map ID 11	Feb 2021 Advisory Committee Meeting
12	Construction of rubber dams in the San Jose Creek to divert storm water for recharge;	Feb 2021 Advisory Committee Meeting
13	Construction of underground infiltration galleries under sports fields at John Marshall Middle School or other schools/parks for recharge of recycled water and other waters	Feb 2021 Advisory Committee Meeting
14	Recharge storm water and recycled water through flood irrigation at Cal Poly Pomona agricultural lands when land is fallow	Feb 2021 Advisory Committee Meeting
15	Potential recharge location south east of the intersection of the 10 Freeway and Dudley Street.	Feb 2021 Advisory Committee Meeting
16	Potential recharge location at University Corporate Center Drive, however previous studies have indicated that the soil is potentially not conducive for recharge	Feb 2021 Advisory Committee Meeting
Pump and/or Treat Projects		
6	Construct a new production well	CPP
7	Connect all wells to the Reverse Osmosis Plant	CPP
8	Operate Reverse Osmosis Plant at maximum capacity 24/7 with surplus potable water going to Pomona, Walnut and Rowland	CPP, Pomona, WVWD
9	Expand treatment capacity at the CPP Reverse Osmosis Plant	CPP, Forest Lawn
10	Utilizing an existing intertie at the intersection of Temple and Valley between WVWD and the City of Pomona, to facilitate use of Spadra Basin water by WVWD by leveraging Pomona's existing pumping capacity in the basin.	WVWD
Management Strategies		
	Replace recycled water going to Forest Lawn with groundwater	CPP
	Conjunctive Water Management to maximize the use of all water resources available to the parties, including storm, recycled, imported, and groundwaters, and the storage capacity of the groundwater basin.	Forest Lawn
	Maximize recharge and pumping to assist in groundwater cleanup and characterize impacts to neighboring basins	Forest Lawn
	Increase reliability of irrigation water with an increase in the use of recycled water	Forest Lawn
	Inventory all existing and adjacent (public and private) water facilities to optimize the basin	Forest Lawn
	Leverage existing infrastructure to move surplus water around between parties	WVWD
	Increase and maximize groundwater pumping with increased artificial recharge	Forest Lawn, WVWD
	Implementing treatment and leveraging cleanup of point sources in the basin	Feb 2021 Advisory Committee Meeting
	Design a management plan to optimally manage and use the basin for local reliable sources without a storage a recovery program	Feb 2021 Advisory Committee Meeting
	Implement recharge programs with a steady and reliable source of water with matched increased pumping.	Feb 2021 Advisory Committee Meeting



★⁴ Location of Proposed Project (labeled by ID in Table 2-1)

Existing Facilities

Existing Production Wells (Symbolized by Well Owner)

- Cal Poly Pomona (CPP)
- City of Pomona (Pomona)
- Walnut Valley Water District (WVWD)

Imported Water Pipelines

- Pomona Walnut Rowland (PWR) Joint Feeder (Treated)
- Badillo Grand Pipeline, Treated
- MWD Orange County Feeder (Treated), and Yorba Linda Feeder (Raw)

- Pomona Water Reclamation Plant (WRP)
- Pomona WRP Recycled Water Pipelines
- CPP Reverse Osmosis (RO) Plant
- ⊕ Intertie between WVWD and Pomona

Other

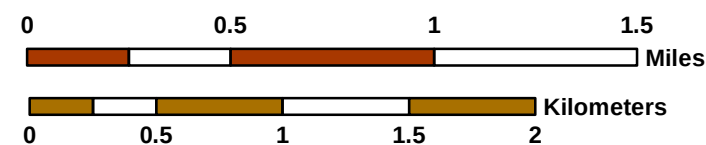
- CPP Agricultural Lands
- ▨ Agricultural Land at Confluence of San Jose and South San Jose Creeks
- Vacant Land
- Streams & Flood Control Channels
- Spadra Basin (GSP Boundary)



Prepared by:



Author: VMW
Date: 11/8/2021
File: Figure 5-15 projects.mxd



Prepared for:

Spadra Basin Groundwater Sustainability Agency
Groundwater Sustainability Plan



Map of Proposed Locations for New Projects for the Spadra Basin

Figure 5-15

Section 5

Projects and Management Actions to Achieve Sustainability



The primary project concepts of interest to the stakeholders were: artificial recharge projects that will support groundwater levels and augment the yield of the basin; the use of surplus recycled water from the Pomona WRP that otherwise is discharged to South San Jose Creek and exits the Spadra Basin; and groundwater treatment projects to increase the potable use of the Spadra Basin. These project concepts and other feedback were used to develop three Basin Optimization Scenarios, described below.

5.3.2 Basin Optimization Scenarios

Three Basin Optimization Scenarios have been developed over the 60-year planning period: Basin Optimization Scenario 1 – Sustainability through Substitution; Basin Optimization Scenario 2 - Sustainability through Recharge; and Basin Optimization Scenario 3 – Maximum Beneficial Use. All three scenarios are intended to achieve long-term sustainability in the Basin, and Basin Optimization Scenario 3 – is intended to maximize its beneficial use. The scenarios will be evaluated using the Spadra Basin ~~G~~groundwater ~~M~~model for the same 60-year planning period of 2019-2079 that was used to evaluate the Baseline Scenario. The hydrologic response of the Spadra Basin to the Basin Optimization Scenarios will be compared to the Sustainable Management Criteria set in the Spadra Basin for groundwater levels, and by proxy groundwater storage and land subsidence. Additionally, cost estimates will be prepared for each Basin Optimization Scenario and compared to each other and the cost of the Baseline Scenario.

The primary cause of the projected decline in groundwater levels in the Baseline Scenario is an increase in projected groundwater pumping by 526 ~~acre-feet-per-year (afy)~~ from the long-term average pumping for the 1978 to 2018 historical period. This observation was used to set the assumption that about 500 afy of recharge or decreased pumping is needed to support groundwater levels and achieve long-term sustainability in the Spadra Basin for the Basin Optimization Scenarios.

All three Basin Optimization Scenarios include the use of surplus recycled water from the Pomona WRP to achieve the objectives of the scenarios. Surplus recycled water is tertiary-treated effluent from the Pomona WRP that is not delivered for direct reuse to existing customers in the Spadra Basin for irrigation or commercial purposes.

Currently, this surplus recycled water is discharged to the South San Jose Creek where it exits the Spadra Basin and either evaporates, is recharged about 15 miles downstream at the Montebello Forebay, or is consumed by riparian vegetation at the Montebello Forebay. ~~The surplus recycled water from the Pomona WRP is about 3.3 million gallons per day (mgd) or about 3,500 afy.~~ The LACSD filed for a wastewater change petition (WW 0104) with the State of California Water Resources Control Board (State Water Board) in October 2019 to reduce the discharge of treated recycled water to the South San Jose Creek from the Pomona WRP to zero for all months of the year (State Water Board, 2019) and be redirected for other uses. The wastewater change petition described the surplus recycled water as 3.2 mgd based on the average discharge that occurred from 2014 to 2018, which is about 3,500 afy. ~~This~~ The change petition was approved in October 2020 allowing for the potential utilization of this surplus recycled water in the Spadra Basin (State Water Board and California EPA, 2020).

The LACSD completed a final Environmental Impact Report (FEIR) for the reduced discharge to the San Gabriel River Watershed envisioned in the wastewater change petition for the Pomona WRP and three other treatment plants in the watershed (ESA, 2019). The FEIR includes a mitigation measure for the LACSD to implement an Adaptive Monitoring Plan (AMP) in coordination with the U.S. Fish and Wildlife Service (USFWS) and the California Department of Fish and Wildlife (CDFW) to ensure the quantity and quality of the riparian and wetland habitat downstream is maintained during reduced flow from the upstream treatment plants. A draft AMP was developed and included as an attachment to the FEIR (Wood,

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2019) and includes the monitoring of various vegetation parameters and trigger levels to implement responsive measures that could include resumed discharges to the river and tributary channels in sufficient volumes to support the habitat sustained by historical discharges. ~~If the final GSP includes the projects that utilize the surplus recycled water from the Pomona WRP, a contingency plan to address the uncertainty of the future availability of all or part of the surplus recycled water will be developed during the planning phases of the projects and management actions during GSP implementation⁴. The contingency plan will include a description of the options for alternative water sources for recharge and projects and management strategies if the surplus recycled water is no longer available.~~

Recycled water is considered the primary source of recharge for the Basin Optimization Scenarios 2 and 3 because of the stakeholder interest to utilize this local available source of water that is currently not being used in the Spadra Basin. Basin Optimization Scenarios 2 and 3 contemplate the use of recycled water for artificial recharge ranging from 500 afy to 3,500 afy at locations that are conceptual at this time. However, there is potential the recycled water available for recharge could be less in the future than the assumed maximum of 3,500 afy in the scenarios. Conditions where less recycled water would be available in the future could include: if the LACSD's AMP implements a response measure to resume some discharge to support the downstream habitat; a decrease in influent and production at the Pomona WRP; or new reuse and storage projects are implemented. The GSP implementation includes planning phases for project implementation to take the conceptual projects described in the GSP to design and construction (Section 6.1.5). The planning phases include the identification and characterization of project alternatives, which could include less recycled water recharge, other sources or combinations of water for recharge, projects to increase recycled water availability, among others. However, it is also possible that imported water, storm water, dry weather flow, or a combination of waters could be recharged at some of the potential locations.

Each Basin Optimization Scenario is summarized below. Figure 5-16 is a map of the Spadra Basin that shows the locations of all existing wells, potential new wells, and potential new recharge facilities included in the three Basin Optimization Scenarios.

5.3.2.1 Basin Optimization Scenario 1 – Sustainability through Substitution

Objective. Support groundwater levels and achieve sustainability in the Spadra Basin by decreasing groundwater pumping.

Description. Scenario 1 eliminates groundwater pumping at Cal Poly wells CPP-2, CPP-3, and CPP-4 (wells currently used for non-potable supply for irrigation) and replaces it with surplus tertiary-treated recycled water from the Pomona WRP. The combined planned pumping in the Baseline Scenario for CPP- 2, CPP-3, and CPP-3 is 430 afy. Therefore, the 430 afy of groundwater supply will be replaced with 430 afy of recycled water from the Pomona WRP. This substitution is viable because the monthly surplus recycled water is greater than the monthly planned pumping at the CPP-2, CPP-3, and CPP-4 wells combined, even during the peak demand months in the summer. Additionally, the sites that are irrigated with groundwater pumped from these CPP wells are near the main recycled water pipelines where turnouts and extensions could be added for irrigation at these sites.

⁴ ~~Section 6.1.5 of the GSP includes a description of how the projects will be taken from the concepts described in the GSP to final design and then through construction in a phased approach of implementation.~~

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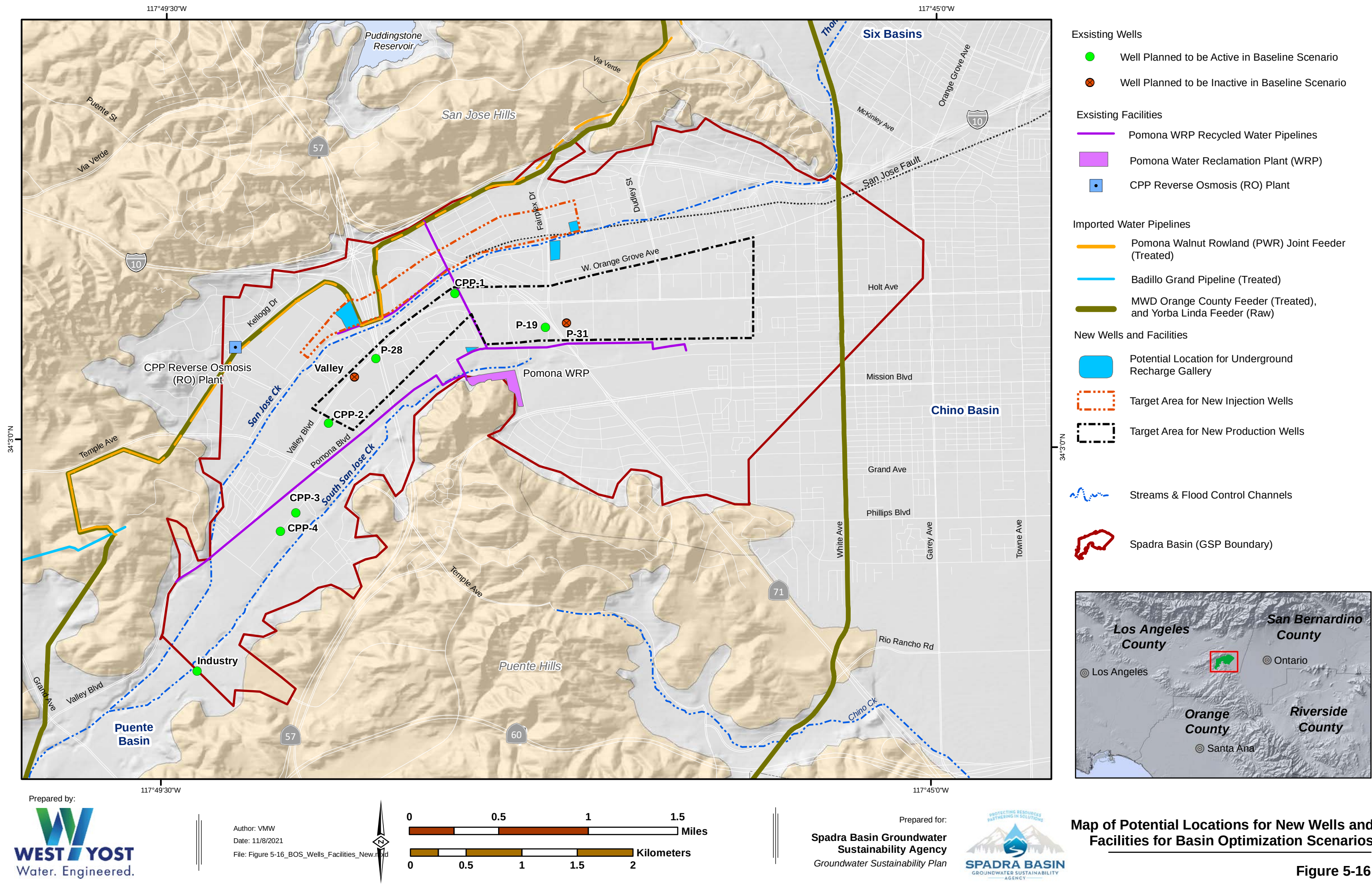
Permitting: Already permitted under existing WRRs for LACSD Order No. 97-072, and potentially the development of a SNMP for the Spadra Basin.

Groundwater Pumping. In Scenario 1, a total of 1,376 afy is pumped from wells CPP-1, P-28, P-19, and Industry. This is 430 afy less than groundwater pumping in the Baseline Scenario.

Managed Aquifer Recharge. There is no artificial recharge included in Scenario 1.

Treatment. There is no additional groundwater treatment included in Scenario 1.

New Wells/Facilities. Additional recycled water pipeline and connections will be necessary to enable irrigation with recycled water at the sites currently irrigated with groundwater.



5.3.2.2 Basin Optimization Scenario 2 – Sustainability through Recharge

Objective. Support groundwater levels and achieve sustainability in the Spadra Basin via managed aquifer recharge of recycled water from Pomona WRP.

Description. Scenario 2 increases artificial recharge to the Spadra Basin from 0 afy to 500 afy via the construction of new recharge facilities for the recharge of recycled water from the Pomona WRP. Two different types of recharge facilities will be constructed for the recharge of 500 afy: an underground recharge gallery with an estimated capacity of 200 - 890 afy (dependent on the selected site's surface area) and an injection well with an estimated recharge capacity of 450 afy. The two types of recharge facilities provide for operational flexibility and reliability, and the option to increase recharge above 500 afy. The two recharge facilities can also act as a pilot program to test the functionality and success of the two types of facilities.

Permitting. The recharge of recycled water will require permitting from the LA Regional Board with oversight from the State Water Board, and potentially the development of a SNMP for the Spadra Basin, or inclusion of the Spadra Basin in the San Gabriel Valley Basin SNMP (Stetson Engineers Inc., 2016). The current regulatory permitting framework of the recycled water recharge via injection (subsurface application) requires the advance treatment of water prior to recharge. This scenario does not include advance treatment prior to injection. Permitting will be a regulatory challenge that will need to be addressed with the Regional Board and State Water Board during the planning stages of project implementation as described in Section 6.1.5 of the GSP.

Groundwater Pumping. In Scenario 2, a total of 1,806 afy is pumped from wells CPP-1, CPP-2, CPP-3, CPP- 4, P-28, P-19, and Industry. This is equal to the planned pumping in the Baseline Scenario.

Managed Aquifer Recharge. In Scenario 2, a total of 500 afy of recycled water is artificially recharged in the Spadra Basin, an increase of 500 afy compared to the Baseline Scenario.

Treatment. There is no additional groundwater treatment included in Scenario 2.

New Wells/Facilities.

- One underground recharge gallery and associated recycled water pipeline. Figure 5-16 shows potential locations for an underground recharge gallery. These locations were identified because they are along and/or near the main Pomona WRP recycled water pipeline in the northern central portion of the Basin and not near existing production wells. The potential locations to the east of Highway 71 will require the construction of new recycled water pipeline, but this new pipeline could be utilized to irrigate the schools and parks in this area and to supply recharge to any new injection wells in this area.
- One injection well and associated recycled water pipeline and connections. The location of the injection well will be within the target area shown in Figure 5-16. This target area was identified as an area along and/or near the main Pomona WRP recycled water pipeline and not nearby or upgradient from existing production wells.

5.3.2.3 Basin Optimization Scenario 3 – Maximum Beneficial Use

Objective. Support groundwater levels, achieve sustainability, and maximize the beneficial use of the Spadra Basin by utilizing all available surplus recycled water from the Pomona WRP for artificial recharge, increasing groundwater production, and increasing groundwater treatment capacity to produce a new potable water supply from the Spadra Basin.

Description. Scenario 3 increases artificial recharge to the Spadra Basin from 0 afy to 3,500 afy via the construction of new recharge facilities for the recharge of recycled water from the Pomona WRP. Two different types of recharge facilities will be constructed for the recharge of 3,500 afy: one underground recharge gallery with an estimated capacity of 200 - 890 afy (dependent on the selected site's surface area) and seven injection wells with a combined recharge capacity of 3,150 afy. The two types of recharge facilities provide for operational flexibility and reliability.

The increase in recharge will be accompanied by an increase in pumping of 3,000 afy to recapture recharge over the 500 afy needed to achieve sustainability. This increase in production will be achieved by increasing production at wells P-19, P-28, and CPP-1 to 90 percent of the design capacity, and the construction and operation of five new production wells with an average pumping capacity of 525 afy each. Two inactive wells (Walnut and P-31) could be rehabilitated to help achieve the increase in pumping instead of constructing some of the new production wells.

Scenario 3 also includes expanding the Reverse Osmosis (RO) Plant owned and operated by CPP to increase the potable use of Spadra Basin groundwater. Currently, the RO Plant treats groundwater pumped from well CPP-1 with a design influent capacity of 538 afy. Scenario 3 assumes 4,304 afy of groundwater pumped from wells CPP-1, P-28, P-19, and five new production wells will be conveyed to an expanded RO Plant for treatment with an influent capacity of about 4,400 afy.

Permitting: Like Scenario 2, the recharge of recycled water in Scenario 3 will require permitting from the LA Regional Board with oversight from the State Water Board, and potentially the development of a SNMP for the Spadra Basin, or inclusion of the Spadra Basin in the San Gabriel Valley Basin SNMP (Stetson Engineers Inc., 2016). Scenario 3 will also require a permit from the State Water Board DDW for water treatment. The current regulatory permitting framework of the recycled water recharge via injection (subsurface application) requires the advance treatment of water prior to recharge. This scenario does not include advance treatment prior to injection, but instead, includes advance treatment after groundwater extraction. Permitting will be a regulatory challenge that will need to be addressed with the Regional Board and State Water Board and DDW during the planning stages of project implementation as described in Section 6.1.5 of the GSP.

Groundwater Pumping. In Scenario 3, a total of 4,864 afy is pumped from wells CPP-1, CPP-2, CPP-3, CPP-4, P-28, P-19, Industry, and five new production wells. This is an increase of about 3,000 afy from the planned pumping in the Baseline Scenario.

Managed Aquifer Recharge. In Scenario 3, a total of 3,500 afy of recycled water is artificially recharged in the Spadra Basin, an increase of 3,500 afy compared to the Baseline Scenario.

Treatment. In Scenario 3, the CPP RO Plant influent capacity is expanded from 538 afy to 4,300 afy for potable supply for the Spadra Basin water purveyors.

New Wells/Facilities.

- One underground recharge gallery and associated recycled water pipeline. Figure 5-16 shows potential locations for an underground recharge gallery. These locations were identified because they are along and/or near the main Pomona WRP recycled water pipeline and not near existing production wells. The potential locations to the east of Highway 71 will require the construction of new recycled water pipeline, but this new pipeline could be utilized to irrigate the schools and parks in this area and to supply recharge to any new injection wells in this area.
- Seven injection wells and associated recycled water pipeline. The location of the injection wells will be within the target area shown in Figure 5-16. This target area was identified as an area along and/or near the main Pomona WRP recycled water pipeline and not nearby or upgradient from existing production wells and the proposed target area for new production wells.

- Five new production wells and conveyance pipelines to the RO Plant. The location of the wells will be in the target area shown in Figure 5-16. This target area was identified because it is the along the central axis and deepest portion of the basin. The inactive wells (Valley and P-31) could be put back into use and conveyed to CPP RO Plant in lieu of constructing two of the new production wells.
- Expansion of the treatment capacity at the CPP RO Plant and conveyance pipelines to and from the RO plant.

The ~~table~~ [Table 5-4 below](#) summarizes the Baseline and Basin Optimization Scenarios.

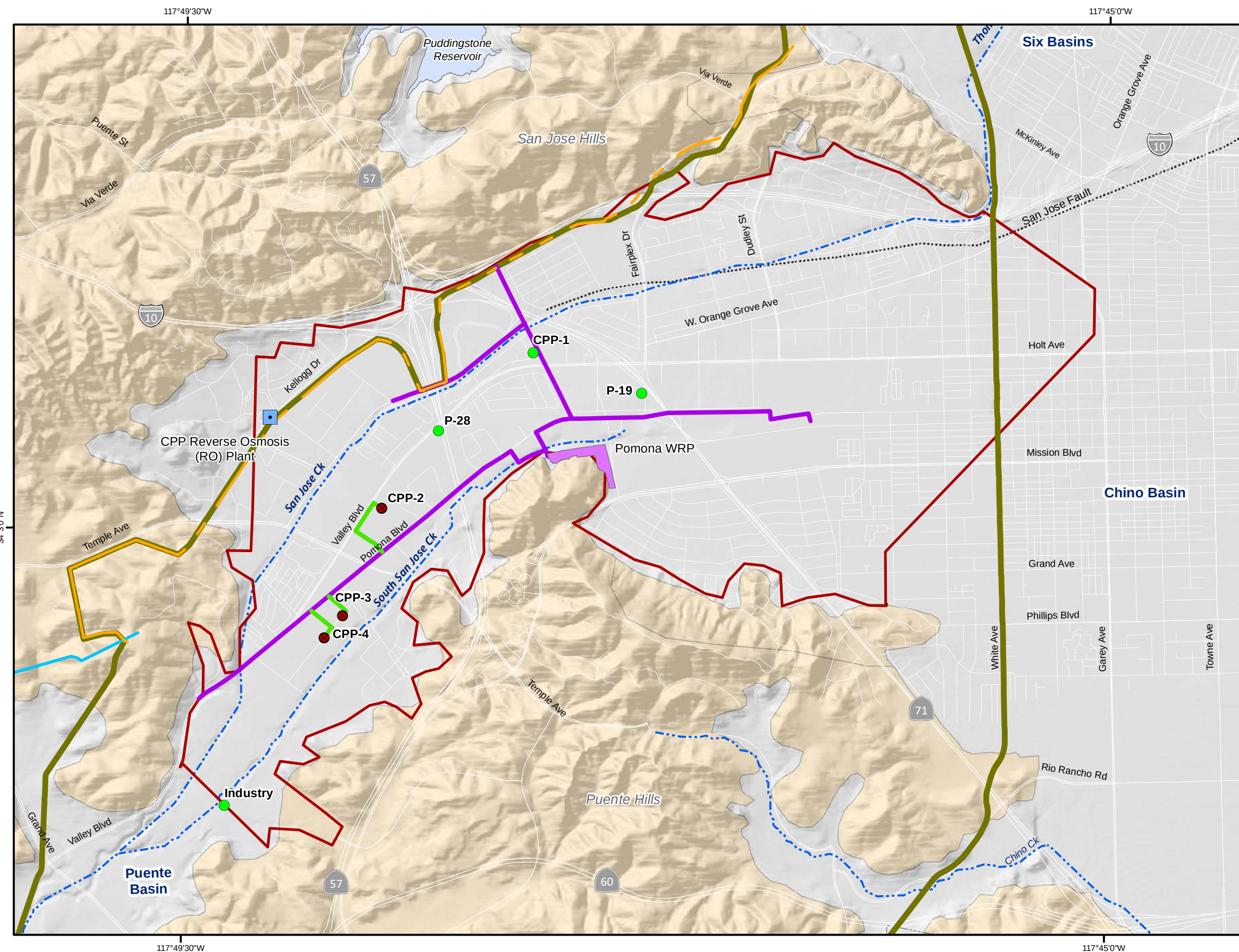
Table 5-4. Summary of Basin Optimization Scenarios vs. Baseline Scenario					
Scenario	Pumping, afy	Pumping from Baseline, afy	Recharge, afy	Recharge from Baseline, afy	New Facilities
Baseline	1,806	—	0	—	—
Scenario 1	1,376	-430	0	0	• Additional recycled water pipeline and connections
Scenario 2	1,806	0	500	500	• Underground recharge gallery and pipeline • Injection well and pipeline
Scenario 3	4,800	2,994	3,500	3,500	• Underground recharge gallery and pipeline • Seven Injection wells and pipeline • Five production wells and pipeline • Expansion of CPP RO Plant and pipeline

5.4 EVALUATION OF THE BASIN OPTIMIZATION SCENARIOS

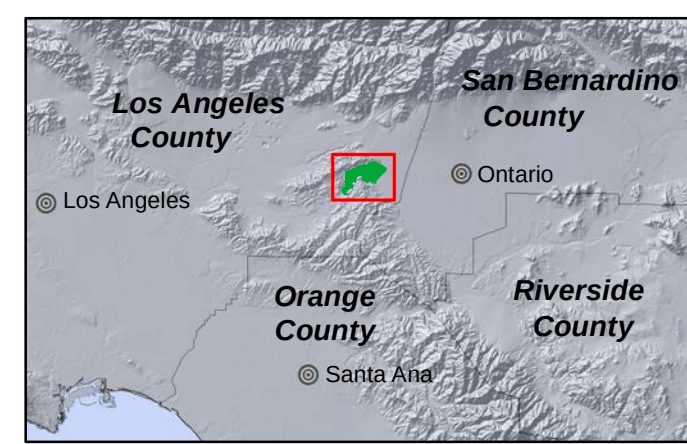
The objective of this section is to describe the predicted hydrologic responses of the three Basin Optimization Scenarios described in *Section 5.3* above over the 60-year planning period of 2019 to 2079. The hydrologic responses were predicted with the Spadra Basin [Groundwater Model](#) and are compared against each other and the hydrologic response of the Baseline Scenario.

Figures 5-17a, 5-17b, and 5-17c show the locations of the existing and planned facilities that are included in Basin Optimization Scenarios 1, 2, and 3, respectively. Table 5-5 summarizes the facilities and operations for the Basin Optimization Scenarios. Tables 5-6a, 5-6b, 5-6c are the model-estimated annual water budgets of the Spadra Basin for the three Basin Optimization Scenarios over the planning period of 2019-2079.

The hydrologic responses are described in the sub-sections below, including groundwater levels, comparison of the groundwater levels to sustainability metrics set in *Section 3 Sustainable Management Criteria*, pumping sustainability, change in storage, subsurface outflow to the Chino and Puente Basins, and sustainable yield.

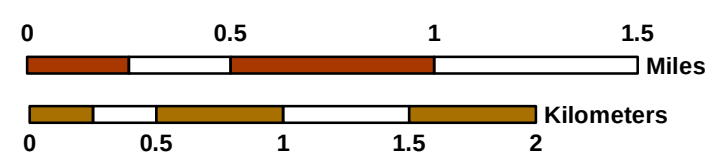


- Existing Facilities**
- Production Well Active in Scenario1
 - Production Well Inactive in Scenario1
 - Pomona Water Reclamation Plant (WRP)
 - Pomona WRP Recycled Water Pipeline
 - CPP Reverse Osmosis (RO) Plant
- Planned New Facilities for Scenario 1**
- Recycled Water Pipeline
- Imported Water Pipelines**
- Pomona Walnut Rowland (PWR) Joint Feeder (Treated)
 - Badillo Grand Pipeline (Treated)
 - MWD Orange County Feeder (Treated), and Yorba Linda Feeder (Raw)
 - Streams & Flood Control Channels
 - Spadra Basin (GSP Boundary)



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Water. Engineered.

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Date: 10/8/2021
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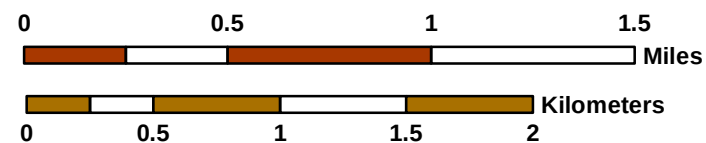
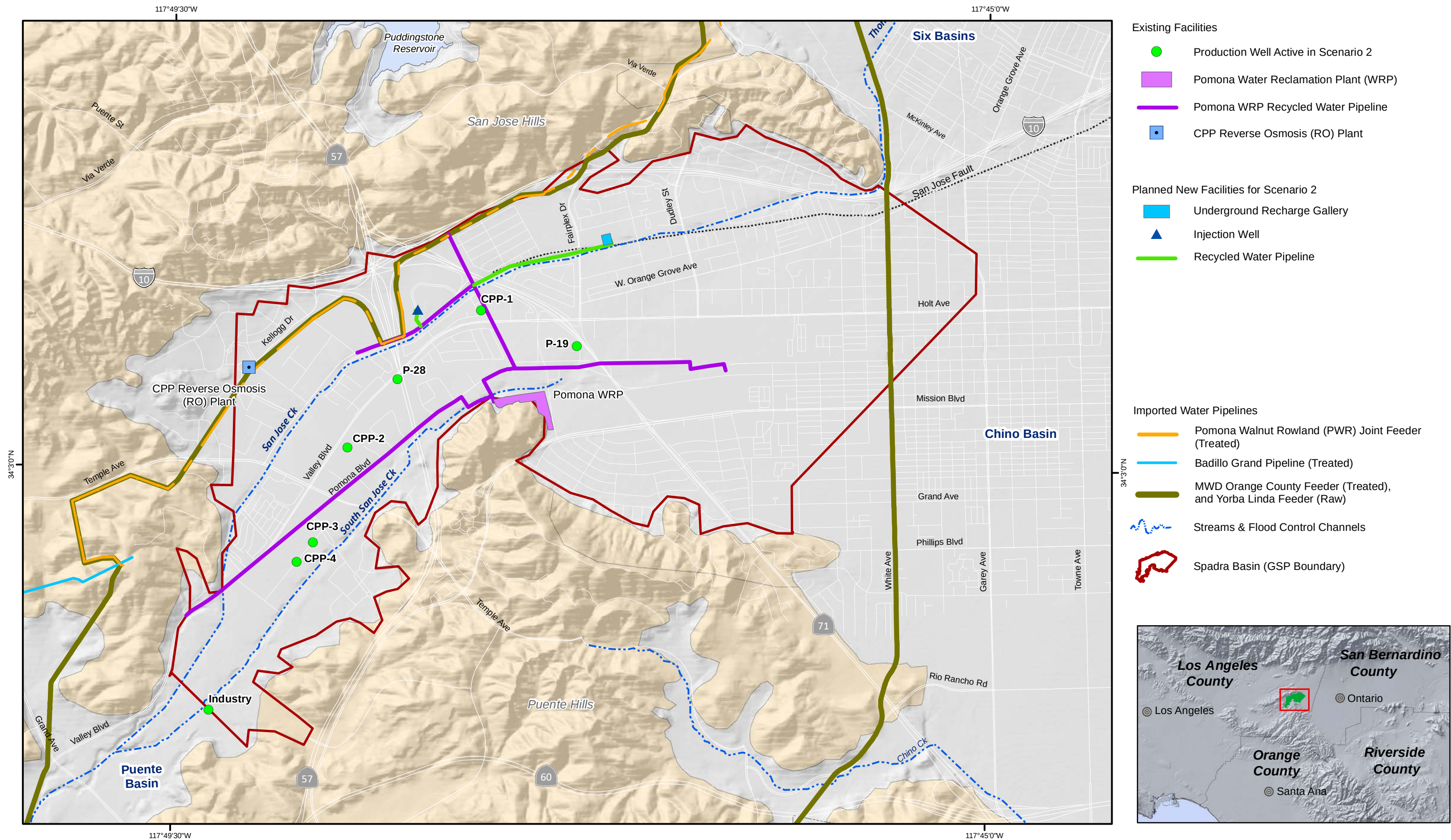


Prepared for:
Spadra Basin Groundwater Sustainability Agency
Groundwater Sustainability Plan



Location Map of Facilities for Basin Optimization Scenario 1

Figure 5-17a



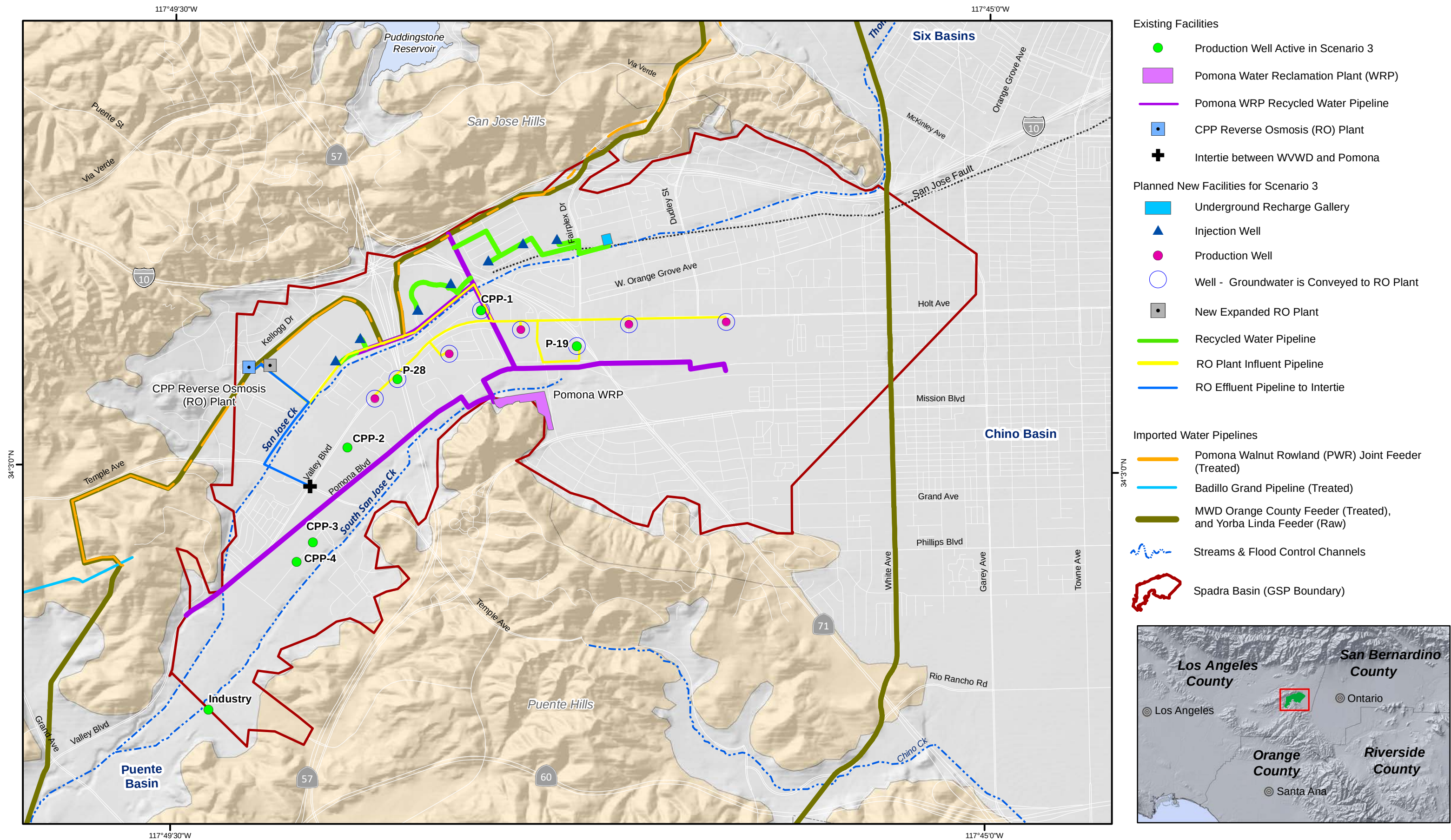


Table 5-5. Summary of Operational Assumptions for the Basin Optimization Scenarios and Facilities

Facility	Capacity (afy)	Volume Assumed in Scenario (afy)			
		Baseline	Scenario 1	Scenario 2	Scenario 3
Assumed Startup Year for Operation of Planned Facilities:			FY 2027	FY 2027	FY 2030
Pumping					
P-19	646	295	295	295	581
P-28	565	550	550	550	550
Industry Well	210	105	105	105	105
CPP-1	662	426	426	426	430
CPP-2	525	200	--	200	200
CPP-3	404	10	--	10	10
CPP-4	807	220	--	220	220
New Well 1	602	--	--	--	542
New Well 2	602	--	--	--	542
New Well 3	602	--	--	--	542
New Well 4	602	--	--	--	542
New Well 5	602	--	--	--	542
Total:	6,829	1,806	1,376	1,806	4,806
Direct Reuse of Recycled Water					
Artificial Recharge					
Underground Recharge Gallery	410	--	--	250	350
Injection Well 1	450	--	--	250	450
Injection Well 2	450	--	--	--	450
Injection Well 3	450	--	--	--	450
Injection Well 4	450	--	--	--	450
Injection Well 5	450	--	--	--	450
Injection Well 6	450	--	--	--	450
Injection Well 7	450	--	--	--	450
Total:	3,560	0	0	500	3,500
Groundwater Treatment					
Wells where groundwater pumped is conveyed to RO Plant:					
CPP-1	662	426	426	426	426
P-19	646	--	--	--	581
P-28	565	--	--	--	550
New Well 1	602	--	--	--	542
New Well 2	602	--	--	--	542
New Well 3	602	--	--	--	542
New Well 4	602	--	--	--	542
New Well 5	602	--	--	--	542
Total:	4,883	426	426	426	4,267
Cal Poly RO Plant:	550 - 4,300 ²	426	426	426	4,267
Notes: 1 - Injection Well capacity is estimated as 25% of the average capacity of the existing production wells in the center o the Spadra Basin 2- 550 afy is the current capacity and 4,300 afy is the expansion capacity for Scenario 3					

Table 5-6a. Water Budget for Spadra Basin - Basin Optimization Scenario 1 -- Fiscal Year 2019-2079 (acre-feet)											
Fiscal Year	Recharge					Discharge				Change in Storage	
	Injection Well	DIPAW	Side Inflows	Vault Recharge	Total Recharge	Groundwater Pumping	Subsurface Outflow to Puente Basin	Subsurface Outflow to Chino Basin	Total Discharge	Total Recharge minus Total Discharge	Cumulative
2019	0	1,581	1,038	0	2,619	843	1,310	537	2,690	(71)	(71)
2020	0	1,705	1,035	0	2,741	707	1,437	389	2,533	207	136
2021	0	1,820	1,039	0	2,859	727	1,440	446	2,612	247	383
2022	0	1,921	1,039	0	2,960	702	1,491	492	2,685	275	658
2023	0	2,033	1,039	0	3,072	702	1,523	535	2,760	313	971
2024	0	2,037	1,036	0	3,073	702	1,543	557	2,802	271	1,242
2025	0	2,164	1,040	0	3,204	1,922	1,388	580	3,890	(686)	556
2026	0	2,168	1,040	0	3,208	1,922	1,254	590	3,766	(558)	(2)
2027	0	2,172	1,040	0	3,212	1,494	1,328	593	3,415	(203)	2,038
2028	0	2,175	1,038	0	3,212	1,494	1,360	593	3,447	(235)	(439)
2029	0	2,178	1,041	0	3,219	1,494	1,354	591	3,439	(221)	(660)
2030	0	2,181	1,041	0	3,222	1,376	1,344	587	3,307	(85)	(745)
2031	0	2,185	1,041	0	3,226	1,376	1,337	582	3,296	(70)	(814)
2032	0	2,188	1,037	0	3,225	1,376	1,332	580	3,288	(63)	(877)
2033	0	2,191	1,040	0	3,231	1,376	1,329	577	3,281	(50)	(927)
2034	0	2,194	1,040	0	3,234	1,376	1,325	573	3,274	(41)	(968)
2035	0	2,195	1,040	0	3,235	1,376	1,322	572	3,271	(36)	(1,003)
2036	0	2,197	1,037	0	3,234	1,376	1,319	570	3,265	(31)	(1,034)
2037	0	2,197	1,040	0	3,237	1,376	1,317	571	3,264	(27)	(1,061)
2038	0	2,198	1,040	0	3,238	1,376	1,314	574	3,264	(27)	(1,088)
2039	0	2,199	1,040	0	3,238	1,376	1,312	577	3,265	(27)	(1,115)
2040	0	2,199	1,037	0	3,235	1,376	1,310	580	3,266	(31)	(1,146)
2041	0	2,199	1,039	0	3,239	1,376	1,309	586	3,271	(32)	(1,178)
2042	0	2,200	1,039	0	3,239	1,376	1,307	594	3,277	(38)	(1,216)
2043	0	2,200	1,039	0	3,239	1,376	1,306	599	3,281	(42)	(1,258)
2044	0	2,201	1,036	0	3,237	1,376	1,304	602	3,283	(46)	(1,304)
2045	0	2,201	1,039	0	3,240	1,376	1,303	605	3,284	(44)	(1,348)
2046	0	2,202	1,038	0	3,240	1,376	1,302	606	3,284	(44)	(1,392)
2047	0	2,203	1,038	0	3,241	1,376	1,301	607	3,284	(43)	(1,435)
2048	0	2,203	1,035	0	3,237	1,376	1,299	607	3,282	(45)	(1,480)
2049	0	2,203	1,038	0	3,241	1,376	1,299	607	3,282	(41)	(1,521)
2050	0	2,204	1,037	0	3,241	1,376	1,298	607	3,281	(40)	(1,562)
2051	0	2,204	1,037	0	3,241	1,376	1,297	608	3,281	(40)	(1,601)
2052	0	2,204	1,034	0	3,238	1,376	1,295	608	3,280	(42)	(1,643)
2053	0	2,205	1,037	0	3,241	1,376	1,295	609	3,280	(38)	(1,681)
2054	0	2,205	1,036	0	3,242	1,376	1,294	609	3,279	(38)	(1,719)
2055	0	2,206	1,036	0	3,242	1,376	1,293	610	3,279	(37)	(1,756)
2056	0	2,206	1,033	0	3,239	1,376	1,292	610	3,278	(39)	(1,795)
2057	0	2,206	1,036	0	3,242	1,376	1,291	610	3,278	(36)	(1,831)
2058	0	2,207	1,035	0	3,242	1,376	1,291	611	3,277	(35)	(1,866)
2059	0	2,207	1,035	0	3,243	1,376	1,290	611	3,277	(34)	(1,900)
2060	0	2,208	1,032	0	3,239	1,376	1,289	611	3,276	(37)	(1,937)
2061	0	2,208	1,035	0	3,243	1,376	1,288	612	3,276	(33)	(1,970)
2062	0	2,208	1,034	0	3,243	1,376	1,288	612	3,276	(33)	(2,003)
2063	0	2,209	1,034	0	3,243	1,376	1,287	612	3,275	(32)	(2,035)
2064	0	2,209	1,031	0	3,240	1,376	1,286	612	3,274	(34)	(2,069)
2065	0	2,210	1,034	0	3,244	1,376	1,285	613	3,274	(31)	(2,100)
2066	0	2,210	1,034	0	3,244	1,376	1,285	613	3,274	(30)	(2,130)
2067	0	2,211	1,033	0	3,244	1,376	1,284	613	3,273	(29)	(2,159)
2068	0	2,211	1,030	0	3,241	1,376	1,283	613	3,272	(32)	(2,191)
2069	0	2,211	1,033	0	3,244	1,376	1,283	613	3,272	(28)	(2,219)
2070	0	2,212	1,033	0	3,244	1,376	1,283	613	3,272	(28)	(2,247)
2071	0	2,212	1,033	0	3,244	1,376	1,282	614	3,272	(27)	(2,274)
2072	0	2,212	1,029	0	3,242	1,376	1,281	617	3,274	(32)	(2,307)
2073	0	2,212	1,033	0	3,245	1,376	1,281	623	3,280	(35)	(2,341)
2074	0	2,213	1,033	0	3,245	1,376	1,280	626	3,282	(37)	(2,379)
2075	0	2,213	1,033	0	3,245	1,376	1,280	627	3,283	(38)	(2,416)
2076	0	2,213	1,029	0	3,242	1,376	1,279	627	3,282	(40)	(2,457)
2077	0	2,213	1,033	0	3,245	1,376	1,279	626	3,281	(35)	(2,492)
2078	0	2,213	1,033	0	3,245	1,376	1,278	613	3,267	(22)	(2,514)
2079	0	2,213	1,033	0	3,245	1,376	1,278	593	3,247	(2)	(2,516)
Statistics for the Calibration Period 2019 through 2079											
Total	0	132,163	63,203	0	195,366	81,509	80,315	36,058	197,882	(2,516)	
Average	0	2,167	1,036	0	3,203	1,336	1,317	591	3,244	(41)	
Median	0	2,203	1,036	0	3,240	1,376	1,298	607	3,277	(36)	
Maximum	0	2,213	1,041	0	3,245	1,922	1,543	627	3,890	313	
Minimum	0	1,581	1,029	0	2,619	702	1,254	389	2,533	(686)	

Table 5-6b. Water Budget for Spadra Basin - Basin Optimization Scenario 2 -- Fiscal Year 2019-2079 (acre-feet)											
Fiscal Year	Recharge					Discharge				Change in Storage	
	Injection Well	DIPAW	Side Inflows	Vault Recharge	Total Recharge	Groundwater Pumping	Subsurface Outflow to Puente Basin	Subsurface Outflow to Chino Basin	Total Discharge	Total Recharge minus Total Discharge	Cumulative
2019	0	1,581	1,038	0	2,619	843	1,310	537	2,690	(71)	(71)
2020	0	1,705	1,035	0	2,741	707	1,437	389	2,533	207	136
2021	0	1,820	1,039	0	2,859	727	1,440	446	2,612	247	383
2022	0	1,921	1,039	0	2,960	702	1,491	492	2,685	275	658
2023	0	2,033	1,039	0	3,072	702	1,523	535	2,760	313	971
2024	0	2,037	1,036	0	3,073	702	1,543	557	2,802	271	1,242
2025	0	2,164	1,040	0	3,204	1,922	1,388	580	3,890	(686)	556
2026	0	2,168	1,040	0	3,208	1,922	1,254	590	3,766	(548)	8
2027	250	2,172	1,040	250	3,712	1,922	1,236	593	3,751	(38)	2,038
2028	250	2,175	1,038	250	3,712	1,922	1,253	593	3,768	(56)	(86)
2029	250	2,178	1,041	250	3,719	1,922	1,255	593	3,771	(52)	(138)
2030	250	2,181	1,041	250	3,722	1,806	1,255	590	3,651	71	(67)
2031	250	2,185	1,041	250	3,726	1,806	1,258	587	3,652	74	7
2032	250	2,188	1,037	250	3,725	1,806	1,263	586	3,655	70	77
2033	250	2,191	1,040	250	3,731	1,806	1,268	585	3,659	72	149
2034	250	2,194	1,040	250	3,734	1,806	1,273	583	3,662	72	221
2035	250	2,195	1,040	250	3,735	1,806	1,277	583	3,667	68	289
2036	250	2,197	1,037	250	3,734	1,806	1,281	582	3,669	64	354
2037	250	2,197	1,040	250	3,737	1,806	1,285	585	3,676	62	415
2038	250	2,198	1,040	250	3,738	1,806	1,289	589	3,683	55	470
2039	250	2,199	1,040	250	3,738	1,806	1,292	593	3,691	48	518
2040	250	2,199	1,037	250	3,735	1,806	1,295	597	3,698	38	556
2041	250	2,199	1,039	250	3,739	1,806	1,298	604	3,708	31	587
2042	250	2,200	1,039	250	3,739	1,806	1,300	613	3,719	21	607
2043	250	2,200	1,039	250	3,739	1,806	1,303	618	3,727	13	620
2044	250	2,201	1,036	250	3,737	1,806	1,305	622	3,733	4	624
2045	250	2,201	1,039	250	3,740	1,806	1,307	625	3,738	2	626
2046	250	2,202	1,038	250	3,740	1,806	1,309	627	3,742	(2)	624
2047	250	2,203	1,038	250	3,741	1,806	1,310	628	3,744	(4)	620
2048	250	2,203	1,035	250	3,737	1,806	1,311	629	3,746	(9)	611
2049	250	2,203	1,038	250	3,741	1,806	1,313	630	3,749	(8)	603
2050	250	2,204	1,037	250	3,741	1,806	1,314	630	3,750	(9)	594
2051	250	2,204	1,037	250	3,741	1,806	1,315	631	3,752	(11)	583
2052	250	2,204	1,034	250	3,738	1,806	1,316	632	3,753	(15)	568
2053	250	2,205	1,037	250	3,741	1,806	1,316	633	3,755	(14)	554
2054	250	2,205	1,036	250	3,742	1,806	1,317	633	3,757	(15)	539
2055	250	2,206	1,036	250	3,742	1,806	1,318	634	3,758	(16)	523
2056	250	2,206	1,033	250	3,739	1,806	1,318	635	3,758	(20)	504
2057	250	2,206	1,036	250	3,742	1,806	1,318	635	3,760	(18)	486
2058	250	2,207	1,035	250	3,742	1,806	1,319	636	3,761	(18)	468
2059	250	2,207	1,035	250	3,743	1,806	1,319	636	3,761	(19)	449
2060	250	2,208	1,032	250	3,739	1,806	1,319	637	3,762	(22)	427
2061	250	2,208	1,035	250	3,743	1,806	1,319	637	3,762	(20)	407
2062	250	2,208	1,034	250	3,743	1,806	1,319	638	3,763	(20)	387
2063	250	2,209	1,034	250	3,743	1,806	1,319	638	3,763	(20)	367
2064	250	2,209	1,031	250	3,740	1,806	1,319	638	3,763	(23)	344
2065	250	2,210	1,034	250	3,744	1,806	1,319	639	3,764	(20)	323
2066	250	2,210	1,034	250	3,744	1,806	1,319	639	3,764	(20)	303
2067	250	2,211	1,033	250	3,744	1,806	1,319	639	3,764	(20)	283
2068	250	2,211	1,030	250	3,741	1,806	1,318	640	3,764	(23)	260
2069	250	2,211	1,033	250	3,744	1,806	1,318	640	3,764	(20)	240
2070	250	2,212	1,033	250	3,744	1,806	1,318	640	3,764	(20)	219
2071	250	2,212	1,033	250	3,744	1,806	1,318	641	3,764	(20)	199
2072	250	2,212	1,029	250	3,742	1,806	1,318	644	3,767	(26)	174
2073	250	2,212	1,033	250	3,745	1,806	1,317	650	3,773	(28)	145
2074	250	2,213	1,033	250	3,745	1,806	1,317	653	3,776	(31)	114
2075	250	2,213	1,033	250	3,745	1,806	1,317	654	3,777	(32)	82
2076	250	2,213	1,029	250	3,742	1,806	1,317	655	3,777	(35)	47
2077	250	2,213	1,033	250	3,745	1,806	1,316	653	3,775	(30)	17
2078	250	2,213	1,033	250	3,745	1,806	1,316	640	3,762	(17)	(0)
2079	250	2,213	1,033	250	3,745	1,806	1,316	621	3,742	3	3
Statistics for the Calibration Period 2019 through 2079											
Total	13,250	132,163	63,203	13,250	221,866	104,293	80,448	37,132	221,873	3	
Average	217	2,167	1,036	217	3,637	1,710	1,319	609	3,637	0	
Median	250	2,203	1,036	250	3,740	1,806	1,316	629	3,753	(15)	
Maximum	250	2,213	1,041	250	3,745	1,922	1,543	655	3,890	313	
Minimum	0	1,581	1,029	0	2,619	702	1,236	389	2,533	(686)	

Table 5-6c. Water Budget for Spadra Basin - Basin Optimization Scenario 3 -- Fiscal Year 2019-2079 (acre-feet)											
Fiscal Year	Recharge					Discharge				Change in Storage	
	Injection Well	DIPAW	Side Inflows	Vault Recharge	Total Recharge	Groundwater Pumping	Subsurface Outflow to Puente Basin	Subsurface Outflow to Chino Basin	Total Discharge	Total Recharge minus Total Discharge	Cumulative
2019	0	1,581	1,038	0	2,619	843	1,310	537	2,690	(71)	(71)
2020	0	1,705	1,035	0	2,741	707	1,437	389	2,533	207	136
2021	0	1,820	1,039	0	2,859	727	1,440	446	2,612	247	383
2022	0	1,921	1,039	0	2,960	702	1,491	492	2,685	275	658
2023	0	2,033	1,039	0	3,072	702	1,523	535	2,760	313	971
2024	0	2,037	1,036	0	3,073	702	1,543	557	2,802	271	1,242
2025	0	2,164	1,040	0	3,204	1,922	1,388	580	3,890	(686)	556
2026	0	2,168	1,040	0	3,208	1,922	1,254	590	3,766	(558)	(2)
2027	0	2,172	1,040	0	3,212	1,922	1,195	593	3,710	(498)	2,038
2028	0	2,175	1,038	0	3,212	1,922	1,155	593	3,669	(457)	(957)
2029	0	2,178	1,041	0	3,219	1,922	1,122	591	3,635	(412)	(1,369)
2030	3,150	2,181	1,041	350	6,722	4,806	1,123	585	6,513	209	(1,160)
2031	3,150	2,185	1,041	350	6,726	4,806	1,243	576	6,625	101	(1,060)
2032	3,150	2,188	1,037	350	6,725	4,806	1,290	568	6,664	61	(999)
2033	3,150	2,191	1,040	350	6,731	4,806	1,306	561	6,674	58	(941)
2034	3,150	2,194	1,040	350	6,734	4,806	1,313	556	6,675	58	(883)
2035	3,150	2,195	1,040	350	6,735	4,806	1,317	555	6,679	57	(826)
2036	3,150	2,197	1,037	350	6,734	4,806	1,321	553	6,680	54	(772)
2037	3,150	2,197	1,040	350	6,737	4,806	1,324	555	6,685	53	(719)
2038	3,150	2,198	1,040	350	6,738	4,806	1,327	558	6,691	47	(673)
2039	3,150	2,199	1,040	350	6,738	4,806	1,329	562	6,697	41	(632)
2040	3,150	2,199	1,037	350	6,735	4,806	1,332	566	6,704	32	(600)
2041	3,150	2,199	1,039	350	6,739	4,806	1,334	573	6,713	26	(574)
2042	3,150	2,200	1,039	350	6,739	4,806	1,336	581	6,723	16	(558)
2043	3,150	2,200	1,039	350	6,739	4,806	1,338	587	6,731	8	(550)
2044	3,150	2,201	1,036	350	6,737	4,806	1,340	591	6,737	0	(550)
2045	3,150	2,201	1,039	350	6,740	4,806	1,341	594	6,741	(1)	(551)
2046	3,150	2,202	1,038	350	6,740	4,806	1,343	596	6,745	(5)	(556)
2047	3,150	2,203	1,038	350	6,741	4,806	1,344	597	6,747	(6)	(562)
2048	3,150	2,203	1,035	350	6,737	4,806	1,345	597	6,749	(11)	(573)
2049	3,150	2,203	1,038	350	6,741	4,806	1,346	598	6,751	(10)	(583)
2050	3,150	2,204	1,037	350	6,741	4,806	1,347	599	6,752	(11)	(594)
2051	3,150	2,204	1,037	350	6,741	4,806	1,348	599	6,754	(12)	(606)
2052	3,150	2,204	1,034	350	6,738	4,806	1,349	600	6,755	(17)	(623)
2053	3,150	2,205	1,037	350	6,741	4,806	1,349	601	6,756	(15)	(638)
2054	3,150	2,205	1,036	350	6,742	4,806	1,350	602	6,758	(16)	(654)
2055	3,150	2,206	1,036	350	6,742	4,806	1,350	602	6,759	(17)	(671)
2056	3,150	2,206	1,033	350	6,739	4,806	1,350	603	6,759	(21)	(691)
2057	3,150	2,206	1,036	350	6,742	4,806	1,351	604	6,760	(18)	(710)
2058	3,150	2,207	1,035	350	6,742	4,806	1,351	604	6,761	(19)	(729)
2059	3,150	2,207	1,035	350	6,743	4,806	1,351	605	6,762	(19)	(748)
2060	3,150	2,208	1,032	350	6,739	4,806	1,351	605	6,762	(23)	(771)
2061	3,150	2,208	1,035	350	6,743	4,806	1,351	606	6,763	(20)	(791)
2062	3,150	2,208	1,034	350	6,743	4,806	1,351	606	6,763	(20)	(811)
2063	3,150	2,209	1,034	350	6,743	4,806	1,351	606	6,764	(20)	(832)
2064	3,150	2,209	1,031	350	6,740	4,806	1,351	607	6,764	(24)	(856)
2065	3,150	2,210	1,034	350	6,744	4,806	1,351	607	6,764	(21)	(876)
2066	3,150	2,210	1,034	350	6,744	4,806	1,351	607	6,764	(21)	(897)
2067	3,150	2,211	1,033	350	6,744	4,806	1,351	607	6,764	(20)	(918)
2068	3,150	2,211	1,030	350	6,741	4,806	1,351	608	6,764	(24)	(941)
2069	3,150	2,211	1,033	350	6,744	4,806	1,351	608	6,765	(20)	(962)
2070	3,150	2,212	1,033	350	6,744	4,806	1,350	608	6,765	(20)	(982)
2071	3,150	2,212	1,033	350	6,744	4,806	1,350	609	6,765	(20)	(1,002)
2072	3,150	2,212	1,029	350	6,742	4,806	1,350	612	6,768	(26)	(1,028)
2073	3,150	2,212	1,033	350	6,745	4,806	1,350	618	6,774	(29)	(1,057)
2074	3,150	2,213	1,033	350	6,745	4,806	1,350	621	6,776	(31)	(1,088)
2075	3,150	2,213	1,033	350	6,745	4,806	1,349	622	6,777	(32)	(1,121)
2076	3,150	2,213	1,029	350	6,742	4,806	1,349	623	6,777	(35)	(1,156)
2077	3,150	2,213	1,033	350	6,745	4,806	1,349	621	6,776	(31)	(1,187)
2078	3,150	2,213	1,033	350	6,745	4,806	1,348	608	6,763	(17)	(1,204)
2079	3,150	2,213	1,033	350	6,745	4,806	1,348	589	6,742	3	(1,201)
Statistics for the Calibration Period 2019 through 2079											
Total	157,500	132,163	63,203	17,500	370,366	254,293	81,652	35,626	371,571	(1,201)	
Average	2,582	2,167	1,036	287	6,072	4,169	1,339	584	6,091	(20)	
Median	3,150	2,203	1,036	350	6,740	4,806	1,349	597	6,749	(17)	
Maximum	3,150	2,213	1,041	350	6,745	4,806	1,543	623	6,777	313	
Minimum	0	1,581	1,029	0	2,619	702	1,122	389	2,533	(686)	

5.4.1 Groundwater Level Response

5.4.1.1 Groundwater Elevation and Groundwater-Flow Directions

Figures 5-18a through 5-18d are maps showing the model-estimated groundwater elevations and flow directions for the Baseline Scenario and the three Basin Optimization Scenarios for the years 2018 (start of the planning period prior to implementation), 2040, 2050, and 2079 (end of the planning period). Also shown on the maps are the pumping and recharge facilities assumed to be operational in the scenarios.

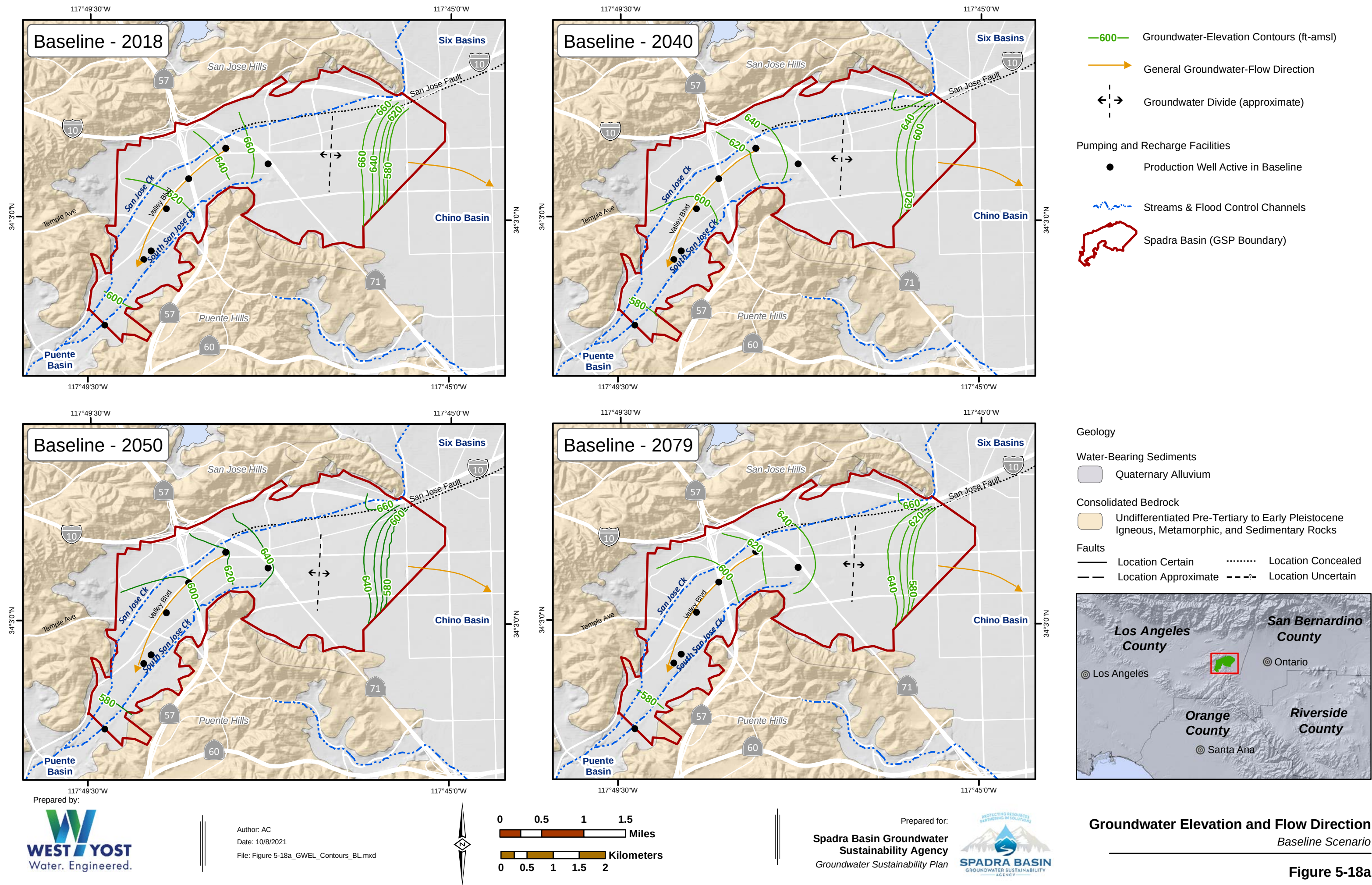
The groundwater-elevation contours are used to analyze and interpret the groundwater-flow directions over the planning period—groundwater flows perpendicular to the contours from higher to lower elevation:

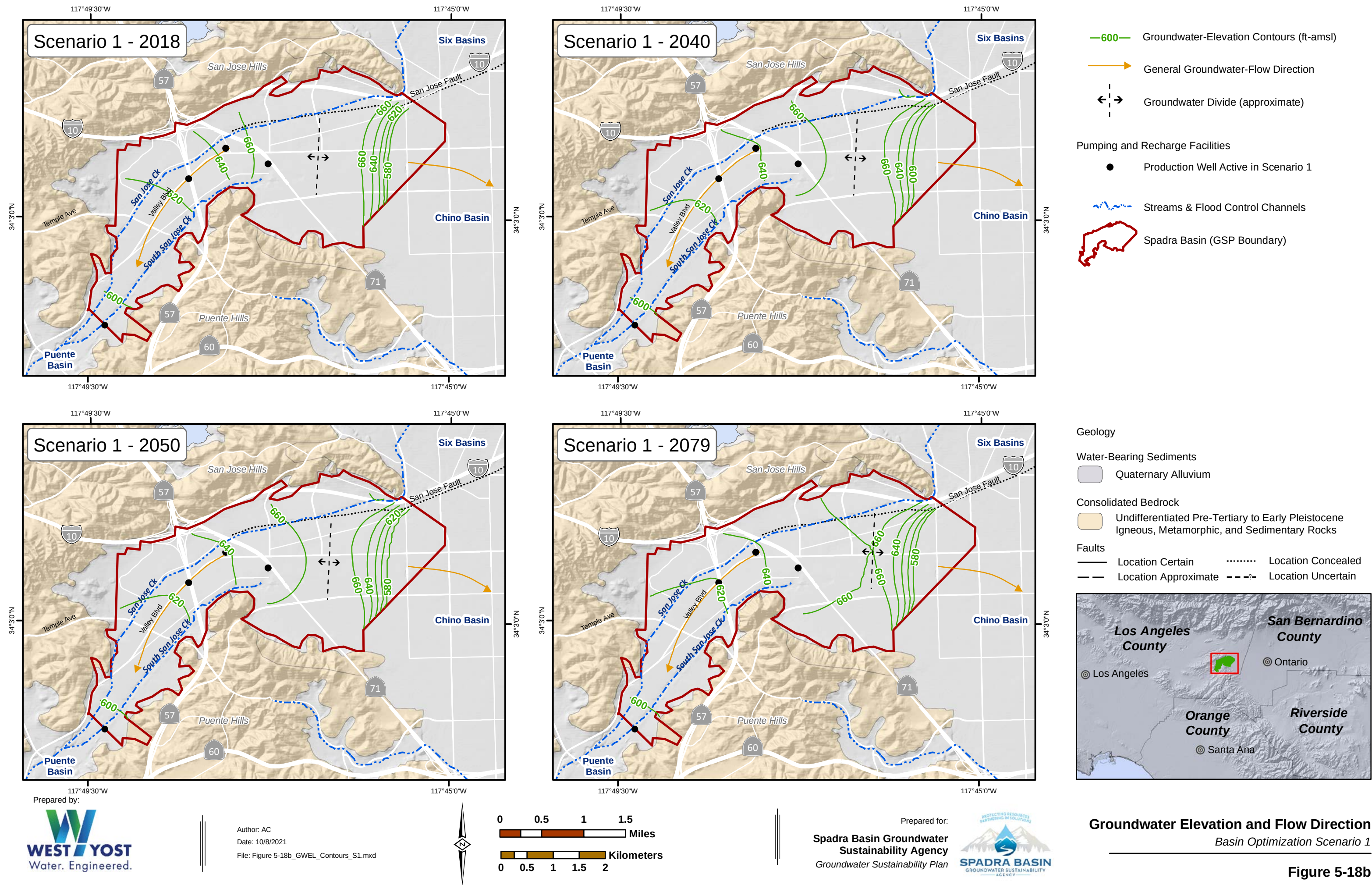
- In the Baseline Scenario, the general groundwater-flow directions remain relatively constant over the planning period and are similar to what was observed historically as described in Section 2.2.2.11 Groundwater Levels and Storage of the Basin Setting. There is a north/south-oriented groundwater divide located in the eastern portion of the basin. In the east, groundwater flows from the groundwater divide towards Chino Basin. West of the groundwater divide, groundwater flows toward Puente Basin. The location of the groundwater divide oscillates slightly in the east/west directions over the planning period.
- In Basin Optimization Scenarios 1 & 2, the groundwater-flow directions are not significantly different than the groundwater-flow directions in the Baseline Scenario.

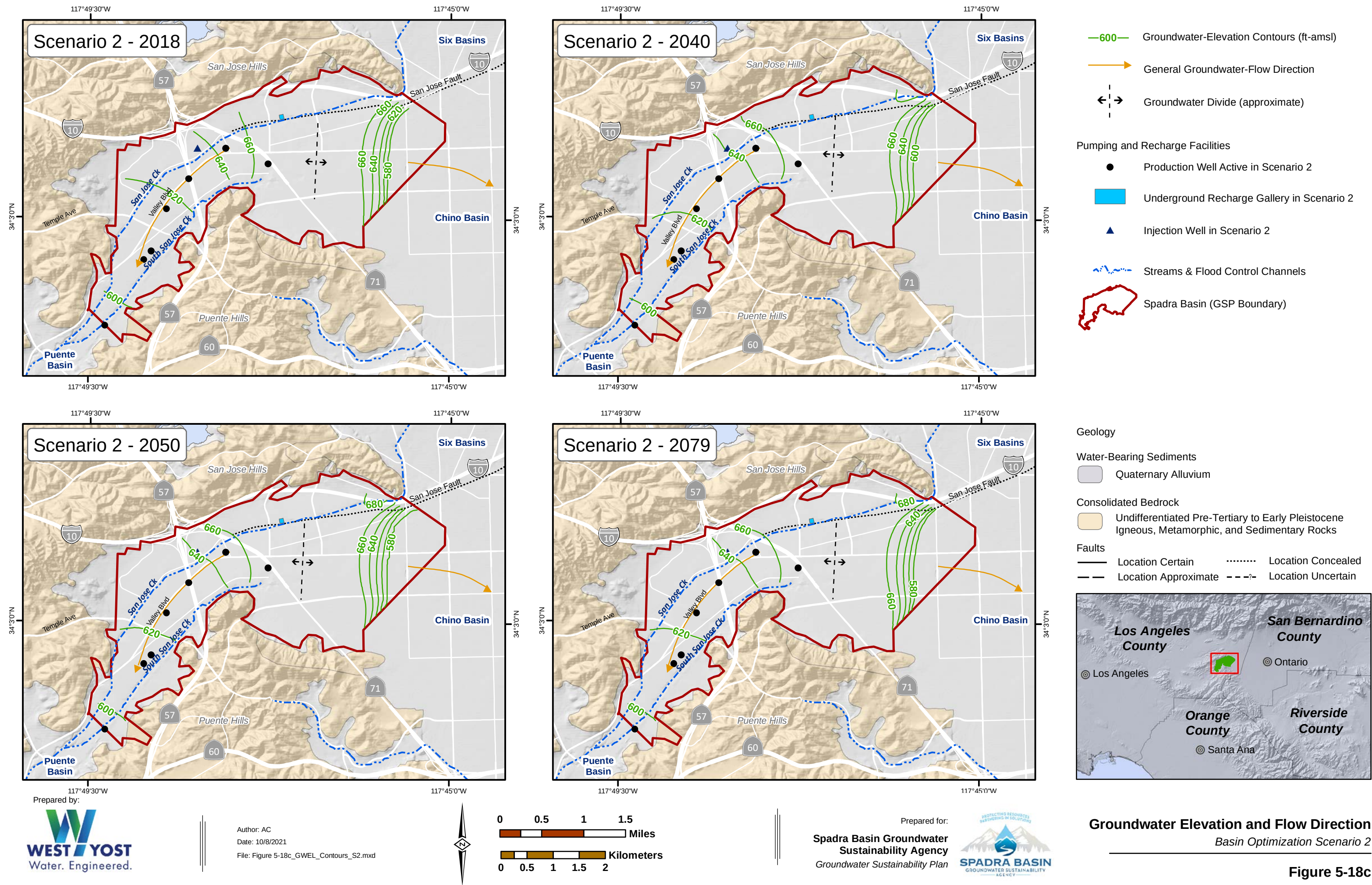
In Basin Optimization Scenario 3, the increases in recharge and pumping cause a change in groundwater-flow directions to a north-to-south direction in the central portion of the basin, and the groundwater divide shifts to the east towards Chino Basin.

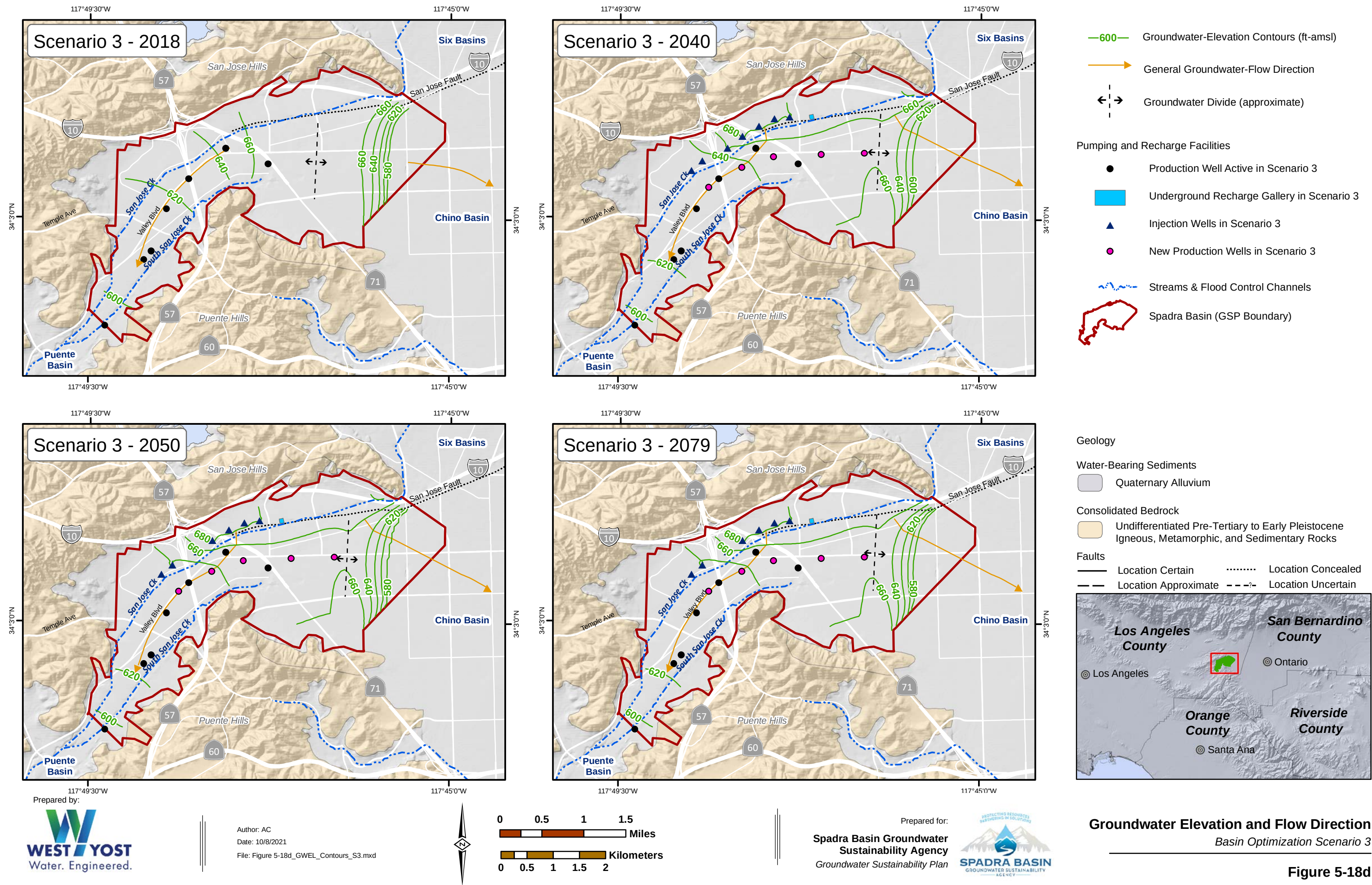
Figures 35-19a through 35-19d are maps showing the model-estimated change in groundwater elevation across the Spadra Basin for the Baseline Scenario and the three Basin Optimization Scenarios for the years: 2030, 2040, 2050, and 2079 (end of planning period). Groundwater elevation change is shown on each map as a color-ramped raster and contours of groundwater-elevation change. The maps also show the existing and planned pumping and recharge facilities included in each scenario.

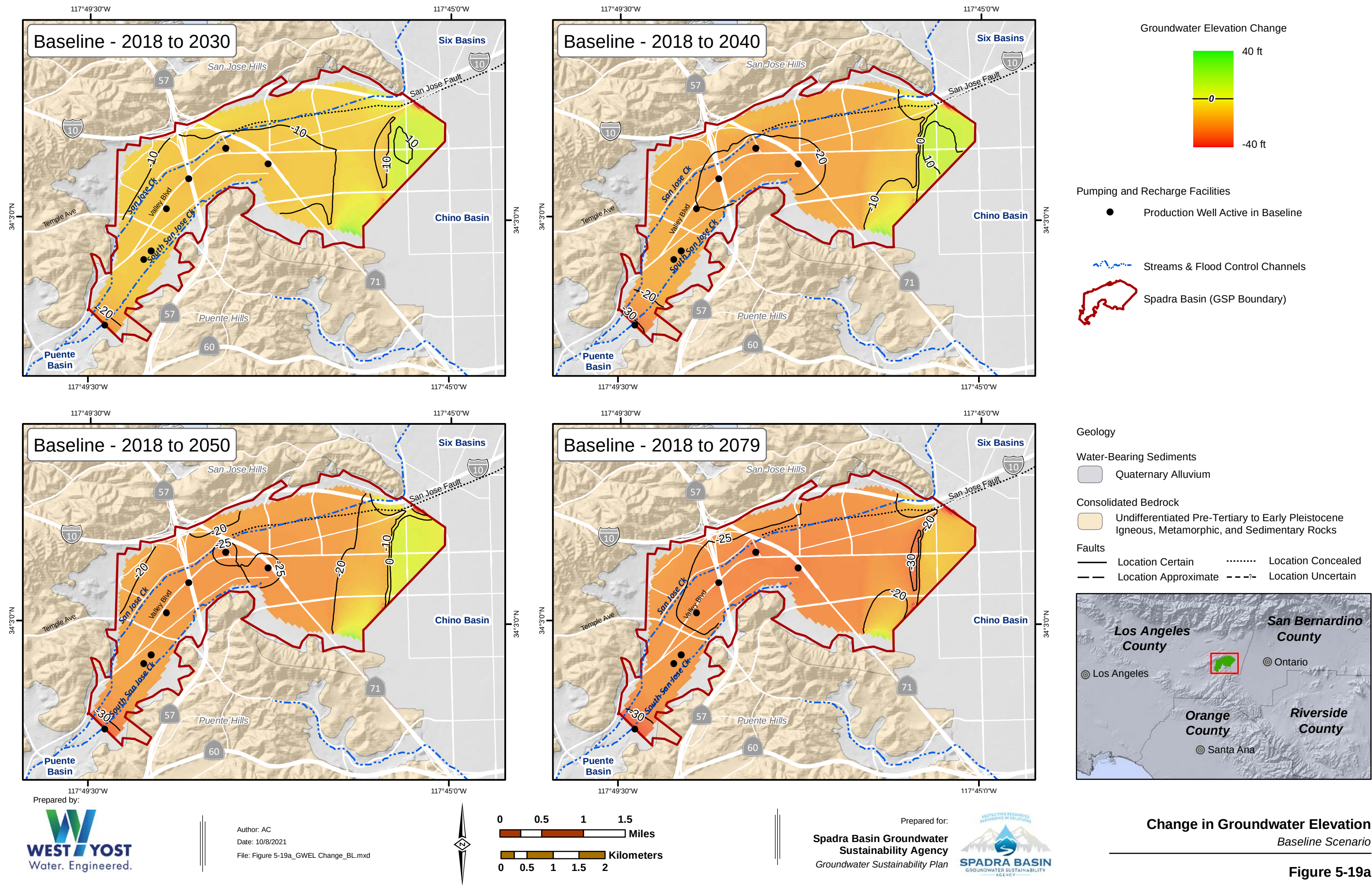
- **Baseline Scenario**, groundwater elevations are projected to decline across most of the basin by about 25 ft over the planning period.
- **Basin Optimization Scenario 1**, groundwater elevations are projected to increase by up to 10 ft in the west, decrease by up to 10 ft in the center of the basin, and decrease by up to 30 ft in the east over the planning period.
- **Basin Optimization Scenario 2**, groundwater elevations are projected to increase by up to 10 ft in the western and central portions of the basin, and decrease by up to 20 ft in the east over the planning period.
- **Basin Optimization Scenario 3**, groundwater elevations are projected to increase by up to 10 ft in the west, increase by up to 30 ft in the central portion of the basin, and decrease by up to 30 ft in the east over the planning period.

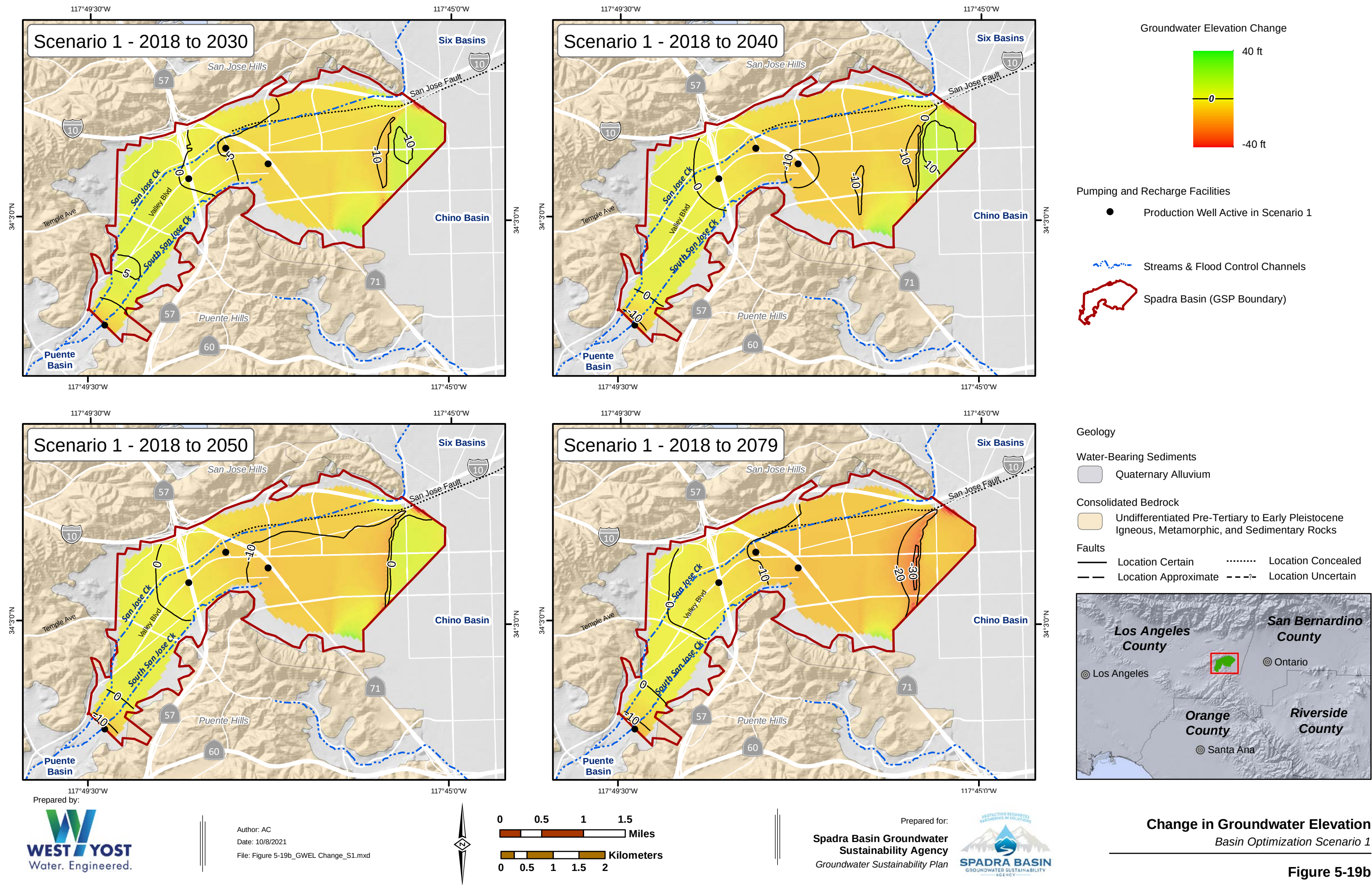


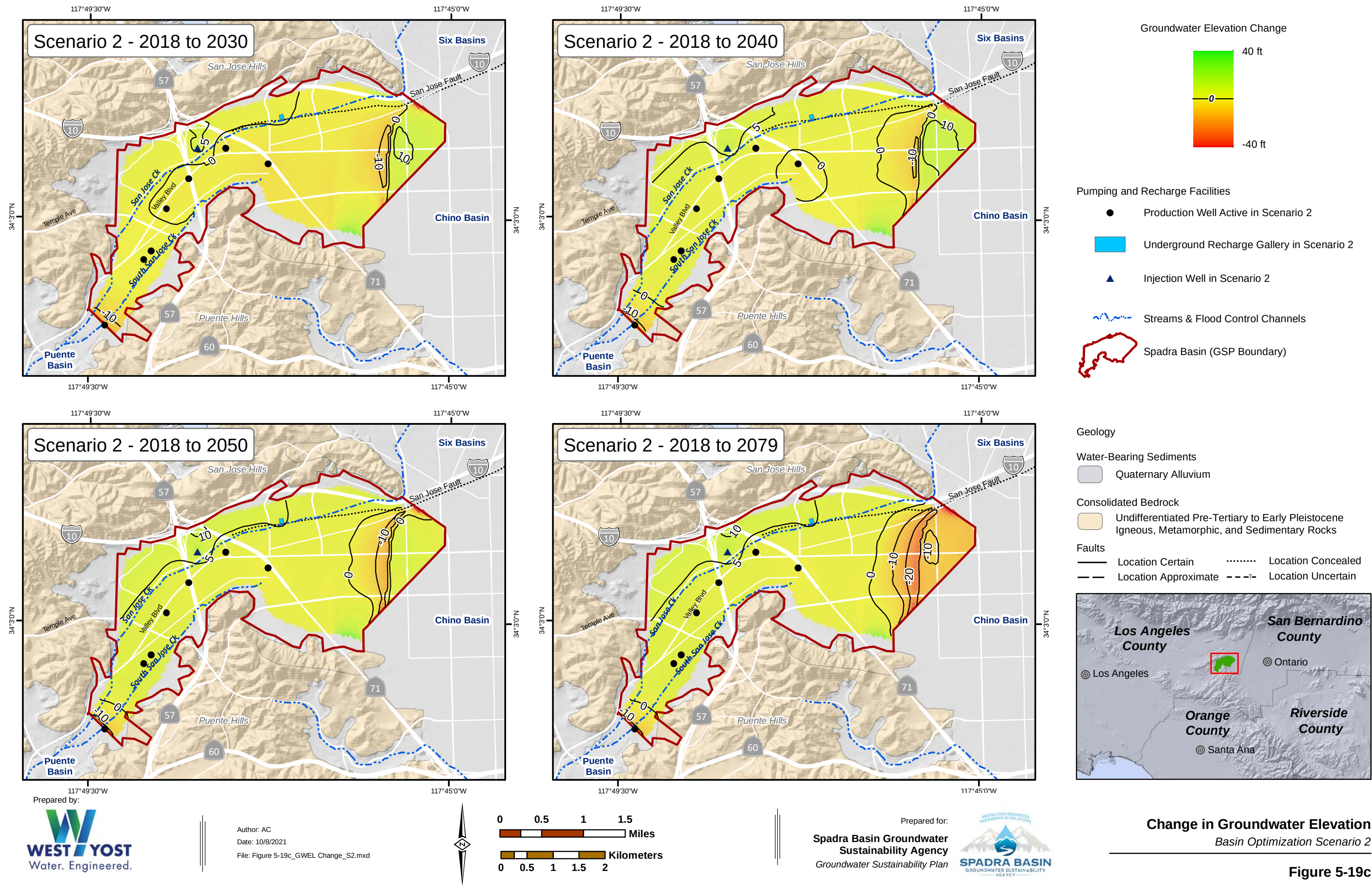


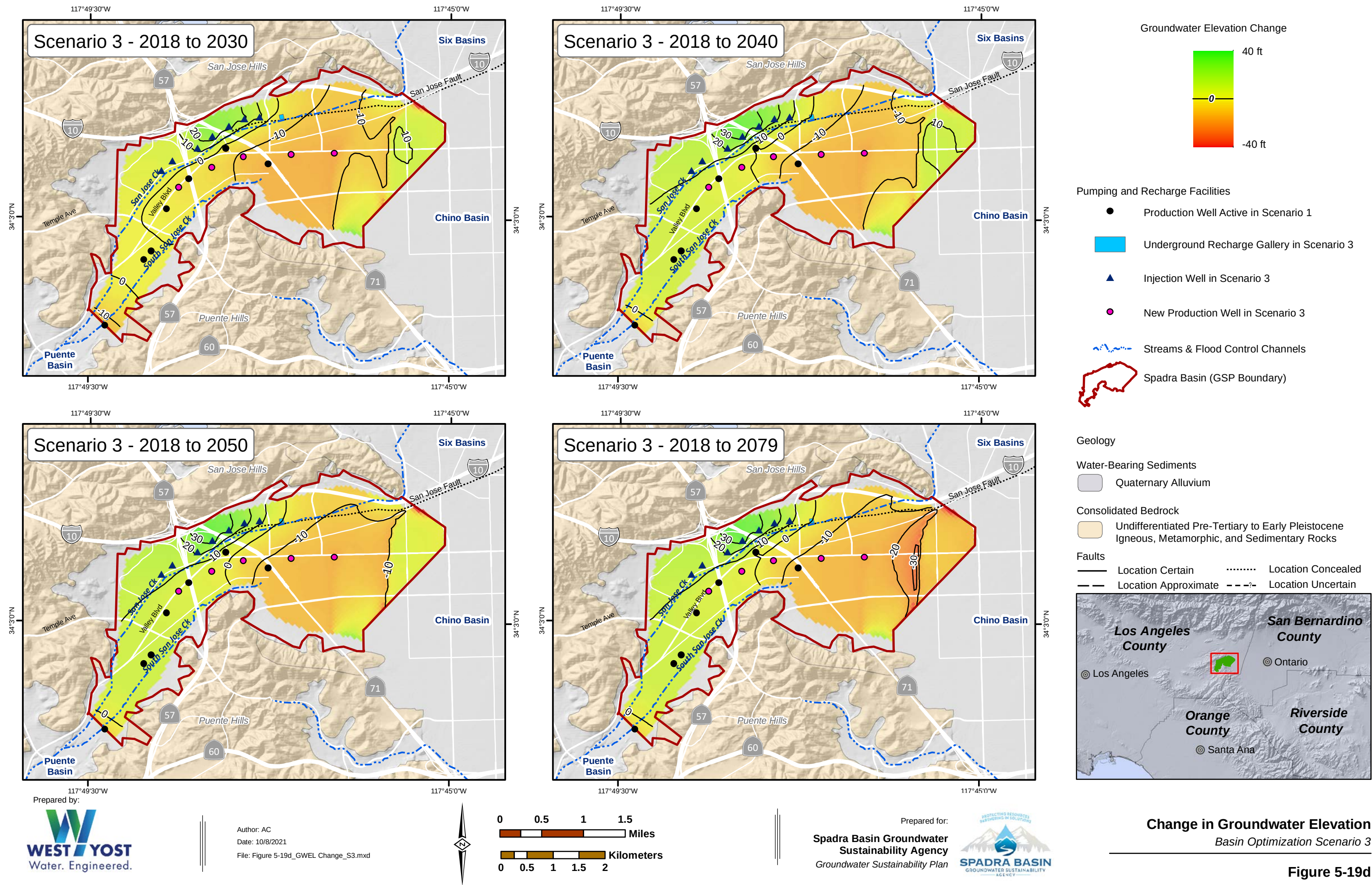












In all three Basin Optimization Scenarios, groundwater levels are projected to decline in the eastern portion of the basin. As described in *Section 2.2.7 Data Gaps*, this is an area of highest uncertainty in the groundwater-flow model of the Spadra Basin, and hence, an area that should be monitored in the future for changes in groundwater levels and potential adverse impacts to the neighboring Chino Basin, such as reduced subsurface outflow. The Spadra Basin GSA is in the process of constructing a new monitoring well within the eastern portion of the basin near the Spadra/Chino Basin boundary. The data that will be collected from the new monitoring well includes borehole lithology, borehole geophysics, depth to bottom of the aquifer, groundwater-quality data, and high-frequency groundwater-level data. The data collected from the new monitoring well, and additional monitoring data collected in the eastern portion of the basin, will be used to detect the potential adverse impacts and Undesirable Results, and also can be used to update and improve the [Spadra Basin Groundwater Model](#) in the future.

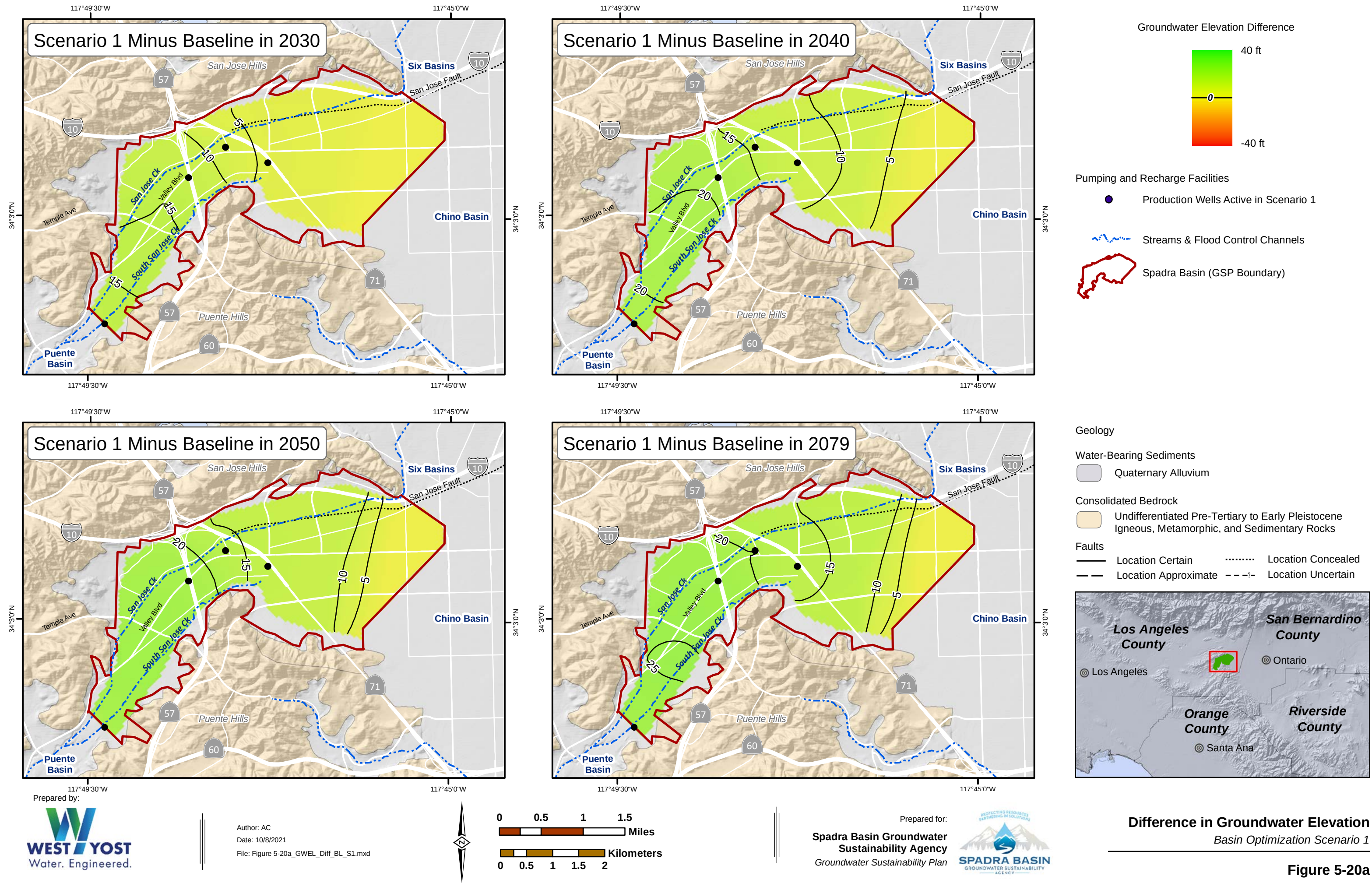
Figures 5-20a through 5-20c show the difference between the model-estimated groundwater elevations for the Baseline Scenario and the three Basin Optimization Scenarios for the years 2030, 2040, 2050, and 2079. The difference in groundwater elevation from the Baseline Scenario is shown on each map as a color-ramped raster and contours of groundwater-elevation difference. These maps show that by 2079 (end of the planning period) groundwater elevations are higher for all Basin Optimization Scenarios compared to the Baseline Scenario:

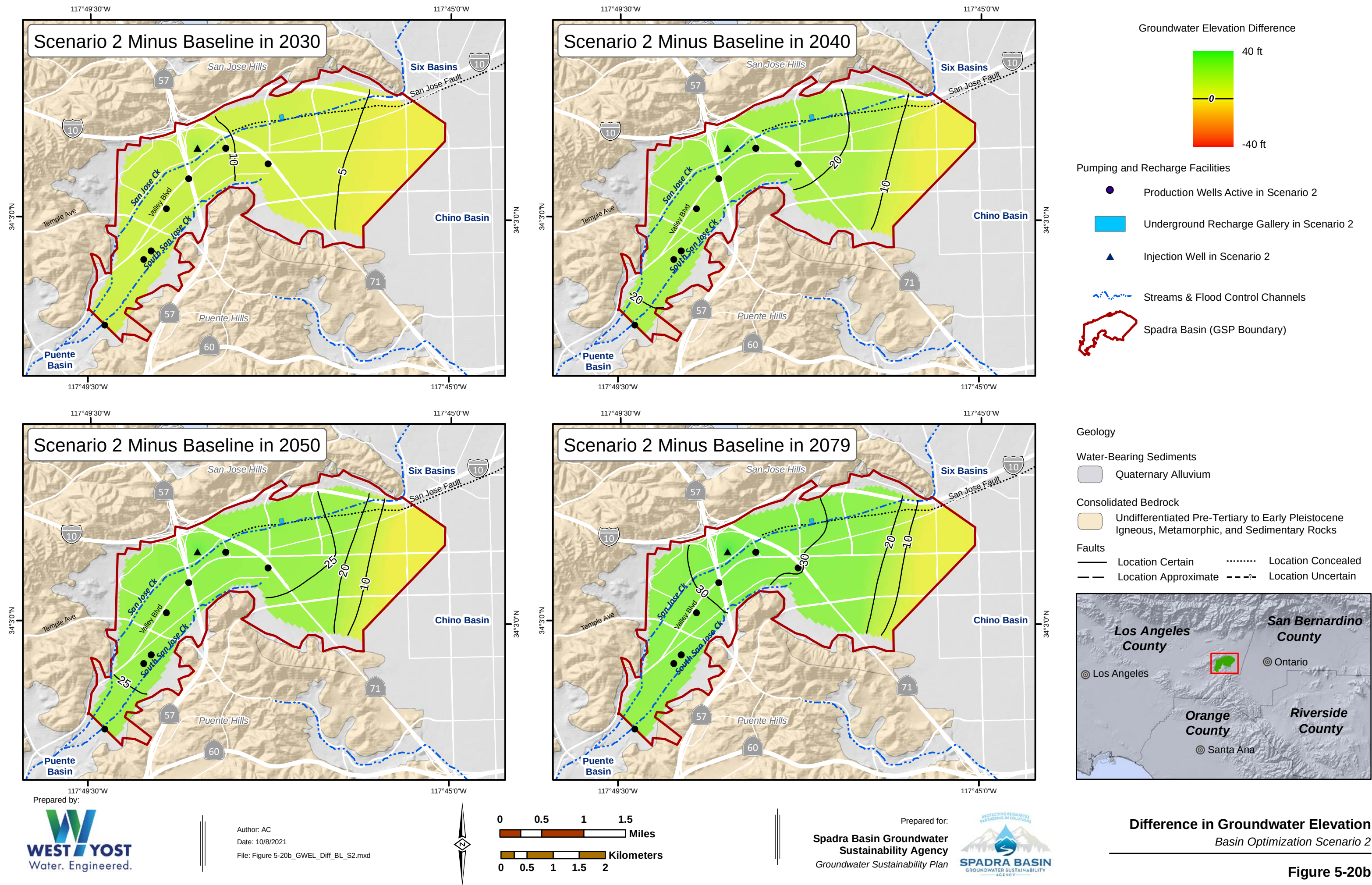
- In Basin Optimization Scenario 1, groundwater elevations across the basin are projected to be about 5 to 25 ft higher compared to the Baseline Scenario.
- In Basin Optimization Scenario 2, groundwater elevations across the basin are projected to be about 5 to 30 ft higher compared to the Baseline Scenario.
- In Basin Optimization Scenario 3, groundwater elevations across the basin are projected to be about 5 to 55 ft higher compared to the Baseline Scenario.

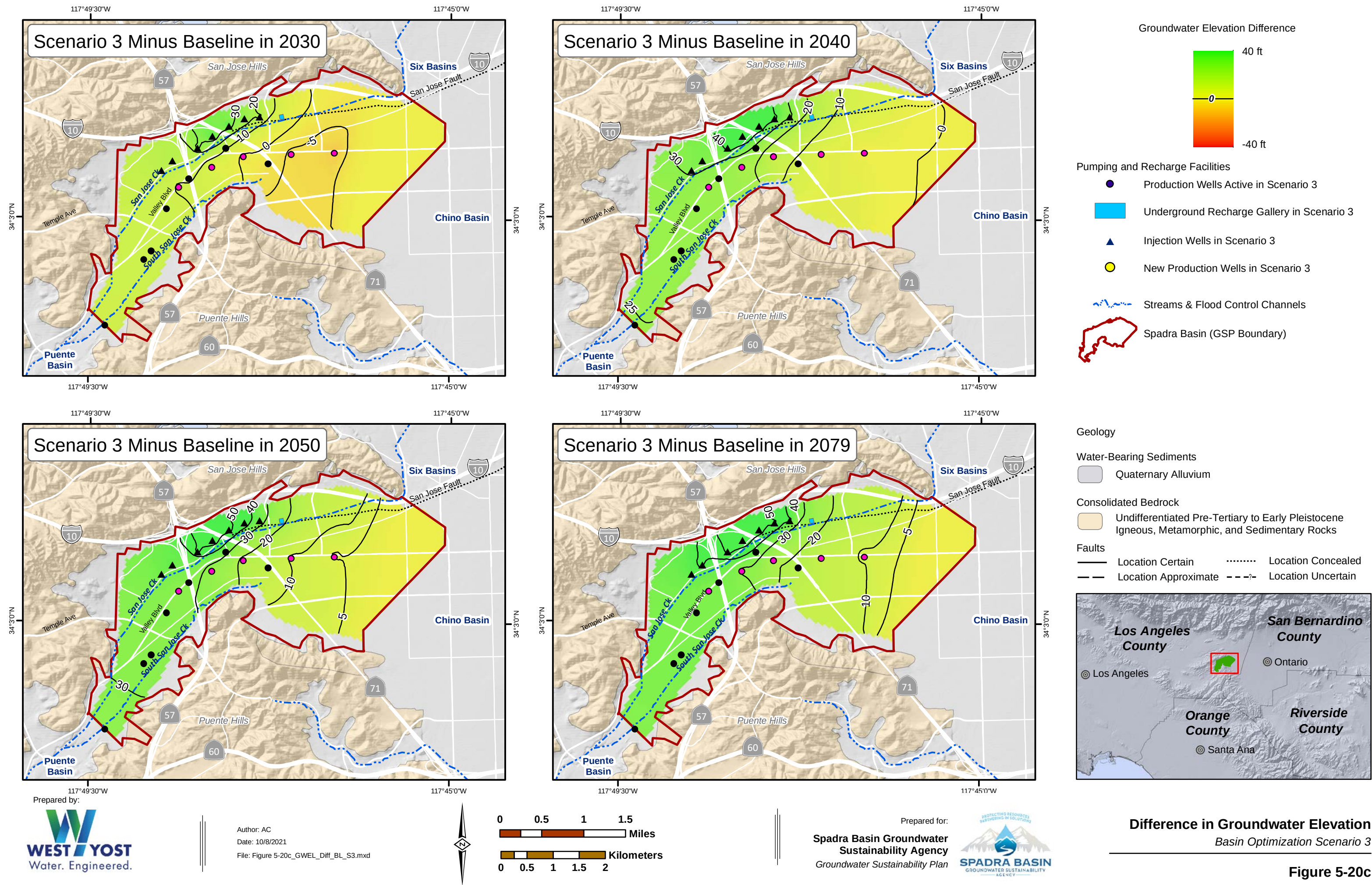
The greatest differences in groundwater elevations between the Basin Optimization Scenarios and the Baseline occur in the areas of the Spadra Basin where projects for either reduced pumping or artificial recharge are proposed. The greatest differences in groundwater elevations compared to the Baseline Scenario occur in the west for Basin Optimization Scenario 1; the central portion of the basin for Basin Optimization Scenario 2; and in the northern portion of the basin for Basin Optimization Scenario 3.

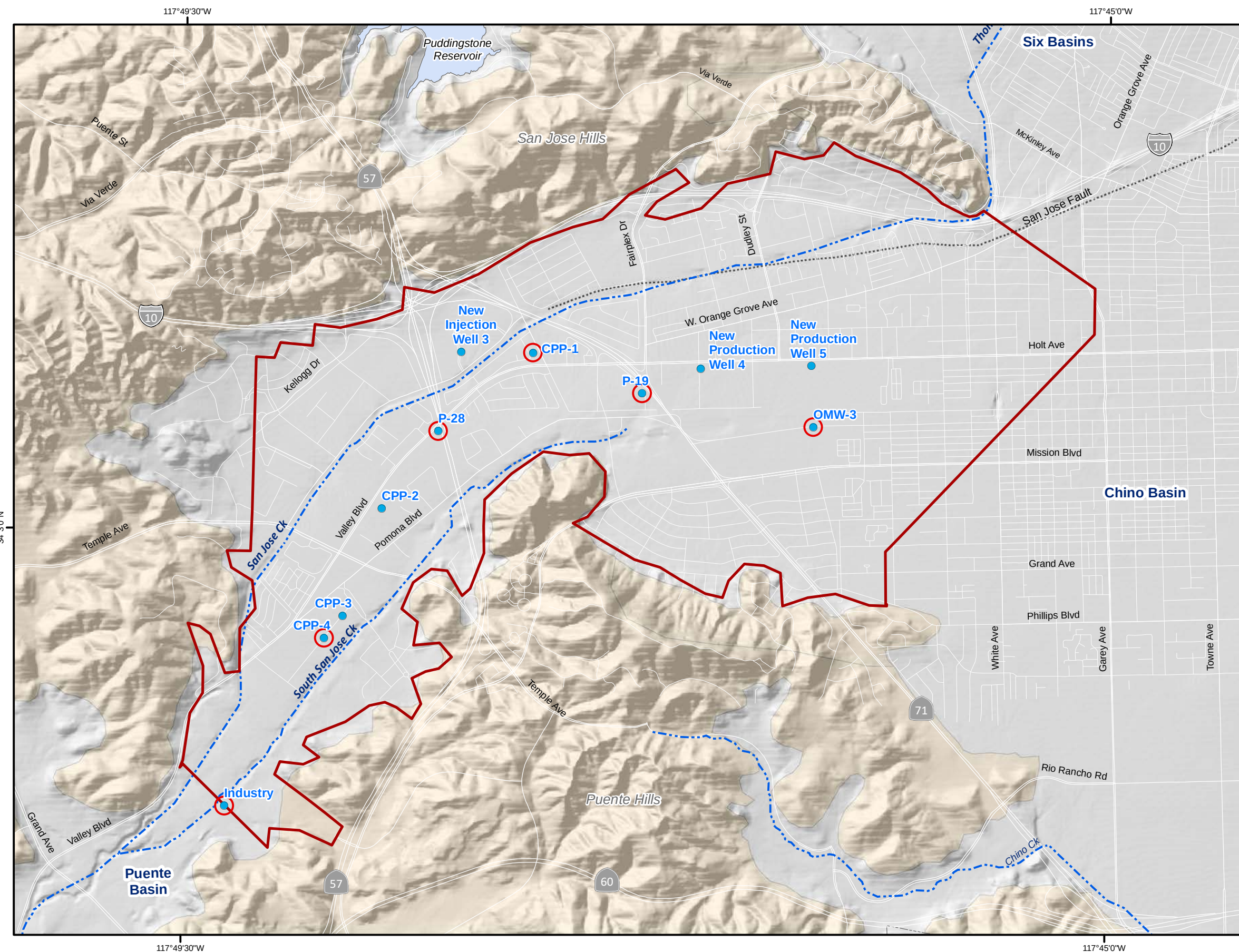
5.4.1.1.1 Groundwater Elevations at Wells

Figure 5-21 shows the locations of eleven wells across the Spadra Basin where time series of model-predicted groundwater elevations were analyzed to evaluate the change in water levels over the planning period and the sustainability of the Basin Optimization Scenarios. Figures 5-22a through 5-22k are time series charts of the historical and projected groundwater elevations for the three Basin Optimization Scenarios compared to the Baseline Scenario for the eleven wells. The wells include all active municipal pumping wells and/or representative monitoring wells where Sustainable Management Criteria were established in Section 3 Sustainable Management Criteria, two proposed pumping well locations in Basin Optimization Scenario 3, and one proposed injection well location in Basin Optimization Scenarios 2 and 3. For the wells that are representative monitoring locations with Sustainable Management Criteria, the Minimum Thresholds and Measurable Objectives are shown on the time-series charts.

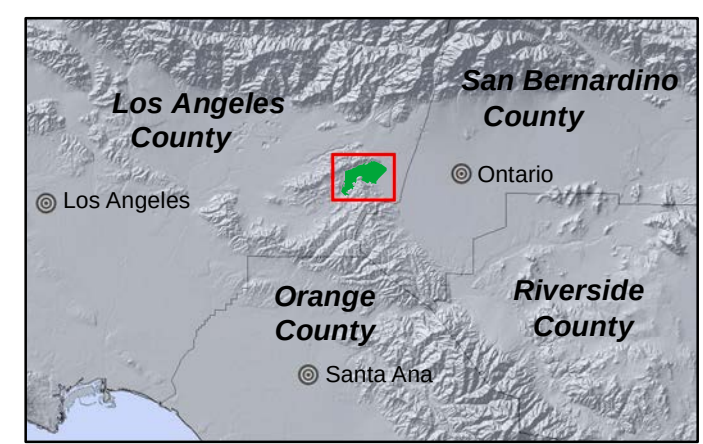






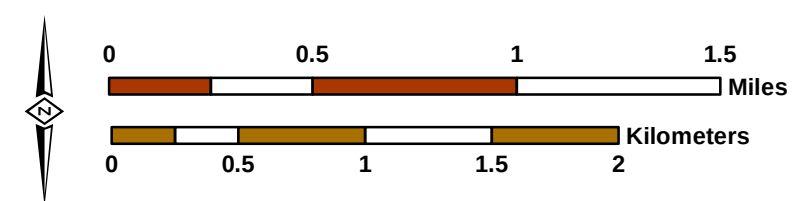


- Well with Time Series of Model-Predicted Groundwater Elevations in Figures 3-6a through 3-6k
- Representative Monitoring Well with Sustainable Management Criteria for Groundwater Levels
- Groundwater-Elevation Change Contours (ft)
- Streams & Flood Control Channels
- Spadra Basin (GSP Boundary)



Prepared by:
WEST YOST
 Water. Engineered.

Author: VMW
 Date: 10/8/2021
 File: Figure 5-21_TS_GWEL.mxd



Prepared for:
Spadra Basin Groundwater Sustainability Agency
 Groundwater Sustainability Plan



Well with Time Series of Model-Predicted Groundwater Elevations

Figure 5-21

Figure 5-22a. Historical and Projected Groundwater Elevations for Baseline and Basin Optimization Scenarios at Industry

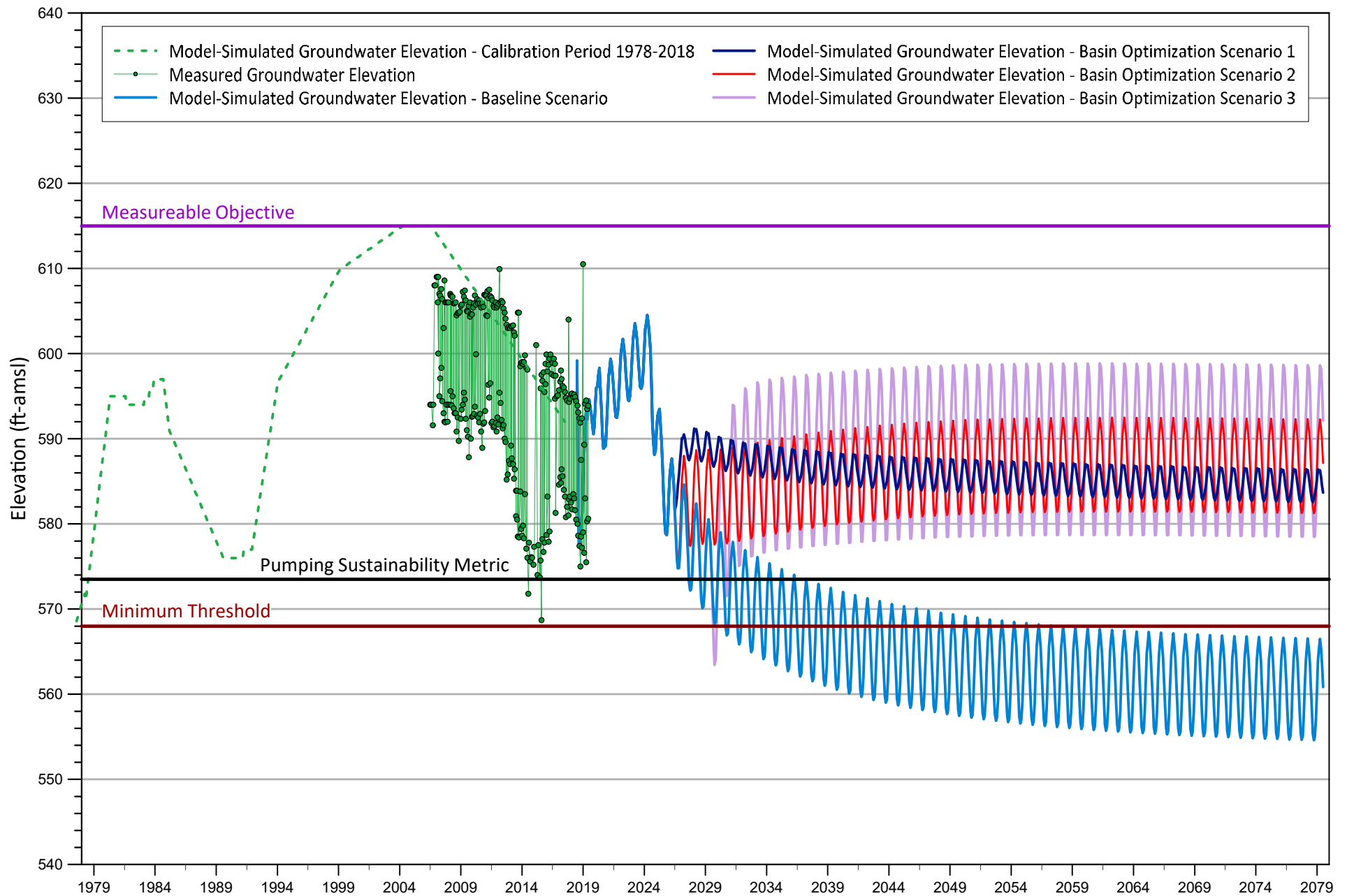


Figure 5-22b. Historical and Projected Groundwater Elevations for Baseline and Basin Optimization Scenarios at CPP-4

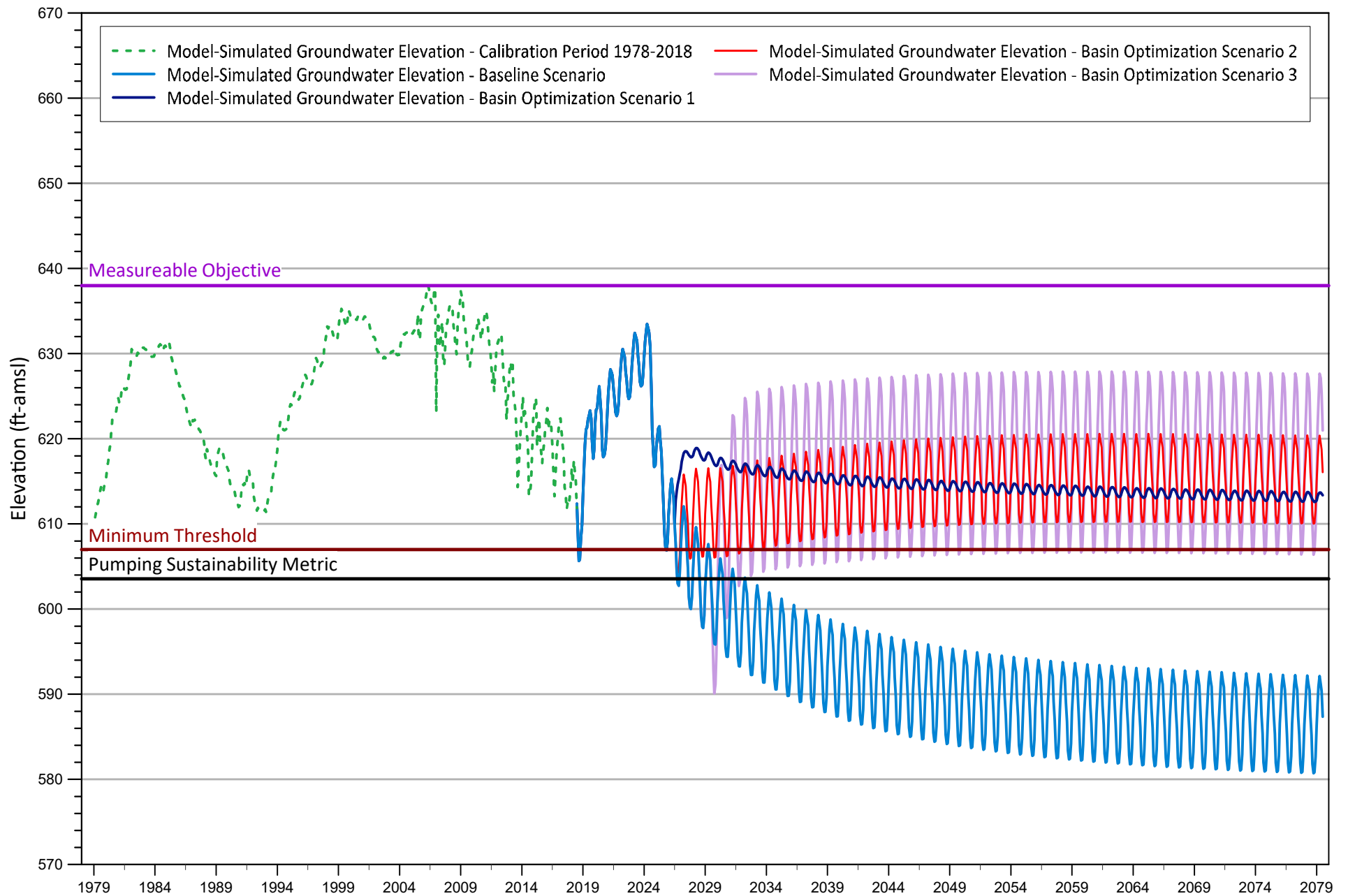


Figure 5-22c. Historical and Projected Groundwater Elevations for Baseline and Basin Optimization Scenarios at CPP-3

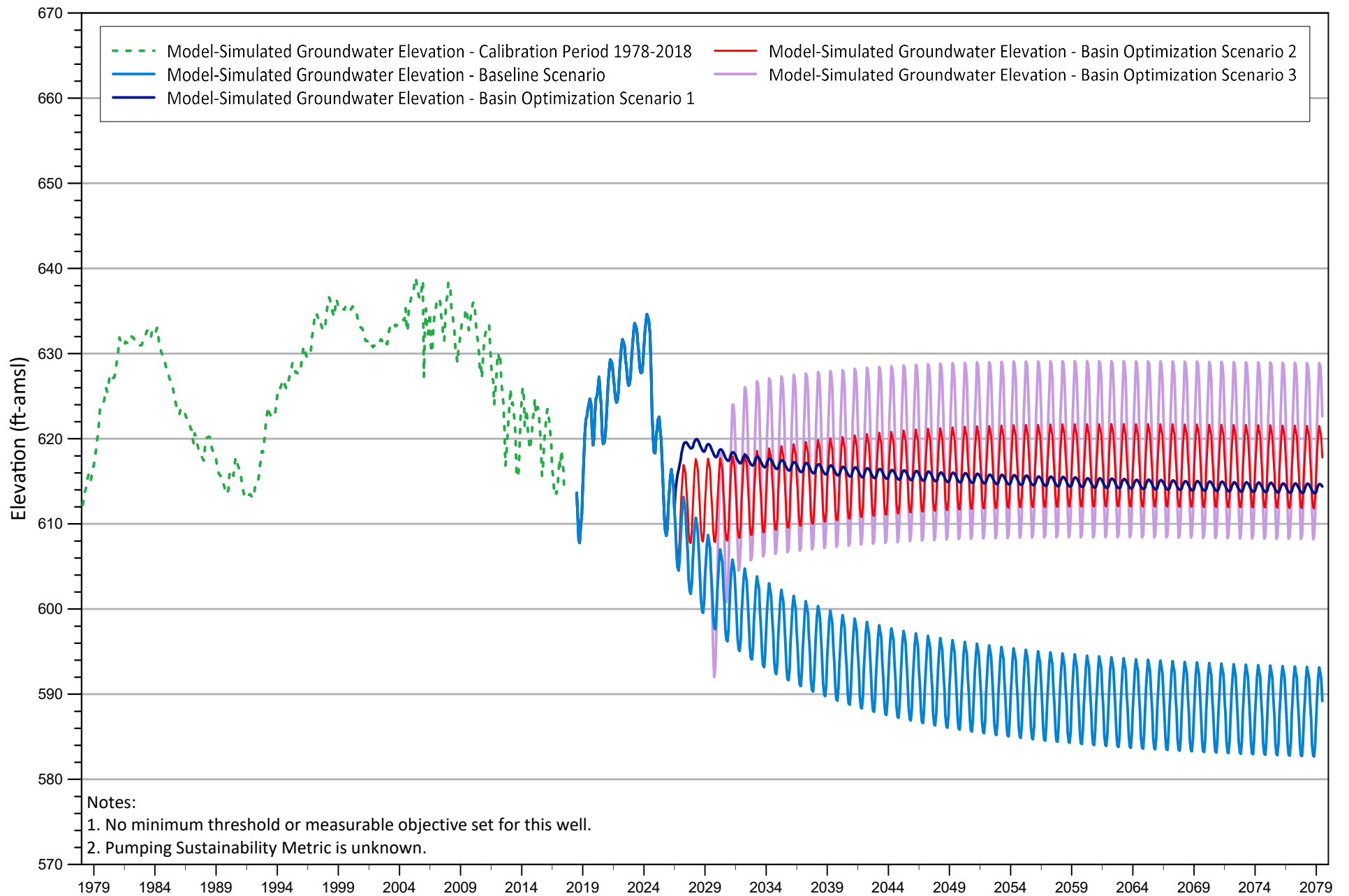


Figure 5-22d. Historical and Projected Groundwater Elevations for Baseline and Basin Optimization Scenarios at CPP-2

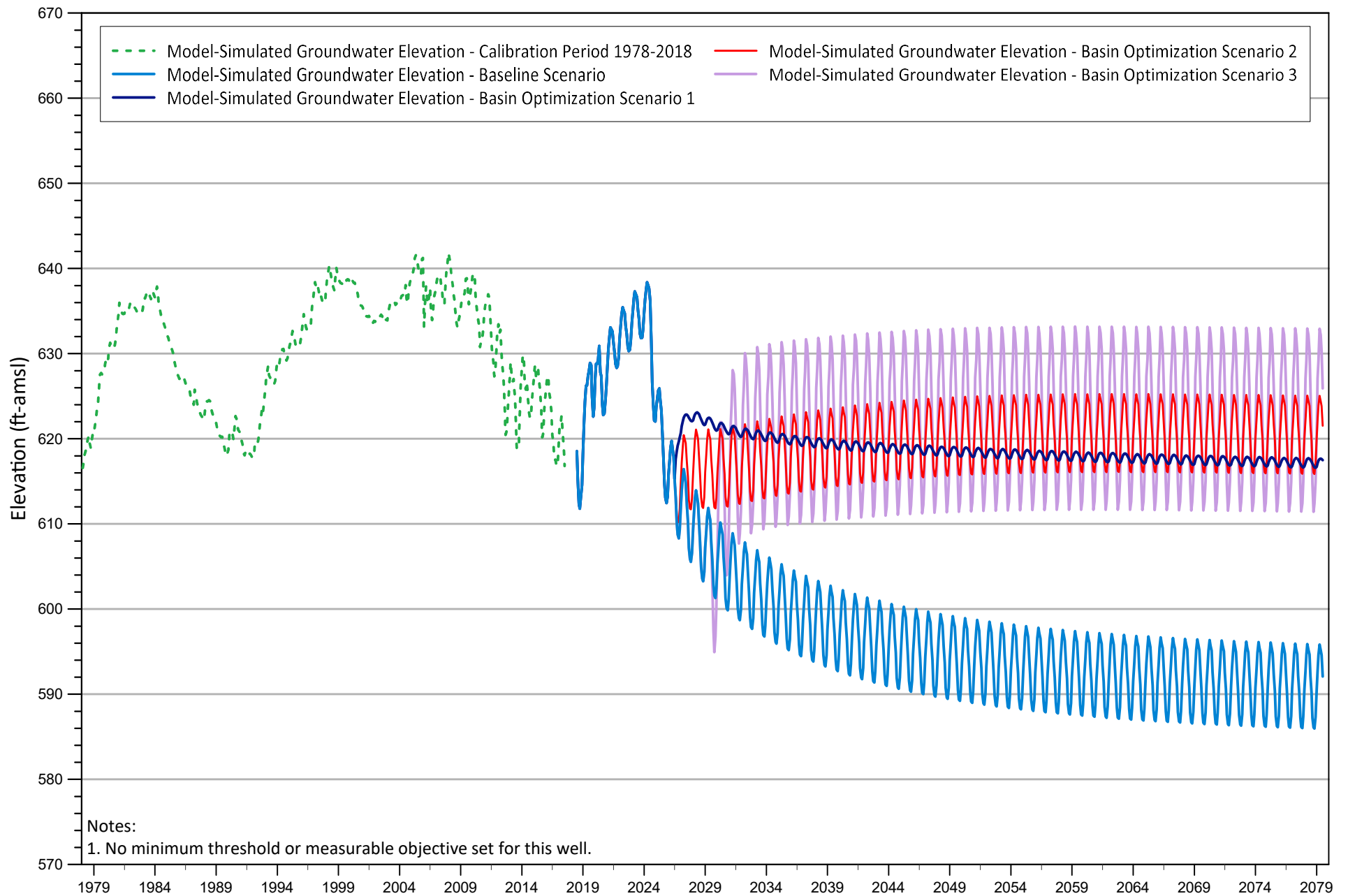


Figure 5-22e. Historical and Projected Groundwater Elevations for Baseline and Basin Optimization Scenarios at P-28

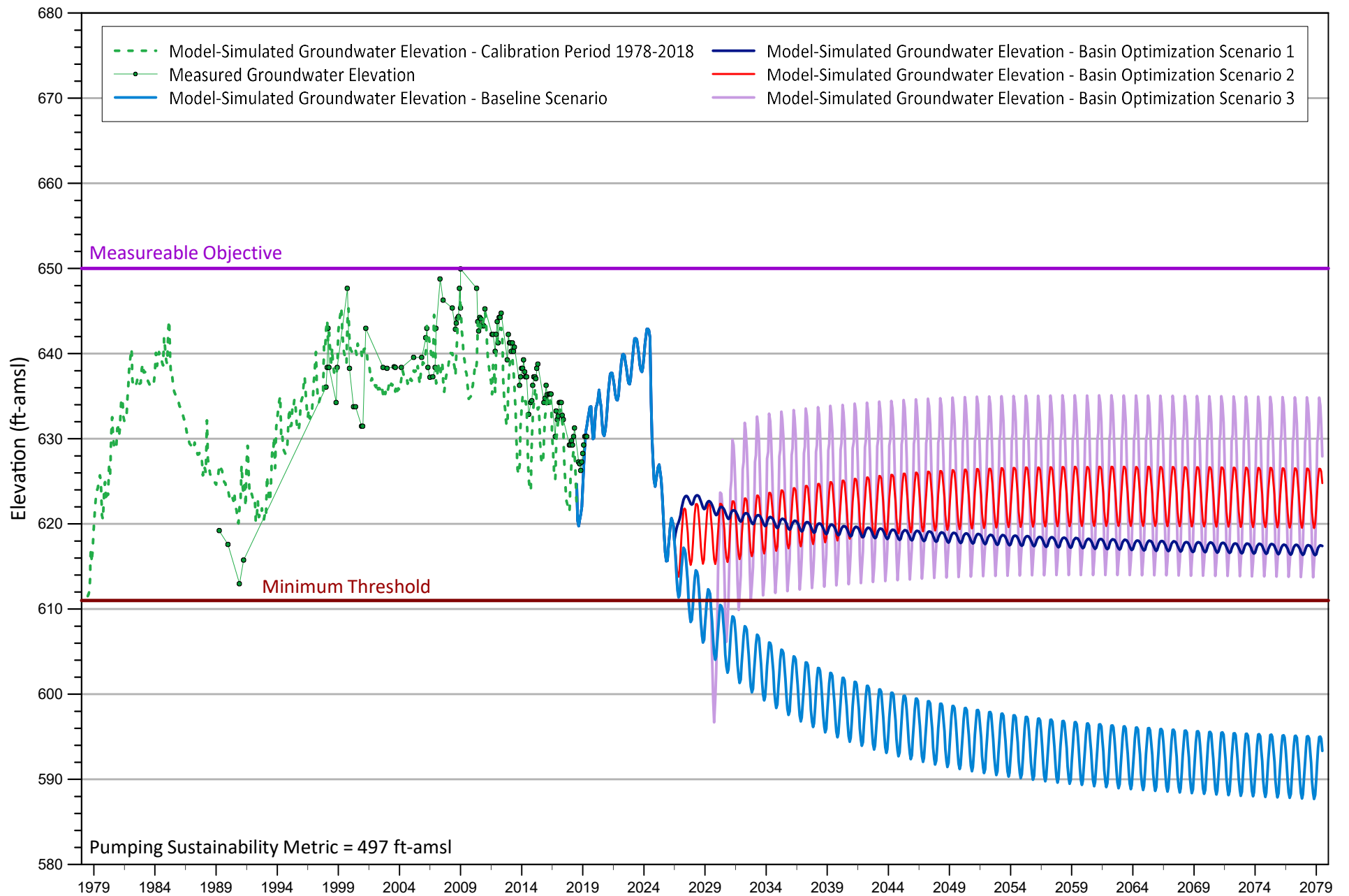


Figure 5-22f. Historical and Projected Groundwater Elevations for Baseline and Basin Optimization Scenarios at CPP-1

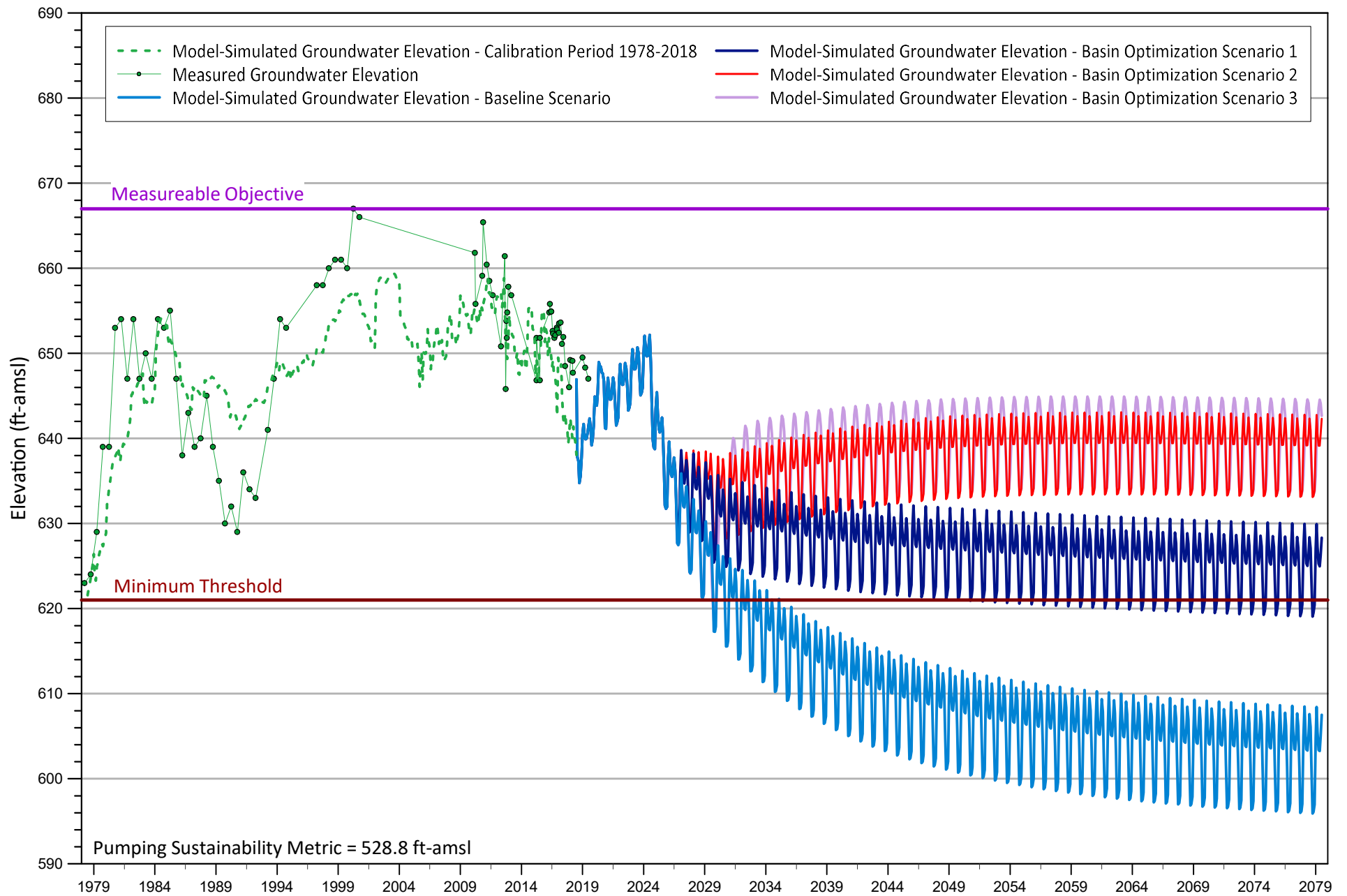


Figure 5-22g. Historical and Projected Groundwater Elevations for Baseline and Basin Optimization Scenarios at P-19

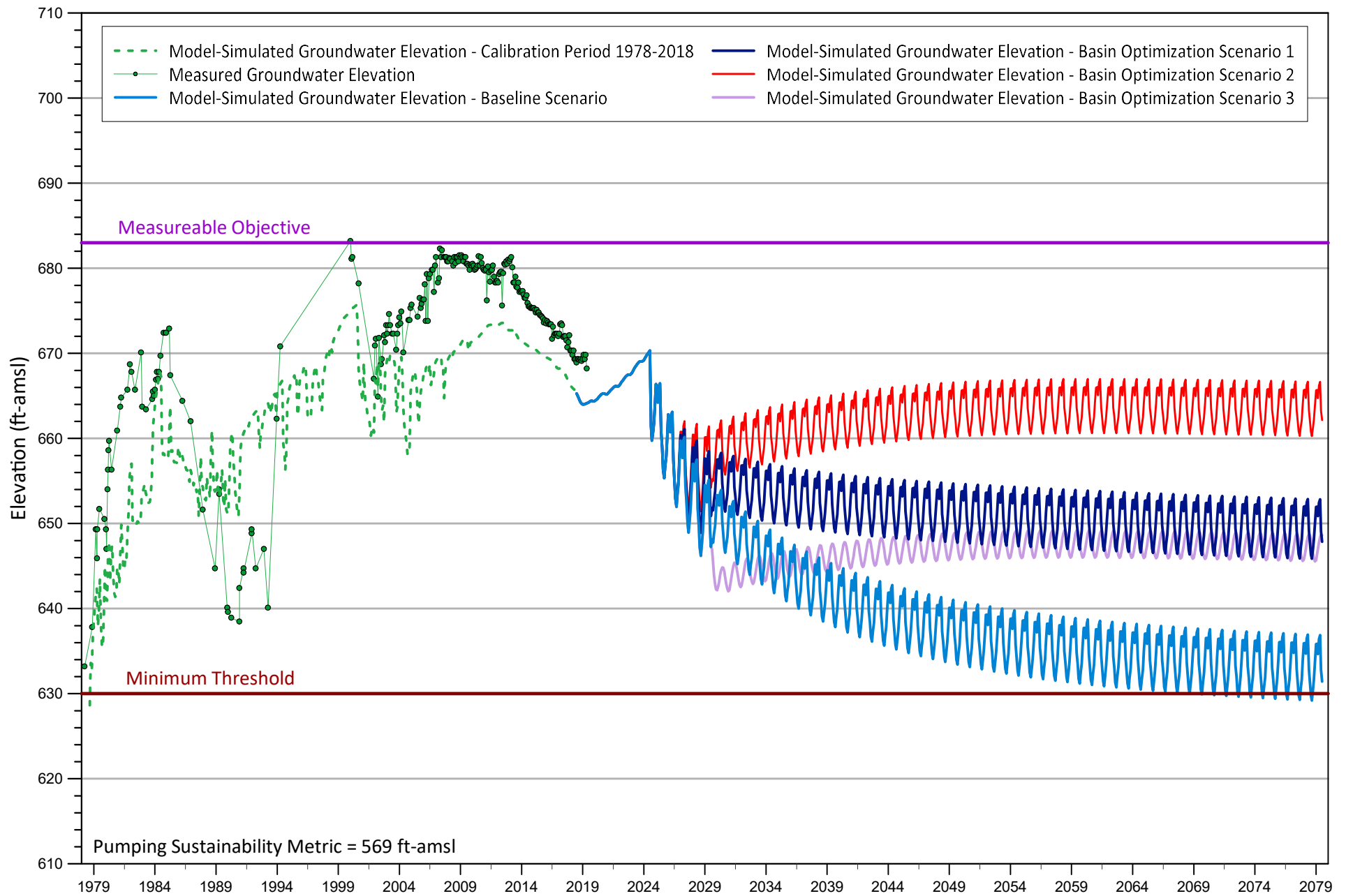


Figure 5-22h. Historical and Projected Groundwater Elevations for Baseline and Basin Optimization Scenarios at OMW-3

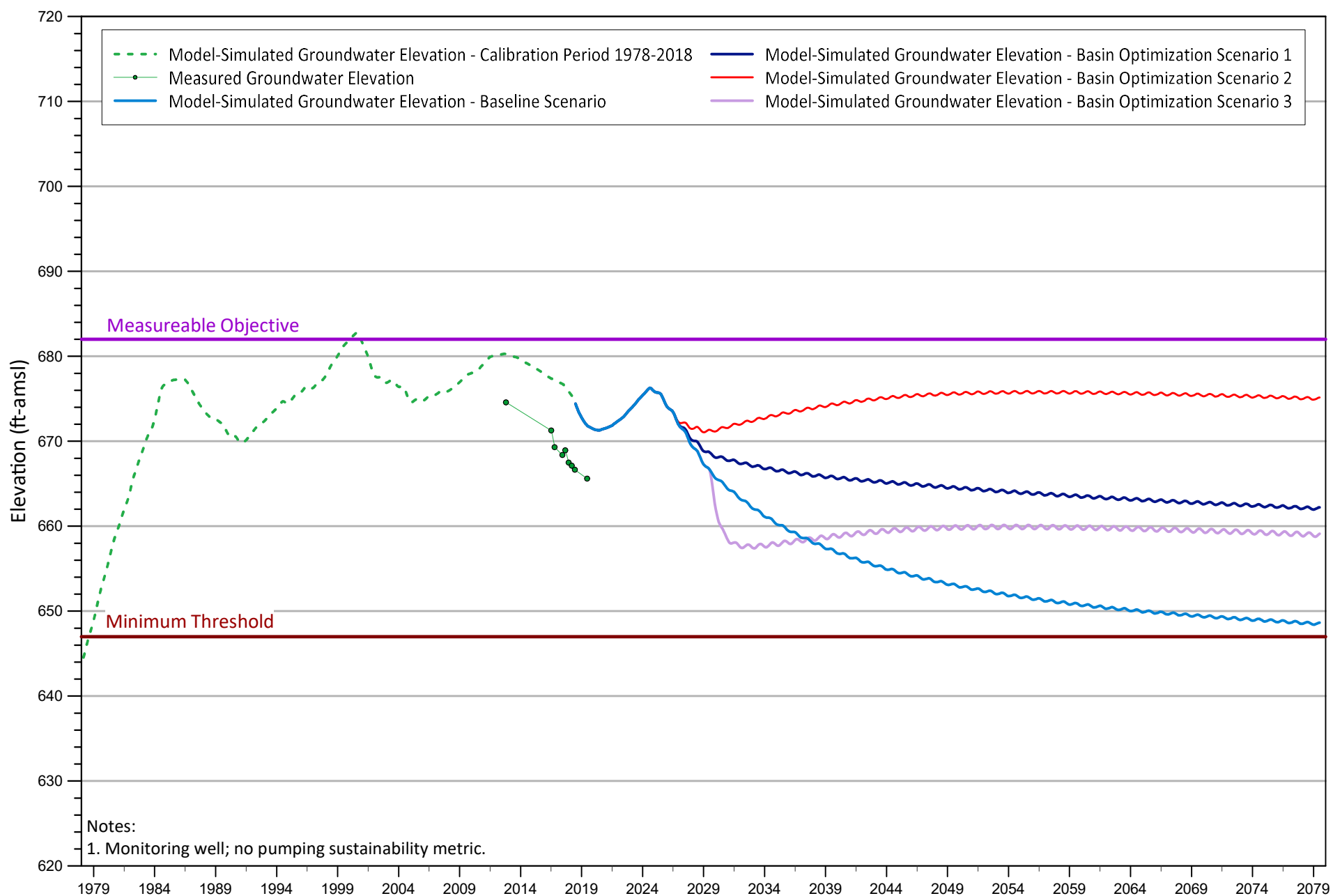


Figure 5-22i. Historical and Projected Groundwater Elevations for Baseline and Basin Optimization Scenarios at New Production Well 4

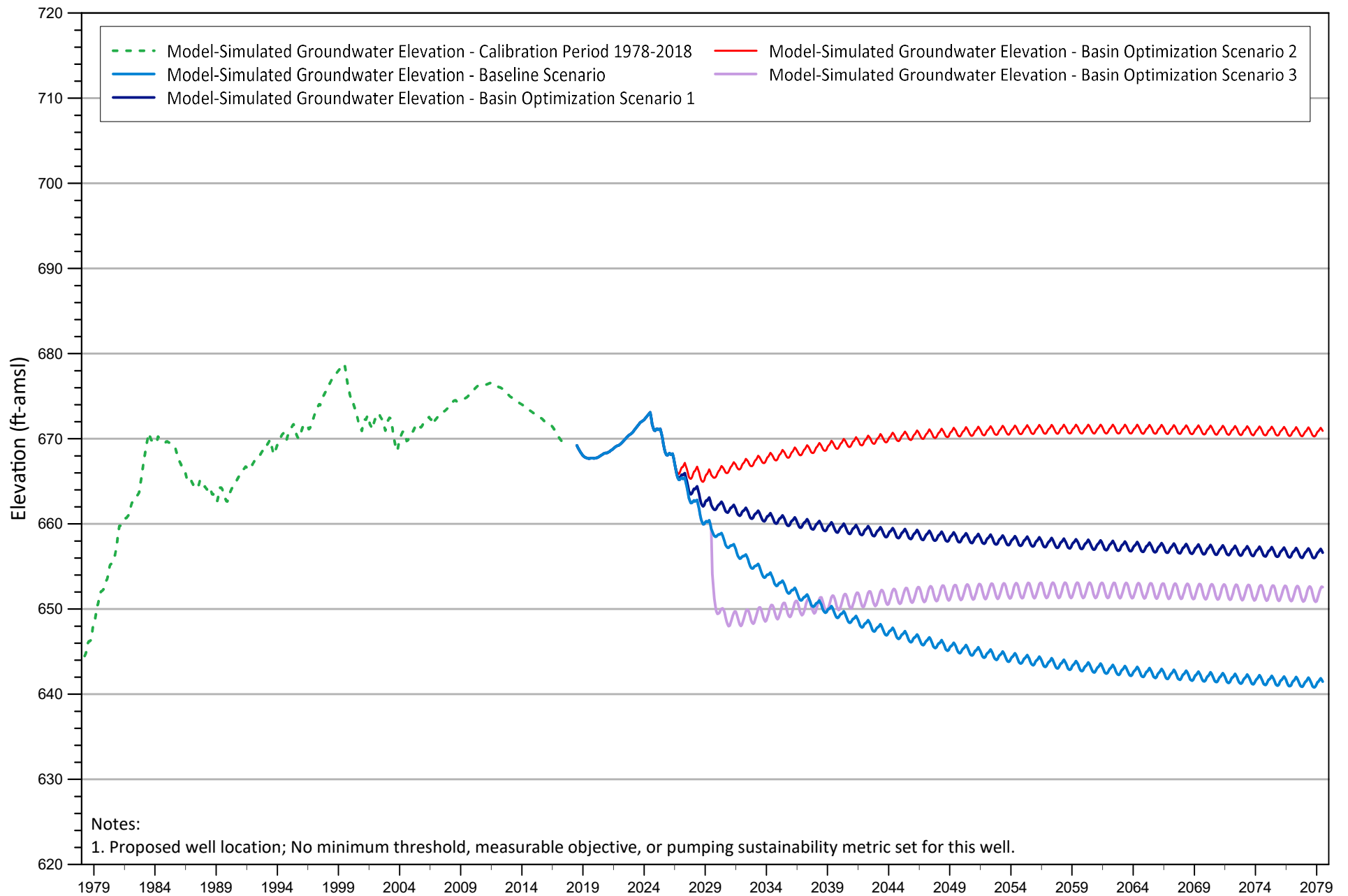


Figure 5-22j. Historical and Projected Groundwater Elevations for Baseline and Basin Optimization Scenarios at New Production Well 5

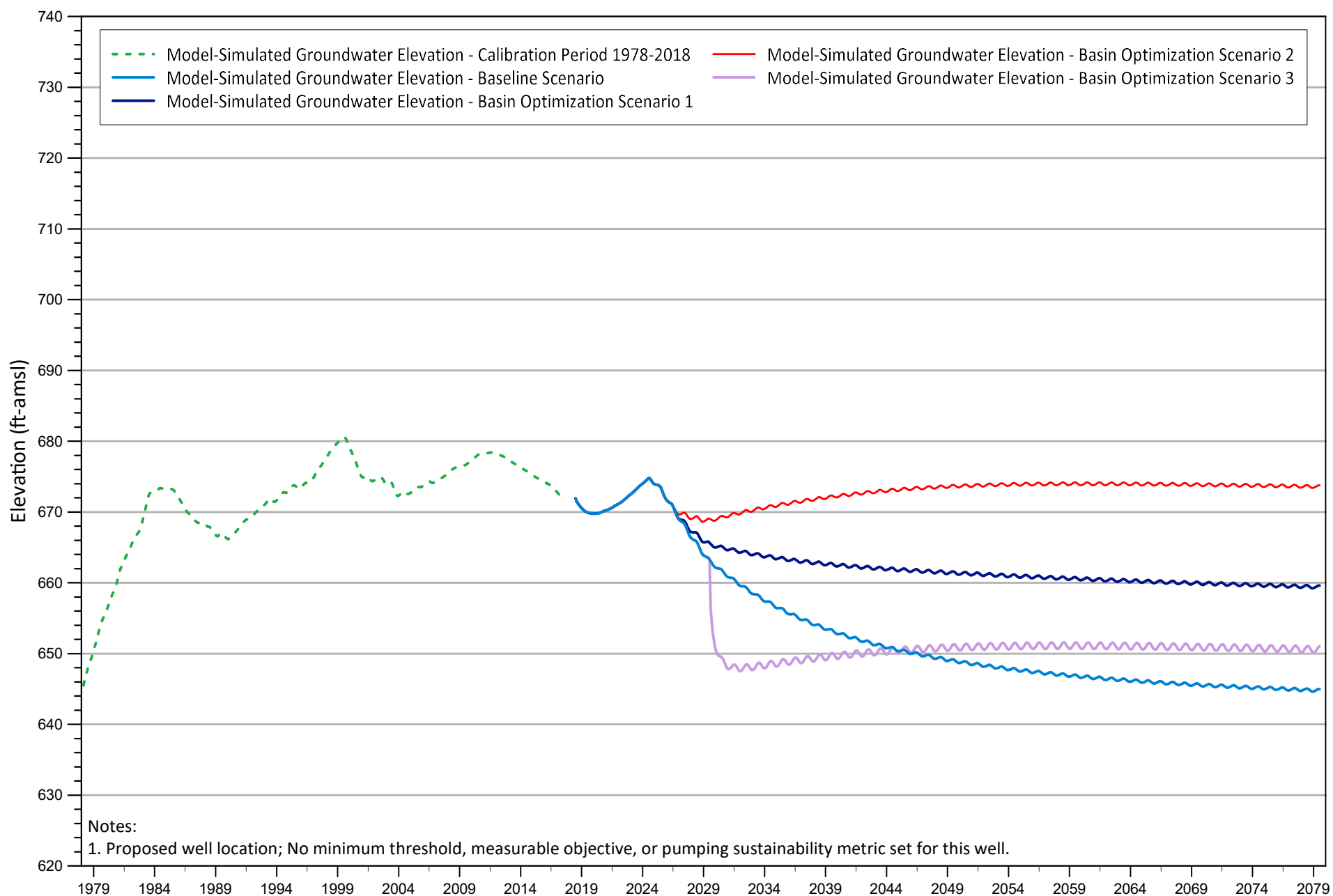
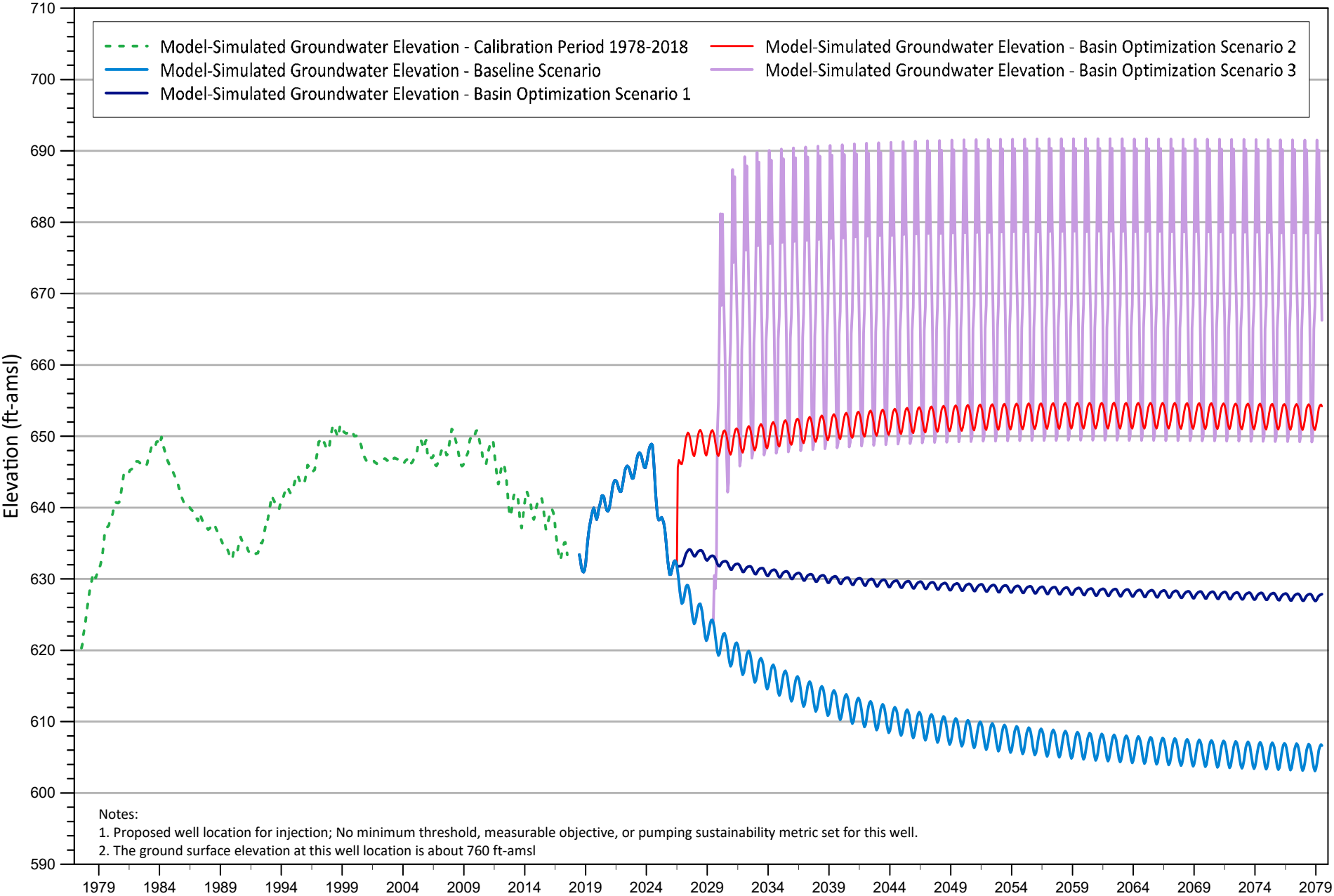


Figure 5-22k. Historical and Projected Groundwater Elevations for Baseline and Basin Optimization Scenarios at New Injection Well 3



Figures 5-22a through 5-22k show that over the planning period, groundwater levels at all eleven wells are predicted to be higher for the three Basin Optimization Scenarios compared to the Baseline Scenario. The seasonal fluctuations of the predicted groundwater elevations are due to the seasonal availability of the recycled water for recharge—more is available for recharge during winter and spring months when recycled water demands are low compared to the summer and fall. The seasonal fluctuations of the predicted groundwater elevations are also due to seasonal pumping schedules for the wells in the basin. The range in the season fluctuations of groundwater elevations is greatest in the western portion of the Basin where most of the pumping occurs and is downgradient of the assumed artificial recharge facilities.

For the wells in the western portion of the Basin (CPP-1, P-28, CPP-2, CPP-3, CPP-4, Industry, Injection Well 3) the highest projected groundwater levels are for Basin Optimization Scenario 3 where artificial recharge is 3,500 afy. For the wells in the eastern portion of the Basin (P-19, New Production Well 4, New Production Well 5, and OMW-3) the highest projected groundwater levels are in Basin Optimization Scenario 2 where artificial recharge in the basin is 500 afy with no increase in the groundwater pumping in the central portion of the Basin. The lowest projected groundwater levels occur in the eastern portion of the basin in Basin Optimization Scenario 3 because pumping increases by 3,000 afy and this area is distant from the areas of artificial recharge.

Figure 5-22k shows the historical and projected groundwater elevations for one assumed injection well in Basin Optimization Scenarios 2 & 3. At this injection well, groundwater elevations are projected to be higher than the Baseline Scenario by about 50 ft for Scenario 2 and by about 85 ft for Scenario 3 by the end of the planning period. The ground-surface elevation at this assumed injection well is about 760 ft-amsl. The highest projected groundwater elevation at this well occurs in Scenario 3 at about 690 ft-amsl, which equates to a minimum depth-to-groundwater of about 70 ft-bgs during the peak periods of injection. Therefore, there is no projected threat of liquefaction hazards due to high groundwater, which would occur at depths to groundwater less than about 40 ft-bgs.

5.4.2 Sustainable Management Criteria

Figures 5-22a through 5-22k include the Minimum Thresholds and Measurable Objectives established as Sustainable Management Criteria for groundwater levels at representative monitoring wells throughout the Spadra Basin when applicable. The Minimum Thresholds represent the groundwater level at a representative monitoring well that, when exceeded individually or in combination with Minimum Thresholds at other monitoring wells, may cause Undesirable Results in the basin. The avoidance of Undesirable Results is key to the success of a GSP and an indication of basin sustainability. The Measurable Objectives are quantitative goals for the maintenance or improvement of groundwater conditions to achieve or maintain sustainability in the basin. Maintaining groundwater levels within the operating band between the Measurable Objectives and Minimum Thresholds will avoid Undesirable Results and achieve and maintain basin sustainability. These Minimum Thresholds and Measurable Objectives are also used as a proxy to assess the Sustainability Indicators of groundwater storage and land subsidence.

The wells in Figure 5-22a through 5-22k where the Minimum Thresholds and Measurable Objectives have been established are: Industry, CPP-4, P-28, CPP-1, P-19, and OMW-3.⁵ The wells in Figures 5-22a through 5-22k that do not have Minimum Thresholds and Measurable Objectives established are wells that are

⁵ Well MW-5 has Minimum Thresholds and Measurable Objectives but was excluded from this analysis because the model-predicted groundwater elevations cannot be used as this is an area of uncertainty identified during calibration of the Spadra Basin Groundwater Model.

close to wells that have Sustainable Management Criteria established and it is not needed as a representative monitoring site, or they are theoretical well locations proposed for Basin Optimization Scenario 3.

Figures 5-22a through 5-22k show that groundwater elevations for all three Basin Optimization Scenarios remain above the Minimum Thresholds throughout the planning period after projects are implemented. This indicates that all three Basin Optimization Scenarios are sustainable relative to these Minimum Thresholds and will not cause an Undesirable Results for groundwater levels, and by proxy groundwater storage and land subsidence. In comparison, the Baseline Scenario is not a sustainable option because groundwater elevations are predicted to decline to levels below the Minimum Thresholds at some of the wells.

At well CPP-4 the seasonal low groundwater elevation is slightly below the Minimum Threshold; this is not considered to be an exceedance of the Minimum Threshold and an Undesirable Result because the evaluation criteria established in *Section 3 Sustainable Management Criteria* is that static groundwater elevations must remain below a Minimum Threshold for an entire year to constitute an Undesirable Result. If a Minimum Threshold for the theoretical well locations for the New Pumping Wells 4 and 5 were set based on the lowest historical groundwater elevation at these locations, the groundwater elevations projected for all three Basin Optimization Scenarios remain above these elevations.

At wells Industry, CPP-4, and P-28, the predicted groundwater elevations for Basin Optimization Scenario 3 temporarily decline below the Minimum Thresholds between 2028 and 2031. This is because the artificial recharge projects to support groundwater levels in Scenario 3 are not implemented until 2030, and increased pumping is assumed to start in 2030 simultaneously with the artificial recharge. If Basin Optimization Scenario 3 is implemented, the startup timing of artificial recharge and new pumping may need to be adjusted to avoid these projected declines of groundwater levels below the Minimum Thresholds.

5.4.3 Pumping Sustainability

The time-series charts in Figures 5-22a through 5-22k include a pumping sustainability metric for the active pumping wells. The pumping sustainability metric is the lowest water-level elevation that enables the well owner to pump groundwater at a desired pumping rate, given the well construction and pumping equipment. Groundwater pumping at a well is presumed to be sustainable if the water level at that well remains above the pumping sustainability metric. Information on the pumping sustainability metric was provided by the well owners for each well. The active pumping wells where these pumping sustainability metrics have been established include: Industry, CPP-4, CPP-2, P-28, CPP-1, and P-19. The pumping sustainability metric for one active well (CPP-3) is undetermined at this time.

Figures 5-22a through 5-22k show that groundwater levels in all three Basin Optimization Scenarios remain above the pumping sustainability metric throughout the planning period after the projects are implemented. This indicates that all three Basin Optimization Scenarios are sustainable relative to the pumping sustainability metrics and improve upon the Baseline Scenario where groundwater levels decline below the pumping sustainability metrics at some wells.

Well No. CPP-4 (Figure 5-22b) in Scenario 3 is an exception where the seasonal low groundwater level declines below the pumping sustainability metric between 2028 and 2031. This is because the artificial recharge projects to support groundwater levels in Scenario 3 are not implemented until 2030, and increased pumping is assumed to start in 2030 simultaneously with the artificial recharge. If Basin Optimization Scenario 3 is implemented, the startup timing of artificial recharge and new pumping may

need to be adjusted to avoid these projected declines of groundwater levels below the pumping sustainability metric.

5.4.4 Change in Storage

Tables 5-6a, 5-6b, 5-6c are water-budget tables for the Spadra Basin that show the model-estimated storage changes that are expected to occur under the three Basin Optimization Scenarios. Figure 5-23 is a time-series chart that shows the cumulative storage change for the three Basin Optimization Scenarios compared against the Baseline Scenario. This chart shows that the storage changes in all three Basin Optimization Scenarios over the planning period are less than in the Baseline Scenario. The increases in storage in Basin Optimization Scenarios 1, 2, and 3 coincide with the implementation of the proposed projects in each scenario in 2027, 2027, and 2030, respectively. Storage is the greatest in Basin Optimization Scenario 2 where storage remains relatively stable over the planning period. At the end of the planning period, the net storage change for Basin Optimization Scenario 1, 2, and 3 is -2,516 af, +3 af, and -1,201 af, respectively.

The Minimum Thresholds for groundwater levels are used as a proxy for groundwater storage. Groundwater levels for the three Basin Optimization Scenarios are predicted to remain above the Minimum Thresholds at the representative monitoring wells over the planning period (see *Section 3 Sustainable Management Criteria*), and hence, this indicates that all three Basin Optimization Scenarios are sustainable for groundwater storage. In comparison, the Baseline Scenario is not a sustainable option because the groundwater elevations are predicted to decline below the Minimum Thresholds at some of the wells.

5.4.5 Subsurface Outflow to the Chino Basin

Tables 5-6a, 5-6b, 5-6c show the model-estimated annual subsurface outflow to the Chino Basin as a discharge component in the water budget for the three Basin Optimization Scenarios. Figure 5-24 is a time-series chart that compares the subsurface outflow to the Chino Basin for the three Basin Optimization Scenarios to the Baseline Scenario. Subsurface outflow to Chino Basin for all three Basin Optimization Scenarios is greater than in the Baseline Scenario, with Scenario 2 resulting in the greatest outflow. In all scenarios, the outflow to Chino Basin is relatively stable over the planning period and the differences between the scenarios is relatively small (typically, less than 60 afy). As described in *Section 2.2.7 Data Gaps*, the groundwater model simulates this boundary area with Chino Basin as having very low hydraulic conductivity with highest model uncertainty. The low hydraulic conductivity in this area of the model domain appears to govern the subsurface outflow to Chino Basin, keeping it relatively constant even as storage changes occur within the Spadra Basin.

Figure 5-23. Cumulative Change in Storage for the Baseline and Basin Optimization Scenarios

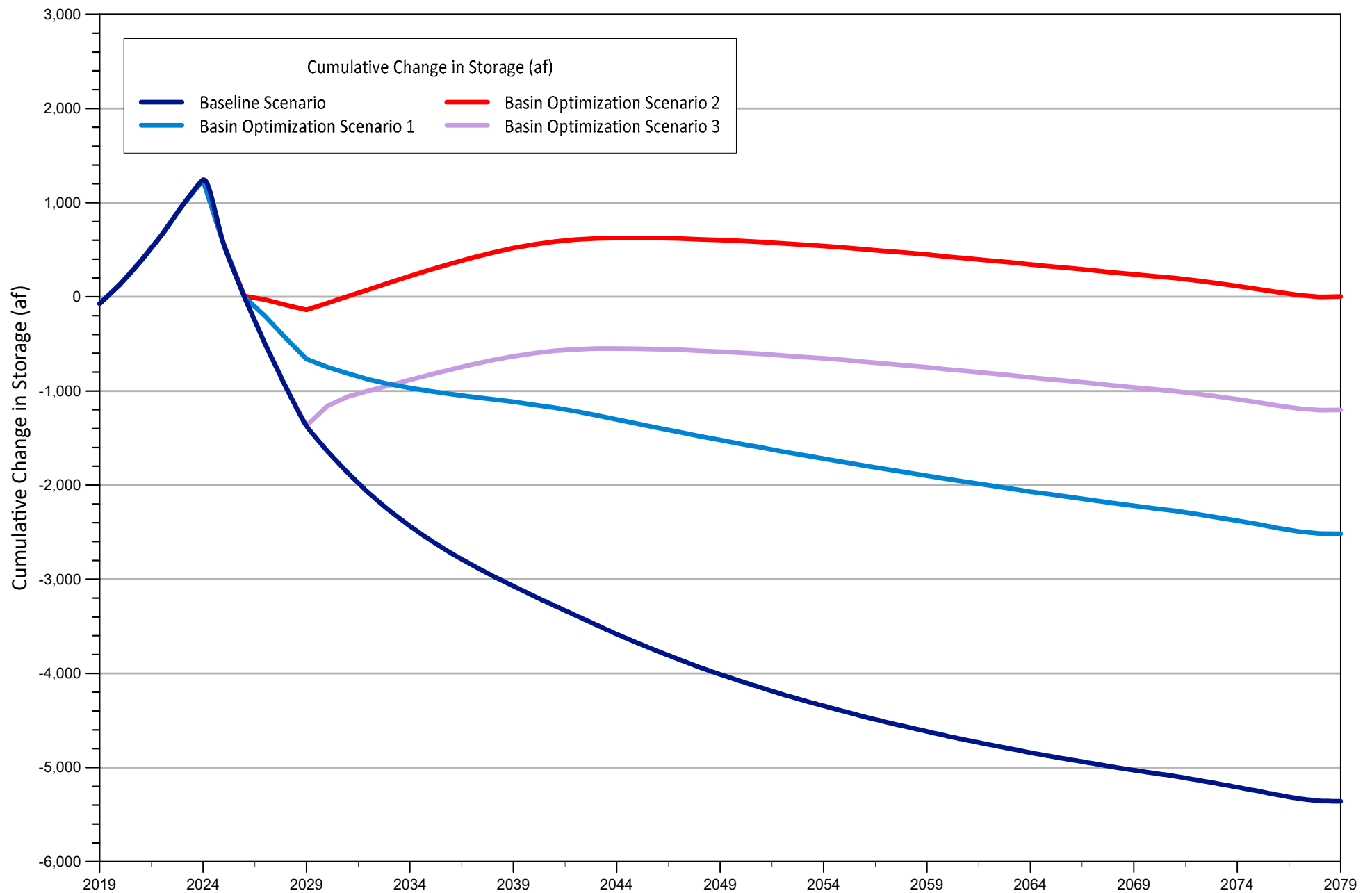
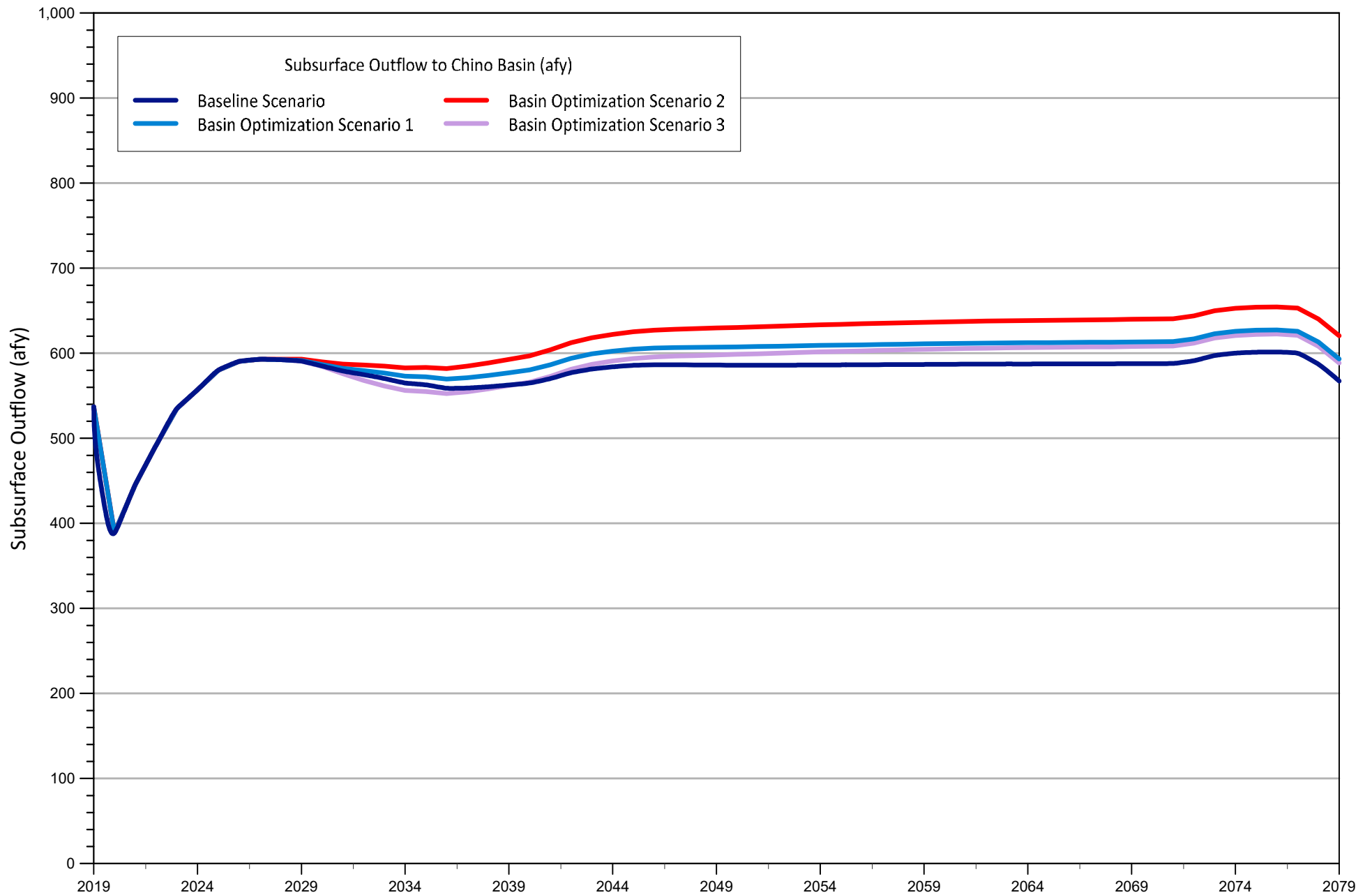


Figure 5-24. Subsurface Outflow to Chino Basin for the Baseline and Basin Optimization Scenarios



5.4.6 Subsurface Outflow to the Puente Basin

Tables 5-6a, 5-6b, 5-6c show the model-estimated annual subsurface outflow to the Puente Basin as a discharge component in the water budget for the three Basin Optimization Scenarios. Figure 5-25 is a time-series chart that compares the subsurface outflow to the Puente Basin for the three Basin Optimization Scenarios to the Baseline Scenario. Subsurface outflow to the Puente Basin for all three Basin Optimization Scenarios is greater than in the Baseline Scenario, with Scenario 3 resulting in the greatest outflow. The increase in the subsurface outflow to Puente Basin for Basin Optimization Scenarios 1, 2, and 3 occurs after implementation of the proposed projects that support groundwater levels. In all scenarios, the outflow to Puente Basin is relatively stable over the planning period after about 2035 and the differences between the scenarios is relatively small (typically, less than 70 afy). By the end of the planning period, subsurface outflow to the Puente Basin in the three Basin Optimization Scenarios is about 400 to 500 afy greater than in the Baseline Scenario.

5.4.7 Sustainable Yield

The term Sustainable Yield is central to SGMA and is defined as the maximum quantity of water that can be withdrawn annually from a groundwater supply without causing Undesirable Results. The model-simulated groundwater elevations at the individual wells analyzed in Section 5.4.1.2 above indicate that for all three Basin Optimization Scenarios groundwater elevations remaining above the Minimum Thresholds over the planning period. Thus, there are no Undesirable Results anticipated for Basin Optimization Scenarios 1, 2, and 3, and the long-term pumping volume associated with each Basin Optimization Scenario (after project startup) is the Sustainable Yield for that scenario. Figure 5-26 is a chart that shows the annual pumping for the three Basin Optimization Scenarios. The chart shows that the Sustainable Yields for Basin Optimization Scenario 1, 2, and 3 are: 1,376 afy, 1,806 afy, and 4,806 afy, respectively.

5.5 COST ANALYSES OF THE BASELINE AND BASIN OPTIMIZATION SCENARIOS

Cost models were developed of the water supply for the Baseline Scenario and the three Basin Optimization Scenarios. The cost model of the Baseline Scenario is used for comparison to the cost models of the three Basin Optimization Scenarios to assist the GSA with selecting projects or a Basin Optimization Scenario for implementation in the GSP implementation plan. However, the Baseline Scenario cannot be directly compared to the Basin Optimization Scenarios because the Baseline Scenario does not have the benefits of basin sustainability like all three Basin Optimization Scenarios.

Figure 5-25. Subsurface Outflow to Puente Basin for the Baseline and Basin Optimization Scenarios

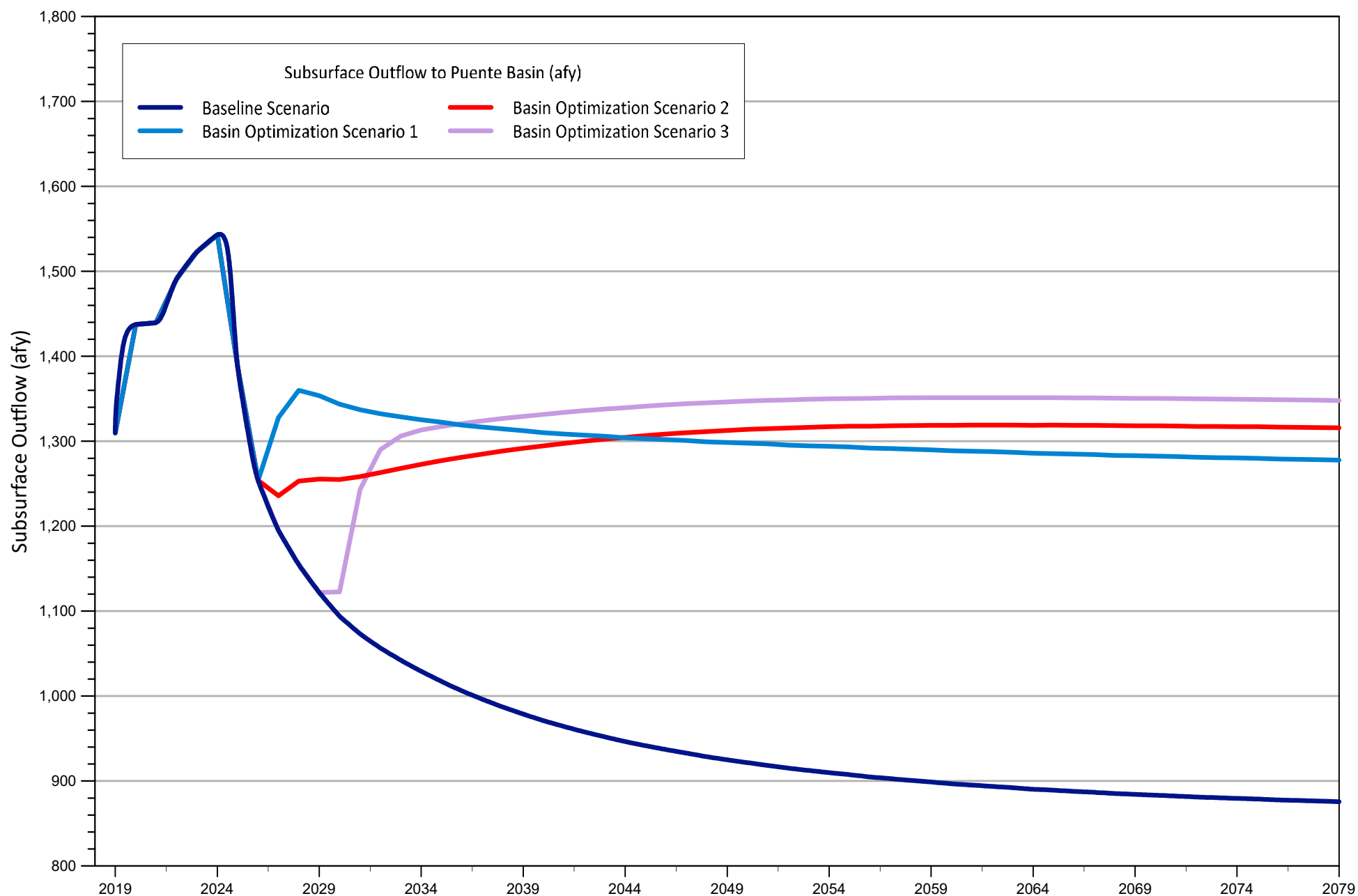
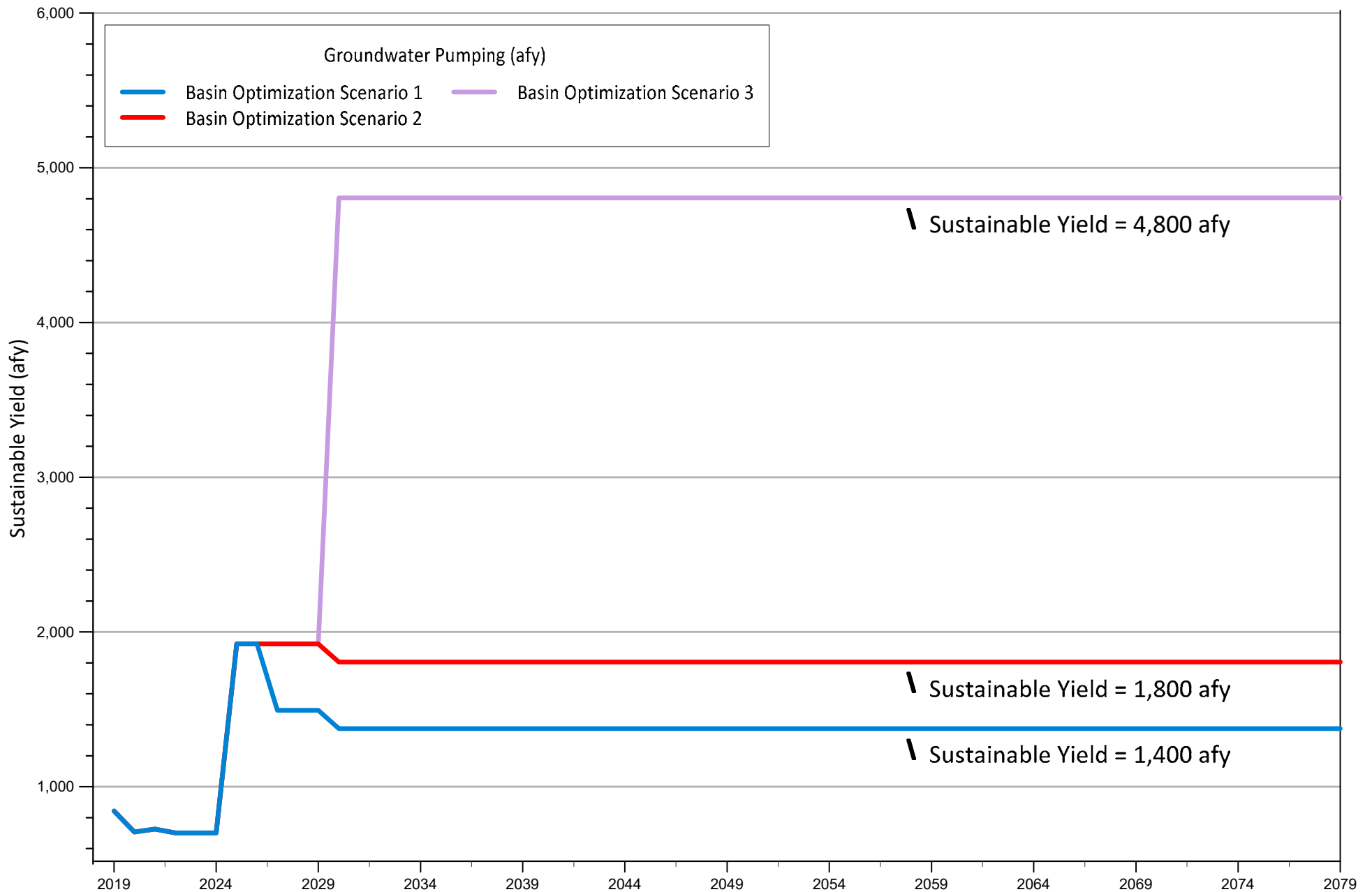


Figure 5-26. Sustainable Yield for the Basin Optimization Scenarios



5.5.1 Water Supply Cost for Baseline Scenario

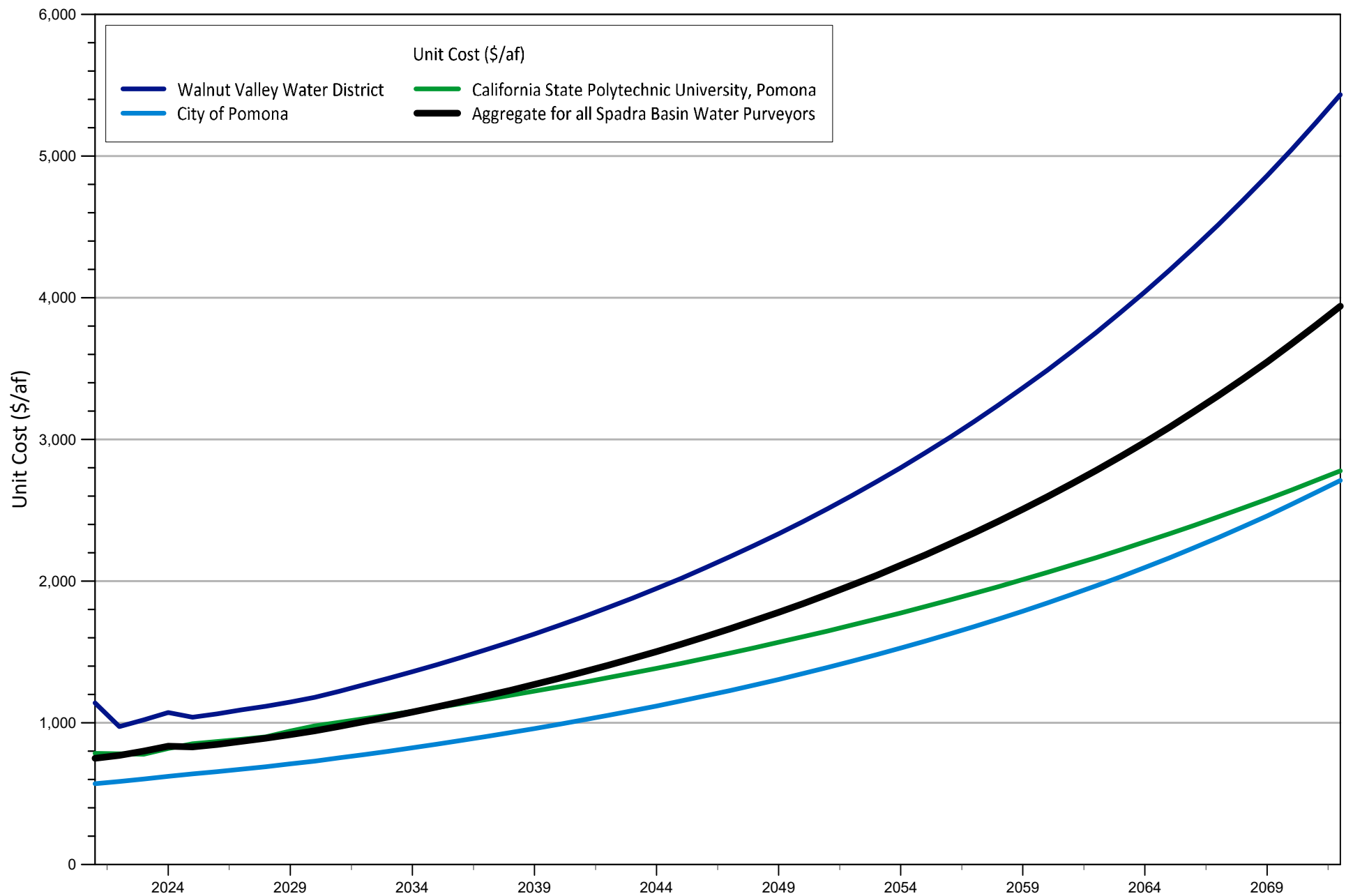
A cost model for the Baseline Scenario was developed for the water-supply plans of the individual water purveyors in the Spadra Basin and in aggregate. The cost model for the Baseline Scenario is shown in multiple steps [as listed below](#) and tables in Appendix K:

- Appendix K Tables K-1a, K-1b, and K-1c include a breakdown of [the](#) water-supply plan for the Baseline Scenario into annual estimates for the period 2021-2072 for each water purveyor and total aggregate of all water purveyors.
- Appendix K Tables K-2a, K-2b, and K-2c include a breakdown of the annual unit costs for each of the water purveyors' water supplies for the period of 2021-2072, and the melded cost for all water supplies for each water purveyor. ~~We worked with each~~ [Each](#) water purveyor ~~to generate~~ [provided](#) the unit costs for 2021. Each water purveyor provided data and information in different formats and level of detail. The unit costs were grouped into the following categories:
 - **Commodity Costs** are the cost of acquiring the water supply. For example, the commodity costs for Six Basins and Chino Basin groundwater are the Watermaster assessments [in those basins](#).
 - **Production Costs** are the energy costs associated with producing the water supply.
 - **Operations and Maintenance (O&M) costs** are the variable costs for field staff, contract services, tools and equipment, training and supplies, repairs and general maintenance, and the regulatory compliance associated with producing the water supply. This excludes maintenance on reservoirs or pipelines and the variable O&M costs associated with treatment.
 - **Treatment Costs** include the costs for chemicals and other variable O&M associated with the treatment necessary to produce potable water.
- Appendix K Table K-3 includes a breakdown of annual water-supply plan as a total aggregate of all water purveyors in the Spadra Basin for the Baseline Scenario.
- Appendix K Table K-4 includes a breakdown of the melded unit cost for all water supplies as a total aggregate for all water purveyors in the Spadra Basin for the Baseline Scenario.

All unit costs, except for the imported water, were assumed to increase by 2.5 percent per year. The unit cost of Tier 1 treated imported water from the TVMWD was obtained from the TVMWD for the cost through 2030, then assumed to increase 4.0 percent annually thereafter based on average rate of inflation from 2003 to 2021 of Tier 1 water.

Figure 5-27 displays the melded unit cost of each water purveyors' water-supply plan for the Baseline Scenario (breakdown shown in Appendix K Tables K-2a, K-2b, and K-2c) along with the melded unit cost for the water purveyors in aggregate (breakdown shown in Appendix K Table K-3b). The melded unit cost of the water purveyors' water-supply plans increases over time, and the rate of increase for each water purveyor is dependent on its mix of water sources. The aggregate melded unit cost of water for the Spadra Basin water purveyors for the Baseline Scenario increases from \$751 af in 2021 to \$3,941 in 2072.

Figure 5-27. Melded Unit Cost of Water Supply for the Spadra Basin Water Purveyors for the Baseline Scenario



5.5.2 Water Supply Cost for Basin Optimization Scenarios

Cost models for the three Basin Optimization Scenarios were developed for the water-supply of the water purveyors in the Spadra Basin in aggregate. The cost model for the Basin Optimization Scenarios includes the conceptual engineering cost estimates for the implementation of the projects in the Basin Optimization Scenarios, and water supply plans and unit costs for water for the Spadra Basin water purveyors in aggregate. The cost model for the Basin Optimization Scenarios 1, 2, and 3 is shown in multiple steps and tables in Appendix L:

- Appendix L Table L-1 lists planning criteria for the unit cost of equipment and materials and other assumptions that were used to estimate the cost for implementing the projects for the three Basin Optimization Scenarios.
- Appendix L Tables L-2a, L-2b, and L-2c include high-level conceptual engineering cost estimates for the projects envisioned for Basin Optimization Scenarios 1, 2, and 3. Feasibility-level design and operating schemes for each new project were cost estimated based on the unit cost and assumptions in Table L-1. The estimates include costs for construction (including engineering, management, and administrative), operations and maintenance, and loans to pay for these capital improvements (assumed 30 years).
- Appendix L Tables L-3a, L-3b, and L-3c include a breakdown of annual water-supply plan as a total aggregate of all water purveyors in the Spadra Basin for the Basin Optimization Scenarios 1, 2, and 3.
- Appendix L Tables L-4a, L-4b, and L-4c include a breakdown of the annual melded unit cost for all water supplies as a total aggregate of all water purveyors in the Spadra Basin for the Basin Optimization Scenarios 1, 2, and 3.

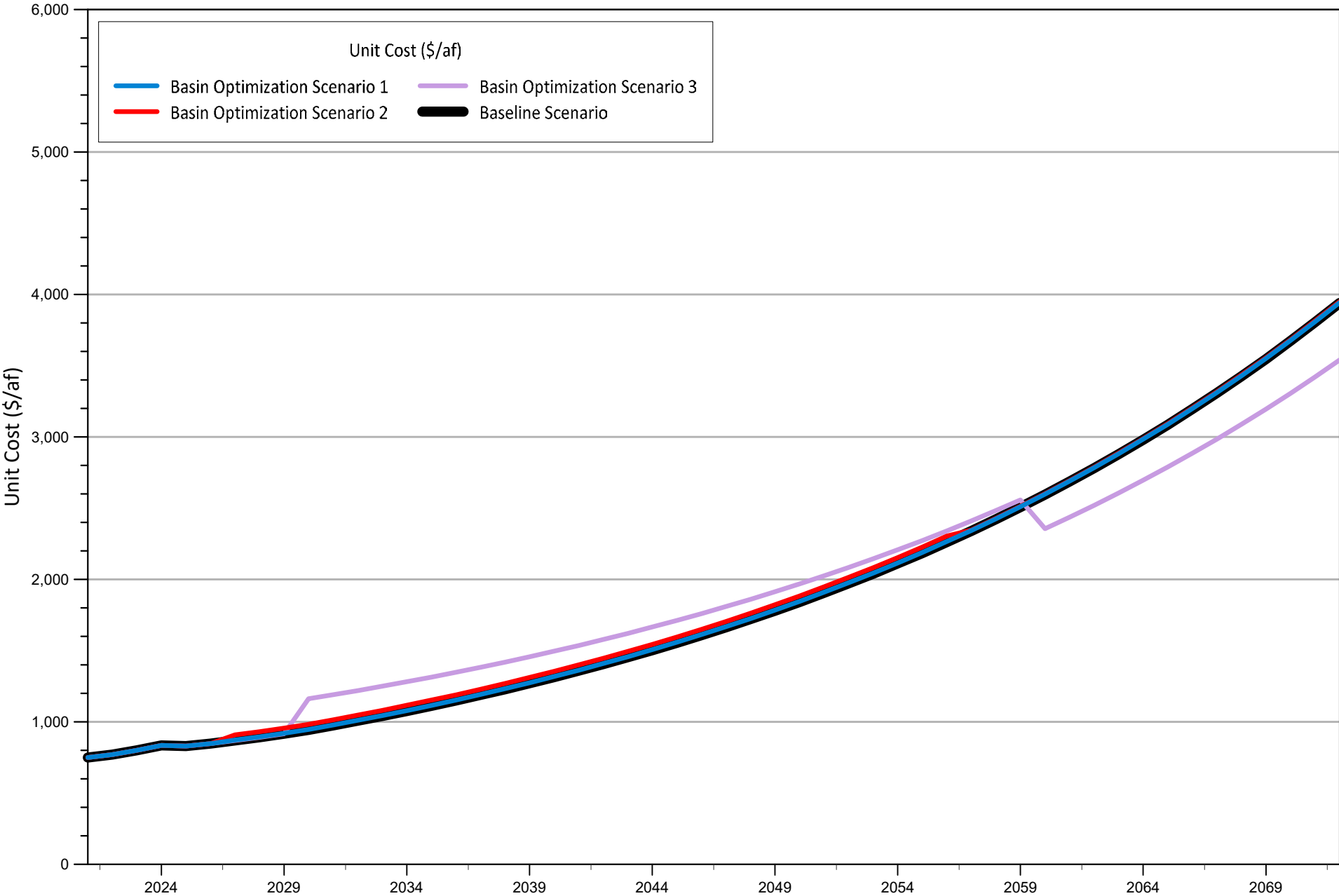
Like the Baseline Scenario, all unit costs, except for the imported water, were assumed to increase by 2.5 percent per year. The unit cost of Tier 1 treated imported water from the TVMWD was obtained from the TVMWD for the cost through 2030, then assumed to increase 4.0 percent annually thereafter based on average rate of inflation from 2003 to 2021 of Tier 1 water.

Figure 5-28 is a time-series chart that displays the annual melded unit cost of water for all Spadra Basin water purveyors in aggregate for the Basin Optimization Scenarios 1, 2, and 3 (breakdown shown in Appendix L Tables L-4a, L-4b, and L-4c) plotted with the annual melded unit cost of water for all Spadra Basin water purveyors in aggregate for the Baseline Scenario (breakdown shown in Appendix K, Table K-3b). Table 5-7 summarizes these annual aggregate melded unit costs of water for the Baseline Scenario and Basin Optimization Scenarios 1, 2, and 3.

Table 5-7. Aggregate Melded Unit Costs of Water Supply for the Baseline and Basin Optimization Scenarios

Year	Total Annual Cost				
	Baseline	Scenario 1	Scenario 2	Scenario 3a	Scenario 3b
2021	\$751	\$751	\$751	\$751	\$751
2022	\$771	\$771	\$771	\$771	\$771
2023	\$801	\$801	\$801	\$801	\$801
2024	\$835	\$835	\$835	\$835	\$835
2025	\$830	\$830	\$830	\$830	\$830
2026	\$848	\$848	\$848	\$848	\$848
2027	\$870	\$873	\$909	\$870	\$870
2028	\$892	\$895	\$931	\$892	\$892
2029	\$917	\$920	\$956	\$917	\$917
2030	\$944	\$947	\$983	\$1,163	\$1,160
2031	\$975	\$979	\$1,015	\$1,191	\$1,188
2032	\$1,008	\$1,011	\$1,048	\$1,220	\$1,217
2033	\$1,042	\$1,045	\$1,082	\$1,251	\$1,248
2034	\$1,077	\$1,080	\$1,117	\$1,282	\$1,279
2035	\$1,113	\$1,116	\$1,153	\$1,315	\$1,312
2036	\$1,150	\$1,154	\$1,190	\$1,349	\$1,346
2037	\$1,189	\$1,193	\$1,230	\$1,384	\$1,381
2038	\$1,230	\$1,233	\$1,270	\$1,420	\$1,417
2039	\$1,271	\$1,275	\$1,312	\$1,458	\$1,455
2040	\$1,315	\$1,318	\$1,355	\$1,497	\$1,494
2041	\$1,359	\$1,363	\$1,400	\$1,537	\$1,534
2042	\$1,406	\$1,410	\$1,447	\$1,578	\$1,575
2043	\$1,454	\$1,458	\$1,495	\$1,622	\$1,619
2044	\$1,504	\$1,507	\$1,545	\$1,666	\$1,663
2045	\$1,555	\$1,559	\$1,596	\$1,712	\$1,709
2046	\$1,609	\$1,613	\$1,650	\$1,760	\$1,757
2047	\$1,664	\$1,668	\$1,705	\$1,810	\$1,807
2048	\$1,721	\$1,725	\$1,763	\$1,861	\$1,858
2049	\$1,781	\$1,785	\$1,822	\$1,914	\$1,911
2050	\$1,842	\$1,847	\$1,884	\$1,969	\$1,966
2051	\$1,906	\$1,910	\$1,948	\$2,025	\$2,022
2052	\$1,972	\$1,977	\$2,014	\$2,084	\$2,081
2053	\$2,041	\$2,045	\$2,083	\$2,145	\$2,142
2054	\$2,112	\$2,116	\$2,154	\$2,208	\$2,205
2055	\$2,185	\$2,190	\$2,228	\$2,274	\$2,270
2056	\$2,262	\$2,266	\$2,304	\$2,341	\$2,338
2057	\$2,341	\$2,344	\$2,347	\$2,411	\$2,408
2058	\$2,423	\$2,425	\$2,429	\$2,484	\$2,481
2059	\$2,507	\$2,510	\$2,515	\$2,559	\$2,556
2060	\$2,595	\$2,599	\$2,603	\$2,357	\$2,357
2061	\$2,687	\$2,690	\$2,694	\$2,438	\$2,437
2062	\$2,781	\$2,784	\$2,789	\$2,521	\$2,521
2063	\$2,879	\$2,883	\$2,887	\$2,607	\$2,607
2064	\$2,981	\$2,984	\$2,989	\$2,697	\$2,697
2065	\$3,086	\$3,090	\$3,094	\$2,790	\$2,790
2066	\$3,195	\$3,199	\$3,204	\$2,886	\$2,886
2067	\$3,309	\$3,312	\$3,317	\$2,986	\$2,985
2068	\$3,426	\$3,430	\$3,435	\$3,089	\$3,088
2069	\$3,548	\$3,552	\$3,557	\$3,196	\$3,195
2070	\$3,674	\$3,678	\$3,683	\$3,307	\$3,306
2071	\$3,805	\$3,809	\$3,814	\$3,421	\$3,421
2072	\$3,941	\$3,945	\$3,950	\$3,540	\$3,540

Figure 5-28. Aggregate Melded Unit Cost of Water Supply for the Baseline and Basin Optimization Scenarios



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The aggregate melded unit cost of water for the Baseline Scenario is plotted and shown in Figure 4-25-28 and Table 5-7 with the aggregate melded unit cost of water for the three Basin Optimization Scenarios for comparison. However, as described above, the Baseline Scenario cannot be directly compared to the Basin Optimization Scenarios because the Baseline Scenario does not have the benefits of basin sustainability like all three Basin Optimization Scenarios.

The aggregate melded unit cost of water for Basin Optimization Scenarios 1 and 2 are slightly more expensive than the aggregate melded unit cost of water for the Baseline Scenario. This is because the Spadra Basin is a relatively small portion of the total water supply, and these scenarios include only a few capital projects.

The aggregate melded unit cost of water for Basin Optimization Scenario 3 averages about \$150/af more than the aggregate melded unit cost of water for the Baseline Scenario and Basin Optimization Scenarios 1 and 2 from 2030-2059, and then declines to about \$400/af less than these other scenarios after the loans for capital improvements are paid off. Basin Optimization Scenario 3 is less expensive in the long run because of the investment in facilities that produce a local, more reliable, and less expensive water supply as an alternative to the imported water.

5.6 CONCLUSIONS AND RECOMMENDATIONS

Table 5-8 summarizes the evaluation of the three Basin Optimization Scenarios compared to the Baseline Scenario.

The Baseline Scenario is not projected to be sustainable with respect to the Sustainable Management Criteria established in *Section 3 Sustainable Management Criteria*. The GSP implementation plan should include plans to implement projects and management actions to support groundwater levels, avoid Undesirable Results, and maintain the sustainability of the Spadra Basin.

The three Basin Optimization Scenarios described and evaluated herein are hydrologically feasible and sustainable based on the model-estimated response of the Spadra Basin. Compared to the Baseline Scenario, all three Basin Optimization Scenarios are expected to result in: (i) higher groundwater levels that do not decline below Minimum Thresholds or pumping sustainability metrics; (ii) no significant and unreasonable land subsidence or reductions of groundwater storage; (iii) higher Sustainable Yields; and (iv) no reductions in subsurface outflow to the neighboring groundwater basins. In other words, the Basin Optimization Scenarios are sustainable and will avoid the occurrence of Undesirable Results.

Basin Optimization Scenario 3 is the recommended scenario for GSP implementation. It produces the highest Sustainable Yield of the Spadra Basin by recharging surplus recycled water from the Pomona WRP and increasing groundwater production by similar volumes. Through groundwater treatment, it increases local, reliable, potable water supplies as an alternative to the use of less reliable imported waters (which are expected to experience higher inflation rates than the local water supplies).

Scenario 3 will require permitting from the LA Regional Board with oversight from the State Water Board, and potentially the development of a SNMP for the Spadra Basin or inclusion of the Spadra Basin in the San Gabriel Valley Basin SNMP (Stetson Engineers Inc., 2016). The permitting process and the development of an SNMP are both extensive efforts that will require multiple years to complete. These efforts will be completed during Phase 4 of the planning process necessary for the implementation of these projects that is described in the GSP in *Section 6 Implementation Plan*. Additionally, the costs and

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schedule for permitting and development of an SNMP are considered in the cost and schedules presented in the GSP in Sections 6.2 and 6.1.

Basin Optimization Scenario 3 is the most expensive scenario through 2059 but is the least expensive scenario thereafter when the assumed loans to fund the capital improvements are paid off. ~~The implementation plan in the final GSP Sections 6.1.1 and 6.3 should~~ include potential plans to identify and apply for grant funding opportunities to reduce the cost of implementing Basin Optimization Scenario 3.

In Basin Optimization Scenario 3, groundwater levels are projected to decline in the eastern portion of the basin because of increased pumping. This is an area of highest uncertainty in the Spadra Basin Ggroundwater-flow Mmodel of the Spadra Basin (see *Section 2.2.7 Data Gaps*), and hence, an area that should be monitored in the future for changes in groundwater levels and potential adverse impacts to the neighboring Chino Basin, such as reduced subsurface outflow. The Spadra Basin GSA is in the process of constructing a new monitoring well within the eastern portion of the basin near the Spadra/Chino Basin boundary. The data collected from the new monitoring well, and additional monitoring data collected in the eastern portion of the basin, will be used to detect potential adverse impacts and Undesirable Results, and also can be used to update and improve the groundwater model in the future.

Table 5-8. Summary of the Evaluation of Basin Optimization Scenarios Compared to the Baseline Scenario

		Baseline	Scenario 1	Scenario 2	Scenario 3
Project Description	Objective	n/a	Basin Sustainability	Basin Sustainability	Basin Sustainability and Maximum Beneficial Use
	Increase in Artificial Recharge from Baseline	n/a	0 afy	500 afy	3,500 afy
	Change in Pumping from Baseline	n/a	- 430 afy	0 afy	2,994 afy
	New Facilities	none	Additional recycled water pipeline and connections	- Underground recharge gallery and pipeline - Injection well and pipeline	- Underground recharge gallery and pipeline - Seven injection wells and pipeline - Five production wells and pipeline - Expansion of CPP RO Plant and pipeline
Project Evaluation	Do groundwater levels decline below Minimum Thresholds?	Yes	No	No	No
	Do groundwater levels decline below pumping sustainability metrics?	Yes	No	No	No
	Subsurface Outflow to the Chino Basin	567 afy	593 afy	621 afy	589 afy
	Subsurface Outflow to the Puente Basin	876 afy	1,278 afy	1,316 afy	1,348 afy
	Sustainable Yield	n/a	1,376 afy	1,806 afy	4,806 afy
	Aggregate melded unit cost of water supply in 2072 (\$/af)	\$3,941	\$3,945	\$3,950	\$3,540
	Benefits Other Than Sustainability	n/a	Partial utilization of surplus recycled water	Partial utilization of surplus recycled water	- Utilization of all surplus recycled water - Increasing the reliability of potable water supplies

SECTION 6

Plan Implementation

6.1 GSP IMPLEMENTATION

The implementation of the GSP for the Spadra Basin includes five main categories: administration and legal support, monitoring, annual reporting, five-year evaluation reporting, and planning and implementation of projects and management actions.

6.1.1 Administrative and Legal Services

The GSA will perform all the administrative activities and legal services to implement the GSP. These include:

- **GSA Administration and Operations.** Includes administrative staff support, finance staff support and related expenses, ~~insurance, and annual financial audits.~~
- **Coordination and Management of GSP.** Includes all coordination and management for continuation of Stakeholder outreach and conducting Advisory Committee meetings; conducting Executive Committee meetings; tracking and prioritizing grant funding and completing grant applications; coordination with technical consultants on monitoring and reporting; review of annual reports and other work products; and ad-hoc tasks to support GSP implementation.
- **Legal Services.** Any legal services needed for: reviewing reports and other work products; preparing for and attending Executive Committee and Advisory Committee meetings; drafting agreements and documents as needed for the GSA; and ad-hoc legal needs for administrating and implementing the GSP.

6.1.2 Monitoring

The GSA will conduct the monitoring program for the Spadra Basin GSP described in *Section 4 Monitoring Program*. The monitoring program includes either direct monitoring by the GSA and/or collection of data in the basin for groundwater (levels, quality, and production), surface water, and land subsidence. All data from the monitoring program is reviewed for QA/QC to ensure data validity and uploaded to the data management system. The monitoring program also includes periodic efforts to fill the data gaps described in Section 4.3

6.1.3 Annual Reporting

Annual reports are required to be submitted to the DWR by April 1 of every year following the adoption of the GSP. Requirements include the preparation and submittal of an annual report and electronic data deliverables. The first annual report for the Spadra Basin GSP will be completed and submitted by April 1, 2023 for the reporting period of water year 2021-2022 (October 2021-September 2022). Pursuant to [the 23](#) CCR § 356.2 of the GSP Regulations, the annual report will include the following:

- General information, including an executive summary and a location map depicting the area covered by the report.
- Groundwater elevation data from wells in the monitoring network, including:
 - Groundwater elevation contour maps illustrating, at a minimum, the seasonal high and seasonal low groundwater conditions.

- Hydrographs of groundwater elevations for a historical period through the current reporting year.
- Groundwater extraction, including:
 - A table that summarizes groundwater extractions by water use sector and identifies the method of measurement (direct or estimate) and accuracy of measurements.
 - Map that illustrates the location and volume of groundwater extractions.
- Annual volume of surface water supply used, or available for use, for groundwater recharge or in-lieu use.
- Annual volumes of total water use in a table that summarizes total water use by water use sector, water source type, and identifies the method of measurement (direct or estimate) and accuracy of measurements.
- Annual change in groundwater in storage, including:
 - Change in groundwater in storage maps
 - Graph depicting water year type, groundwater use, the annual change in groundwater in storage, and the cumulative change in groundwater in storage for a historical period through the current reporting year
- A description of progress towards implementing the GSP, including achieving Interim Milestones, and implementation of projects or management actions since the previous annual report.

Data collected and maintained from the monitoring program (see Section 4 Monitoring Program) along with water use data collected annually from the Spadra Basin water purveyors, will be used to perform the required analyses and prepare the annual report. The groundwater elevation hydrographs required in item 2 above will include a comparison to Minimum Thresholds, Measurable Objectives, and Interim Milestones at the representative monitoring sites. This analysis will be an annual check in, between the five-year evaluations described below, on current groundwater conditions and the potential for exceedance of Minimum Thresholds and occurrence of Undesirable Results.

The annual report will be submitted to the DWR's GSP Reporting System on the SGMA Portal by April 1 of each year, along with the required electronic data submittals for corresponding water year. The electronic data will be submitted using standardized Excel templates provided by the DWR to submit the following required data for the water year: groundwater extractions, groundwater extraction methods, surface water supply, total water use, change in storage, and monitoring network wells and groundwater elevation measurements.

6.1.4 Five-Year Evaluation Reporting

Periodic written assessments of the GSP are required to be submitted to the DWR at least once every five years. The five-year assessments shall describe whether the implementation of the GSP, including the implementation of projects and management actions, are meeting the Sustainability Goal. The first five-year assessment for the Spadra Basin GSP will occur in 2027. Pursuant to [23](#) CCR § 356.4 of the GSP Regulations, the five-year assessments will include the following information:

- A description of current groundwater conditions for each applicable Sustainability Indicator relative to Measurable Objectives, Interim Milestones, and Minimum Thresholds.
- A description of the implementation of any projects or management actions, and the effect on groundwater conditions resulting from those projects or management actions.

- Elements of the GSP, including the Basin Setting, the identification of Undesirable Results, and the setting of Minimum Thresholds and Measurable Objectives, shall be reconsidered and revisions proposed, if determined necessary.
- An evaluation of the Basin Setting in light of significant new information or changes in water use, and an explanation of any significant changes. If the GSA's evaluation shows that the basin is experiencing overdraft conditions, the GSA shall include an assessment of measures to mitigate the overdraft.
- A description of the monitoring network within the basin, including whether data gaps exist, or if there are areas within the basin represented by data that does not satisfy requirements in the GSP Regulations ([23 CCR § 352.4](#) and [23 CCR § 354.34\(c\)](#)). This shall include:
 - An assessment of monitoring network function with an analysis of data collected to date, identification of data gaps, and the actions necessary to improve the monitoring network, consistent with the requirements of [23 CCR § 354.38](#).
 - If the GSA identifies data gaps, the GSP will be updated with a program for the acquisition of additional data sources, and the incorporation of new information into the GSP.
 - If the GSA identifies new data collection facilities are needed, the installation and analysis of new facilities will be prioritized.
- A description of significant new information that has been made available since the adoption or amendment of the GSP, or the last five-year assessment. The description shall also include whether new information warrants changes to any aspect of the GSP, including the evaluation of the Basin Setting, Measurable Objectives, Minimum Thresholds, or the criteria defining Undesirable Results.
- A description of any relevant actions taken by the GSA, including any regulations or ordinances related to the GSP.
- Information describing any enforcement or legal actions taken by the GSA in furtherance of the Sustainability Goal for the Basin.
- A description of any completed or proposed GSP amendments, if applicable.
- Where appropriate, a summary of coordination that occurred between multiple agencies in the Basin, agencies in hydrologically connected basins, and land use agencies.
- Other information the GSA deems appropriate, along with any information required by the DWR to conduct a periodic review as required by Water Code § 10733.

The GSA will perform these periodic evaluations of the GSP every-five years in accordance [23 CCR § 356.4](#) unless new information or analyses warrant an interim evaluation to address conditions such as the exceedance of Minimum Thresholds.

As described in the Section 3.4 Sustainability Goal, the GSA will use new hydrological data and information obtained through the monitoring program ~~and use it for~~ periodic updates and recalibration of the Spadra [Basin](#) groundwater-flow model (minimum of every ten years) and use it to evaluate sustainability of current and future conditions for the Spadra Basin GSP implementation. These periodic model updates should coincide with the five-year evaluations to support the various components required in the evaluation. The modeling results can inform if updates are required to the GSP to achieve the Sustainability Goal, and

what updates are needed including adaptation of pumping and recharge and/or revisions to the Sustainable Management Criteria.

6.1.5 Planning and Implementation of Projects and Management Actions

The GSA, in collaboration with the Spadra Basin stakeholders, developed concepts for proposed projects and management actions as three “Basin Optimization Scenarios” to achieve sustainability and/or maximize the beneficial use of the Spadra Basin (Section 5.3). The Basin Optimization Scenarios were described at a conceptual level for the location, size, and operating schemes for the capital improvements (i.e., facilities). The Basin Optimization Scenarios were evaluated with the Spadra Basin groundwater model to ~~assess~~ assess hydrologic feasibility, and Class-5¹ engineering cost options were developed for each scenario to ~~assess~~ assess economic feasibility (Section 5.4). The evaluation concluded that all Basin Optimization Scenarios are hydrologically feasible, and that Basin Optimization Scenario 3 is the preferred scenario for GSP implementation to achieve the Sustainability Goal.

Taking the projects in Basin Optimization Scenario 3 from the concepts described in this GSP to final design and then through construction will occur in a phased approach:

- **Phase 1** – Identify Project Alternatives. In this phase, existing information is collected, compiled and reviewed, and the need to develop new information is identified. If necessary, new information is developed (e.g., new monitoring, surveys, studies, etc.). The new information is incorporated with the existing information and is used to develop project concepts and describe project alternatives for assessment in Phase 2.
- **Phase 2** – Project Screening Assessment. In this phase, a reconnaissance-level feasibility investigation is conducted to estimate the range in project yield and develop associated Class-5 cost opinions. An engineering economic analysis is prepared and used to refine the project alternatives. In this phase, major implementation requirements and challenges are identified, and a preliminary implementation plan is developed. This information is used to determine if the project should advance to a feasibility assessment in Phase 3.
- **Phase 3** – Feasibility Assessment. In this phase, a preliminary design report (PDR) and project- specific environmental review are prepared. The PDR effort includes a 10 to 20 percent design and a Class-4² cost opinion. The PDR is used to refine the engineering economic analysis, refine the implementation plan, and to determine whether the project should proceed to implementation in Phase 4.
- **Phase 4** – Project Implementation. In this phase, permits are acquired, implementation and financing agreements are developed and finalized, project financing is secured, final design is completed, and the project is constructed.

¹ As defined by Advancement of Cost Engineering International, a Class-5 cost opinion is based on a limited amount of information on the project and is used for project screening. Class-5 cost opinion accuracy range is - 20 to -50 percent on the low side, and +30 to +100 percent on the high side.

² As defined by Advancement of Cost Engineering International, a Class-4 cost opinion is based on a one to 15 percent engineering design and is used during studies and feasibility. A Class-4 accuracy range is -15 to -30 percent on the low side, and +20 to +50 percent on the high side.

6.2 ESTIMATE OF GSP IMPLEMENTATION COST

The Spadra Basin GSA will incur cost for the implementation of the GSP, which will require funding. The costs have been categorized as:

- **Administrative.** These are costs associated with GSA administration and legal expenses.
- **Monitoring/Reporting.** These are costs associated with monitoring and data collection, data management, and reporting required by the DWR annually and for five-year evaluations.
- **Projects and Management Actions.** These are costs associated with the planning, permitting, construction, and O&M.

Conceptual costs estimates for GSP implementation were developed for these categories. The costs are shown in Table 6-1 and described in below in more detail. The cost estimates are based on the best information available. Actual costs may vary. The GSA will have an annual budgeting process to determine and approve an annual budget based on the requirements and needs for GSP implementation for the upcoming year.

Table 6-1. Cost of The Spadra Basin GSP Implementation

Category	Cost	Frequency
Administrative		
GSA Administration and Operations	\$9,000	annually
Coordination and Management of GSP	\$31,000	annually
Legal Services	\$6,000	annually
Contingency (15 percent)	\$7,000	annually
Administrative - Annual Cost:	\$53,000	
Monitoring/Reporting		
Monitoring, Data Collection, and Database Maintenance		
Setup of monitoring network	\$18,000	one-time annual event 1st year
Groundwater-level monitoring	\$22,000	annually
Groundwater-quality monitoring	\$22,000	annually
Production monitoring	\$5,000	annually
Surface water monitoring	\$5,000	annually
Subsidence monitoring	\$3,000	annually
Data Gap Filling Efforts - Private Well Canvas and Outreach	\$11,000	one-time annual event 1st year
Reporting		
Annual Reporting - first year	\$100,000	one-time annual event 1st year
Annual Reporting - subsequent years	\$80,000	annually
Model Update and Five-Year Evaluation of the GSP ^(a)	\$250,000	every five years
Monitoring/Reporting - Annual Cost - First Year Only:	\$186,000	
Monitoring/Reporting - Annual Cost:	\$137,000	
Monitoring/Reporting - Annual Cost - With Five-Year Evaluation:	\$387,000	
Administrative & Monitoring/Reporting - Annual Cost - First Year:	\$239,000	
Administrative & Monitoring/Reporting - Annual Cost:	\$190,000	
Administrative & Monitoring/Reporting - Annual Cost - With Five-Year Evaluation:	\$440,000	
3. Projects and Management Actions		
Basin Optimization Scenario 3 - Recommended/Preferred Scenario		
Construction	\$160,000,000	Assume 30 years for planning, construction, and payoff of capital improvement loans
Operations and Maintenance	\$472,000	annually after construction
Annual Cost Range ^(b)	\$5,300,000 to 5,800,000	
Basin Optimization Scenario 2		
Construction	\$23,000,000	Assume 30 years for planning, construction, and payoff of capital improvement loans
Operations and Maintenance	\$43,000	annually after construction
Annual Cost Range ^(b)	\$767,000 to \$810,000	
Basin Optimization Scenario 1		
Construction	\$1,100,000	Assume 30 years for planning, construction, and payoff of capital improvement loans
Operations and Maintenance	\$4,000	annually after construction
Annual Cost Range ^(b)	\$37,000 to \$ 41,000	
(a) The cost for the five-year elevation assumes that the concurrence of a periodic update and recalibration of the Spadra groundwater-flow model to evaluate sustainability and inform the evaluation and any updates required to the GSP.		
(b) The annual cost range: Low end is cost for a 30-year loan for the lump sum costs for planning and construction divide by 30 years; High end is cost for a 30-year loan for the lump sum costs for planning and construction divide by 30 years plus annual O&M		

6.2.1 Administrative Costs

These costs are broken down into the following main categories:

- **GSA Administration and Operations.** These are costs for administrative staff support, finance staff support and related expenses, [insurance, and annual financial audits.](#)
- **Coordination and Management of GSP.** These are costs for continuation of Stakeholder outreach and conducting Advisory Committee meetings; conducting Executive Committee meetings; tracking and prioritizing grant funding and completing grant applications; coordination with technical consultants on monitoring and reporting; review of annual reports and other work products; and ad-hoc tasks to support GSP implementation.
- **Legal Services.** These are costs for legal services for: reviewing reports and other work products; preparing for and attending Executive Committee and Advisory Committee meetings; drafting agreements and documents as needed for the GSA; and ad-hoc legal needs for administrating and implementing the GSP.
- **Contingency.** A 15 [percent](#) % contingency is added for unknown variables and unanticipated costs.

The GSP implementation costs for Administrative are estimated to be about \$53,000 annually.

6.2.2 Monitoring/Reporting Costs

These costs are broken down into the following main categories:

- **Monitoring, Data Collection, and Database Maintenance.** These are costs to conduct all monitoring activities described in Section 4 of the GSP, including: fill gaps in the monitoring network; data collection; and the QA/QC and upload of the data into the data management. Some of these costs are one-time expenses for setting up the monitoring network and installing transducers in the 12 wells monitoring by the GSA and conducting the [well](#)-canvas of private wells.
- **Reporting.** These are costs for preparing annual reports, DWR data deliverables described in Section 6.1.3, and the five-year GSP evaluation described in Section 6.1.4. The cost to prepare the first annual report are higher than for the subsequent years due to the work required to set up the format and processes to prepare the annual report. The cost for the five-year evaluation assumes an update and recalibration of the Spadra groundwater-flow model to evaluate sustainability and inform the any required updates to the GSP (see Section 6.1.4).

The GSP implementation costs for Monitoring/Reporting are estimated to range between \$137,000 to \$612,000. The estimated annual cost for the first year of GSP implementation is \$186,000, and subsequent years are \$137,000. The costs for the years when a five-year evaluation of the GSP is performed is expected to be higher at \$612,000.

6.2.3 Projects and Management Actions Costs

The costs for the projects and management actions shown in Table 6-1 are the Class-5 engineering cost estimates presented in Appendix L (Tables L-2a, L-2b, L-2c) for implementation of the three Basin Optimization Scenarios described [and evaluated](#) in Sections 5.3 and [4.25.4](#) of this GSP. Basin Optimization Scenario 3 is the preferred scenario for GSP implementation. The cost estimates in Table 6-1 include the one-time capital costs for planning and construction of the facilities and the ongoing annual costs for O&M of the facilities after startup.

The annual costs for these Basin Optimization Scenarios will vary depending on the stage of project implementation (planning, construction, and O&M). Table 6-1 also shows an estimated annual range in cost for each scenario that assumes the cost for a 30-year loan for the lump sum costs for planning and construction divided by 30 years as the low end, and the cost for a 30-year loan lump sum cost for planning and construction divided by 30 years plus the annual O&M cost as the high end. The annual cost for the preferred Basin Optimization Scenario 3 ranges from \$5.3 to \$ 5.8 million per year. As described in Section 5.5.3, Basin Optimization Scenario 3 is the most expensive scenario through 2059 as [a](#) total aggregate water supply cost for the Spadra Basin but is the least expensive scenario thereafter when the assumed loans to fund the capital improvements are paid off. The annual range shown in Table 6-1 does not account for annual cost after 30 years when the assumed loans for capital improvements would be paid off.

6.3 GSP FUNDING AND FINANCING

This GSP was funded 50 percent through a Proposition 1 Sustainable Groundwater Planning Grant (Appendix A). The Spadra Basin GSA operations are partially funded through this grant and by volunteer contributions from the GSA member agencies. The Spadra Basin GSA will fund the ongoing cost for the operation of GSA and implementation of the GSP through contributions from its member agencies and grant funding if available. Additionally, the Spadra Basin GSA has the authority to impose certain fees and assessments on groundwater pumping to fund all aspects of GSP implementation (Water Code § 10730 and § 10732). The GSA will develop a funding structure to pay for the costs to implement the GSP upon adoption of the GSP within the first year.

Additionally, the GSA may pursue other financing sources for capital projects, repayment of debt, O&M, and other ongoing expenses for the projects and management actions.

6.4 SCHEDULE FOR IMPLEMENTATION

Table 6-2 is a schedule for the first 20 years of GSP Implementation, showing [and](#) estimated timeline for the following major implementation categories: Administrative, Monitoring, Reporting, and Planning and Implementation of Projects and Management Actions.

Table 6-2. General Schedule for Spadra Basin GSP Implementation - 20 Years

Task	2022	2023	2024	2025	2026	2027	2028	2029	2030	2031	2032	2033	2034	2035	2036	2037	2038	2039	2040	2041	2042
Administrative																					
-- Ongoing GSA Administration and Operations, Coordination and Management of GSP, and Legal Services																					
Monitoring																					
-- Ongoing Monitoring, Data Collection, and Database Maintenance																					
-- Setup of monitoring network																					
-- Private Well Canvas and Outreach																					
-- Filling Other Data Gaps																					
Reporting																					
-- Annual Reporting																					
-- Five-Year Evaluation Reports																					
Planning and Implementation of Projects and Management Actions																					
Implementation of Projects and Management Actions in the Preferred Basin Optimization Scenario 3 ^(a)																					
-- Planning/Permitting/CEQA																					
-- Construction																					
-- Operation and Maintenance																					
(a) Basin Optimization Scenario 3 is assumed operational in fiscal year 2030 (July 1, 2029 - June 30, 2030)																					

SECTION 7

References

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