Salinas Valley Groundwater Basin
180/400-Foot Aquifer Subbasin
Groundwater Sustainability Plan

Salinas Valley Basin
Groundwater Sustainability Agency

(Approved by Salinas Valley Basin Groundwater Sustainability Agency Board of Directors on January 9, 2020)

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Salinas Valley: 180/400-Foot Aquifer Subbasin
Groundwater Sustainability Plan
CONTENTS

LIST OF APPENDICES

LIST OF FIGURES

LIST OF TABLES

ACRONYMS & ABBREVIATIONS

ADEQ	Arizona Department of Environmental Quality
ADWR	Arizona Department of Water Resources
AF	acre-feet
AF/yr.	acre-feet per year
Alco	Alisal Water Corporation
AMBAG	Association of Monterey Bay Area Governments
amls	above mean sea level
AWPF	Advanced Water Purification Facility
Basin Plan	Water Quality Control Plan for the Central Coast Basin
BCM	Basin Characterization Model
bgs	below ground surface
BLM	U.S. Bureau of Land Management
Cal-Am	California-American Water
CASGEM	California Statewide Groundwater Elevation Monitoring
CCGC	Central Coast Groundwater Coalition
CCR	California Code of Regulations
CCRWQCB	Central Coast Regional Water Quality Control Board
CCTAG	Climate Change Technical Advisory Group
cfs	cubic feet per second
CIFP	Capital Improvement and Financing Plan
COCs	Constituents of Concern
COOP	Cooperative Observer program
County GSA	County of Monterey Ground Water Sustainability Agency
CSD	Community Services District
CSIP	Castroville Seawater Intrusion Project
DCE	dichloroethylene
DDW	Division of Drinking Water
DEM	Digital Elevation Model
DMS	Data management system
DTSC	Department of Toxic Substances Control
DWR	California Department of Water Resources
EIR	environmental impact report
EIS	environmental impact statement
EPA	U.S. Environmental Protection Agency
ET	evapotranspiration
eWRIMS	Electronic Water Rights Information Management System
ft/d	feet per day
ft/yr	feet per year
ft2/d	square feet per day
FORA	Fort Ord Reuse Authority
GAMA	Groundwater Ambient Monitoring and Assessment

GDE	groundwater-dependent ecosystem
GIS	geographic information systems
GMP	Groundwater Management Plan
gpd/ft	gallons per day per foot
gpm	gallons per minute
GPS	global positioning system
GRC	General Rate Case
GSA	Groundwater Sustainability Agency
GSP	Groundwater Sustainability Plan
gSSURGO	Gridded Soil Survey Geographic
HCP	Habitat Conservation Plan
HSU	hydrostratigraphic unit
ILRP	Irrigated Lands Regulatory Program
InSAR	Interferometric Synthetic Aperture Radar
IRWM	Integrated Regional Water Management
JPA	Joint Powers Authority
LID	Low Impact Development
M1W	Monterey One Water
MA	Management Area
MCL	Maximum Contaminant Level
MCRCD	Monterey County Resource Conservation District
MCWD	Marina Coast Water District
MCWRA	Monterey County Water Resources Agency
meq/L	milliequivalents per liter
mg/L	milligrams per liter
MPWSP	Monterey Peninsula Water Supply Project
MTBE	methyl tert butyl ether
NCCAG	Natural Communities Commonly Associated with Groundwater
NCSS	National Cooperative Soil Survey
NEPA	National Environmental Policy Act
NHD	National Hydrology Dataset
NMFS	National Marine Fisheries Service
NOAA	National Oceanographic and Atmospheric Administration
NPDES	National Pollutant Discharge Elimination System
NRCS	USDA Natural Resources Conservation Service
NWIS	National Water Information System (USGS)
NWS	National Weather Service
O&M	operations and maintenance
OSWCR	Online System for Well Completion Reports
PAH	polycyclic aromatic hydrocarbons
PCB	polychlorinated biphenyl
PCE	tetrachloroethylene
PET	potential evapotranspiration

PRISM	Parameter-elevation Regressions on Independent Slopes Model
PWM	Pure Water Monterey
QA/QC	quality assurance / quality control
QAPP	Quality Assurance Project Plan
R2	correlation coefficient
RMS	representative monitoring sites
RTP	Regional Wastewater Treatment Plan
RWMG	Regional Water Management Group
SAGBI	Soil Agricultural Groundwater Banking Index
SB	Senate Bill
SGMA	Sustainable Groundwater Management Act
SMC	Sustainable Management Criteria
SMCA	State Marine Conservation Area
SMCL	secondary maximum contaminant level
SMR	State Marine Reserve
SRDF	Salinas River Diversion Facility
Subbasin	Salinas Valley – 180/400-Foot Aquifer Subbasin
SVBGSA	Salinas Valley Basin Groundwater Sustainability Agency
SVIHM	Salinas Valley Integrated Hydrologic Model
SVRP	Salinas Valley Reclamation Project
SVWP	Salinas Valley Water Project
SWQCB	State Water Quality Control Board
SWRCB	State Water Resources Control Board
TCE	trichloroethylene
TDS	total dissolved solids
TNC	The Nature Conservancy
USGS	United States Geological Survey
UWMP	Urban Water Management Plan
VIC	Variable Infiltration Capacity
VOC	volatile organic compound
VSMOW	Vienna Standard Mean Ocean Water
WDR	Waste Discharge Requirements

DEFINITIONS

California Water Code

Sec. 10721

Unless the context otherwise requires, the following definitions govern the construction of this part:

(a) Adjudication action means an action filed in the superior or federal district court to determine the rights to extract groundwater from a basin or store water within a basin, including, but not limited to, actions to quiet title respecting rights to extract or store groundwater or an action brought to impose a physical solution on a basin.

(b) Basin means a groundwater basin or subbasin identified and defined in Bulletin 118 or as modified pursuant to Chapter 3 (commencing with Section 10722).

(c) Bulletin 118 means the department's report entitled California's Groundwater: Bulletin 118 updated in 2003, as it may be subsequently updated or revised in accordance with Section 12924.

(d) Coordination agreement means a legal agreement adopted between two or more groundwater sustainability agencies that provides the basis for coordinating multiple agencies or groundwater sustainability plans within a basin pursuant to this part.

(e) De minimis extractor means a person who extracts, for domestic purposes, two acre-feet or less per year.

(f) Governing body means the legislative body of a groundwater sustainability agency.

(g) Groundwater means water beneath the surface of the earth within the zone below the water table in which the soil is completely saturated with water, but does not include water that flows in known and definite channels.

(h) Groundwater extraction facility means a device or method for extracting groundwater from within a basin.

(i) Groundwater recharge or recharge means the augmentation of groundwater, by natural or artificial means.

(j) Groundwater sustainability agency means one or more local agencies that implement the provisions of this part. For purposes of imposing fees pursuant to Chapter 8 (commencing with Section 10730) or taking action to enforce a groundwater sustainability plan, groundwater sustainability agency also means each local agency comprising the groundwater sustainability agency if the plan authorizes separate agency action.

(k) Groundwater sustainability plan or plan means a plan of a groundwater sustainability agency proposed or adopted pursuant to this part.

(l) Groundwater sustainability program means a coordinated and ongoing activity undertaken to benefit a basin, pursuant to a groundwater sustainability plan.

(m) In-lieu use means the use of surface water by persons that could otherwise extract groundwater in order to leave groundwater in the basin.

(n) Local agency means a local public agency that has water supply, water management, or land use responsibilities within a groundwater basin.

(o) Operator means a person operating a groundwater extraction facility. The owner of a groundwater extraction facility shall be conclusively presumed to be the operator unless a satisfactory showing is made to the governing body of the groundwater sustainability agency that the groundwater extraction facility actually is operated by some other person.

(p) Owner means a person owning a groundwater extraction facility or an interest in a groundwater extraction facility other than a lien to secure the payment of a debt or other obligation.

(q) Personal information has the same meaning as defined in Section 1798.3 of the Civil Code.

(r) Planning and implementation horizon means 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.

(s) Public water system has the same meaning as defined in Section 116275 of the Health and Safety Code.

(t) Recharge area means the area that supplies water to an aquifer in a groundwater basin.

(u) Sustainability goal means the existence and implementation of one or more groundwater sustainability plans that achieve sustainable groundwater management by identifying and causing the implementation of measures targeted to ensure that the applicable basin is operated within its sustainable yield.

(v) Sustainable groundwater management means the management and use of groundwater in a manner that can be maintained during the planning and implementation horizon without causing undesirable results.

(w) Sustainable yield means the maximum quantity of water, calculated over a base period representative of long-term conditions in the basin and including any temporary surplus that can be withdrawn annually from a groundwater supply without causing an undesirable result.

(x) Undesirable result means one or more of the following effects caused by groundwater conditions occurring throughout the basin:

  (1) Chronic lowering of groundwater levels indicating a significant and unreasonable depletion of supply if continued over the planning and implementation horizon. Overdraft during a period of drought is not sufficient to establish a chronic lowering of groundwater levels if extractions and groundwater recharge are managed as necessary to ensure that reductions in groundwater levels or storage during a period of drought are offset by increases in groundwater levels or storage during other periods.

  (2) Significant and unreasonable reduction of groundwater storage.

  (3) Significant and unreasonable seawater intrusion.

  (4) Significant and unreasonable degraded water quality, including the migration of contaminant plumes that impair water supplies.

  (5) Significant and unreasonable land subsidence that substantially interferes with surface land uses.

  (6) Depletions of interconnected surface water that have significant and unreasonable adverse impacts on beneficial uses of the surface water.

(y) Water budget means an accounting of the total groundwater and surface water entering and leaving a basin including the changes in the amount of water stored.

(z) Watermaster means a watermaster appointed by a court or pursuant to other law.

(aa) Water year means the period from October 1 through the following September 30, inclusive.

(ab) Wellhead protection area means the surface and subsurface area surrounding a water well or well field that supplies a public water system through which contaminants are reasonably likely to migrate toward the water well or well field.

Official California Code of Regulations

Title 23. Waters
Division 2. Department of Water Resources
Chapter 1.5. Groundwater Management
Subchapter 2. Groundwater Sustainability Plans
Article 2. Definitions
23 CCR § 351
§ 351. Definitions.

The definitions in the Sustainable Groundwater Management Act, Bulletin 118, and Subchapter 1 of this Chapter, shall apply to these regulations. In the event of conflicting definitions, the definitions in the Act govern the meanings in this Subchapter. In addition, the following terms used in this Subchapter have the following meanings:

(a) "Agency" refers to a groundwater sustainability agency as defined in the Act.

(b) "Agricultural water management plan" refers to a plan adopted pursuant to the Agricultural Water Management Planning Act as described in Part 2.8 of Division 6 of the Water Code, commencing with Section 10800 et seq.

(c) "Alternative" refers to an alternative to a Plan described in Water Code Section 10733.6.

(d) "Annual report" refers to the report required by Water Code Section 10728.

(e) "Baseline" or "baseline conditions" refer to historic information used to project future conditions for hydrology, water demand, and availability of surface water and to evaluate potential sustainable management practices of a basin.

(f) "Basin" means a groundwater basin or subbasin identified and defined in Bulletin 118 or as modified pursuant to Water Code 10722 et seq.

(g) "Basin setting" refers to the information about the physical setting, characteristics, and current conditions of the basin as described by the Agency in the hydrogeologic conceptual model, the groundwater conditions, and the water budget, pursuant to Subarticle 2 of Article 5.

(h) “Best available science” refers to the use of sufficient and credible information and data, specific to the decision being made and the time frame available for making that decision, that is consistent with scientific and engineering professional standards of practice.

(i) “Best management practice” refers to a practice, or combination of practices, that are designed to achieve sustainable groundwater management and have been determined to be technologically and economically effective, practicable, and based on best available science.

(j) “Board” refers to the State Water Resources Control Board.

(k) “CASGEM” refers to the California Statewide Groundwater Elevation Monitoring Program developed by the Department pursuant to Water Code Section 10920 et seq., or as amended.

(l) “Data gap” refers to a lack of information that significantly affects the understanding of the basin setting or evaluation of the efficacy of Plan implementation, and could limit the ability to assess whether a basin is being sustainably managed.

(m) “Groundwater dependent ecosystem” refers to ecological communities or species that depend on groundwater emerging from aquifers or on groundwater occurring near the ground surface.

(n) “Groundwater flow” refers to the volume and direction of groundwater movement into, out of, or throughout a basin.

(o) “Interconnected surface water” refers to surface water that is hydraulically connected at any point by a continuous saturated zone to the underlying aquifer and the overlying surface water is not completely depleted.

(p) “Interested parties” refers to persons and entities on the list of interested persons established by the Agency pursuant to Water Code Section 10723.4.

(q) “Interim milestone” refers to a target value representing measurable groundwater conditions, in increments of five years, set by an Agency as part of a Plan.

(r) “Management area” refers to an area within a basin for which the Plan may identify different minimum thresholds, measurable objectives, monitoring, or projects and management actions based on differences in water use sector, water source type, geology, aquifer characteristics, or other factors.

(s) “Measurable objectives” refer to specific, quantifiable goals for the maintenance or improvement of specified groundwater conditions that have been included in an adopted Plan to achieve the sustainability goal for the basin.

(t) “Minimum threshold” refers to a numeric value for each sustainability indicator used to define undesirable results.

(u) “NAD83” refers to the North American Datum of 1983 computed by the National Geodetic Survey, or as modified.

(v) “NAVD88” refers to the North American Vertical Datum of 1988 computed by the National Geodetic Survey, or as modified.

(w) “Plain language” means language that the intended audience can readily understand and use because that language is concise, well-organized, uses simple vocabulary, avoids excessive acronyms and technical language, and follows other best practices of plain language writing.

(x) “Plan” refers to a groundwater sustainability plan as defined in the Act.

(y) “Plan implementation” refers to an Agency's exercise of the powers and authorities described in the Act, which commences after an Agency adopts and submits a Plan or Alternative to the Department and begins exercising such powers and authorities.

(z) “Plan manager” is an employee or authorized representative of an Agency, or Agencies, appointed through a coordination agreement or other agreement, who has been delegated management authority for submitting the Plan and serving as the point of contact between the Agency and the Department.

(aa) “Principal aquifers” refer to aquifers or aquifer systems that store, transmit, and yield significant or economic quantities of groundwater to wells, springs, or surface water systems.

(ab) “Reference point” refers to a permanent, stationary and readily identifiable mark or point on a well, such as the top of casing, from which groundwater level measurements are taken, or other monitoring site.

(ac) “Representative monitoring” refers to a monitoring site within a broader network of sites that typifies one or more conditions within the basin or an area of the basin.

(ad) “Seasonal high” refers to the highest annual static groundwater elevation that is typically measured in the Spring and associated with stable aquifer conditions following a period of lowest annual groundwater demand.

(ae) "Seasonal low" refers to the lowest annual static groundwater elevation that is typically measured in the Summer or Fall, and associated with a period of stable aquifer conditions following a period of highest annual groundwater demand.

(af) "Seawater intrusion" refers to the advancement of seawater into a groundwater supply that results in degradation of water quality in the basin, and includes seawater from any source.

(ag) "Statutory deadline" refers to the date by which an Agency must be managing a basin pursuant to an adopted Plan, as described in Water Code Sections 10720.7 or 10722.4.

(ah) "Sustainability indicator" refers to any of the effects caused by groundwater conditions occurring throughout the basin that, when significant and unreasonable, cause undesirable results, as described in Water Code Section 10721(x).

(ai) "Uncertainty" refers to a lack of understanding of the basin setting that significantly affects an Agency's ability to develop sustainable management criteria and appropriate projects and management actions in a Plan, or to evaluate the efficacy of Plan implementation, and therefore may limit the ability to assess whether a basin is being sustainably managed.

(aj) "Urban water management plan" refers to a plan adopted pursuant to the Urban Water Management Planning Act as described in Part 2.6 of Division 6 of the Water Code, commencing with Section 10610 et seq.

(ak) "Water source type" represents the source from which water is derived to meet the applied beneficial uses, including groundwater, recycled water, reused water, and surface water sources identified as Central Valley Project, the State Water Project, the Colorado River Project, local supplies, and local imported supplies.

(al) "Water use sector" refers to categories of water demand based on the general land uses to which the water is applied, including urban, industrial, agricultural, managed wetlands, managed recharge, and native vegetation.

(am) "Water year" refers to the period from October 1 through the following September 30, inclusive, as defined in the Act.

(an) "Water year type" refers to the classification provided by the Department to assess the amount of annual precipitation in a basin.

EXECUTIVE SUMMARY

ES-1 INTRODUCTION AND AGENCY INFORMATION (GSP CHAPTERS 1 - 2)

The 2014 California Sustainable Groundwater Management Act (SGMA) requires that medium- and high-priority groundwater basins and subbasins develop Groundwater Sustainability Plans (GSPs) that outline how they will achieve groundwater sustainably in 20 years, and maintain sustainability for an additional 30 years. This GSP fulfills that requirement for the Salinas Valley - 180/400-Foot Aquifer Subbasin.

In 2017, local GSA-eligible entities formed the Salinas Valley Basin Groundwater Sustainability Agency (SVBGSA) to develop and implement the GSPs for the Salinas Valley. The SVBGSA is a Joint Powers Authority (JPA) with membership comprising the County of Monterey, Water Resources Agency of the County of Monterey (Monterey County Water Resources Agency, or MCWRA), City of Salinas, City of Soledad, City of Gonzales, City of King, Castroville Community Services District, and Monterey One Water. The SVBGSA is governed by an eleven-member Board of Directors, representing public and private groundwater interests throughout the Salinas Valley Groundwater Basin. In addition, an Advisory Committee ensures participation by, and input to, the Board by constituencies whose interests are not directly represented on the Board. The SVBGSA's activities are coordinated by a General Manager.

The Salinas Valley Groundwater Basin consists of nine subbasins, of which six fall entirely or partially under the SVBGSA's jurisdiction. One of the nine subbasins, the Seaside Subbasin, is adjudicated and not managed by the SVBGSA. Another two subbasins, the Paso Robles and Atascadero Subbasins, lie completely in San Luis Obispo County and are managed by other groundwater sustainability agencies.

The SVBGSA developed this GSP in coordination with the Marina Coast Water District Groundwater Sustainability Agency (MCWD GSA) and the County of Monterey Ground Water Sustainability Agency (County GSA). The SVBGSA developed this GSP for the 180/400-Foot Aquifer Subbasin (Subbasin) in concert with the GSPs for its five other Salinas Valley Subbasins: the Eastside Aquifer Subbasin (DWR subbasin number 3-004.02), the Forebay Aquifer Subbasin (DWR subbasin number 3-004.04), the Upper Valley Aquifer Subbasin (DWR subbasin number 3-004.05), the Langley Area Subbasin (DWR subbasin number 3-004.09) and the Monterey Subbasin (DWR subbasin number 3-004.10). Together, the six subbasin plans under the SVBGSA will be integrated into the Salinas Valley Integrated Groundwater Sustainability Plan.

This GSP covers all of the 89,700 acres of the 180/400-Foot Aquifer Subbasin, as shown in Figure 1.The GSP describes current groundwater conditions, develops a hydrogeologic conceptual model, establishes a water budget, outlines local sustainable management criteria, and provides projects and programs for reaching sustainability in the Subbasin by 2040.

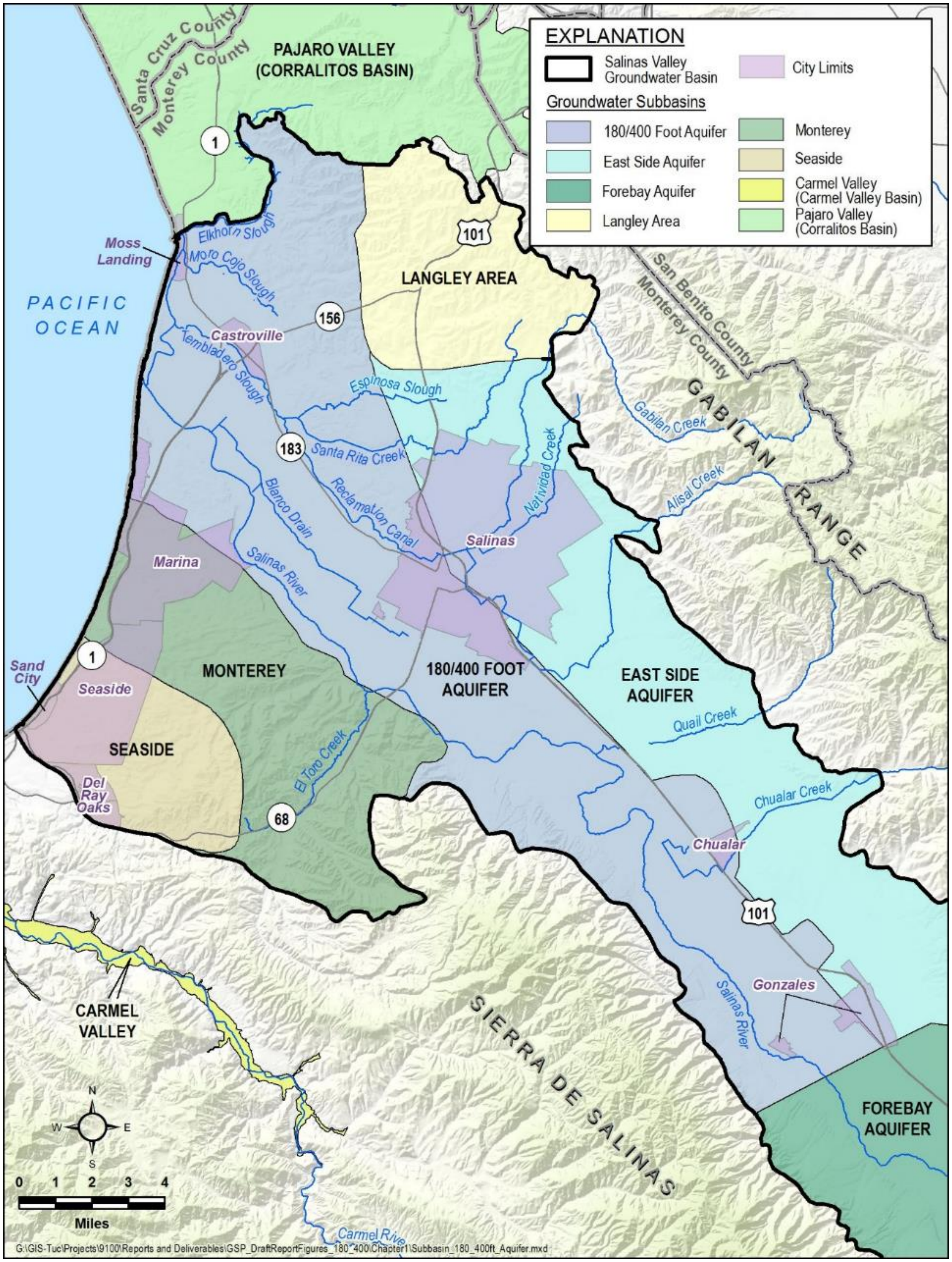

Figure ES-1. 180/400-Foot Aquifer Subbasin

ES-2 DESCRIPTION OF PLAN AREA (GSP CHAPTER 3)

The 180/400-Foot Aquifer Subbasin is a high-priority groundwater subbasin in northwestern Monterey County that includes the northern end of the Salinas River Valley. The Salinas River flows into the Subbasin from the south and discharges into Monterey Bay in the north. The majority of land in the Subbasin is used for agriculture, with lettuce, strawberries, and broccoli as the top three crops (Monterey County Agriculture Commissioner, 2018). The Subbasin contains the municipalities of Marina, Salinas, and Gonzales; and the census-designated places of Castroville, Moss Landing, Elkhorn, Boronda, Spreckels, and Chualar.

Groundwater is the main water source in the Subbasin. The Salinas River and its tributaries provide limited surface water; and the Castroville Seawater Intrusion Project (CSIP) delivers a combination of groundwater, surface water, and recycled water from Monterey One Water to the coastal farmland surrounding Castroville. The primary water use sector is agriculture, which uses 85% of the water in the Subbasin. Most of the remaining water use is urban, with only minimal use by wetlands and native vegetation.

A significant number of existing groundwater and surface water monitoring programs active in the Subbasin will be directly incorporated into the GSP implementation. Ongoing monitoring programs include:

- CASGEM groundwater elevation monitoring
- Non-CASGEM groundwater elevation monitoring
- MCWRA’s groundwater pumping annual reporting
- MCWRA’s seawater intrusion monitoring
- Municipal, small water system, and agricultural groundwater quality monitoring
- Stream gauge measurements

ES-3 HYDROGEOLOGIC CONCEPTUAL MODEL (GSP CHAPTER 4)

Due to decades of extensive study and groundwater development, the structure and boundaries of the 180/400-Foot Aquifer Subbasin are relatively well-developed. The 180/400-Foot Subbasin is an alluvial basin with elevations that range from sea level at the coast to approximately 500 feet (NAVD88) along the Sierra de Salinas. Lateral boundaries between subbasins are determined in part by geologic structures and depositional changes that influence flow and interaction between basins and subbasins. The northern boundary of the 180/400-Foot Aquifer Subbasin follows the current course of Elkhorn Slough and corresponds to a paleo-drainage of the Salinas River (DWR, 2003) that limits groundwater flow between basins (Durbin, et al., 1978). The boundary with the Langley Subbasin to the northeast is based on a topographic change from the valley floor to an elevated foothill area, but there is no hydraulic barrier to groundwater flow. To the east, hydraulic connectivity is restricted by depositional changes along the border with the Eastside Aquifer. To the southeast, there is hydraulic connectivity with the Forebay Subbasin. To the southwest, the boundary with the Monterey Subbasin is based on topographic rise that coincides with a buried trace of the Reliz fault, which may act as a groundwater flow barrier (Durbin, et al. 1978); however, more data is needed to determine the extent of hydraulic connectivity. Finally, there is no hydraulic barrier between the 180/400-Foot Aquifer Subbasin and the Monterey Bay.

Vertically, the shallowest water-bearing sediments are not considered a principal aquifer because they are thin, laterally discontinuous, and a minor source of water. Groundwater in these shallow sediments is hydraulically connected to the Salinas River but poorly connected to the underlying productive principal aquifers: the 180-Foot, 400-Foot, and Deep Aquifers. The base of the shallow sediments is the Salinas Valley Aquitard, which overlies and confines the 180-Foot Aquifer. The 180-Foot Aquifer consists of interconnected sand and gravel beds that are 50 to 150 feet thick. Below the 180-Foot Aquifer, the 180/400-Foot Aquitard confines the 400-Foot Aquifer. The 400-Foot Aquifer is a relatively permeable horizon that is approximately 200 feet thick near Salinas; but in other areas the aquifer is split into multiple permeable zones by clay layers (DWR, 1973). Below the 400-Foot Aquifer the 400-Foot/Deep Aquitard, confines the Deep Aquifers, also referred to as the 900-Foot and 1500-Foot Aquifers. There are limited data available from the Deep Aquifers. The Subbasin does not have a well-defined base, and this GSP adopts the base of the Subbasin defined by the USGS (Durbin, et al., 1978).

Detailed aquifer property values (storativity, conductivity, and transmissivity) for each aquifer were not available at the time of GSP development, although estimates from calibrated groundwater models were available. The SVBGSA will fill this data gap during GSP implementation. This GSP uses specific capacity data as a proxy for transmissivity data. The specific capacity data indicate that the 180-Foot Aquifer and the 400-Foot Aquifer are relatively transmissive aquifers with high well yields.

Natural groundwater recharge occurs through infiltration of surface water, deep percolation of excess applied irrigation water, and deep percolation of infiltrating precipitation. Recharge to the 180-Foot Aquifer is likely limited due to the low permeability of the Salinas Valley Aquitard. No mapped springs, seeps, or discharge to streams have been identified in the Subbasin. Some phreatophytes discharge groundwater through evapotranspiration in areas where the water table is sufficiently high.

The primary surface water body in the Subbasin is the Salinas River. Two reservoirs outside of the Subbasin, Lake Nacimiento and Lake San Antonio, control river flows and are important controls for managed aquifer recharge. Agricultural diversions have altered the Salinas River's hydrology, and the River no longer exhibits natural seasonal variation in flows.

ES-4 GROUNDWATER CONDITIONS (GSP CHAPTER 5)

General groundwater conditions in the Subbasin are described for current (after January 1, 2015) and historical conditions (before January 1, 2015), organized by DWR's six sustainability indicators.

- **Groundwater Elevations** – Groundwater hydrographs show a general decline in groundwater elevations in the 180/400-Foot Aquifer Subbasin. Groundwater elevations have been chronically lowered due to pumping and are lowest during higher irrigation seasons. The lowered groundwater elevations are the cause of seawater intrusion in both the 180-Foot and the 400-Foot Aquifers.
- **Change in Groundwater Storage –** This GSP defines change in usable groundwater storage as the annual average increase or decrease in groundwater that can be safely used for domestic, industrial, or agricultural purposes. Change in usable groundwater storage is the sum of change in storage determined from groundwater elevation changes and the change in storage due to seawater intrusion. For the 180/400-Foot Aquifer Subbasin, the historical average annual loss of storage is approximately 11,700 acre-feet per year (AF/yr.).
- **Seawater Intrusion –** The 180-Foot and 400-Foot Aquifers have been subject to seawater intrusion for more than 70 years. MCWRA and others have implemented projects to slow seawater intrusion; however, it remains an ongoing threat. Seawater intrusion is less extensive in the 400-Foot Aquifer than in the 180-Foot Aquifer; however, between 2013 and 2017, the area impacted by intrusion in the 400-Foot Aquifer increased from approximately 12,500 acres to 18,000 acres. To date, seawater intrusion has not been reported in the Deep Aquifers.
- **Groundwater Quality –** Elevated nitrate concentrations in groundwater were locally present in the 1960s and significantly increased in 1970s and 1980s. In 2005, nitrate levels exceeding the primary maximum contaminant level (MCL) were found in 32% of public water supply samples in the Salinas Valley Groundwater Basin (USGS, 2005). In 2018, nitrate levels exceeded the primary MCL in 26% of On-Farm Domestic Wells and 21% of Irrigation Supply Wells in the Subbasin (CCRWQCB, 2018), a majority of which originated from irrigated agricultural waste discharges. Other constituents found at levels of concern for either potable or irrigation uses include 1,2,3-trichloropropane, arsenic, cadmium, chloride, fluoride, hexavalent chromium, iron, manganese, methyl tert-butyl ether, perchlorate, total dissolved solids, and thallium.
- **Subsidence –** No measurable subsidence has been recorded anywhere in the Subbasin between June 2015 and June 2018.
- **Interconnected Surface Water –** Although the Salinas Valley Aquitard inhibits hydraulic connectivity between the 180/400-Foot Aquifer and Salinas River,

interconnection may exist in the two limited areas where groundwater is less than 20 feet below ground surface: near the southern boundary where the Salinas River enters the Subbasin and northern boundary where the River discharges into Monterey Bay. While this analysis is based on best available data, it contains significant uncertainty and data gaps that will be filled during GSP implementation.

ES-5 WATER BUDGETS (GSP CHAPTER 6)

Water budgets provide an accounting and assessment of the total annual volume of surface water and groundwater entering and leaving the Subbasin. This GSP presents three water budgets – historical (1995-2014), current (2015-2017), and projected. A surface water budget and a groundwater budget are presented for each time period. The groundwater budget is the budget for the entire groundwater system, including the shallow sediments and principal aquifers. It contains aggregate numbers for the Subbasin and is not differentiated spatially or by aquifer.

Historical and Current Water Budgets – Historical and current water budgets use best available data and tools to determine the water budget components; however, no groundwater model was available at the time of writing to produce an integrated historical and current water budget. Data include surface flow gauges, calculations from historical studies, precipitation records and estimated subsurface flows based on flow directions and hydraulic gradients. In 2020, the USGS will release its Salinas Valley Integrated Hydrologic Model (SVIHM). The historical and current water budgets will be updated to reflect the SVIHM output when it is released. Figure 2 summarizes annual average components of the historical groundwater water budget.

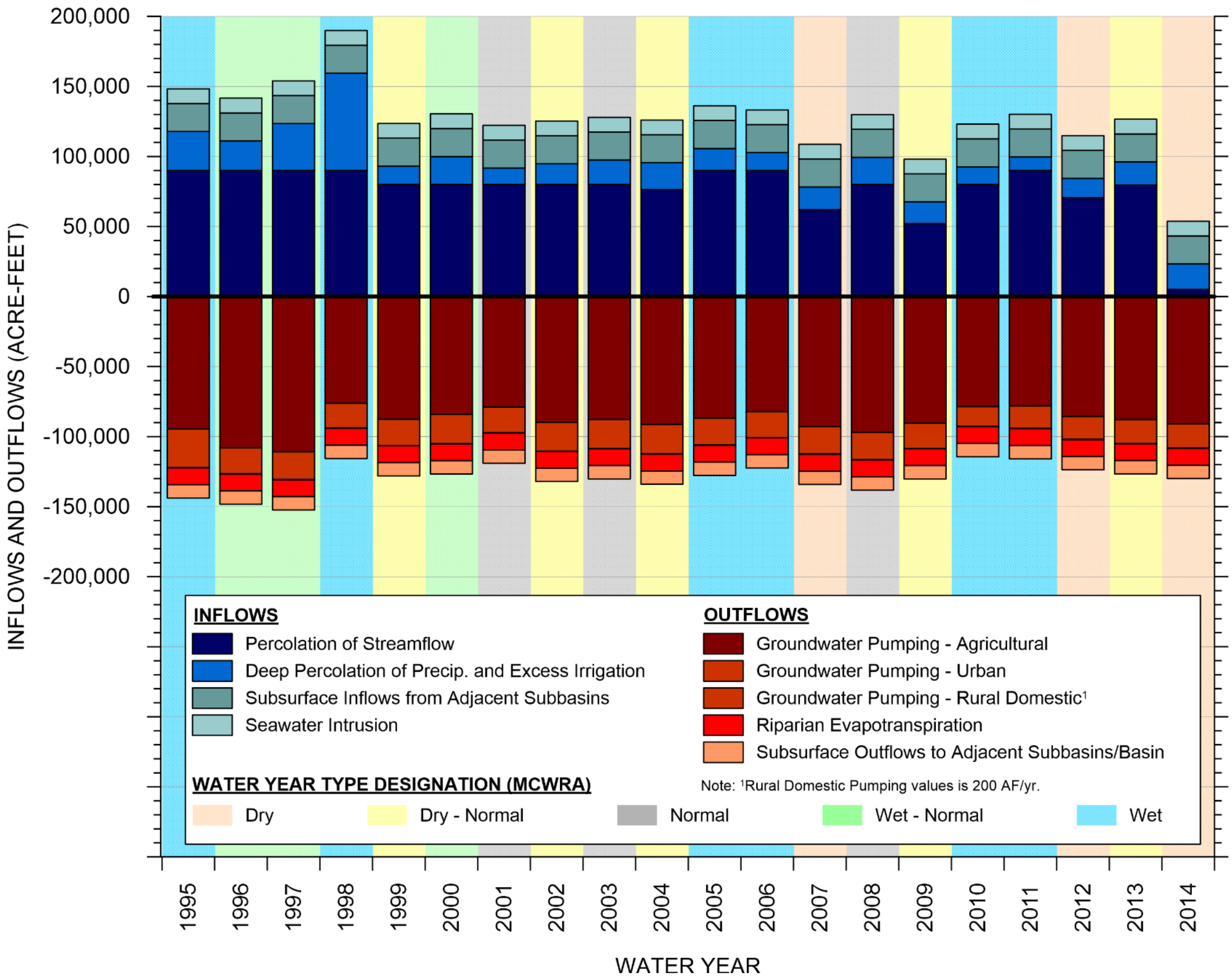

Figure ES-2. Annual Average Historical Groundwater Budget

The average loss in storage due to groundwater level fluctuations during the historical and current periods are approximately 400 AF/yr. and 600 AF/yr., respectively. Additionally, seawater intrusion decreases usable water by 10,500 AF/yr.

Uncertainty of the groundwater budgets was calculated by subtracting change in storage estimated using groundwater levels from the change in storage based on inflow and outflow components of the groundwater budgets. Table ES-1 shows the main components of the historical and current groundwater budgets; and calculates the percent uncertainty for each budget. The relatively high percent uncertainty in the current budget emphasizes the need to adopt the modeled historical groundwater budget when the historical SVIHM becomes available.

Table ES-1. Estimated Historical and Current Groundwater Budgets and Uncertainties

Groundwater Component	Historical Budget	Current Budget
Average Annual Inflow (AF/yr.)	116,700	64,800
Average Annual Outflow (AF/yr.)	129,600	130,600
Average Annual Change in Storage (AF/yr.)	-12,900	-65,800
Seawater Intrusion (AF/yr.)	-10,500	-10,500
Average Annual Change in Storage Based on Inflows and Outflows (AF/yr.)	-2,400	-55,300
Estimated Average Annual Change in Storage (AF/yr.) Based on MCWRA Water Level Measurements	-400	-600
Difference Between Budget and Estimated (AF/yr.)	-2,000	-54,700
Difference Between Budget and Estimated (% of Outflow)	-2%	-42%

Note: although seawater intrusion is identified as an inflow to quantify the overall basin water budget, it is not considered part of the sustainable yield.

The sustainable yield of the Subbasin is an estimate of the quantity of groundwater that can be pumped on a long-term average annual basis without causing a net decrease in storage. Sustainable yield is calculated as total pumping minus loss of storage. Based on the water budget, the historical sustainable yield of the Subbasin was 97,200 AF/yr., which is 10% less than the average annual pumping rate.

Projected Water Budgets – The projected water budgets are based on output from the operational version of the SVIHM that was provided by USGS. Because the projected water budgets are derived from a draft model, but the current and water budgets are not, the water budgets are not directly comparable due to differing analytical approaches. Two projected water budgets, one for 2030 and one for 2070, are developed from the draft operational SVIHM, which include climate change and sea level rise estimates. DWR's climate change factors were adopted to account for 2030 and 2070 projected climate change. The projected water budgets are used to establish how sustainability will be achieved in the 20-year implementation period and maintained over the 50-year planning and implementation horizon. The projected sustainable yield is the long-term management number once all undesirable results have been addressed. It is the sustainable yield that will continue to avoid all six undesirable results at that point, but is not the amount of pumping needed to stop undesirable results, which may be substantially less.

Table ES-2 lists the groundwater inflow and outflow components derived from the SVIHM and calculates the percent error. The percent error from the modeled, projected water budgets is substantially less than the percent error from the calculated historical or current water budgets. This demonstrates the utility of using a groundwater model for estimating water budgets.

Based on these projections, pumping will need to be about 7% lower than projected pumping rates to meet the long-term sustainable yield. The projected water budgets can be interpreted as most likely future conditions; however, there is inherent uncertainty associated with using climate scenarios.

Table ES-2. Average Annual Groundwater Budget and Groundwater Storage Change for Future Projections

	Projected Climate Change Timeframe	
GROUNDWATER BUDGET	**2030 (AF/yr.)**	**2070 (AF/yr.)**
Inflows		
Stream leakage	71,500	71,700
Deep Percolation	76,300	81,800
Interflow in Wells	20,400	20,900
Underflow from Monterey Subbasin	10,900	11,500
Underflow from East Side Subbasin	9,800	10,400
Underflow from Forebay Subbasin	5,300	5,300
Underflow from Langley Subbasin	1,800	1,800
Mountain front recharge	2,600	2,700
Underflow from Pajaro Valley Basin	100	100
Net mountain front recharge	1,700	1,800
Outflows		
Pumping	135,800	141,600
Drain Flows	7,100	8,000
Flow to Streams	1,800	1,900
Groundwater ET	35,100	36,700
Underflow to Ocean	800	700
Underflow to Monterey Subbasin	5,400	5,300
Underflow to East Side Subbasin	17,000	16,600
Underflow to Forebay Subbasin	300	300
Underflow to Langley Subbasin	100	100
Underflow to Upland Areas	900	900
Underflow to Pajaro	1,000	1,000
Groundwater Storage		
Groundwater Level Change	4,600	4,700
Seawater Intrusion	-3,500	-3,900
Total	1,100	800
Total Inflows	198,700	206,200
Total Outflows	-205,300	-213,100
Change in Storage	-6,600	-6,900
% Error	0.74%	0.81%

ES-6 MONITORING NETWORKS (GSP CHAPTER 7)

Monitoring networks are developed to promote the collection of data of sufficient quality, frequency, and distribution to characterize groundwater and related surface water conditions in the Subbasin and to evaluate changing conditions that occur as the Plan is implemented. The SVBGSA developed monitoring networks for each of the six sustainability indicators, based on existing monitoring sites. For some sustainability indicators, it is necessary to expand existing monitoring systems. Filling data gaps and developing more extensive and complete monitoring systems will improve the SVBGSA's ability to demonstrate sustainability and refine the hydrogeologic conceptual model.

- **Groundwater Elevations** are measured in designated monitoring wells that form a network sufficient to demonstrate groundwater occurrence, flow directions, and hydraulic gradients between principal aquifers and surface water features. The SVBGSA will build upon the existing California Statewide Groundwater Elevation Monitoring (CASGEM) network of wells, which have been regularly monitored by MCWRA.

- **Groundwater Storage** is measured by the annual amount of groundwater pumping. Monitoring includes municipal groundwater users and small water system pumping available from the State's Drinking Water Information Clearinghouse, agricultural pumping reported to the MCWRA and estimated using Monterey County crop data, and domestic pumping estimated based on number of domestic users.

- **Seawater Intrusion** is evaluated based on an isochloride contour derived from measurements at a specific network of monitoring wells. Well data are collected and maintained by MCWRA, who produces chloride isocontour maps to provide an indication of the extent of seawater intrusion.

- **Groundwater Quality Distribution and Trends** are evaluated by monitoring groundwater quality at a network of existing water supply wells. Drinking water constituents of concern will be assessed at public water supply wells. Agricultural constituents of concern will be assessed at agricultural supply wells that are monitored through the Irrigated Lands Regulatory Program.

- **Land Subsidence** is assessed based on the land subsidence data DWR has collected with InSAR satellite data.

- **Interconnected Surface Water** depletion rates are estimated through modeling, and checked with shallow wells near areas of interconnection. Given the extremely limited monitoring data, the SVBGSA plans to install shallow wells to establish the level of interconnection of the Salinas River with the underlying shallow sediments. The SVIHM will be used to assess the rate of streamflow exchange between the two systems.

The SVBGSA has developed a Data Management System (DMS) to store, review, and upload data collected as part of GSP development and implementation. The DMS includes a publicly accessible web-map hosted on the SVBGSA website; accessed at https://svbgsa.org/gsp-web-map-and-data/.

ES-7 SUSTAINABLE MANAGEMENT CRITERIA (GSP CHAPTER 8)

Sustainable Management Criteria (SMC) define the conditions that constitute sustainable groundwater management. A description of the SMC for each of the six sustainability indicators is included in Table ES-3. Each sustainability indicator includes:

- **Minimum thresholds** – specific, quantifiable values for each sustainability indicator used to define undesirable results *(i.e., indicators of unreasonable conditions that should not be exceeded)*
- **Measurable objectives** – specific, quantifiable goals that provide operational flexibility above the minimum thresholds *(i.e., goals the GSP is designed to achieve)*
- **Undesirable results** – Quantitative combinations of minimum thresholds

The SMC detailed in Table ES-3 define the Subbasin’s future conditions and commit the GSA to actions that will meet these objectives.

Table ES-3. Sustainable Management Criteria Summary

Sustainability Indicator	*Measurable Objective*	*Minimum Threshold*	*Undesirable Result*
Chronic lowering of groundwater levels	Set to 2003 groundwater elevations	Set to 1 foot above 2015 groundwater elevations	Over the course of any one year, no more than 15% of groundwater elevation minimum thresholds shall be exceeded in any single aquifer and no one well shall exceed its minimum threshold for more than two consecutive years. Allows two exceedances in the 180-Foot aquifer and two exceedances in the 400-Foot aquifer.
Reduction in groundwater storage	Pumping set to the estimated long-term future sustainable yield of 112,000 AF/yr. for the entire 180/400-Foot Aquifer Subbasin (Minimum thresholds and measurable objectives are identical)		During average hydrogeologic conditions, and as a long-term average over all hydrogeologic conditions, the total groundwater pumping shall not exceed the minimum threshold.
Seawater intrusion	The line defined by Highway 1 for the 180-Foot, 400-Foot, and Deep Aquifers	The 2017 extent of 500 mg/L chloride isocontour for the 180- and 400-Foot Aquifers, and the line defined by Highway 1 for the Deep Aquifers	On average in any one year there shall be no mapped seawater intrusion beyond the 2017 extent of the 500 mg/L chloride isocontour.
Degraded groundwater quality	Minimum threshold is zero additional exceedances of groundwater quality constituents of concern known to exist in the subbasin above drinking water or agricultural limits. (Minimum thresholds and measurable objectives are identical)		On average during any one year, no groundwater quality minimum threshold shall be exceeded as a direct result of projects or management actions taken as part of GSP implementation.
Subsidence	Minimum threshold is zero net long-term subsidence. (Minimum thresholds and measurable objectives are identical)		In any one year, there will be zero exceedances of the groundwater elevation proxy minimum thresholds based on average groundwater levels.
Depletion of interconnected surface water	Set to the estimated average historical rate of stream depletion, adjusted for climate change. This is currently estimated to be 69,700 acre-feet per year for future conditions including climate change. (Minimum thresholds and measurable objectives are identical)		During average hydrogeologic conditions, and as a long-term average over all hydrogeologic conditions, the depletion of interconnected surface waters shall not exceed the minimum threshold.

ES-8 PROJECTS AND MANAGEMENT ACTIONS (GSP CHAPTER 9)

This GSP identifies projects and actions that provide stakeholders with options to reach sustainability. The set of projects and actions achieve the following objectives:

- Achieving groundwater sustainability by meeting Subbasin-specific SMC by 2040
- Creating equity between who benefits from projects and who pays for projects
- Establishing a source of funding for project implementation
- Providing incentives to constrain groundwater pumping within limits

The projects and actions included in the GSP are defined as a toolbox of options. The GSP demonstrates that sufficient options exist to reach sustainability. Specific details need to be developed for stakeholders to determine which projects and actions to implement. The projects and management actions described in this GSP constitute an integrated management program for the entire Salinas Valley Groundwater Basin.

Water Charges Framework – This GSP proposes a water charges framework the provides incentives to constrain groundwater pumping to the sustainable yield while generating funds for project implementation. The framework creates sustainable pumping allowances, charging a Tier 1 Sustainable Pumping Charge for pro-rata shares of sustainable yield, Tier 2 Transitional Pumping Charge to help users transition to pumping allowances, and higher Tier 3 Supplementary Pumping Charge for using more water. Pumping allowances are not water rights, but would be established to incentivize pumping reductions.

Management Actions – This GSP identifies six management actions that are the most reliable, implementable, cost-effective, and acceptable to stakeholders. The six management actions include:

- Agricultural land and pumping allowance retirement
- Outreach and education for agricultural best management practices
- Reservoir reoperation
- Restrict pumping in CSIP area
- Support and strengthen Monterey County restrictions on additional wells in the Deep Aquifers
- Establish a seawater intrusion technical working group

Specific Projects Prioritized for Integrated Management of the Salinas Valley – This GSP identifies nine priority projects, categorized below by type of project. A preliminary ranking based on cost effectiveness is noted after each project. These rankings may change after project details are refined during GSP implementation.

***Project Type 1: In-lieu recharge through direct delivery of water to replace groundwater pumping* –** projects that use available water supplies for irrigation in lieu of groundwater

- Optimize CSIP Operations (ranked #2 in terms of cost effectiveness)
- Modify Monterey One Water Recycled Water Plant (ranked #3 in terms of cost effectiveness)
- Expand Area Served by CSIP (ranked #4 in terms of cost effectiveness)
- Maximize Existing SRDF Diversion (ranked #5 in terms of cost effectiveness)

***Project Type 2: Direct recharge through recharge basins or wells (also commonly referred to as Managed Aquifer Recharge)* –** projects that fill large artificial ponds with water to percolate from the basin into the groundwater system or construct injection wells

- 11043 Diversion Facilities Phase I: Chualar (ranked #7 in terms of cost effectiveness)
- 11043 Diversion Facilities Phase II: Soledad (ranked #8 in terms of cost effectiveness)
- SRDF Winter Flow Injection (ranked #9 in terms of cost effectiveness)

***Project Type 3: Indirect recharge through decreased evapotranspiration or increased infiltration* –** projects to remove invasive species from riparian corridors to decrease evapotranspiration or to capture stormwater to increase percolation

- Invasive Species Eradication (ranked #1 in terms of cost effectiveness)

***Project Type 4: Hydraulic barrier to control seawater intrusion* –** projects to construct a hydraulic barrier consisting of a series of wells drilled a short distance inland, aligned parallel to the coast. It could be operated as a recharge barrier that injects water into the wells, or an extraction barrier that pumps water from wells. Both approaches would create a hydraulic barrier to seawater intrusion

- Seawater Intrusion Pumping Barrier (ranked #6 in terms of cost effectiveness)

Additionally, the GSA identified a number of alternative projects that could help achieve sustainability if needed, including desalinizing water from the seawater barrier extraction wells, recharging local runoff from Eastside Range, injecting winter potable reuse water, and seasonally storing water in 180/400-Foot Aquifer.

Other Groundwater Management Activities – Although not specifically funded or managed by the SVBGSA, a number of associated groundwater management activities will be promoted and encouraged by the SVBGSA as part of general good groundwater management practices. These include: promoting agricultural best management practices, continuing urban and rural residential conservation, promoting stormwater capture, supporting well destruction policies, and watershed protection and management.

Mitigation of Overdraft – The water charges framework is specifically designed to promote pumping reductions. Should adequate pumping reductions not be achieved to mitigate all overdraft, funds collected through the water charges framework will support recharge of imported water, either through direct recharge or in-lieu means. Potential projects to mitigate overdraft include: invasive species eradication, optimizing CSIP, modifying Monterey One Water Plant, expanding CSIP area, maximizing the existing SRDF, and using SRDF winter flows.

ES-9 IMPLEMENTATION (GSP CHAPTER 10)

This GSP lays out a roadmap for addressing all of the activities needed for GSP implementation between 2020 and 2040, focusing mainly on the activities between 2020 and 2025. Implementing this GSP requires the following formative activities:

- **Monitoring and Reporting** – This activity will begin immediately following adoption of the GSP and will rely primarily on existing monitoring programs. Monitoring data will be stored in the DMS and will be routinely evaluated to ensure progress is being made toward sustainability and to identify whether undesirable results are occurring. The GSA will submit to DWR and make publicly available: annual reports, Five-Year GSP Assessment Reports, and GSP Periodic Evaluations and Assessment.
- **Refining and Implementing the Water Charges Framework –** Long-term GSP implementation will be funded through the water charges framework described in this GSP, or in combination with other financing methods where appropriate. Details of the framework will be developed during the first three years of this GSP's implementation through a facilitated process.
- **Addressing Identified Data Gaps** – An aquifer properties assessment and deep aquifers investigation will be conducted to address key data gaps.
- **Expanding and Improving the Existing Monitoring Networks –** Monitoring networks will be expanded and enhanced to provide more robust data on the sustainability indicators.
- **Updating the Data Management System** – As new information is collected during monitoring and provided by local stakeholders, the GSA will update the DMS and make publicly available via the web application.
- **Implementing the New Upcoming USGS Groundwater Model for the Salinas Valley (SVIHM) –** The USGS is currently working on revising and calibrating the SVIHM. When available, it will be used to revisit water budgets, update estimated sustainable

yield, refine numerical minimum thresholds for interconnected surface water depletion, and more rigorously evaluate benefits of projects and management actions.

- **Refining and Implementing Projects and Management Actions –** The SVBGSA will refine projects and actions during the first three years of implementation. These projects and actions depend in part on the five subbasins in the Valley that will not complete GSPs until January 2022.

The SVBGSA estimates that planned activities will cost $11,406,100 over the first five years of implementation (an estimated $2,281,220 per year). Of this, $1,783,500 are costs directly attributable to the 180/400-Foot Aquifer Subbasin and $9,422,600 are Valley-wide costs. These costs include routine administrative operations, public outreach, supplemental hydrogeologic investigations to address data gaps, improvements to the monitoring networks (including installation of new monitoring wells), annual monitoring and reporting of sustainability conditions, and early planning efforts.

Implementing the 180/400-Foot Aquifer Subbasin GSP must be integrated with the implementation of the five other GSPs in the Salinas Valley. The general implementation schedule refines details of the water charges framework, the sustainability projects, and the management actions during the first three years of implementation as the five other subbasin GSPs are produced. This will ensure the 180/400-Foot Aquifer Subbasin GSP is implemented in coordination with the other Valley subbasins, while at the same time moving ahead with negotiating implementation details.

ES-10 STAKEHOLDER ENGAGEMENT AND COMMUNICATION STRATEGY (GSP CHAPTER 11)

The SVBGSA designed all phases of SGMA implementation to be open collaborative processes with active stakeholder engagement that allows stakeholders and public participants opportunities to provide input and to influence the planning and development process. The four main phases consist of:

- **GSA Formation and Coordination** – from 2015-2017, local agencies and stakeholders worked with the Consensus Building Institute to facilitate the formation of the SVBGSA.
- **GSP Preparation and Submission** – starting in 2017, the GSA developed this GSP and will continue to develop the five other subbasin GSPs through the January 2022 deadline.
- **GSP Review and Evaluation** – the GSA engaged in a public review process of the full draft prior to submission, giving stakeholders an opportunity to provide feedback and comments, and DWR will also give stakeholders a 60-day comment period after submission.

- **Implementation and Reporting** – following submission of the GSP to DWR, the SVBGSA will begin implementation efforts to reach sustainability within the basin.

Public participation is supported by the development of an interactive website that allows access to all planning and meeting materials, data sets, and meeting notifications. The website can be accessed at: https://svbgsa.org.

1 INTRODUCTION TO THE 180/400-FOOT AQUIFER SUBBASIN GROUNDWATER SUSTAINABILITY PLAN

1.1 Purpose of the Groundwater Sustainability Plan

The State of California enacted the Sustainable Groundwater Management Act (SGMA) in 2014. This law requires groundwater basins or subbasins that are designated as medium or high priority to be managed sustainably. The Salinas Valley Groundwater Basin comprises nine subbasins, of which seven are within Monterey County. The subject of this report is one of those subbasins: the 180/400-Foot Aquifer Subbasin.

Satisfying the requirements of SGMA generally requires four basic activities:

1. Forming one or more Groundwater Sustainability Agency(s) (GSAs) in the basin
2. Developing a Groundwater Sustainability Plan (GSP)
3. Implementing the GSP and managing to measurable, quantifiable objectives
4. Providing regular reports to the California Department of Water Resources (DWR)

This document satisfies the GSP requirement for the Salinas Valley – 180/400-Foot Aquifer Subbasin (Subbasin or 180/400-Foot Subbasin). The purpose of this GSP is to outline how the Salinas Valley Basin Groundwater Sustainability Agency (SVBGSA) and its partner GSAs will achieve groundwater sustainably in the Subbasin in 20 years, and maintain sustainability for an additional 30 years. The SVBGSA developed this GSP in coordination with the Marina Coast Water District Groundwater Sustainability Agency (MCWD GSA) and the County of Monterey Ground Water Sustainability Agency (County GSA), each of which has exclusive jurisdiction over part of the 180/400-Foot Aquifer Subbasin.

1.2 Description of the 180/400-Foot Aquifer Subbasin

The 180/400-Foot Aquifer Subbasin is identified by DWR as Subbasin 3-004.01. The Subbasin is part of the greater Salinas Valley Groundwater Basin in the Central Coastal region of California (DWR, 2016a). DWR has designated the 180/400-Foot Aquifer Subbasin as a critically overdrafted basin. DWR defines critically overdrafted basins as basins in which the continuation of present water management practices would probably result in significant adverse overdraft-related environmental, social, or economic impacts. The Subbasin is named for its two primary water-bearing units: the 180-Foot Aquifer and the 400-Foot Aquifer. The Subbasin encompasses an area of approximately 89,700 acres, or 140 square miles (DWR, 2019). The Subbasin lies in Monterey County and contains parts of the urban areas of Salinas, Castroville, Moss Landing, Marina, Chualar, and Gonzales (Figure 1-1).

The Subbasin is bounded by Monterey Bay to the northwest. Five groundwater basins or subbasins adjoin the 180/400-Foot Subbasin (Figure 1-1).

- The Corralitos - Pajaro Valley Basin is located along the northern Subbasin boundary. The boundary with the Corralitos – Pajaro Valley Basin coincides with the inland projection of a clay-filled paleodrainage of the Salinas River buried beneath Elkhorn Slough which acts as a flow barrier between the basins (DWR, 2004).
- The Eastside Aquifer Subbasin (DWR subbasin number 3-004.02) is located along most of the northeastern boundary of the Subbasin. There is some, although potentially limited, hydraulic communication between the Eastside Aquifer Subbasin and the 180/400-Foot Aquifer Subbasin.
- The Langley Area Subbasin (DWR subbasin number 3-004.09) is located along a short length of the northeastern boundary of the Subbasin.
- The Forebay Aquifer Subbasin (DWR subbasin number 3-004.04) is located along the southeastern boundary, near the city of Gonzales. The boundary is the approximate limit of confining conditions in the up-valley direction (DWR, 2004).
- The Monterey Subbasin (DWR subbasin number 3-004.10) is located along the southwestern boundary of the Subbasin. The boundary roughly follows portions of the King City fault and a groundwater divide.

All five surrounding basins and subbasins are medium or high priority and are required to develop GSPs under SGMA. GSPs for the Eastside,Langley Area, and Upper Valley Subbasins will be developed by the SVBGSA. The GSP for the Forebay Subbasin will be developed jointly by the SVBGSA and the Arroyo Seco GSA. The GSP for the Monterey Subbasin will be developed jointly by the SVBGSA and the MCWD GSA. An alternative GSP submittal for the Corralitos – Pajaro Valley Basin was submitted by the Pajaro Valley Water Management Agency and accepted by DWR in August 2019.

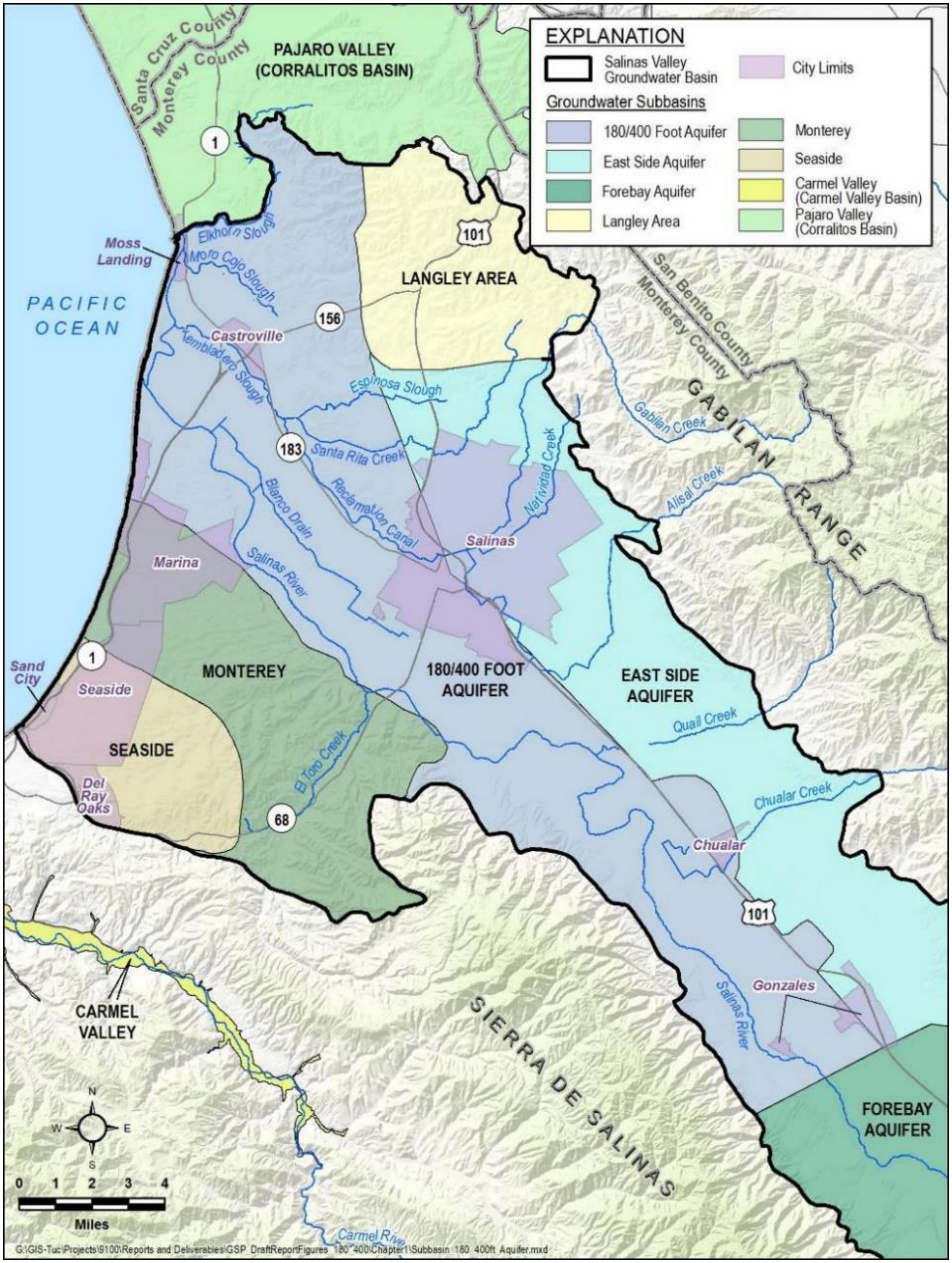

Figure 1-1. 180/400-Foot Aquifer Subbasin Location

1.3 Overview of this GSP

The SVBGSA, with input from MCWD and County GSA, developed this GSP for the entire 180/400-Foot Aquifer Subbasin. This GSP is developed in concert with GSPs for five other Salinas Valley Groundwater Basin subbasins under SVBGSA jurisdiction: the Eastside Aquifer Subbasin, the Forebay Aquifer Subbasin, the Upper Valley Aquifer Subbasin, the Langley Area Subbasin and the Monterey Subbasin. The projects and programs presented in this GSP are part of a cohesive set of projects and programs designed to achieve sustainability throughout the entire Salinas Valley Groundwater Basin. The 180/400-Foot Aquifer Subbasin is referred to as the Subbasin throughout this GSP, and the collection of Salinas Valley Groundwater Basin subbasins that fall partially or entirely under SVBGSA jurisdiction are collectively referred to as the Basin or the Valley.

The SVBGSA used a collaborative process to develop this GSP. Chapter 11 details the stakeholders that participated, and process followed to develop this GSP. Stakeholders worked together to gather existing information, define sustainable management criteria for the Subbasin, and develop a list of projects and management actions.

This GSP includes the SVBGSA's administrative information, describes the basin setting, presents the hydrogeologic conceptual model, and describes historical and current groundwater conditions. It further establishes estimates of the historical, current, and future water budgets based on the best available information. This GSP defines local sustainable management criteria, details required monitoring networks, and outlines projects and programs for reaching sustainability in the Subbasin by 2040. Finally, it describes the communication and outreach strategy used to develop the Plan.

The SVBGSA used best available existing data to develop this GSP. The SVBGSA intended to use the Salinas Valley Integrated Hydrologic Model (SVIHM) developed by the United States Geological Service (USGS) for this GSP. The USGS provided SVBGSA with limited information from the SVIHM during part of GSP development; however, the model could not be used as initially intended. The USGS anticipates releasing the revised SVIHM in spring 2020, at which point the SVBGSA plans to use the Model to update and implement this GSP.

The SVBGSA developed this GSP as part of an adaptive management process. This GSP will be updated and adapted as new information and more refined models become available. This includes updating SMCs and projects and management actions to reflect updates and future conditions. Adaptive management will be reflected in the required five-year updates to GSPs and annual reports. The SVBGSA also envisions completing a two-year update to this Plan as the GSPs for surrounding subbasins are developed.

2 AGENCY INFORMATION

Three GSAs cover the GSP area: the SVBGSA, MCWD GSA, and County GSA. This GSP was developed by the SVBGSA with input and assistance from the MCWD GSA and the County GSA. Each is an exclusive GSA for its respective portion of the Subbasin. The jurisdictional areas of all three GSAs in relation to the Subbasin boundary are shown on Figure 2-1.

2.1 Agency Names and Mailing Addresses

Contact information is provided for each GSA that is a signatory to this GSP, pursuant to California Water Code § 10723.8.

Salinas Valley Basin Groundwater Sustainability Agency
Attn.: Gary Petersen, General Manager
1441 Schilling Place
Salinas, CA 93901
https://svbgsa.org

Marina Coast Water District Groundwater Sustainability Agency
Attn.: Keith Van Der Maaten, General Manager
11 Reservation Road
Marina, CA 93933
http://www.mcwd.org

County of Monterey Ground Water Sustainability Agency
Attn: Brian Briggs, Deputy County Counsel
169 W Alisal St, 3rd Floor
Salinas, CA 93901
https://www.co.monterey.ca.us/

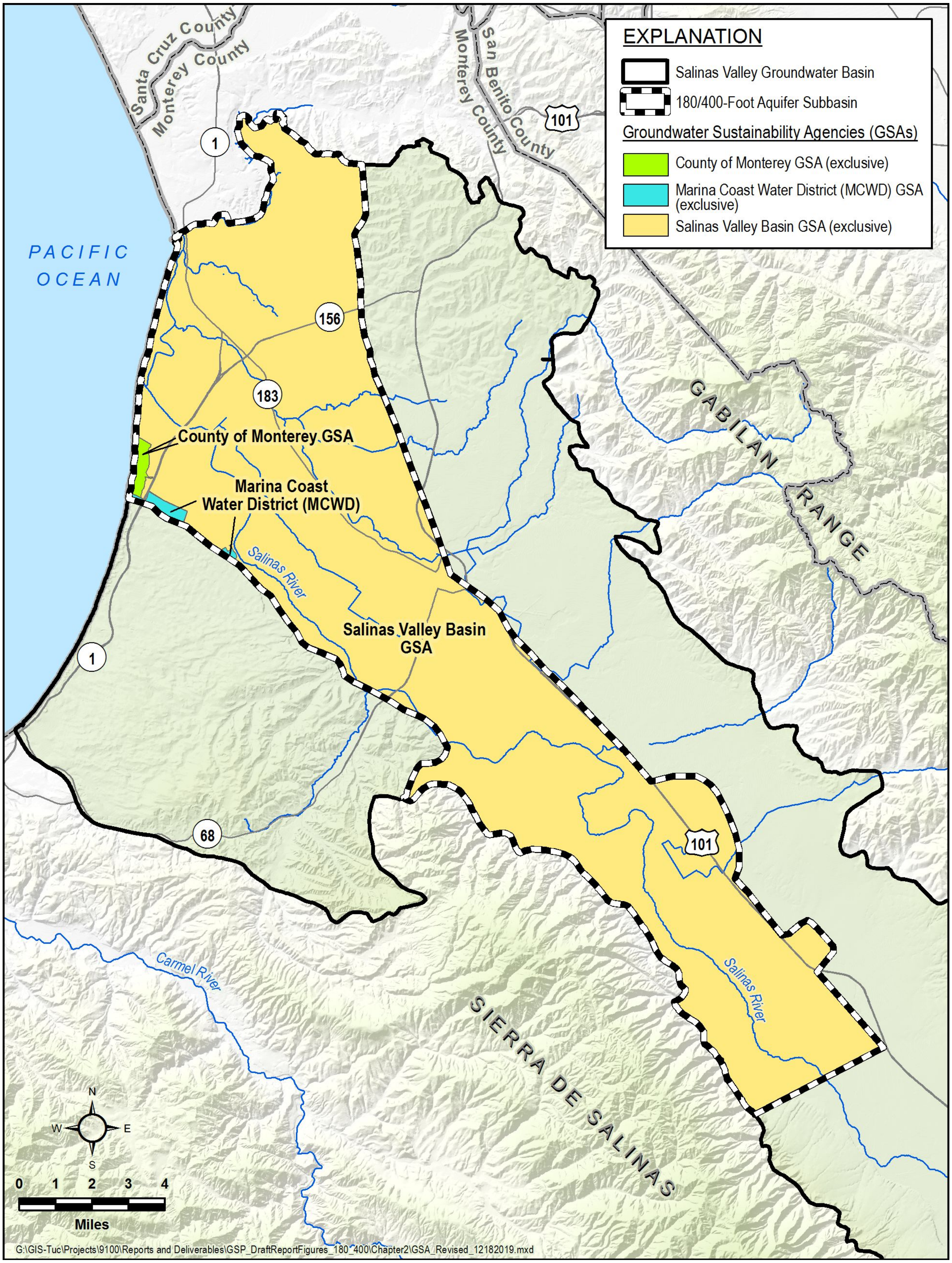

Figure 2-1. Map of Areas Covered by GSAs and Overlap Areas

2.2 Agencies' Organization and Management Structure

The organization and management structure of each of the three GSAs that cover the GSP area are described in the sections below. Relevant documentation regarding the formation of the GSAs is included in Appendix 2A.

2.2.1 SVBGSA

The SVBGSA was formed in 2017. The SVBGSA represents agriculture, public utility, municipal, county, and environmental stakeholders; and is partially or entirely responsible for developing GSPs in six of the Salinas Valley Groundwater Subbasins.

The SVBGSA is a Joint Powers Authority (JPA). The JPA membership comprises the County of Monterey, Water Resources Agency of the County of Monterey (Monterey County Water Resources Agency, or MCWRA), City of Salinas, City of Soledad, City of Gonzales, City of King (King City), the Castroville Community Services District (CSD), and Monterey One Water (formerly the Monterey Regional Water Pollution Control Agency). The SVBGSA is governed and administered by an eleven-member Board of Directors, representing public and private groundwater interests throughout the Valley. When a quorum is present, a majority vote is required to conduct business. Some business items require a super majority vote or a super majority plus vote. A super majority requires an affirmative vote by eight of the eleven Board members. A super majority vote is required for:

- Approval of a GSP
- Amendment of budget and transfer of appropriations
- Withdrawal or termination of Agency members

A super majority plus requires an affirmative vote by eight of the eleven Board members, including an affirmative vote by three of the four agricultural representatives. A super majority plus vote is required for:

- Decisions to impose fees not requiring a vote of the electorate or property owners
- Proposals to submit to the electorate or property owners (as required by law) decisions to impose fees or taxes
- Limitations on well extractions (pumping limits)

In addition to the Board of Directors, SVBGSA includes a Budget and Finance Committee consisting of five Directors, an Executive Committee consisting of five Directors, a Planning Committee consisting of five Directors, and an Advisory Committee consisting of Directors and non-directors. The Advisory Committee is designed to ensure participation by, and input to, the

Board of Directors by constituencies whose interests are not directly represented on the Board. The SVBGSA's GSA activities are coordinated by a general manager.

2.2.2 MCWD

MCWD is governed by a five-member Board of Directors who each serve four-year terms. Board members are elected at large. Decisions on all GSA-related matters require an affirmative vote of a majority of the five Board of Directors members. The MCWD's GSA activities are coordinated by the MCWD's existing staff.

2.2.3 County GSA

The County GSA is governed by the Board of Supervisors of the County of Monterey. The Board of Supervisors is composed of five members who are elected by their respective geographical districts within the County. The County's GSA activities are coordianted by its Deputy General Counsel.

2.3 Authority of Agency/Agencies

All GSAs involved in the development of this GSP were formed in accordance with the requirements of California Water Code § 10723 *et seq*. Each agency's specific authorities for GSA formation and groundwater management are listed below.

2.3.1 SVBGSA

SVBGSA is a JPA that was formed in accordance with the requirements of California Government Code §6500 *et seq*. The JPA agreement is included in Appendix 2A. In accordance with California Water Code §10723 *et seq*, the JPA signatories are all cities, counties, and water agencies with water or land use authority; and are all independently eligible to serve as GSAs:

- The County of Monterey has land use authority over the unincorporated areas of the County, including areas overlying the 180/400-Foot Aquifer Subbasin. The County of Monterey is therefore a local agency under California Water Code §10721 with the authority to establish itself as a GSA.
- The MCWRA is a California Special Act District with broad water management authority in Monterey County. The MCWRA is therefore a local agency under California Water Code §10721 with the authority to establish itself as a GSA.
- The City of Salinas is incorporated under the laws of the State of California. The City provides water supply and land use planning services to its residents. The City is therefore a local agency under California Water Code §10721 with the authority to establish itself as a GSA.

- The City of Soledad is incorporated under the laws of the State of California. The City provides water supply and land use planning services to its residents. The City is therefore a local agency under California Water Code §10721 with the authority to establish itself as a GSA.
- The City of Gonzales is incorporated under the laws of the State of California. The City provides water supply and land use planning services to its residents. The City is therefore a local agency under California Water Code §10721 with the authority to establish itself as a GSA.
- King City is incorporated under the laws of the State of California. The City provides water supply and land use planning services to its residents. The City is therefore a local agency under California Water Code §10721 with the authority to establish itself as a GSA.
- The Castroville CSD is a local public agency of the State of California, organized and operating under the Community Services District Law, Government Code §6100 *et seq*. Castroville CSD provides water services to its residents. Castroville CSD is therefore a local agency under California Water Code §10721 with the authority to establish itself as a GSA.
- Monterey One Water is itself a joint powers authority whose members include many members of the SVBGSA. Monterey One Water is a local agency under California Water Code §10721 with authority to establish itself as a GSA.

Upon establishing itself as a GSA, the SVBGSA retains all the rights and authorities provided to GSAs under California Water Code §10725 *et seq*. as well as the powers held in common by the members.

2.3.2 MCWD GSA

MCWD was formed in accordance with California Water District Law, California Water Code §34000, and is responsible for water supply in a portion of the Subbasin. MCWD is therefore a local agency under California Water Code § 10721 with the authority to establish itself as a GSA. Upon establishing itself as a GSA, MCWD retains all the rights and authorities provided to GSAs under California Water Code §10725 *et seq*.

2.3.3 County GSA

Pursuant to California Water Code section §10724, the Board of Supervisors of the County of Monterey elected to be the exclusive GSA for the 372-acre parcel within the 180/400-Foot Aquifer Subbasin currently owned by RMC Pacific Materials, LLC, known as the CEMEX site.

2.3.4 Coordination Agreements

Because the SVBGSA is developing a single GSP for the entire 180/400-Foot Aquifer Subbasin, with input of MCWD GSA and County GSA, coordination agreements with MCWD GSA and County GSA are not required (California Water Code section §10720.7). However, the SVBGSA and MCWD GSA developed agreements to cooperatively develop this GSP. MCWD GSA will adopt those aspects of the SVBGSA's 180/400-Foot Aquifer Subbasin GSP that apply to their respective jurisdictions within the 180/400-Foot Aquifer Subbasin. These agreements to cooperatively develop this GSP are included in Appendix 2B.

2.3.5 Contact Information for Plan Manager

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Salinas, CA 93901 | (831) 682-2592
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https://svbgsa.org

3 DESCRIPTION OF PLAN AREA

3.1 GSP Area Introduction

This GSP covers the entire 180/400-Foot Aquifer Subbasin as shown on Figure 3-1. This includes the areas within the Subbasin under the jurisdiction of the MCWD GSA and County GSA, as shown on Figure 2-1. The 180/400-Foot Aquifer Subbasin lies in northwestern Monterey County and includes the northern end of the Salinas River Valley. The Subbasin covers an area of 89,700 acres, or 140 square miles (DWR, 2019a). The boundaries of the Subbasin, combined with those of the Monterey and Seaside subbasins, are generally consistent with MCWRA's Pressure Subarea (MCWRA, 2006). When this report refers to the 180/400-Foot Aquifer Subbasin, it refers to the area under the jurisdiction of the SVBGSA, MCWD, and County GSA.

The Salinas River drains the Subbasin, discharging into Monterey Bay. The Subbasin contains the municipalities of Salinas and Gonzales, part of Marina, and the census-designated places of Castroville, Moss Landing, Elkhorn, Boronda, Spreckels, and Chualar. United States Highway 101 runs generally north-south along the eastern border of the Subbasin. State Highways 1, 156, 183, and 68 also cross the Subbasin. Rivers and streams, urban areas, and major roads are shown on Figure 3-1.

3.2 Adjudicated Areas, Other GSAs, and Alternatives

An adjudicated basin is one in which, through legal action, the basin has certain requirements placed on it by the Court, and those requirements are normally administered by a Watermaster that is appointed by the Court. The Subbasin is not adjudicated. The only adjudicated area in the Salinas Valley Groundwater Basin is the Seaside Subbasin (DWR subbasin number 3-004.08), which is not adjacent to the 180/400-Foot Aquifer Subbasin. The adjudicated Seaside Subbasin is shown by the shaded area on Figure 3-2.

No alternative plans have been submitted for any part of the Subbasin, or for any other Salinas Valley Groundwater Basin subbasins.

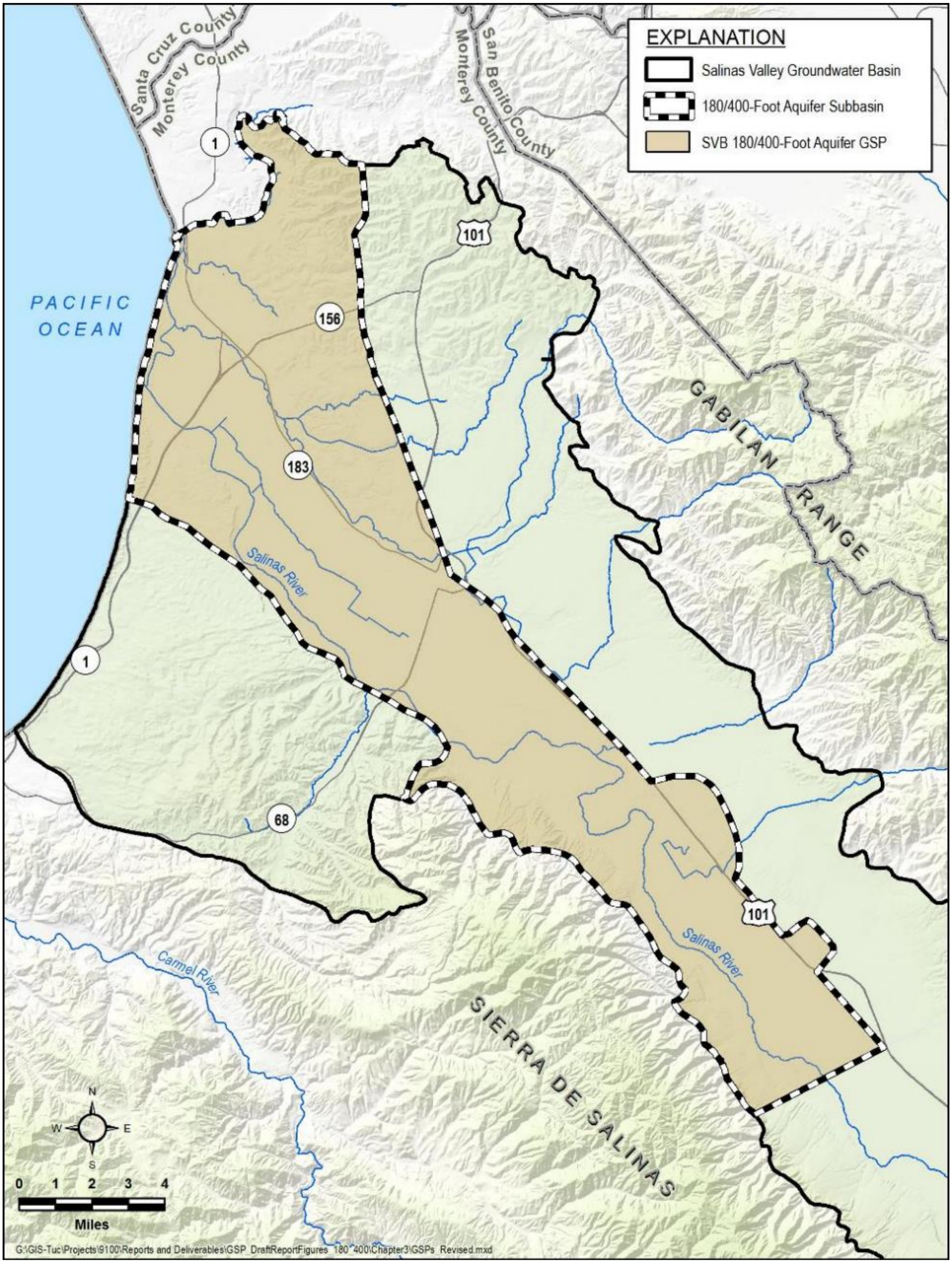


Figure 3-1: Area Covered by GSP

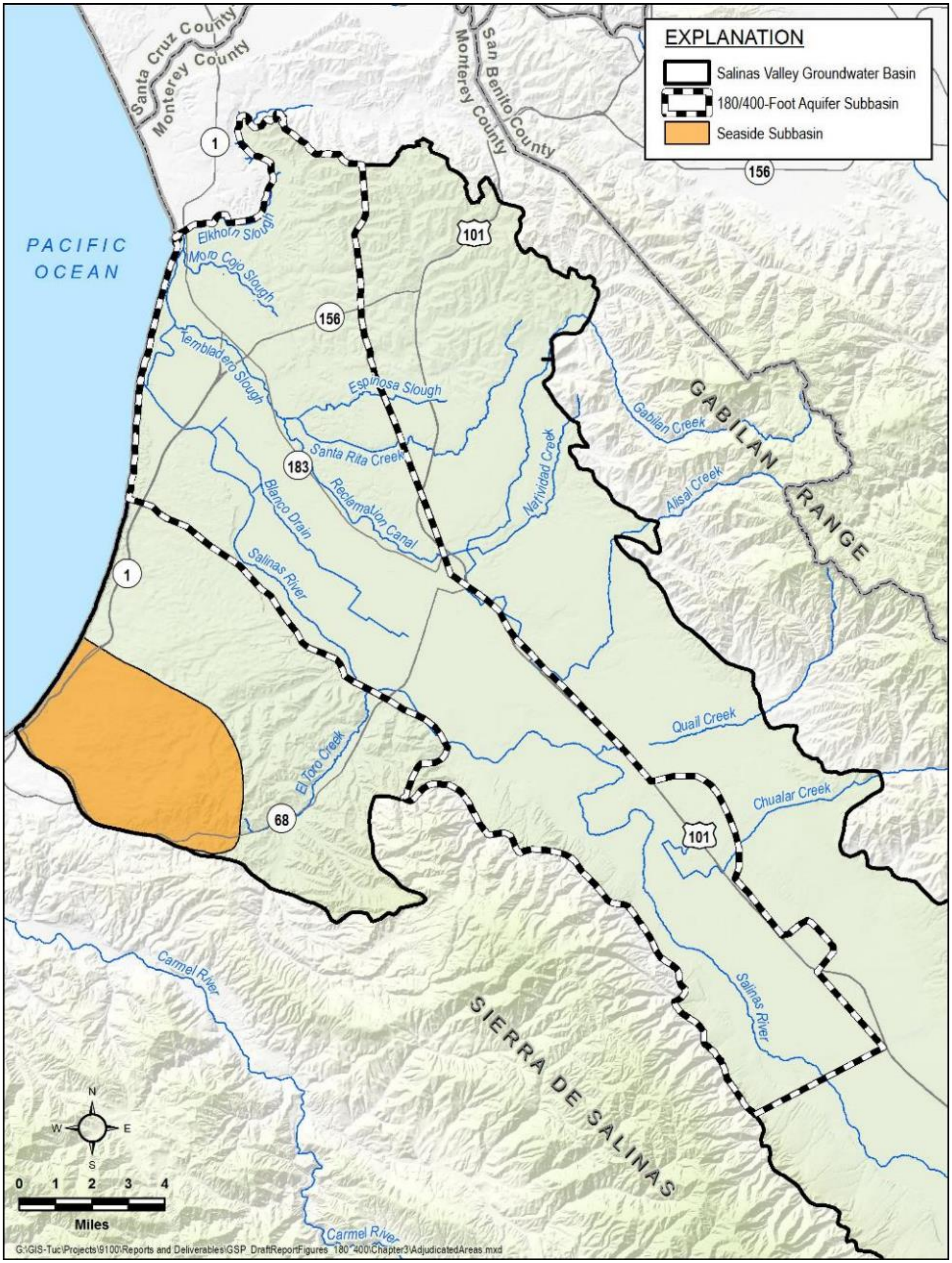


Figure 3-2. Location of the Adjudicated Seaside Subbasin

3.3 Jurisdictional Areas

There are several federal, state, and local agencies with water management authority in the Subbasin. There are no tribal lands in the Subbasin.

3.3.1 Federal Jurisdiction

Areas under federal jurisdiction are shown on Figure 3-3. The United States Department of Fish and Wildlife manages the Salinas River National Wildlife Refuge. A portion of the Fort Ord former Army base lies in the Subbasin and encompasses the Marina Municipal Airport. Although the DWR land use dataset depicts this area as federal land, this land has been transferred to civilian use and is no longer under federal jurisdiction.

3.3.2 State Jurisdiction

Areas under State jurisdiction are shown on Figure 3-3. The California Department of Fish and Wildlife owns and operates the Elkhorn Slough Ecological Reserve, the Moro Cojo Slough State Marine Reserve (SMR), Elkhorn Slough State Marine Conservation Area (SMCA), Elkhorn SMR, and the Moss Landing Wildlife Area. The California Department of Parks and Recreation manages several areas in the Subbasin near Moss Landing including: Moss Landing State Beach, Salinas River Dunes Natural Preserve, Salinas River State Beach, and the Salinas River Mouth Natural Preserve.

3.3.3 County Jurisdiction

The entire Subbasin lies in Monterey County; the County of Monterey has jurisdiction over the entire Subbasin.

3.3.4 City and Local Jurisdiction

In accordance with the SGMA Regulations § 354.8 (a)(3), this section only cities and governmental agencies with water management responsibilities. The jurisdictional boundaries of these areas are shown on Figure 3-4.The cities of Salinas, Gonzales, and Marina have water management authority in their incorporated areas, although the City of Salinas is served by California Water Company and Alisal Water Corporation (Alco). The Castroville CSD provides water and sewer collection services in the town of Castroville. The MCWD provides water and sewer collection services within its jurisdictional boundaries. A small portion of the MCWD's service area extends from the Monterey Subbasin into the 180/400-Foot Aquifer Subbasin. Pajaro/Sunny Mesa Community Services District provides water service to part of the northern Subbasin.

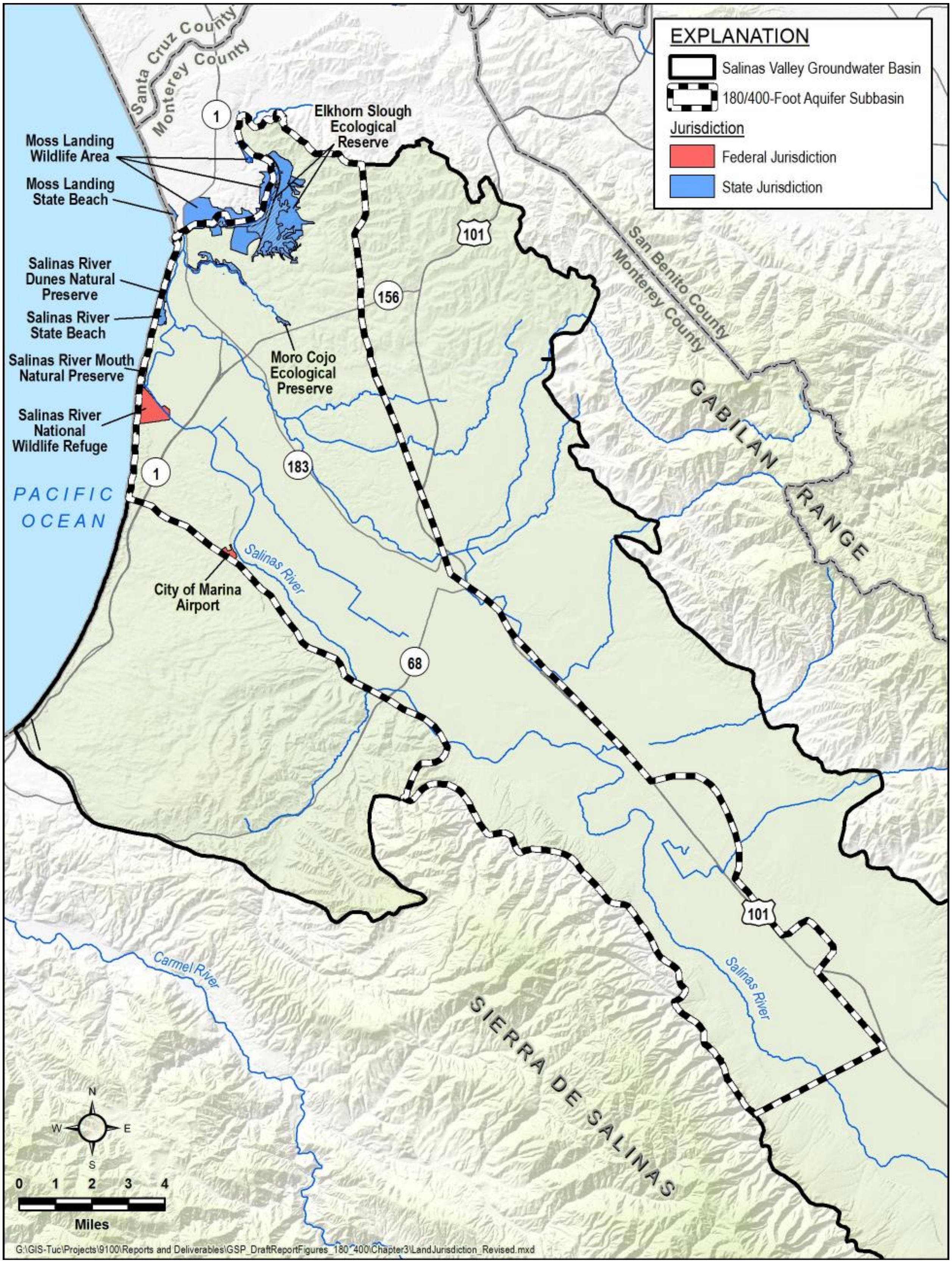


Figure 3-3. Map of Federal and State Groundwater Jurisdictional Areas

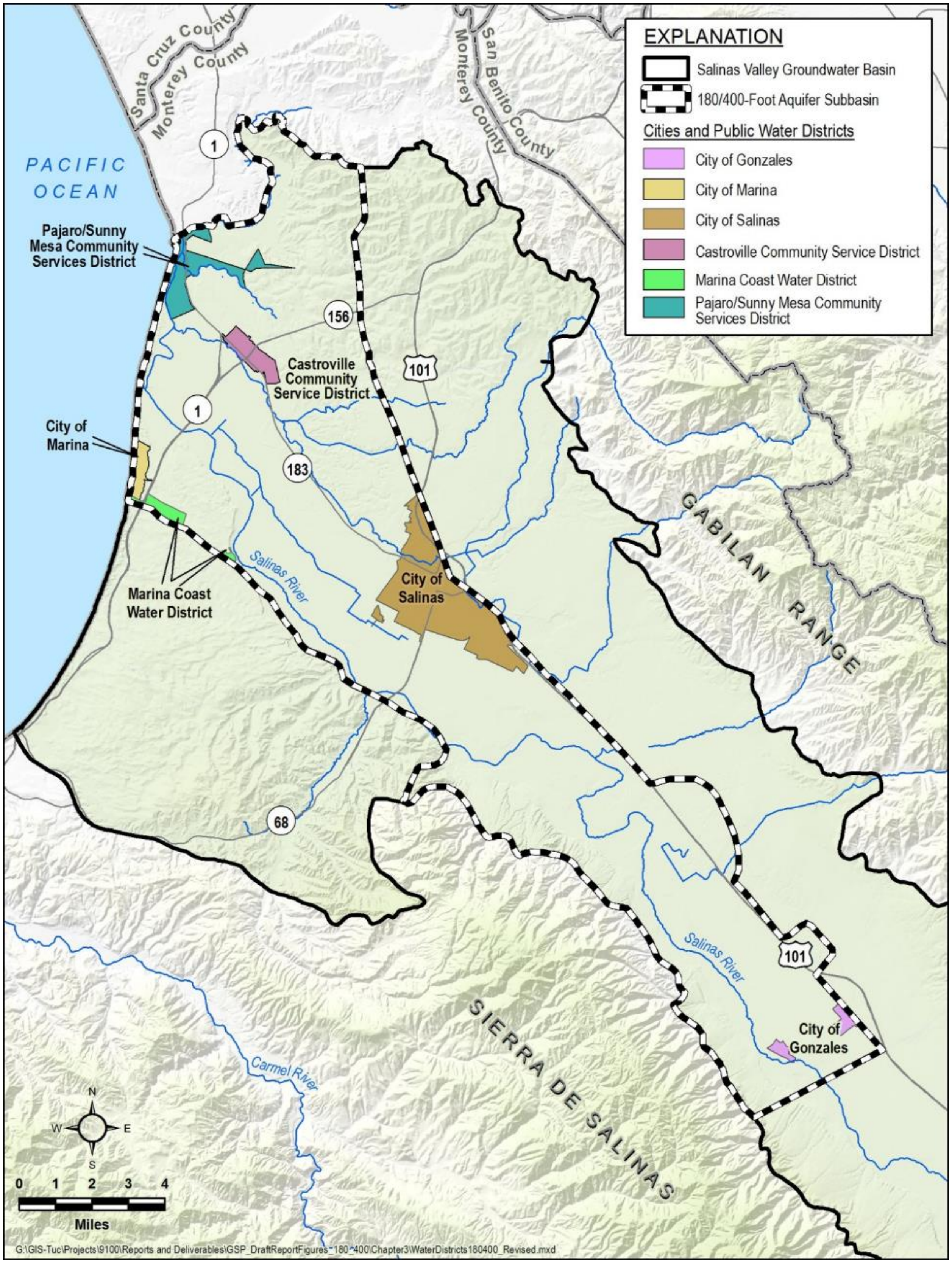


Figure 3-4. City, CSD, and Water District Jurisdictional Areas

3.4 Land Use

The Monterey County Assessor's office maintains a Geographic Information System (GIS) database of land use at the parcel level. These data were used to develop land use maps for the SVBGSA exclusive area. Current land use in the 180/400-Foot Aquifer Subbasin is shown on Figure 3-5 and summarized by major category in Table 3-1. The difference between the land use area in Table 3-1 and the total Subbasin area of 89,000 arecres is the result of 1) MCWD parcels not being included in the table, 2) some parcels having null land use values, and 3) small gaps between parcels that are not counted.

Table 3-1. Land Use Summary

Category	Area in Subbasin (acres)
Irrigated Agriculture	62,519
Non-irrigated Agriculture	2,534
Commercial	823
Industrial	2,175
Institutional	5,019
Miscellaneous	1,276
Multi-Family	563
Residential (Urban)	2,574
Rural	6,562
Other	1,233
Total	**85,278**

Source: Monterey County Assessor's Office parcel data

The majority of land in the Subbasin is used for agriculture; the top three crops, by value, in Monterey County in 2017 were lettuce, strawberries, and broccoli (Monterey County Agriculture Commissioner, 2018). Vineyards are also a major crop in Monterey County. Other crops included under irrigated agriculture are various row crops, field crops, alfalfa, pasture, orchards (fruits and nuts), and irrigated agricultural preserves.

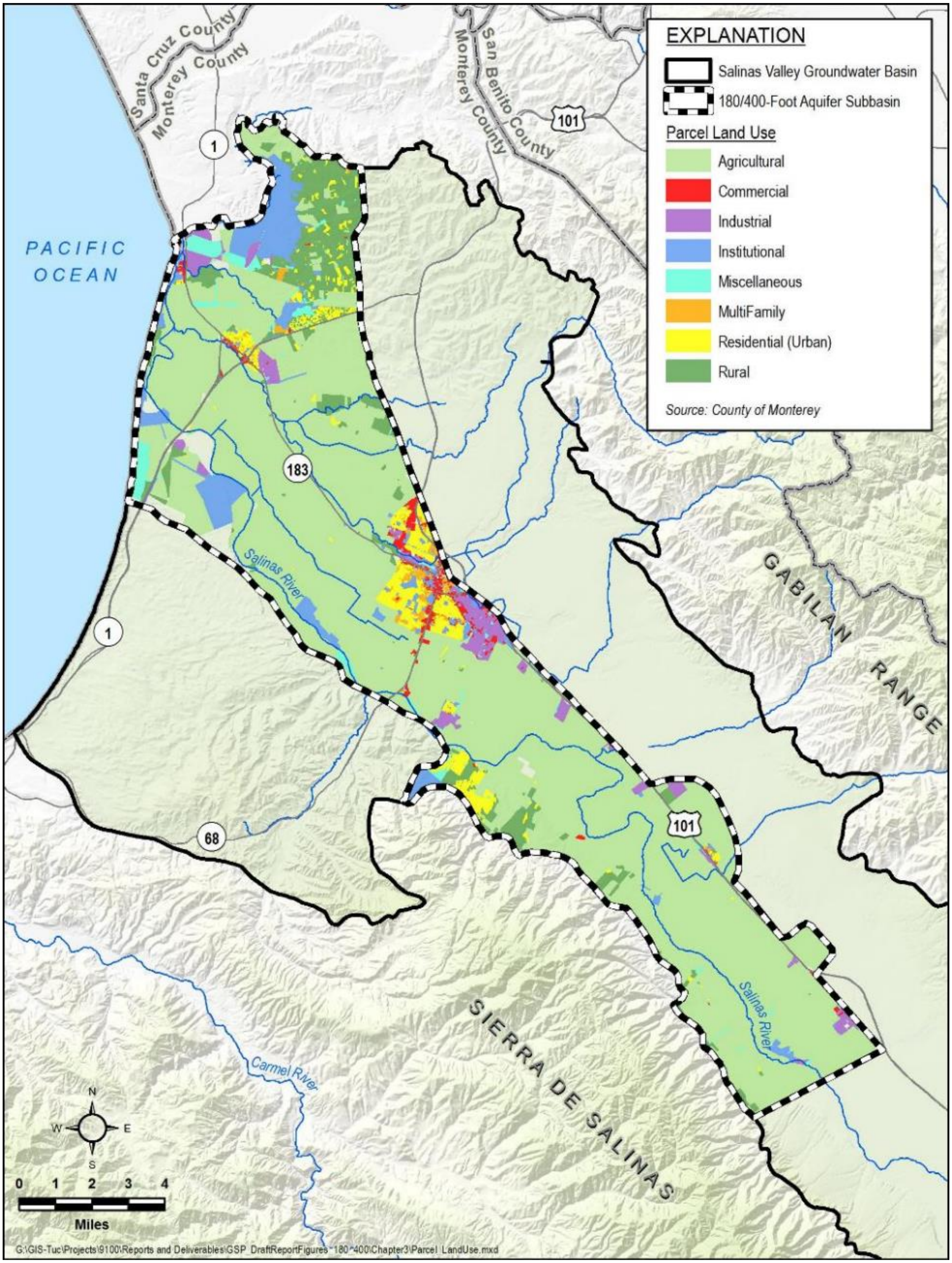


Figure 3-5. Existing Land Use

3.4.1 Water Source Types

The Subbasin has three water source types: groundwater, surface water, and recycled water. Groundwater is the primary water source for all water use sectors in the Subbasin. Water districts that depend on groundwater are shown in orange on Figure 3-6. The water districts areas shown on this figure are derived from the DWR Water Districts shapefile, which contains both municipal water districts and small state districts that rely groundwater. Groundwater is also used for rural residential areas, small community systems, and small commercial operations such as golf courses and schools.

The coastal farmland surrounding Castroville receives a combination of recycled water from SVBGSA member entity Monterey One Water, groundwater, and surface water through the Castroville Seawater Intrusion Project (CSIP). CSIP delivers this water to the agricultural land shown in green on Figure 3-6. Recycled water is additionally used for irrigation in the Las Palmas Ranch development.

Surface water supplies are derived from the Salinas River and its tributaries. Direct diversions provide surface water to agriculture, and additional surface water is diverted through a pneumatic diversion dam known as the Salinas River Diversion Facility (SRDF). This dam is located on the Salinas River near Marina. The SRDF provides surface water to the CSIP distribution system to offset groundwater pumping.

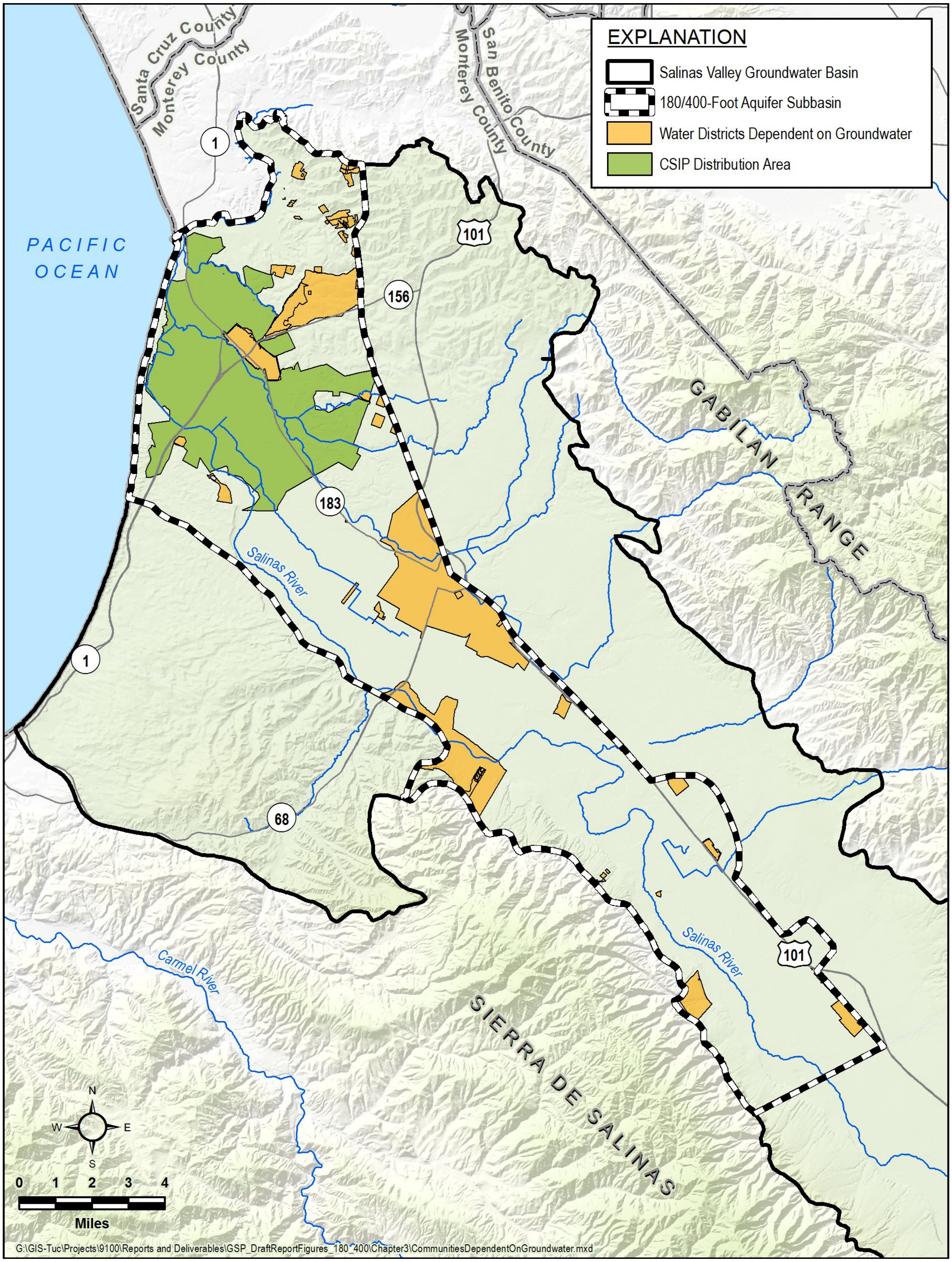


Figure 3-6. Water Districts Dependent on Groundwater and the CSIP Distribution Area

3.4.2 Water Use Sectors

Groundwater demands in the Subbasin are classified into the six water use sectors identified in the GSP Regulations. Groundwater demand categories include:

- **Urban**. Urban water use is assigned to non-agricultural water uses in the cities and census-designated places. Domestic use outside of census-designated places is not considered urban use. For the years 2010-2015, urban water use averaged 17,400 acre-feet (AF) and accounted for an average of 15% of the groundwater pumped in the Subbasin (MCWRA, 2015a; MCWRA, 2017a).
- **Industrial**. There is limited industrial use in the Subbasin. DWR does not have any records of wells in the Subbasin that are categorized as industrial use. MCWRA records lump industrial use and urban use together as a single type of water use.
- **Agricultural**. This is the largest water use sector in the Subbasin, with an annual average use of 96,600 AF between 2010 and 2015. Agricultural water use accounted for an average of 85% of the groundwater pumped in the Subbasin (MCWRA, 2015a; MCWRA 2017a).
- **Managed wetlands**. DWR land use records indicate that there is one managed wetland in the Subbasin, an 11.2-acre wetland owned by the State of California and located northeast of the Monte De Lago neighborhood, between state highway 156 and Castroville Boulevard. The water use of this wetland is unknown.
- **Managed recharge**. There is no managed recharge in the Subbasin. Wastewater treated by the Salinas Valley Reclamation Project (SVRP) is distributed by the CSIP distribution system and used to offset agricultural groundwater pumping within the CSIP service area resulting in in-lieu recharge.
- **Native vegetation.** Approximately 90% of the Subbasin comprises commercial, industrial, agricultural, or residential land uses. Approximately 4% is identified as “conservation” and approximately 5% is identified as “public” or “quasi-public”. Groundwater use by native vegetation is minimal. Although not a native species, water use by *Arundo donax* is estimated at between 32,000 and 64,000 acre-feet per year (AF/yr.) in the entire Salinas Valley Groundwater Basin (Giessow, 2011); an unknown quantity occurs within the 180/400-Foot Aquifer Subbasin.

3.5 Existing Well Types, Numbers, and Density

Well density data were derived from the database of wells that DWR specifically developed for use in GSPs. Other data sources are available from MCWRA or other sources, and they may result in different well densities. The DWR data were used for simplicity and consistency with other DWR data used in this GSP.

DWR's Well Completion Report Map Application classifies wells as domestic, production, and municipal; the majority of wells classified as production wells are assumed to be used for agricultural irrigation, with some production wells used for industrial purposes. More than half of the wells in the DWR dataset are production wells. Domestic wells account for most of the remaining wells. Some of the domestic wells identified by DWR may be classified as *de minimis* extractors, defined as pumping less than 2 AF/yr for domestic purposes. Well counts in the Subbasin are summarized in Table 3-2. Figure 3-7 and Figure 3-8 show the density of domestic and agricultural production wells, respectively, in the Subbasin.

Fewer than 3% of wells in the Subbasin are classified as public supply wells, even though groundwater is the primary water source for urban and rural communities in the Subbasin.

Figure 3-9 shows the density of municipal wells in the Subbasin. As previously described, Figure 3-6 identifies municipal areas dependent upon groundwater.

Table 3-2. Well Count Summary

Category	Number of Wells
Domestic	691
Production	780
Public Supply	43
Total	**1,514**

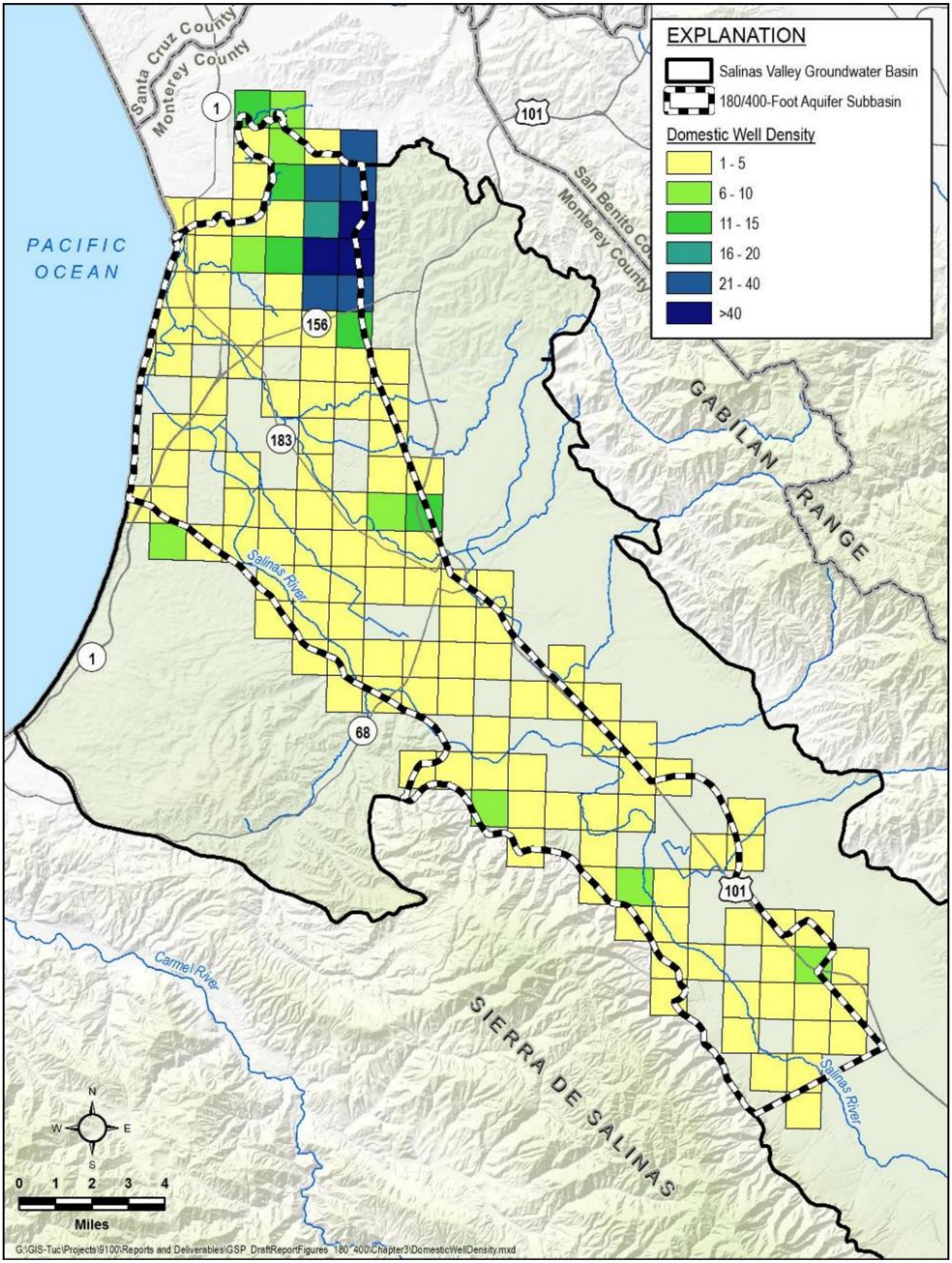


Figure 3-7. Density of Domestic Wells (Number of Wells per Square Mile)

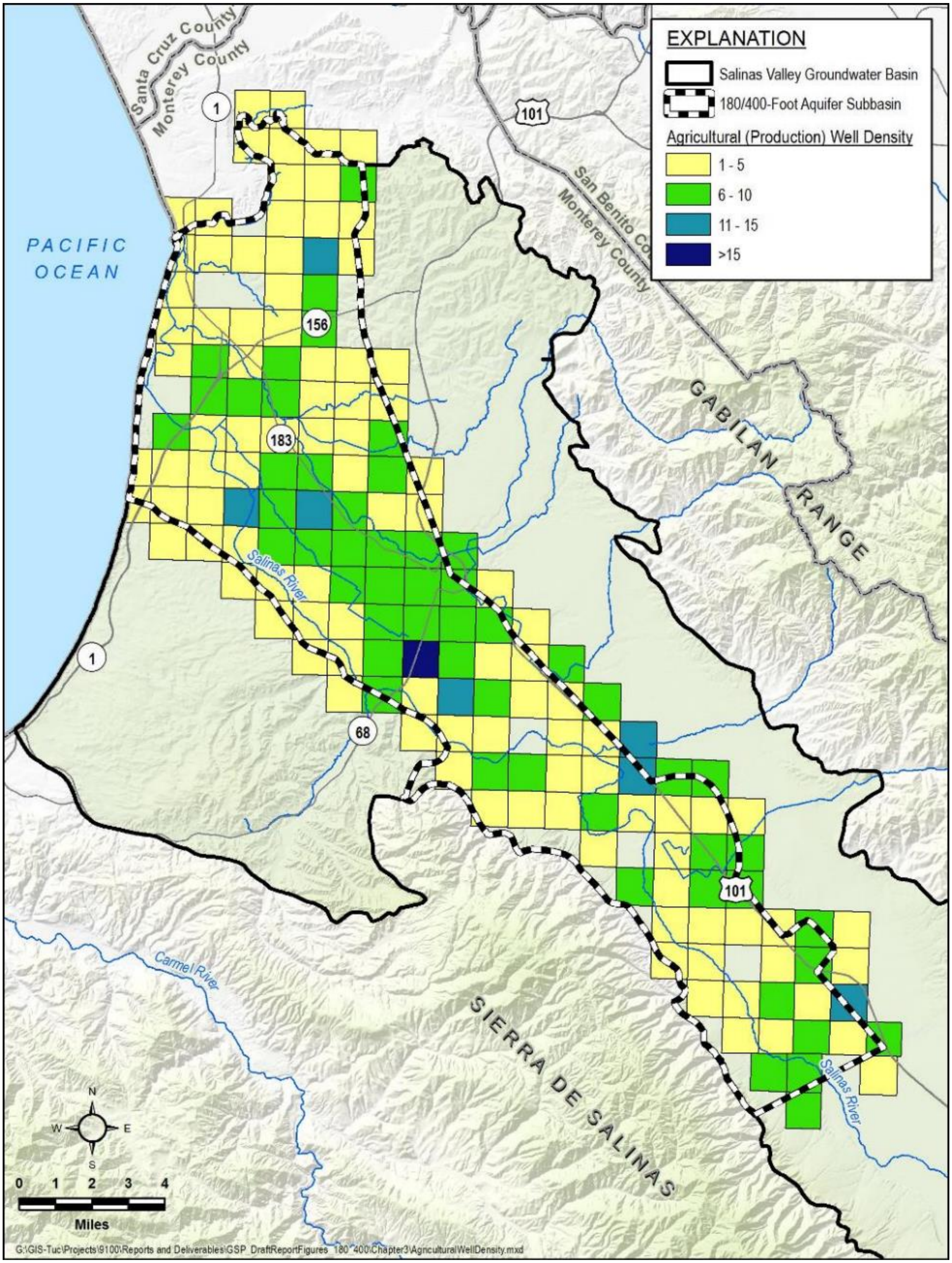


Figure 3-8. Density of Agricultural Production Wells (Number of Wells per Square Mile)

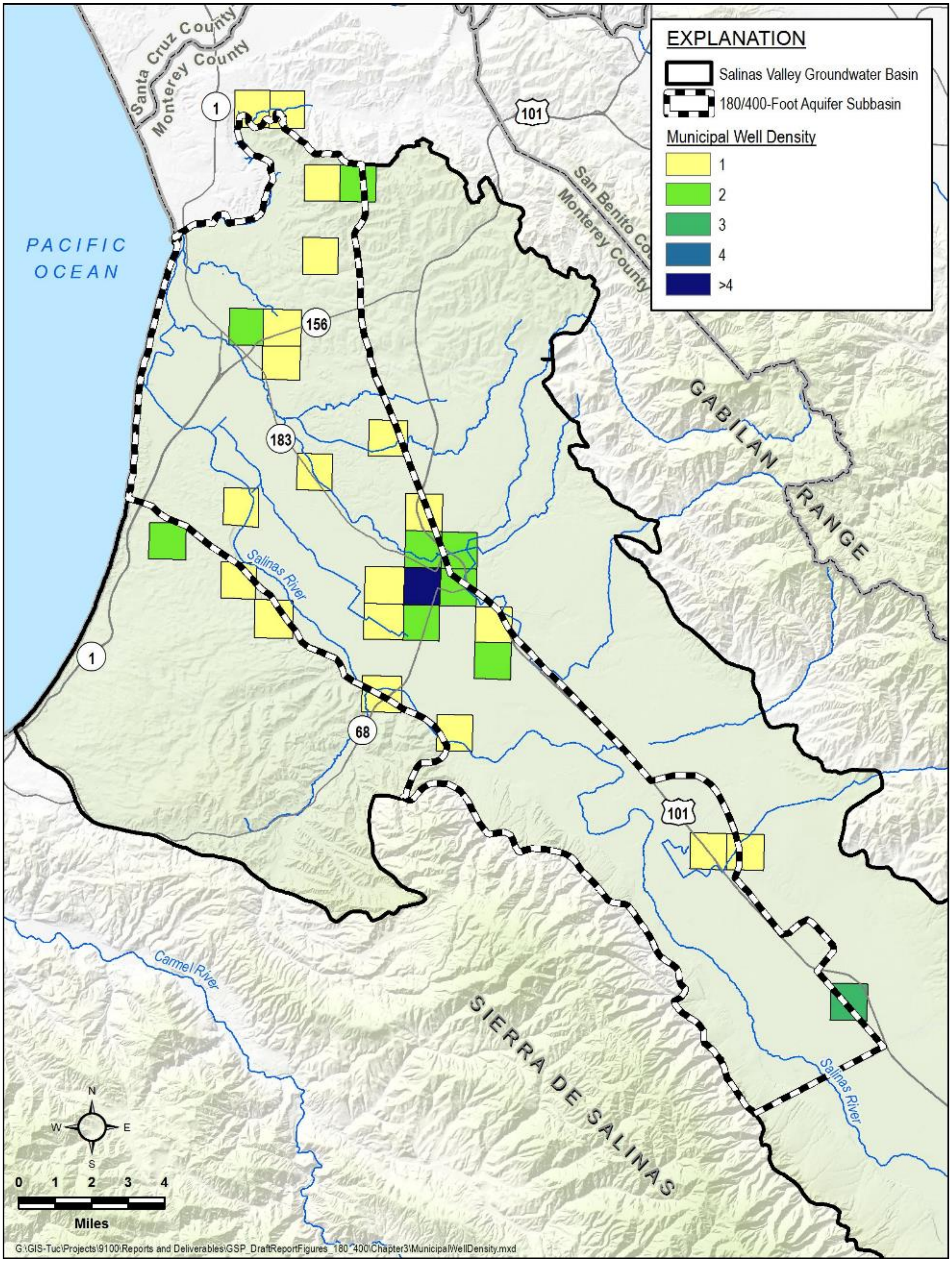


Figure 3-9. Density of Municipal Wells (Number of Wells per Square Mile)

3.6 Existing Monitoring Programs

3.6.1 Existing Groundwater Elevation Monitoring

3.6.1.1 MCWRA Monthly Groundwater Elevation Monitoring

MCWRA collects monthly groundwater elevation measurement from approximately 100 wells throughout the Salinas Valley Groundwater Basin. Of these wells, 38 are in the 180/400-Foot Aquifer Subbasin. MCWRA processes these monthly measurements to develop a computed average depth to water for the Subbasin.

3.6.1.2 MCWRA Annual Fall Groundwater Elevation Monitoring

MCWRA collects groundwater elevation measurements from an additional 120 wells in the 180/400-Foot Aquifer Subbasin each fall. MCWRA uses these annual measurements to develop contour maps depicting the annual groundwater elevation.

3.6.1.3 MCWRA August Groundwater Elevation Monitoring

MCWRA collects groundwater elevation measurements every August from approximately 100 wells in the 180/400-Foot Aquifer Subbasin to establish the location and extent of groundwater pumping depressions that drive seawater intrusion. The August measurements usually coincide with the end of the irrigation season, and groundwater elevations at this time reflect low groundwater elevations prior to the onset of seasonal winter recharge. MCWRA uses the August groundwater elevation data to develop groundwater contour maps of the coastal pumping depressions in odd-numbered years.

3.6.1.4 California Statewide Groundwater Elevation Monitoring (CASGEM)

MCWRA is the responsible agency for CASGEM monitoring in most areas of Monterey County. The monitoring network comprises 51wells throughout the Salinas Valley Groundwater Basin. Of these 51 wells, 23 are in the 180/400-Foot Aquifer Subbasin. Some of the CASGEM monitoring wells are owned by MCWRA and others are privately owned by owners who have volunteered the well for inclusion in the CASGEM program. MCWRA collects monthly groundwater elevation data from the CASGEM wells, except for a few that are monitored biannually, and reports the groundwater elevation data to DWR twice per year. Figure 3-10 shows the locations of the CASGEM monitoring wells in the 180/400-Foot Aquifer Subbasin.

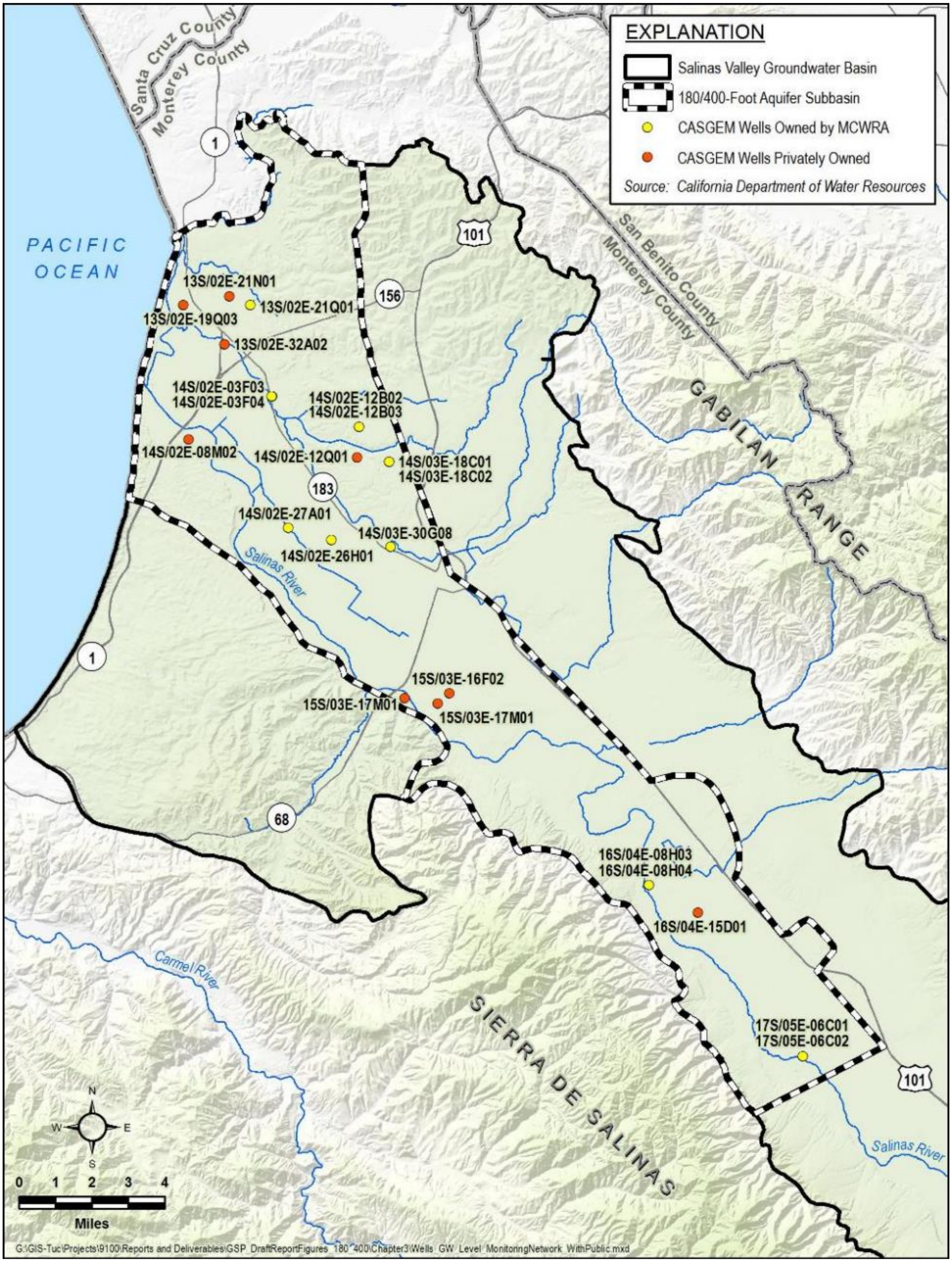


Figure 3-10. Locations of CASGEM Wells in the 180/400-Foot Aquifer Subbasin

3.6.2 Groundwater Extraction Monitoring

MCWRA collects groundwater extraction information from all wells in the 180/400-Foot Aquifer Subbasin that have discharge pipes of three inches or greater in diameter. These data have been collected since 1993. Extraction is self-reported by well owners.

3.6.3 Groundwater Quality Monitoring

3.6.3.1 MCWRA Seawater Intrusion Monitoring

MCWRA monitors seawater intrusion in the Salinas Valley Groundwater Basin with a network of 121 monitoring wells located in the 180/400-Foot Aquifer Subbasin. Ninety-six wells in the network are agricultural production wells that are sampled annually in June and August. Twenty-five of the wells in the network are dedicated monitoring wells that are maintained by either MCWRA or by California-American Water (Cal-Am) as part of its Monterey Peninsula Water Supply Project (MPWSP).

Water quality samples from the wells are analyzed for general water chemistry constituents, including anions and cations, conductivity, etc. The data are used to develop time-series plots of chloride and conductivity trends, stiff and piper diagrams, and to compute molar ratios of chloride to sodium. The data are used to prepare maps of seawater intrusion in the 180- and 400-Foot Aquifers in odd-numbered years. Additional information about the occurrence and extent of seawater intrusion in both the 180- and 400-Foot Aquifers is provided in Section 5.

3.6.3.2 Other Groundwater Quality Monitoring

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

- Municipal and community water purveyors must collect water quality samples on a routine basis for compliance monitoring and reporting to the California Division of Drinking Water.
- The United States Geological Survey (USGS) has sporadically collected groundwater quality data under the Groundwater Ambient Monitoring and Assessment (GAMA) program. These data are stored in the State's GAMA/Geotracker system. Figure 3-11 shows the location of wells in the State's GAMA Geotracker database that are in the 180/400-Foot Aquifer Subbasin.
- There are multiple sites at which groundwater quality monitoring is conducted as part of investigation or compliance monitoring programs through the Central Coast Regional Water Quality Control Board.

Cal-Am and MCWRA monitor Cal-Am's proposed source wells for the MPWSP.

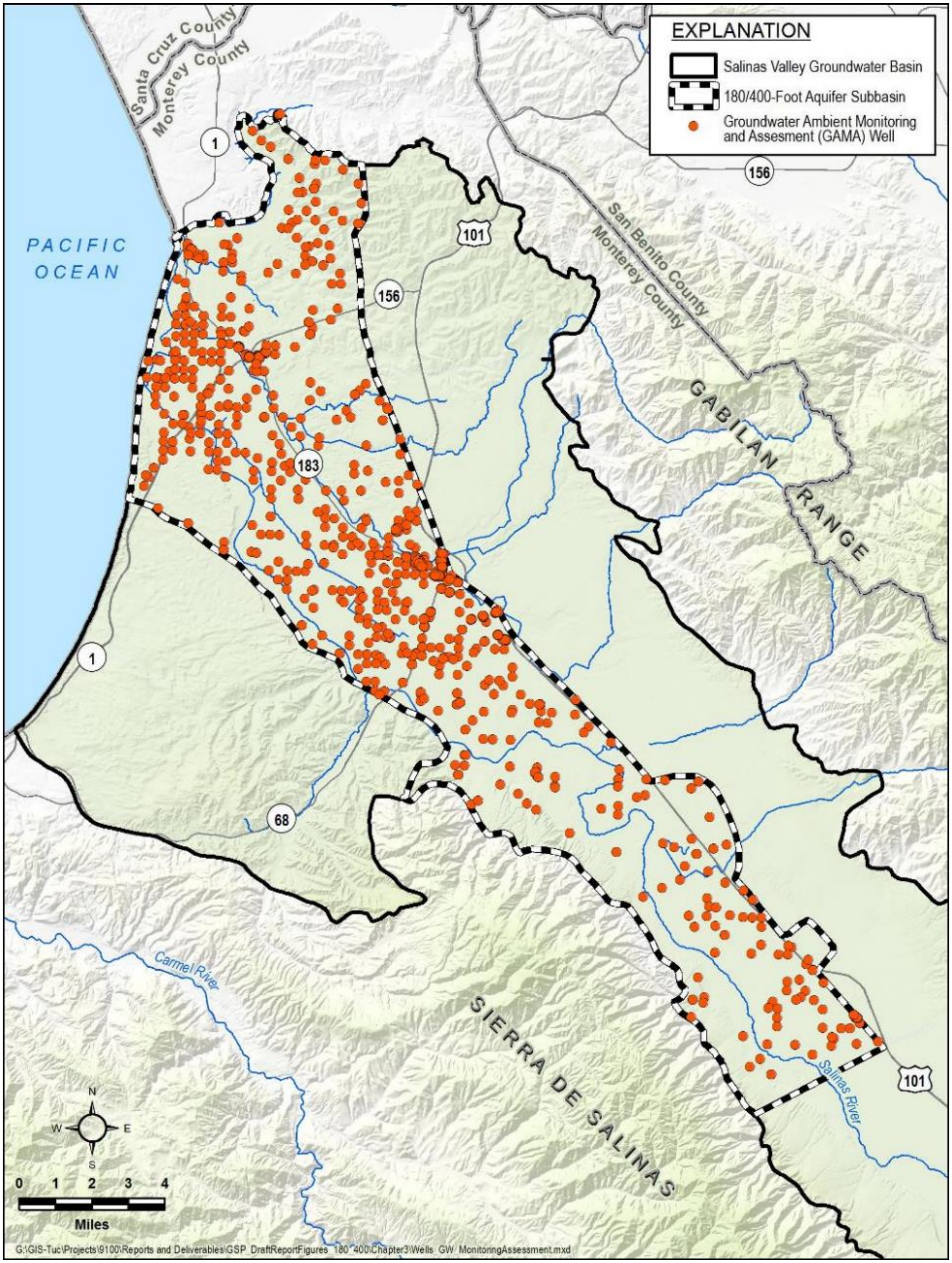


Figure 3-11. Locations of USGS GAMA Wells in the 180/400-Foot Aquifer Subbasin

3.6.4 Surface Water Monitoring

Streamflow gauges operated by the USGS within the 180/400-Foot Aquifer Subbasin include:

- Reclamation Ditch near Salinas (USGS Site #11152650)
- Salinas River near Chualar (USGS Site #11152300)
- Salinas River near Spreckels (USGS Site #11152500)

Water levels in the Salinas River Lagoon are measured by MCWRA at Monte Road and near the slide gate to the Old Salinas River. The locations of the surface-water monitoring facilities are depicted on Figure 3-12.

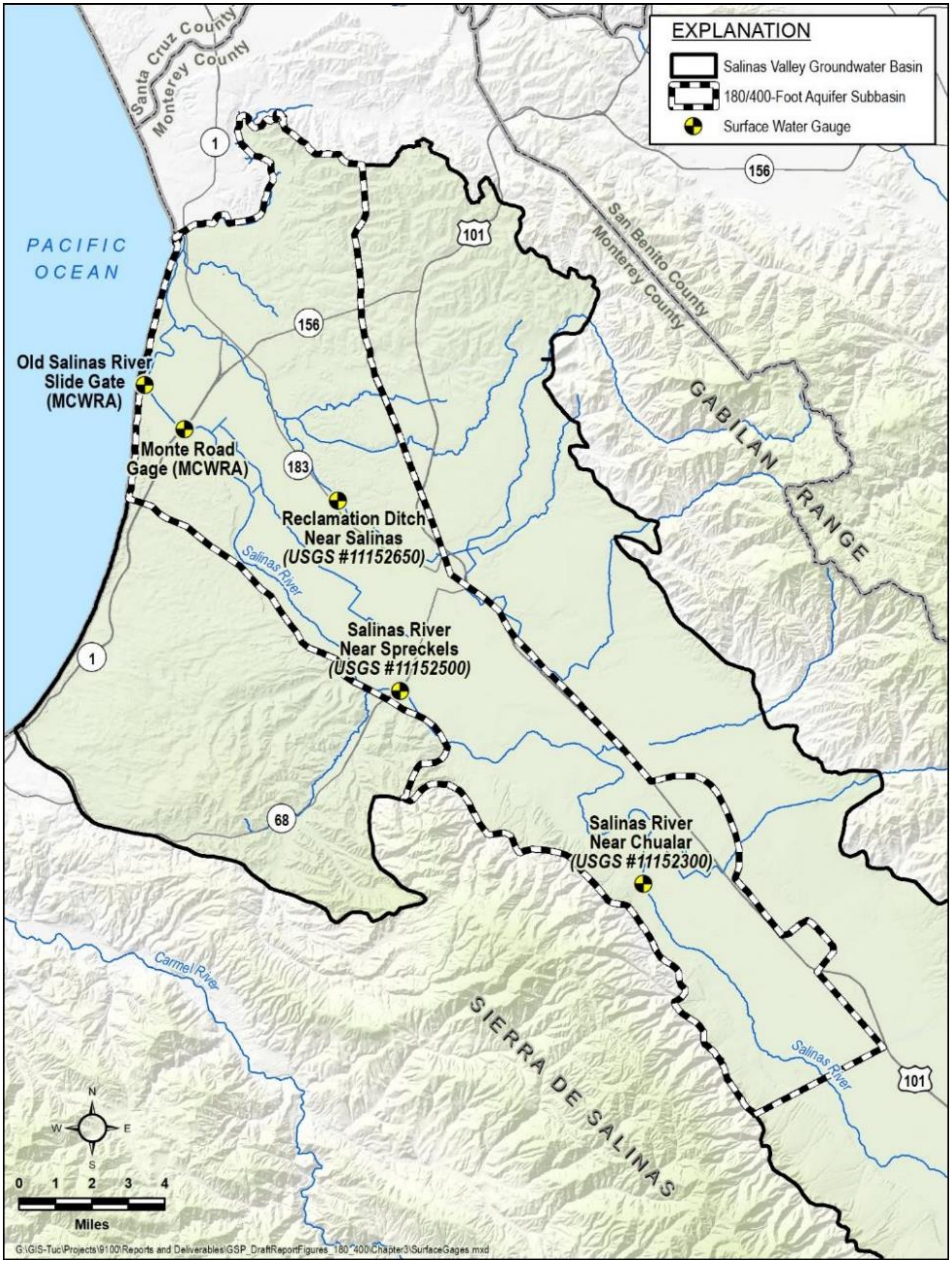


Figure 3-12. Surface Water Gaging Locations

3.6.5 Incorporating Existing Monitoring Programs into the GSP

The existing monitoring programs and monitoring networks constitute a well-developed and broadly distributed system that provides representative data throughout the Subbasin. The groundwater elevation monitoring programs are operated by an existing member of the SVBGSA, and therefore are incorporated into the GSP monitoring plan as appropriate. The existing groundwater elevation monitoring programs will be updated and improved to document the avoidance of undesirable results in each significant aquifer in the Subbasin.

MCWRA currently monitors 23 wells with publicly available data within the 180/400-Foot Aquifer Subbasin as part of the CASGEM network. This network will be used for long-term water elevation monitoring under GSP implementation. MCWRA also monitors seawater intrusion at dedicated monitoring wells and creates chloride concentration maps to track seawater intrusion in the 180/400-Foot Aquifer Subbasin aquifers. This seawater intrusion monitoring network will be used for the seawater intrusion sustainability indicator.

Groundwater quality data will be downloaded and reviewed from existing networks and programs for public water system wells, small public water system wells that are monitored by the County Department of Public Health, and the Irrigated Lands Program agricultural and domestic wells monitored under Ag Order 4.0.

The existing stream gages, primarily those maintained by the USGS, will be incorporated into this GSP monitoring plan to validate projections of surface water depletions from pumping. InSAR data provided by DWR will be used to monitor subsidence in the Subbasin.

3.6.6 Limits to Operational Flexibility

The existing monitoring programs are not anticipated to limit the operational flexibility of this GSP.

3.7 Existing Management Plans

3.7.1 Monterey County Groundwater Management Plan

MCWRA developed a Groundwater Management Plan (GMP) that is compliant with AB3030 and SB1938 legislation (MCWRA, 2006). This GMP exclusively covered the Salinas Valley Groundwater Basin in Monterey County.

The GMP identified three objectives for groundwater management:

Objective 1: Development of Integrated Water Supplies to Meet Existing and Projected Water Requirements

Objective 2: Determination of Sustainable Yield and Avoidance of Overdraft

Objective 3: Preservation of Groundwater Quality for Beneficial Use

To meet these three objectives, the GMP identified 14 elements that should be implemented by MCWRA:

Plan Element 1: Monitoring of Groundwater Elevations, Quality, Production, and Subsidence

Plan Element 2: Monitoring of Surface Water Storage, Flow, and Quality

Plan Element 3: Determination of Basin Yield and Avoidance of Overdraft

Plan Element 4: Development of Regular and Dry Year Water Supply

Plan Element 5: Continuation of Conjunctive Use Operations

Plan Element 6: Short-Term and Long-Term Water Quality Management

Plan Element 7: Continued Integration of Recycled Water

Plan Element 8: Identification and Mitigation of Groundwater Contamination

Plan Element 9: Identification and Management of Recharge Areas and Wellhead Protection Areas

Plan Element 10: Identification of Well Construction, Abandonment, and Destruction Policies

Plan Element 11: Continuation of Local, State and Federal Agency Relationships

Plan Element 12: Continuation of Public Education and Water Conservation Programs

Plan Element 13: Groundwater Management Reports

Plan Element 14: Provisions to Update the Groundwater Management Plan

3.7.2 Integrated Regional Water Management Plan

The Integrated Regional Water Management (IRWM) Plan for the Greater Monterey County Region was developed by the Greater Monterey County Regional Water Management Group (RWMG), which consists of government agencies, nonprofit organizations, educational organizations, water service districts, private water companies, and organizations representing agricultural, environmental, and community interests, including:

- Big Sur Land Trust

- California State University Monterey Bay
- California Water Service Company
- Castroville Community Services District
- City of Salinas
- City of Soledad
- Elkhorn Slough National Estuarine Research Reserve
- Environmental Justice Coalition for Water
- Garrapata Creek Watershed Council
- Marina Coast Water District
- Monterey Bay National Marine Sanctuary
- Monterey County Agricultural Commissioner's Office
- Monterey County Water Resources Agency
- Monterey Regional Water Pollution Control Agency
- Moss Landing Marine Laboratories
- Resource Conservation District of Monterey County
- Rural Community Assistance Corporation
- San Jerardo Cooperative, Inc.

The 180/400-Foot Aquifer Subbasin falls within the IRWM Plan area. The IRWM Plan consists of a set of goals and objectives that were identified by the RWMG as being critical to address water resource issues within the planning area in the areas of:

- Water Supply
- Water Quality
- Flood Protection and Floodplain Management
- Environment
- Regional Communication and Cooperation
- Disadvantaged Communities
- Climate Change

The IRWM Plan includes more than 25 projects that could assist regional groundwater management (Greater Monterey County Regional Water Management Group, 2018).

3.7.3 Urban Water Management Plans

3.7.3.1 California Water Service (Salinas District) Urban Water Management Plan

California Water Service serves a portion of the City of Salinas. Its 2015 Urban Water Management Plan (UWMP) (California Water Service, 2016) describes the service area; reports historic and projected population; identifies historical and projected water demand by category such as single-family, multi-family, commercial, industrial, institutional/government, and other; and describes the distribution system and identifies system losses.

The UWMP describes the system's reliance on groundwater and California Water Service's support for efforts to avoid overdraft, including working cooperatively with MCWRA and participating in the development of this GSP. Specific activities that California Water Service intends to conduct include:

- Outreach to public agencies to ensure that the Company's presence, rights and interests, as well as historical and current resource management concerns are honored/incorporated within the GSA and GSP formulation process(es).
- Outreach to applicable local and regulatory agencies to ensure the Company's full participation, while also meeting the requirements and expectations set forth by SGMA.
- The enhanced use of digital/electronic groundwater monitoring equipment and other new technology aimed at measuring withdrawal rates, pumping water elevations, and key water quality parameters within the context of day-to-day operations.
- Full participation in the development of GSPs and formulation of groundwater models constructed in basins where the Company has an operating presence.
- Full participation in individual and/or joint projects aimed at mitigating seawater intrusion and other undesirable results.
- Inclusion of sound groundwater management principles and data in all applicable technical reports, studies, facility master plans, and urban water management, particularly as these undertakings relate or pertain to water resource adequacy and reliability.
- Inclusion of sound groundwater management principles and data in all general rate case filings and grant applications to ensure that resource management objectives remain visible and central to Cal Water's long-term planning/budgeting efforts.

The UWMP also addresses California Water Service's position on alternative supplies currently being developed for the Salinas Valley Groundwater Basin. California Water Service is evaluating the possibility of using up to 10,000 AF/yr., or more, of water from the proposed Deep Water Desal LLC desalination plant at Moss Landing.

The UWMP addresses the need for California Water Service to implement a well replacement program to mitigate water quality impacts from nitrates, uranium, MTBE, and sand contamination.

California Water Service's UWMP notes that groundwater will continue to remain as its sole supply due to uncertainties regarding the cost and implementation other options, such as surface water diversion or desalination. However, the UWMP recognizes that it would be beneficial for California Water Service to diversify its supply portfolio. California Water Service evaluated the impact of climate change on its water supply. The study found that climate change could result in a supply reduction of 6% to 7% by the end of the century.

3.7.3.2 California American Water Company (Chualar)

Cal-Am operates a satellite water system serving approximately 1,000 residents near Chualar. The operation of this system is described in Cal-Am's 2010 UWMP. The Cal-Am UWMP provides a description of the system, historical and projected water demands, and an assessment of current and future water supplies. Although the Cal-Am UWMP discusses future water supply options such as desalination, aquifer storage and recovery, and recycled water, none of these are applicable to the Chualar satellite system.

The Chualar system is entirely dependent on groundwater from the 180-Foot Aquifer and is far enough inland that it is not considered susceptible to seawater intrusion. The UWMP reports that water quality from the Chualar system wells is generally good.

3.7.3.3 Marina Coast Water District Urban Water Management Plan

The MCWD most recently updated its UWMP in 2015 (MCWD, 2016). The UWMP describes the service area; reports historical and projected population; identifies historical and projected water demand by category such as single-family, multi-family, commercial, industrial, institutional/government, and other; and describes the distribution system and identifies losses.

The MCWD currently relies solely on groundwater, although the UWMP notes that, "The District is located along the Salinas River, and MCWD Board of Directors has considered purchasing surface water rights in the Salinas River Basin as a means of meeting long-term (beyond 2030) demands." The UWMP further notes that, "…the total Ord Community groundwater supply of 6,600 AF/yr. falls short of the total 2030 Ord Community demand of 8,293 AF/yr. by 1,693 AF/yr. [and] …the Central Marina service area is not projected to exceed its current SVGB groundwater allocation from the Fort Ord Reuse Authority (FORA) within the planning period."

The MCWD UWMP includes a number of demand management measures including:

- Water Waste Prevention Ordinances

- Metering
- Conservation Pricing
- Public Education and Outreach
- Programs to Assess and Manage Distribution System Real Loss
- Water Conservation Program Coordination and Staffing Support
- Water Survey Programs for Residential Customers
- Residential Plumbing Retrofits
- Residential Ultra-Low Flow Toilet Replacement Programs
- High-Efficiency Washing Machine Rebate Programs
- Commercial, Industrial, and Institutional Accounts
- Landscape Conservation Programs and Incentives

3.8 Existing Groundwater Regulatory Programs

3.8.1 Groundwater Export Prohibition

The Monterey County Water Resources Agency Act, § 52.21 prohibits the export of groundwater from any part of the Salinas Valley Groundwater Basin, including the 180/400-Foot Aquifer Subbasin. In particular, the Act states:

> *For the purpose of preserving [the balance between extraction and recharge], no groundwater from that basin may be exported for any use outside the basin, except that use of water from the basin on any part of Fort Ord shall not be deemed such an export. If any export of water from the basin is attempted, the Agency may obtain from the superior court, and the court shall grant, injunctive relief prohibiting that exportation of groundwater.*

3.8.2 Agricultural Order

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

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

Negotiations with the CCRWQCB staff and Board Members for the next iteration of the Agricultural Order are on-going, and expected to conclude in March 2020 with the adoption of a new Irrigated Lands Regulatory Program (ILRP) Waste Discharge Requirements (WDR) for farming operations in the Salinas Valley Groundwater Basin area. As mandated by the State Water Resources Control Board (SWRCB), specific reporting requirements for nitrogen applications and removal, irrigation and surface water discharge management, and groundwater quality monitoring will be included with quantifiable milestones. While the outcome is not certain, the expectation is that the next Agricultural Order will be more complex with additional compliance reporting measures for all growers.

3.8.3 Water Quality Control Plan for the Central Coast Basins

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

The Basin Plan lists benceficial users, describes the water quality which must be maintained to allow those uses, provides an implementation plan, details SWRCB and CCRWQCB plans and policies to protect water quality, and details statewide and regional survelliance and monitoring programs. The SWRCB's Sources of Drinking Water Policy, adopted in Resolution No. 88-63 and incorporated in its entirety in the CCRWQCB's Basin Plan, provides that water with TDS less than or equal to 3,000 mg/L is considered suitable or potentially suitable for drinking water beneficial uses.

Present and potential future beneficial uses for waters in the Basin are municipal supply; agricultural supply; groundwater recharge; recreation; sport fishing; warm fresh water habitat; wildlife habitat; rare, threatened or endangered species habitat; and, spawning, reproduction, and/or early development of fish.

3.8.4 Requirements for New Wells

In October, 2017, Governor Brown signed Senate Bill (SB) 252 which became effective on January 1, 2018. SB 252 requires well permit applicants in critically overdrafted basins to include information about the proposed well, such as location, depth, and pumping capacity (California Legislature, 2017). The bill also requires the permitting agency to make the information easily accessible to the public and the GSAs. These requirements expire on January 30, 2020.

3.8.5 Title 22 Drinking Water Program

The SWRCB Division of Drinking Water (DDW) regulates public water systems in the State to ensure the delivery of safe drinking water to the public. A public water system is defined as a system for the provision of water for human consumption that has 15 or more service connections or regularly serves at least 25 individuals daily at least 60 days out of the year. Private domestic wells, wells associated with drinking water systems with less than 15 residential service connections, industrial, and irrigation wells are not regulated by the DDW.

The DDW enforces the monitoring requirements established in Title 22 of the California Code of Regulations (CCR) for public water system wells, and all the data collected must be reported to the DDW. Title 22 also designates the Maximum Contaminant Levels (MCLs) for various waterborne contaminants, including volatile organic compounds, non-volatile synthetic organic compounds, inorganic chemicals, radionuclides, disinfection byproducts, general physical constituents, and other parameters.

3.8.6 County Moratorium on Accepting and Processing New Well Permits

On May 22, 2018, the Monterey County Board of Supervisors adopted Ordinance No. 5302 pursuant to Government Code Section 65858. The ordinance was an Interim Urgency Ordinance, which took effect immediately upon adoption. The ordinance prohibits the acceptance or processing of any applications for new wells in the defined Area of Impact within the180/400-Foot Aquifer Subbasin, with stated exceptions including municipal wells and replacement wells. The ordinance was originally only effective for 45 days, but at the June 26 Monterey County Board of Supervisors meeting, the Board of Supervisors extended the ordinance to May 21, 2020, by adoption of Ordinance No. 5303. During the moratorium, the County has stated that it will conduct further studies to assess groundwater conditions in the Subbasin.

3.8.7 County Ordinance 3709

County Ordinance 3709, passed in 1993, prohibits groundwater extractions and the drilling of new extraction wells in certain portions of the 180-foot aquifer after January 1, 1995.

3.8.8 County Ordinance 3790

Ordinance 3790, passed in 1994, establishes regulations for the classification, operation, maintenance and destruction of groundwater wells in the Castroville Seawater Intrusion Project area, known as Zone 2B.

3.8.9 Incorporating Regulatory Programs into the GSP

Information in these various plans has been incorporated into this GSP and used during the preparation of Sustainability Goals, when setting Minimum Thresholds and Measurable Objectives when developing Projects and Management Actions.

3.8.10 Limits to Operational Flexibility

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

- The groundwater export prohibition included in the Monterey County Water Resources Agency Act prevents export of water out of the Subbasin. This prohibition is not expected to adversely affect SVBGSA's ability to reach sustainability.
- The Basin Plan and the Title 22 Drinking Water Program restrict the quality of water that can be recharged into the Subbasin.
- The Interim Urgency Ordinance, which imposes a temporary moratorium on wells in the Area of Impact, may limit certain activities and the SVBGSA's ability to access certain sources of water. However, the moratorium is not expected to adversely affect SVBGSA's ability to reach sustainability.
- The Habitat Conservation Plan being developed by MCWRA on the Salinas River will limit operational flexibility for Nacimiento and San Antonio reservoir releases for groundwater recharge in the Basin.

3.9 Conjunctive Use Programs

One conjunctive use project operates in the 180/400-Foot Aquifer Subbasin. This project uses recycled water from the SVRP and distributes it through the CSIP distribution system. This project serves approximately 12,000 acres of farmland within the Subbasin. The extent of the current CSIP distribution area is shown on Figure 3-6. The recycled water in the CSIP is supplemented with groundwater and surface water diverted from the SRDF. When river water is available and the SRDF is operating, grower groundwater pumping has been reduced by about 80% during peak irrigation demand periods. However, it is currently necessary to conjunctively manage all three water sources to match irrigation demands with water supplies.

3.10 Land Use Plans

Monterey County and the cities of Gonzales, Marina, and Salinas have land use authority over all or portions of the 180/400-Foot Aquifer Subbasin. Land use is an important factor in water management. The following sections provide a general description of these land use plans and how implementation may affect groundwater management in the 180/400-Foot Aquifer Subbasin. The following descriptions were taken from publicly available general plans at the time of the GSP preparation.

3.10.1 Monterey County General Plan

Relevant elements of the Monterey County General Plan (Monterey County, 2010) are summarized in Table 3-3.

Table 3-3 Monterey County General Plan Summary

Element		Goal / Policy
Land Use	LU-1.4	Growth areas shall be designated only where an adequate level of services and facilities such as water, sewerage, fire and police protection, transportation, and schools exist or can be assured concurrent with growth and development. Phasing of development shall be required as necessary in growth areas in order to provide a basis for long-range services and facilities planning.
Open Space	OS-3.8	The County shall cooperate with appropriate regional, state and federal agencies to provide public education/outreach and technical assistance programs on erosion and sediment control, efficient water use, water conservation and re-use, and groundwater management. This cooperative effort shall be centered through the Monterey County Water Resources Agency.
***et. seq.* Public Services**	GOAL PS-2	Assure an adequate and safe water supply to meet the county's current and long-term needs.
	PS-2.1	Coordination among, and consolidation with, those public water service providers drawing from a common water table to prevent overdrawing the water table is encouraged.
	PS-2.2	The County of Monterey shall assure adequate monitoring of wells in those areas experiencing rapid growth provided adequate funding mechanisms for monitoring are established in the CIFP.
	PS-2.3	New development shall be required to connect to existing water service providers where feasible. Connection to public utilities is preferable to other providers.
	PS-2.4	Regulations for installing any new domestic well located in consolidated materials (e.g., hard rock areas) shall be enacted by the County.
	PS-2.5	Regulations shall be developed for water quality testing for new individual domestic wells on a single lot of record to identify: a) Water quality testing parameters for a one-time required water quality test for individual wells at the time of well construction. b) A process that allows the required one-time water quality test results to be available to future owners of the well. Regulations pursuant to this policy shall not establish criteria that will prevent the use of the well in the development of the property. Agricultural wells shall be exempt from the

Element		Goal / Policy
		regulation.
	GOAL PS-3	Ensure that new development is assured a long-term sustainable water supply.
	PS-3.1	Except as specifically set forth below, new development for which a discretionary permit is required, and that will use or require the use of water, shall be prohibited without proof, based on specific findings and supported by evidence, that there is a long-term, sustainable water supply, both in quality and quantity to serve the development [see Plan for list].
	PS-3.2	Specific criteria for proof of a Long-Term Sustainable Water Supply and an Adequate Water Supply System for new development requiring a discretionary permit, including but not limited to residential or commercial subdivisions, shall be developed by ordinance with the advice of the General Manager of the Water Resources Agency and the Director of the Environmental Health Bureau. A determination of a Long-Term Sustainable Water Supply shall be made upon the advice of the General Manager of the Water Resources Agency. The following factors shall be used in developing the criteria for proof of a long-term sustainable water supply and an adequate water supply system: [see Plan for list]
	PS-3.3	Specific criteria shall be developed by ordinance for use in the evaluation and approval of adequacy of all domestic wells. The following factors shall be used in developing criteria for both water quality and quantity including, but not limited to: [see Plan for list]
	PS-3.4	The County shall request an assessment of impacts on adjacent wells and instream flows for new high-capacity wells, including high-capacity urban and agricultural production wells, where there may be a potential to affect existing adjacent domestic or water system wells adversely or in-stream flows, as determined by the Monterey County Water Resources Agency. In the case of new high-capacity wells for which an assessment shows the potential for significant adverse well interference, the County shall require that the proposed well site be relocated or otherwise mitigated to avoid significant interference. The following factors shall be used in developing criteria by ordinance for use in the evaluation and approval of adequacy of all such high-capacity wells, including but not limited to: a) Effect on wells in the immediate vicinity as required by the Monterey County Water Resources Agency or Environmental Health Bureau. b) Effects of additional extractions or diversion of water on in-stream flows necessary to support riparian vegetation, wetlands, fish, and other aquatic life including migration potential for steelhead, for the purpose of minimizing impacts to those resources and species. This policy is not intended to apply to replacement wells.
	PS-3.5	The Monterey County Health Department shall not allow construction of any new wells in known areas of saltwater intrusion as identified by Monterey County Water Resources Agency or other applicable water management agencies: a) Until such time as a program has been approved and funded that will minimize or avoid expansion of salt water intrusion into useable groundwater supplies in that area; or b) Unless approved by the applicable water resource agency. This policy shall not apply to deepening or replacement of existing wells, or wells used in conjunction with a desalination project.
	PS-3.6	The County shall coordinate and collaborate with all agencies responsible for the management of existing and new water resources.

Element		Goal / Policy
	PS-3.7	A program to eliminate overdraft of water basins shall be developed as part of the Capital Improvement and Financing Plan (CIFP) for this Plan using a variety of strategies, which may include but are not limited to: a) Water banking; b) Groundwater and aquifer recharge and recovery; c) Desalination; d) Pipelines to new supplies; and/or e) A variety of conjunctive use techniques. The CIFP shall be reviewed every five years in order to evaluate the effectiveness of meeting the strategies noted in this policy. Areas identified to be at or near overdraft shall be a high priority for funding.
	PS-3.8	Developments that use gray water and cisterns for multi-family residential and commercial landscaping shall be encouraged, subject to a discretionary permit.
	PS-3.9	A tentative subdivision map and/or vesting tentative subdivision map application for either a standard or minor subdivision shall not be approved until the applicant provides evidence of a long-term sustainable water supply in terms of yield and quality for all lots that are to be created through subdivision.
	PS-3.10	In order to maximize agricultural water conservation measures to improve water use efficiency and reduce overall water demand, the County shall establish an ordinance identifying conservation measures that reduce agricultural water demand.
	PS-3.11	In order to maximize urban water conservation measures to improve water use efficiency and reduce overall water demand, the County shall establish an ordinance identifying conservation measures that reduce potable water demand
	PS-3.12	The County shall maximize the use of recycled water as a potable water offset to manage water demands and meet regulatory requirements for wastewater discharge, by employing strategies including, but not limited to, the following: a) Increase the use of treated water where the quality of recycled water is maintained, meets all applicable regulatory standards, is appropriate for the intended use, and re-use will not significantly impact beneficial uses of other water resources. b) Work with the agricultural community to develop new uses for tertiary recycled water and increase the use of tertiary recycled water for irrigation of lands currently being irrigated by groundwater pumping. c) Work with urban water providers to emphasize use of tertiary recycled water for irrigation of parks, playfields, schools, golf courses, and other landscape areas to reduce potable water demand. d) d. Work with urban water providers to convert existing potable water customers to tertiary recycled water as infrastructure and water supply become available.
	PS-3.13	To ensure accuracy and consistency in the evaluation of water supply availability, the Monterey County Health Department, in coordination with the MCWRA, shall develop guidelines and procedures for conducting water supply assessments and determining water availability. Adequate availability and provision of water supply, treatment, and conveyance facilities shall be assured to the satisfaction of the County prior to approval of final subdivision maps or any changes in the General Plan Land Use or Zoning designations.
	PS-3.14	The County will participate in regional coalitions for the purpose of identifying and supporting a variety of new water supply projects, water management programs, and multiple agency agreements that will provide additional domestic water supplies for the Monterey Peninsula and Seaside basin, while continuing to protect the Salinas and Pajaro River groundwater basins from saltwater intrusion. The County will also participate in

Element		Goal / Policy
		regional groups including representatives of the Pajaro Valley Water Management Agency and the County of Santa Cruz to identify and support a variety of new water supply, water management and multiple agency agreement that will provide additional domestic water supplies for the Pajaro Groundwater Basin. The County's general objective, while recognizing that timeframes will be dependent on the dynamics of each of the regional groups, will be to complete the cooperative planning of these water supply alternatives within five years of the adoption of the General Plan and to implement the selected alternatives within five years after that time.
	PS-3.15	The County will pursue expansion of the Salinas Valley Water Project (SVWP) by investigating expansion of the capacity for the Salinas River water storage and distribution system. This shall also include, but not be limited to, investigations of expanded conjunctive use, use of recycled water for groundwater recharge and seawater intrusion barrier, and changes in operations of the reservoirs. The County's overall objective is to have an expansion planned and in service by the date that the extractions from the Salinas Valley groundwater basin are predicted to reach the levels estimated for 2030 in the EIR for the Salinas Valley Water Project. The County shall review these extraction data trends at five-year intervals. The County shall also assess the degree to which the Salinas Valley Groundwater Basin (Zone 2C) has responded with respect to water supply and the reversal of seawater intrusion based upon the modeling protocol utilized in the Salinas Valley Water Project EIR. If the examination indicates that the growth in extractions predicted for 2030 are likely to be attained within ten years of the date of the review, or the groundwater basin has not responded with respect to water supply and reversal of seawater intrusion as predicted by the model, then the County shall convene and coordinate a working group made up of the Salinas Valley cities, the MCWRA, and other affected entities. The purpose will be to identify new water supply projects, water management programs, and multiple agency agreements that will provide additional domestic water supplies for the Salinas Valley. These may include, but not be limited to, expanded conjunctive use programs, further improvements to the upriver reservoirs, additional pipelines to provide more efficient distribution, and expanded use of recycled water to reinforce the hydraulic barrier against seawater intrusion. The county's objective will be to complete the cooperative planning of these water supply alternatives within five years and to have the projects on-line five years following identification of water supply alternatives.

The Monterey County General Plan does not include population projections; however, the Association of Monterey Bay Area Governments (AMBAG) has developed population projections through 2050, as shown in Table 3-4.

Table 3-4. Monterey County Population Projections
(AMBAG, 2018)

Geography	2015	2020	2025	2030	2035	2040	Change 2015-2040	
							Numeric	Percent
AMBAG Region	**762,676**	**791,600**	**816,900**	**840,100**	**862,200**	**883,300**	**120,624**	**16%**
Monterey County	**432,637**	**448,211**	**462,678**	**476,588**	**489,451**	**501,751**	**69,114**	**16%**
Carmel-By-The-Sea	3,824	3,833	3,843	3,857	3,869	3,876	52	1%
Del Rey Oaks	1,655	1,949	2,268	2,591	2,835	2,987	1,332	80%
Gonzales	8,411	8,827	10,592	13,006	15,942	18,756	10,345	123%
Greenfield	16,947	18,192	19,425	20,424	21,362	22,327	5,380	32%
King City	14,008	14,957	15,574	15,806	15,959	16,063	2,055	15%
Marina	20,496	23,470	26,188	28,515	29,554	30,510	10,014	49%
Marina balance	19,476	20,957	22,205	22,957	23,621	24,202	4,726	24%
CSUMB (portion)	1,020	2,513	3,983	5,558	5,933	6,308	5,288	518%
Monterey	28,576	28,726	29,328	29,881	30,460	30,976	2,400	8%
Monterey balance	24,572	24,722	25,324	25,877	26,456	26,972	2,400	10%
DLI & Naval Postgrad	4,004	4,004	4,004	4,004	4,004	4,004	0	0%
Pacific Grove	15,251	15,349	15,468	15,598	15,808	16,138	887	6%
Salinas	159,486	166,303	170,824	175,442	180,072	184,599	25,113	16%
Sand City	376	544	710	891	1,190	1,494	1,118	297%
Seaside	34,185	34,301	35,242	36,285	37,056	37,802	3,617	11%
Seaside balance	26,799	27,003	27,264	27,632	28,078	28,529	1,730	6%
Fort Ord (portion)	4,450	4,290	4,340	4,490	4,690	4,860	410	9%
CSUMB (portion)	2,936	3,008	3,638	4,163	4,288	4,413	1,477	86%
Soledad	24,809	26,399	27,534	28,285	29,021	29,805	4,996	20%
Soledad balance	16,510	18,100	19,235	19,986	20,722	21,506	4,996	30%
SVSP & CTF	8,299	8,299	8,299	8,299	8,299	8,299	0	0%
Balance Of County	104,613	105,361	105,682	106,007	106,323	106,418	1,805	2%
San Benito County	**56,445**	**62,242**	**66,522**	**69,274**	**72,064**	**74,668**	**18,223**	**32%**
Hollister	36,291	39,862	41,685	43,247	44,747	46,222	9,931	27%
San Juan Bautista	1,846	2,020	2,092	2,148	2,201	2,251	405	22%
Balance Of County	18,308	20,360	22,745	23,879	25,116	26,195	7,887	43%
Santa Cruz County	**273,594**	**281,147**	**287,700**	**294,238**	**300,685**	**306,881**	**33,287**	**12%**
Capitola	10,087	10,194	10,312	10,451	10,622	10,809	722	7%
Santa Cruz	63,830	68,381	72,091	75,571	79,027	82,266	18,436	29%
Santa Cruz balance	46,554	49,331	51,091	52,571	54,027	55,266	8,712	19%
UCSC	17,276	19,050	21,000	23,000	25,000	27,000	9,724	56%
Scotts Valley	12,073	12,145	12,214	12,282	12,348	12,418	345	3%
Watsonville	52,562	53,536	55,187	56,829	58,332	59,743	7,181	14%
Balance Of County	135,042	136,891	137,896	139,105	140,356	141,645	6,603	5%

Sources: Data for 2015 are from the U.S. Census Bureau and California Department of Finance. Forecast years were prepared by AMBAG and PRB.

3.10.2 City of Salinas General Plan

The Land Use and Conservation/Open Space Elements of the City of Salinas General Plan (City of Salinas, 2002) are relevant to water-resources within the 180/400-Foot Aquifer Subbasin, and are summarized in Table 3-5.

Table 3-5. City of Salinas General Plan Summary
(City of Salinas, 2002)

Element	Goal / Policy	
Land Use	Goal LU-6	Work with water suppliers and distributors such as Cal Water and Alco to continue to provide quality water supply and treatment capacity to meet community needs.
	Policy LU-6.1	Actively work with Cal Water and Alco, as well as regional water suppliers and distributors, to ensure that high quality water is available for the community.
	Policy LU-6.2	Review development proposals to ensure that adequate water supplies, treatment, and distribution capacity is available to meet the needs of the development without negatively impacting the existing community,
	Policy LU-6.3	Participate in and support regional programs and projects that target the improvement and conservation of the region's groundwater and surface water supply.
	Policy LU-6.4	Actively promote water conservation by City residents, businesses, and surrounding agricultural producers.
	Policy LU-6.5	Review projects subject, such as residential projects with 500 or more units, for compliance with Section 10910-10915 of the California Water Code.
Conservation	Goal COS-1	Provide a safe and adequate water supply for community uses.
	Policy COS-1.1	Work with regional and local water providers to ensure that adequate supplies of water are available to meet existing and future demand.
	Policy COS-1.2	Cooperate with local, regional, and state water agencies to develop new water sources.
	Policy COS-1.3	Work with local and regional water providers to increase the production, distribution, and use of recycled water,
	Policy COS-1.4	Maintain and restore natural watersheds to recharge the aquifers and ensure the viability of the ground water resources.
	Policy COS-1.5	Cooperate with the Monterey County Water Resources Agency, the State Water Resources Control Board and the Regional Water Quality Control Board to implement programs that address the two primary causes of poor water quality in the planning area: salt water intrusion and nitrate contamination.
	Policy COS-1.6	Enforce national (NPDES) requirements and participate in regional efforts to protect and enhance water quality.
	Goal COS-2	Encourage the conservation of water resources.
	Policy COS-2.1	Participate in and implement local and regional programs that promote water conservation.
	Policy COS-2.2	Work with water providers to institute conservation programs to address water supply problems caused by groundwater overdrafting,
	Policy COS-2.3	Apply standards that promote water conservation in agricultural, residential and non-residential uses.
	Policy COS-2.4	Enforce the City's Water Conservation Ordinance.

3.10.3 City of Gonzales General Plan

Relevant elements of the City of Gonzales General Plan are summarized in Table 3-6.

Table 3-6. City of Gonzales General Plan Summary
(City of Gonzales, 2011)

Element	Goal / Policy	
Land Use	LU-1.2.2	New developments must have adequate water supplies.
	LU-8.3.1:	Modify proposed designs for industrial development to reduce adverse environmental impacts, particularly noise, air, and water pollution, odor, soil, and groundwater contamination, traffic, and visual blight to the degree practicable.
	LU-8.3.2	Plan for Sewer and Water Expansion. Ensure that adequate water and sewer capacity is available to support all areas designated for industrial development
Housing	HE-9.2	Promote Water Conservation. Promote the use of water-saving devices, drought-tolerant landscaping, and other water conservation measures to achieve a reduction in home water bills for residential customers
	HE-9.4.1	Water Conservation. The City will continue to promote ways to reduce monthly home water bills. Such measures already include: (a) requiring new houses to utilize low-flow toilets, low-flow shower heads, and low flow faucets consistent with the requirements of the Monterey County Water Resources Agency, and (b) requiring the use of drought-tolerant landscaping within new developments (as specified in the State Model Landscape Ordinance). The City will also support new water retrofitting programs undertaken by the Monterey County Water Resources Agency, such as providing free low-flow plumbing fixtures to existing customers in Gonzales. Responsibility: Building Department, Public Works Department, Planning Department Timing: Ongoing
Community Health and Safety	Community Health and Safety Element, Paragraph H Water Quality	Groundwater and surface water quality both affect the health of Gonzales residents. Because groundwater is the sole source of domestic water in Gonzales, a healthful supply is essential to the city's future. Surface water pollution creates negative aesthetic and environmental impacts, as well as creating potential health hazards locally and downstream. The Community Health and Safety Element includes policies to reduce the extent of water pollution that could occur from urban development in Gonzales, as well as policies to minimize potential risks if contamination does occur. The groundwater beneath Gonzales is vulnerable to contamination from lawn fertilizer, leaking underground storage tanks, failing septic systems, animal waste, and naturally occurring minerals. High nitrate levels are a persistent problem in the Salinas Valley, with about half of the 58 wells sampled exceeding the State water standard over a testing period of about 30 years. Nitrate problems around Gonzales are most prevalent on the northeast side of the Planning Area, where former greenhouse and dairy operations and the existing feed lot are probably the primary contaminant sources. Elsewhere in the Planning Area, groundwater quality is generally acceptable and meets all water quality standards. The Gonzales Public Works Department conducts regular measurements of water quality for city wells and takes corrective actions if nitrate levels exceed acceptable standards. In the past, well water quality problems have been addressed with special seals which block nitrates from entering the water supply. If activities and land uses around the wells are not properly managed in the future, contamination could result. This would require that wells be relocated or that well-head treatment be introduced.

3.10.4 City of Marina General Plan

The City of Marina General Plan (City of Marina, 2010) recognizes that future water demands will require changes in the management of water resources in the area. The City of Marina's 2020 water demand is projected to be 7,720 AF/yr. The General Plan includes the following measures related to water-supply planning.

- New developments must have identified water sources. [General Plan Section 3.45]
- A 15-percent reserve will be maintained between demand and supply. When demand exceeds 85% of the available supply, no new development will be allowed until supplemental water sources are identified. [General Plan Section 3.47].

3.10.5 Well Permitting

The Public Service element of the Monterey County General Plan addresses permitting of individual wells in rural or suburban areas. New residential or commercial lots in rural or suburban areas with limited utility services must be a minimum area of 2.5 acres if a well is the water source. Existing lots (of any size) can use an on-site well if they are outside of a water system service area. Existing lots within an established water system service area can use wells if they are greater than 2.5 acres or have a connection to a public sewage system. Table 3-7 summarizes the Monterey County General Plan's water supply guidelines for new lots (Monterey County, 2010, Table PS-1). Table 3-8 depicts the decision matrix from the Monterey County General Plan for permitting new wells for existing lots (Monterey County, 2010, Table PS-2).

On August 29, 2018, the State Third Appellate District Court of Appeal published an opinion in *Environmental Law Foundation v. State Water Resources Control Board* (No. C083239), a case that has the potential to impact future permitting of wells near navigable surface waters to which they may be hydrologically connected. The Court of Appeal found that while groundwater itself is not protected by the public trust doctrine, the doctrine does protect navigable waters from harm caused by extraction of groundwater if it adversely affects public trust uses. Further, it found that the County (Siskiyou County in this case), as a subdivision of the State, shares responsibility for administering the public trust. Monterey County is responsible for well permitting. Therefore, it has a responsibility to consider the potential impacts of groundwater withdrawals on public trust resources when permitting wells near areas where groundwater may be interconnected with navigable surface waters.

Table 3-7. Monterey County Water Supply Guidelines for New Lots

Major Land Groups	Water Well Guidelines
Public Lands	Individual Wells Permitted in Areas with Proven Long-Term Water Supply
Agriculture Lands	Individual Wells Permitted in Areas with Proven Long-Term Water Supply
Rural Lands	Individual Wells Permitted in Areas with Proven Long-Term Water Supply
Rural Centers	Public System; Individual Wells Allowed in limited situations
Community Areas	Public System

Table 3-8. Monterey County Well Permitting Guidelines for Existing Lots

Characteristics of Property	Water Connection Existing or Available from the Water System	Not Within a Water System or a Water Connection Unavailable
Greater than or equal to 2.5 Acres connected to a Public Sewage System or an on-site wastewater treatment system	Process Water Well Permit	Process Water Well Permit
Less than 2.5 Acres and connected to a Public Sewage System	Process Water Well Permit	Process Water Well Permit
Less than 2.5 Acres and connected to an on-site wastewater treatment system	Do not Process Water Well Permit	Process Water Well Permit

3.10.6 Land Use Plans Outside of Basin

The Cities of Greenfield and Soledad have general plans with land use elements in the adjoining Forebay Aquifer Subbasin. Because Soledad is a member of the SVBGSA, management actions taken by the SVBGSA will be in alignment with the concerns and plans of that city. If a cooperation agreement is reached with the City of Greenfield, management action taken by the SVBGSA should likewise be in alignment with that City's concerns. Therefore, it is unlikely that these two land use plans will affect the ability of the SVBGSA to achieve sustainable groundwater management.

3.10.7 Effects of Land Use Plan Implementation on Water Demand

The GSA does not have authority over land use planning. However, the GSA will coordinate with the County on General Plans and land use planning/zoning as needed when implementing the GSP.

A lawsuit filed against the County of Monterey's general plan led to a settlement agreement that affects water supplies. The settlement agreement requires the County of Monterey to develop a study of a portion of the Basin's water supplies that includes, among other items:

- An assessment of whether the total water demand for all uses designated in the General Plan for the year 2030 are likely to be reached or exceeded
- An evaluation and conclusions regarding future expected trends in groundwater elevations
- An evaluation and conclusions regarding expected future trends in seawater intrusion

Should the study conclude that:

- Total water demand for all uses is likely to be exceeded by 2030, or
- Groundwater elevations are likely to decline by 2030, or
- The seawater intrusion boundary is likely to advance inland by 2030

Then the study shall make recommendations on how to address those conditions.

The outcomes from this study may affect the GSP implementation. However, the GSP assumes pumping will be limited to the sustainable yield through the measures laid out in Chapter 9. The study and GSP implementation are two parallel efforts, and the results of the County's study will be reviewed when finalized and considered during GSP implementation.

The settlement agreement furthermore required the USGS to develop the SVIHM that will be used during implementation of this GSP. The USGS is currently developing and working on the final calibration of this model and is planning to release it in spring 2020.

3.10.8 Effects of GSP Implementation on Water Supply Assumptions

Implementation of this GSP is not anticipated to affect water supply assumptions of relevant land use plans over the planning and implementation horizon. The water charges framework, one of the main implementation measures described in Chapter 9, will promote voluntary pumping reductions and impose a tiered pumping fee structure. Changes in the cost of groundwater may affect whether surface water or groundwater is used. Land use changes may occur as a result of these activities and based on financial decisions by individual growers. However, there is no direct impact from the GSP implementation on land use management.

4 HYDROGEOLOGIC CONCEPTUAL MODEL

4.1 Subbasin Setting

The 180/400-Foot Aquifer Subbasin is at the northern end of the Salinas Valley Groundwater Basin: an approximately 90-mile long alluvial basin underlying the elongated, intermountain valley of the Salinas River. The Subbasin is oriented southeast to northwest, with the Salinas River draining towards the northwest into the Pacific Ocean at Monterey Bay (Figure 4-1).

The Subbasin slopes at an average grade of approximately 5 feet/mile to the northwest. Elevations in the Subbasin range from approximately 500 feet along the Sierra de Salinas to sea level at Monterey Bay. The colored bands on Figure 4-1 shows the topography of the Subbasin, derived from the USGS Digital Elevation Model (DEM).

4.2 Subbasin Geology

The Subbasin was formed through periods of structural deformation and periods of marine and terrestrial sedimentation in a tectonically active area on the eastern edge of the Pacific Plate. Figure 4-2 presents a geologic map of the basin and vicinity, illustrating both the locations of faults and the geologic formations present at ground surface. This geologic map was adopted from the California Geologic Survey's 2010 statewide geologic map (Jennings, et al., 2010). The locations of cross sections used to define principal aquifers in Section 4.4 are also shown on Figure 4-2. The legend on Figure 4-2 presents the age sequence of the geologic materials from the youngest unconsolidated Quaternary sediments to the oldest pre-Cambrian basement rock.

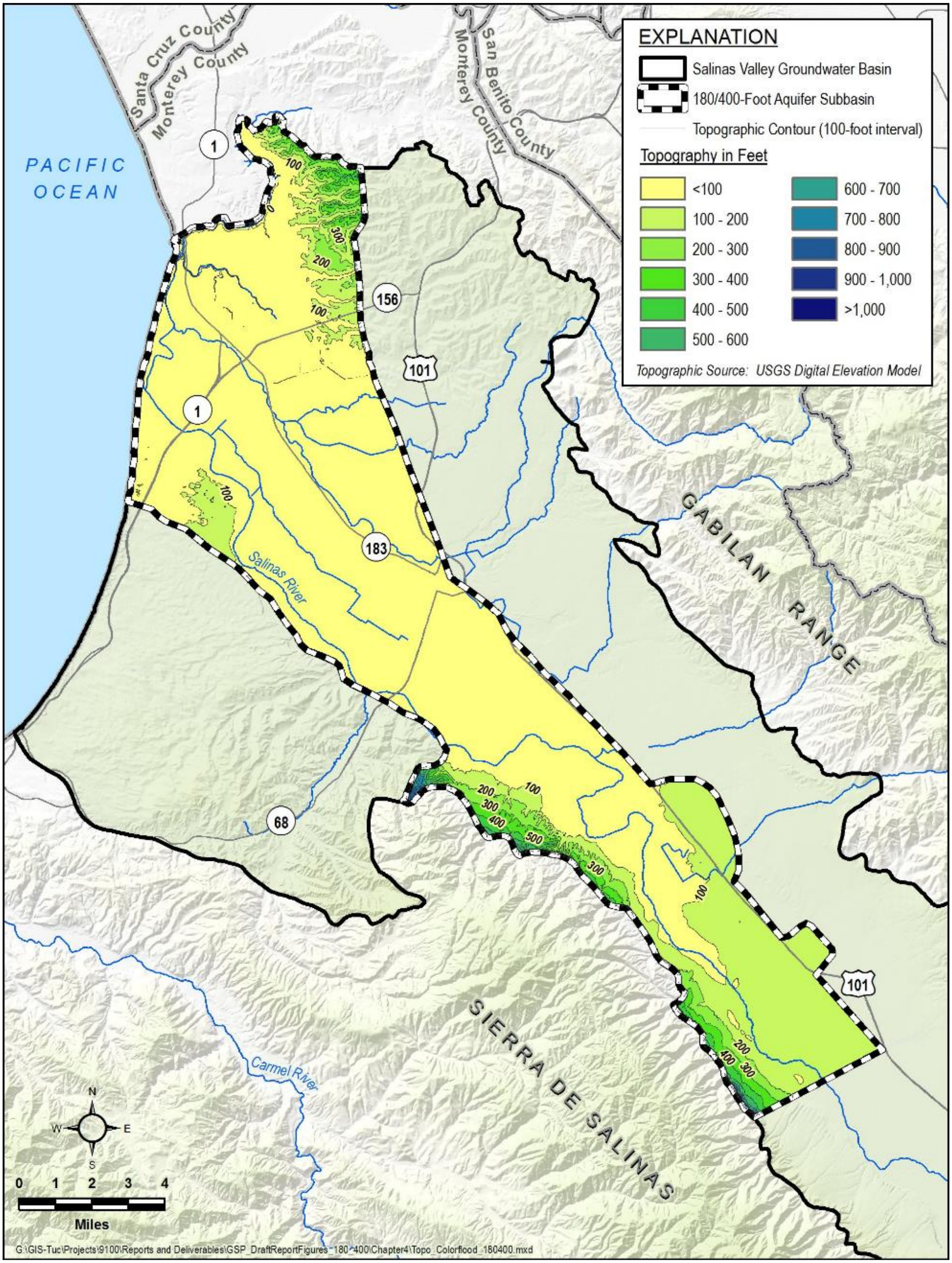


Figure 4-1. Salinas Valley Topography

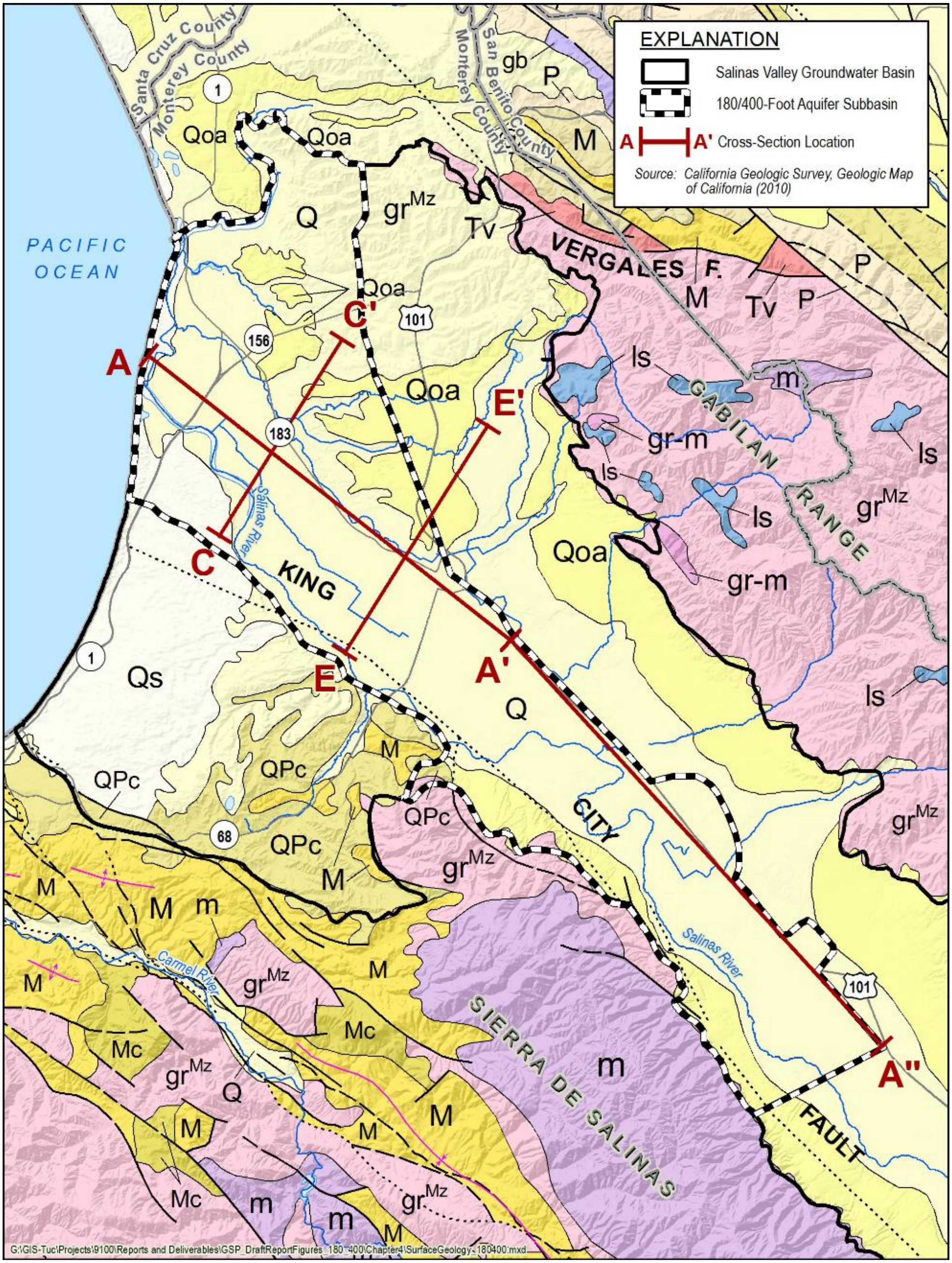


Figure 4-2. Subbasin Geology

FIGURE 4-2. EXPLANATION

QUATERNARY DEPOSITS

Qs	Extensive marine and nonmarine sand deposits, generally near the coast or desert playas
Q	Alluvium, lake, playa, and terrace deposits; unconsolidated and semi-consolidated
Qoa	Older alluvium, lake, playa, and terrace deposits
QPc	Pleistocene and/or Pliocene sandstone, shale, and gravel deposits, mostly loosely consolidated

TERTIARY SEDIMENTARY ROCKS

P	Pliocene marine sandstone, siltstone, shlae, and conglomerate, mostly moderately consolidated
M	Miocene marine sandstone, shale, siltstone, conglomerate, and breccia, moderately to well consolidated
Mc	Miocene nonmarine sandstone, shale, conglomerate, and fanglomerate, moderately to well consolidated
O	Oligocene marine sandstone, shale, and conglomerate, mostly well consolidated

TERTIARY VOLCANIC ROCKS

Tv	Tertiary volcanic flow rocks, minor pyroclastic deposits

MESOZOIC SEDIMENTARY AND METASEDIMENTARY ROCKS

ls	Limestone, dolomite, and marble whose age is uncertain but probably Paleozoic or Mesozoic

MESOZOIC MIXED ROCKS

gr-m	Mesozoic to Precambrian granitic and metamorphic rocks, mostly gneiss and other metamorphic rocks injected by granitic rocks

MESOZOIC PLUTONIC ROCKS

grMz	Mesozoic granite, quartz monzonite, granodiorite, and quartz diorite
gb	Gabbro and dark dioritic rocks, chiefly Mesozoic

PALEOZOIC MIXED ROCKS

m	Undivided pre-Cenozoic metasedimentary and metavolcanic rocks of great variety. Mostly slate, quartzite, hornfels, chert, phyllite, mylonite, schist gneiss, and minor marble

GEOLOGIC SYMBOLS

- fault, certain
- fault, approx. located
- fault, concealed
- normal fault, approx. located
- dextral fault, certain
- Plunging anticline, certain
- Syncline, certain

4.2.1 Geologic Formations

Major geologic units present in the 180/400-Foot Aquifer Subbasin are described below, starting at the surface and moving from youngest to oldest. The corresponding designation on Figure 4-2 is provided in parenthesis.

- *Alluvium (Qa)* – This Holocene unit predominately consists of unconsolidated layers of mixed sand, gravel, silt, and clay that were deposited in a fluvial environment by the Salinas River and its tributaries. In this Subbasin, this unit also includes extensive, laterally continuous clay layers that were deposited in a shallow marine to brackish-water estuarine environment during periods when sea level rise caused submergence of the northern portion of the basin (Durham, 1974). The estuarine clay deposits extend throughout most of the Subbasin and the hydrogeologic impact of these extensive clays is one of the defining characteristics of this Subbasin. This unit covers nearly the entire valley floor. The thickness is not well established because the Alluvium is difficult to distinguish from underlying units, but it is likely 100 to 300 feet thick along the axis of the valley (Durham, 1974).

  In some reports, the Alluvium is limited to the shallowest deposits overlying the first estuarine clay layer, and the remaining thickness of Alluvium is combined with the underlying Older Alluvium to form a unit called Valley Fill Deposits (e.g., Harding ESE 2001; Kennedy-Jenks, 2004). These alternative geologic descriptions have not been adopted in this GSP, and do not have a bearing on the identification of principal aquifers in this conceptual model.

- *Older Alluvium (Qoa)* – This Pleistocene unit comprises alternating, interconnected beds of fine-grained and coarse-grained deposits, predominately associated with alluvial fan depositional environments. The Older Alluvium underlies the Alluvium throughout the Subbasin but is not exposed at the ground surface. The alluvial fan deposits have an estimated maximum saturated thickness of 500 feet (Durham, 1974).

- *Aromas Sand (QPc)* – This Pleistocene unit is composed of cross-bedded sands containing some clayey layers (Harding ESE, 2001). This unit was deposited in a combination of eolian, high-energy alluvial, alluvial fan, and shoreline environments (Harding ESE, 2001; Greene, 1970; Dupre, 1990). The Aromas Sand Formation likely extends into the northern portion of the 180-400 Foot Aquifer Subbasin (MCWRA, 2017b).

- *Paso Robles Formation (Tc)* – This Pliocene to lower Pleistocene unit is composed of lenticular beds of sand, gravel, silt, and clay from terrestrial deposition (Thorup, 1976; Durbin, et al., 1978). The depositional environment is largely fluvial but also includes alluvial fan, lake and floodplain deposition (Durbin, 1974; Harding ESE, 2001; Thorup, 1976; Greene, 1970). The individual beds of fine and coarse materials typically have thicknesses of 20 to 60 feet (Durbin, et al., 1978). Durham (1974) reports that the thickness of the Formation is variable due to erosion of the upper part of the unit; and that the Formation is approximately 1,500 feet thick near Spreckels and 1,000 feet thick near the City of Salinas. The Paso Robles Formation underlies the entire Subbasin but is rarely exposed at the surface. Through most of the Subbasin, this is the deepest unit and the underlying marine deposits typically do not yield high rates of fresh water.

- *Purisima Formation (P)* – This Pliocene unit consists of interbedded siltstone, sandstone, conglomerate, clay and shale deposited in a shallow marine environment (Greene, 1977; Harding ESE, 2001). The Purisima Formation is ranges from 500 to 1,000 feet in thickness (WRIME, 2003). It underlies most of the Subbasin.

- *Santa Margarita Sandstone and Monterey Formation (M)* – Two Miocene units generally underlie the Subbasin. The Santa Margarita Formation is a friable arkosic sandstone. The Monterey Formation is a shale or mudstone deposited in a shallow marine environment (Harding ESE, 2001; Greene, 1977). In some areas, the Santa Margarita Sandstone directly underlies the Paso Robles Formation where the Purisima Formation is absent (Greene, 1977).

4.2.2 Structural Restrictions to Flow

There are no known structural features such as faults or anticlines that restrict groundwater flow in the 180/400-Foot Aquifer Subbasin.

4.2.3 Soils

The soils of the Subbasin are derived from the underlying geologic formations and influenced by the historical and current patterns of climate and hydrology. Soil types can influence groundwater recharge and the placement of recharge projects. Productive agriculture in the Subbasin is supported by deep, dark, fertile soils. The arable soils of the Subbasin historically were classified into four groups (Carpenter and Cosby 1925): residual soils, old valley-filling soils, young valley-filling soils, and recent-alluvial soils. In addition, five classes of miscellaneous soils were mapped that included tidal marsh, peat, coastal beach, and dune sands.

More recent surveys classify the soils into categories based on detailed soil taxonomy (U.S. Department of Agriculture, 2019). Figure 4-3 is a composite soil map of soils in the Subbasin from the USDA Natural Resources Conservation Service (NRCS) and the Gridded Soil Survey Geographic (gSSURGO) Database that is produced by the National Cooperative Soil Survey (NCSS).

The Subbasin is dominated by four soil orders: mollisols, entisols, vertisols, and alfisols.

- Mollisols are the most widespread soil order in the Salinas Valley Groundwater Basin. Mollisols are characterized by a dark surface horizon, indicative of high organic content. The organic content often originates from roots of surficial grasses or similar vegetation. They are highly fertile and often alkaline rich. Mollisols can have any moisture regime, but enough available moisture to support perennial grasses is typical.

- Entisols are the predominant soil order along the river corridor. Entisols are mineral soils without distinct soil horizons because they have not been in place long enough for distinct horizons to develop. These soils are often found in areas of recent deposition such as active flood plains, river basins, and areas prone to landslides. Nearly all the soils along active river corridor are entisols.

- Vertisols are present over large areas on the valley lowlands in the central and northern Salinas Valley Groundwater Basin. Vertisols are predominantly clayey soils with high shrink-swell potential. Vertisols are present in climates that have distinct wet and dry seasons. During the dry season these soils commonly have deep, wide cracks. During the wet season these soils trend to have water pooling on the surface due to the high clay content.

- Alfisols are present along portions of the margin of the management area. Alfisols are known to have natural fertility both from clay acumination in the subsurface horizons and from leaf litter when under forested conditions. This order of soils is commonly associated with high base minerals such as calcium, magnesium, sodium, and potassium.

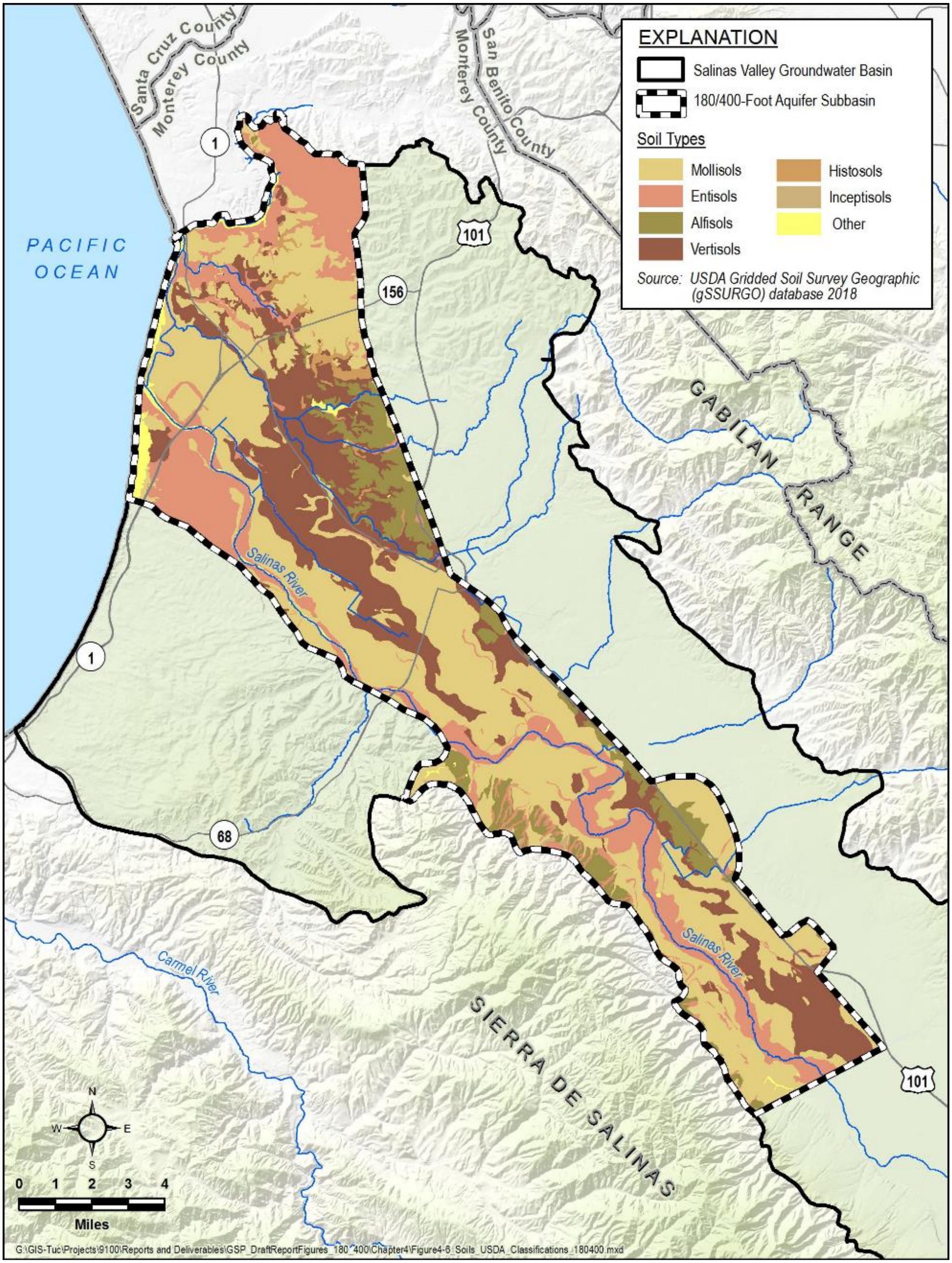


Figure 4-3. Composite Soils Map

4.3 Subbasin Extent

The 180/400-Foot Aquifer Subbasin extents are defined by the California Department of Water Resources (DWR) and are documented in Bulletin 118, (DWR, 2003; DWR, 2016a). Figure 1-1 illustrates the extent of the Subbasin.

4.3.1 Lateral Subbasin Boundaries

The 180/400-Foot Aquifer Subbasin is bounded by a combination of subbasin boundaries and physical boundaries of the Salinas Valley Grounwater Basin, all shown on Figure 1-1.

4.3.1.1 Boundaries with Adjacent Subbasins

The 180/400-Foot Aquifer Subbasin abuts four other subbasins of the Salinas Valley Groundwater Basin.

- **The Forebay Subbasin**. The southeastern boundary with the adjacent Forebay Subbasin is approximately located near the southern limit of the regional clay layers that are characteristic of the 180/400-Foot Aquifer Subbasin. Previous studies of groundwater flow across this boundary indicate there is is reasonable hydraulic connectivity with the Forebay Subbasin, although the principal aquifers change from relatively unconfined to confined near this boundary.
- **The Eastside Subbasin**. The northeastern boundary with the adjacent Eastside Subbasin generally follows the trace of Highway 101 and coincides with the northeastern limit of confining conditions in the 180/400-Foot Aquifer Subbasin. An analysis of stratigraphic correlations concluded that there is a change in the depositional facies near this boundary, with tributary alluvial fan deposits on the east side of the boundary and Salinas River fluvial deposits on the west side of the boundary (Kennedy-Jenks, 2004). Previous studies of groundwater flow across this boundary indicate that there is restricted hydraulic connectivity between the subbasins.
- **The Langley Subbasin.** The boundary with the Langley Subbasin is based on a topographic change from the valley floor to an elevated foothill area. This boundary generally coincides with the northeastern limit of confining conditions in the 180/400-Foot Aquifer Subbasin. Although the Langley Subbasin is not on the valley floor, there are no reported hydraulic barriers separating these two subbasins.
- **The Monterey Subbasin**. The boundary with the Monterey Subbasin is based on topographic rise that coincides with a buried trace of the King City-Reliz fault. This fault may act as a groundwater flow barrier between subbasins beneath a cover of Holocene sand dunes (Durbin, et al., 1978). Although a groundwater divide is commonly found

near the Subbasin boundary, there is potential for groundwater flow between these two subbasins.

4.3.1.2 Physical Basin Boundaries

Physical basin boundaries surrounding the 180/400-Foot Aquifer Subbasin include:

- **The Monterey Bay shoreline**. The northern Subbasin boundary is defined by the Monterey Bay shoreline. The Subbasin aquifers extend across this boundary into the subsurface underlying Monterey Bay and there are no hydrogeologic barriers limiting groundwater flow across this coastal boundary.
- **Elkhorn Slough**. The northern boundary of the Subbasin follows the current course of Elkhorn Slough; corresponding to a paleo-drainage of the Salinas River (DWR, 2003). Elkhorn Slough separates the 180/400-Foot Aquifer Subbasin from the Pajaro Valley Groundwater Basin. This paleo-drainage is a 400-Foot deep, buried, clay-filled boundary that limits groundwater flow between these basins (Durbin, et al., 1978).
- **The Sierra de Salinas**. The southwest extension of the King City fault corresponds to the contact between the Quaternary deposits and the low-permeability granitic and metamorphic basement rock of the Sierra de Salinas. This geologic contact creates a groundwater flow barrier and the southwestern hydrogeologic boundary of the Subbasin.

4.3.2 Vertical Subbasin Boundaries

Investigators have estimated the sedimentary sequence in the Salinas Valley Groundwater Basin to be between 10,000 to 15,000 feet thick. However, productive fresh water principal aquifers occur only at shallower depths, with the effective thickness of the groundwater Subbasin being approximately 1,500 feet. With increasing depth, two factors limit the viability of the sediments as productive, principal aquifers:

1. Deeper strata show increased consolidation and cementation of the sediments, which decreases aquifer yields; and
2. Deeper strata contain poor-quality brackish water unsuitable for most uses.

Because these factors gradually change with depth, there is not a sharp well-defined base to the Subbasin. The SVBGSA has adopted the base of the aquifer defined by the USGS (Durbin, et al., 1978) and extrapolated that surface to the edges of the Subbasin. Figure 4-4 shows a map of elevation contours of the base of the Subbasin. Figure 4-5 shows a contour map of depth to base of the Subbasin based on the base elevation and ground surface elevation.

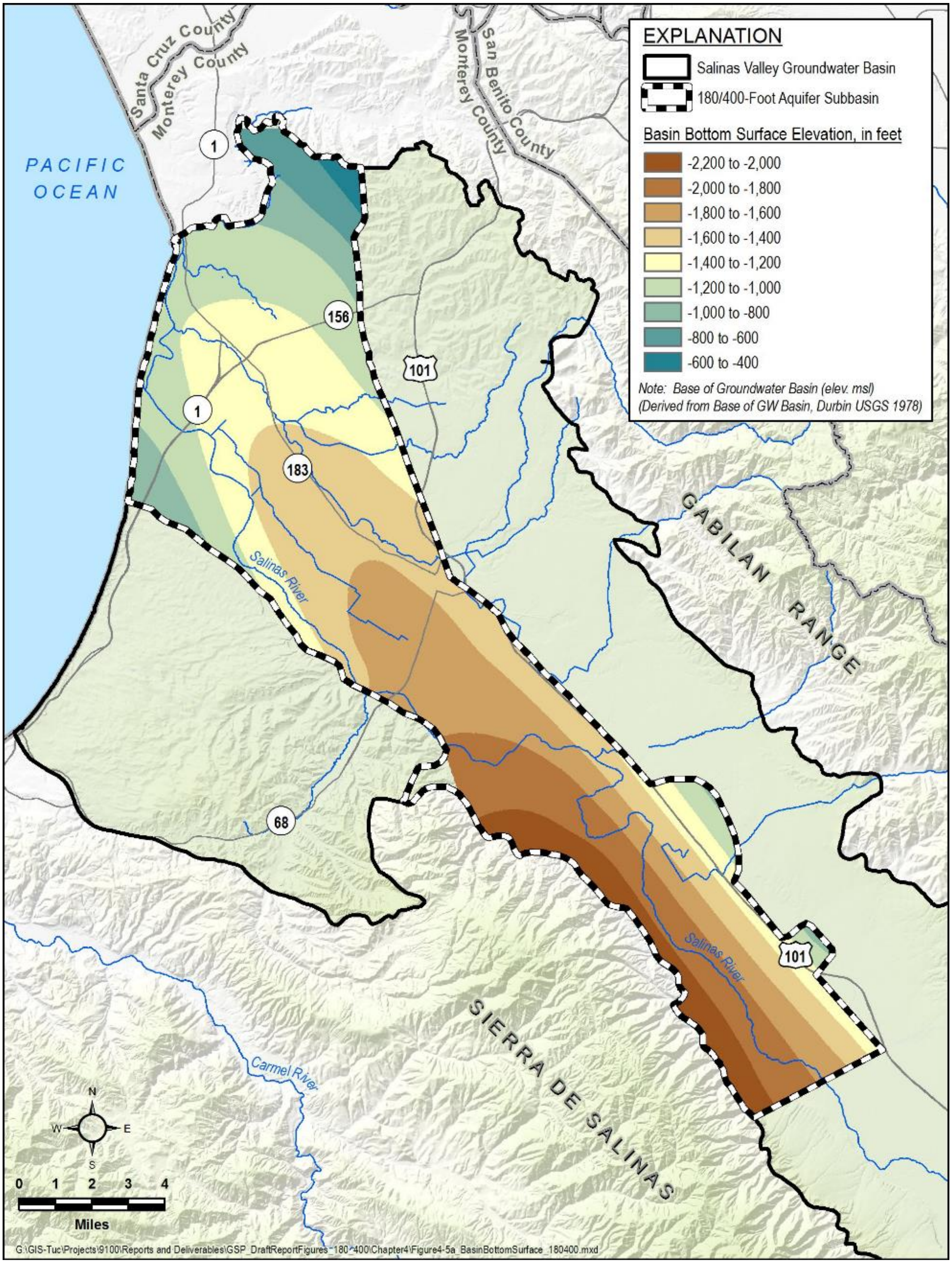


Figure 4-4. Elevation of the Base of the 180/400-Foot Aquifer Subbasin

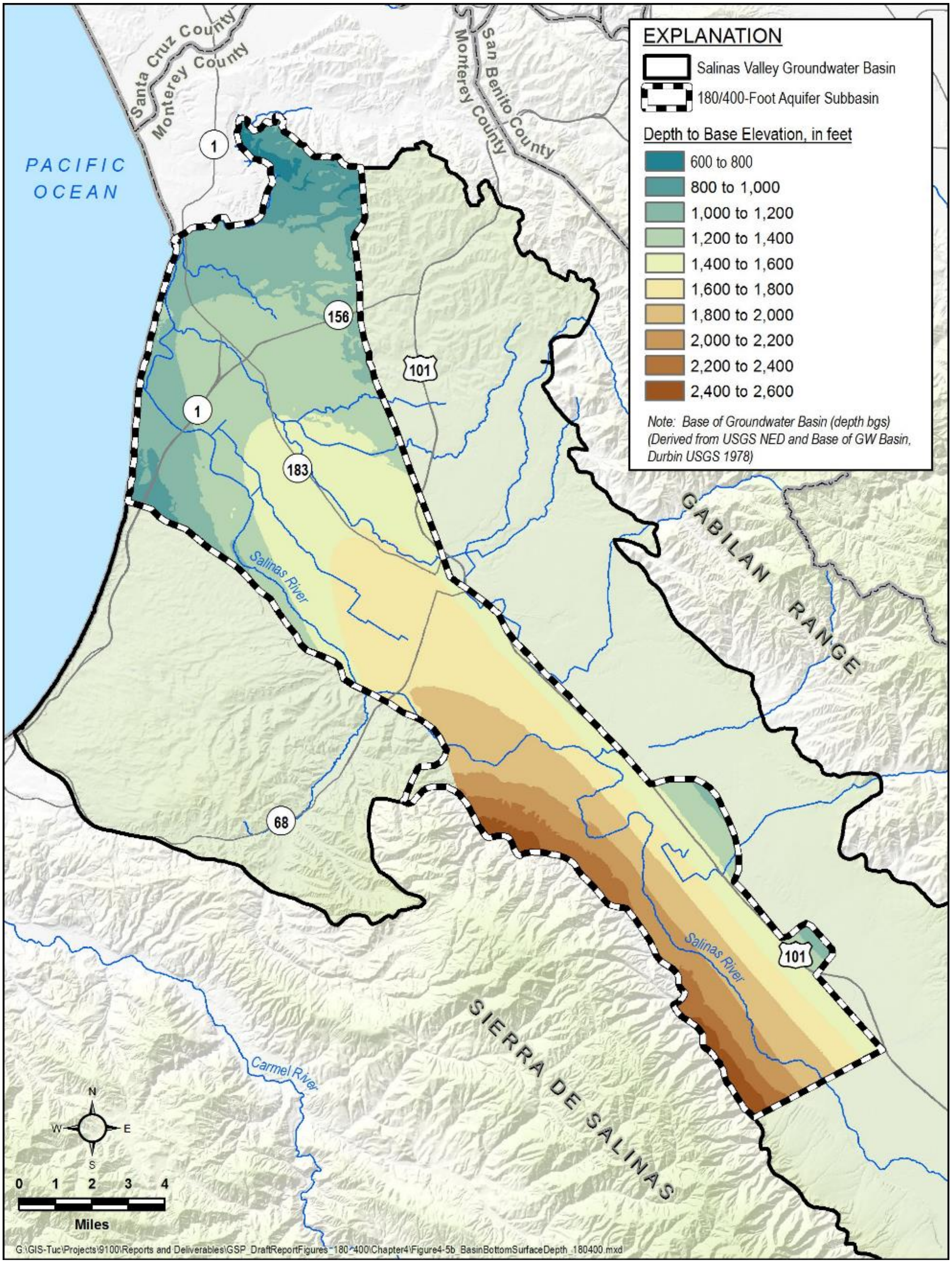


Figure 4-5. Depth Below Ground Surface of the Base of the 180/400-Foot Aquifer Subbasin

4.4 Subbasin Hydrogeology

Groundwater in the 180/400-Foot Aquifer Subbasin is primarily produced from alluvial deposits belonging to three geologic units: the Holocene Alluvium, the Quaternary Older Alluvium, and the Pliocene Paso Robles Formation described above. Although these three geologic formations differ in age, they have similar distributions of sediment type and layering; and in practice it is difficult to distinguish between these formations during borehole drilling. For purposes of groundwater development in the Subbasin, these geologic units are collectively referred to as alluvium. The principal aquifers and aquitards have been historically identified and recognized based not on geologic characteristics, but rather on their depth, influence on groundwater production, groundwater elevations, and groundwater quality.

Groundwater can be found in most of the sedimentary units described above. However, not all groundwater is part of a principal aquifer, which is defined in SGMA as "…aquifers or aquifer systems that store, transmit, and yield significant or economic quantities of groundwater to wells, springs, or surface water systems" (CCR, 2016). All of the groundwater encountered is a part of the overall groundwater system, but the focus of this GSP is on the principal aquifers.

The most recent, detailed hydrostratigraphic analysis of the 180/400-Foot Aquifer Subbasin was published in 2004 with an update in 2015 (Kennedy-Jenks, 2004; Brown and Caldwell, 2015). Three cross-sections parallel and perpendicular to the long axis of the Subbasin are shown on Figure 4-6, Figure 4-7, and Figure 4-8. The cross-section on Figure 4-6 is adopted from the *State of the Salinas River Groundwater Basin* report (Brown and Caldwell, 2015). The cross-sections on Figure 4-7 and Figure 4-8 are adapted from the *Final report, hydrostratigraphic analysis of the Northern Salinas Valley* (Kennedy-Jenks, 2004). The locations of these cross-sections are depicted on Figure 4-2. The hydrogeologic cross-sections are based on geologic logs provided in California Department of Water Resources Water Well Drillers Reports filed by the well drillers. Geologic log descriptions were grouped into generalized sedimentary groups:

- Fine-grained sediments (e.g., clay, silt, sandy clay, and gravelly clay) are shown as aquitards;
- Coarse-grained sediments (e.g., sand, gravel, and sand-gravel mixtures) are shown as aquifers; and
- Sediments logged as gravel/clay, sand/clay, and sand/gravel/clay are interpreted to consist of interbedded coarse-grained and fine-grained deposits and are included with aquifer materials.

In some cases, the logs may be old, the depth resolution poor, or the lithologic distinction suspect, and therefore the lithology shown on the well logs should not be viewed as precise (Kennedy-Jenks, 2004).

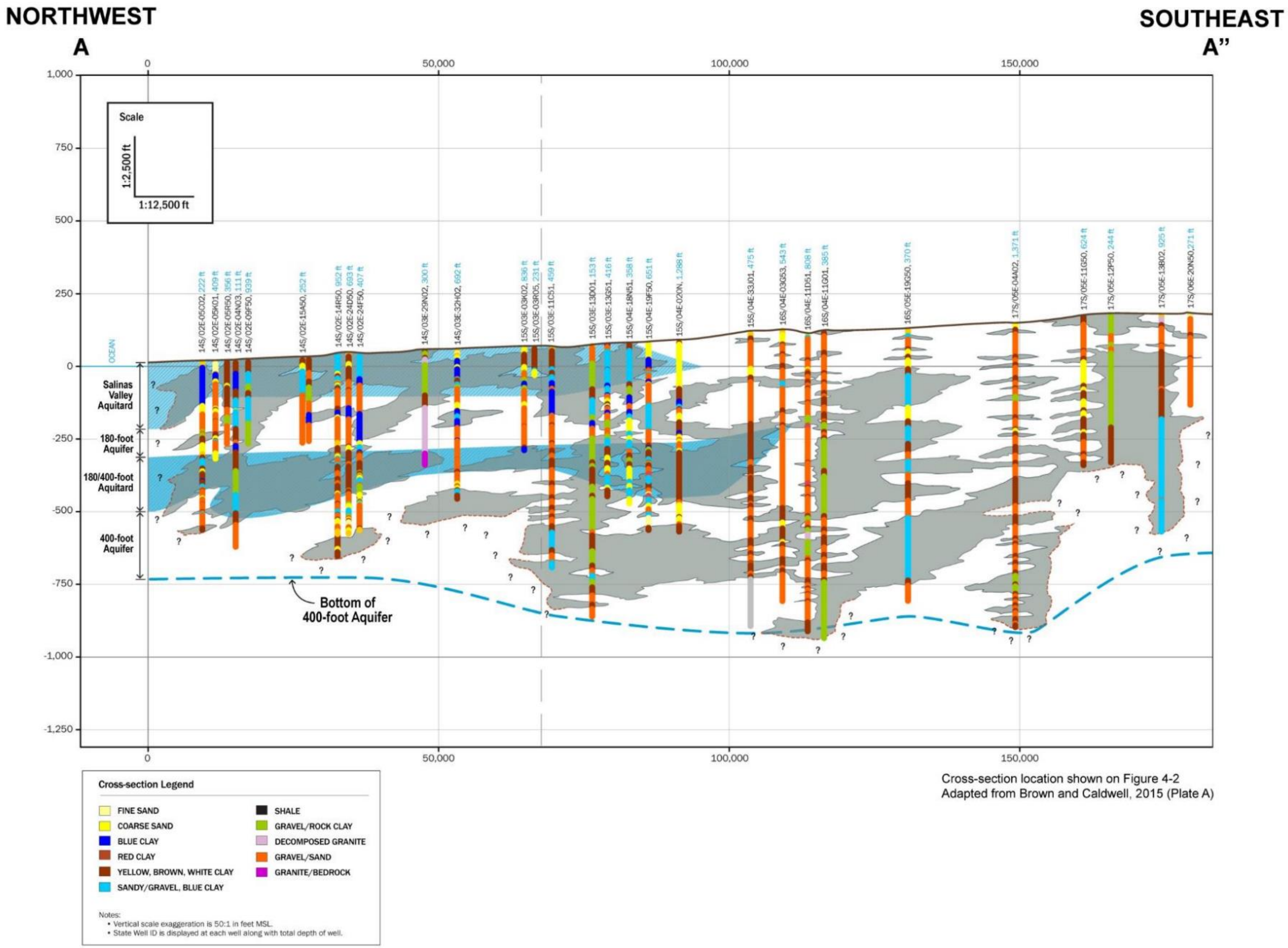


Figure 4-6. Cross-Section A-A'

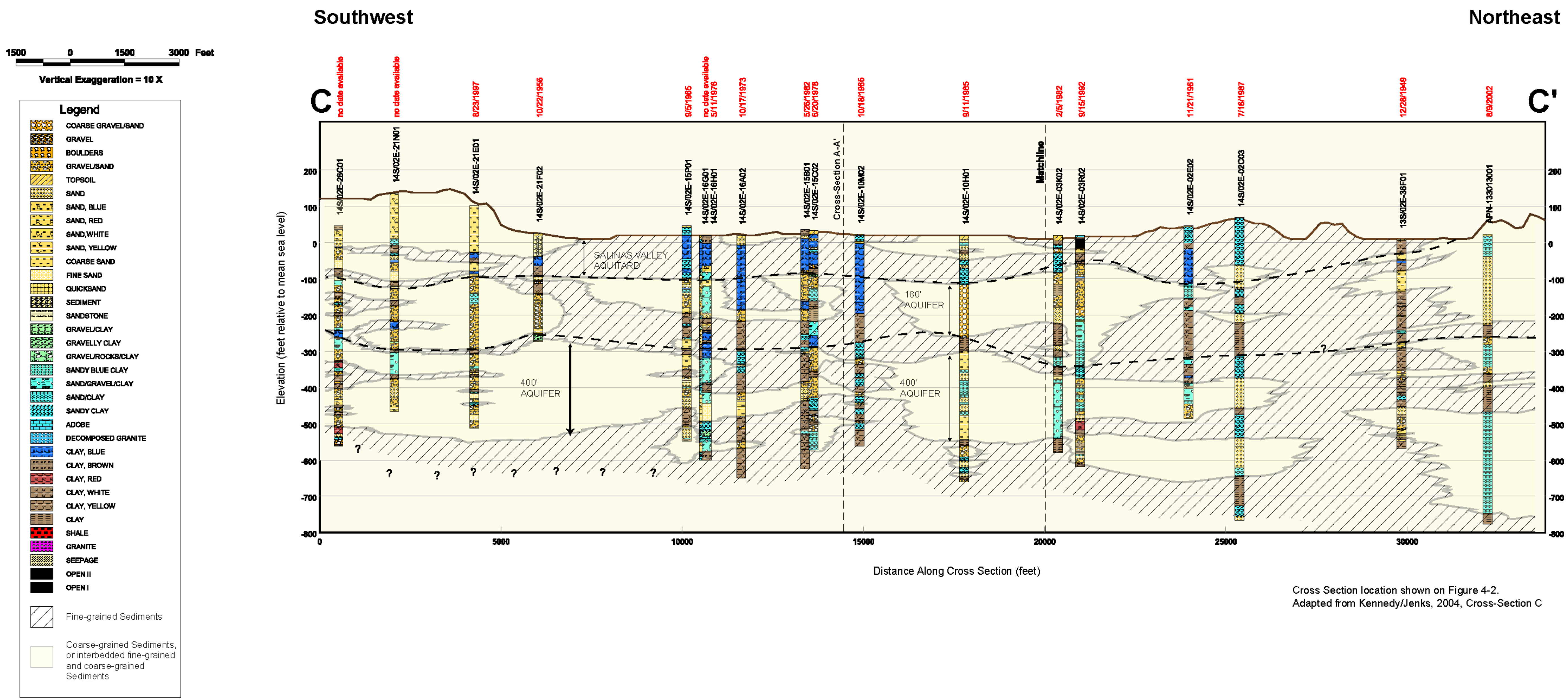


Figure 4-7. Cross-Section C-C'

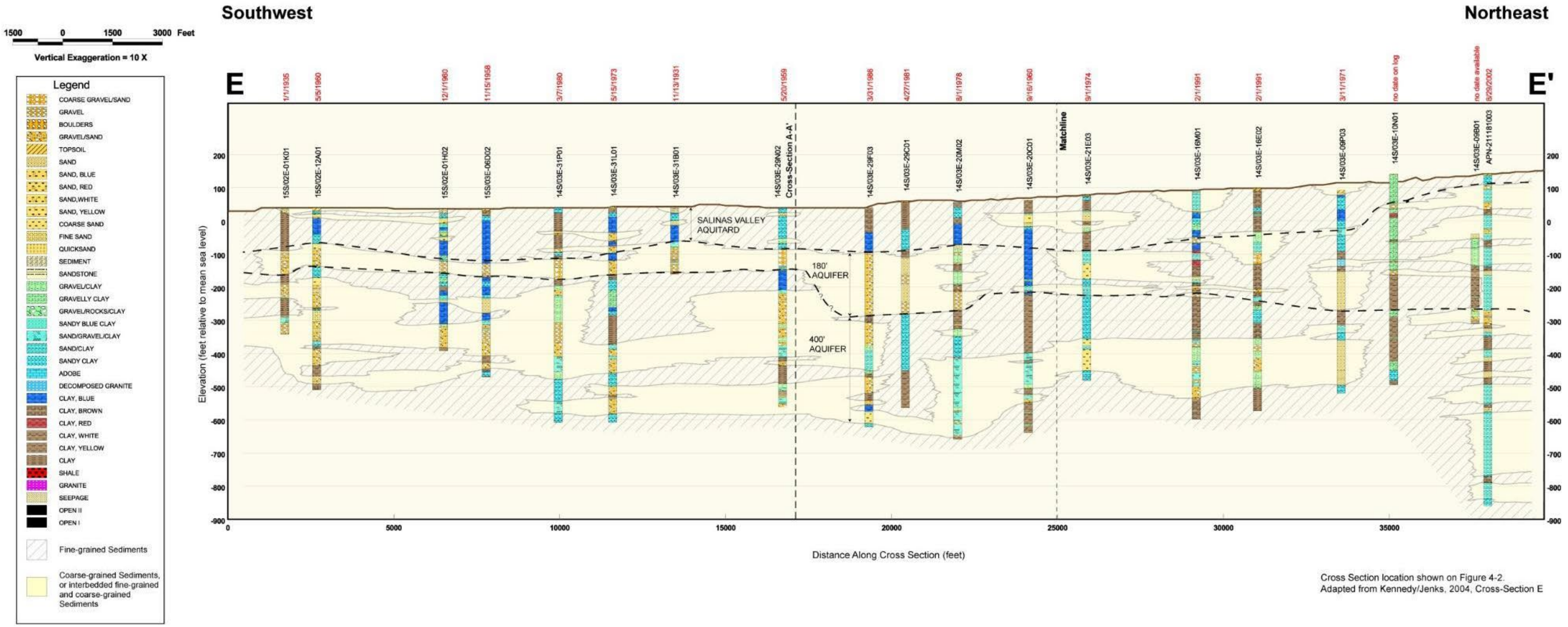


Figure 4-8. Cross-Section E-E'

4.4.1 Principal Aquifers and Aquitards

The shallowest water-bearing sediments are thin, laterally discontinuous, and do not constitute a significant source of water for the Subbasin. These shallow sediments are therefore not considered a principal aquifer. These sediments are less than 100 feet thick and are part of the Holocene Alluvium unit. Although these sediments are a minor source of water due to their poor quality and low yield, some small domestic wells draw water from this zone (Kennedy-Jenks, 2004; DWR, 2003; Showalter, 1984). Groundwater in these sediments is hydraulically connected to the Salinas River but is assumed to be relatively poorly connected to the underlying productive principal aquifers due to the presence of the underlying Salinas Valley Aquitard.

Beneath the shallow seidments, the following series of aquitards and principal aquifers have long been recognized in a multitude of studies and reports. They are the distinguishing hydrostratigraphic features of this Subbasin.

- Salinas Valley Aquitard
- 180-Foot Aquifer
- 180/400-Foot Aquitard
- 400-Foot Aquifer
- 400-Foot/Deep Aquitard
- Deep Aquifers

4.4.1.1 Salinas Valley Aquitard

The Salinas Valley Aquitard is the shallowest, relatively continuous hydrogeologic feature in the Subbasin. The aquitard is composed of blue or yellow sandy clay layers with minor interbedded sand layers (DWR, 2003). The Salinas Valley Aquitard correlates to the Pleistocene Older Alluvium stratigraphic unit and was deposited in a shallow sea during a period of relatively high sea level.

Laterally, the Salinas Valley Aquitard extends from Monterey Bay in the north to Chualar in the south, and to an irregular contact in the east that is roughly represented by the DWR-designated boundary with the Eastside Subbasin (DWR, 2003). The Salinas Valley Aquitard is generally encountered at depths of less than 150 feet. Close to Monterey Bay, the Salinas Valley Aquitard is over 100 feet thick but thins to 25 feet near the City of Salinas, eventually pinching out near Chualar and east of the City of Salinas (DWR, 1975). While this clay layer is relatively continuous in the northern portion of the Valley, it is not monolithic. The clay layer is missing in some areas and pinches out in certain areas.

4.4.1.2 180-Foot Aquifer

The Salinas Valley Aquitard overlies and confines the 180-Foot Aquifer. The 180-Foot Aquifer is the shallowest laterally extensive aquifer in the 180/400-Foot Aquifer Subbasin. This aquifer consists of interconnected sand and gravel beds that are from 50 to 150 feet thick. The sand and gravel layers are interlayered with clay lenses. This aquifer is correlated to the Older Alluvium or upper Aromas Sand formations (Harding ESE, 2001; Kennedy-Jenks, 2004). The 180-Foot Aquifer is exposed on the floor of the Monterey Bay (Todd Engineers, 1989).

The primary uses of the 180-Foot Aquifer are for domestic, irrigation, and municipal water supply.

4.4.1.3 180/400-Foot Aquitard

The base of the 180-Foot Aquifer is an aquitard consisting of interlayered clay and sand layers, including a marine blue clay layer similar to the Salinas Valley Aquitard (DWR, 2003). This aquitard is known as the 180/400-Foot Aquitard. It is widespread in the Subbasin but varies in thickness and quality, and areas of hydrologic connection between the 400-Foot and 180-Foot Aquifers are known to exist (Kennedy-Jenks, 2004). In areas where the 180/400-Foot Aquitard is thin or discontinuous, seawater in the 180-Foot Aquifer can migrate downward into the 400-Foot Aquifer in response to pumping (Kennedy-Jenks, 2004).

4.4.1.4 400-Foot Aquifer

The 180/400-Foot Aquitard overlies and confines the 400-Foot Aquifer. The 400-Foot Aquifer is a hydrostratigraphic layer of sand and gravel with varying degrees of interbedded clay layers. It is usually encountered between 270 and 470 feet below ground surface. This hydrogeologic unit correlates to the Aromas Red Sands and the upper part of the Paso Robles Formation. Near the City of Salinas, the 400-Foot Aquifer is a single permeable bed approximately 200 feet thick; but in other areas the aquifer is split into multiple permeable zones by clay layers (DWR, 1973). The upper portion of the 400-Foot Aquifer merges and interfingers with the 180-Foot Aquifer in some areas where the 180/400-Foot Aquitard is missing (DWR, 1973).

The primary uses of the 180-Foot Aquifer are for domestic, irrigation, and municipal water supply.

4.4.1.5 400-Foot/Deep Aquitard and Deep Aquifers

The base of the 400-Foot Aquifer is the 400-Foot/Deep Aquitard. The 400-Foot/Deep Aquitard is a blue marine clay layer. This aquitard can be several hundred feet thick (Kennedy-Jenks, 2004).

The 400-Foot/Deep Aquitard overlies and confines the Deep Aquifers. The Deep Aquifers, also referred to as the 900-Foot and 1500-Foot Aquifers, are up to 900 feet thick and have alternating sandy-gravel layers and clay layers which do not differentiate into distinct aquifer and aquitard units (DWR, 2003). The Deep Aquifers correlate to the lower Paso Robles, Purisima, and Santa Margarita formations. The Deep Aquifers overlie the low permeability Monterey Formation. While the Deep Aquifers are relatively poorly studied, some well owners have indicated that there are different portions of the Deep Aquifers with different water qualities. No public data exists to substantiate these statements.

The Deep Aquifers are used primarily for irrigation and municipal water supply.

4.4.2 Aquifer Properties

The magnitude and distribution of hydrogeologic properties of the principal aquifers in the Subbasin have not been well characterized or documented. The relatively sparse amount of measured aquifer properties from the Subbasin's principal aquifers is a data gap that will be addressed during implementation of this GSP.

Although hydrogeologic properties have not been measured at many specific locations in the Subbasin, the aquifer properties have been estimated through the process of model calibration. Aquifer property calibration has been completed for numerous published modeling studies including studies by Durbin (1974); Yates (1988); WRIME (2003); and the unpublished SVIHM developed by USGS.

There are two general types of aquifer properties relevant to groundwater management:

- **Aquifer storage properties**: these properties control the relationship between the volume of groundwater stored in the aquifer and the water elevation measured in the aquifer, and
- **Groundwater transmission properties**: these properties control the relationship between hydraulic gradients and the rate of groundwater flow.

4.4.2.1 Aquifer Storage Properties

The aquifer properties that characterize the relation between water elevation and volume of water in storage are specific yield for unconfined aquifers, and specific storage for confined aquifers. Storativity is equal to specific storage times aquifer thickness. Both specific yield and specific storage are measured in units of cubic feet of water per cubic feet of aquifer material. These ratios are often expressed as a percent.

- Specific yield is the amount of water that drains from pores when an unconfined aquifer is dewatered. Often specific yield values range from 8% to 20%. Estimated specific yield values complied by DWR for the Subbasin range from 6% to 16%.
- Specific storage is the amount of water derived from a cubic foot of confined aquifer due to the pressure changes in the aquifer. Often specific storage values are on the order of

$5x10^{-4}$ to $1x10^{-5}$. Estimated specific storage values compiled by the USGS for the Subbasin range from $1.2x10^{-4}$ to $2.9x10^{-4}$.

Detailed aquifer property values for each aquifer were not available at the time of this GSP development. This is a data gap that will be filled during implementation.

4.4.2.2 Groundwater Transmission Properties

Hydraulic conductivity measures the ability of an aquifer to transmit water. Hydraulic conductivity is measured in units of feet per day. Units with higher hydraulic conductivities, such as sands and gravels, transmit groundwater more easily than units with lower hydraulic conductivities. Transmissivity is equivalent to the hydraulic conductivity of an aquifer times the thickness of an aquifer. Unfortunately, very few estimates of hydraulic conductivity or transmissivity exist for the Subbasin.

Specific capacity of a well is sometimes used as a surrogate for estimating aquifer transmissivity. The specific capacity of a well is the ratio between the well production rate in gallons per minute (gpm) and the water level drawdown in the well during pumping, measured in feet. Specific capacity is moderately well correlated, and approximately proportional to, aquifer transmissivity. Durbin, et al. (1978) reported the following well yields and specific capacity estimates:

- Fluvial deposits that constitute the shallowest productive zones in most of the Subbasin, including the 180-Foot aquifer, have well yields of 500 to 4,000 gpm and an average specific capacity of approximately 70 gpm/ft.
- In the 400-Foot aquifer, well yields range from 300 to 4,000 gpm and average 1,200 gpm, with specific capacity averaging about 30 gpm/ft.

These values suggest that the principal aquifers have relatively high transmissivities and hydraulic conductivities. Wells completed in the principal aquifers can produce substantial amounts of water with limited drawdown.

4.4.3 Natural Recharge Areas

Areas of significant, natural, areal recharge and discharge within the Subbasin are discussed below. Quantitative information about all natural and anthropogenic recharge and discharge is provided in Chapter 6. Natural recharge to the overall groundwater system, which includes both the shallow sediments and principal aquifers, occurs through the following processes:

- Infiltration of surface water from the Salinas River and tributary channels
- Deep percolation of excess applied irrigation water
- Deep percolation of infiltrating precipitation

The capacity for recharge to the groundwater system is a dependent on a combination of factors, including steepness of grade, surface condition such as paving or compaction, and ability of soil to transmit water past the root zone. To assist agricultural communities in California with assessing groundwater recharge potential, a consortium of researchers at UC Davis developed a Soil Agricultural Groundwater Banking Index (SAGBI) and generated maps of recharge potential in agricultural areas of California (O'Geen, et al., 2015). Figure 4-9 presents the SAGBI index map for the Subbasin. This map ranks soil suitability to accommodate recharge to the groundwater system based on five major factors that affect recharge potential including: deep percolation, root zone residence time, topography, chemical limitations, and soil surface condition. Areas with excellent surficial recharge properties are shown in green. Areas with poor surficial recharge properties are shown in red. Not all land is classified, but this map provides good guidance on where natural recharge to the groundwater system likely occurs.

Although Figure 4-9 shows some areas of good potential recharge in the 180/400-Foot Aquifer Subbasin, recharge to the principal aquifers of the Subbasin is very limited because of the low permeability Salinas Valley Aquitard. It is likely that only limited surficial recharge in the 180/400-Foot Aquifer Subbasin reaches the productive 180-Foot Aquifer or the 400-Foot Aquifer. This demonstrates the limited utility of potential recharge maps that are based on soil properties. This map should not be used as the sole data source for identifying recharge areas that will directly benefit the extensive principal aquifers in the 180/400-Foot Aquifer Subbasin.

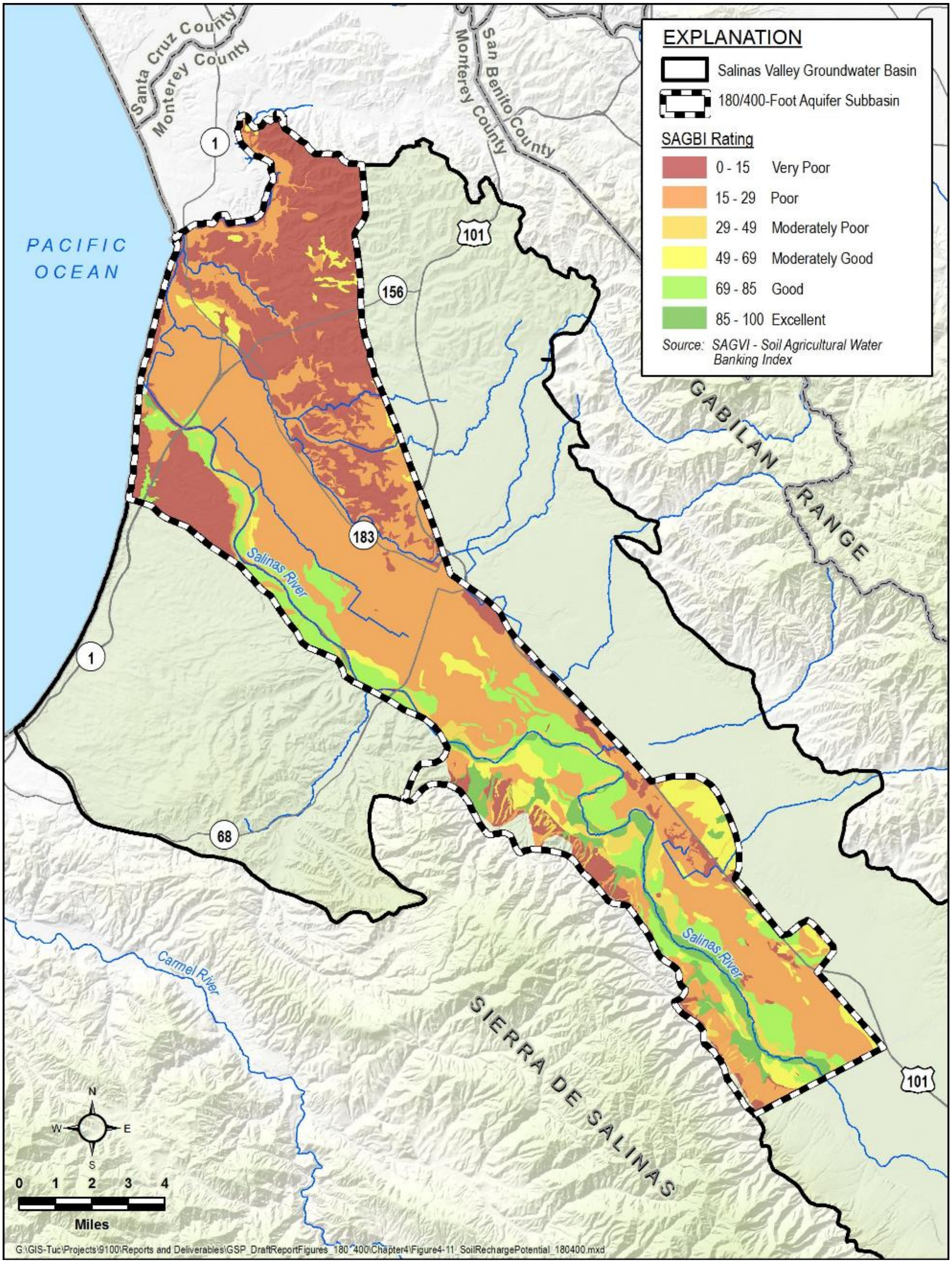


Figure 4-9. SAGBI Soils Map for Areas of Good Potential Recharge in the 180/400-Foot Aquifer Subbasin

4.4.4 Natural Discharge Areas

Natural groundwater discharge areas within the Subbasin include groundwater discharge to surface water bodies, and evapotranspiration (ET) by phreatophytes. There are no springs and seeps in the Subbasin as identified in the National Hydrology Dataset (NHD). Natural groundwater discharge to streams, primarily, the Salinas River and its tributaries, has not been mapped to date. Areas of potential groundwater discharge to streams will be identified using the SVIHM, which will be available in 2020. Therefore, identifying all natural discharge areas is a data gap that will be resolved in a future GSP update.

Figure 4-10 shows the distribution of potential groundwater-dependent ecosystems (GDEs), also referred to as Natural Communities Commonly Associated with Groundwater (NCCAG), within the Subbasin area. In areas where the water table is sufficiently high, groundwater discharge may occur as ET from phreatophyte vegetation within these potential GDEs. Potential GDEs were identified based on the methodology proposed by The Nature Conservancy (TNC). Appendix 4A describes methods used to determine the extent and type of potential GDEs. Figure 4-10 shows only potential GDEs. There has been no verification that the locations shown on this map constitute verified groundwater dependent ecosystems. Additional field reconnaissance is necessary to verify the existence of these potential GDEs.

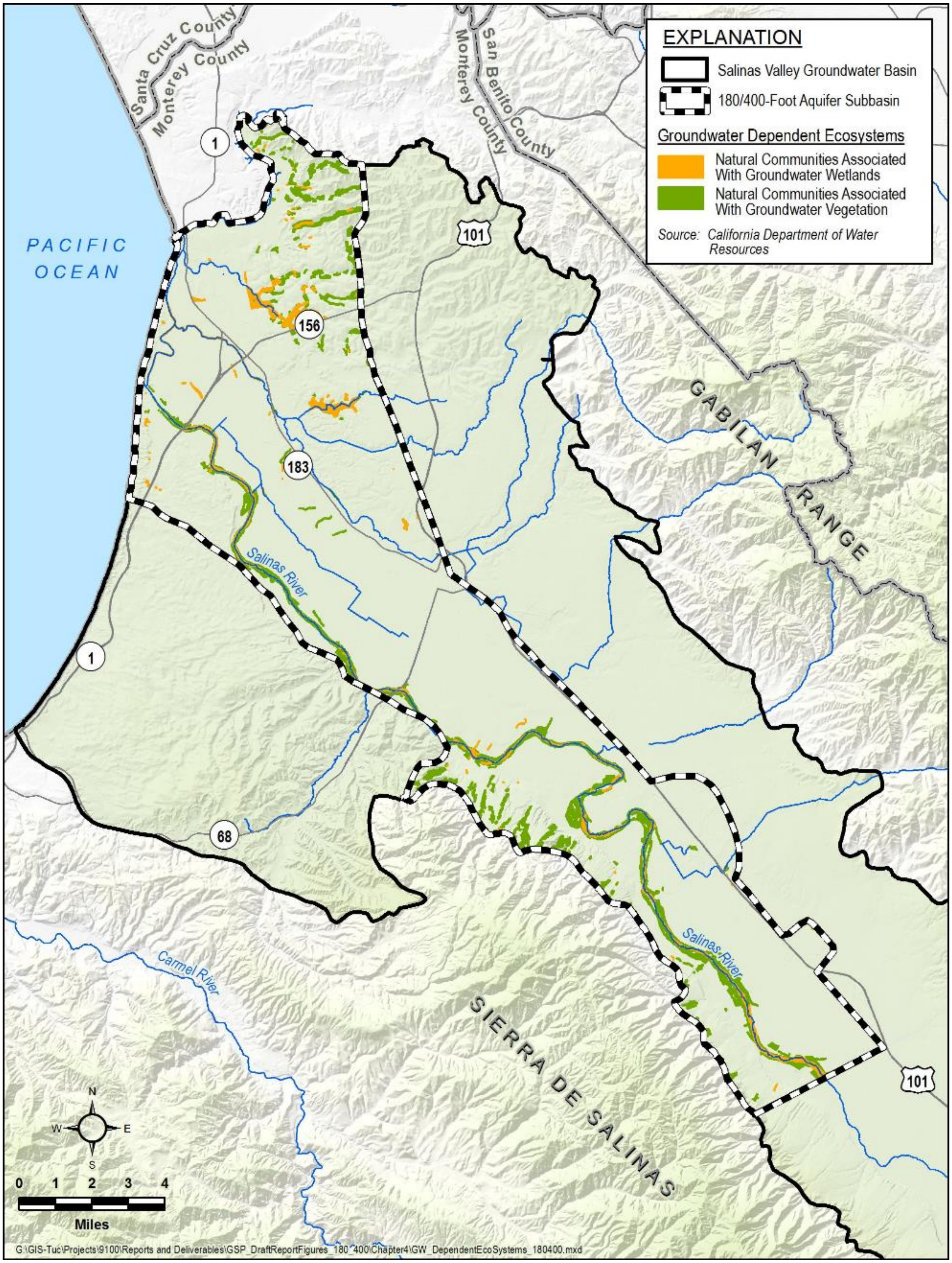


Figure 4-10. Potential Groundwater Dependent Ecosystems

4.5 Surface Water Bodies

The primary surface water body in the Subbasin is the Salinas River. This river runs the entire length of the Subbasin and is fed by local tributaries (Figure 4-11). The following surface water bodies are located outside of the Subbasin but are important controls on the rate and timing of Salinas River flows in the Subbasin:

- Two reservoirs constructed to control flooding and to increase recharge from Salinas River to groundwater including:
    - Lake Nacimiento, in San Luis Obispo County, was constructed in 1957 and has a storage capacity of 377,900 AF (MCWRA, 2015b).
    - Lake San Antonio, in Monterey County, was constructed in 1967 and has a storage capacity of 335,000 AF.
- Arroyo Seco, a tributary with a 275 square mile drainage area that has no dams in its drainage basin and is characterized by both very high flood flows and extended dry periods.

Agricultural diversions and the construction of dams on the Salinas River and its tributaries have altered the river's hydrology, and the river no longer exhibits the seasonal variation in flows that were observed before the mid-20th century. The restoration of natural flows to the Salinas River is not within the scope of this GSP.

Within the Subbasin, two constructed canals convey surface water across the valley floor, as shown on Figure 4-11. Reclamation Ditch #1665 (Rec Ditch) was originally constructed in 1917 and is operated in part by MCWRA for flood management. The ditch flows southeast to northwest and drains the stormwater detention from Smith Lake and Carr Lake before flowing northwest towards Castroville, discharging into Tembladero Slough, and then flowing into the Old Salinas River Channel and ultimately into Moss Landing Harbor. The Blanco Drain, also known as Storm Maintenance District No. 2, is a drainage system that covers approximately 6,400 acres of farmland, predominately receiving agricultural return flow from tile drains in the dry season and stormwater runoff in the wet season. The Blanco Drain discharges into the Salinas River.

The mouth of the Salinas River forms a lagoon; and its outflow to Monterey Bay is blocked by sand dunes except during winter high-water flows. MCWRA operates a slide-gate to transfer water through a culvert from the lagoon into Old Salinas River during the wet season for flood control (MCWRA, 2014). The Old Salinas River discharges through tide gates at Potrero Road into Moss Landing Harbor and ultimately the Monterey Bay.

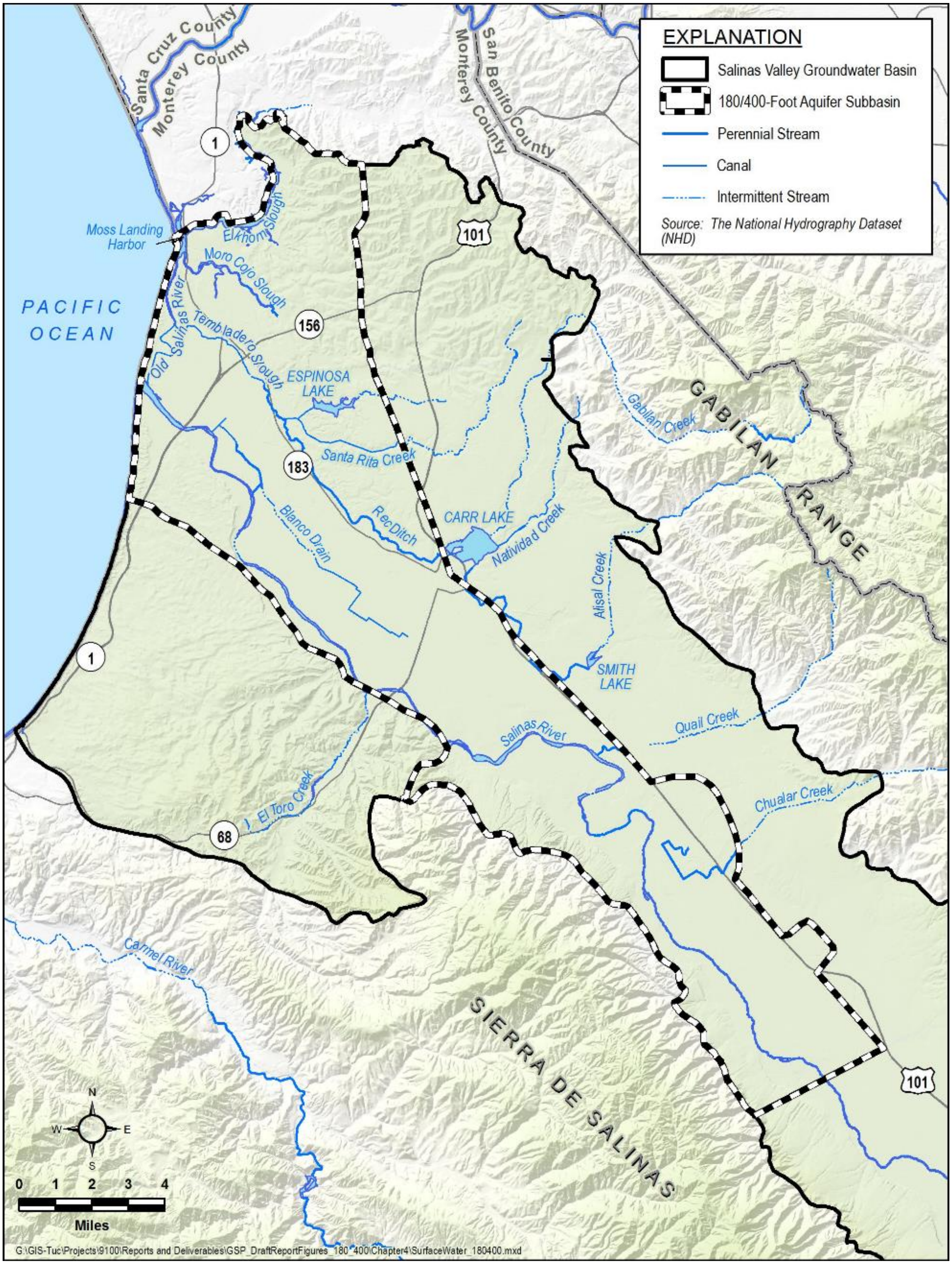


Figure 4-11. Surface Water Bodies in the 180/400-Foot Aquifer Subbasin

4.5.1 Imported Water Supplies

There is no water imported into the 180/400-Foot Aquifer Subbasin from outside the Salinas River watershed.

4.6 Water Quality

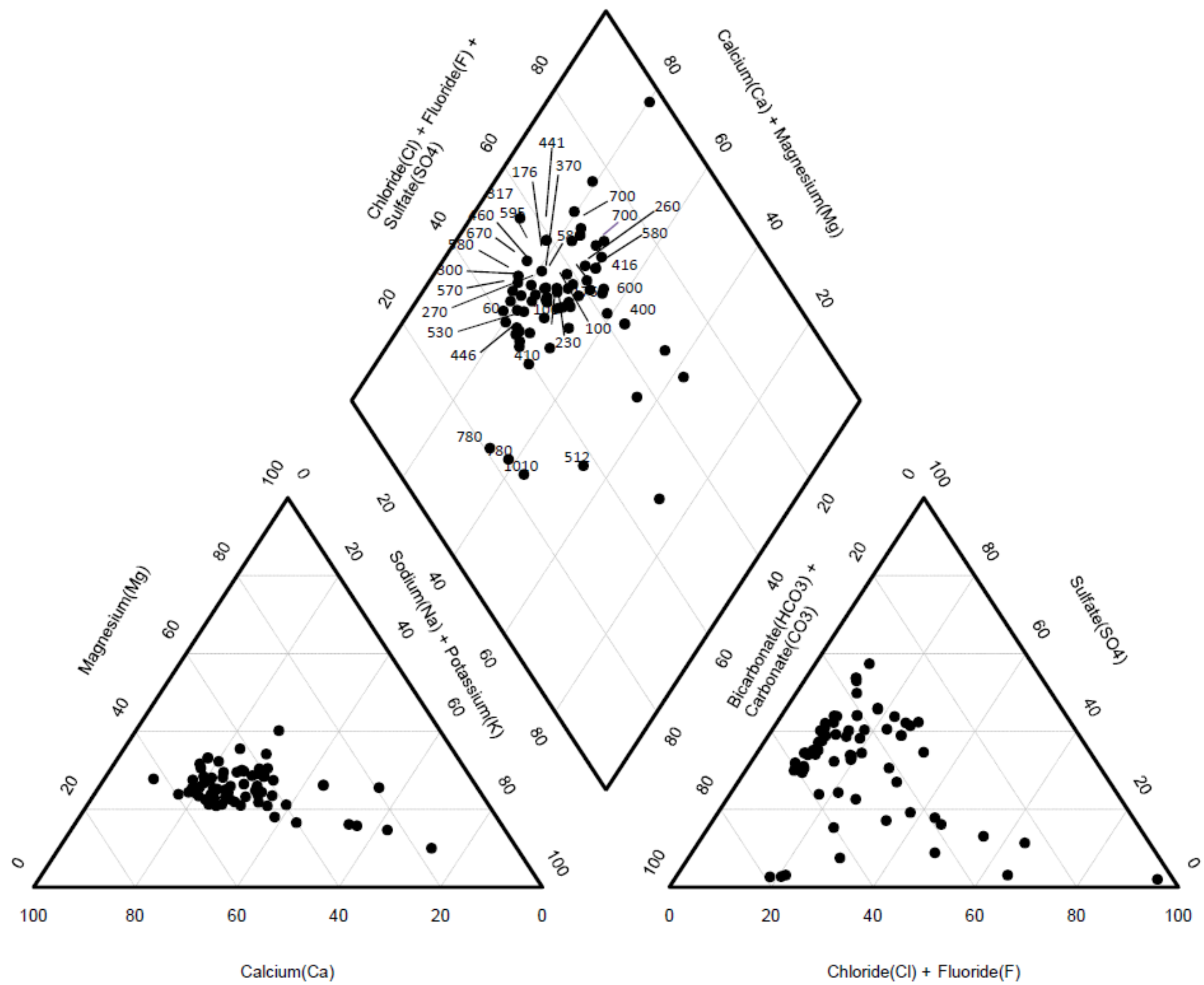
This section presents a general discussion of the natural groundwater quality in the Subbasin, focusing on general minerals. This discussion is based on data from previous reports. The distribution and concentrations of specific constituents of concern is presented in Chapter 5.

4.6.1 General Mineral Chemistry

The major ion chemistry of the Salinas Valley Groundwater Basin's groundwater was characterized in a report prepared for the CCGC titled *Distribution of groundwater nitrate concentrations, Salinas Valley, California* (HydroFocus, 2014). The purpose of the report was to respond to the Regional Board requirement for monitoring elevated nitrate concentrations near drinking water supply wells. The report included the results of extensive groundwater quality sampling and thus provided a good characterization of the general mineral water quality.

General water chemistry provides a baseline of understanding of the water by showing major ions that are dissolved in the groundwater. The major ions that are dissolved can inform users if the water is more alkaline or more acidic. In many areas with more alkaline water, which has more dissolved cations such as calcium, magnesium, and sodium, many users report their water as being 'hard'.

Figure 4-12 presents a piper diagram from the CCGC report that plots major ion data from within and near the Subbasin. The diagram provides a means of representing the proportions of major anions and cations in water samples. The lower left triangle of the piper diagram plots the relative abundance of cations in groundwater samples. The lower right triangle of the piper diagram plots the relative abundance of anions in groundwater samples. The diamond in the middle of the diagram combines the cation and anion abundances into a single plot. Groundwater samples with similar general mineral chemistries will group together on these diagrams. The data plotted on Figure 4-12 show that most groundwater samples are of a similar type and plot in a single cluster. The samples are generally of a magnesium bicarbonate type, which is a more alkaline type of water. However, there are outlier samples that are higher in sodium and potassium than the other samples, and are most noticeable in the dots that plot in the middle and right portions of the cation triangle. Piper diagrams do not provide spatial information about groundwater samples, and therefore it is difficult to assess the source of the sodium and/or potassium in the outlier samples.



Note: Well depths indicated when available.

Figure 4-12. Piper Diagram of Groundwater General Mineral Chemistry for the 180/400-Foot Aquifer Subbasin

4.6.2 Seawater Intrusion

Groundwater pumping has lowered groundwater elevations to an point that allows seawater to flow into the Subbasin from the Monterey Bay. Increased salt concentrations from seawater intrusion, measured as TDS or chloride concentration, are considered a nuisance for domestic or municipal uses rather than a health or toxicity concern. Additionally, increased salt concentrations from seawater intrusion may impact the ability to use groundwater for irrigation.

The impact of seawater intrusion on the beneficial uses of groundwater occurs at concentrations much lower than that of seawater. The TDS of seawater is approximately 35,000 mg/L. The State of California has adopted a recommended Secondary Maximum Contaminant Level (SMCL) for TDS of 500 mg/L, and a short term maximum SMCL of 1,500 mg/L. Groundwater with total dissolved solids of 3,000 mg/L or less, however, is considered to be suitable, or potentially suitable, for beneficial uses in accordance with SWRCB Resolution No. 88-63 as adopted in its entirety in the Central Coast Regional Water Quality Control Board's Basin Plan. The TDS limit for agricultural use is crop dependent: a 10% loss of yield in lettuce crops has been observed at a TDS of 750 mg/L; a 10% loss of yield in tomatoes has been observed at a TDS of 1,150 mg/L (Ayers and Westcot, 1985).

The current seawater intrusion conditions are described more fully in Chapter 5.

4.7 Data Gaps

Due to decades of extensive study and groundwater development, the structure and boundaries of the hydrogeologic conceptual model in the 180/400-Foot Aquifer Subbasin is relatively well developed. However, there are notable data gaps including:

- There are very few measurements of aquifer properties such as hydraulic conductivity and specific yield in the Subbasin.
- The hydrostratigraphy, vertical and horizontal extents, and potential recharge areas for the Deep Aquifers are poorly known.
- Areas of Salinas River recharge and discharge have not been mapped.

These data gaps have led to some minor uncertainties in how the principal aquifers function, and the SVBGSA will minimize these uncertainties by filling data gaps. As described in Chapter 7, the GSP will include ongoing data collection and monitoring that will allow continued refinement and quantification of the groundwater system. Chapter 10 includes activities to address the identified data gaps and improve the hydrogeologic conceptual model.

5 GROUNDWATER CONDITIONS

This chapter describes the current and historical groundwater conditions in the 180/400-Foot Aquifer Subbasin. In this GSP, current conditions are any conditions occurring after January 1, 2015. By implication, historical conditions are any conditions occurring prior to January 1, 2015. The chapter focuses on information required by the GSP regulations and information that is important for developing an effective plan to achieve sustainability. This chapter provides a description of current and historical groundwater conditions at a scale and level of detail appropriate for meeting the GSP sustainability requirements under SGMA.

This chapter is organized to align the groundwater conditions descriptions with the six sustainability indicators, including:

1. Chronic lowering of groundwater levels
2. Changes in groundwater storage
3. Seawater intrusion
4. Subsidence
5. Groundwater quality
6. Depletion of interconnected surface waters

5.1 Groundwater Elevations

5.1.1 Data Sources

The assessment of groundwater elevation conditions is largely based on data collected by MCWRA from 1944 through the present. At the time of this report, MCWRA regularly collects groundwater elevation measurements from 166 locations in the 180/400-Foot Aquifer Subbasin for various monitoring programs. The groundwater elevation data are primarily obtained from private well owners that have provided data on a confidential basis. Therefore, the contoured groundwater elevations are available for public release as raw data, but the underlying elevation data and well locations are not publicly available and are not used as a basis for the GSP.

MCWRA collects groundwater elevation data at specific times of the year to understand seasonal changes and monitor longer term trends. Some of the monitored wells are equipped with pressure transducers that take automated measurements hourly. Other wells are measured monthly, annually for the fall measurement program, and/or annually for the August trough measurement program (MCWRA, 2018a).

From mid-November to mid-December, MCWRA conducts its fall measurement program to observe groundwater elevations after the irrigation season ends but before the rainy season begins (Brown and Caldwell, 2015). The fall measurements are intended to provide the most representative year-to-year comparison because the groundwater elevations are not greatly influenced by either drawdown due to irrigation pumping or the rise in groundwater elevations associated with each wet season. The fall measurements provide insight into long-term storage trends in the aquifers (Brown and Caldwell, 2015).

During August, MCWRA conducts a localized August Trough measurement program in the 180/400-Foot Aquifer Subbasin and the Eastside Aquifer Subbasin to observe groundwater elevations at the peak of the irrigation pumping season. Groundwater elevations in August represent the lowest groundwater elevations of the year. The August Trough measurements provide insight into how groundwater pumping affects groundwater head gradients and seawater intrusion.

In addition to the fall and August Trough groundwater elevation measurement programs, MCWRA is the primary local Monitoring Entity for the Subbasin under CASGEM. Created by the State of California in 2009, CASGEM is a statewide program to collect groundwater elevations and make the data accessible to the public.

In the 180/400-Foot Aquifer Subbasin, 23 wells are monitored for the CASGEM program. The locations of these wells are shown on Figure 5-1. Wells were selected for the CASGEM program based on their distribution throughout Monterey County, the availability of detailed and reliable well construction data, and relative ease of data collection (MCWRA, 2015b). Fifteen wells are equipped with transducers that record groundwater elevations hourly; eight others are monitored manually on a monthly basis (MCWRA, 2015b). The average period of record for these wells is 10 years. The earliest groundwater elevations were recorded in 2003.

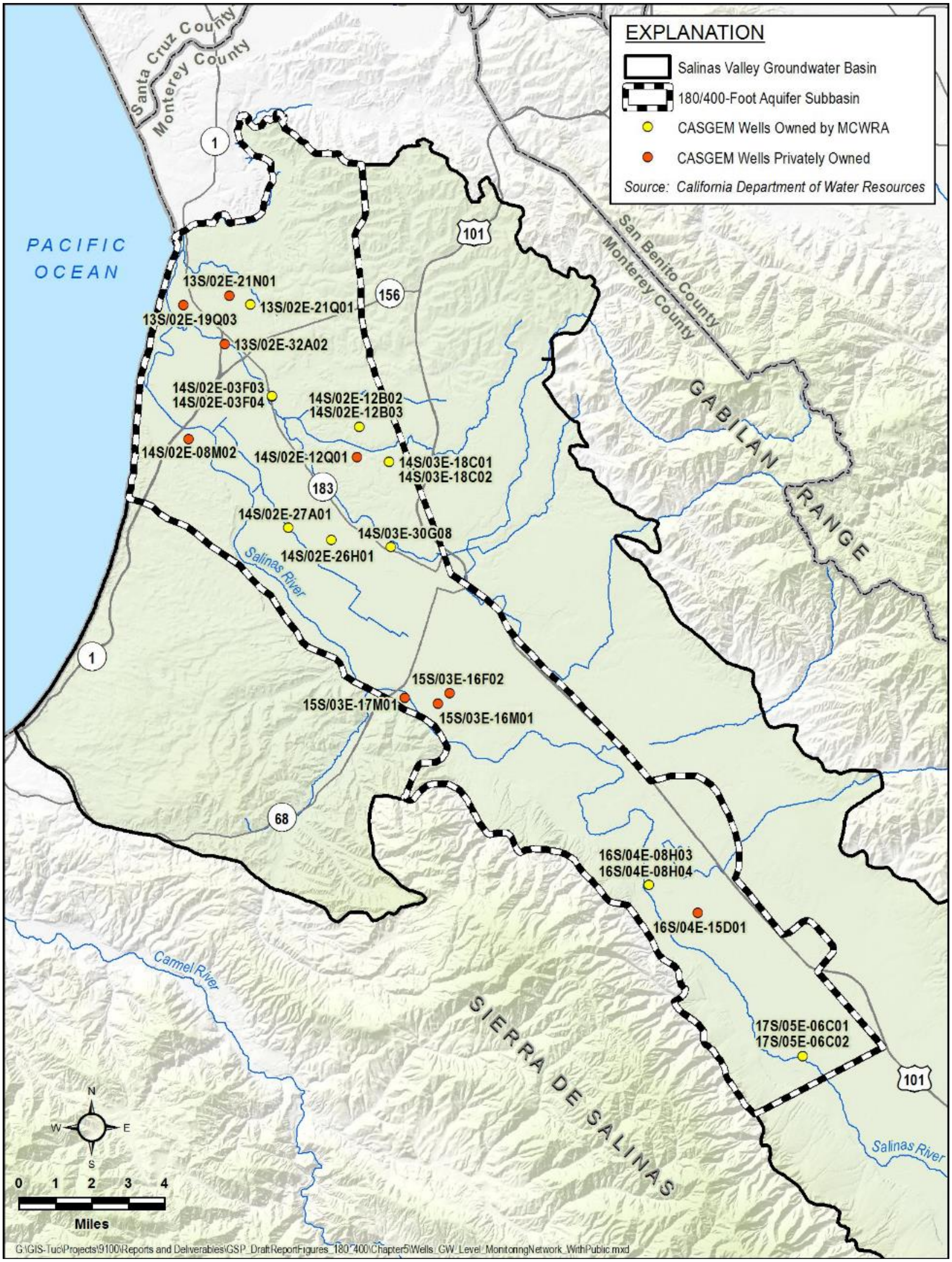


Figure 5-1. CASGEM Well Locations

Given the various regional and local influences on groundwater elevations, it is illustrative to characterize the Basin groundwater elevation conditions through at least three distinct methodologies:

- Maps of groundwater elevation contours that show the geographic distribution of groundwater elevations at a specific time. These contours represent the elevation of the groundwater in feet, using the NAVD88 vertical datum. The contour interval is 10 feet, meaning each blue line represents an area where groundwater elevations are either 10 feet higher or 10 feet lower than the nearby blue line.
- Hydrographs of individual wells that show the variations in groundwater elevations at individual wells over an extended period.
- Vertical hydraulic gradients in a single location that assess the potential for vertical groundwater flow direction.

For this GSP, all three approaches are used to develop the current and historical groundwater elevation conditions.

5.1.2 Groundwater Elevation Contours and Horizontal Groundwater Gradients

MCWRA produces groundwater elevation contour maps for the Salinas Valley Groundwater Basin in odd-numbered years using data from the August trough and fall measurement programs. It does not produce groundwater elevation contour maps in the spring. MCWRA's August trough and fall measurements are the best available data. The lack of spring contour maps is a data gap, and spring contour maps will be produced during GSP implementation. In the 180/400-Foot Aquifer Subbasin, MCWRA produces separate contour maps for the 180-Foot and 400-Foot Aquifers.

The following eight maps present the Current (2017) and Historical (1995) groundwater elevation contours developed by MCWRA.

Table 5-1. Figures Showing Current and Historical Groundwater Elevation Contours

Figure #	Year	Season	Aquifer
Figure 5-2	Current (2017)	Fall	180-Foot
Figure 5-3	Current (2017)	August Trough	180-Foot
Figure 5-4	Current (2017)	Fall	400-Foot
Figure 5-5	Current (2017)	August Trough	400-Foot
Figure 5-6	Historical (1995)	Fall	180-Foot
Figure 5-7	Historical (1995)	August Trough	180-Foot
Figure 5-8	Historical (1995)	Fall	400-Foot
Figure 5-9	Historical (1995)	August Trough	400-Foot

The contours on each of these eight maps originated from contours developed by MCWRA. Therefore, the contours only cover the portions of the basin monitored by MCWRA. Contours do not always extend to the basin margins; nor do they cover the entire 180/400-Foot Aquifer Subbasin. This is a data gap that will be addressed during GSP implementation.

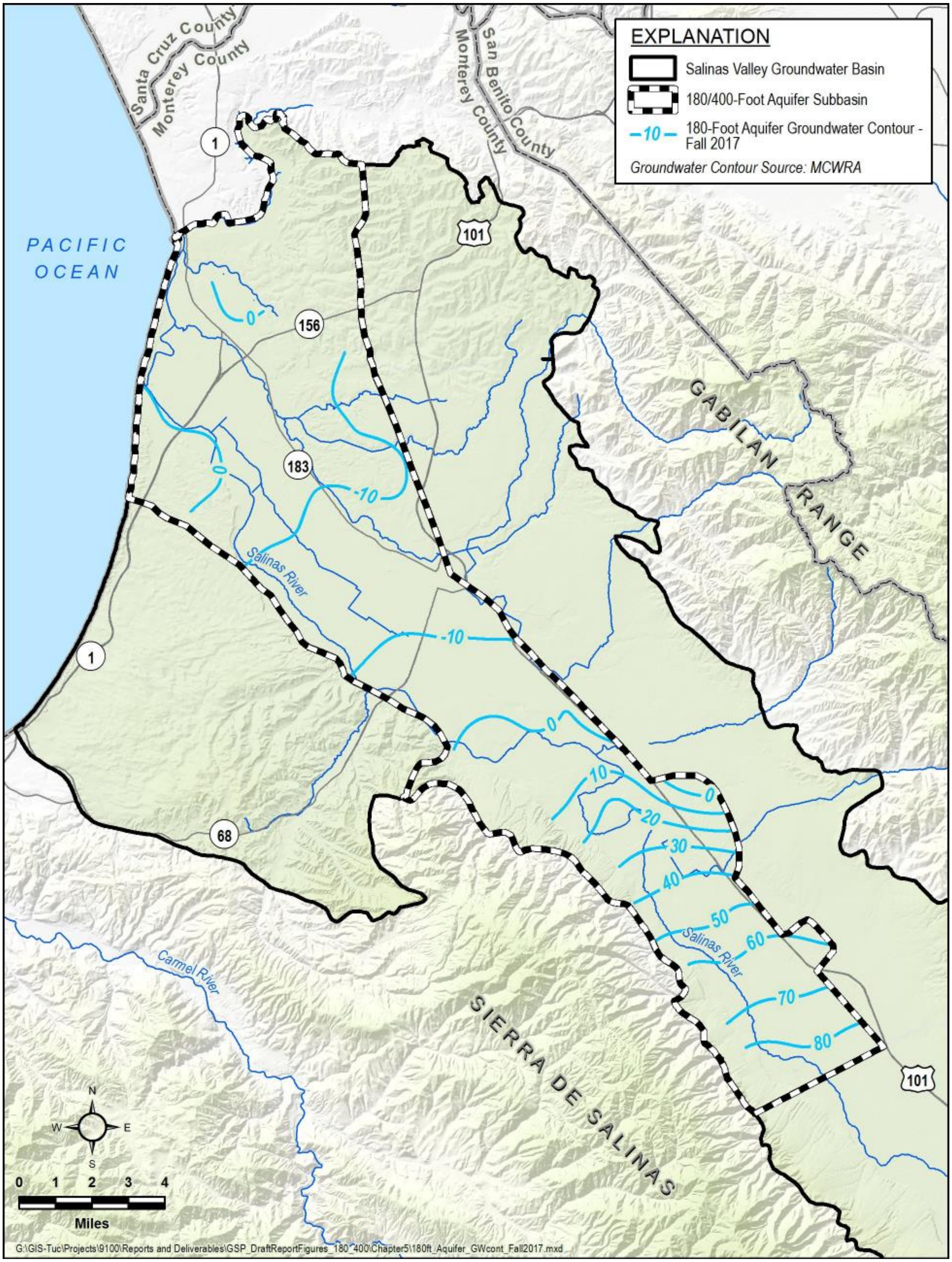


Figure 5-2. Fall 2017 180-Foot Aquifer Groundwater Elevation Contours

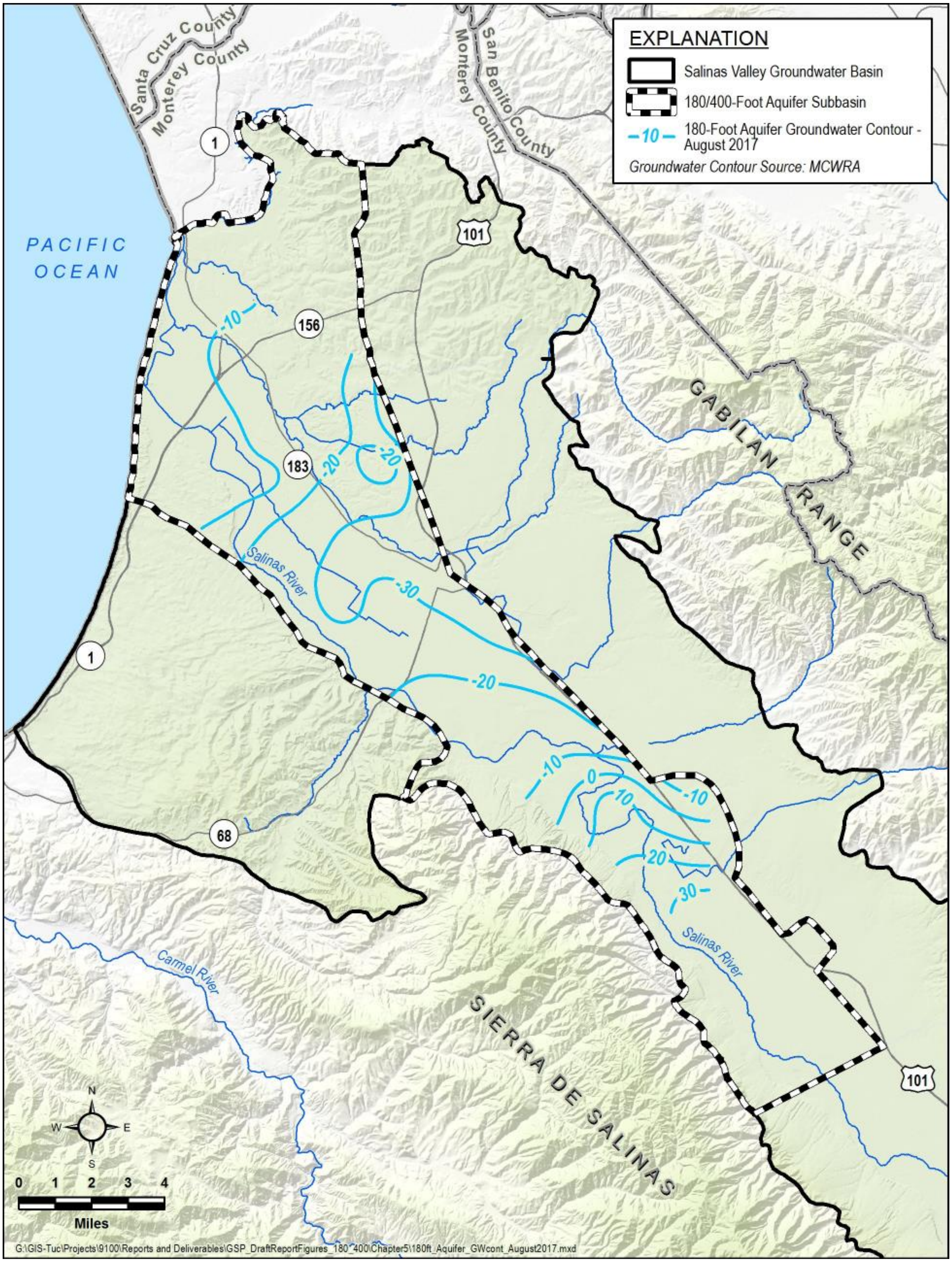


Figure 5-3. August 2017 180-Foot Groundwater Elevation Contours

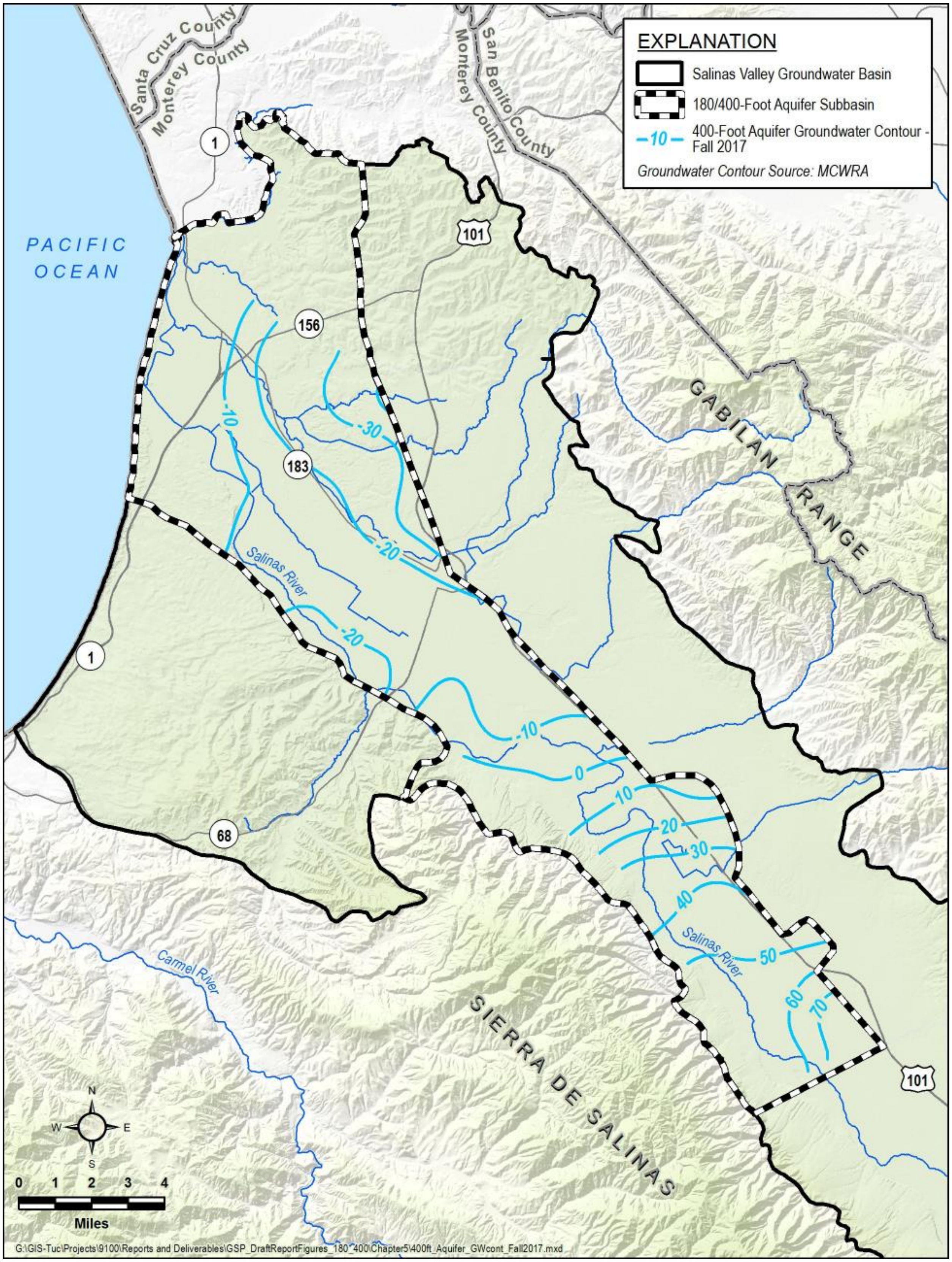


Figure 5-4. Fall 2017 400-Foot Aquifer Groundwater Elevation Contours

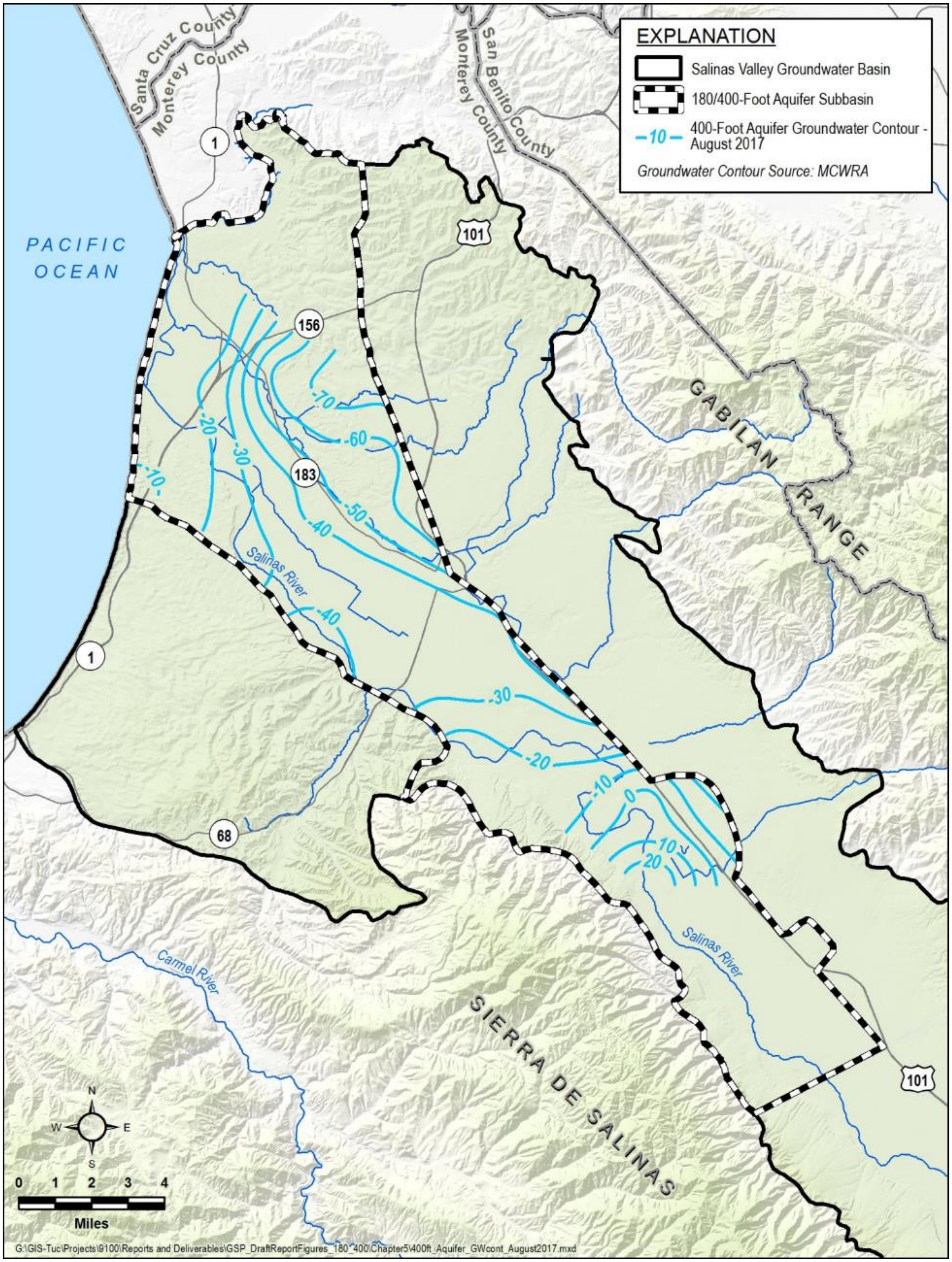


Figure 5-5. August 2017 400-Foot Aquifer Groundwater Elevation Contours

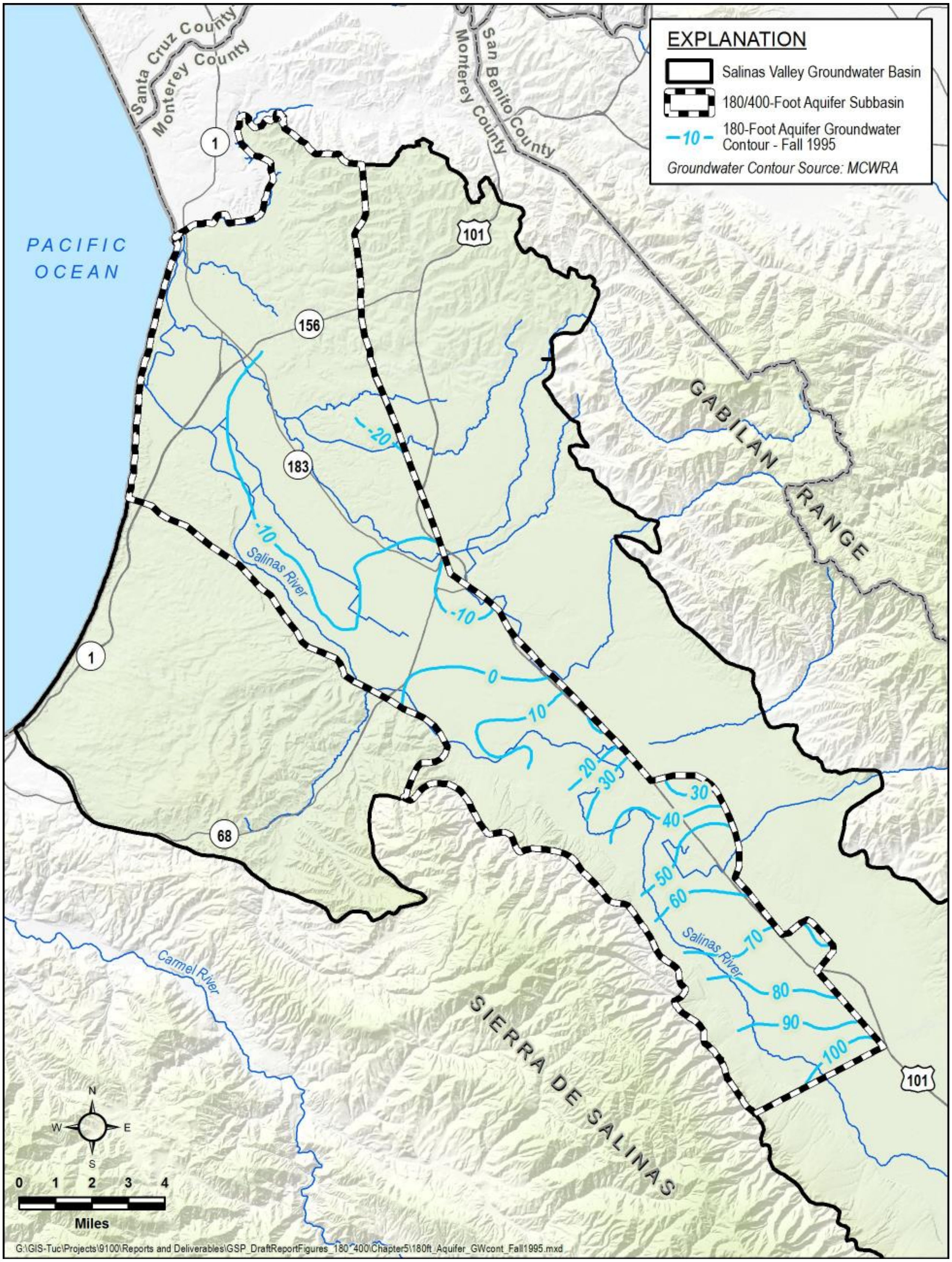


Figure 5-6. Fall 1995 180-Foot Aquifer Groundwater Elevation Contour

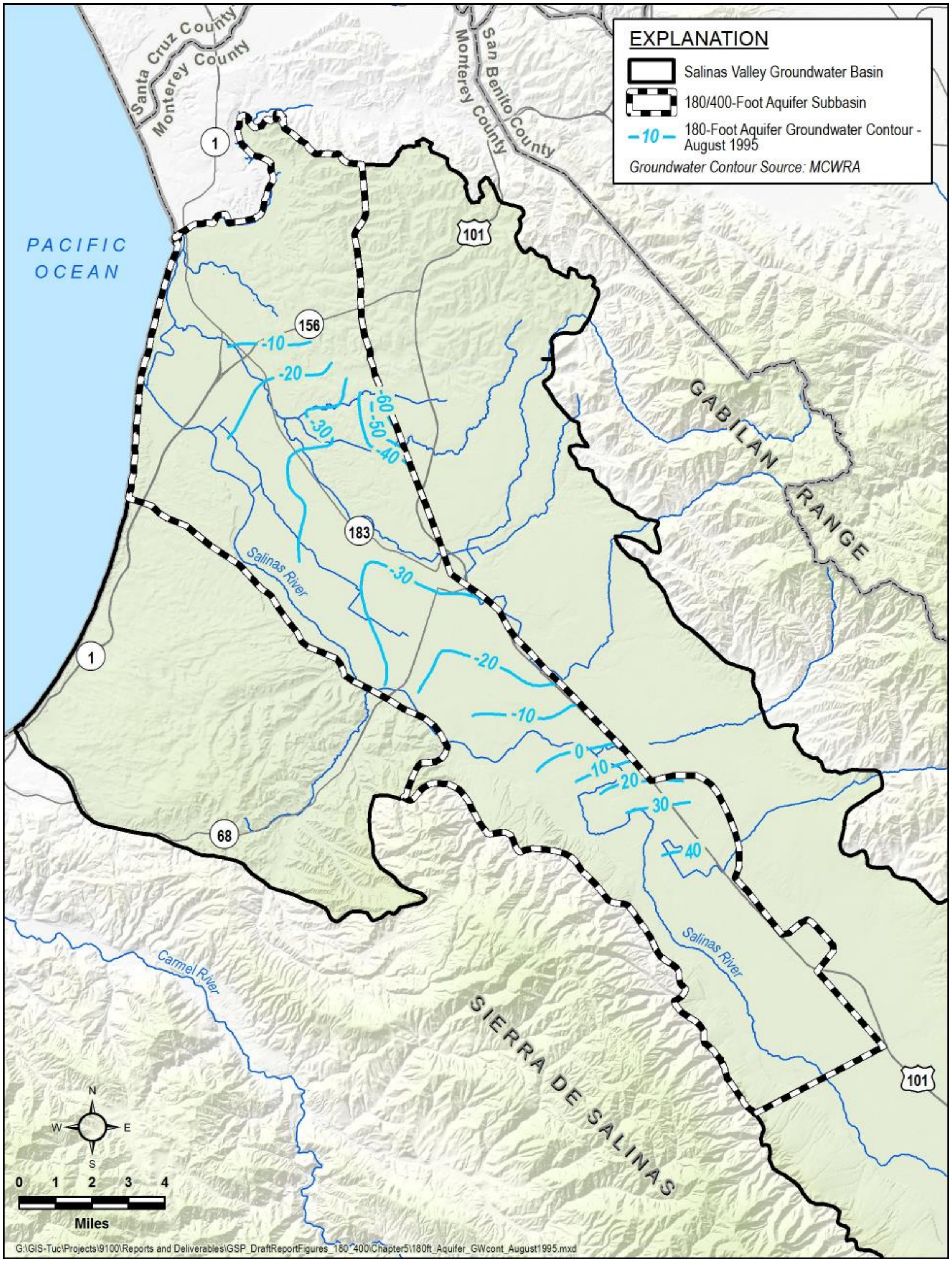


Figure 5-7. August 1995 180-Foot Aquifer Groundwater Elevation Contours

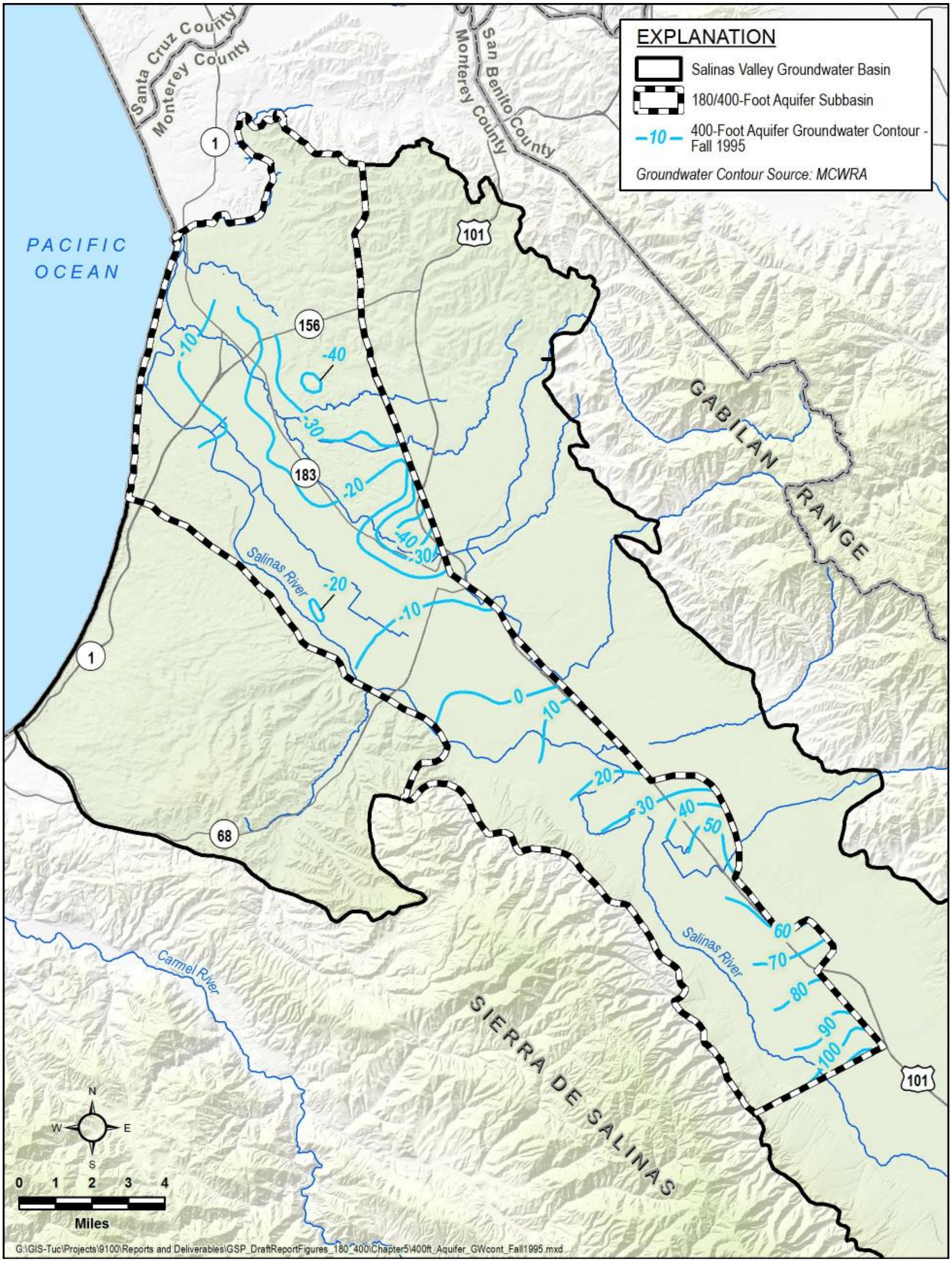


Figure 5-8. Fall 1995 400-Foot Aquifer Groundwater Elevation Contours

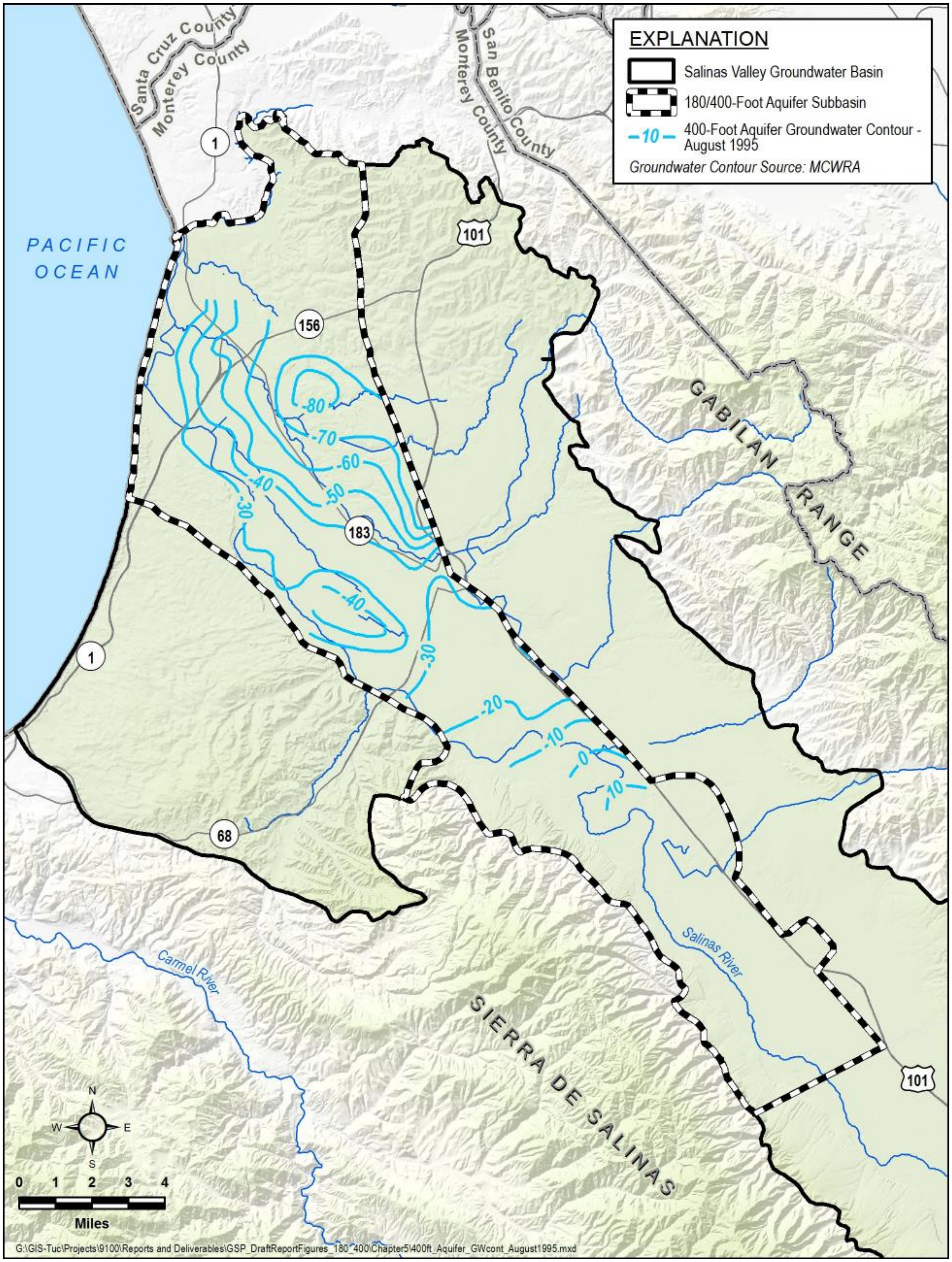


Figure 5-9. August 1995 400-Foot Aquifer Groundwater Elevation Contours

The contours indicate that groundwater flow directions are similar in the 180- and 400-Foot Aquifers. However, groundwater elevations in the 400-Foot Aquifer are lower than groundwater elevations in the 180-Foot Aquifer during both 1995 and 2017.

Under current conditions (Figure 5-2 through Figure 5-4), groundwater elevations in the Subbasin are below sea level (zero feet NAVD88) as indicated by the negative values on the contour lines in the northern two-thirds of the Subbasin. The lowest groundwater elevations in the Subbasin are along the boundary with the Eastside Subbasin near the City of Salinas. In the 180-Foot Aquifer, minimum groundwater elevations are approximately -20 ft NAVD88 during the fall measurements and -40 ft NAVD88 during the August measurements. In the 400-Foot Aquifer, minimum groundwater elevations are approximately -30 ft NAVD88 during the fall measurements and -70 ft NAVD88 during the August measurements. These low groundwater elevations are related to a pumping trough centered north of Salinas in the Eastside Subbasin. In this area, groundwater flow gradients are not parallel to the Valley's long axis, but rather are cross-valley towards the pumping trough. The hydraulic gradient steepens in the vicinity of the pumping trough, with observed gradients of approximately 0.003 ft/ft, or 16 ft/mile.

Groundwater elevations increase toward the northwestern boundary of the Subbasin until they are near sea level near the Monterey Bay coastline. As described in Sections 5.2 and 5.3.2, the groundwater elevations near the coast are maintained near sea level through the hydraulic connection to the ocean. The process of seawater intrusion counteracts the lowering groundwater elevations in both the 180-Foot and the 400-Foot Aquifers and creates an influx of high salinity water into the Subbasin.

Groundwater elevations also increase toward the southern boundary, with groundwater elevations of approximately 90 ft NAVD88 and 75 ft NAVD88 in the 180-Foot and 400-Foot Aquifers at the boundary with the Forebay Subbasin.

Under the historical conditions of 1995, the same flow pattern was present in both aquifers; however, the magnitude of the pumping trough has varied over time. A discussion of historical groundwater elevation changes is presented in Section 5.1.3.

The MCWRA does not produce groundwater elevation maps of the Deep Aquifers. Insufficient data currently exist to map flow directions and groundwater elevations in the Deep Aquifers. This is a data gap that will be addressed in GSP implementation.

5.1.3 180/400-Foot Aquifer Subbasin Hydrographs

Representative temporal trends in groundwater elevations can be assessed with hydrographs that plot changes in groundwater elevations over time. Groundwater elevation data from wells within the Subbasin are available from monitoring conducted and reported by MCWRA.

Figure 5-10 depicts the locations and hydrographs of representative wells monitored by MCWRA in the 180-Foot Aquifer and their hydrographs. Larger versions of the hydrographs shown on Figure 5-10 are included on Figure 5-11 through Figure 5-13. Figure 5-14 depicts the locations and hydrographs of representative wells monitored by MCWRA in the 400-Foot Aquifer. Larger versions of the hydrographs shown on Figure 5-14 are included on Figure 5-15 through Figure 5-18. MCWRA only monitors one well in the Deep Aquifers. Figure 5-19 and Figure 5-20 depict the location and hydrograph of this representative well within the Deep Aquifers.

Representative wells were chosen based on their distribution across the Subbasin, and the length and continuity of their monitoring record. Hydrographs for all wells in the Subbasin that are monitored by MCWRA and not limited by confidentiality agreements are included in Appendix 5A. The locations of all of these wells are shown on Figure 5-21.

These climatic variations influenced groundwater elevations much more than the benefits realized from the projects.

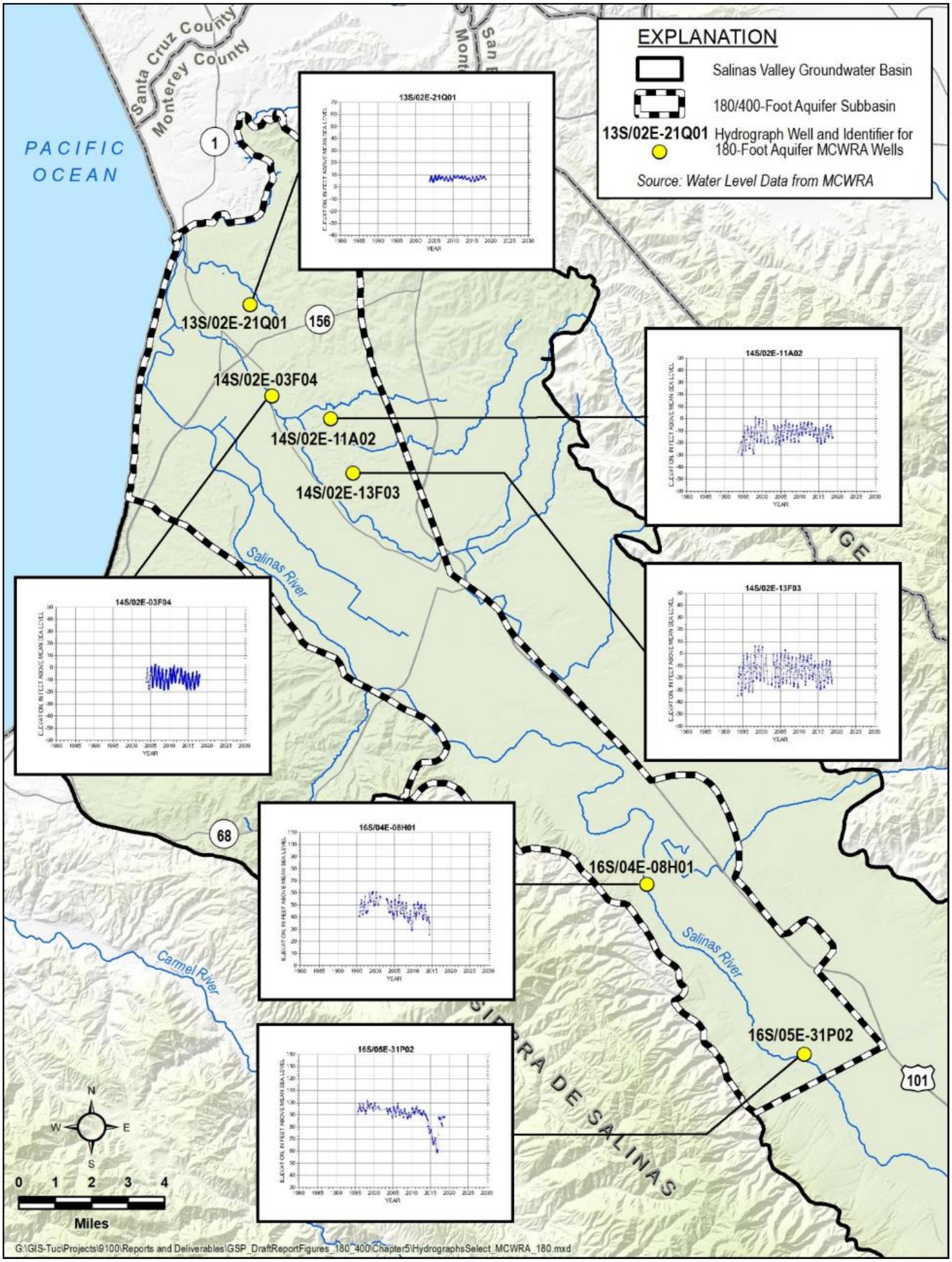
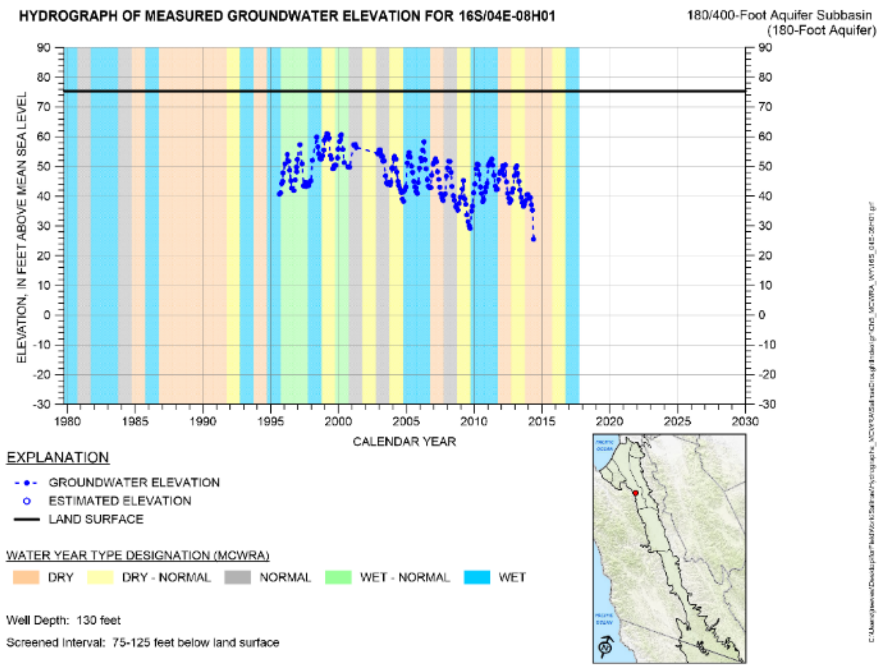


Figure 5-10. Map of Representative Hydrographs in the 180-Foot Aquifer



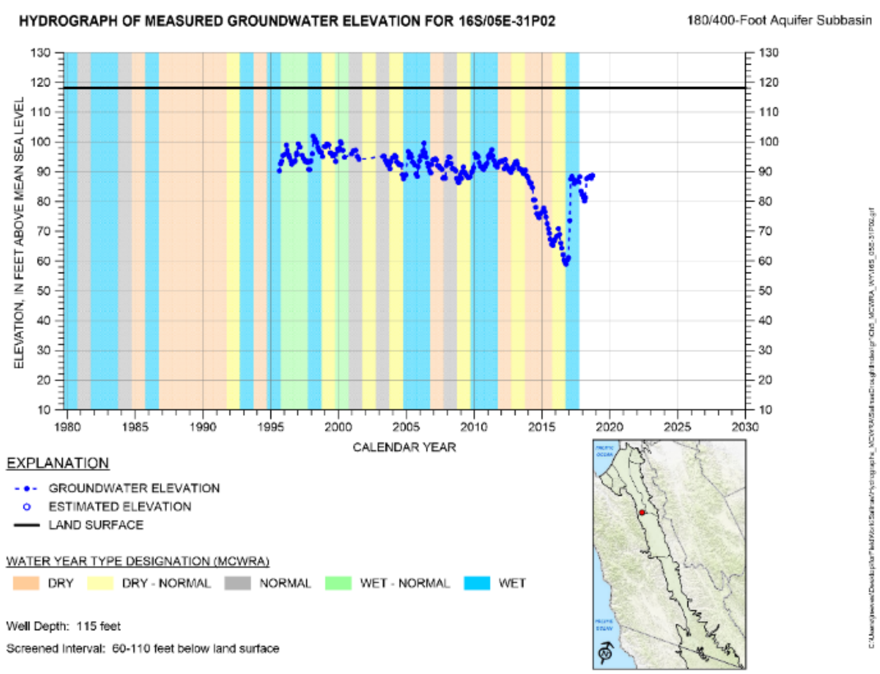
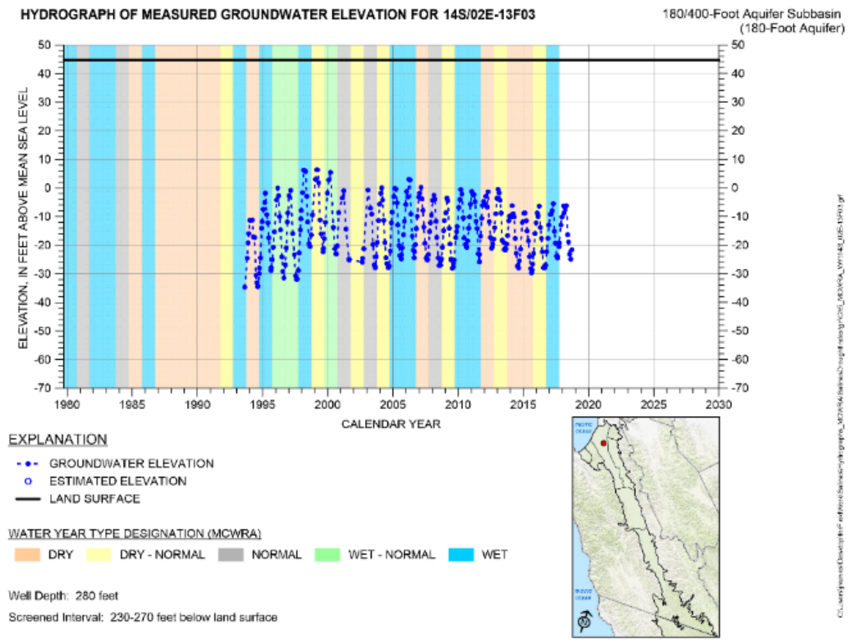


Figure 5-11. Representative Hydrographs Shown on the 180-Foot Aquifer Map (1)



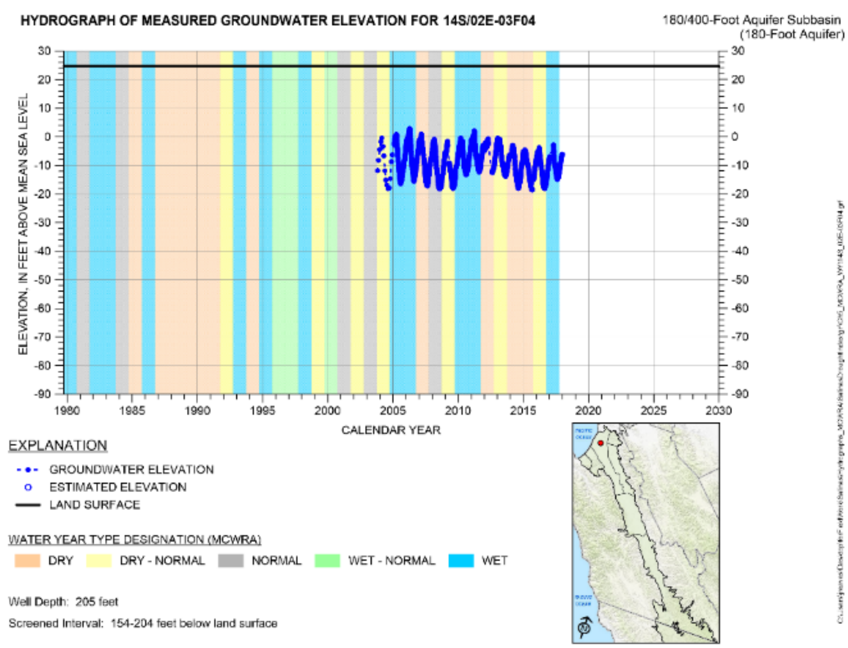
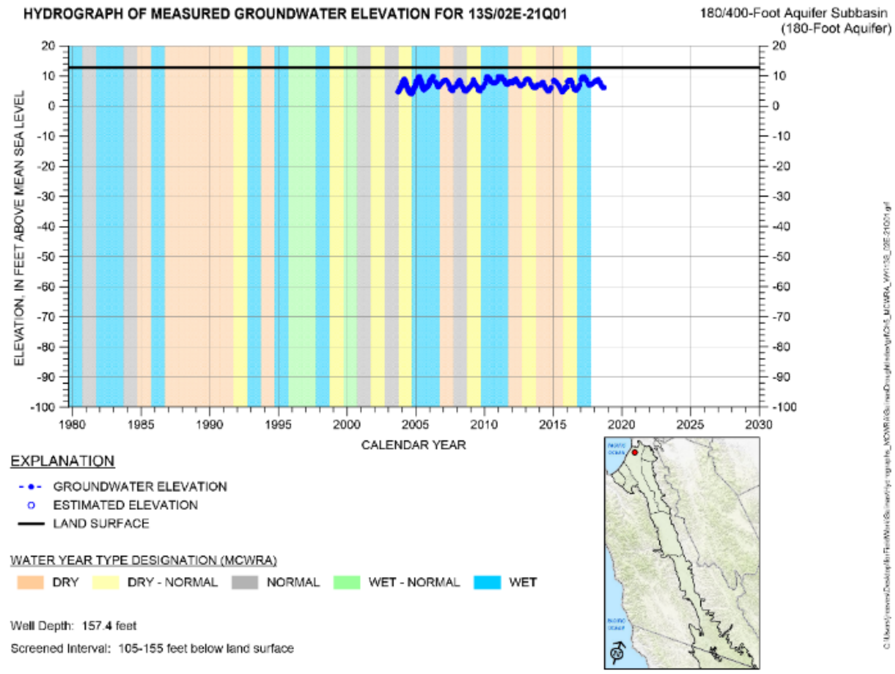


Figure 5-12. Representative Hydrographs Shown on the 180-Foot Aquifer Map (2)



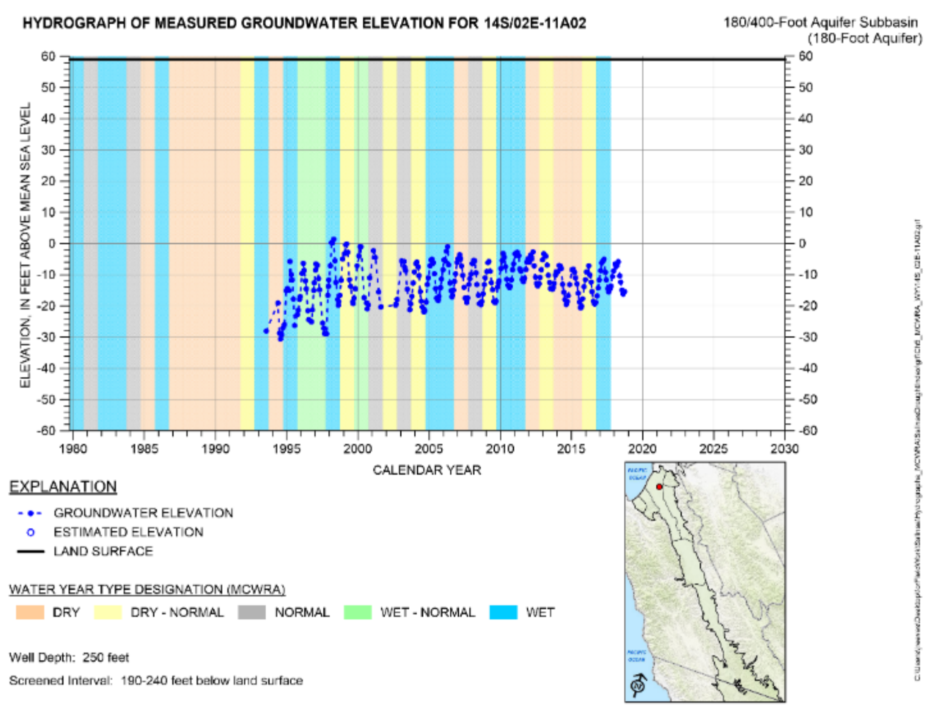


Figure 5-13. Representative Hydrographs Shown on the 180-Foot Aquifer Map (3)

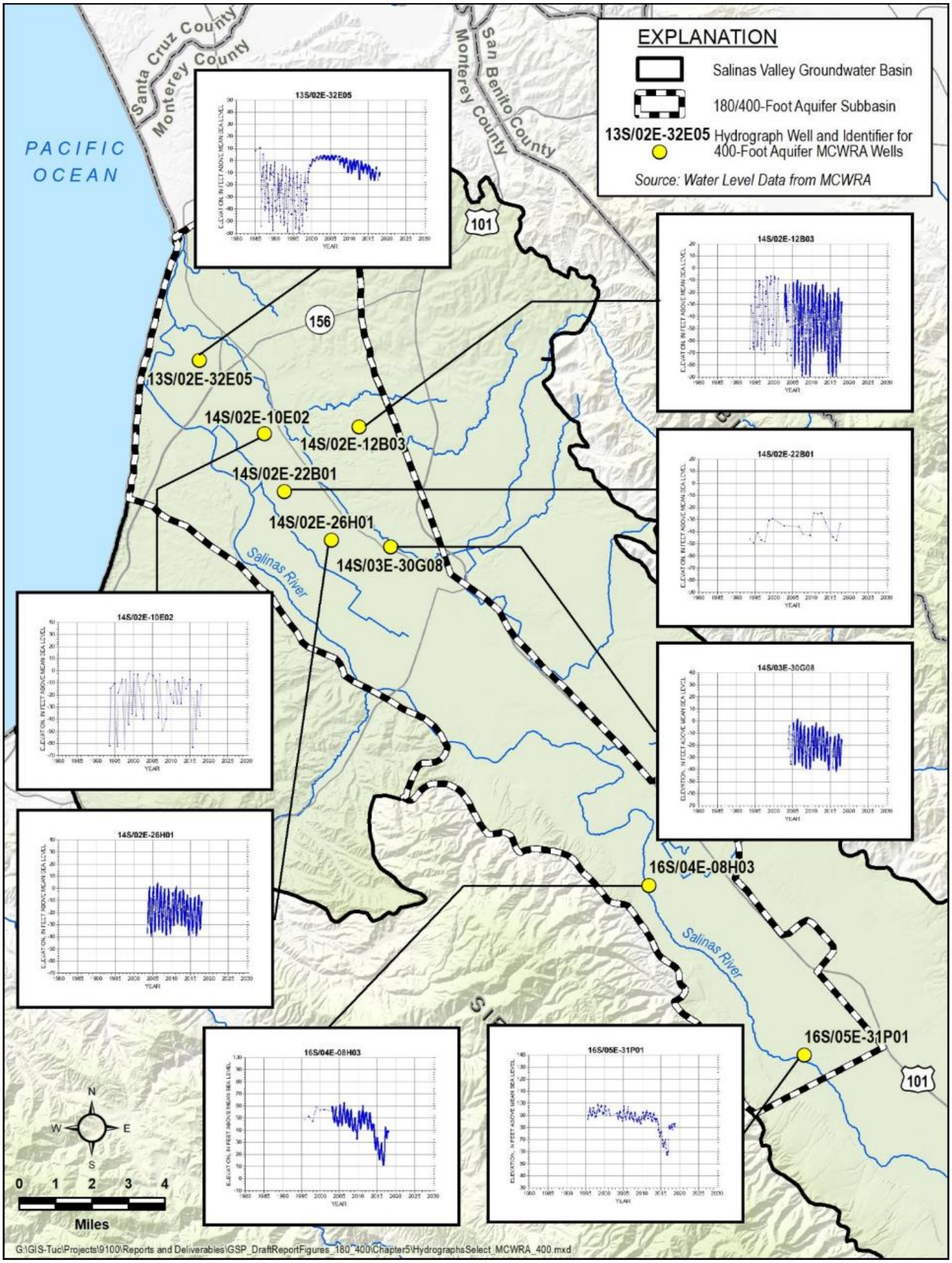
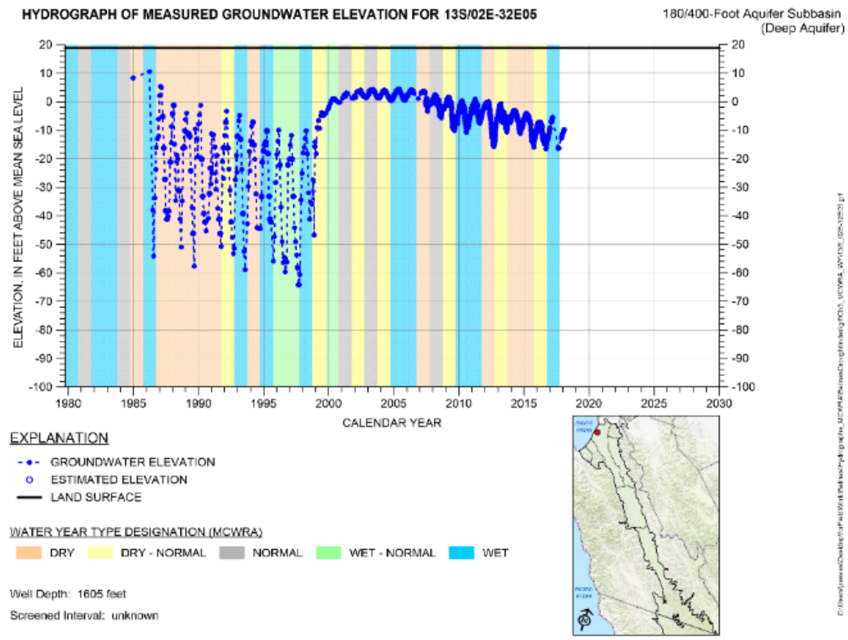


Figure 5-14. Map of Representative Hydrographs in the 400-Foot Aquifer



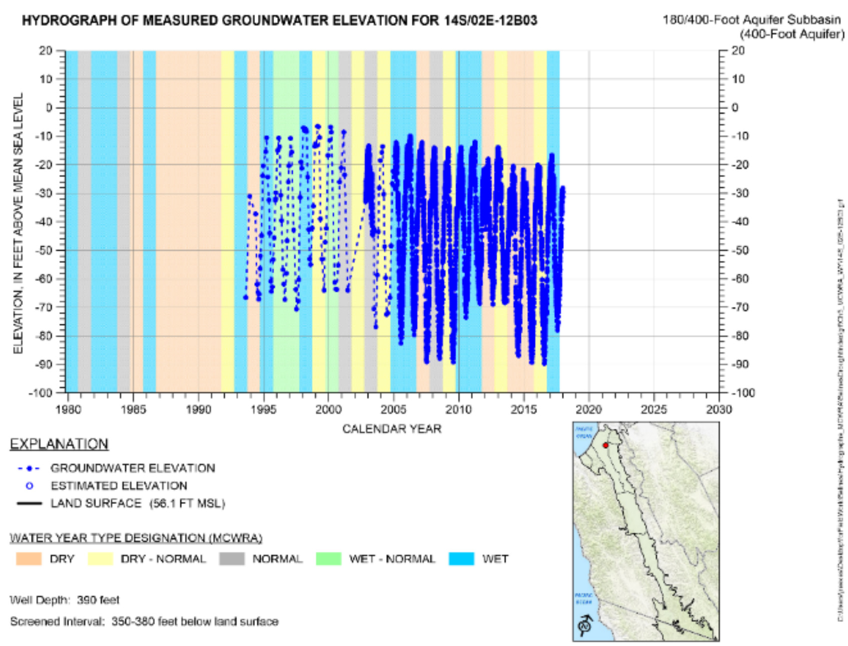
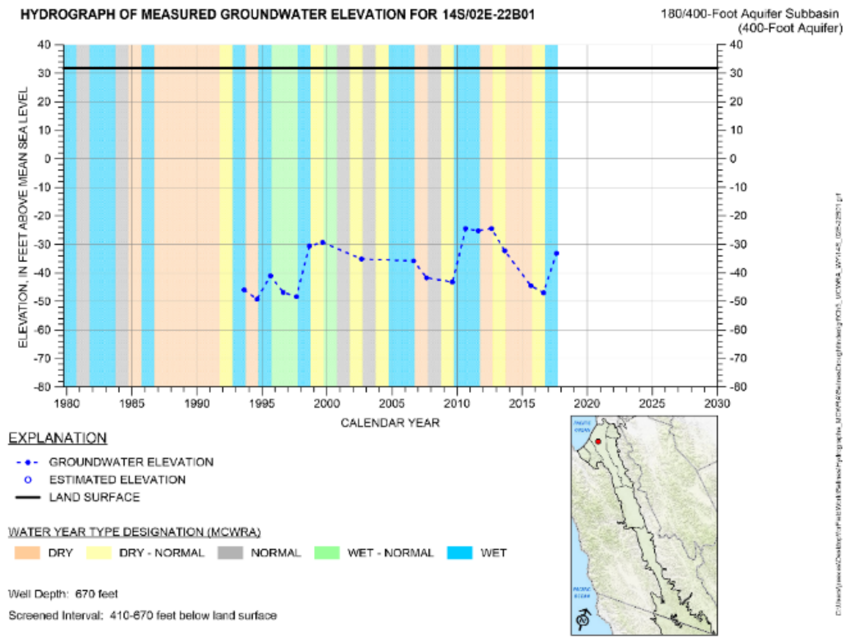


Figure 5-15. Representative Hydrographs Shown on the 400-Foot Aquifer Map (1)



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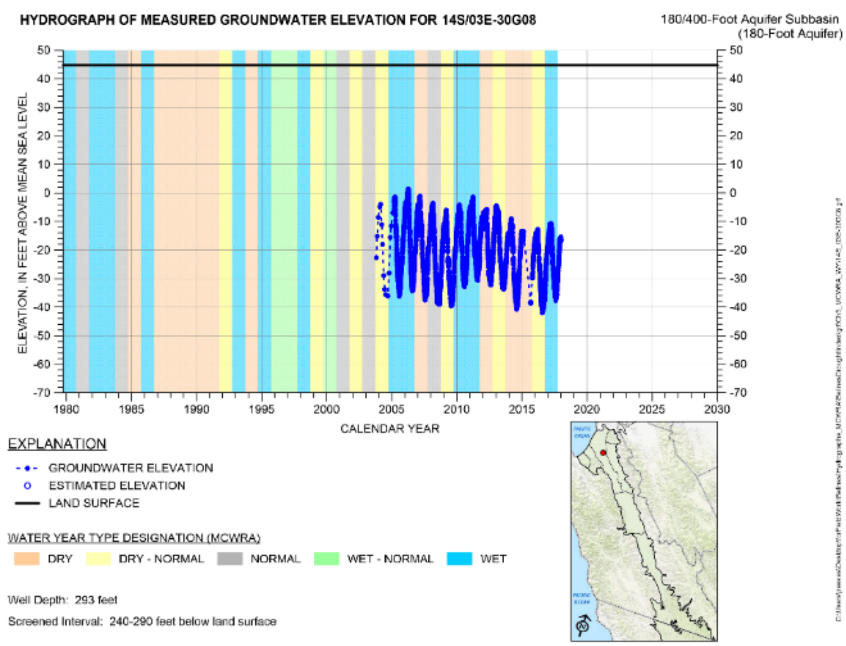
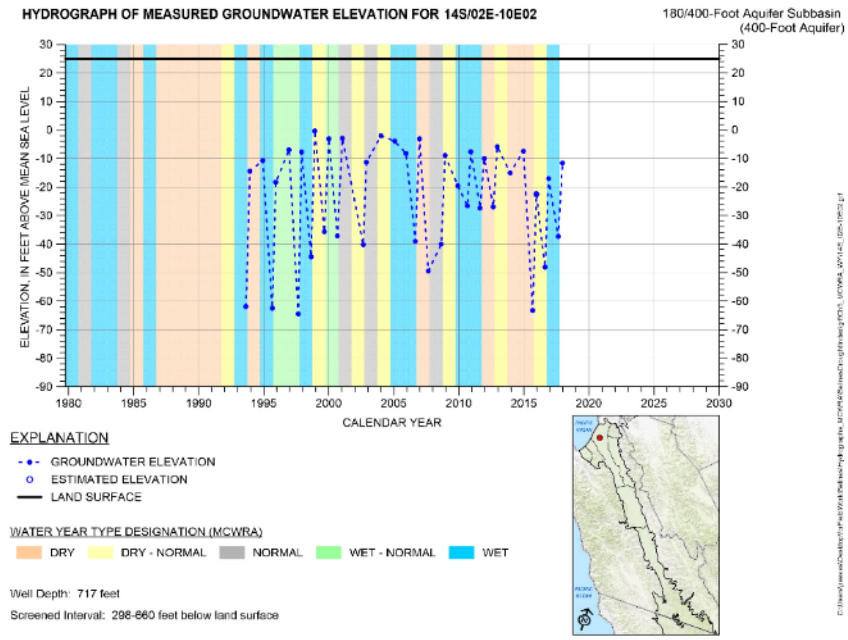


Figure 5-16. Representative Hydrographs Shown on the 400-Foot Aquifer Map (2)



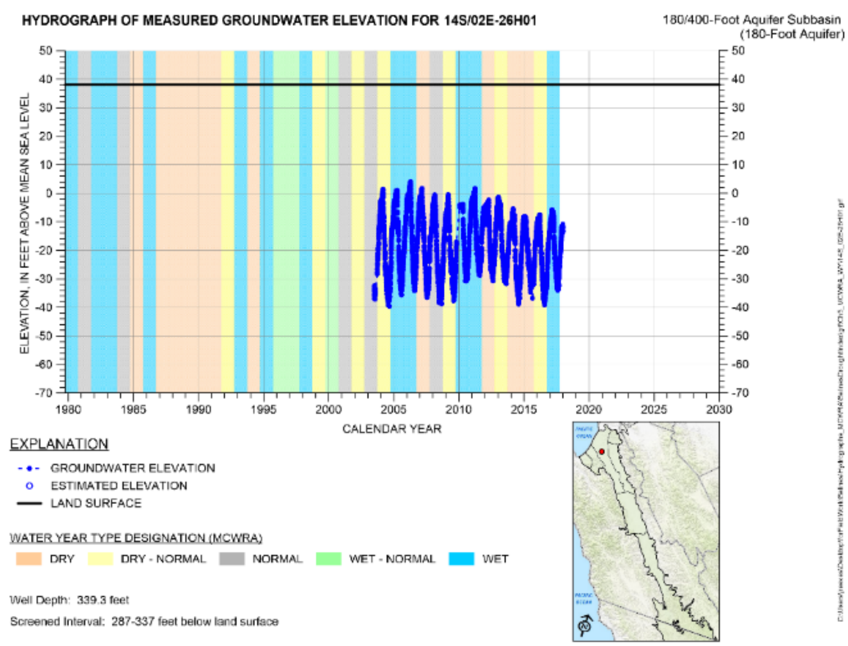
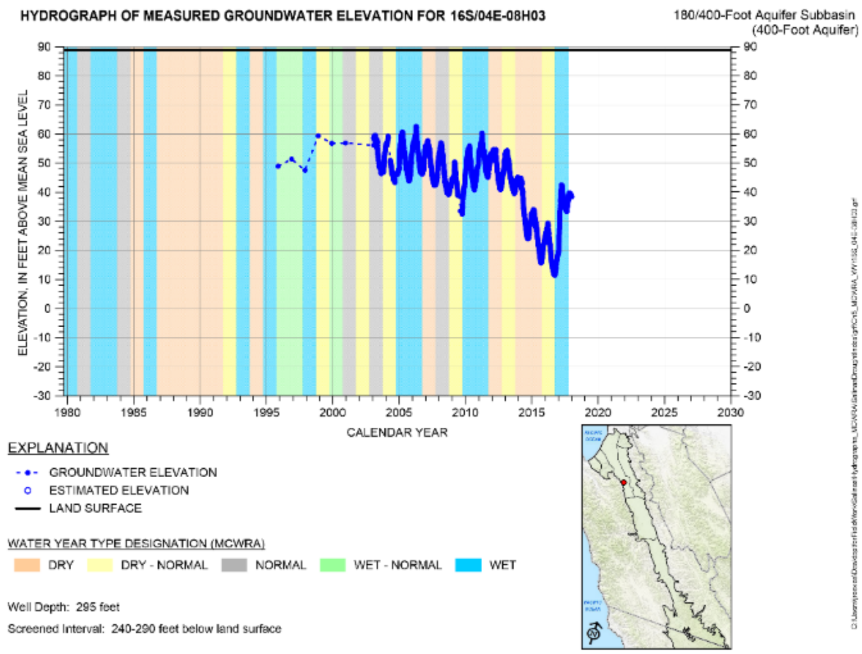


Figure 5-17. Representative Hydrographs Shown on the 400-Foot Aquifer Map (3)



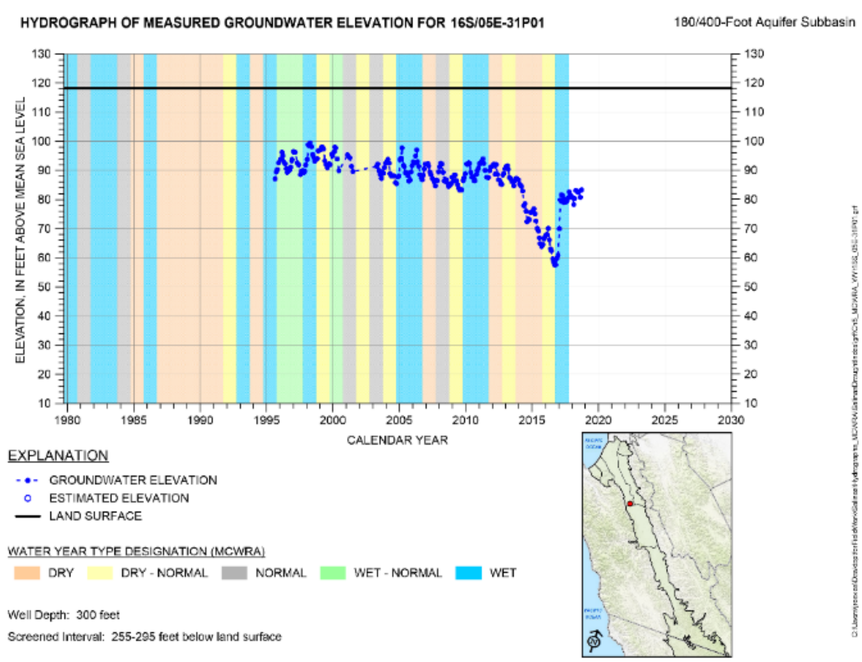


Figure 5-18. Representative Hydrographs Shown on the 400-Foot Aquifer Map (4)

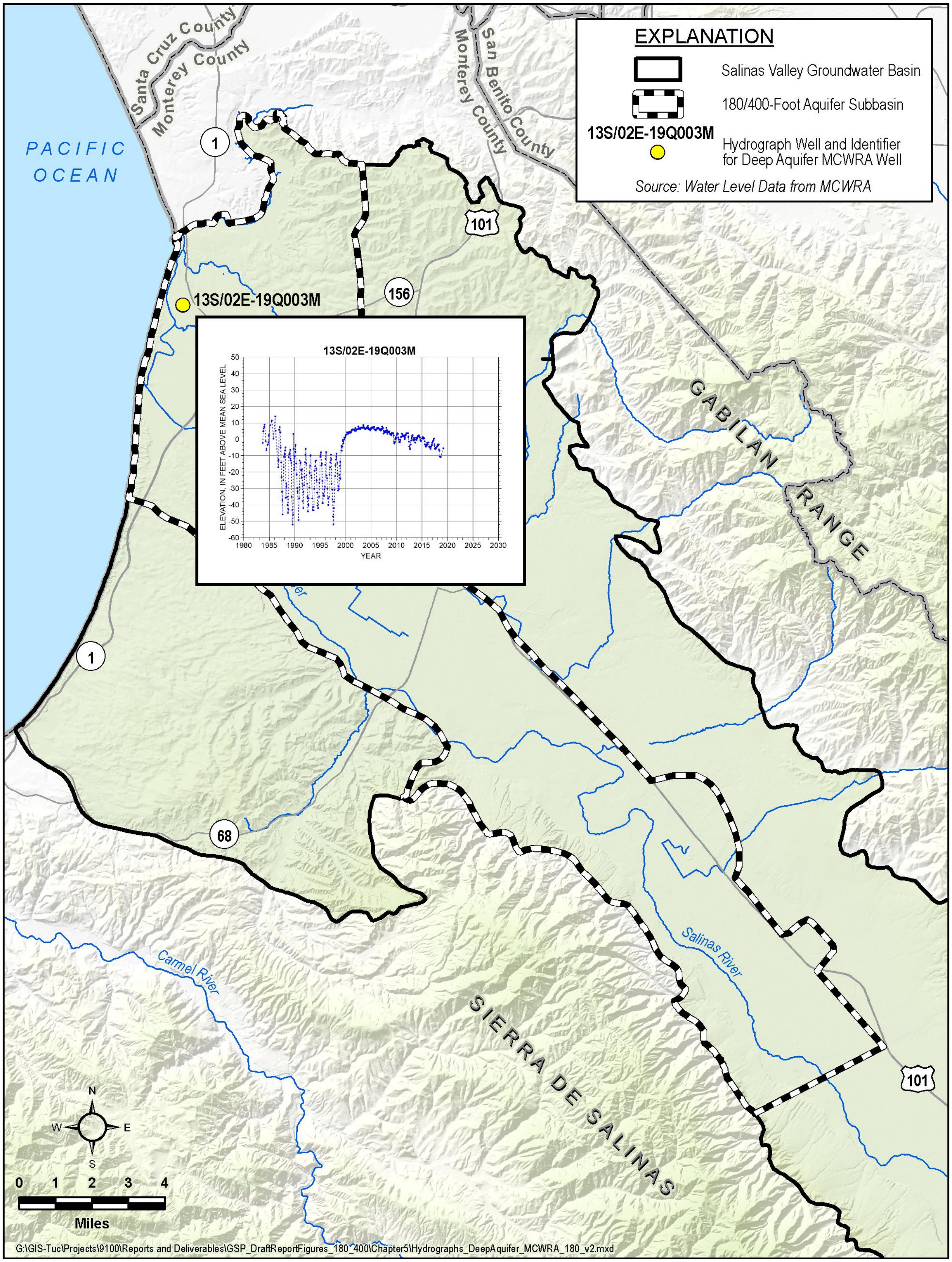


Figure 5-19. Map of Representative Hydrograph in the Deep Aquifers

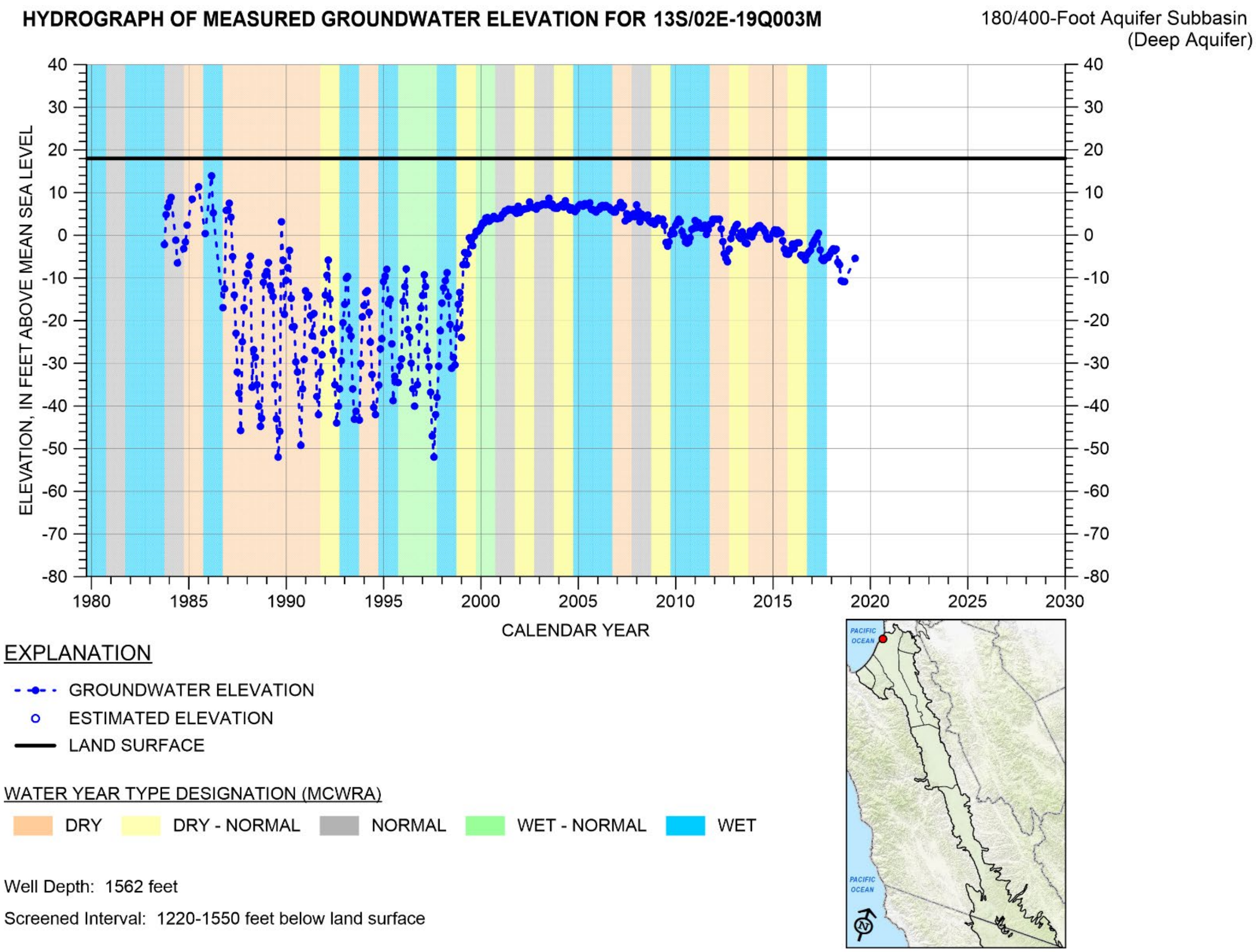


Figure 5-20. Representative Hydrograph Shown on the Deep Aquifers Map

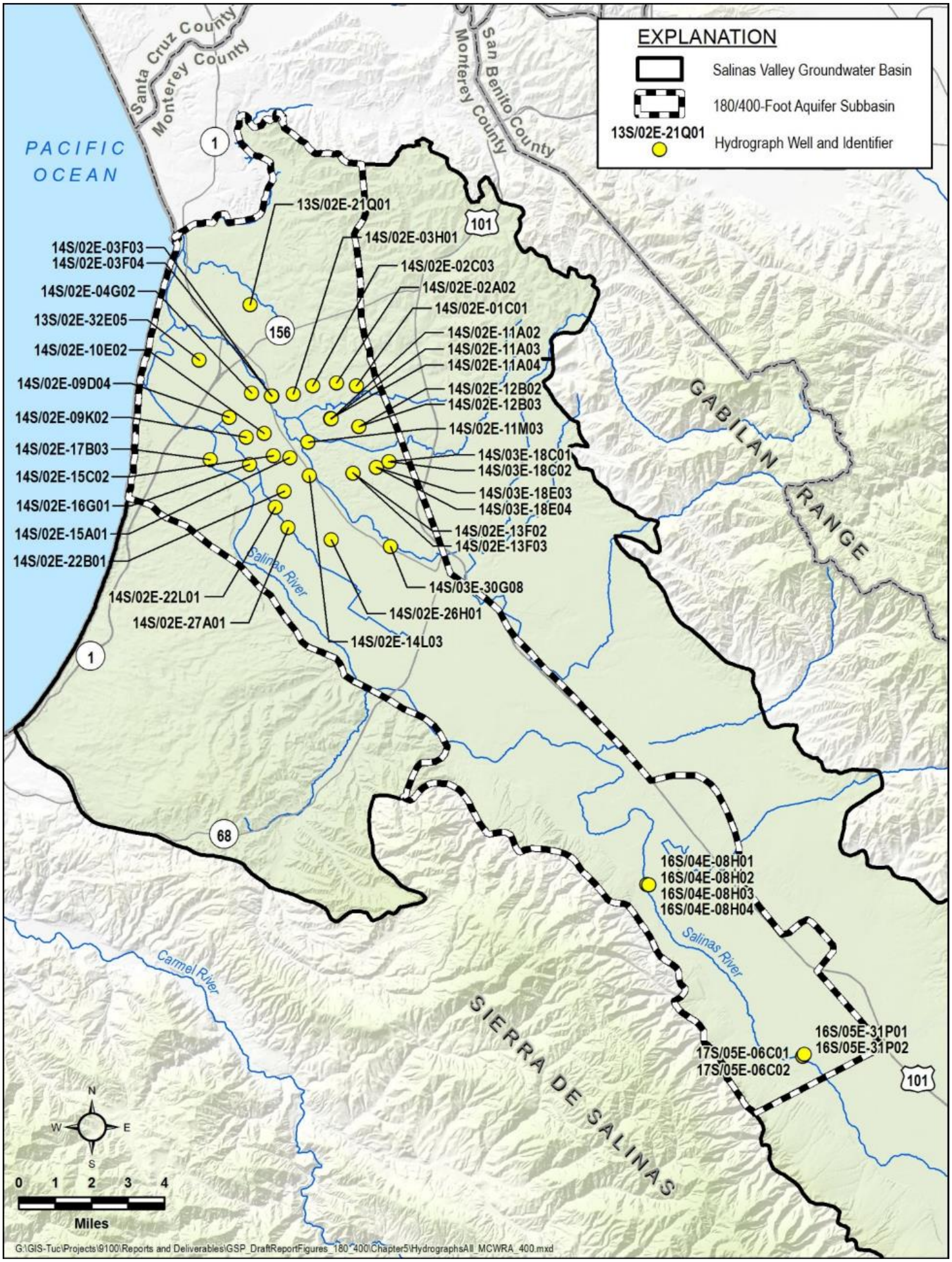


Figure 5-21. Locations of Wells with Hydrographs Included in Appendix 5A

In addition to the hydrographs of the representative wells, there is value in looking at representative average groundwater elevation at the subbasin scale. Figure 5-22 presents the graph of cumulative groundwater elevation change for the MCWRA-designated Pressure subarea. The Pressure subarea used by MCWRA for its analyses overlaps the 180/400-Foot Aquifer Subbasin, along with most of the Monterey Subbasin and part of the adjudicated Seaside Subbasin (Figure 5-23).

The plot on Figure 5-22 is based on calculations performed by MCWRA where the annual change in groundwater elevation is averaged for all wells in the subarea each year, beginning in 1945. The cumulative groundwater elevation change plot is therefore an estimation of the average hydrograph for the subarea. Although this plot does not reflect the groundwater elevation change at any specific location, it provides a clear illustration of how the average groundwater elevation in the subarea changes in response to changes in climatic cycles, groundwater extraction, and water-resources management at the subbasin scale.

The cumulative data presented on Figure 5-22, and the specific hydrographs presented above show that groundwater elevations in the 180/400-Foot Aquifer Subbasin show a general decline over time, with a fairly steady decline since 1998. MCWRA's subarea cumulative groundwater elevation change calculations include groundwater elevations measured in privately-owned wells. As these data are considered confidential, they are not presented in this document.

The cumulative groundwater elevation change graph shown on Figure 5-22 shows an apparent drop in average groundwater elevations following activation of the CSIP system in 1998; and another apparent drop in average groundwater elevations following activation of the SVWP in 2010. These apparent drops in average groundwater elevations are not the result of either of these projects but are rather the result of natural climatic variation. The water year type information shown behind the hydrographs on Figure 5-11 through Figure 5-13 indicate that there was a dry period between 2000 and 2005, soon after the CSIP project was initiated. Similarly, the SVWP project came online during an alternating climatic period, and just before an extended dry period.

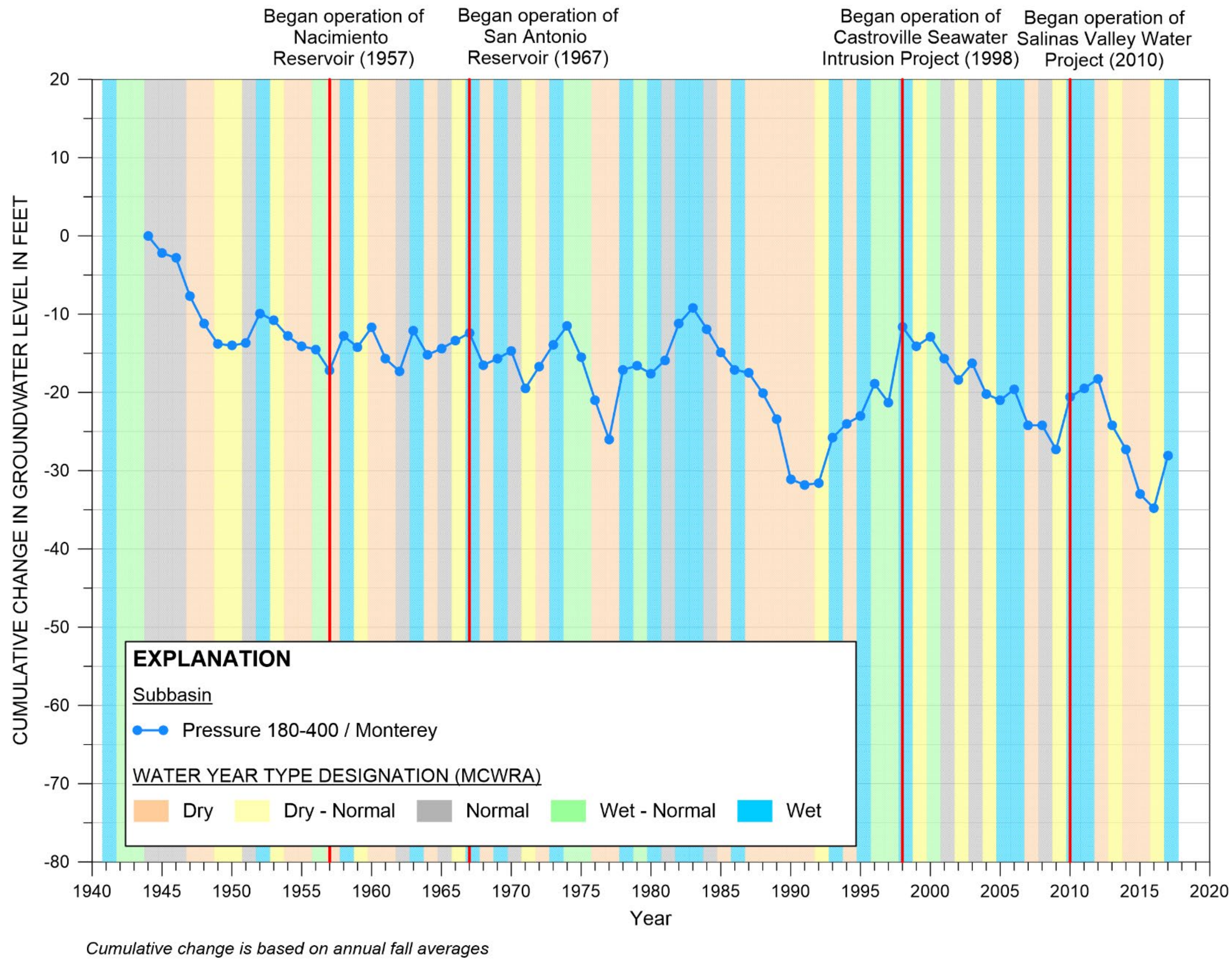


Figure 5-22. Cumulative Groundwater Elevation Change Graph for the MCWRA Pressure Subarea (from MCWRA, 2018, personal communication)

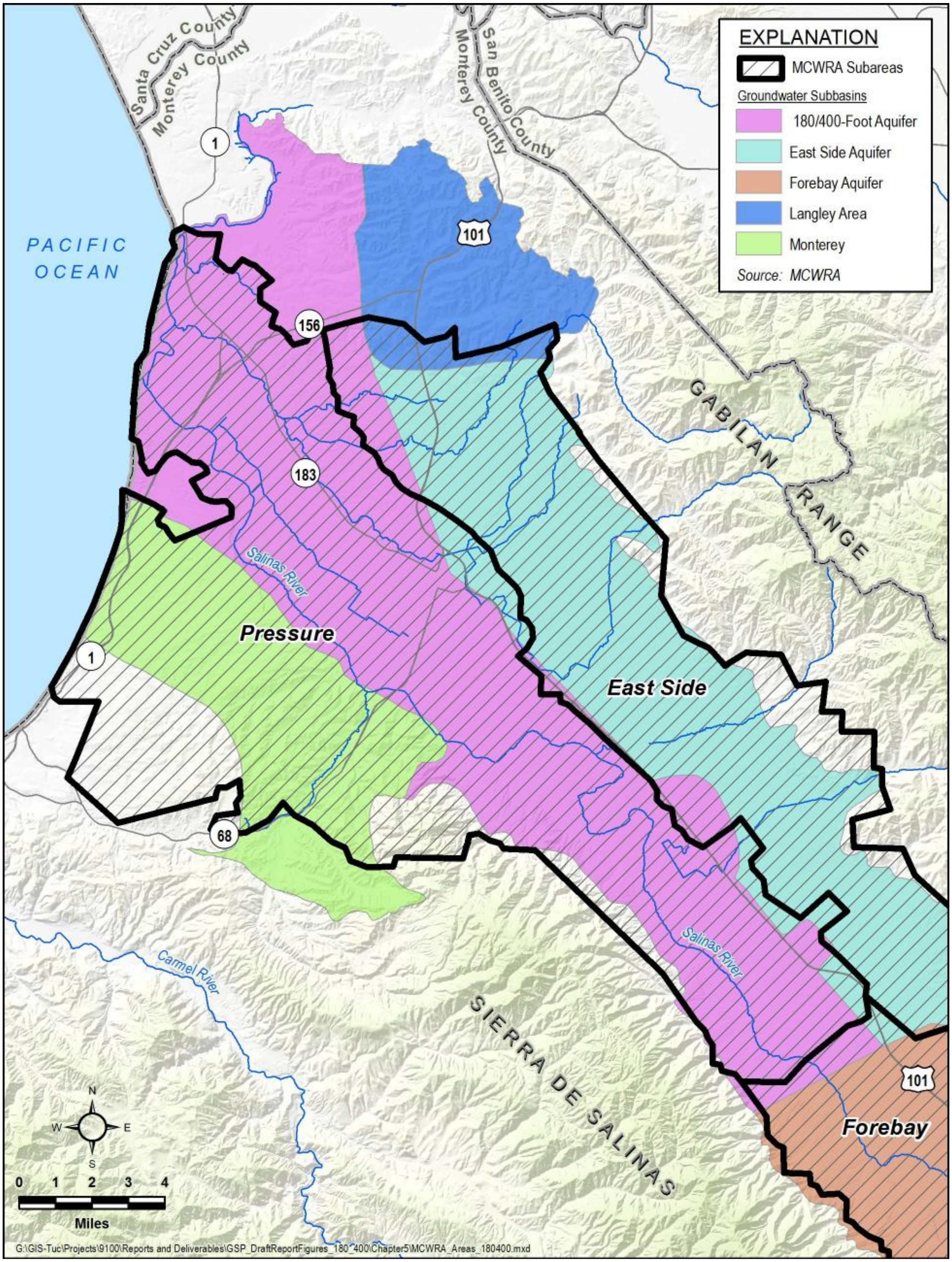


Figure 5-23. MCWRA Management Areas

5.1.4 Vertical Groundwater Gradients

In addition to the horizontal hydraulic gradients discussed above, there are vertical hydraulic gradients in the Subbasin. With groundwater recharge occurring at the ground surface and groundwater withdrawal from wells at depth, there is a basin-wide vertical downward hydraulic gradient. The practical impact of the vertical gradients is that wells completed at deeper depths, such as the 400-Foot Aquifer, may have lower groundwater elevations than shallower wells completed in the 180-Foot Aquifer. These vertical groundwater gradients can impact the location and amount of natural groundwater discharge to groundwater dependent ecosystems.

In the 180/400-Foot Aquifer Subbasin, the laterally extensive aquitards result in notable vertical hydraulic gradients: in some places groundwater elevations are approximately 20 to 50 feet lower in deeper wells than in shallower wells. Because the downward vertical gradients are caused by pumping, the magnitudes of the vertical gradients in many areas are greater during the irrigation season. Currently, there is very little data for the Deep Aquifers to establish vertical gradients between the Deep Aquifers and either the 400-Foot or 180-Foot Aquifers.

Figure 5-24 illustrates how vertical gradients at representative well pairs vary throughout the Subbasin. Each representative well pair consists of two adjacent wells with different well depths. The hydrographs for each well pair illustrate the difference in groundwater potentiometric elevation between wells of different depths at the same location. Well pair 1, in the northern portion of the Subbasin, has noticeably different groundwater potentiometric elevations at the two depths, while well pair 3, in the southern portion of the Subbasin shows no appreciable groundwater elevation difference between wells.

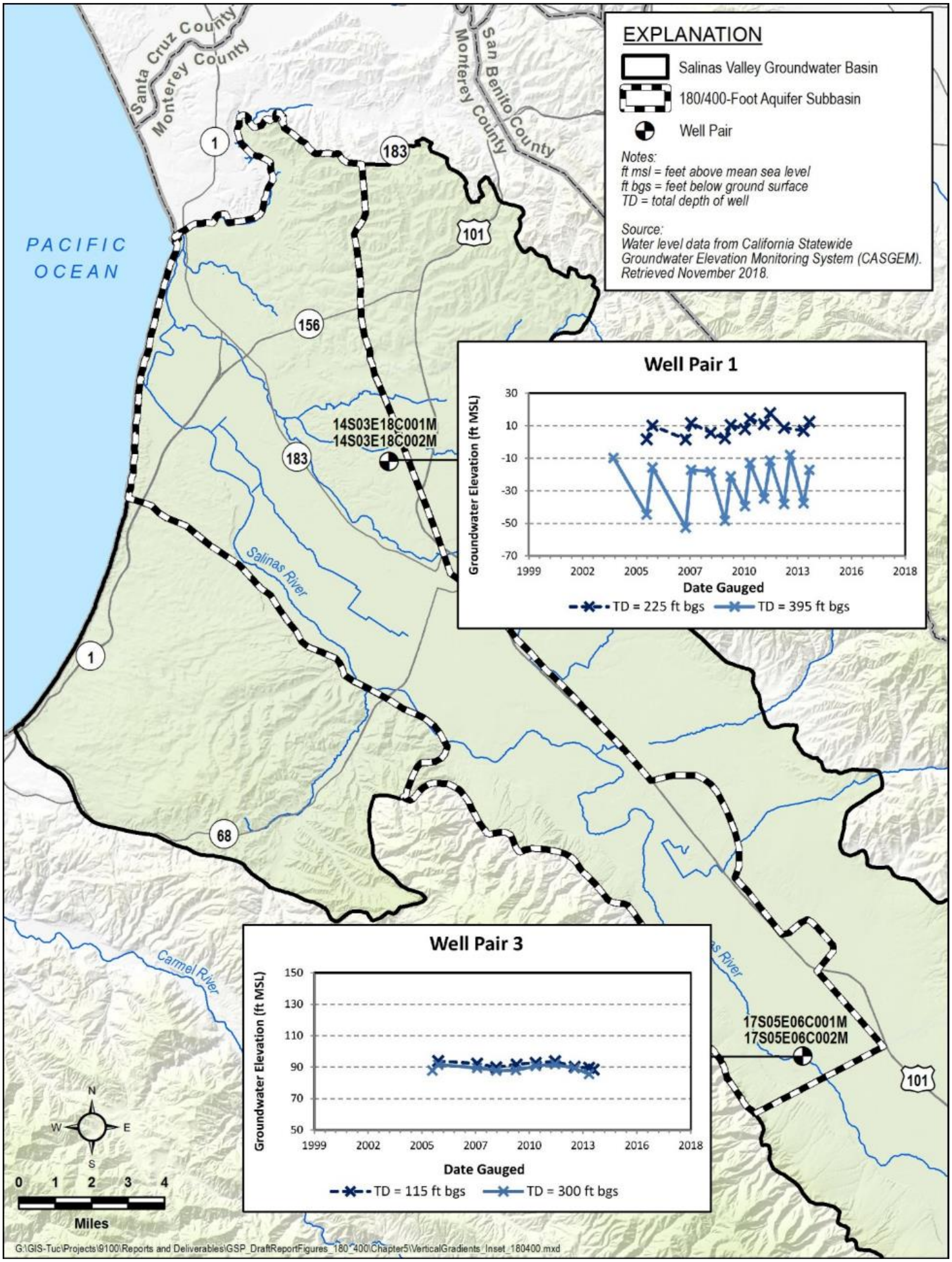


Figure 5-24. Vertical Gradients

5.2 Change in Groundwater Storage

This GSP adopts the concept of change in usable groundwater storage: defined as the annual average increase or decrease in groundwater that can be safely used for municipal, industrial, or agricultural purposes. Change in usable groundwater storage is the sum of change in storage due to groundwater elevation changes and the change in storage due to seawater intrusion.

5.2.1 Data Sources

MCWRA estimates average annual change in groundwater elevation for each Salinas Valley Groundwater subarea (Figure 5-22). These change in groundwater elevation plots are used to estimate change in groundwater storage due to elevation changes. Changes in groundwater storage due to seawater intrusion was estimated from previously published reports.

5.2.2 Change in Groundwater Storage Due to Groundwater Elevation Changes

One component of the change in groundwater storage is calculated from groundwater elevations in the Subbasin. The observed groundwater elevation changes provide a measure of the amount of groundwater that has moved into and out of storage during each year, not accounting for seawater intrusion. The change in storage can be calculated by multiplying a change in groundwater elevation by a storage coefficient. Storage coefficients depend on the hydraulic properties of the aquifer materials and are commonly measured through long-term pumping tests or laboratory tests.

The average groundwater elevation change that is shown on Figure 5-22 is used to estimate annual changes in water storage through the following relationship:

$$\Delta S = \Delta WL \times A \times SC$$

Where: ΔS = Annual change in storage volume in the Subbasin (AF/yr.)

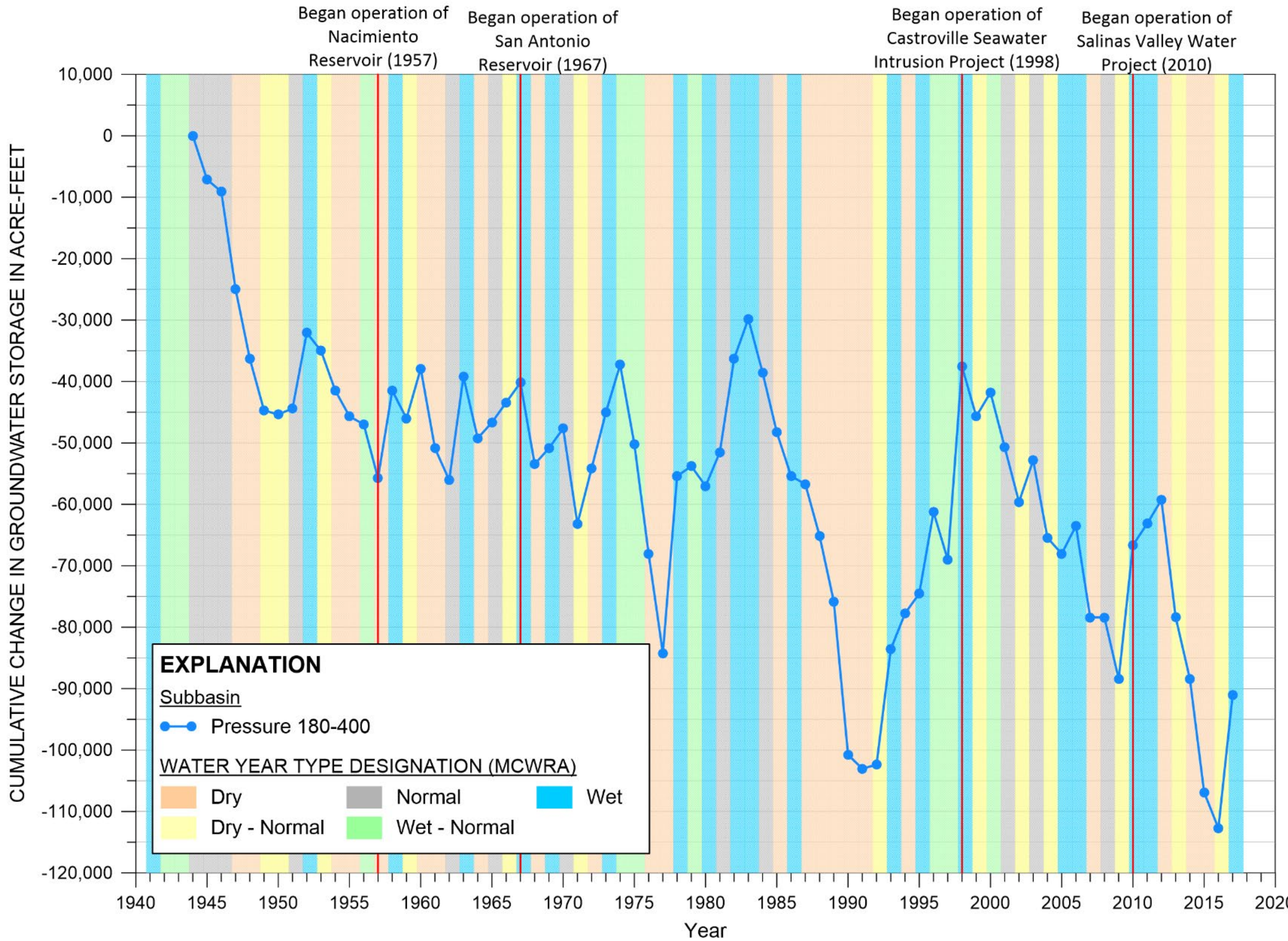
ΔWL= Annual change in average groundwater elevation in the Subbasin (ft/yr.)

A = Land area of Subbasin (acres)

SC = Storage coefficient (ft^3/ft^3)

The storage coefficient for the 180/400 Foot Aquifer Subbasin was estimated at 0.04 based on the *State of the Basin Report* (Brown and Caldwell, 2015). The area of the 180/400-Foot Aquifer Subbasin is approximately 89,700 acres.

Figure 5-25 presents a time series graph from 1944 through 2017 showing the estimated cumulative change in groundwater storage in the 180/400-Foot Aquifer Subbasin. It is based on groundwater levels collected by MCWRA in the fall of each year, which were the best available data.



Cumulative change is based on annual fall averages

Figure 5-25. Cumulative Change in Groundwater Storage in the Pressure Subarea, Based on Groundwater Elevations (From MCWRA, 2018, personal communication)

The timing of groundwater storage declines and recovery match the groundwater elevation patterns described in Section 5.1.3. However, the magnitudes of the groundwater storage changes are scaled by the storage coefficient and size of the Subbasin.

Figure 5-25 shows that the 180/400-Foot Aquifer Subbasin has experienced a long-term decline in groundwater storage due to lowering groundwater elevations. The average annual storage loss due to lowering groundwater elevation in the 180/400-Foot Aquifer Subbasin between 1944 and 2017 is approximately 1,200 AF/yr. Changes in the total basin groundwater storage can be divided into the following three periods:

- 1944 to 1948: decrease of 40,000 AF in groundwater storage
- 1947 to 1998: trend of steadily decreasing groundwater storage in most years with marked increases in 1974, 1983, and 1997
- 1998 to 2017: decrease of approximately 50,000 AF in groundwater storage.

5.2.3 Change in Groundwater Storage due to Seawater Intrusion

Estimates of groundwater storage losses due to seawater intrusion have ranged from 8,000 to 14,000 AF/yr. This GSP adopts a mid-range estimate of 10,500 AF/yr. of storage loss due to seawater intrusion in the 180/400-Foot Aquifer Subbasin. The sources of these estimates are discussed further in Section 5.3.3. This storage loss is in addition to the change in groundwater storage due to changes in groundwater elevations.

5.2.4 Total Annual Average Change in Groundwater Storage

The total annual average change in groundwater storage is the sum of the changes in groundwater storage due to groundwater elevation changes and seawater intrusion. The total annual loss in groundwater storage for the entire period of record is therefore:

- Annual storage loss due to groundwater elevation decrease 1,200 AF/yr.
- Annual loss due to seawater intrusion 10,500 AF/yr.
- Total annual loss of storage 11,700 AF/yr.

5.3 Seawater Intrusion

The 180-Foot and 400-Foot Aquifers have been subject to seawater intrusion for more than 70 years, as demonstrated by increased salt concentrations in wells near the Monterey Bay coastline. The negative impact of seawater intrusion on local water resources and the agricultural economy has been the primary motivation for many studies dating back to 1946 (DWR, 1946). MCWRA and others have implemented a series of engineering and management projects including well construction moratoriums, developing the (CSIP system, and implementing the Salinas Valley Water Project (SVWP), among other actions to halt seawater intrusion. Although those actions have managed to slow the advance of intrusion and reduce its impacts, seawater intrusion remains an ongoing threat.

5.3.1 Data Sources

The extent and advance of seawater intrusion has been monitored and reported by MCWRA. Monitoring seawater intrusion has been on-going since the Agency formed in 1947 and currently includes a network of 96 agricultural wells and 25 dedicated monitoring wells that are sampled twice annually: in June and August. The water samples are analyzed for general minerals; and the analytical results are used by MCWRA to analyze and report the following:

- Maps and graphs of historical chloride and specific conductivity trends
- Stiff diagrams and Piper diagrams
- Plots of chloride concentration vs. Na/Cl molar ratio trends

MCWRA publishes estimates of the extent of seawater intrusion every 2 years. The MCWRA maps define the extent of seawater intrusion as the inferred location of the 500 mg/L chloride concentration isocontour. This chloride concentration is significantly lower than the 19,000 mg/L chloride concentration typical of seawater, but it represents a concentration that may begin to impact use of the water. The 500 mg/L threshold is considered the Upper Limit Secondary Maximum Contaminant Level (SMCL) for chloride as defined by the EPA, and is approximately ten times the concentration of naturally occurring groundwater in the Subbasin.

5.3.2 Seawater Intrusion Maps and Cross Section

Figure 5-26 and Figure 5-27 present the MCWRA maps of the most current and historical extent of seawater intrusion for the 180-Foot Aquifer and the 400-Foot Aquifer, respectively. In each of the two figures, the extent of the shaded contours represents the extent of groundwater with chloride exceeding 500 mg/L during the 2017 monitoring period. The historical progression of the 500 mg/L extent is also illustrated on these figures through the colored overlays that represent the extent of seawater intrusion observed during selected years.

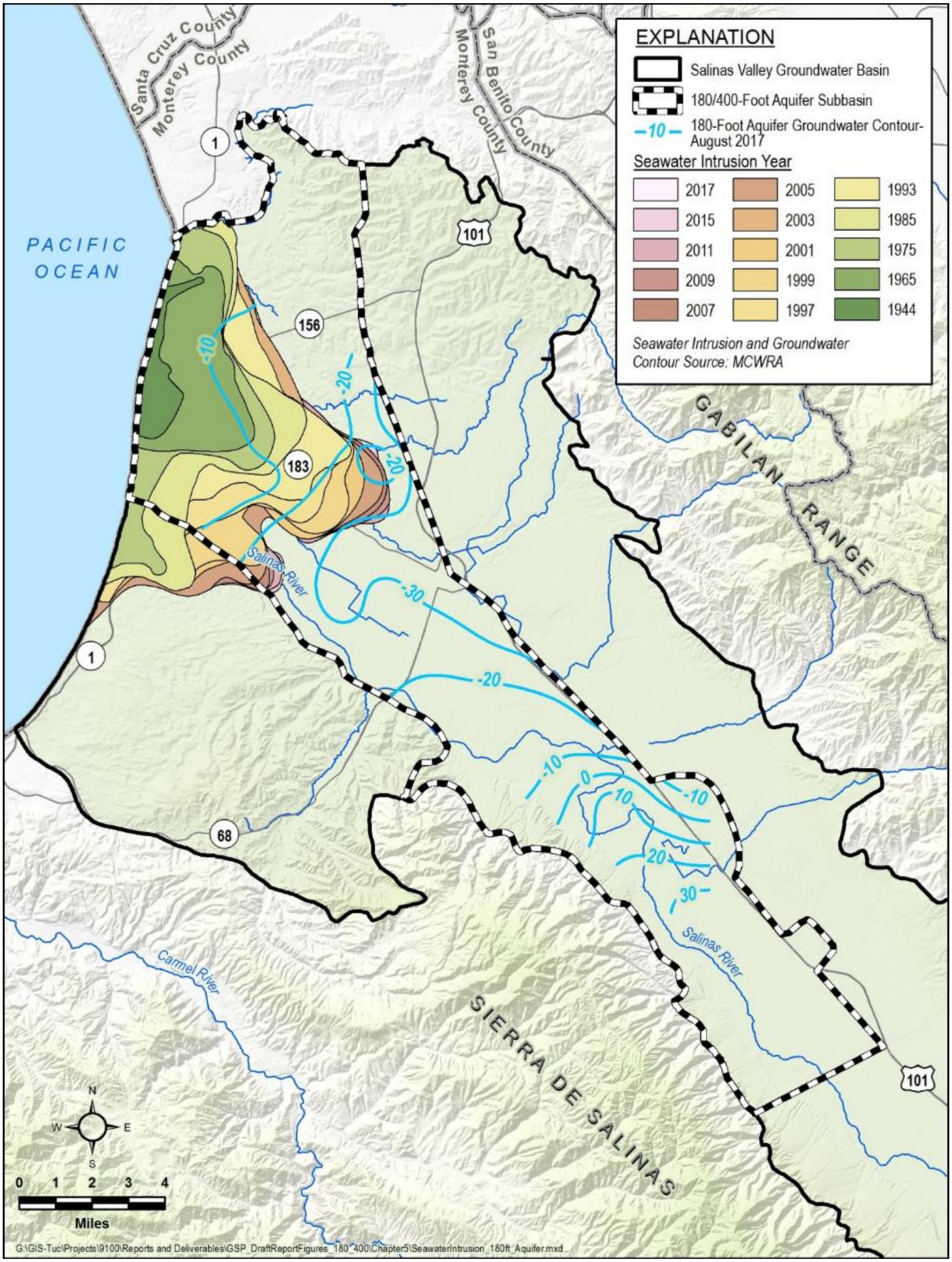


Figure 5-26. Seawater Intrusion in the 180-Foot Aquifer
(from MCWRA)

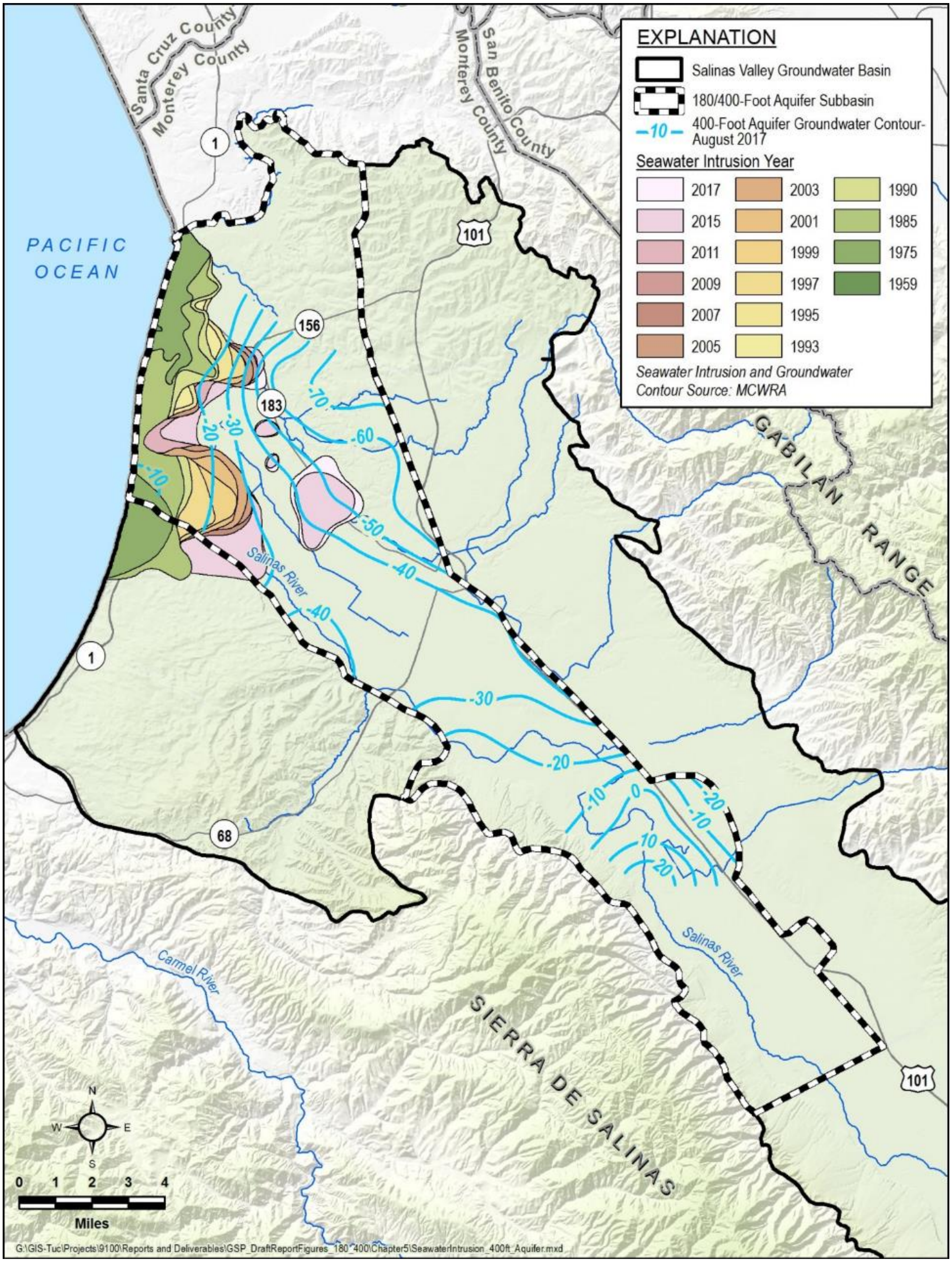


Figure 5-27. Seawater Intrusion in the 400-Foot Aquifer
(from MCWRA)

Figure 5-26 and Figure 5-27 also present the mapped August 2017 groundwater elevations for the 180-Foot Aquifer and the 400-Foot Aquifer. These maps show the seasonally low groundwater elevations that drive seawater intrusion.

A cross-section showing the vertical distribution of seawater intrusion is shown on Figure 5-28. The hydrostratigraphy shown on this cross section is adapted from the *Final report, hydrostratigraphic analysis of the Northern Salinas Valley* (Kennedy-Jenks, 2004). The location of the cross-section is shown as line A-A’ on Figure 5-29. The superposition of the seawater intrusion on the existing hydrostratigraphic cross-section was based on the 2017 500mg/L contour from MCWRA and recent groundwater quality data in the GSP database. The entire saturated thickness of the aquifer was assumed to be seawater intruded if any well in the aquifer indicated seawater intrusion.

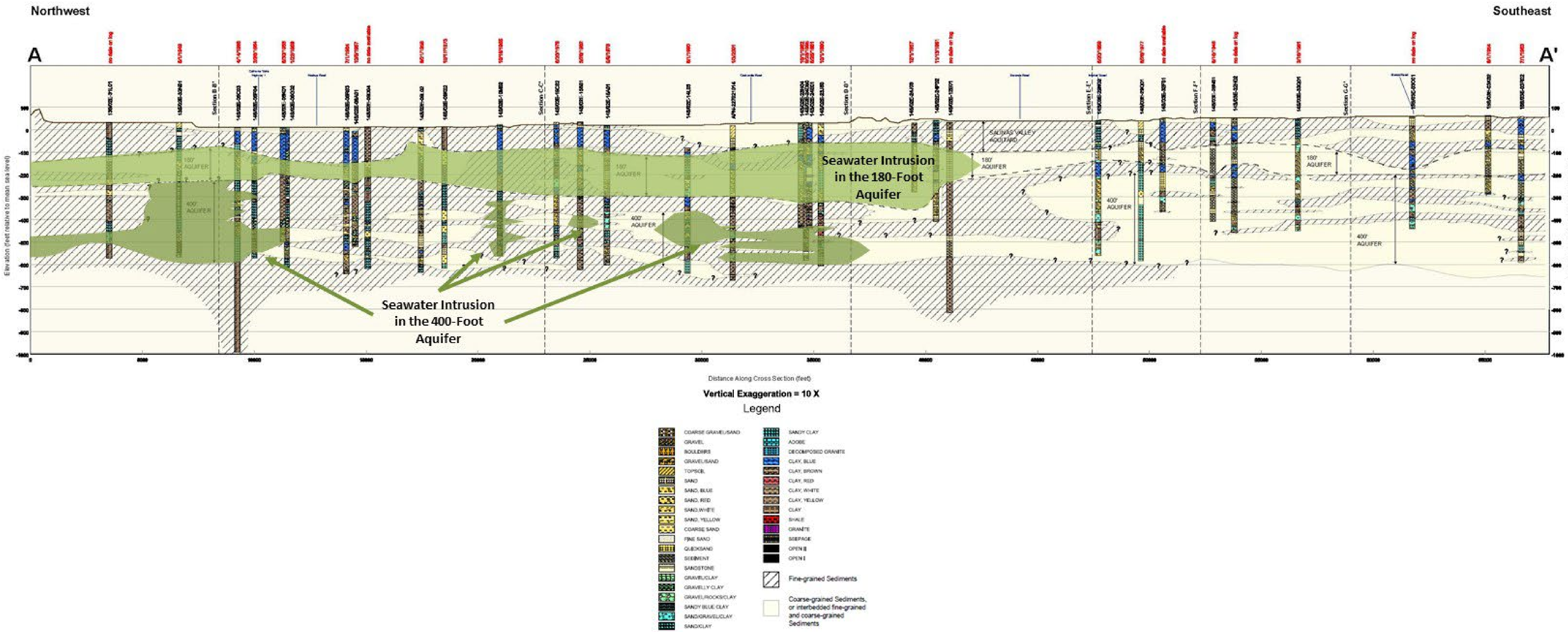


Figure 5-28. Cross-Section of Estimated Depth of Seawater Intrusion Based on Mapped 2017 Intrusion

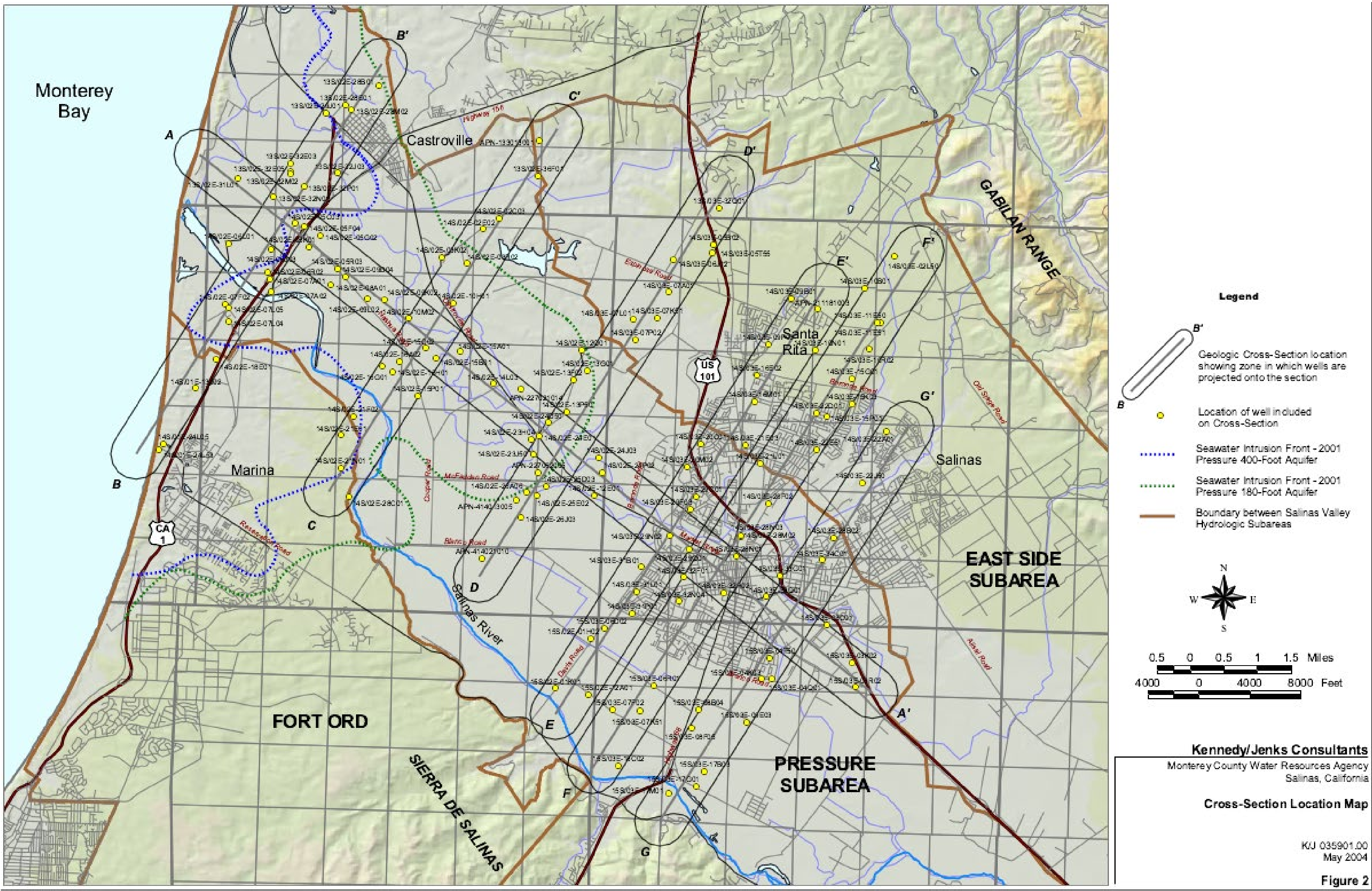


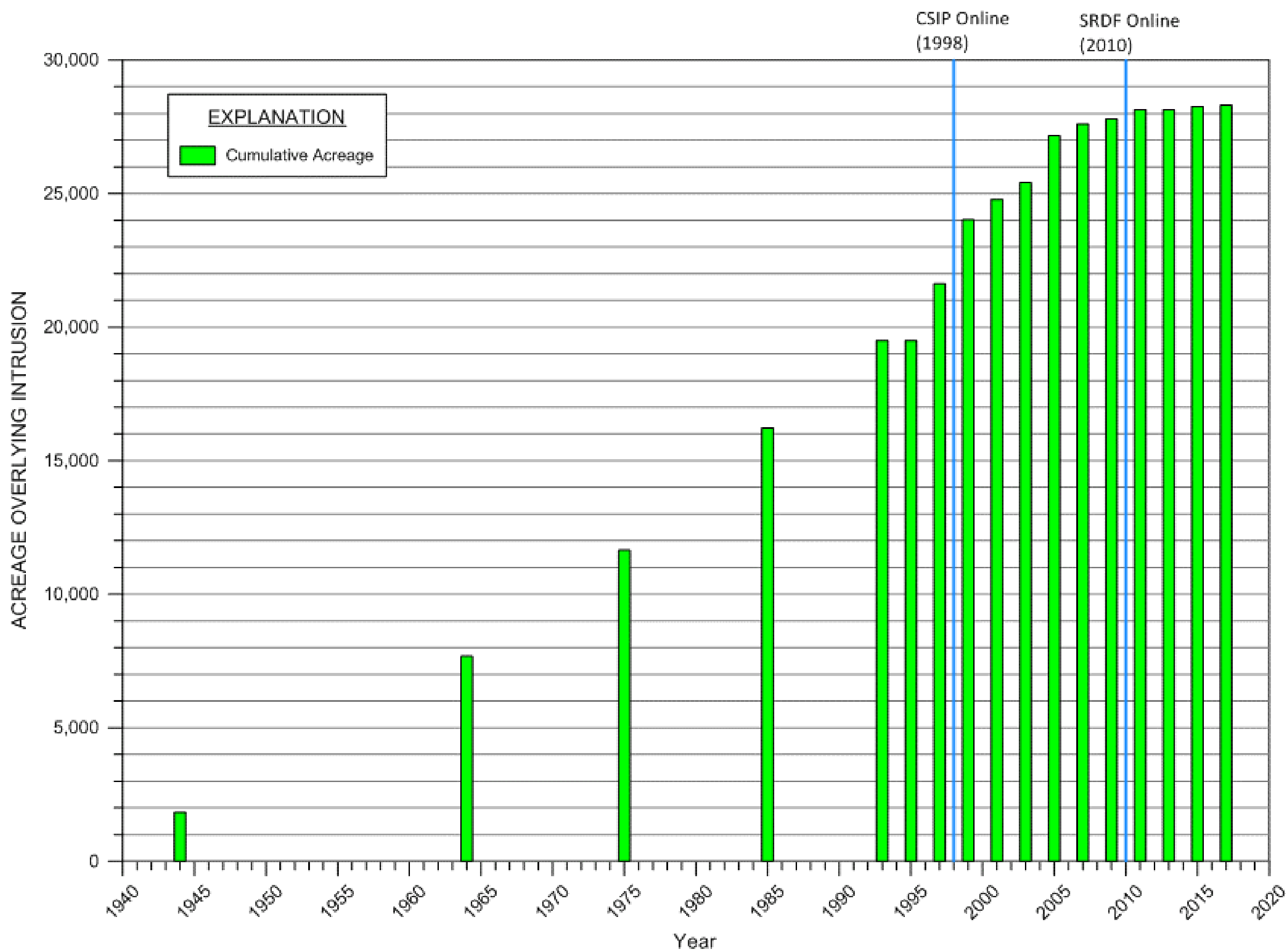
Figure 5-29. Location of Cross-Section A-A' Used for Hydrostratigraphy on Figure 5-28

5.3.3 Seawater Intrusion Rates

Figure 5-30 and Figure 5-31 present the time series graphs of the total acreage that overlies groundwater with chloride concentration greater than 500 mg/L. Figure 5-30 shows the time series of acreage overlying seawater intrusion in the 180-Foot Aquifer. In 2017 89% of this seawater intruded area was in the 180/400-Foot Aquifer Subbasin and the remainder was in the adjacent Monterey Subbasin. Figure 5-31 shows the time series of acreage overlying seawater intrusion in the 400-Foot Aquifer. In 2017, 78% of this seawater intruded area was in the 180/400-Foot Aquifer Subbasin and the remainder was in the adjacent Monterey Subbasin.

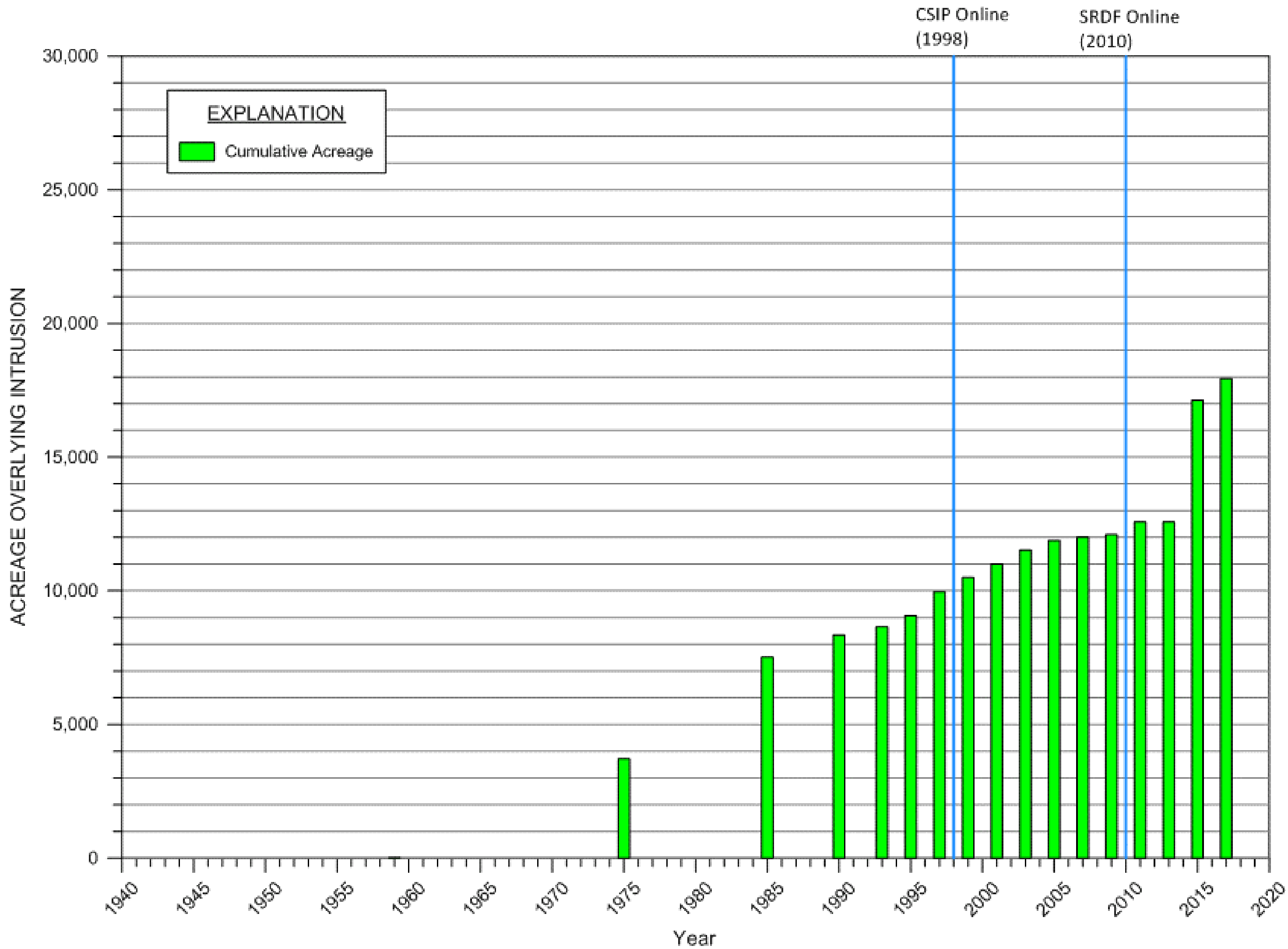
As shown on Figure 5-30, seawater intrusion into the 180-Foot Aquifer covered approximately 20,000 acres in 1995 and had expanded to approximately 28,000 acres by 2010. Since then, the rate of expansion has decreased, with an overlying area of 28,300 acres in 2017.

The area overlying intrusion into the 400-Foot Aquifer is not as extensive, with an overlying area of approximately 12,000 acres in 2010. However, between 2013 and 2015, the 400-Foot Aquifer experienced a significant increase in the area of seawater intrusion, from approximately 12,500 acres to approximately 18,000 acres. This apparent rapid increase in this area is likely the result of localized downward migration of high chloride groundwater from the 180-Foot Aquifer to the 400-Foot Aquifer. The process of downward migration between aquifers may be in part attributed to wells that are screened across both aquifers, discontinuous aquitards, or improperly abandoned wells. Regardless of the specific pathways, the presence of vertical downward hydraulic gradients from the 180-Foot Aquifer to the 400-Foot Aquifer presents a risk that eventually the intruded area of the 400-Foot Aquifer will be as large as that of the 180-Foot Aquifer.



Source: Special Joint Meeting of MCWRA BOD and Monterey County BOS

Figure 5-30. Acreage Overlying Seawater Intrusion in the 180-Foot Aquifer
(created with data from MCWRA)



Source: Special Joint Meeting of MCWRA BOD and Monterey County BOS

Figure 5-31. Acreage Overlying Seawater Intrusion in the 400-Foot Aquifer
(created with data from MCWRA)

Seawater intrusion has not been reported in the Deep Aquifers. However, due to concern over this risk, the County has a current moratorium under its Ordinance 5303 on the construction of new wells in the Deep Aquifers beneath the areas impacted by seawater intrusion.

The volume of seawater flowing into the Subbasin every year does not strictly correspond to the acreages overlying the seawater-intruded area that are shown on Figure 5-30 and Figure 5-31. As the seawater intrusion front approaches pumping depressions, the front will slow down and stop at the lowest point in the pumping depression. The seawater intrusion front will then appear to stop; and no more acreage will be added every year. However, seawater will continue to flow in from the ocean towards the pumping depression.

The *State of the Salinas River Groundwater Basin* report estimated that approximately 11,000 acre-feet of seawater flows into the Pressure subarea every year. Previous estimates have ranged between 14,000 and 18,000 AF/yr. of seawater intrusion (Brown and Caldwell, 2016). These seawater inflow estimates include portions of the Monterey Subbasin. The length of coastline subject to seawater intrusion is approximately 75% in the 180/400-Foot Aquifer Subbasin and therefore this GSP estimates the flow into the 180/400-Foot Aquifer Subbasin is between 8,250 and 13,500 AF/yr. This analysis adopts a middle value of 10,500 AF/yr.

5.4 Groundwater Quality Distribution and Trends

This section presents a summary of current groundwater quality conditions. The SVBGSA does not have regulatory authority over groundwater quality and is not charged with improving groundwater quality in the Salinas Valley Groundwater Basin. Projects and actions implemented by the SVBGSA are not required to improve groundwater quality; however, they must not further degrade groundwater quality.

5.4.1 Data Sources

Groundwater quality samples have been collected and analyzed in the Subbasin for various studies and programs. Groundwater quality samples have also been collected on a regular basis for compliance with regulatory programs. In particular, a broad survey of groundwater quality was conducted in 2015 by the CCGC (CCGC, 2015).

Groundwater quality in the Salinas Valley Groundwater Basin and adjacent areas was evaluated by the USGS in two studies under the Groundwater Ambient Monitoring and Assessment Program (GAMA) - a statewide groundwater quality monitoring program established in 2000 by the California State Water Resources Control Board (SWRCB). The USGS investigated water quality in groundwater used for public supply, and in the shallower zones used for domestic wells (USGS, 2005; Burton and Wright, 2018). These GAMA projects sampled 22 wells in the 180/400-Foot Aquifer Subbasin; and the samples were analyzed for up to 270 constituents and water-quality indicators including volatile organic compounds (VOCs), pesticides, pesticide degradates, nutrients, major and minor ions, trace elements, radioactivity, microbial indicators, dissolved noble gases, and naturally occurring isotopes (USGS, 2005). In addition, through the voluntary GAMA Domestic Well Project, 10 domestic wells in the 180/400-Foot Aquifer Subbasin were sampled for 208 constituents, including volatile organic compounds, pesticides, trace elements, isotopic tracers, and radioactivity. All quality-assured data collected for the GAMA Program are publicly available through the USGS National Water Information System (NWIS) web interface (http://waterdata.usgs.gov/ca/nwis/) and the SWRCB GeoTracker groundwater information system (https://geotracker.waterboards.ca.gov/gama/) (Burton and Wright, 2018).

5.4.2 Point Sources of Groundwater Pollutants

Because of overlapping agency responsibilities, clean-up and monitoring of point source pollutants may be under the responsibility of either the Regional Board or the California State Department of Toxic Substances Control (DTSC). The Regional Board and DTSC make all related materials available to the public through two public portals: GeoTracker (https://geotracker.waterboards.ca.gov/) managed by the Regional Board and Envirostor (https://www.envirostor.dtsc.ca.gov/public/) managed by DTSC.

Table 5-2 provides a summary of the active clean-up sites, and Figure 5-32 presents a map with the location of active clean-up sites within the Subbasin. Table 5-2 does not include sites that have leaking underground storage tanks, which are not overseen by DTSC or the Regional Board.

Table 5-2. Active Cleanup Sites

Label	Site Name	Site Type	Status	Constituents of Concern (COCs)	Address	City
1	Dynegy Moss Landing	Corrective Action	Active	metals, petroleum, polychlorinated biphenyls (PCBs), volatile organic compounds (VOCs)	Highway 1 & Dolan Road	Moss Landing
2	Moss Landing Power Plant	Cleanup Program Site	Open - Verification Monitoring	metals/heavy metals, petroleum/fuels/oils, polynuclear aromatic hydrocarbons, volatile organic compounds (VOCs)	Highway 1 & Dolan Road	Moss Landing
3	National Refractories (Former)	Cleanup Program Site	Open - Remediation	chromium, trichloroethylene (TCE)	7697 California Highway 1	Moss Landing
4	Union Pacific Railroad - Salinas Yard	Cleanup Program Site	Open - Verification Monitoring	petroleum hydrocarbons, polycyclic aromatic hydrocarbons (PAHs), naphthalene, VOCs, metals	Rico and West Lakes Streets	Salinas
5	Toro Petroleum-Agt	Cleanup Program Site	Open - Verification Monitoring	benzene, petroleum hydrocarbons	308 West Market Street	Salinas
6	Pacific Gas & Electric (PG&E), Salinas Manufactured Gas Plant (MPG)	Voluntary Cleanup	Active	cyanide, metals, contaminated soil, hydrocarbon mixtures	2 Bridge Street	Salinas
7	Borina Foundation	Cleanup Program Site	Open - Remediation contaminated soil was excavated in 2013. Soil vapor extraction remedy is operating to treat soil gas	halogenated volatile organic compounds (VOCs) in soil and soil gas	110-124 Abbott Street	Salinas
8	Crop Production Services, Inc. - Salinas	Cleanup Program Site	Open - Remediation Pump and treat system in place	nitrate, pesticides in shallow areas	1143 Terven Avenue	Salinas
9	Pure-Etch Co	Corrective Action	Active - dual phase extraction remedy implemented	benzene, ethylbenzene, petroleum hydrocarbon-gas, toluene, xylenes	1031 Industrial Street	Salinas
10	NH3 Service Company	Cleanup Program Site	Open - Verification Monitoring Pump and treat system in place	nitrate	945 Johnson Avenue	Salinas
11	Firestone Tire (Salinas Plant)	National Priorities List	Delisted	1,2-dichloroethylene (DCE), tetrachloroethylene (PCE)	340 El Camino Real South	Salinas

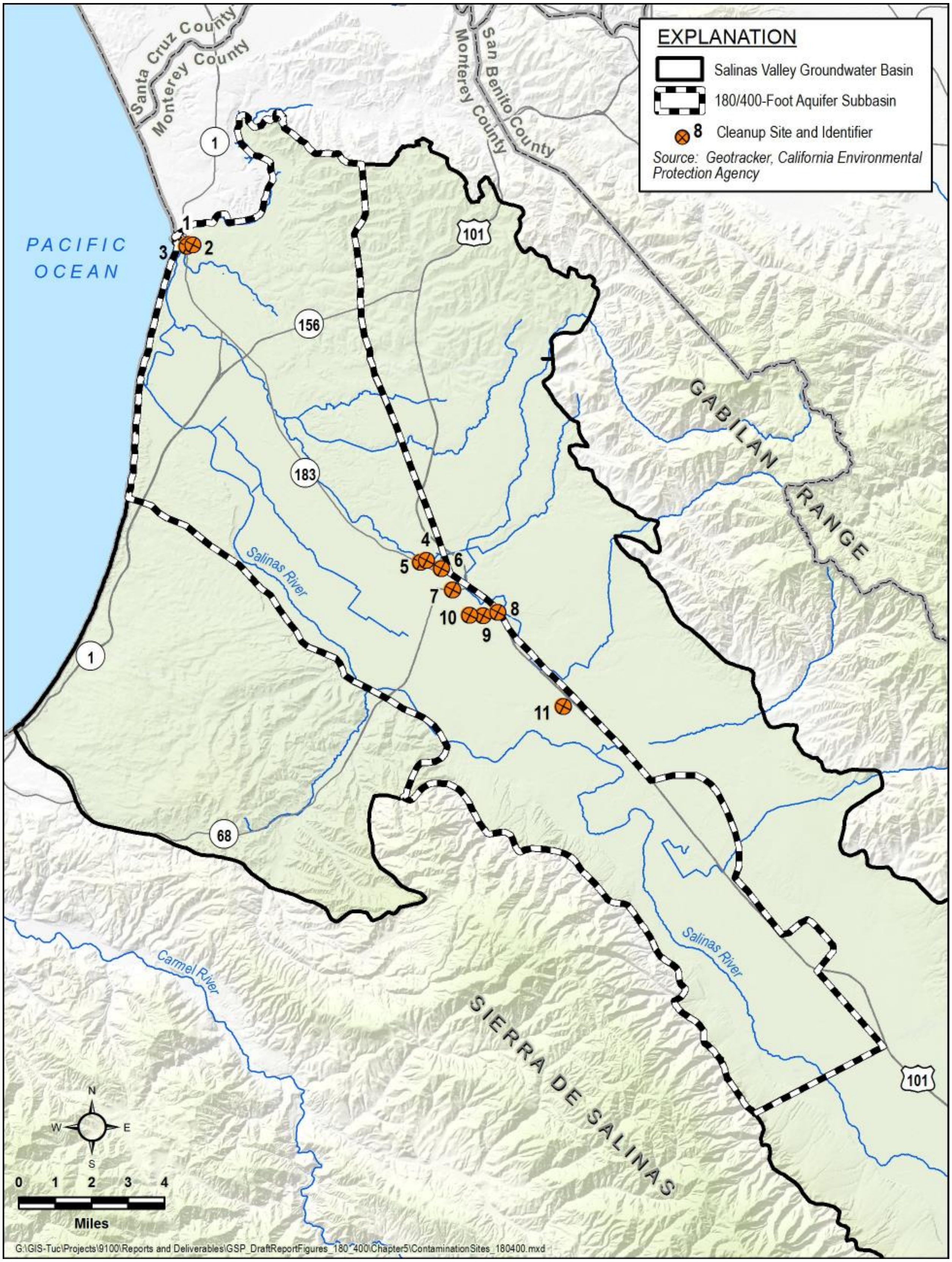


Figure 5-32. Active Cleanup Sites

5.4.3 Distribution and Concentrations of Diffuse or Natural Groundwater Constituents

In addition to the point sources described above, the Regional Board monitors and regulates activities and discharges that can contribute to non-point pollutants, which are constituents that are released to groundwater over large areas. In the Subbasin, the most prevalent non-point source water quality concern is nitrate. The current distribution of nitrate was extensively monitored and evaluated by the CCGC and documented in a report submitted to the CCRWQCB (CCGC, 2015).

Figure 5-33 presents a map of nitrate distribution in the Subbasin prepared by CCGC (2015) and included in the report prepared for CCGC. This map is a focused portion of a larger map that covers the entire Salinas Valley Groundwater Basin. The blurry quality of this map results from zooming in on a small portion of the original map. The orange and red areas illustrate the portions of the Subbasin where groundwater has nitrate concentrations above 45 mg/L as NO_3. This is equivalent to the MCL for drinking water and the Basin Plan Water Quality Objective set by the Regional Board.

Figure 5-34 presents maps of measured nitrate concentration from six decades of monitoring for the entire Salinas Valley Groundwater Basin. These maps, prepared by MCWRA, indicate that elevated nitrate concentrations in groundwater were locally present through the 1960s, but significantly increased in 1970s and 1980s. It appears that the extensive distribution of nitrate concentrations above the MCL as shown on Figure 5-33 has been present for 20 to 30 years.

A May 2018 staff report to the CCRWQCB included a summary of nitrate concentrations throughout the Central Coast Region, including the Salinas Valley Groundwater Basin. This staff report includes data from 2008 to 2018 collected at 2,235 wells in the Salinas Valley Groundwater Basin, during Ag Orders 2.0 and 3.0 sampling events. As summarized in this staff report, "nitrate exceeded the primary MCL in 20 percent of all groundwater wells sampled [Valley-wide]." Data were summarized by groundwater basin/subbasin and well type:

- On-farm domestic wells: tend to be of shallower depths and represents water used for domestic drinking water supply
- Irrigation supply wells: tend to be of intermediate depths and represents water used for primarily for agricultural supply beneficial uses.

Specifically, 26 percent of On-Farm Domestic Wells in the Subbasin exceeded the MCL with a mean concentration of 11.9 mg/l NO3-N. In addition, the 21 percent of Irrigation Supply Wells in the Subbasin exceeded the MCL with a mean concentration of 6.7 mg/l NO3-N (CCRWQCB, 2018).

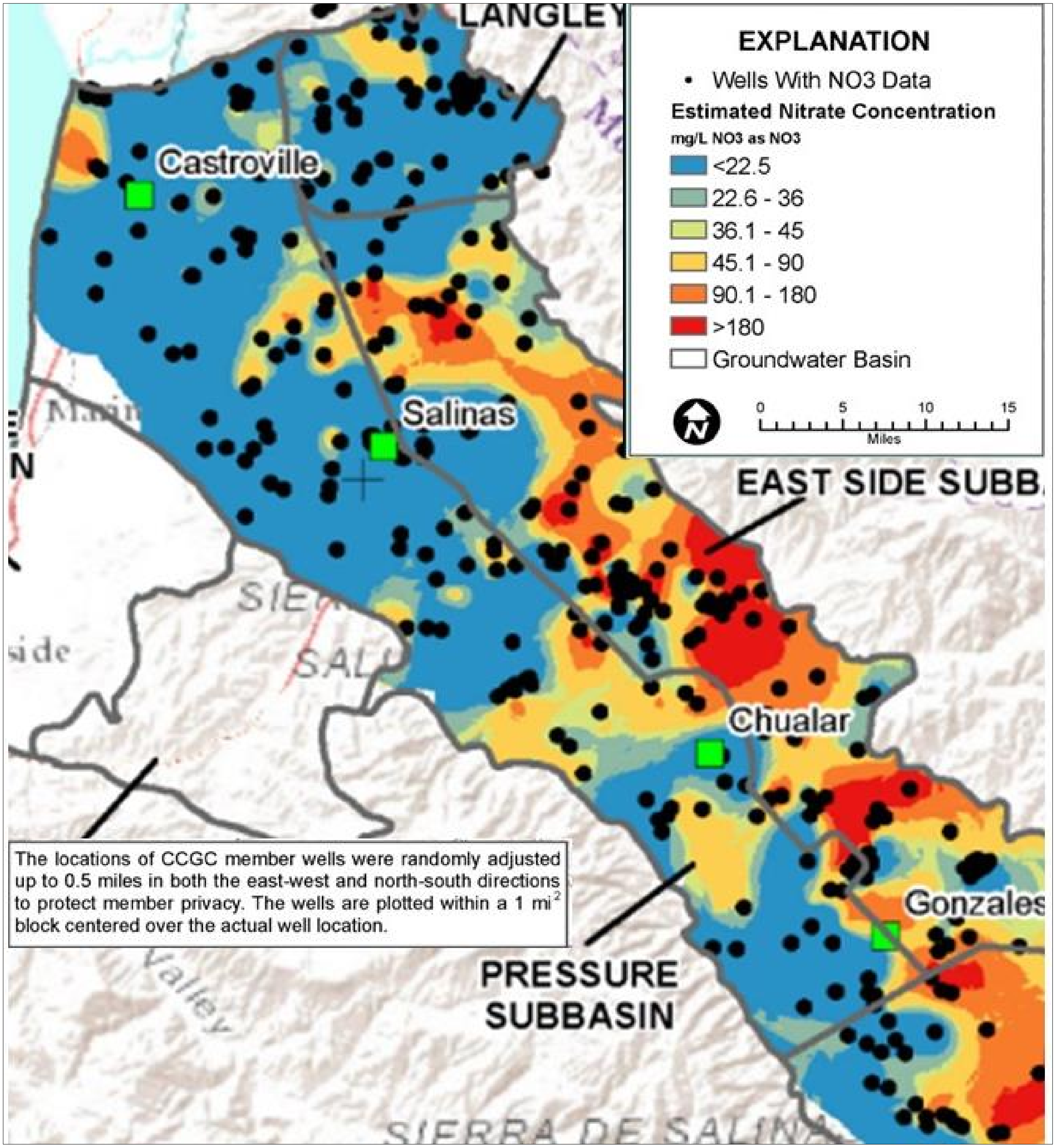


Figure 5-33. Estimated Nitrate Concentrations
(from CCGC, 2015)

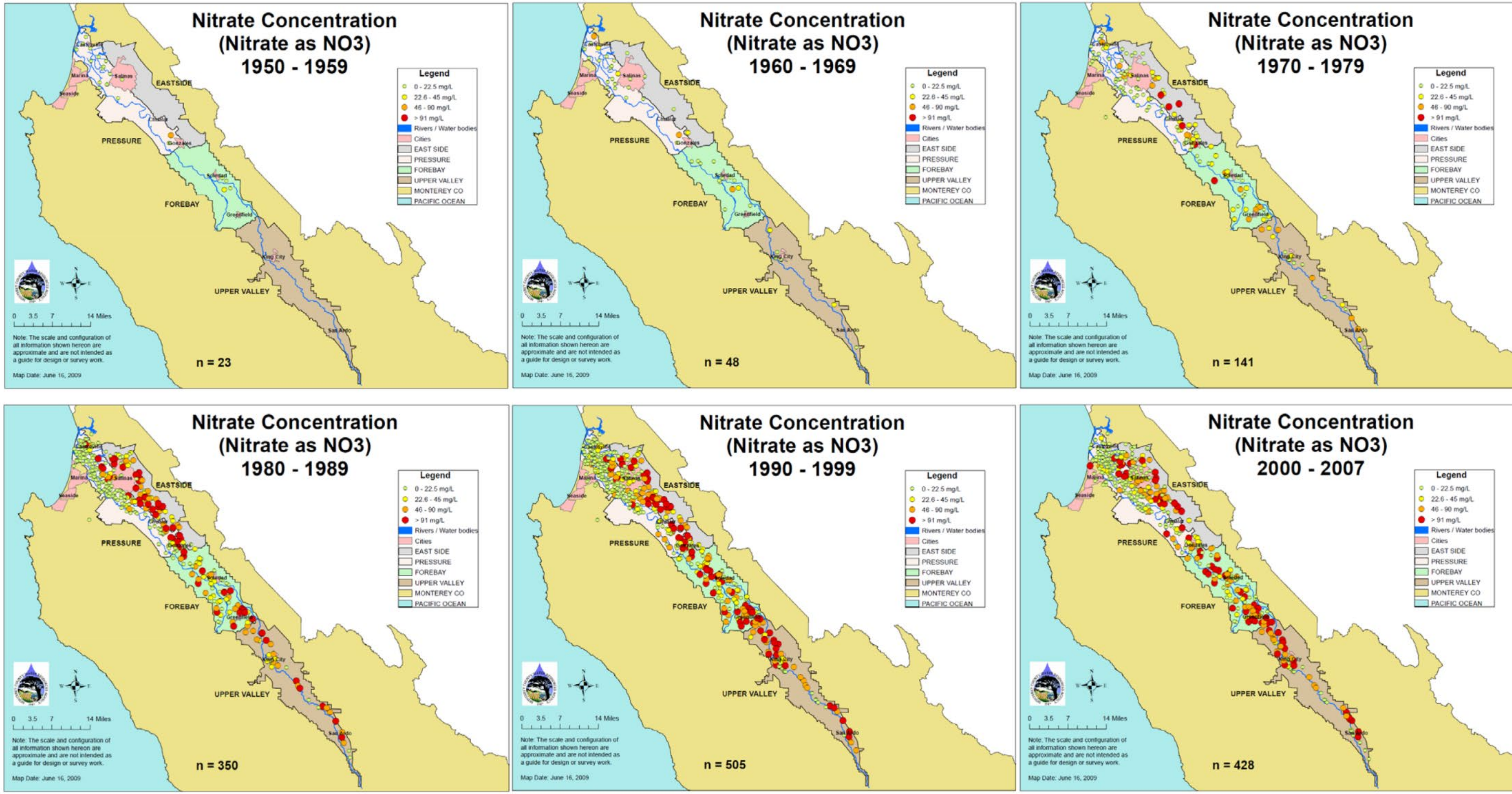


Figure 5-34. Nitrate Concentrations, 1950 to 2007
(from MCWRA)

Additional groundwater quality conditions in the basin are summarized below based on the two USGS water quality studies for the GAMA Priority Basin Project in the Salinas Valley Groundwater Basin (USGS, 2005; Burton and Wright, 2018) as well as data from the GAMA Domestic Well Project.

The 2005 GAMA study in Salinas Valley characterized deeper groundwater resources used for public water supply (USGS, 2005). The 2018 GAMA study characterized shallower groundwater resources used primarily as a water supply for domestic wells (Burton and Wright, 2018). A total of 22 wells were sampled in the 180/400-Foot Aquifer Subbasin for these two studies. Out of the 270 constituents analyzed, one constituent was detected at concentrations above the MCL and two constituents were detected at concentrations above the secondary maximum contaminant level (SMCL), which are levels set for aesthetic rather than health-based reasons.

- Nitrate was detected in 100% of the 19 samples analyzed for nitrate. Nitrate concentrations above the MCL of 10 mg/L as N occurred in 32% of these samples
- Total dissolved solids were detected at concentrations above the SMCL of 1,000 mg/L in 26% of 19 samples
- Chloride was detected at concentrations above the SMCL of 500 mg/L in 11% of 19 samples

Groundwater samples for the GAMA Domestic Well Project were collected from 10 wells in the 180/400-Foot Aquifer Subbasin on a voluntary basis in 2011. Samples were analyzed for 208 constituents, including volatile organic compounds, pesticides, trace elements, isotopic tracers, and radioactivity. Five constituents were detected at concentrations above the MCL: cadmium, thallium, fluoride, perchlorate, and nitrate. Iron and manganese were detected at concentrations above the SMCL.

- Cadmium was detected in 2 of 10 wells. One sample had concentrations above the MCL of 5 micrograms per liter (µg/L)
- Thallium was detected in 5 of 10 wells. One sample had concentrations above the MCL of 2 µg/L
- Fluoride was detected in 5 of 10 wells. One sample had concentrations above the MCL of 2 mg/L
- Perchlorate was detected in 8 of 10 wells. One sample had concentrations above the MCL of 6 µg/L
- Nitrate was detected in 9 of 10 wells. One sample had concentrations above the MCL of 10 mg/L
- Iron was detected in 7 of the 10 wells. One sample had concentrations above the SMCL of 300 µg/L

- Manganese was detected in 5 out of 10 wells. Two samples had concentrations above the SMCL of 50 (µg/L)

Of these constituents, most were detected at concentrations above regulatory limits in a small percentage of the sampled wells (<10%). Since constituents with low detection frequency do not represent groundwater quality issues throughout the entire Subbasin, these constituents will not be considered further in this GSP. More information can be found in the original reports (USGS, 2005; Burton and Wright, 2018) and at the GeoTracker GAMA online database (http://geotracker.waterboards.ca.gov/gama/gamamap/public/#).

The following constituents have been identified in the California Water Service Company's Salinas District wellfields: nitrate, Methyl tert-butyl ether (MTBE), and hexavalent chromium (Cr(VI)). Six of Cal Water's wells have been placed on inactive status due to water quality issues (California Water Service, 2016). Wellhead treatment is used to reduce nitrate and Cr(VI) concentrations to levels that meet applicable standards. Cal Water is currently in compliance with the USEPA standard for arsenic (10 ppb) but may be impacted if the standard is lowered to 5 ppb (California Water Service, 2016).

5.4.4 Groundwater Quality Summary

Based on the water quality information presented in the previous sections, the following constituents have been identified above levels of concern in the Subbasin and will be considered for inclusion in the GSP monitoring program:

- 1,2,3-trichloropropane
- arsenic
- cadmium
- chloride
- fluoride
- hexavalent chromium
- iron
- manganese
- methyl tert-butyl ether
- nitrate
- perchlorate
- TDS
- thallium

The monitoring system is further defined in Chapter 7. The constituents listed above are the constituents of concern for all aquifers in the 180/400-Foot Aquifer Subbasin.

5.5 Subsidence

Land subsidence is the lowering of the ground surface elevation. This is often caused by pumping below thick clay layers. Land subsidence can be elastic or inelastic. Inelastic subsidence is generally irreversible. Elastic subsidence is small, reversible lowering and rising of the ground surface.

5.5.1 Data Sources

DWR has made Interferometric Synthetic Aperture Radar (InSAR) satellite data available on their SGMA Data Viewer web map to estimate subsidence. These are the only data used for estimating subsidence in this GSP.

5.5.2 Subsidence Mapping

Figure 5-35 presents a map showing the InSAR subsidence data in the 180/400-Foot Aquifer between June 2015 and June 2018. The yellow area on the map is the area with measured changes in ground elevation of between -0.1 and 0.1 feet. As discussed in Section 8.10, because of measurement error in this methodology, any measured ground level changes between -0.1 and 0.1 feet is considered the area of no subsidence. The white areas on the map are areas with no data available. The map shows that no measurable subsidence has been recorded anywhere in the 180/400-Foot Aquifer Subbasin between June 2015 and June 2018.

The 180/400-Foot Aquifer Subbasin is one of two subbasins in the Salinas Valley Groundwater Basin that has geologic conditions that may make it susceptible to subsidence if groundwater elevations drop below historical lows. The geology that may cause subsidence is the thick clay units that define the confining layers in the Subbasin. Most of the pumping in this area occurs below these clay layers, potentially inducing subsidence. However, seawater intrusion has kept groundwater elevations relatively stable and no subsidence has been observed.

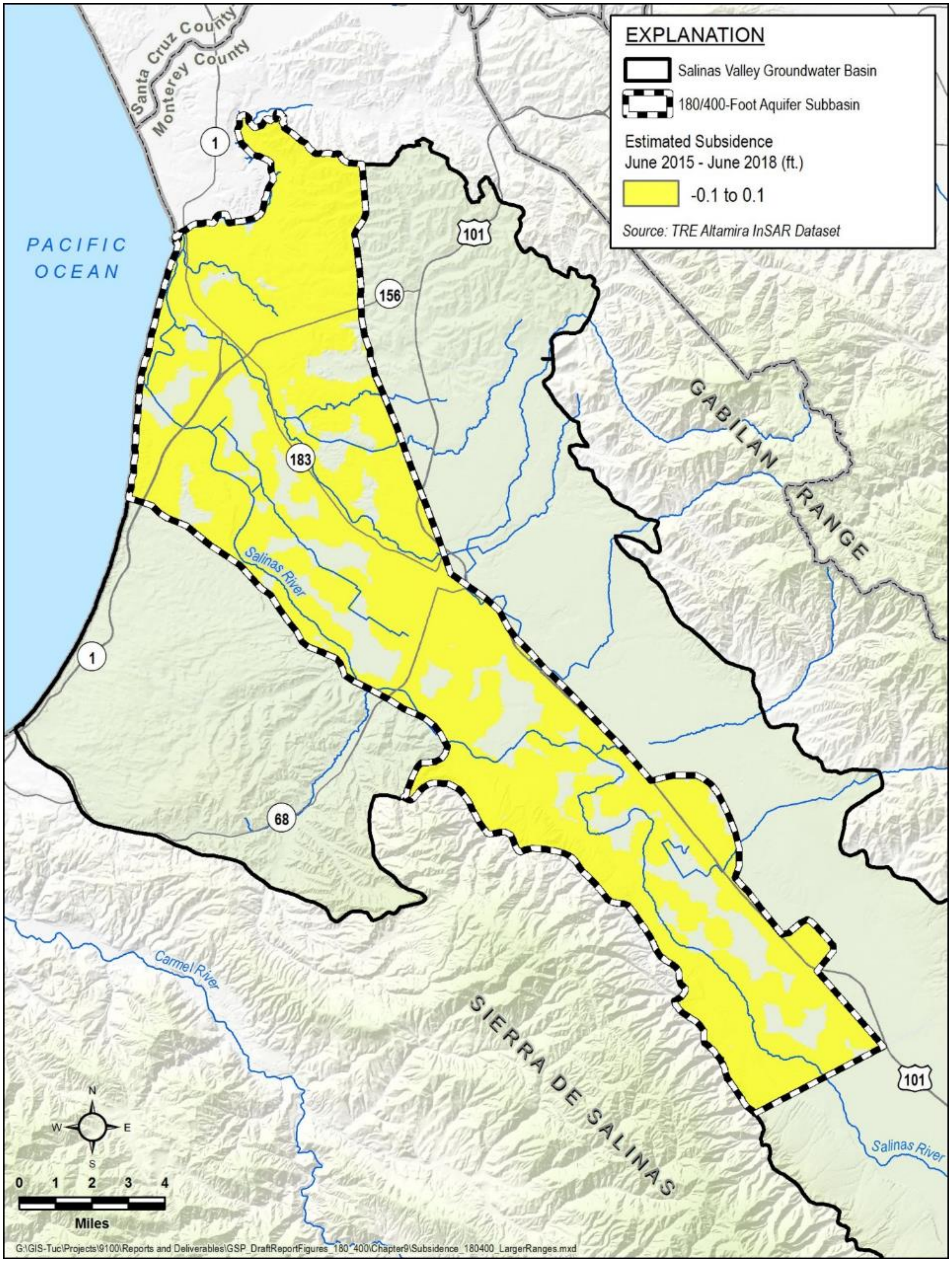


Figure 5-35. Estimated InSAR Subsidence in Subbasin
(created with data from DWR, 2019)

5.6 Interconnected Surface Water

Surface water that is connected to the groundwater flow system is referred to as interconnected surface water. If the groundwater elevation is higher than the water level in the stream, the stream is said to be a gaining stream because it gains water from the surrounding underlying groundwater. If the groundwater elevation is lower than the water level in the stream, it is termed a losing stream because it loses water to the surrounding groundwater flow system. If the groundwater elevation is below the streambed elevation, the stream and groundwater are considered to be disconnected. SGMA does not require that disconnected stream reaches be analyzed or managed. These concepts are illustrated on Figure 5-36.

5.6.1 Data Sources

The primary characteristic of the 180/400-Foot Aquifer Subbasin is the presence of the Salinas Valley Aquitard – a shallow laterally extensive clay layer that effectively separates the Salinas River from the underlying aquifers. As mentioned in Chapter 4, this aquitard is not completely continuous, and there are locations where the 180-Foot Aquifer may be in hydraulic connection with overlying sediments. However, groundwater in the 180- and 400-Foot Aquifers is generally not considered to be hydraulically connected to the Salinas River or its tributaries. This aspect of the 180/400-Foot Aquifer Subbasin has been well documented in multiple independent studies (DWR, 1946; DWR, 2018; Durbin, et al., 1978; Kennedy-Jenks, 2004).

There is evidence that the shallow sediments which occur above the Salinas Valley Aquitard are connected to the surface water system. However, there is limited groundwater pumping in this area and it is not identified as a principal aquifer (see Chapter 4).

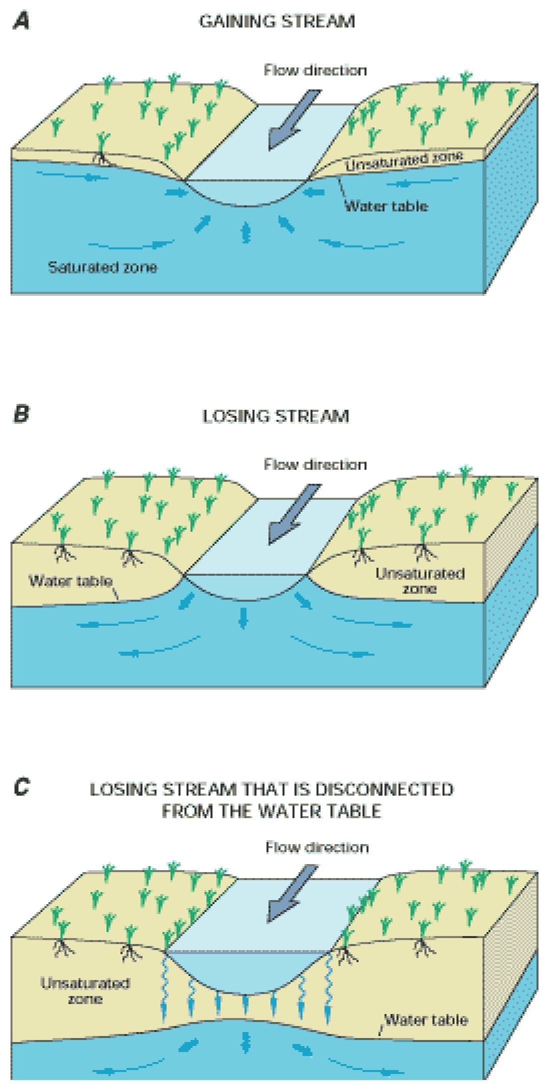


Figure 5-36. Conceptual Representation of Interconnected Surface Water (Winter, et al., 1999)

5.6.2 Analysis of Surface Water and Groundwater Interconnection

Even with the physical clay barrier between surface water and the 180-Foot Aquifer; an additional evaluation of the connection between surface water and the 180-Foot Aquifer is warranted. An additional check on the potential locations of interconnected surface waters was conducted by reviewing depth to groundwater data. If the depth to groundwater is less than 20 feet, it is possible that groundwater and the surface water are interconnected.

To document this relationship, groundwater elevations measured in the fall of 2013 in the 180-Foot Aquifer were compared to ground surface elevations to estimate the depth to groundwater. Fall 2013 was selected because it is a recent year with groundwater elevations mapped by MCWRA that does not represent the end of a drought period. For this analysis, any area with a depth to groundwater of less than 20 feet is assumed to be an area of potentially interconnected surface water. Figure 5-37 presents the results of that analysis and shows that groundwater in the 180-Foot Aquifer is greater than 20 feet below ground surface in most of the 180/400-Foot Subbasin.

For areas of the Subbasin that are connected to surface water, a detailed analysis of hydraulic connection is required. There are two limited areas where the depth to groundwater in 2013 was less than 20 feet below ground surface: the northern end of the Subbasin where the Salinas River discharges into the Monterey Bay and near the southern boundary of the Subbasin adjacent to the Salinas River. These areas may require additional evaluation of hydraulic interaction, which will be possible with the USGS SVIHM model once it is made publicly available.

This identification of interconnected surface water is supported by previous numerical groundwater modeling conducted by Durbin *et. al* (1978). Figure 5-38 is a profile of the Salinas Valley Groundwater Basin showing simulated groundwater elevations in May 1971 and September 1970 relative to the thalweg, or lowest point, of the Salinas River. Although this profile is developed for the entire Valley, the left side of the profile is relevant to the 180/400-Foot Aquifer Subbasin. This profile shows that between the Arroyo Seco Confluence and Spreckels, groundwater elevations have historically been much deeper than the Salinas River, indicating that the surface water is disconnected from groundwater.

This analysis of locations of interconnected surface water is based on best available data but contains significant uncertainty. Additional data are needed to reduce uncertainty and refine the map of interconnected surface waters. The main source of these data will be the Valley-wide groundwater flow model when it becomes available. Additional shallow groundwater monitoring wells may be necessary to verify groundwater elevations adjacent to surface water bodies. This is a data gap that will be addressed during GSP implementation. An evaluation of surface water depletion rates is provided in Chapter 6.

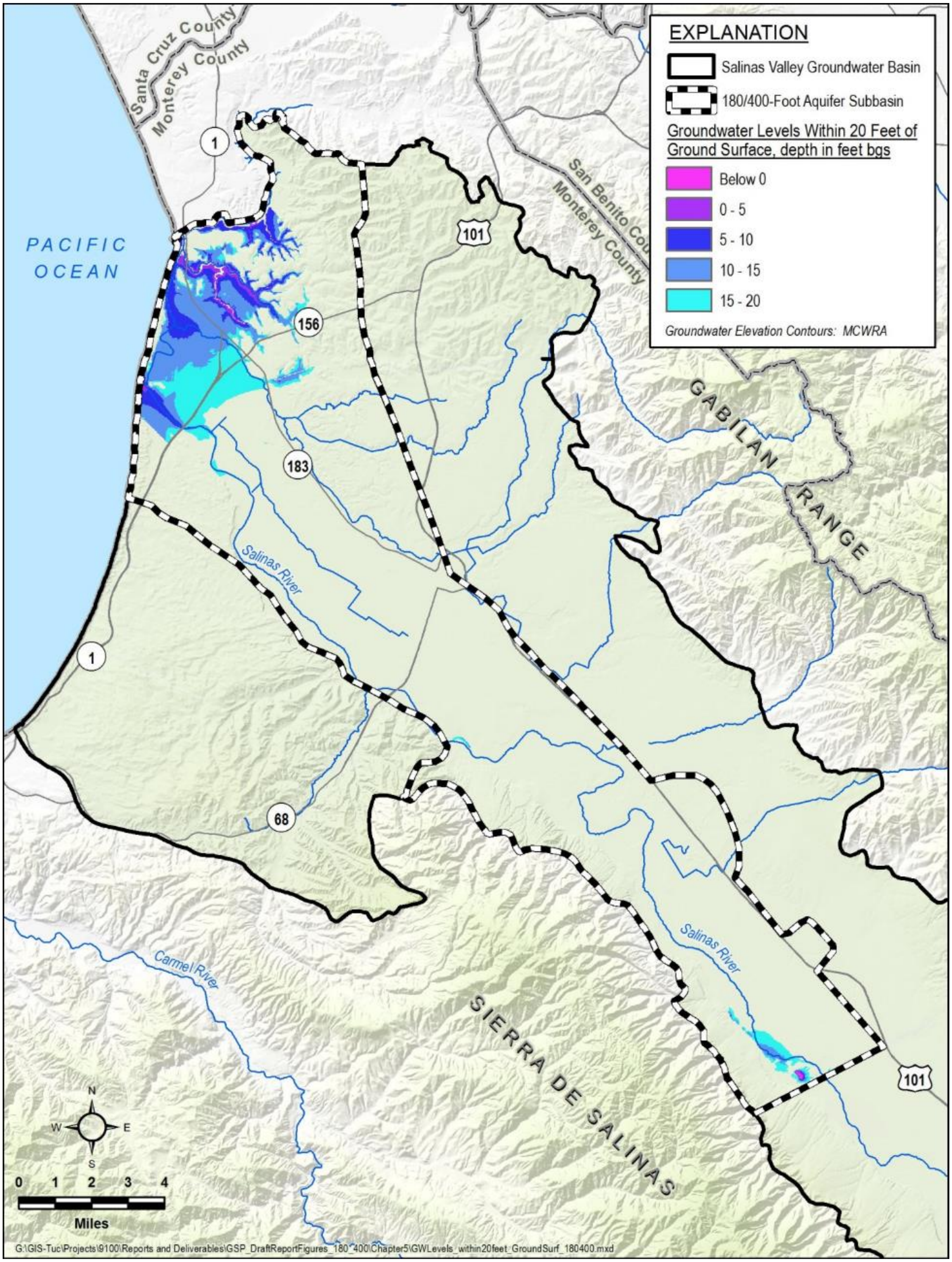


Figure 5-37. Groundwater Within 20 Feet of Land Surface

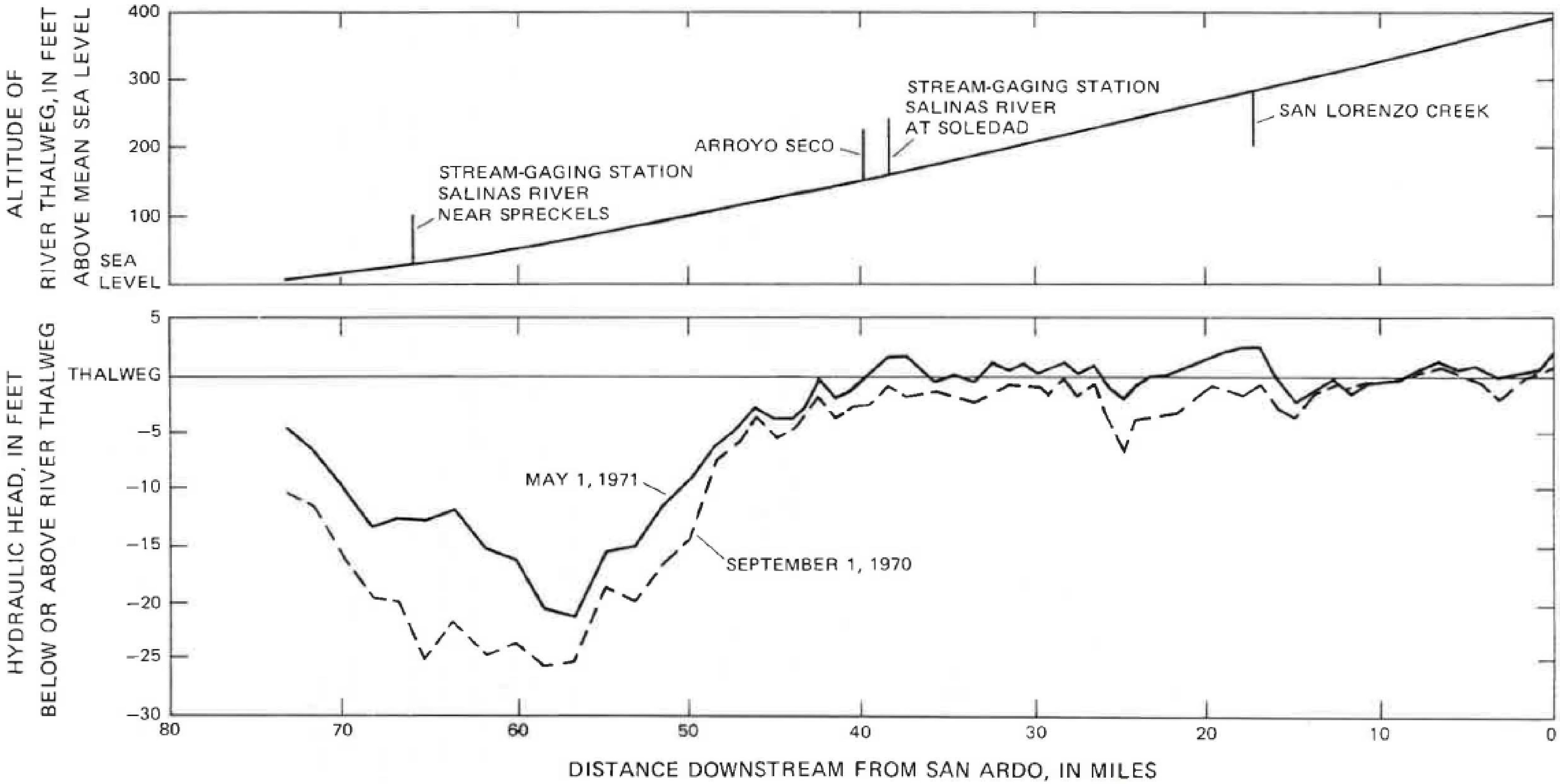


Figure 5-38. Groundwater Profiles Computed by Two-Dimensional Groundwater Model and Thalweg Profile Along the Salinas River (Durbin, et al., 1978)

6 WATER BUDGETS

This chapter summarizes the estimated water budgets for the 180/400-Foot Aquifer Subbasin, including information required by the SGMA Regulations and information that is important for developing an effective plan to achieve sustainability. In accordance with SGMA Regulations §354.18, this water budget provides an accounting and assessment of the total annual volume of surface water and groundwater entering and leaving the Subbasin, including historical, current, and projected water budgets, and the change in the volume of groundwater stored in the Subbasin. Water budgets are reported in graphical and tabular formats, where applicable. Water budget volumes are reported on a water year (October 1 to September 30) basis, unless otherwise indicated.

The water budgets presented in this chapter are based on best available data and tools. However, the limited availability of historical data results in some water budget terms having significant uncertainty. Therefore, these water budgets should be used for general guidance only and not to definitively quantify the various water budget inflows and outflows. These water budgets will be improved during GSP implementation as new data and new tools become available.

Three water budgets are included in this chapter:

- Historical water budgets cover the years 1995 to 2014
- Current water budgets cover the years 2015 to 2017
- Future water budgets cover a 47-year period simulated by the SVIHM

The three water budgets presented in this chapter - historical, current, and future - are developed using different approaches, and are therefore not directly comparable with each other. The historical and current water budgets are developed by aggregating data and analyses from previous reports and publicly available sources. The future water budget is developed from the output of the SVIHM groundwater model being developed by the USGS. Because of these different approaches, caution should be exercised when comparing historical or current water budgets to future water budgets. Once the historical groundwater model is made available by the USGS, the historical and current water budgets will be extracted from this historical model. This future update will allow the three water budgets to be based on a consistent approach.

6.1 Overview of Water Budget Chapter

This chapter is organized in sections that develop the water budgets in a structured fashion. The chapter sections are organized with the following approach:

1. Establishing the water budget components. These are the individual constituents that are estimated for each water budget.

2. Identifying the source data and quantifying each of the historical and current surface water budget components. Separate sections are included for quantifying surface water inflows and surface water outflows. The component quantification is mainly for the historical and current water budgets; future water budget quantities are extracted from the USGS's SVIHM.
3. Identifying the source data and quantifying each of the historical and current groundwater budget components. Separate sections are included for quantifying groundwater inflow and groundwater outflow components. The component quantification is mainly for the historical and current water budgets; future water budget quantities are extracted from the USGS's SVIHM.
4. Estimating the change in groundwater in storage in the Subbasin.
5. Combining the individual components into historical and current water budgets.
6. Discussing the uncertainties in the historical and current water budgets.
7. Developing a future water budget from the model output.

The water budget terms are presented in tables, graphs, and charts in this chapter. More detailed tables of annual water budget time series are presented in a series of Appendices attached to this chapter.

6.2 Water Budget Components

The water budget is an inventory of surface water and groundwater inflows into, and outflows from, the Subbasin. A few components of the water budget can be measured, such as streamflow at a gauging station or groundwater pumping from a metered well. Other components of the water budget are estimated, such as recharge from precipitation or unmetered groundwater pumping.

Figure 6-1 presents the general schematic diagram of the hydrologic cycle that is included in the water budget BMP (DWR, 2016b).

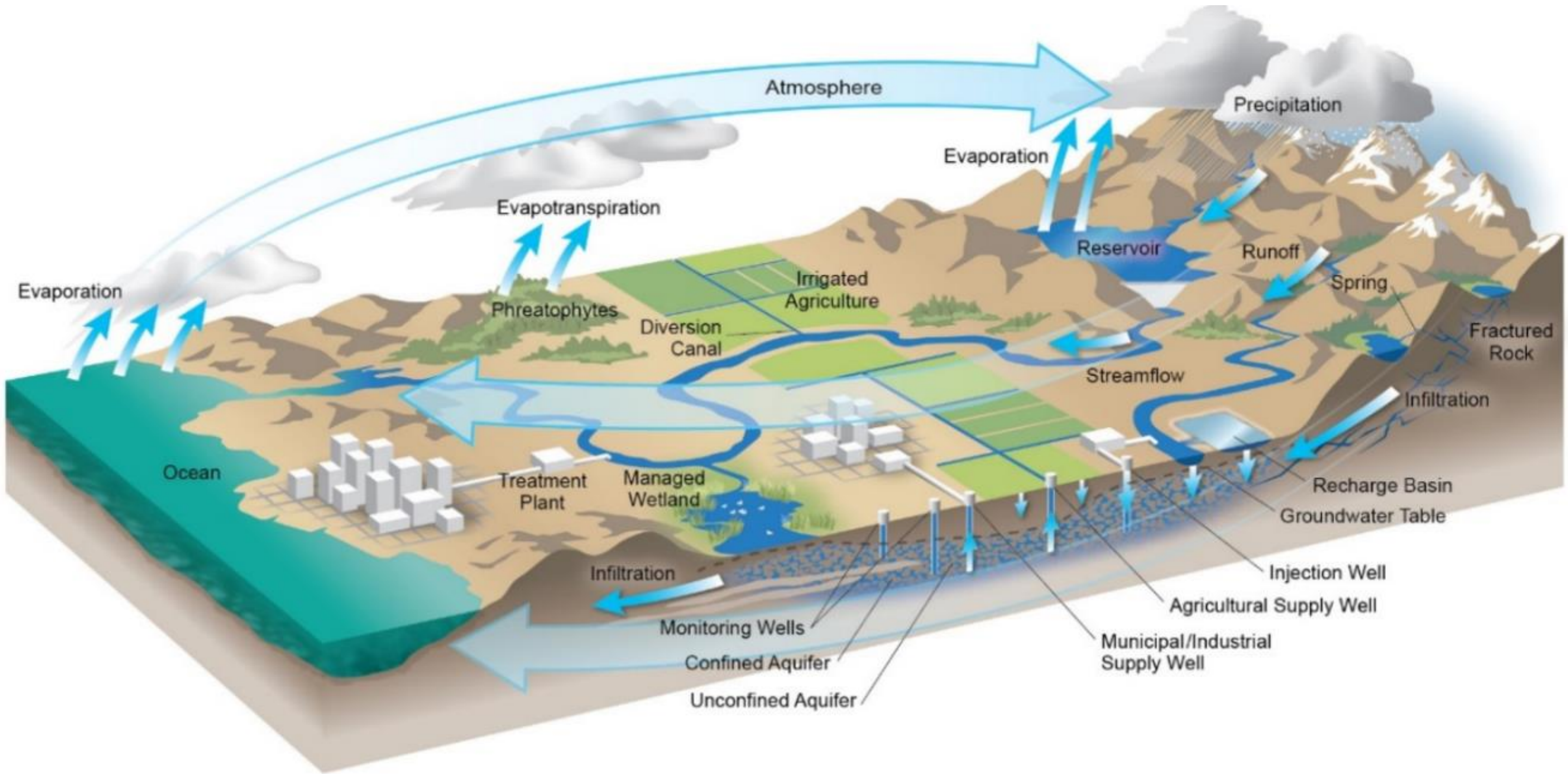


Figure 6-1. Schematic Hydrologic Cycle
(from DWR, 2016b)

The water budgets for the Subbasin are calculated within the following boundaries:

- Lateral boundaries for the water budget are the perimeter of the 180/400-Foot Aquifer Subbasin as shown on Figure 1-1.
- Bottom of the water budget is the base of the groundwater subbasin as described in Chapter 4. The water budget is not sensitive to the exact definition of this base elevation because it is defined as a depth below where there is no significant inflow, outflow, or change in storage.
- Top of the water budget is above the ground surface, so that surface water is included in the water budget.

6.2.1 Surface Water Budget Components

Within the boundaries discussed above, the surface water budget inflows include:

- Runoff from precipitation
- Salinas River inflow from the Forebay Subbasin
- Tributary inflows from the Eastside Subbasin
- Irrigation return flow to agricultural drains

The surface water budget outflows include:

- Salinas River direct diversions
- Salinas River outflow to Monterey Bay
- Outflows to Monterey Bay through the Blanco Drain and Reclamation Ditch
- Streamflow percolation to groundwater

6.2.2 Groundwater Budget Components

Within the boundaries discussed above, the groundwater budget inflows include:

- Streamflow percolation
- Deep percolation of precipitation
- Deep percolation of excess irrigation
- Subsurface inflows from adjacent subbasins

The groundwater budget outflows include:

- Groundwater pumping
- Riparian evapotranspiration
- Subsurface outflows to adjacent subbasins

6.2.3 Change in Groundwater Storage Components

Change in groundwater storage has two components in the Subbasin: change in groundwater elevation and seawater intrusion. Changes in groundwater elevation represent water gained or lost in the aquifer due to pumping and recharge. Seawater intrusion is included as a change in storage component because seawater intrusion reduces the amount of usable groundwater stored in the Subbasin.

6.3 Surface Water Inflow Data

This section quantifies each of the surface water inflow components listed in Section 6.2.1. Data are only provided for the historical and current water budgets. The future water budget is addressed in Section 6.10.

6.3.1 Runoff from Precipitation

Runoff of precipitation for the historical and current water budgets were obtained from the California Basin Characterization Model (BCM) (Flint, et al., 2013). The BCM is a physically based, high-resolution water balance model that simulates evapotranspiration, infiltration, runoff, and recharge to groundwater based on climatic records. Figure 6-2 is a schematic showing the inputs, components, and outputs of the BCM. Additional information regarding the BCM methodology can be found in its documentation.

Complete data for water year 2017 were not available from the BCM. In water year 2017, the precipitation gage at the Salinas Airport (National Oceanographic and Atmospheric Administration (NOAA) / National Weather Service (NWS) Cooperative Observer Program (COOP) Station 047669) recorded 12.77 inches of rainfall. Runoff was estimated for water year 2017 as the average of all years in the historical budget that had between 11 and 13 inches of precipitation at the Salinas Airport; including 1996, 1999, 2009, and 2014.

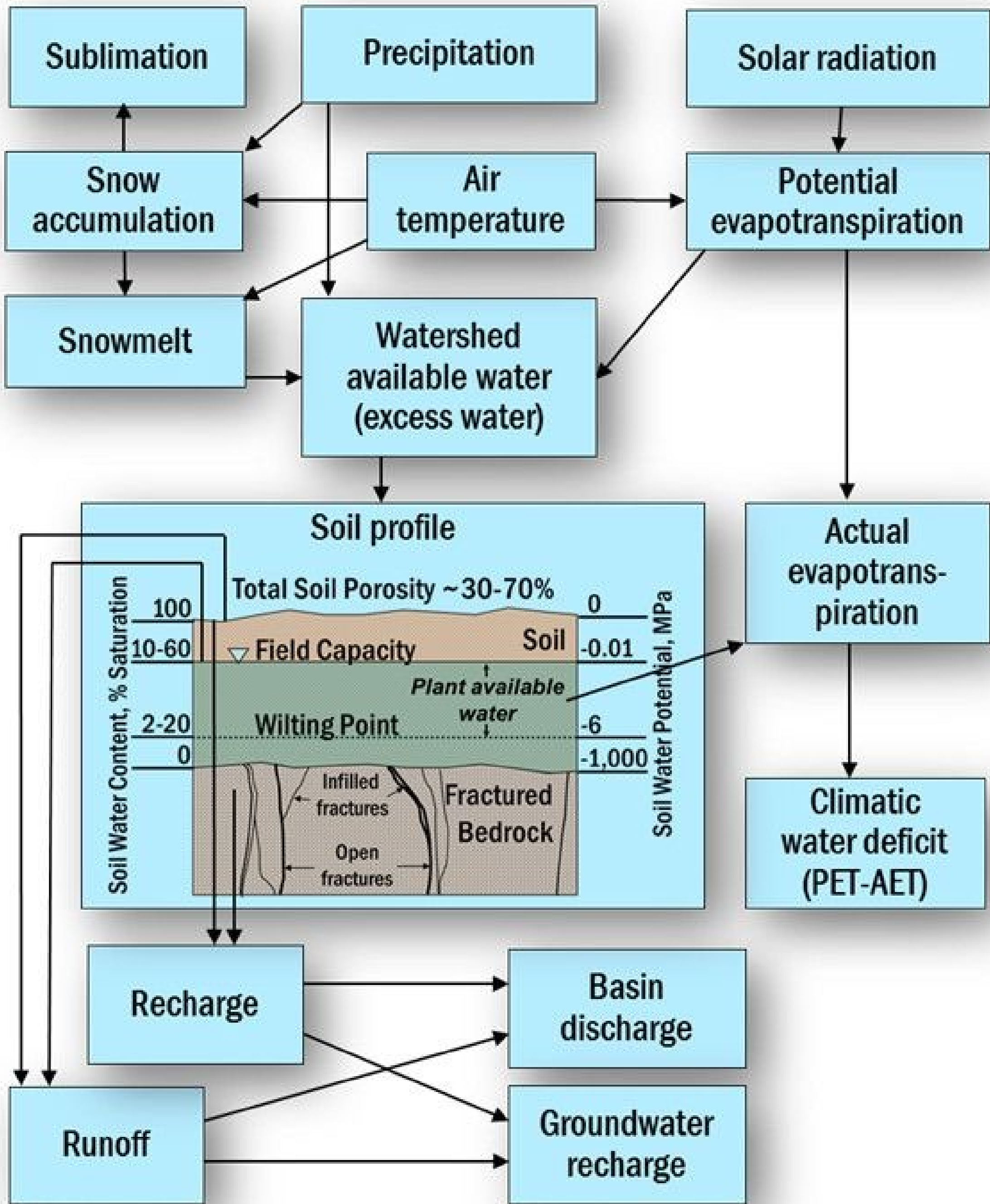


Figure 6-2. Basin Characterization Model Schematic
(Source: Flint, et al., 2013)

The BCM-reported average annual precipitation in the 180/400-Foot Aquifer Subbasin is 114,100 AF/yr. for the historical water budget period and 106,600 AF/yr. for the current water-budget period. As shown in Table 6-1, the runoff for the historical and current periods was 1,100 and 1,700 AF/yr., respectively; equivalent to approximately 1 to 2% of precipitation.

Table 6-1. Runoff from Precipitation

	Average for the Historical Water Budget (AF/yr.)	Average for the Current Water Budget (AF/yr.)
Precipitation	114,100	106,600
Runoff from Precipitation	1,100	1,700
Runoff as % of Precipitation	1%	2%

6.3.2 Salinas River Inflow from the Forebay Subbasin

The primary surface water inflow to the 180/400-Foot Aquifer Subbasin is the Salinas River. Annual Salinas River inflow to the Subbasin at the boundary with the Forebay Subbasin was estimated by using annual flow data from three of the permanent USGS stream gauges, shown in blue on Figure 6-3, and the estimated distribution of 2017 river depletions that are summarized in a 2018 memorandum titled *2017 Salinas River Discharge Measurement Series Results in Context* (MCWRA, 2018b). The 2017 reported supplemented data from the three permanent stream gauges with data from temporary gauges shown in red on Figure 6-3. The data in this report are limited but are the best available data. As reported by MCWRA, the Salinas River depletion during September 2017 between Soledad and Gonzales, near the Subbasin boundary, was 134 cubic feet per second (cfs). The Salinas River depletion between Gonzales and the Chualar gauge was 79 cfs. Therefore, approximately 63% of the Salinas River depletion between Soledad and the Chualar gauge occurred in the Forebay Subbasin, above Gonzales; and 37% of the Salinas River depletion occurred in 180/400-Foot Aquifer Subbasin, below Gonzales.

Annual flow at the boundary between the 180/400-Foot Aquifer Subbasin and the Forebay Subbasin is therefore estimated as the annual flow at the Chualar gauge plus 37% of the loss between Soledad and Chualar. The flow at Soledad is a combination of flows from the main stem of the Salinas River and flow from the Arroyo Seco River and is estimated by combining the flows at the Salinas River Soledad gauge (#11151700) and the Arroyo Seco below Reliz Creek gauge (# 11152050). The average annual flow calculations are shown in Table 6-2.

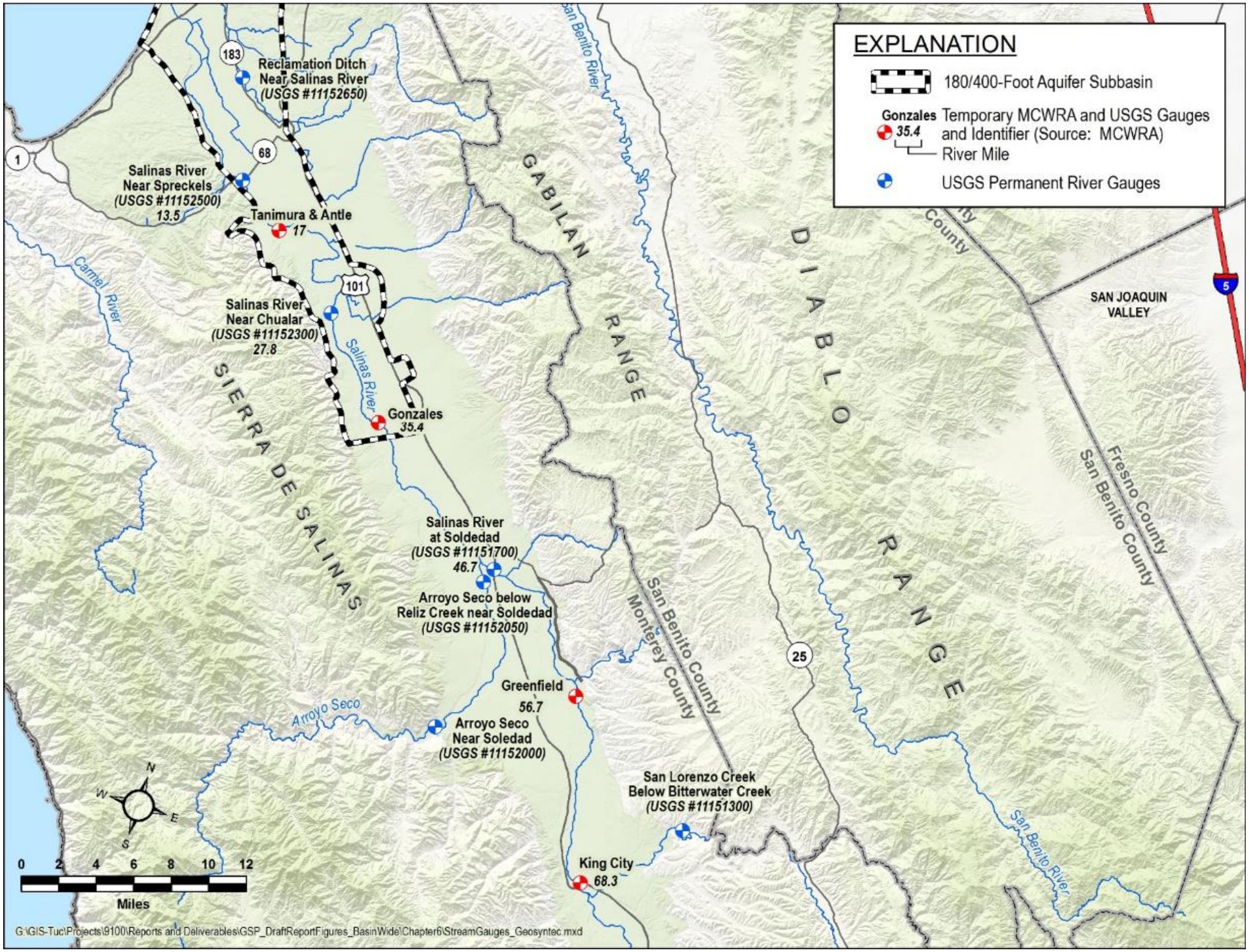


Figure 6-3. USGS Stream Gauge Locations

Table 6-2. Average Annual Salinas River Flow from the Forebay Subbasin

	Flow Component	Average for the Historical Water Budget (AF/yr.)	Average for the Current Water Budget (AF/yr.)
A	Flow at Salinas River Soledad Gauge	272,600	120,900
B	Flow at Arroyo Seco below Reliz Creek Gauge	84,600	91,200
C	Combined flows, representing the total flow at Soledad (A + B)	357,200	212,100
D	Salinas River Flow at the Chualar Gauge	285,500	135,200
E	Depletion between Soledad and Chualar (C – D)	71,700	76,900
F	Depletion in 180/400-Foot Aquifer Subbasin (37% of E)	26,500	28,500
G	Estimated Flow at Gonzales (D + F)	312,000	163,700

6.3.3 Tributary Flows from the Eastside Subbasin

There are ungauged tributaries to the Salinas River that discharge from the Gabilan and Diablo Ranges after flowing across the Eastside Subbasin. These tributaries contribute surface water inflow to the Subbasin downstream of the Chualar gauge. These ephemeral tributaries are dry for much of the year but can have significant flow during the wet season. The San Lorenzo Creek gauge (#11151300, Figure 6-3) is representative of flow from the Gabilan and Diablo Ranges and was used to estimate surface water inflow from these tributaries. Based on tabulated data from Durbin *et. al*. (1978) for the areas of watersheds that drain into the Salinas Valley Groundwater Basin from the east, the combined catchments of the small tributaries is approximately 96 square miles, or approximately 40% of the 233 square mile catchment of San Lorenzo Creek. For the Subbasin surface water budget, we assumed that half of this surface water inflow percolates into the Eastside Subbasin and half flows into to the 180/400-Foot Aquifer Subbasin. Therefore, contribution from these tributaries is estimated as 20% of the San Lorenzo Creek gauge annual flow.

The estimated tributary inflows from the Eastside Subbasin for the historical and current water budgets are shown in Table 6-3.

Table 6-3. Tributary Inflows from Eastside Subbasins

Flow Component	Average for the Historical Water Budget (AF/yr.)	Average for the Current Water Budget (AF/yr.)
Annual average flows at the San Lorenzo Creek gauge	11,600	4,400
Estimated tributary inflows from Eastside Subbasin	2,300	900

6.3.4 Irrigation and Precipitation Return Flow to Agricultural Drains

A portion of precipitation that infiltrates the ground and applied irrigation water is captured by agricultural drains and is routed to the Blanco Drain and Reclamation Ditch as surface water. A USGS stream gauge (#11152650, Figure 6-3) on the Reclamation Ditch provides annual drain flow data from 2003 through 2017. The average annual flows from 2003-2014 were assumed for years prior to 2003.

In 2014, an estimate of Blanco Drain annual flows was developed as part of the Pure Water Monterey Draft Environmental Impact Report (EIR) (Schaaf & Wheeler, 2014). This report estimated the average annual flow in the Blanco Drain to be 2,600 AF/yr.

Table 6-4 summarizes the average annual values of irrigation and precipitation return flow into the two agricultural drains.

Table 6-4. Irrigation and Precipitation Return Flow to Agricultural Drains for Historical and Current Water Budgets

Flow Component	Average for the Historical Water Budget (AF/yr.)	Average for the Current Water Budget (AF/yr.)	Notes
Blanco Drain	2,600	2,600	Schaaf & Wheeler, (2014)
Reclamation Ditch	7,400	15,400	Reclamation Ditch gauge
Total Irrigation Return Flow	10,000	18,000	

6.4 Surface Water Outflow Data

This section quantifies each of the surface water outflow components listed in Section 6.2.1. Data are only provided for the historical and current water budgets. The future water budget is addressed in Section 6.10.

6.4.1 Salinas River Diversion Data

Direct stream diversions are reported to the SWRCB. The State's system for annual reporting of diversions changed from hard copy to a computerized format between 2004 and 2010. Data reported to the State through the computerized system are available for download from the Electronic Water Rights Information Management System (eWRIMS) website (https://www.waterboards.ca.gov/waterrights/water_issues/programs/ewrims/). Annual surface water diversions from the Salinas River from 2011to 2017 were obtained from eWRIMS for use in the historical and current water budgets. Diversions in years prior to 2010 were set equal to the 2011-2017 average.

Table 6-5 lists the estimated average direct diversions from the Salinas River for the historical and current water budgets. Detailed annual time series for the diversions within the Subbasin are provided in Appendix 6A.

Table 6-5. Salinas River Direct Diversions for Historical and Current Water Budget

Flow Component	Average for the Historical Water Budget (AF/yr.)	Average for the Current Water Budget (AF/yr.)	Notes
Salinas River Diversions	8,000	7,900	eWRIMS data 2011-2017 and average assumed for prior years

Many growers and residents have noted that some irrigation is reported both to the SWRCB as Salinas River Diversion, and to the MCWRA as groundwater pumping. Because the SWRCB system is reported by diversion number and the MCWRA system is reported by well, it can be difficult to reconcile the two reporting systems. Therefore, both the SWRCB diversion data and the MCWRA groundwater pumping data are presented in this chapter. This may result in an over-estimate of the amount of water used for irrigation for the historical and current groundwater budgets. The estimated water used for irrigation in the future water budget does not rely on these reports, and therefore does not over-estimate the water used for irrigation. The SVBGSA will update the historical and current groundwater budgets when the SVIHM becomes available, and the updated historical and current water budgets will not have the potential double counting of irrigation problem.

6.4.2 Salinas River Outflow to Monterey Bay

Salinas River outflow to Monterey Bay was estimated based on annual flow data from the Salinas River gauge near Spreckels (Gauge #11152500, Figure 6-3). Because the gauge is located approximately 14 miles upstream of the Salinas River lagoon, an adjustment was made to the gauged data to better estimate the Salinas River flow to Monterey Bay. Between Spreckels and the coast the river depletion rate is assumed to be 2 cfs per mile. This is based on an assumed reduction from the 3.5 cfs per mile river depletion rate observed upstream of Spreckels (MCWRA, 2018b). Assuming this depletion rate is constant over an entire year, the total annual depletion between the Spreckels gauge and the coast is approximately 20,000 AF/yr. Therefore, the assumed outflow of the Salinas River to Monterey Bay is 20,000 AF/yr. less than the average annual flow at the Spreckels gauge.

Table 6-6 lists the estimated average Salinas River outflow to Monterey Bay for the historical and current water budgets.

Table 6-6. Salinas River Outflow to Monterey Bay for Historical and Current Water Budgets

Flow Component	Average for the Historical Water Budget (AF/yr.)	Average for the Current Water Budget (AF/yr.)	Notes
Salinas River Outflow to Monterey Bay	240,800	103,400	Spreckels gauge – 20,000 AF/yr. downstream percolation

6.4.3 Other Surface Water Outflows to Monterey Bay

The Blanco Drain discharges to the Salinas River upstream of the Salinas River Diversion Facility (SRDF). Near Castroville, the Reclamation Ditch discharges into Tembledero Slough, which flows into the Old Salinas River and ultimately to Monterey Bay (Figure 4-11). As described in Section 6.3.4, flows into the Blanco Drain and the Reclamation Ditch were estimated based on annual flow at the Reclamation Ditch gauge (USGS gauge # 11152650, Figure 6-3) and the 2,600 AF/yr. average flow in Blanco Drain estimated as part of the Pure Water Monterey Draft EIR (Schaaf & Wheeler, 2014), as described in Section 6.3.4. Because the two drains do not store water, the flow into the two drains is equal to the annual flow out of the two drains. The average annual discharge of the Blanco Drain and the Reclamation Ditch into Monterey Bay are summarized in Table 6-7.

Table 6-7. Other Surface Water Outflows to Monterey Bay for Historical and Current Water Budgets

	Average for the Historical Water Budget (AF/yr.)	Average for the Current Water Budget (AF/yr.)	Notes
Blanco Drain	2,600	2,600	Schaaf & Wheeler (2014)
Reclamation Ditch	7,400	15,400	Reclamation Ditch gauge
Sum of Blanco Drain and Reclamation Ditch Outflows to Monterey Bay	10,000	18,000	

6.4.4 Streamflow Percolation

The rate of Salinas River percolation into the groundwater system was estimated based on the annual USGS stream gauge data and the MCWRA river depletion analysis summarized in the *2017 Salinas River Discharge Measurement Series Results in Context* (MCWRA, 2018b). The gauge data and depletion rates were used to generate estimates of annual Salinas River inflow from the Forebay Subbasin and annual Salinas River outflow to Monterey Bay. The difference between inflow and outflow was used to generate a preliminary estimate of annual stream depletion. When the stream depletion rates were compared to the annual inflow rates, the data suggested the following three conditions.

- **Salinas River Inflow less than 80,000 AF/yr. (110 cfs):** Stream depletion was approximately equal to inflow. During these relatively dry years, the amount of outflow to Monterey Bay is negligible relative to the water budget.

- **Salinas River Inflow between 80,000 AF/yr. (110 cfs) and 300,000 AF/yr. (415 cfs):** Stream depletion estimates are approximately 80,000 AF/yr. for all inflow rates.

- **Salinas River Inflow greater than 300,000 AF/yr. (415 cfs):** Stream depletion estimates are highly variable, but the average of all values is approximately 90,000 AF/yr.

Based on the above relationship of Salinas River inflow and depletion, this component of the surface water budget was estimated for each year based on the Salinas River inflow. Based on the Salinas River inflow, the stream depletion was set to either the total Salinas River inflow, 80,000 AF/yr., or 90,000 AF/yr. The corresponding annual streamflow percolation results are provided in Appendix 6A.

6.5 Groundwater System Inflow Data

This section quantifies each of the groundwater system inflow components listed in Section 6.2.2. Data are only provided for the historical and current water budgets. Future groundwater system budget data extracted from the SVIHM are provided in Section 6.10.

6.5.1 Streamflow Percolation

As stated in Section 6.4.4, annual percolation of streamflow into the groundwater system set to either the Salinas River inflow into the 180/400-Foot Aquifer Subbasin, 80,000 AF/yr., or 90,000 AF/yr., depending on the Salinas River inflow data. Appendix 6A summarizes streamflow percolation for the historical and current water budgets.

6.5.2 Percolation of Precipitation

Precipitation that is not lost to runoff, agricultural drainage, or evapotranspiration recharges the groundwater system as deep percolation. The BCM values of precipitation, runoff, and groundwater system recharge for the historical and current water budgets are presented in Table 6-8. As described in Section 6.3.1, groundwater system recharge for water year 2017 was assumed to be the average of prior years with similar precipitation. Some of the groundwater system recharge estimated by BCM is captured by agricultural drains and does not directly recharge the principal aquifers.

Table 6-8. BCM-Reported Precipitation, Runoff, and Groundwater System Recharge for Historical and Current Water Budget

	Average for the Historical Water Budget (AF/yr.)	Average for the Current Water Budget (AF/yr.)
Total precipitation	114,100	106,600
Runoff	1,100	1,700
Deep percolation of precipitation (groundwater system recharge and flow to agricultural drains)	8,500	6,000

6.5.3 Percolation of Excess Irrigation

Applied irrigation water that is not consumptively used by plants and is not captured as return flow by agricultural drains percolates below the root zone and becomes an inflow component to the groundwater system. BCM estimates natural recharge from precipitation and does not consider additional recharge from agricultural irrigation. The deep percolation of excess agricultural irrigation was estimated separately.

The total amount of water applied for irrigation is the sum of the groundwater pumping for irrigation, Salinas River diversions for irrigation, and CSIP deliveries.

- Agricultural pumping is reported annually by MCWRA for the Pressure Subarea. This value was adjusted proportionally for the area of the Subbasin relative to the total area of the Pressure Subarea.
- Salinas River diversions in the Subbasin are estimated from eWRIMS data for 2011 to 2017; and the average value for those years was applied to prior years in the historical water budget.
- CSIP deliveries began in 1999 and are reported annually.

As discussed earlier, this approach likely overestimates the amount of irrigation because some irrigation is reported as both a surface water diversion in the eWRIMS system and as groundwater pumping in MCWRA's pumping database. Crop consumptive use was estimated using an average irrigation efficiency of 80% for the Subbasin. This assumes 80% of applied irrigation is consumed by evapotranspiration and 20% becomes either return flow to agricultural drains or deep percolation to the groundwater system.

Table 6-9 presents the calculated deep percolation of irrigation water. Some of the groundwater recharge from irrigation is captured by agricultural drains, and does not directly recharge the deep groundwater.

Table 6-9. Deep Percolation from Excess Irrigation for Historical and Current Water Budget

	Average for the Historical Water Budget (AF/yr.)	Average for the Current Water Budget (AF/yr.)
Total Agricultural Applied Water	107,200	112,100
Crop Consumptive Use	85,800	89,700
Deep Percolation (groundwater system recharge and flow to agricultural drains)	21,400	22,500

6.5.4 Total Deep Percolation to Groundwater System

Table 6-10 estimates the total deep percolation to the groundwater system from precipitation and excess irrigation. A portion of the deep percolation from precipitation and a portion of the deep percolation from excess irrigation is captured by the Blanco Drain and the Reclamation Ditch. It is impossible to differentiate between water in the agricultural drains originating from irrigation and water originating from precipitation. Therefore, the two sources of infiltration are combined, and the drain flows are then removed to estimate total deep percolation.

Table 6-10. Net Deep Percolation from Precipitation and Excess Irrigation

	Average for the Historical Water Budget (AF/yr.)	Average for the Current Water Budget (AF/yr.)
Percolation from precipitation	8,500	6,000
Percolation from excess irrigation	21,400	22,500
Combined drain flows from Table 6-4	10,000	18,000
Net deep percolation to groundwater system from both precipitation and excess irrigation	19,900	10,500

6.5.5 Subsurface Inflows from Adjacent Subbasins

Based on groundwater flow directions and hydraulic gradients at the Subbasin boundaries, subsurface inflow to the 180/400-Foot Aquifer Subbasin from the Forebay Subbasin has been estimated as approximately 17,000 AF/yr. (Montgomery Watson, 1997). The boundary with the Monterey Subbasin is subparallel to groundwater flow direction resulting in a small amount of subsurface flow between the basins. The flow between basins is estimated as a net inflow of 3,000 AF/yr. from the Monterey Subbasin into the 180/400-Foot Aquifer Subbasin based on quantities reported by Montgomery Watson (1997). The estimated values are assumed constant for the historical and current water budgets. Groundwater generally flows from the 180/400-Foot Aquifer Subbasin into the Eastside and Langley Subbasins, as well as to Pajaro Valley. These subsurface outflows are quantified in Section 6.6.3.

The boundary flows will be reassessed when the calibrated historical SVIHM is available. Table 6-11 summarizes the subsurface inflow components for the historical and current water budgets.

Table 6-11. Subsurface Inflow from Adjacent Subbasins in Historical and Current Water Budgets

	Average for the Historical Water Budget (AF/yr.)	Average for the Current Water Budget (AF/yr.)	Notes
Inflow from Forebay Subbasin	17,000	17,000	Estimate from Brown and Caldwell (2015)
Inflow from Monterey Subbasin	3,000	3,000	Estimate from Montgomery Watson (1997)
Total Inflows	20,000	20,000	

6.6 Groundwater Outflow Data

This section quantifies each of the groundwater outflow components listed in Section 6.2.2. Data are only provided for the historical and current water budgets. Future groundwater budget data extracted from the SVIHM are provided in Section 6.10.

6.6.1 Groundwater Pumping

Groundwater is pumped from the Subbasin for multiple water use sectors including agricultural, domestic, and urban. Groundwater pumping is reported annually to MCWRA in accordance with MCWRA Ordinance 3717. Reliable annual pumping records, categorized as Agricultural or Urban, are available from MCWRA for the period 1995-2015. The records provide annual pumping rates for all years of the historical water budget. Agricultural pumping is reported on a water-year basis; urban pumping is reported on a calendar-year basis. For the current water budget, only one year of data is available (2015) and therefore the average values of the historical budget period were used for 2016 and 2017. The pumping rates for the current water budget will be updated when the MCWRA data for 2016 and 2017 are available. The annual pumping amounts reported by MCWRA for 1995-2015 are tabulated in Appendix 6A.

The reported groundwater pumping excludes rural domestic pumping because Monterey County Ordinance 3717 exempts reporting pumping from wells with a discharge pipe less than 3 inches in diameter. Therefore, rural domestic pumping was estimated based on the number of DWR permitted domestic wells in the Subbasin in 2018 and adjusted for 1995 through 2017 based on percent change in Monterey County population. The calculations assumed that each well was associated with a single parcel, and that the annual groundwater pumping was 0.39 AF per parcel. This is consistent with the *Codes and Standards Consulting: California's Residential Indoor Water Use* report (Consol, 2014) that estimated the annual indoor water use of a new, three-bedroom home occupied by four people at 46,521 gallons per year (0.14 AF). Combined indoor and outdoor water use was estimated at 0.39 ac-ft per household.

Table 6-12 and Table 6-13 summarize the average, minimum, and maximum groundwater pumping rates in the historical and current water budgets. The minimum and maximum of total pumping are not equal to the sum of the sectors because the timing of pumping sector extremes is not coincident.

Table 6-12. Historical Annual Groundwater Pumping by Water Use Sector

Water Use Sector	Average (AF/yr.)	Minimum (AF/yr.)	Maximum (AF/yr.)
Agricultural	89,000	76,200	110,800
Urban	18,900	14,000	27,500
Rural-Domestic	200	200	200
Total Pumping*	108,100	92,900	130,800

Note: Agricultural pumping is reported on a water-year basis whereas urban pumping is reported on a calendar-year basis. Rural domestic pumping is estimated on a calendar year basis.

Table 6-13. Current Annual Groundwater Pumping by Water Use Sector

Water Use Sector	Average (AF/yr.)	Minimum (AF/yr.)	Maximum (AF/yr.)
Agricultural	91,900	89,000	97,700
Urban	17,000	12,900	19,000
Rural-Domestic	200	200	200
Total Pumping	109,100	108,200	110,900