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

VOLUME 2

Chapter 5. Groundwater Conditions

Chapter 6. Water Budgets

Chapter 7. Monitoring Networks

Chapter 8. Sustainable Management Criteria

Prepared for:

Salinas Valley Basin Groundwater Sustainability Agency

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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.

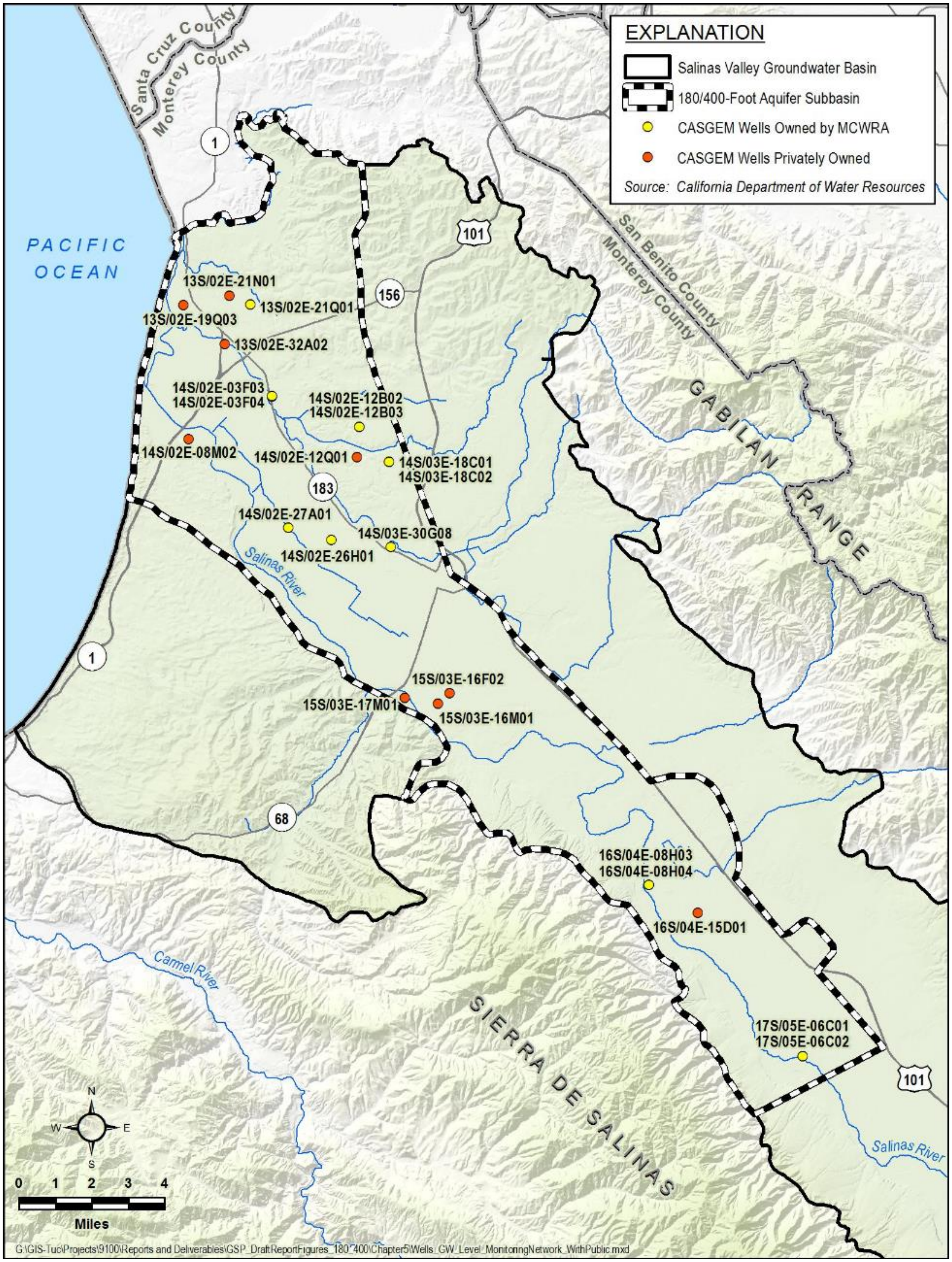


Figure 5-1. CASGEM Well Locations

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.

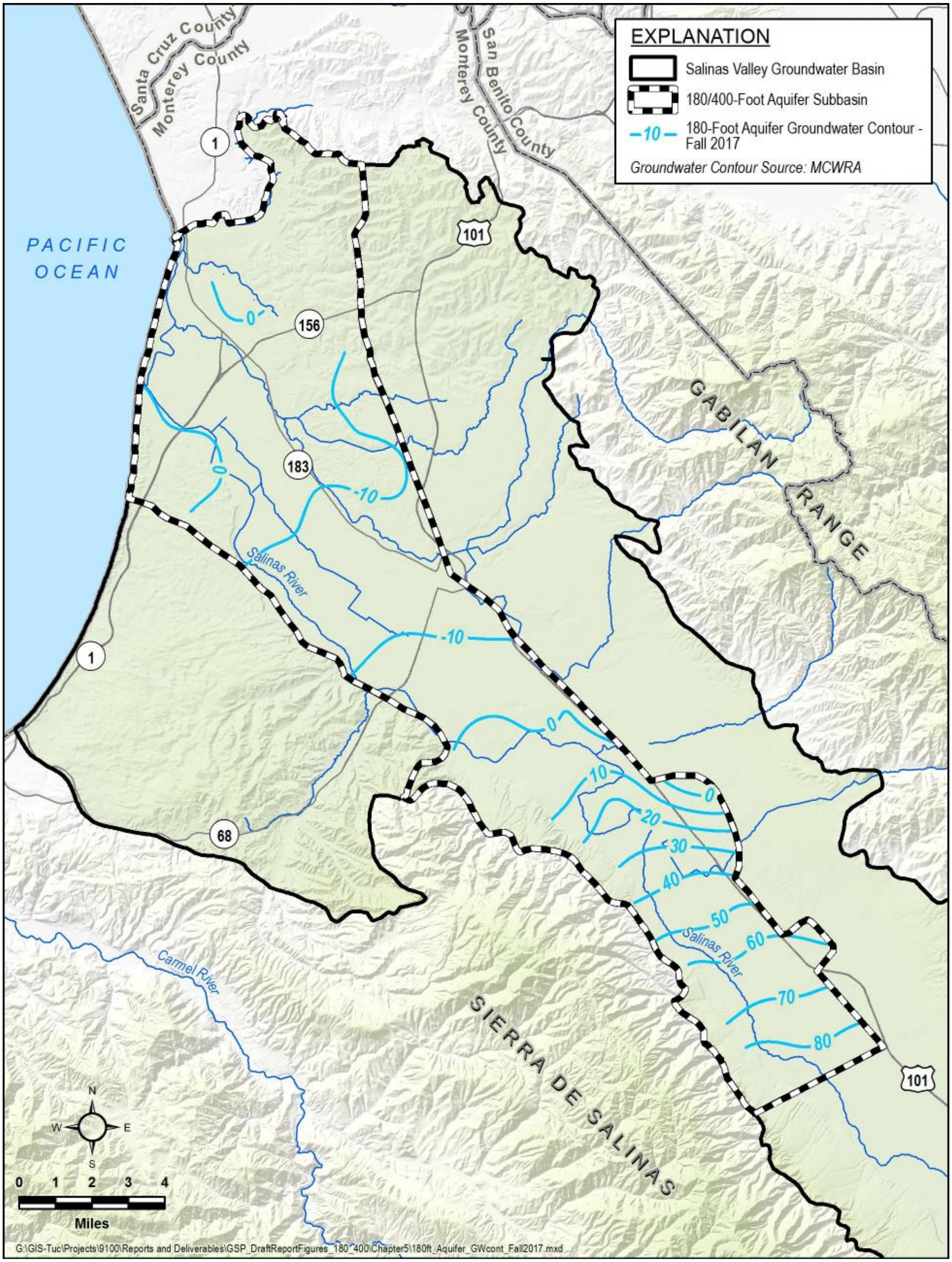


Figure 5-2. Fall 2017 180-Foot Aquifer Groundwater Elevation Contours

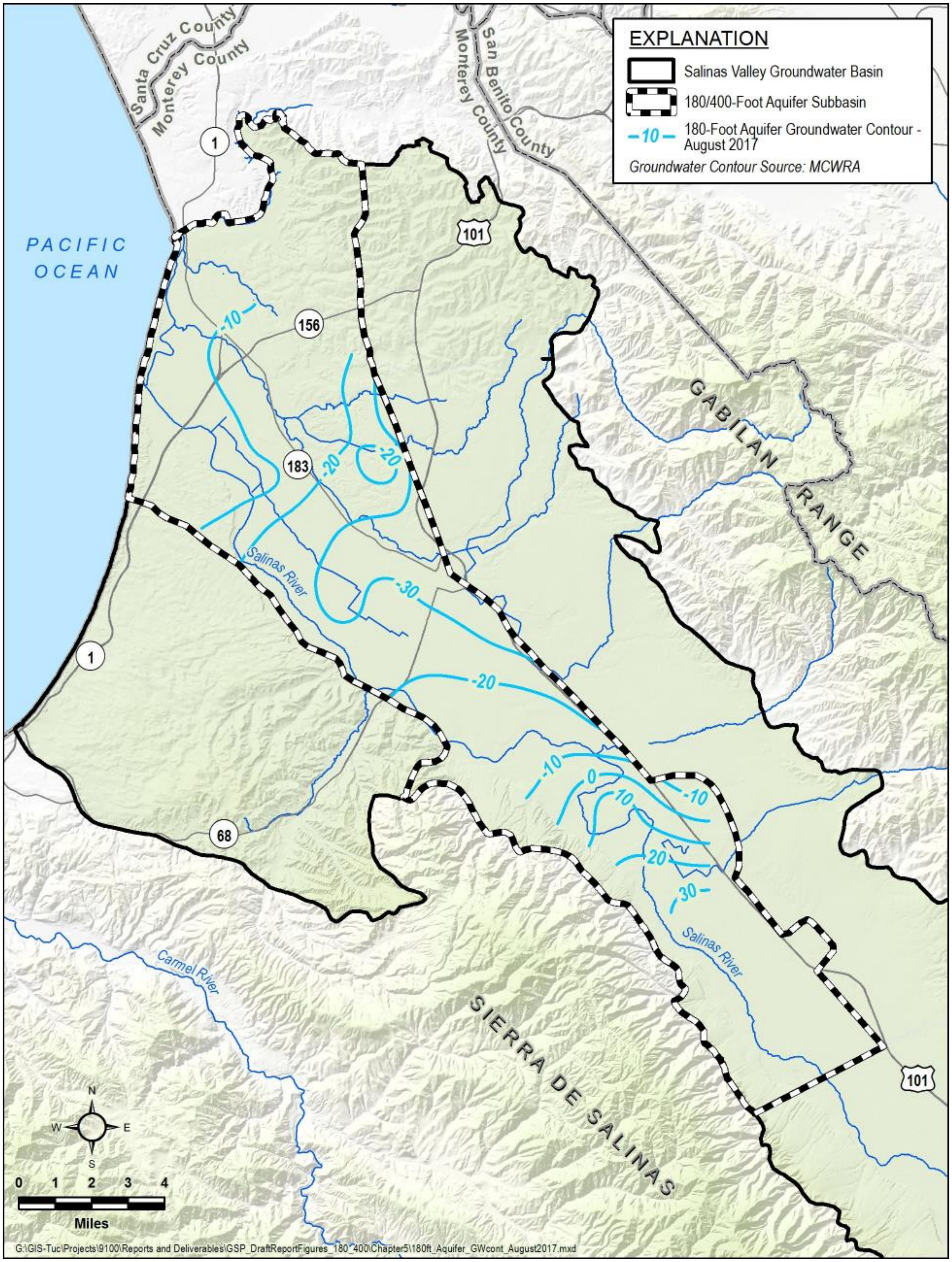


Figure 5-3. August 2017 180-Foot Groundwater Elevation Contours

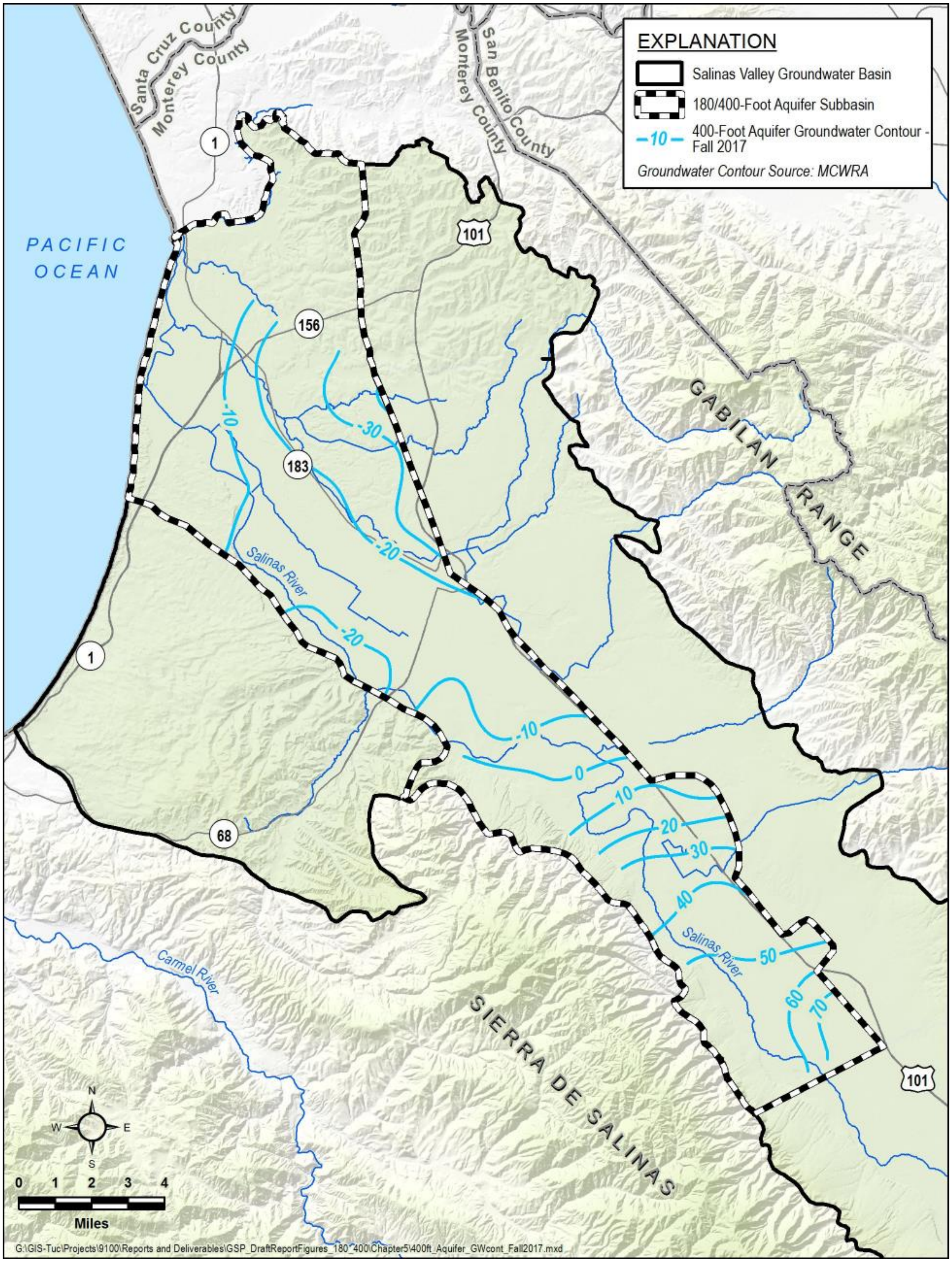


Figure 5-4. Fall 2017 400-Foot Aquifer Groundwater Elevation Contours

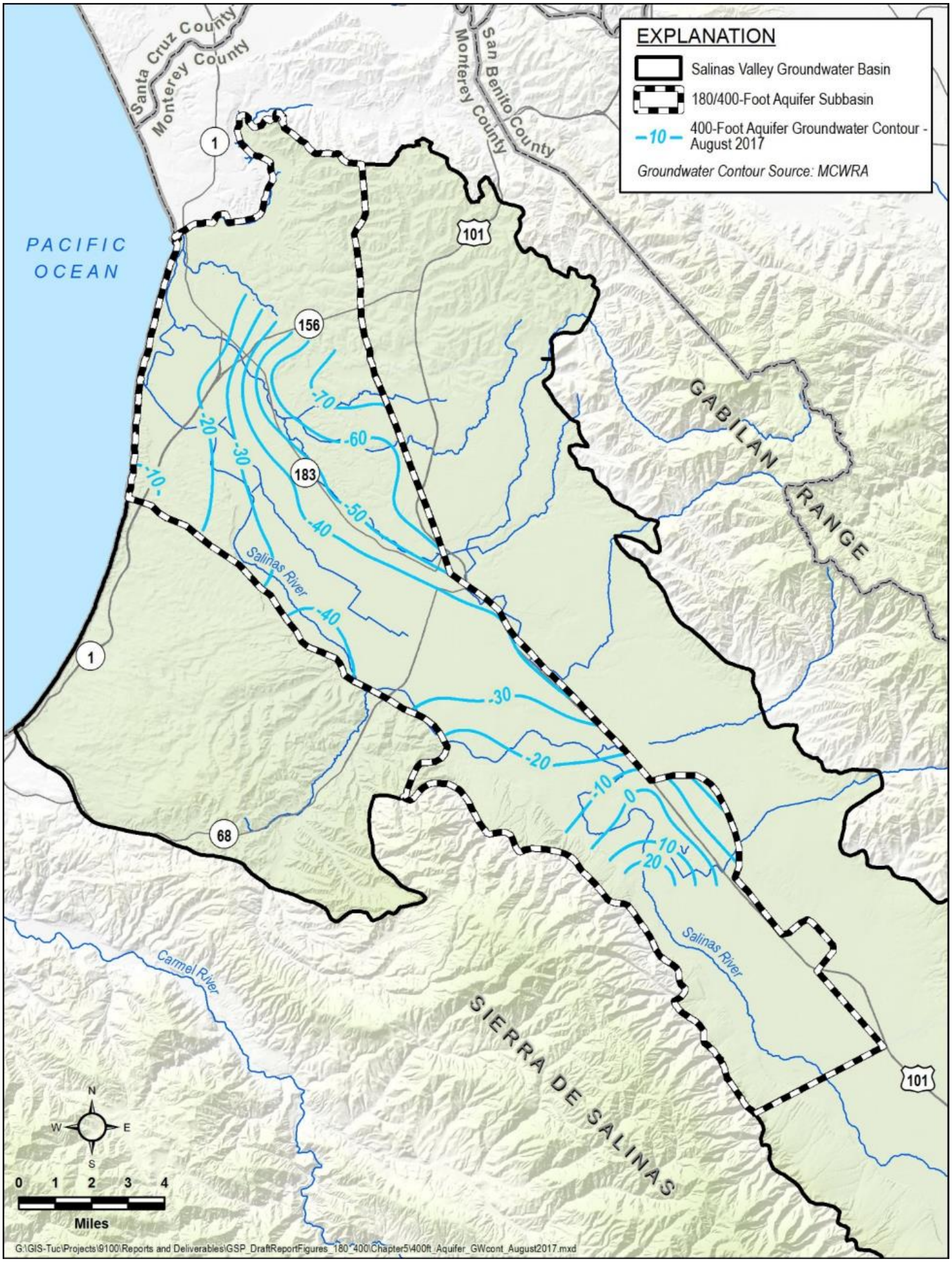


Figure 5-5. August 2017 400-Foot Aquifer Groundwater Elevation Contours

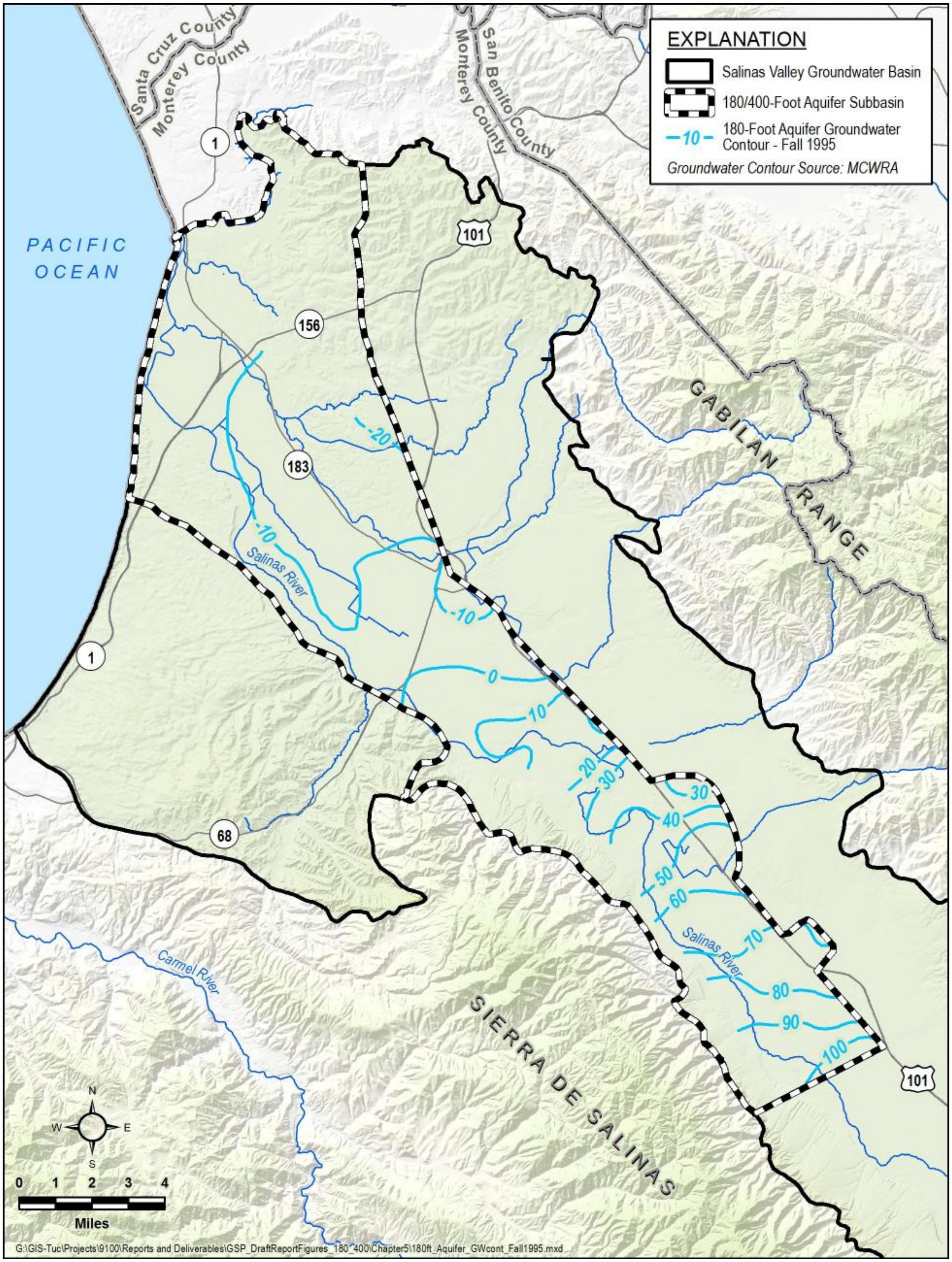


Figure 5-6. Fall 1995 180-Foot Aquifer Groundwater Elevation Contour

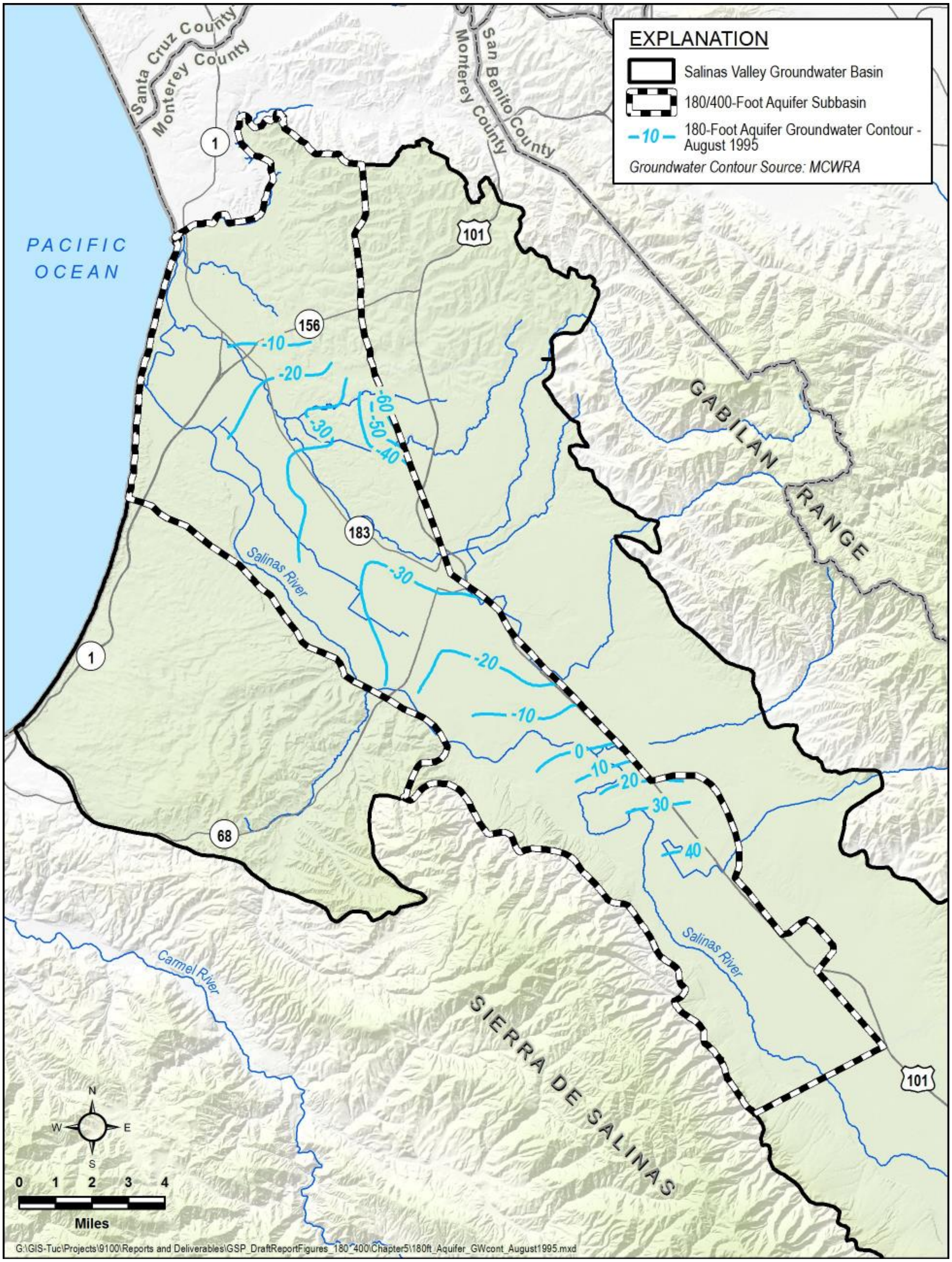


Figure 5-7. August 1995 180-Foot Aquifer Groundwater Elevation Contours

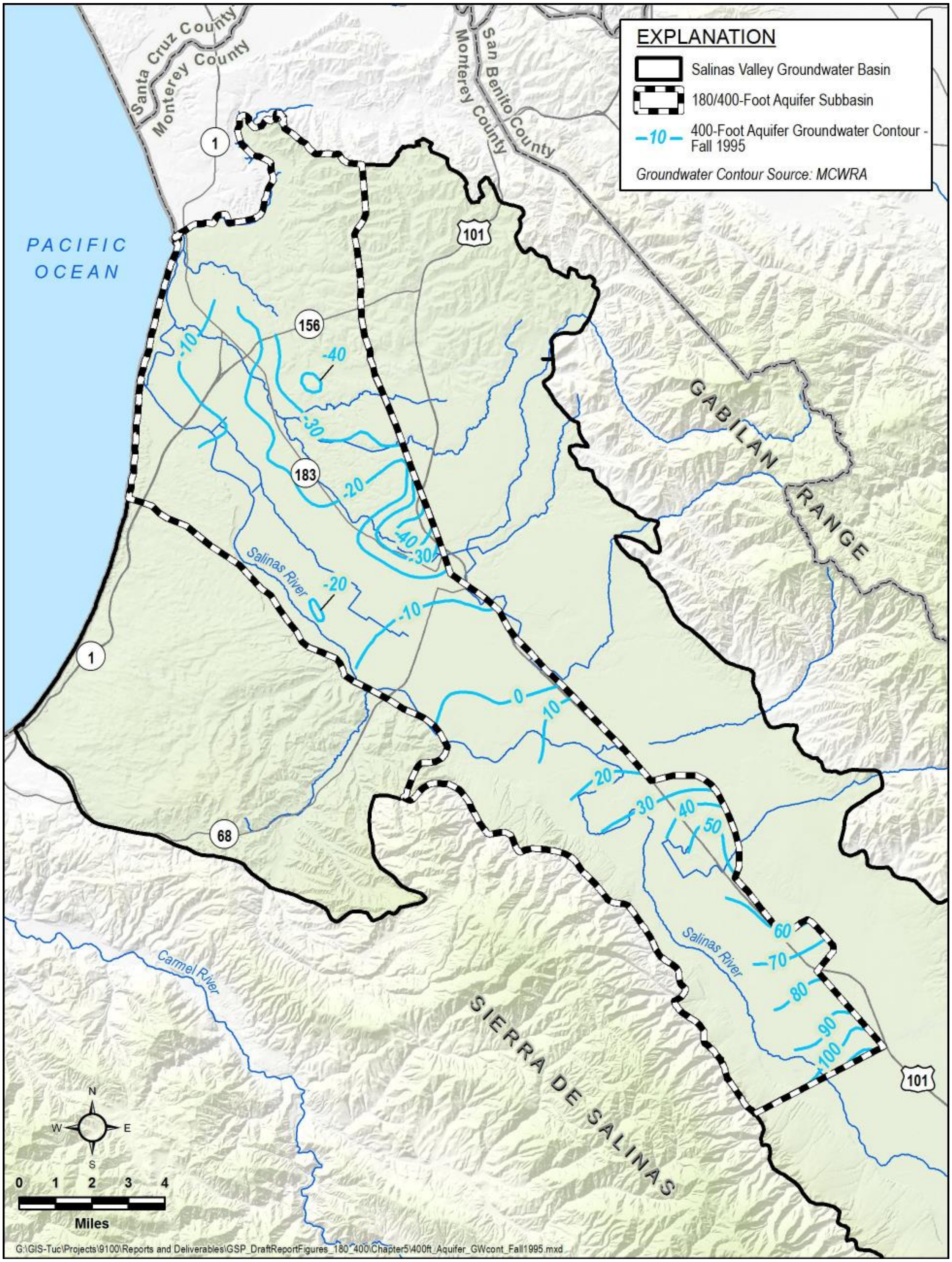


Figure 5-8. Fall 1995 400-Foot Aquifer Groundwater Elevation Contours

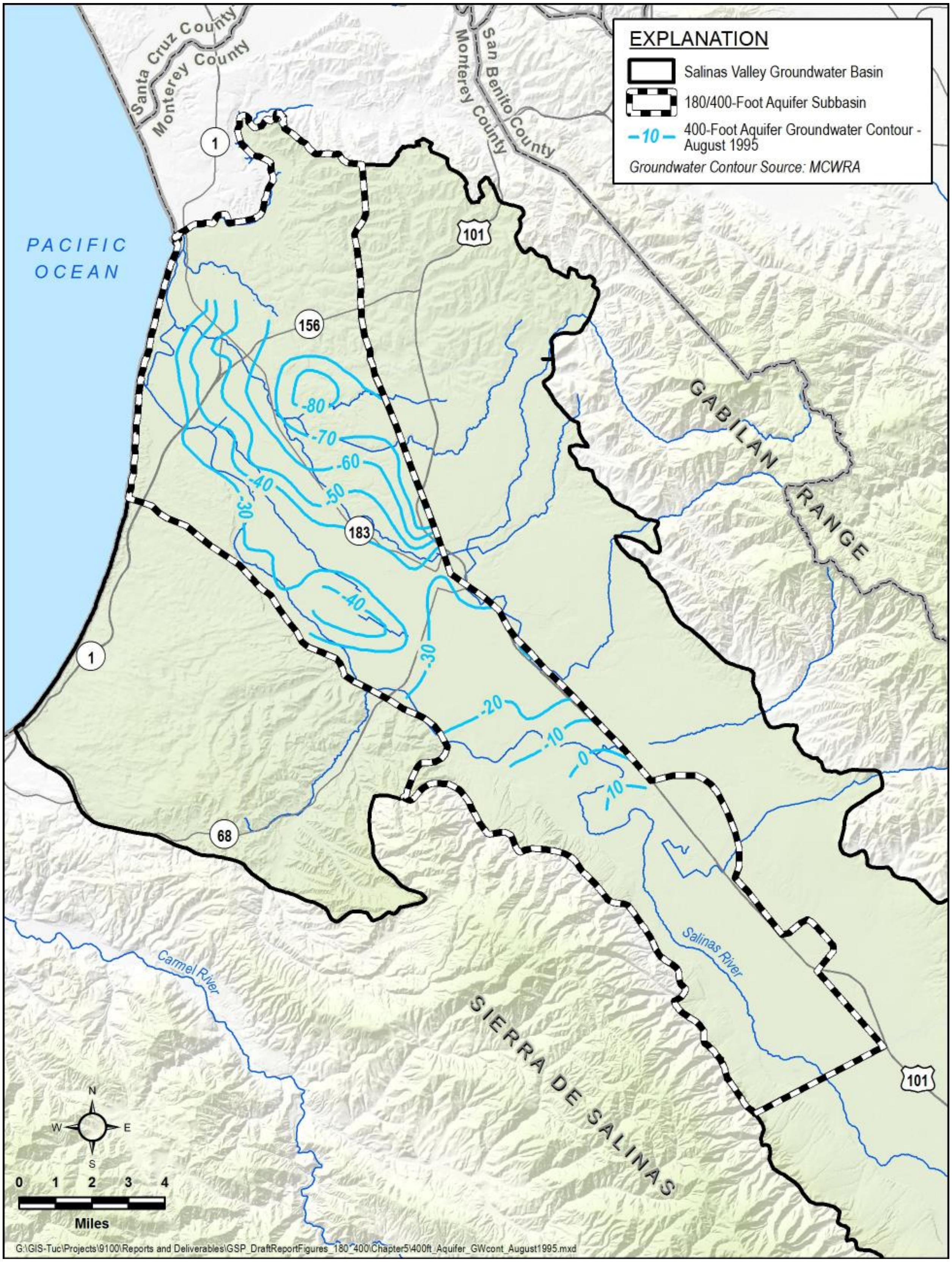


Figure 5-9. August 1995 400-Foot Aquifer Groundwater Elevation Contours

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.

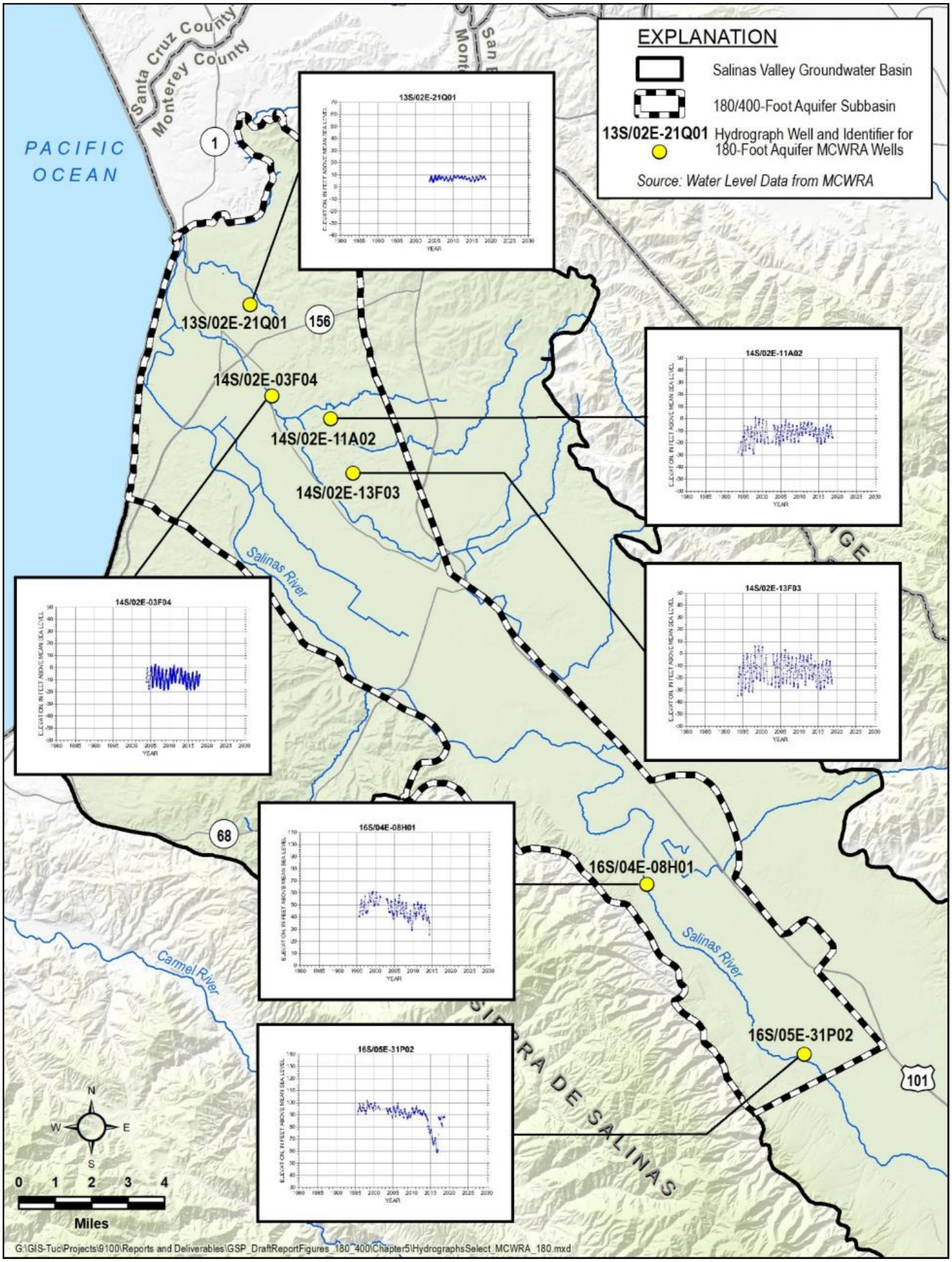
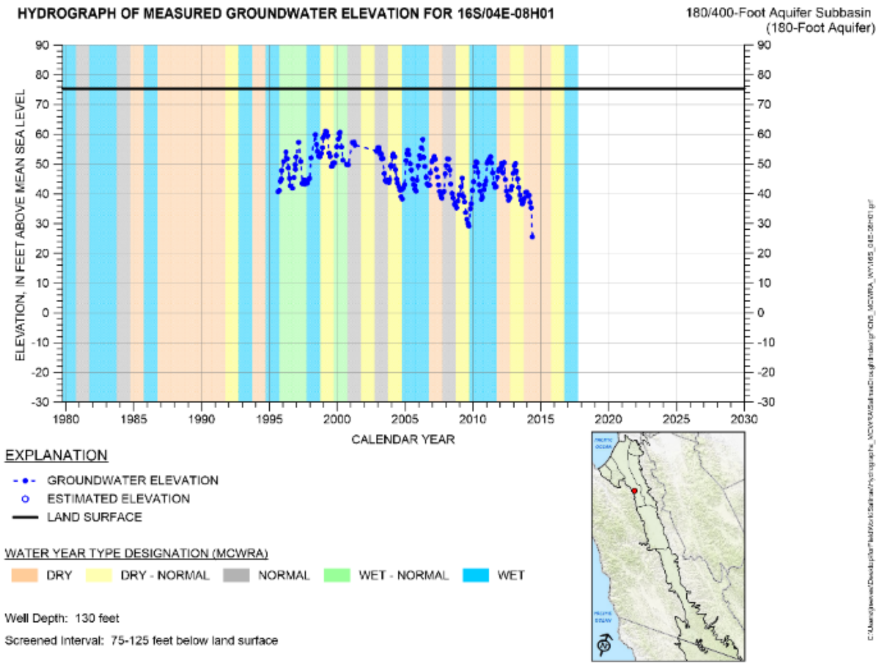


Figure 5-10. Map of Representative Hydrographs in the 180-Foot Aquifer



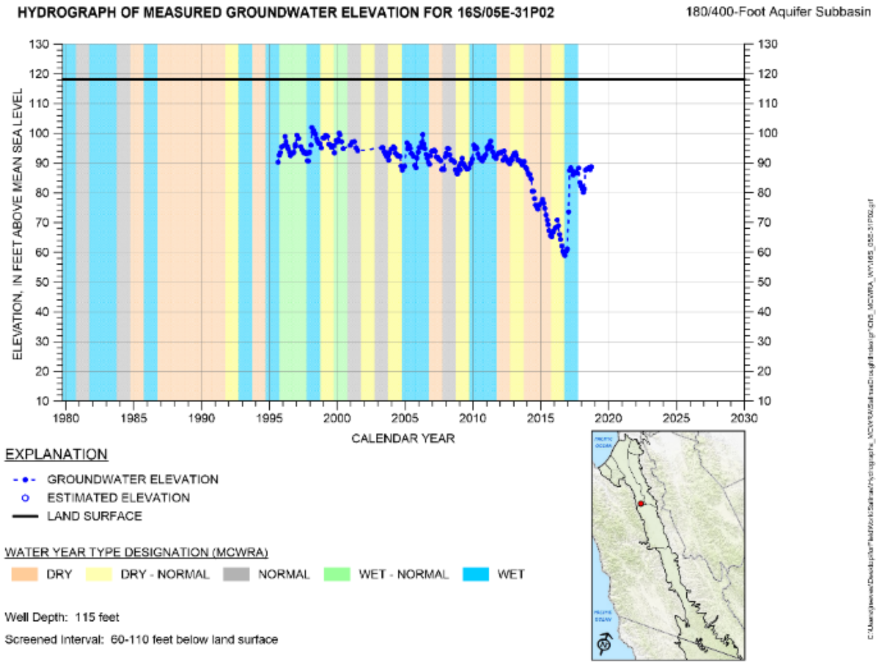


Figure 5-11. Representative Hydrographs Shown on the 180-Foot Aquifer Map (1)

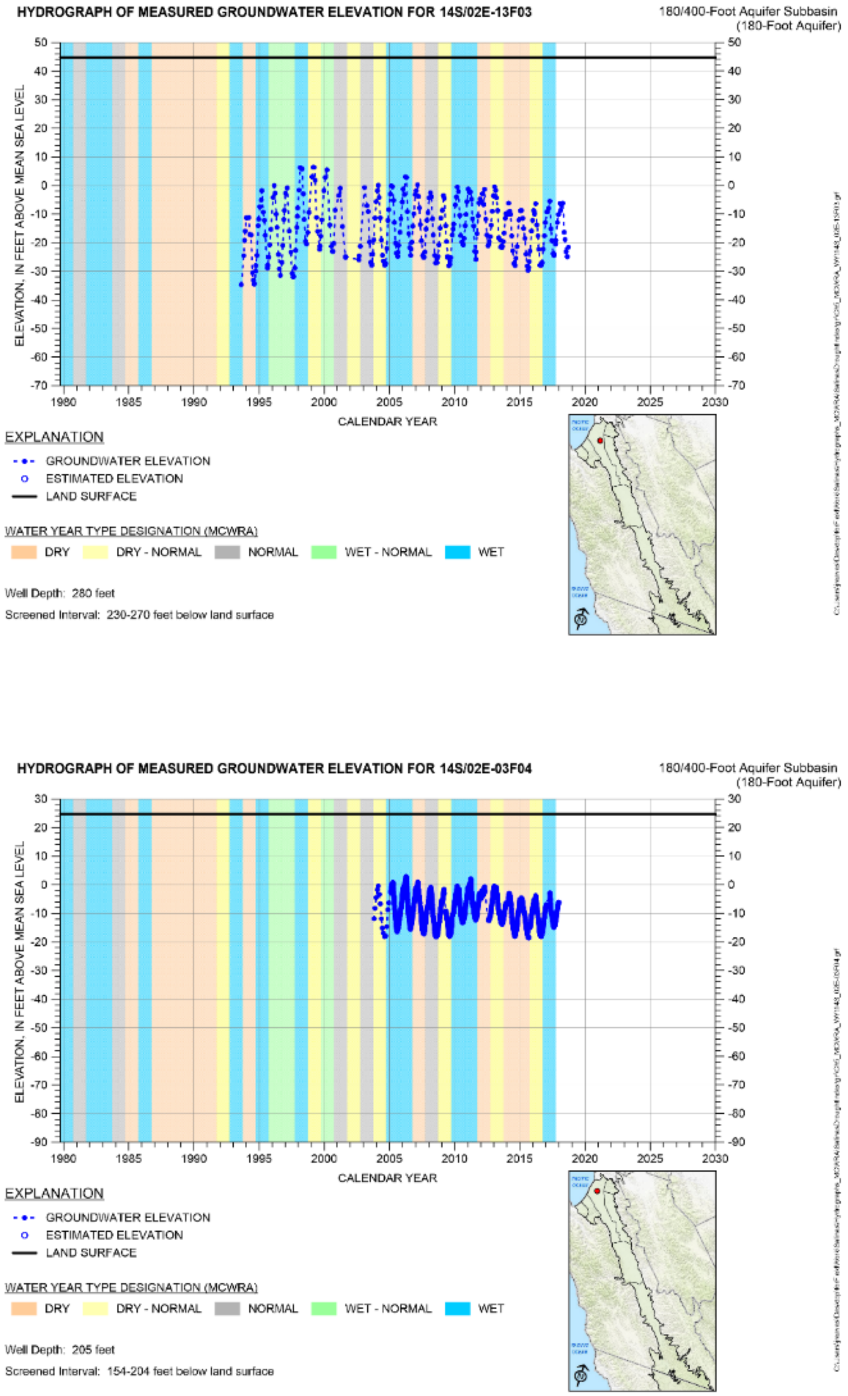
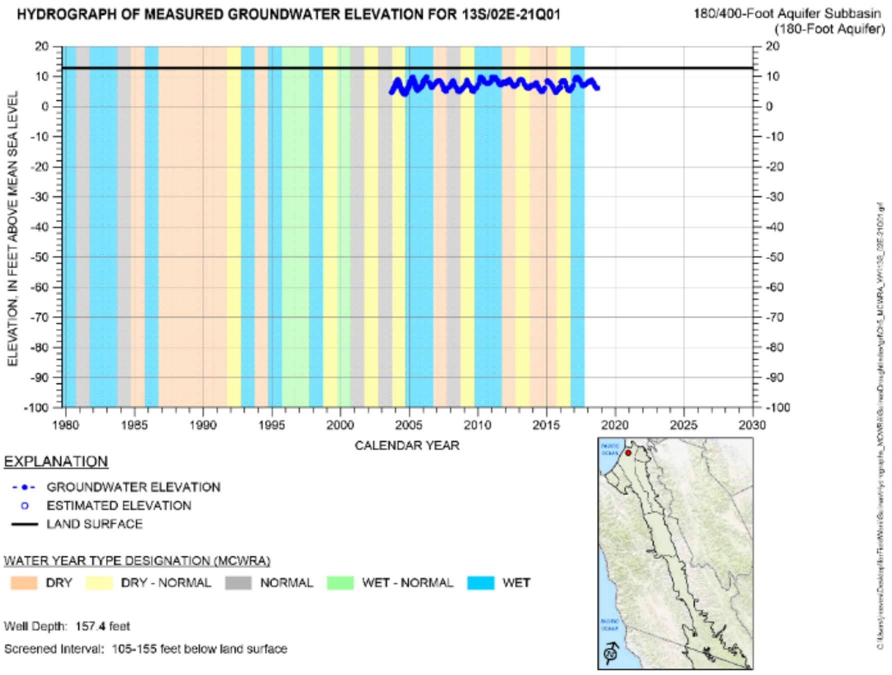


Figure 5-12. Representative Hydrographs Shown on the 180-Foot Aquifer Map (2)



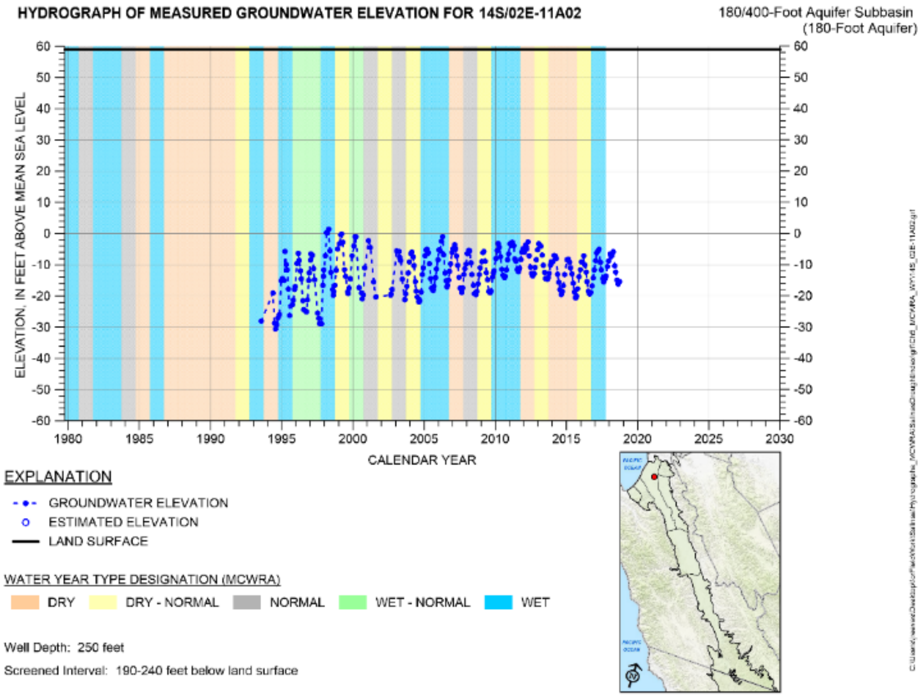


Figure 5-13. Representative Hydrographs Shown on the 180-Foot Aquifer Map (3)

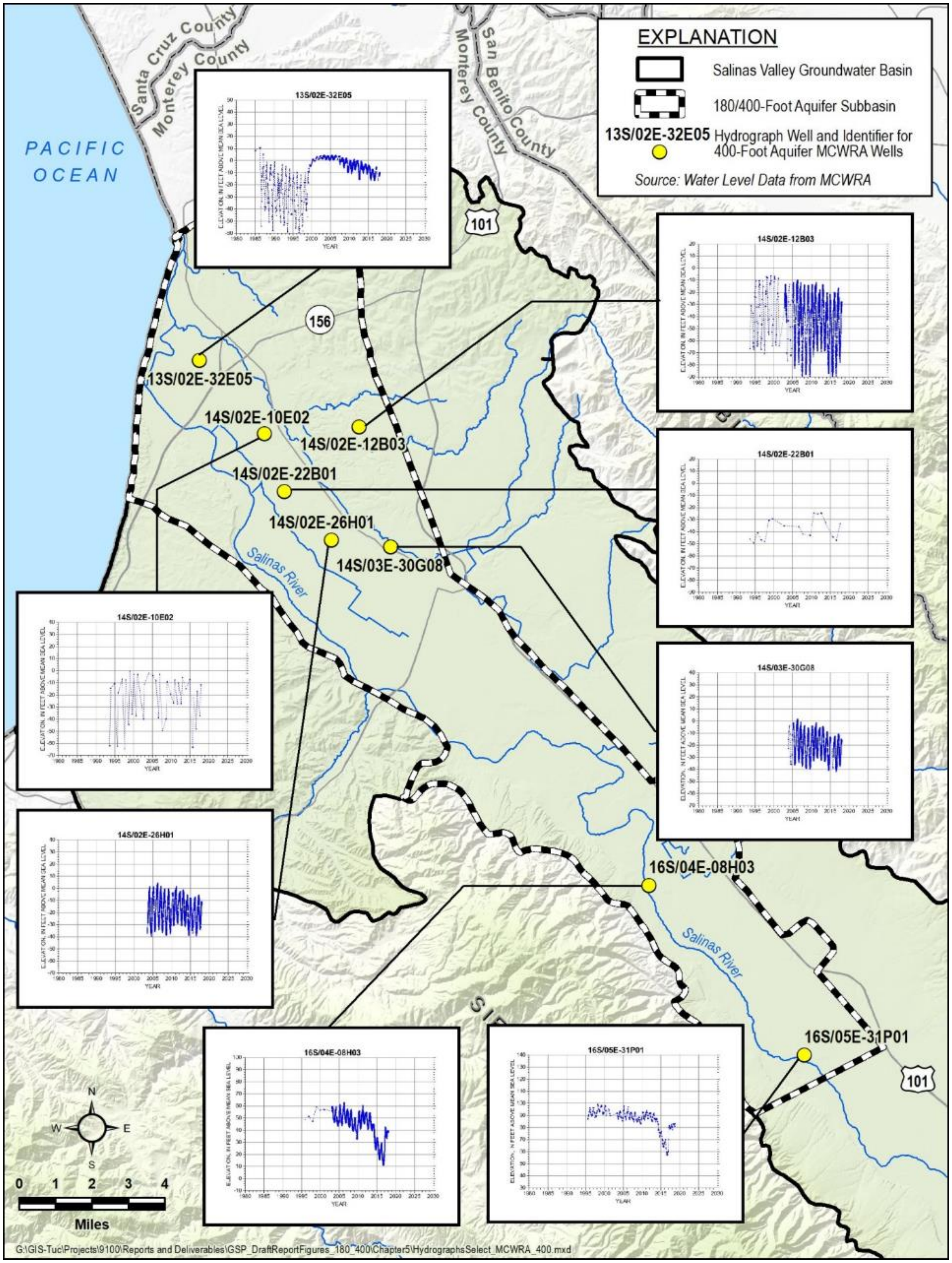
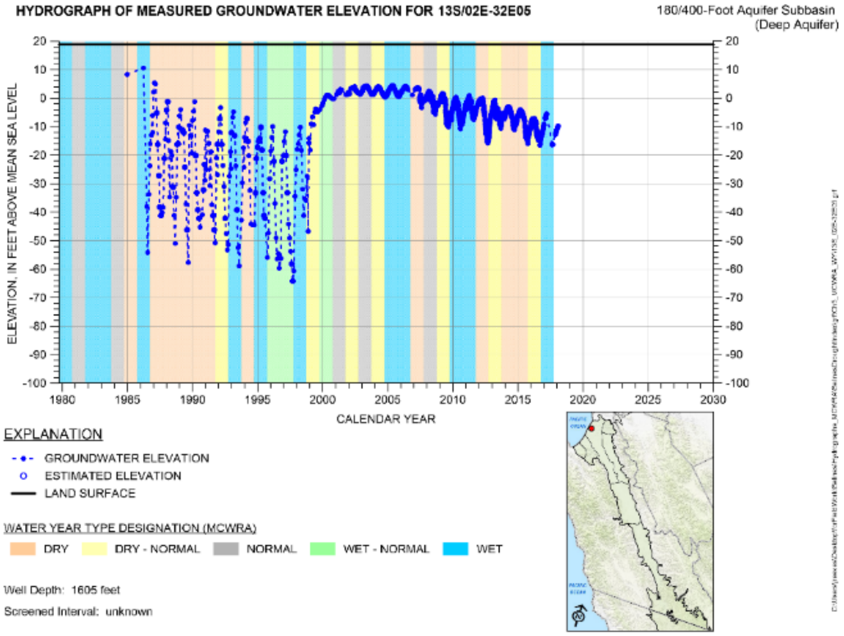


Figure 5-14. Map of Representative Hydrographs in the 400-Foot Aquifer



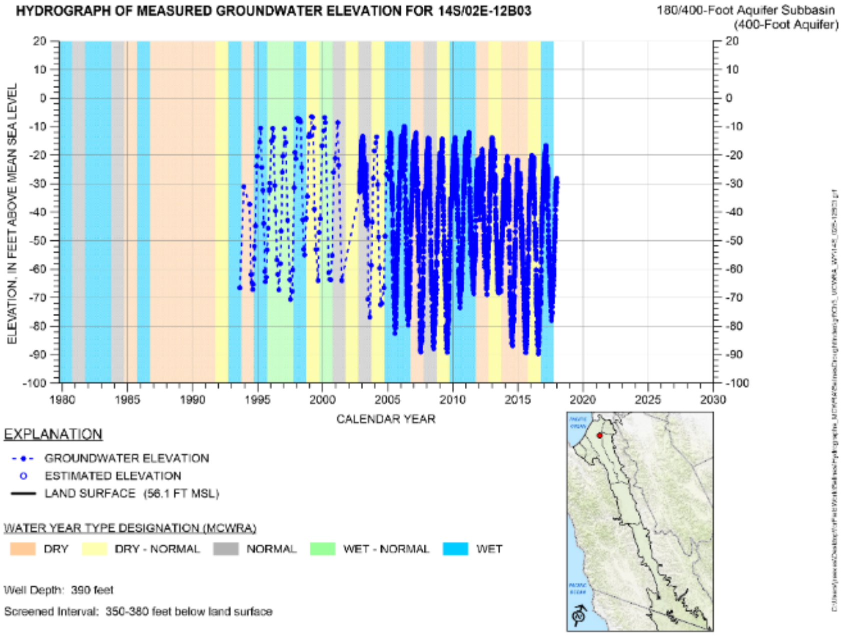
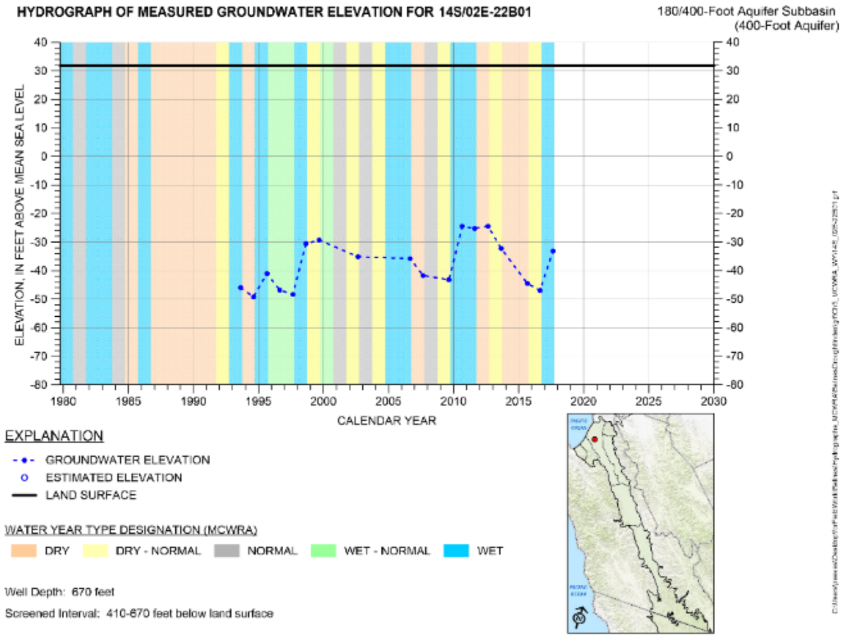


Figure 5-15. Representative Hydrographs Shown on the 400-Foot Aquifer Map (1)



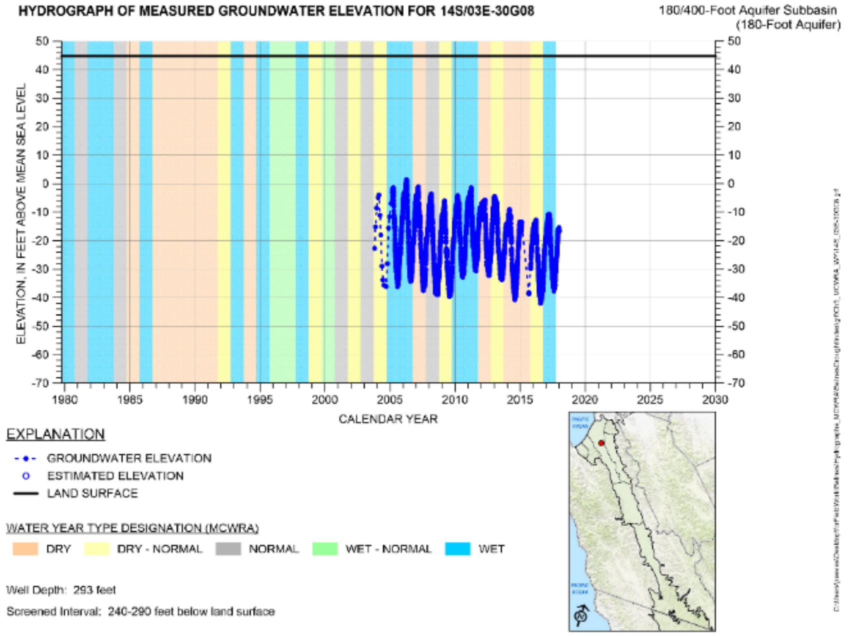
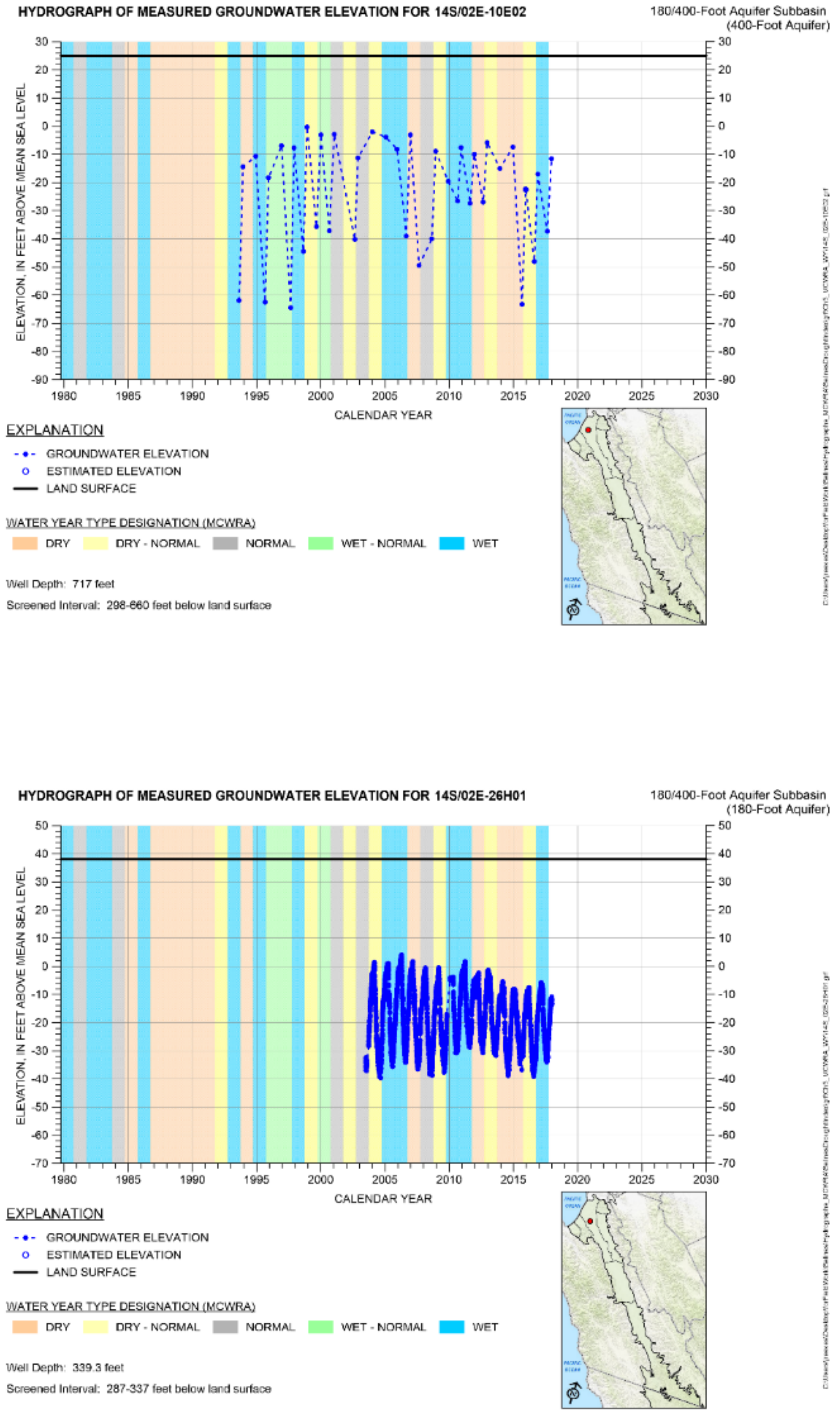


Figure 5-16. Representative Hydrographs Shown on the 400-Foot Aquifer Map (2)



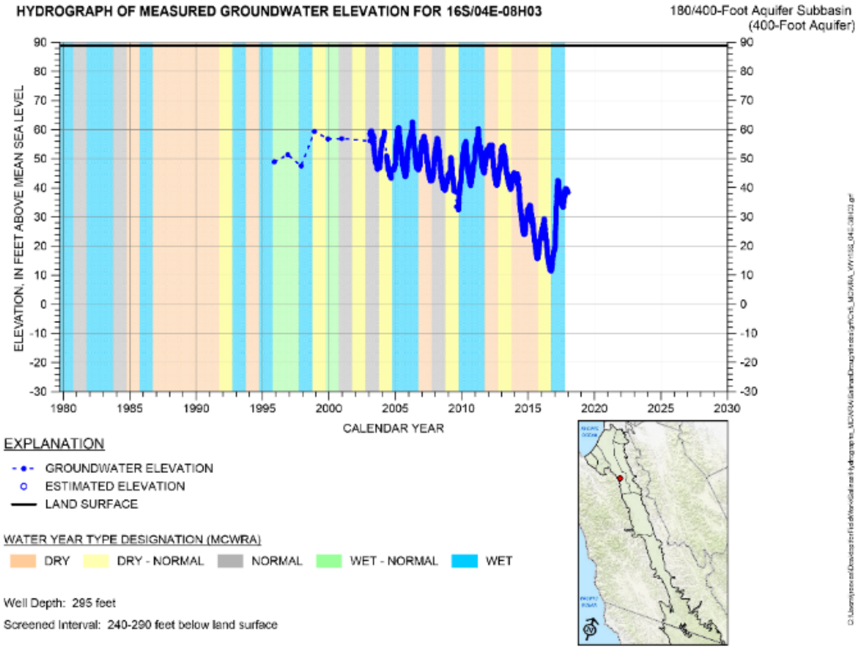
Well Depth: 717 feet

Screened Interval: 298-660 feet below land surface

Well Depth: 339.3 feet

Screened Interval: 287-337 feet below land surface

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



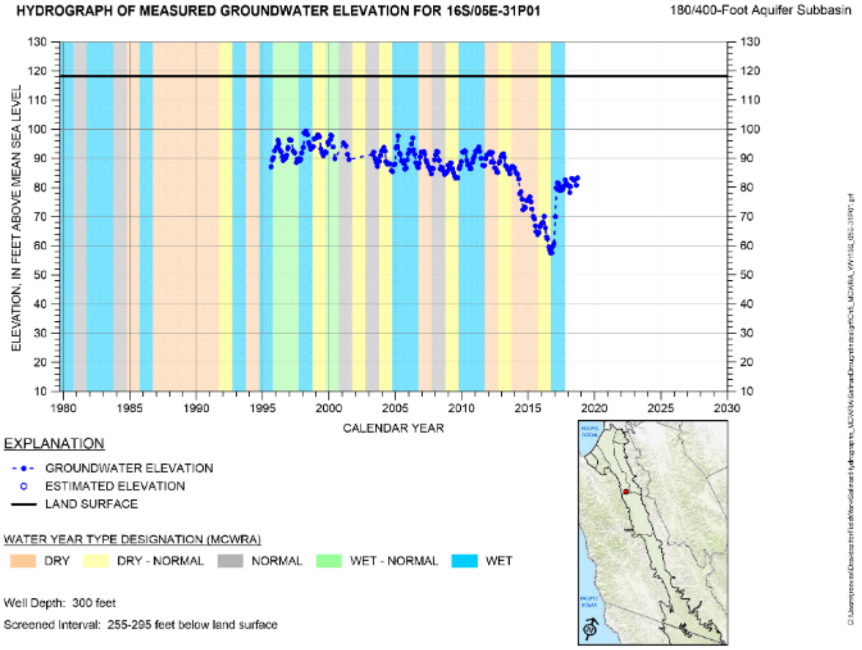


Figure 5-18. Representative Hydrographs Shown on the 400-Foot Aquifer Map (4)

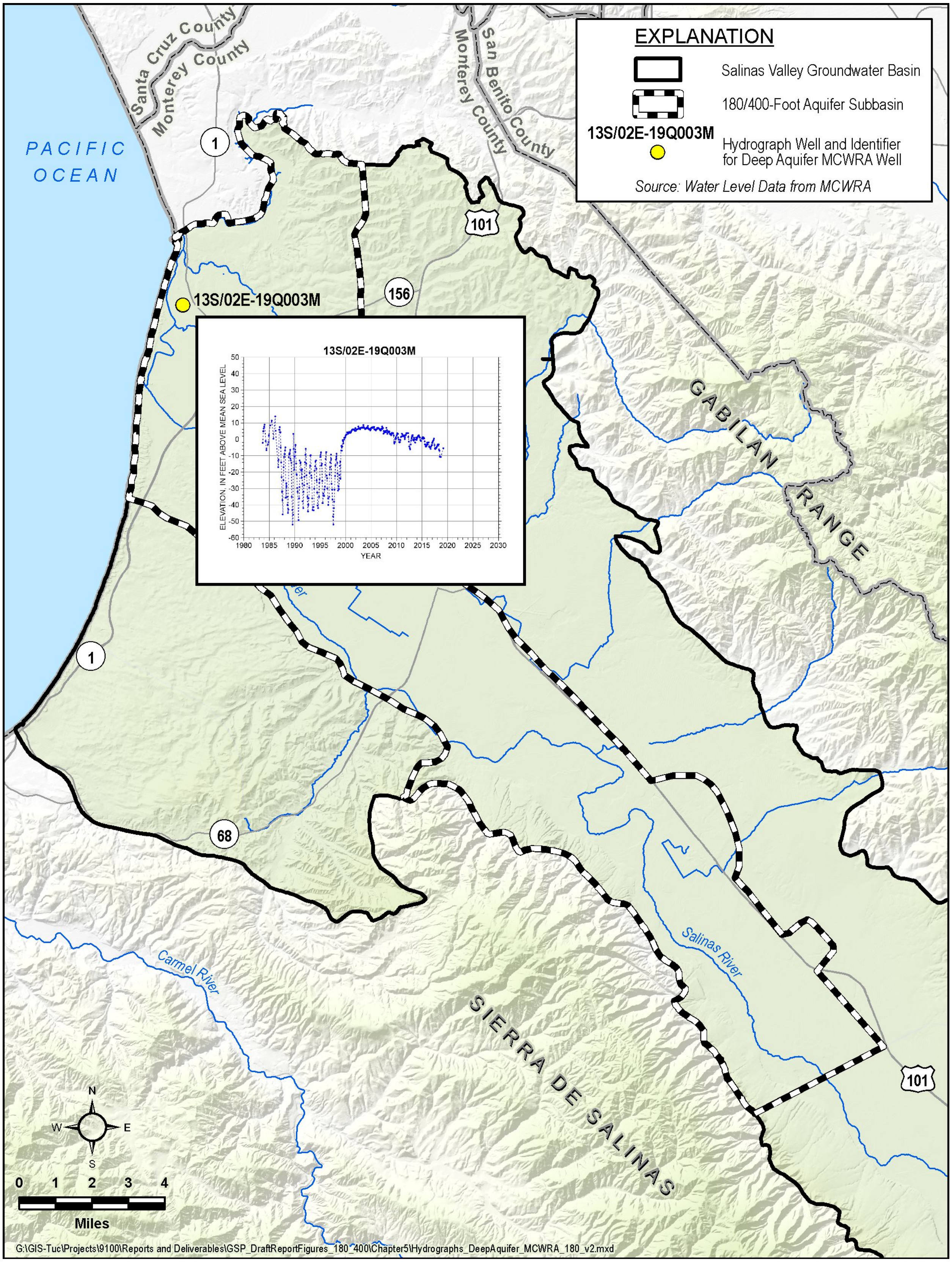
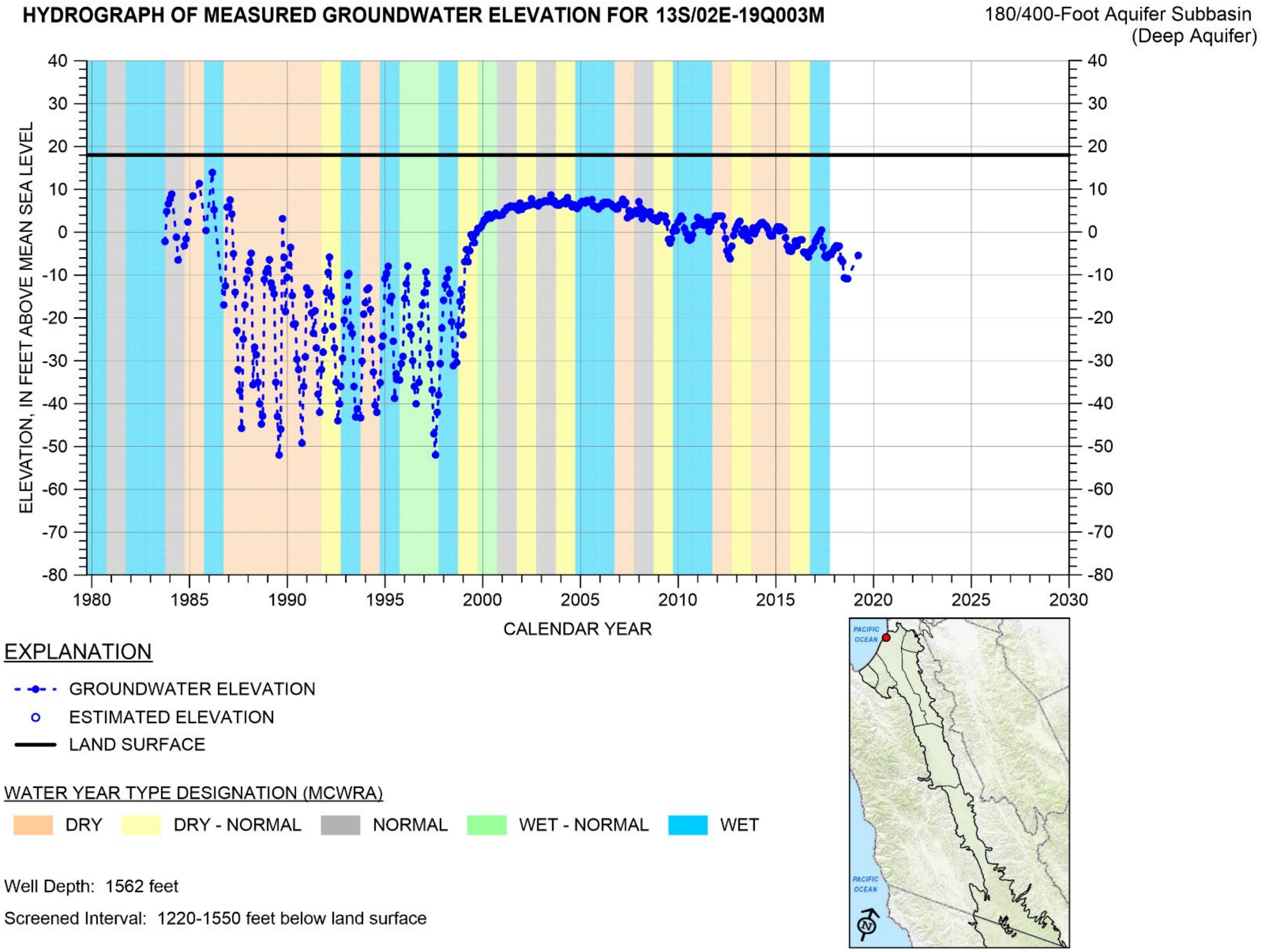


Figure 5-19. Map of Representative Hydrograph in the Deep Aquifers



Well Depth: 1562 feet

Screened Interval: 1220-1550 feet below land surface

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

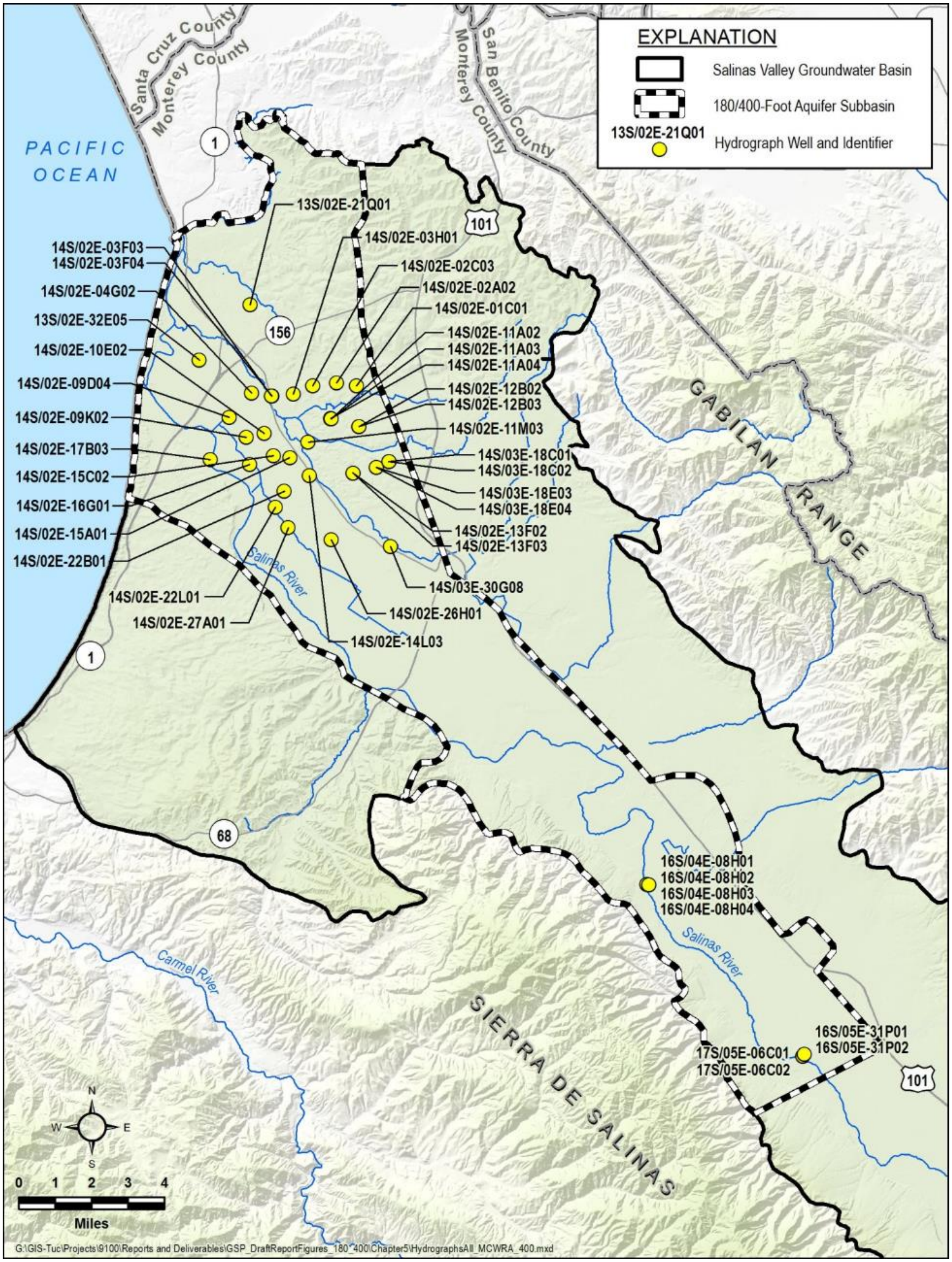


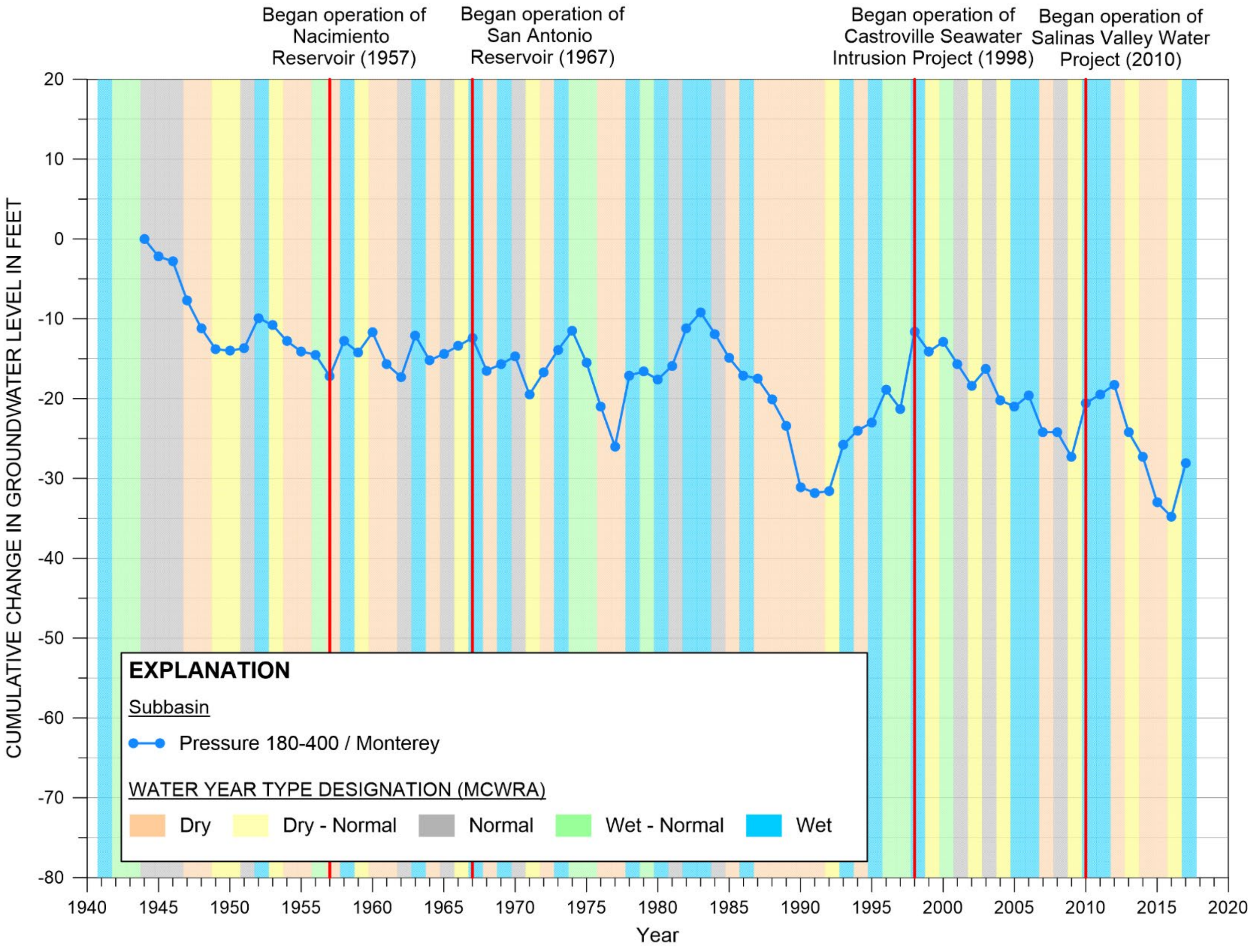
Figure 5-21. Locations of Wells with Hydrographs Included in Appendix 5A

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.



Cumulative change is based on annual fall averages

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

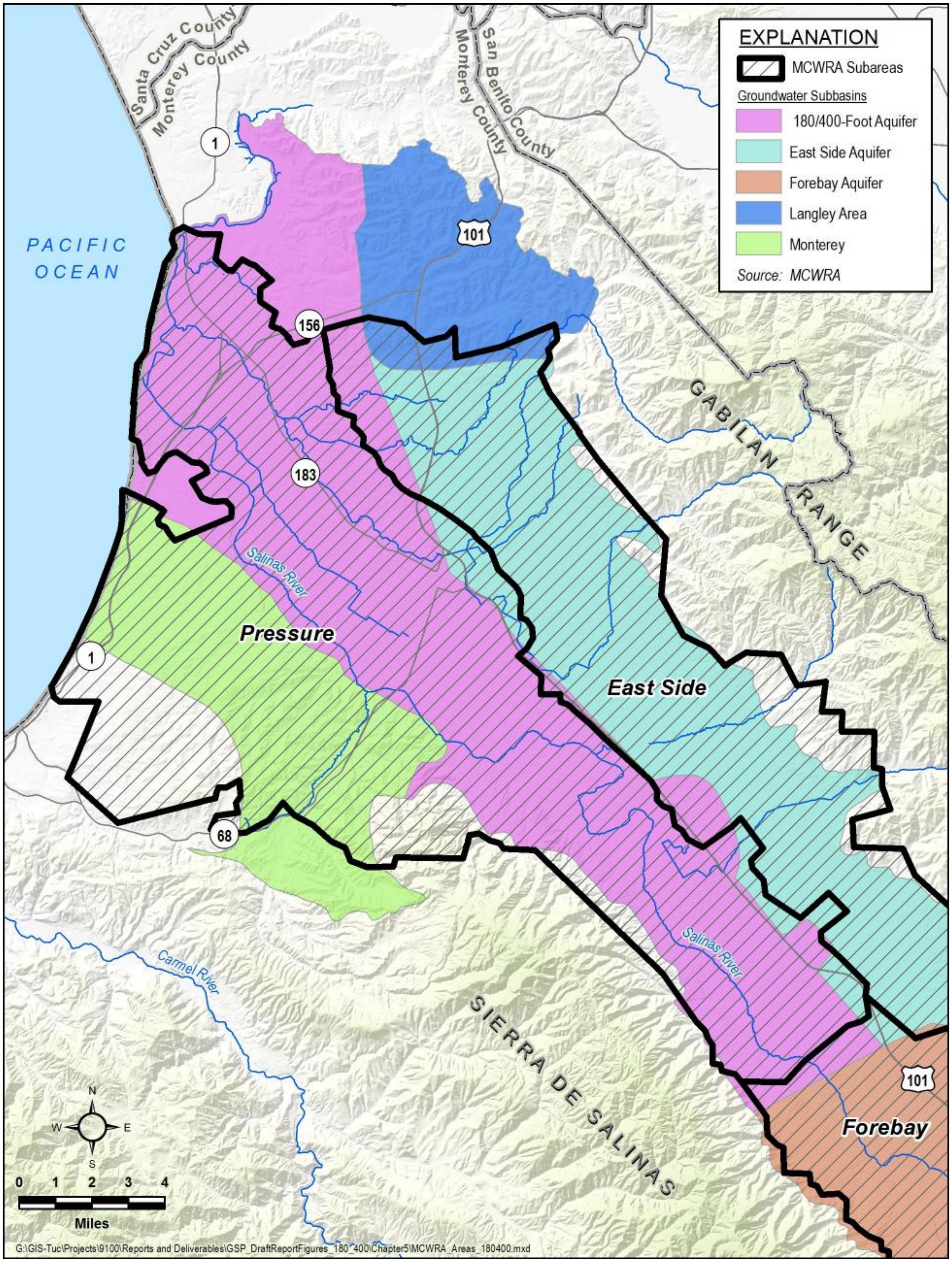


Figure 5-23. MCWRA Management Areas

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.

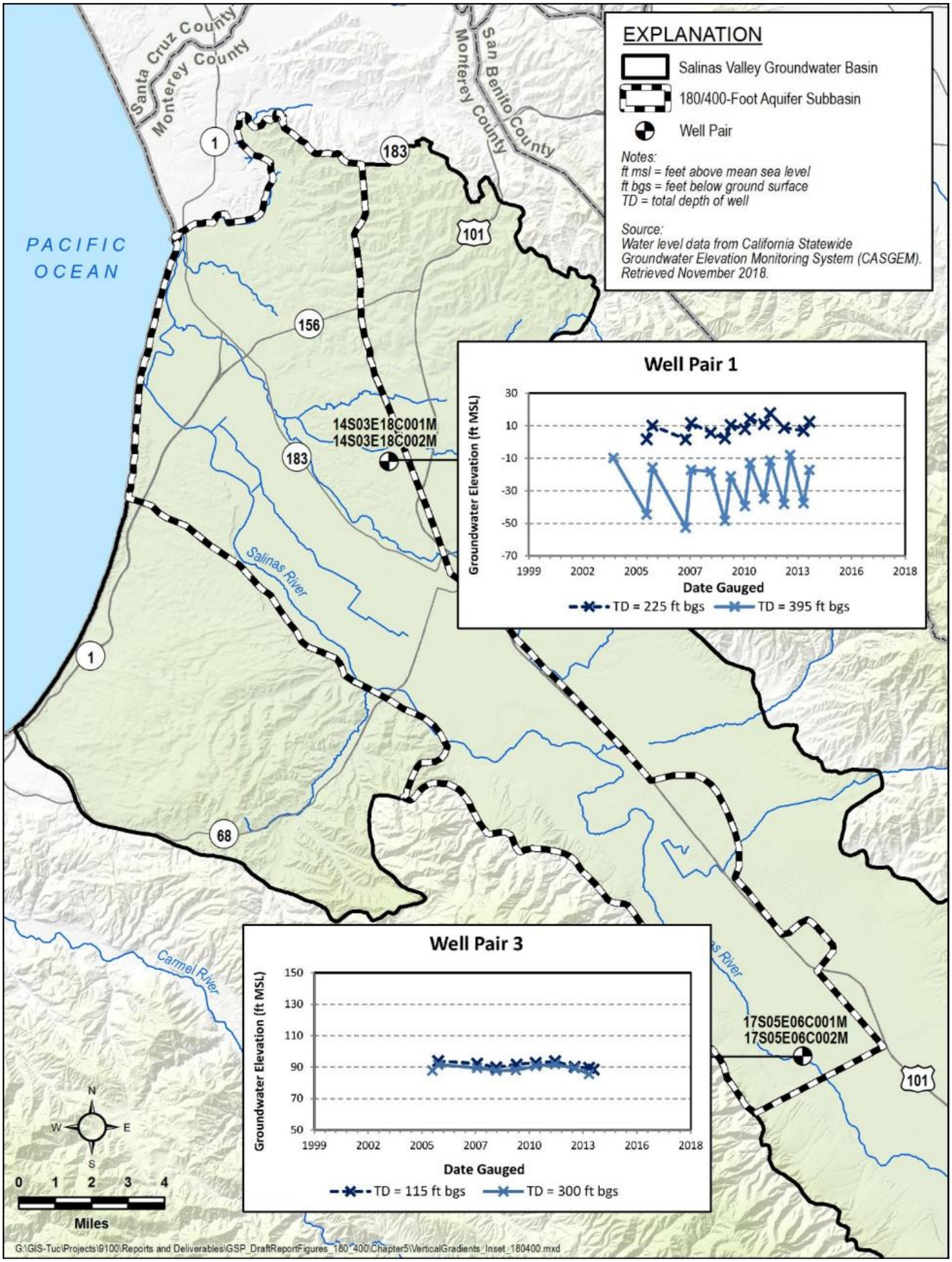


Figure 5-24. Vertical Gradients

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.)

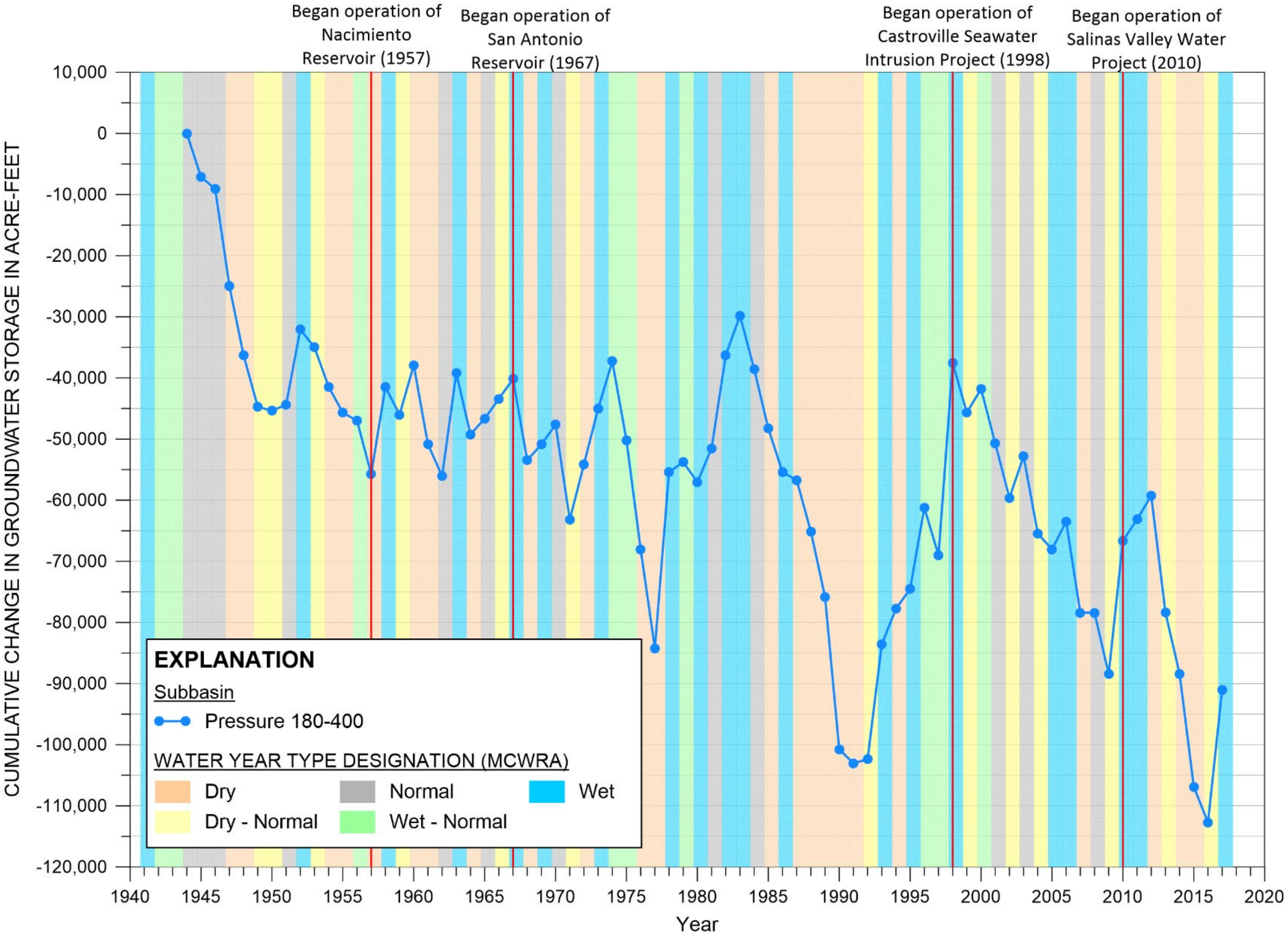
ΔWL= Annual change in average groundwater elevation in the Subbasin (ft/yr.)

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.

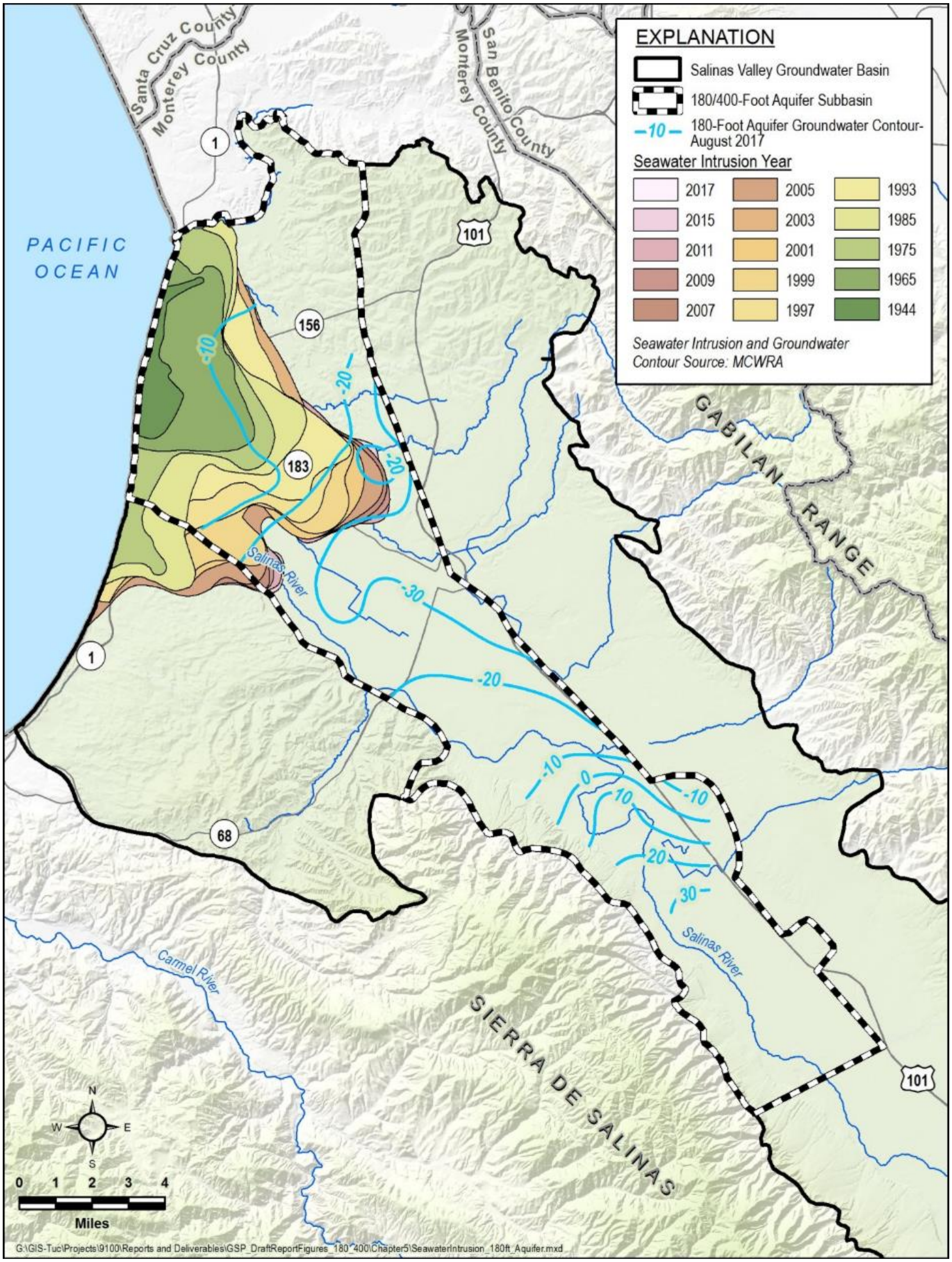


Figure 5-26. Seawater Intrusion in the 180-Foot Aquifer (from MCWRA)

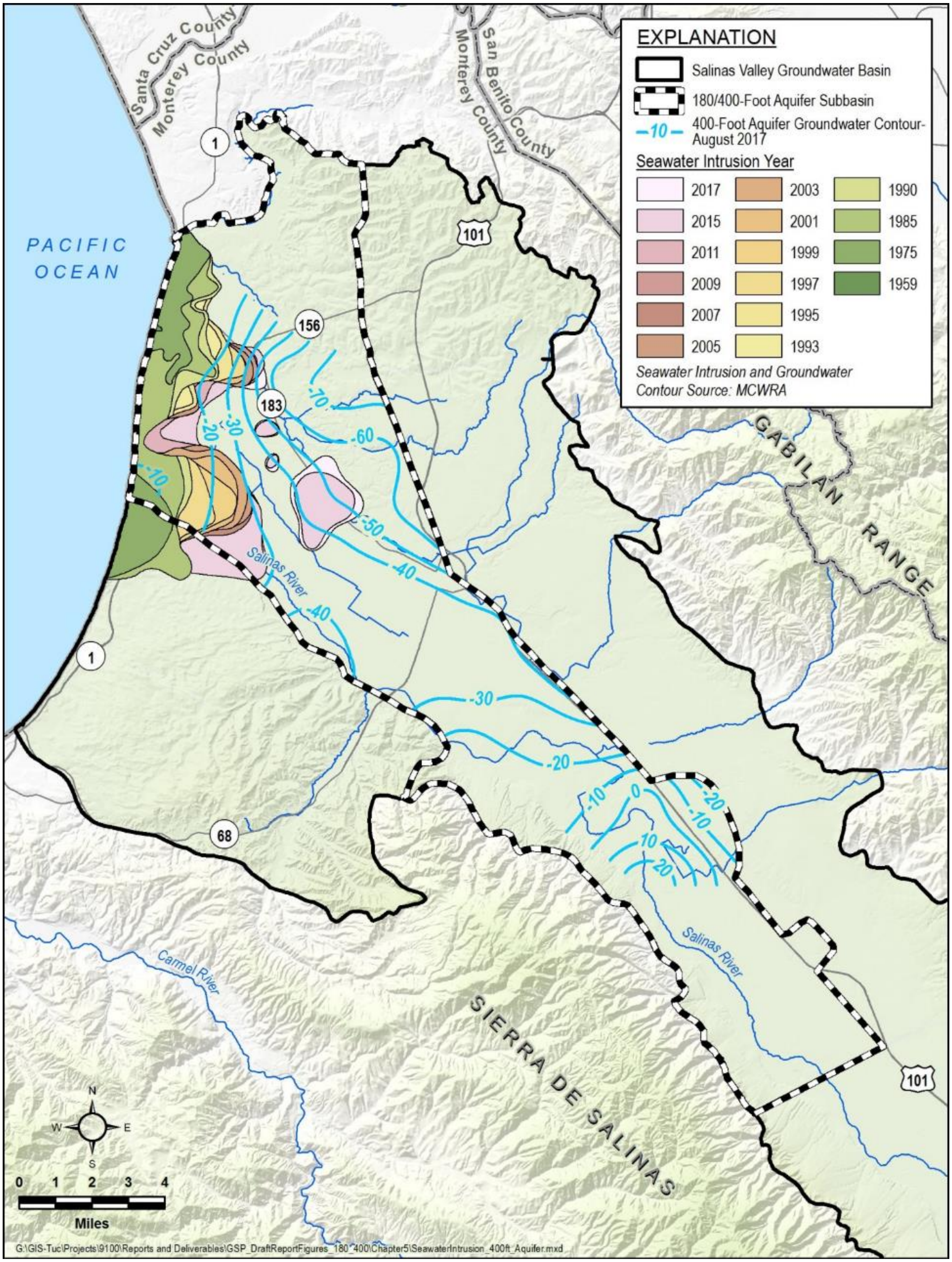


Figure 5-27. Seawater Intrusion in the 400-Foot Aquifer
(from MCWRA)

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.

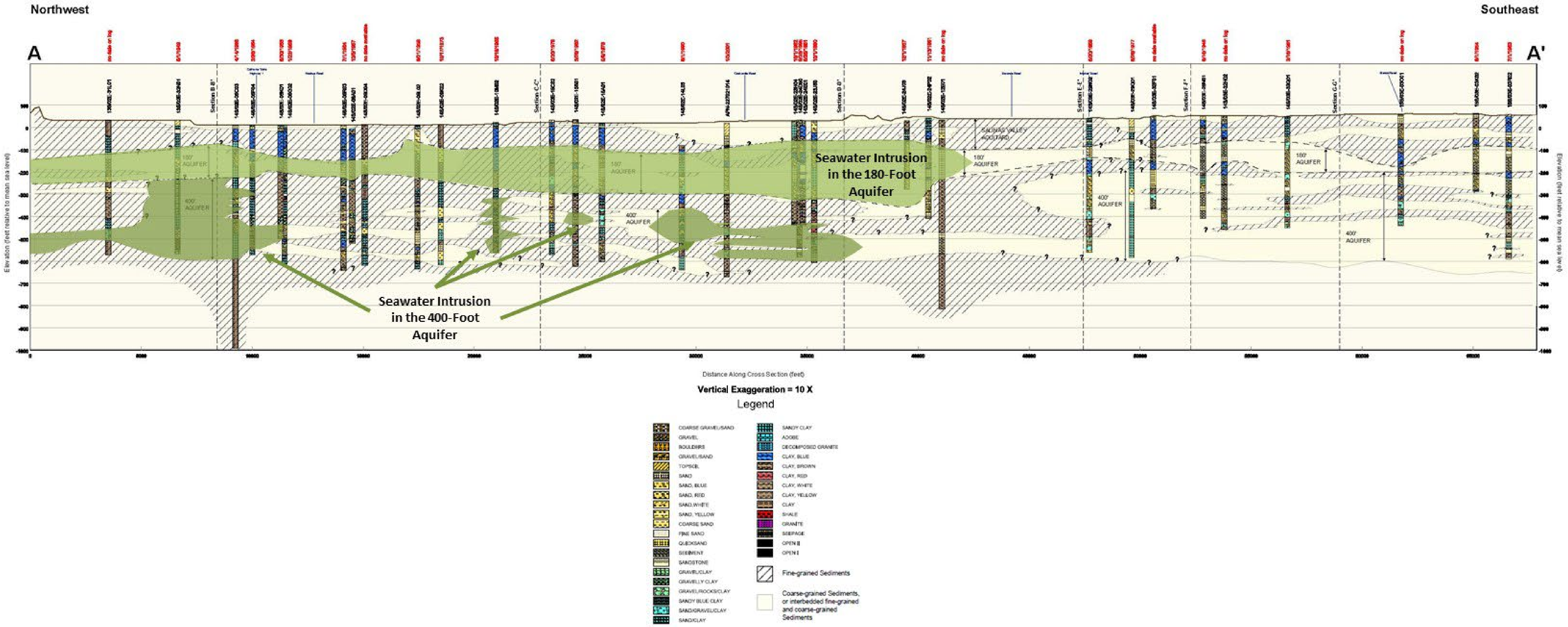


Figure 5-28. Cross-Section of Estimated Depth of Seawater Intrusion Based on Mapped 2017 Intrusion

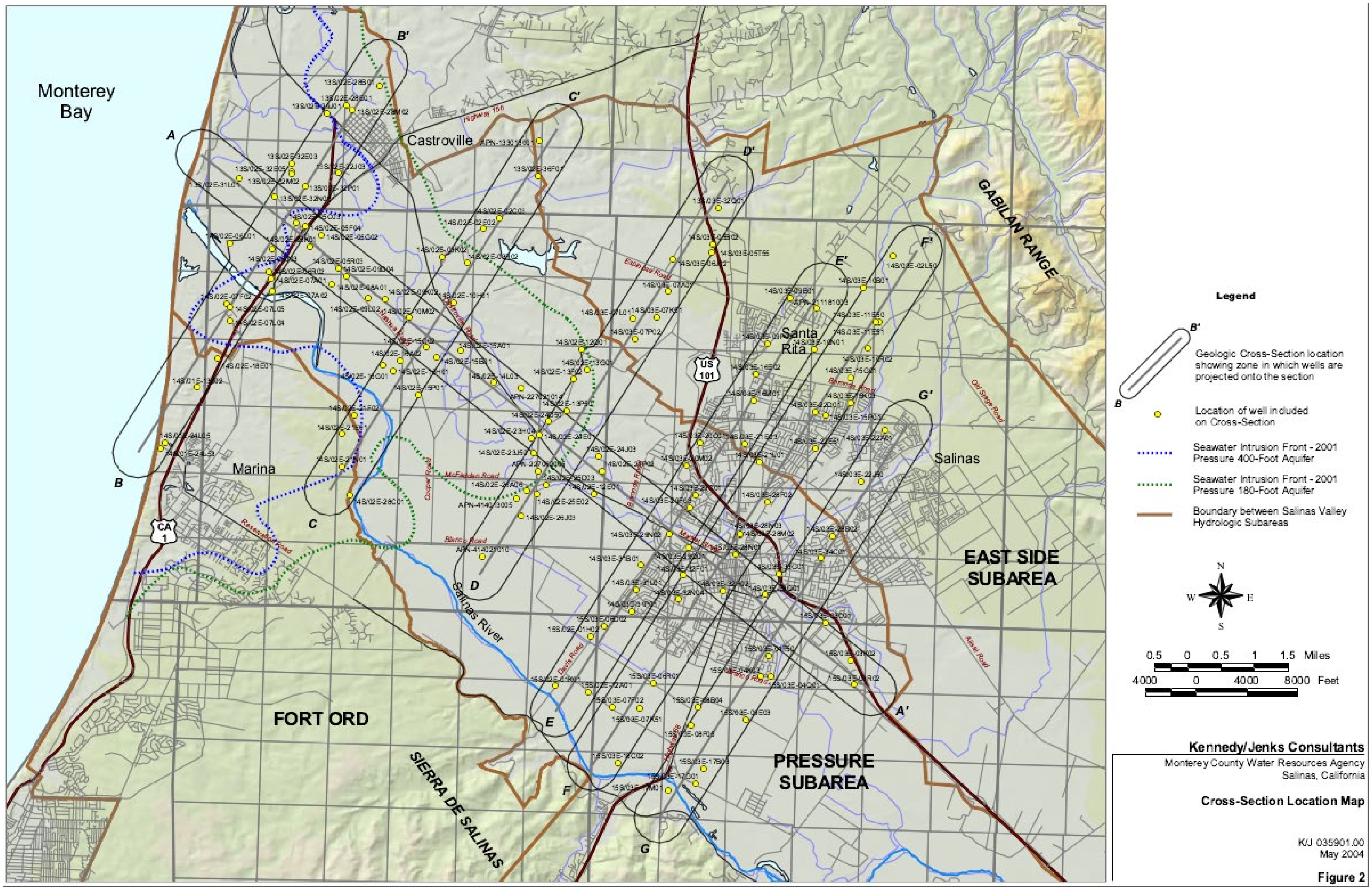


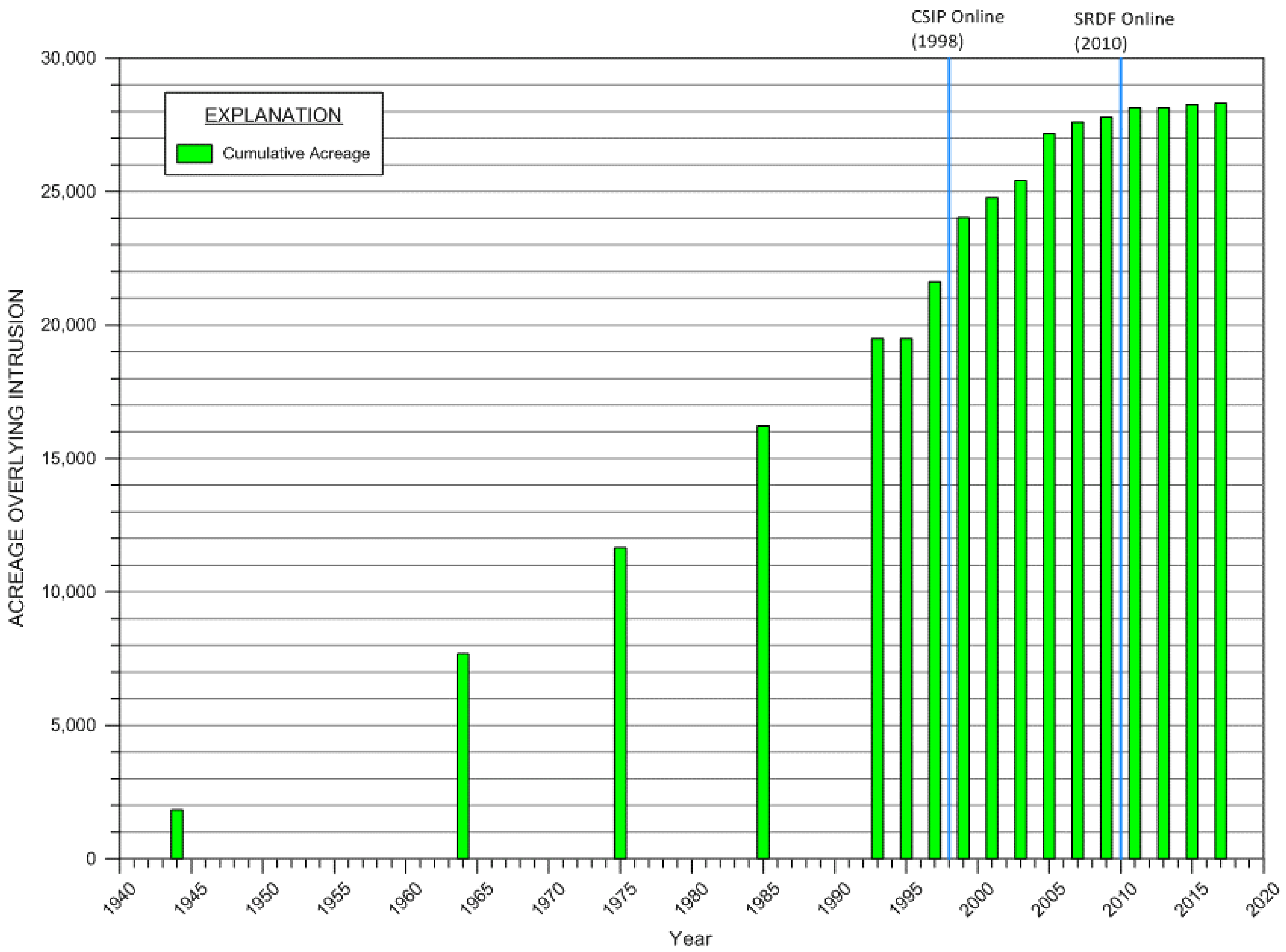
Figure 5-29. Location of Cross-Section A-A' Used for Hydrostratigraphy on Figure 5-28

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.

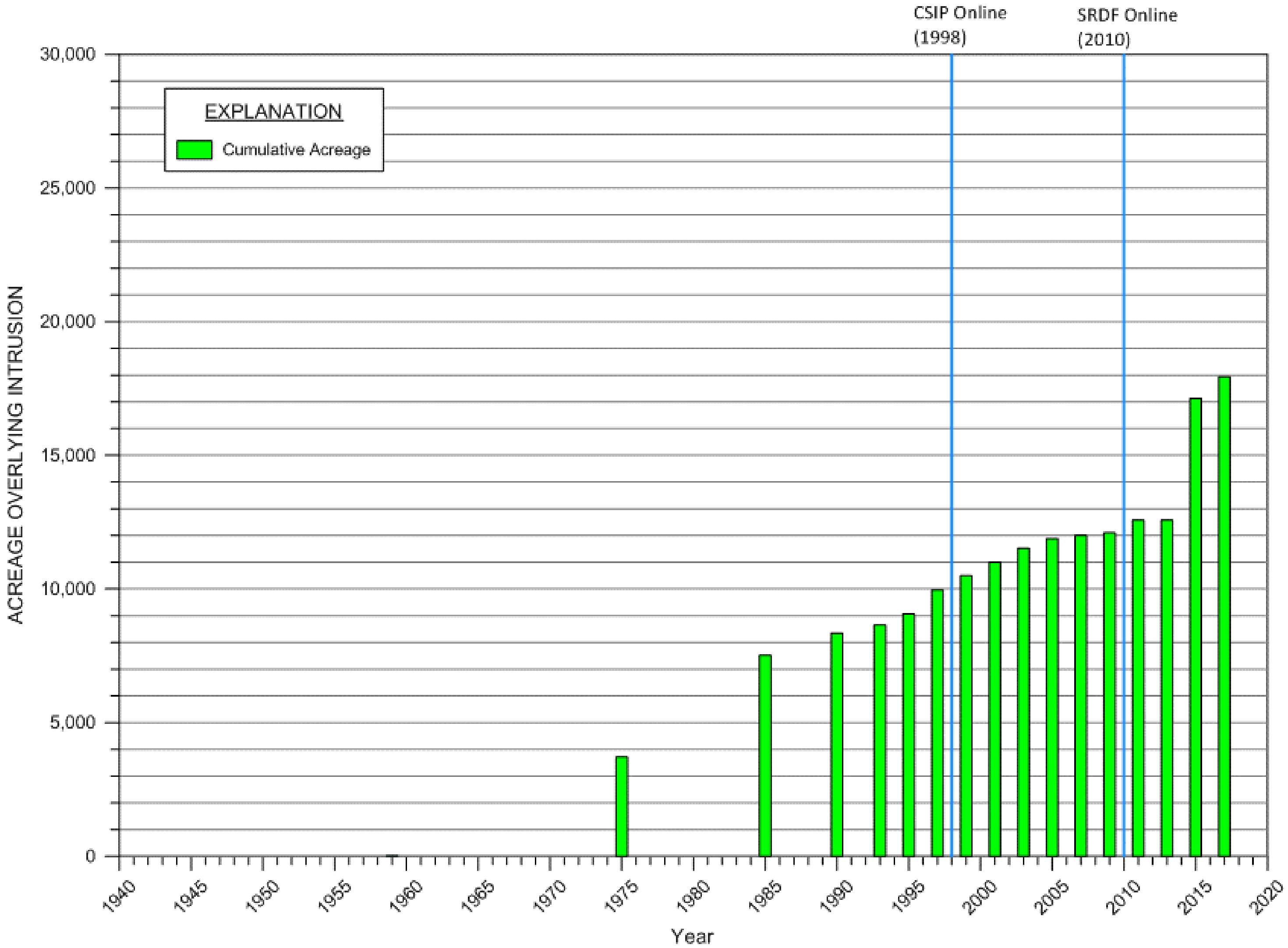
As shown on Figure 5-30, seawater intrusion into the 180-Foot Aquifer covered approximately 20,000 acres in 1995 and had expanded to approximately 28,000 acres by 2010. Since then, the rate of expansion has decreased, with an overlying area of 28,300 acres in 2017.

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

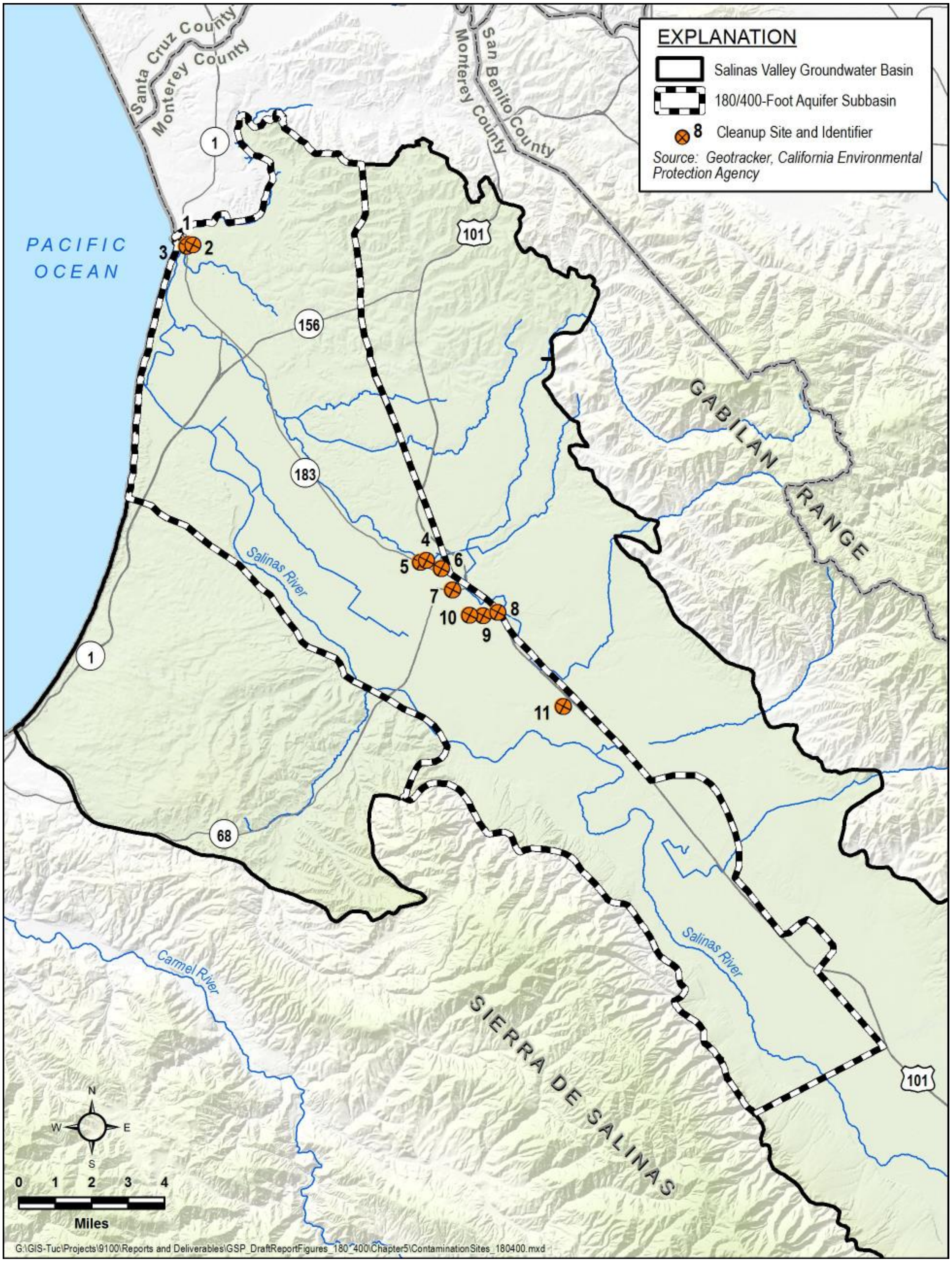


Figure 5-32. Active Cleanup Sites

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 W**a**ter 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).

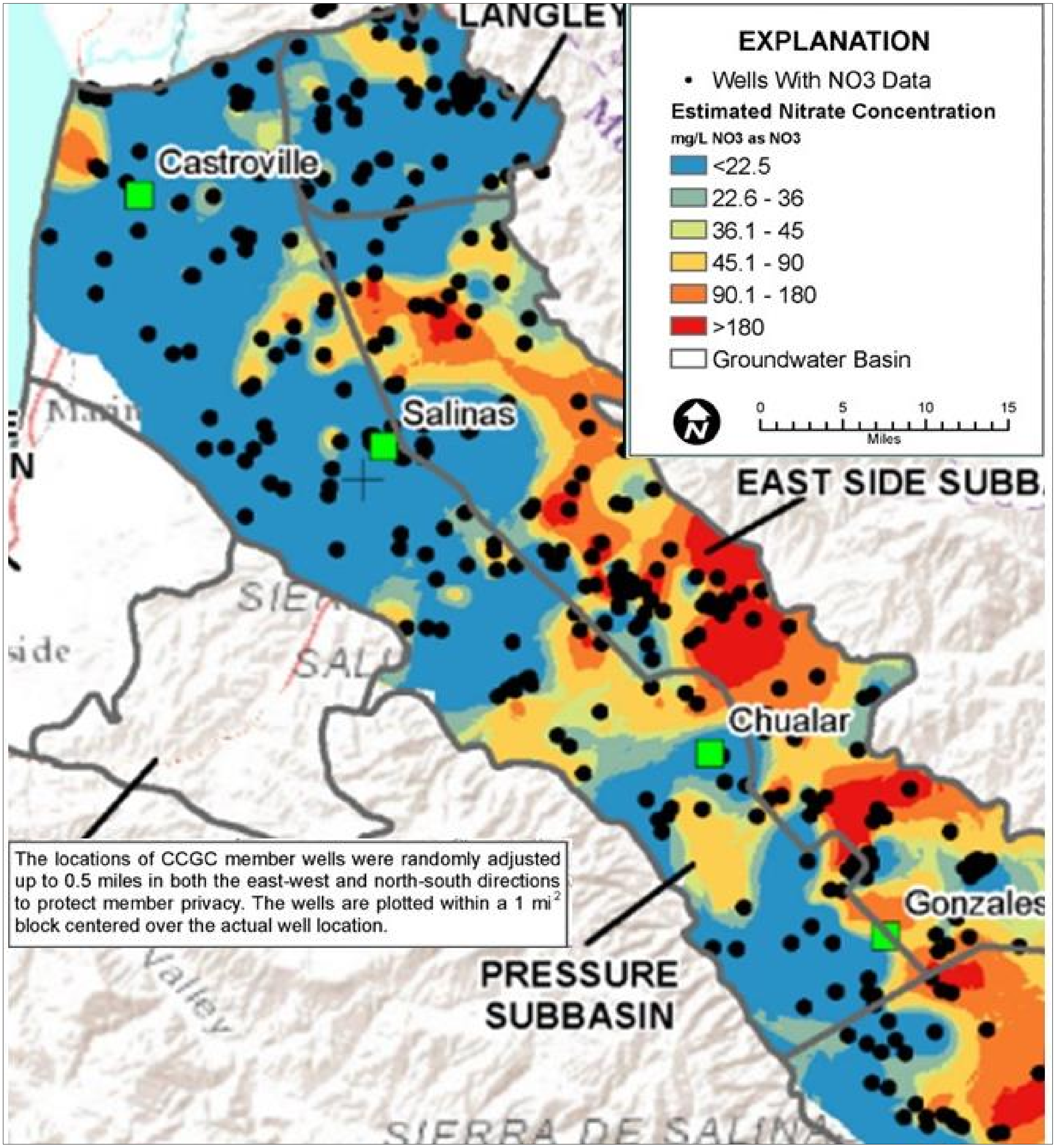


Figure 5-33. Estimated Nitrate Concentrations
(from CCGC, 2015)

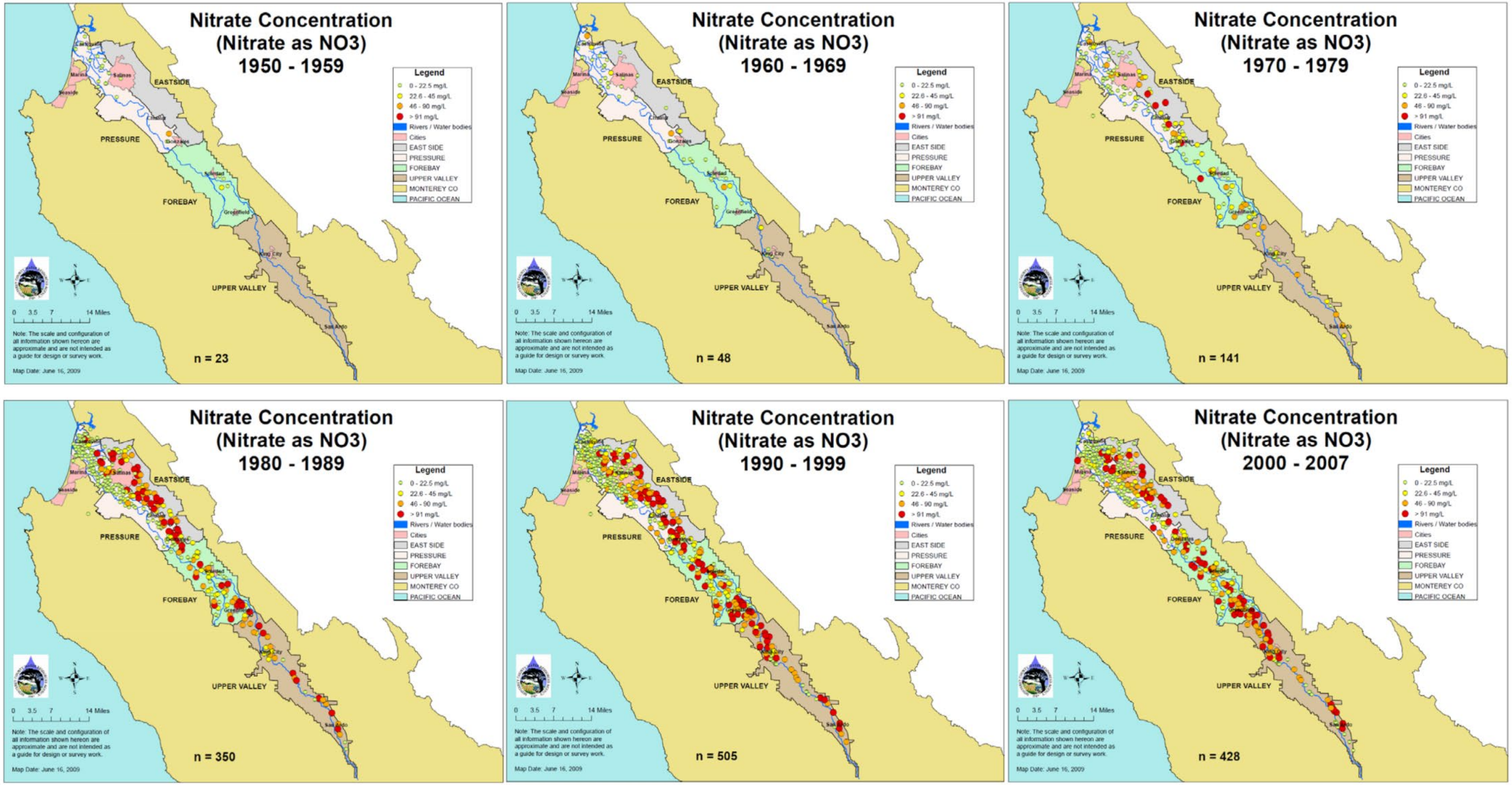


Figure 5-34. Nitrate Concentrations, 1950 to 2007
(from MCWRA)

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.

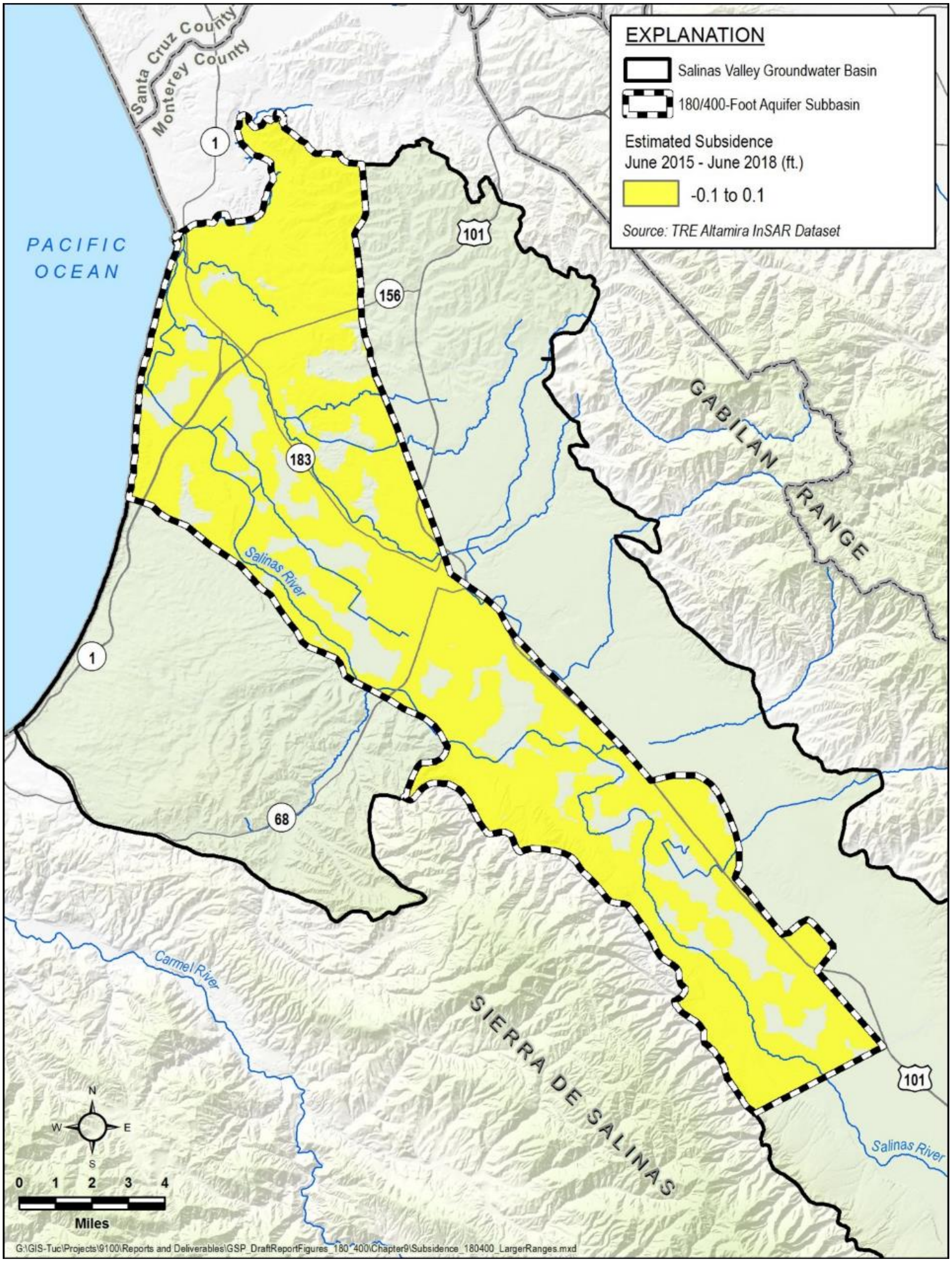


Figure 5-35. Estimated InSAR Subsidence in Subbasin
(created with data from DWR, 2019)

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).

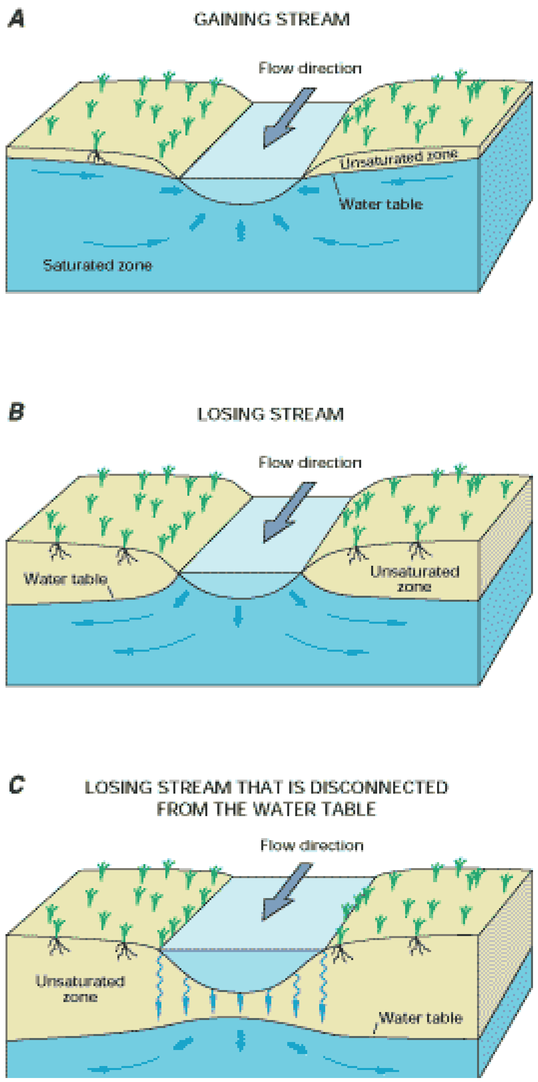


Figure 5-36. Conceptual Representation of Interconnected Surface Water (Winter, et al., 1999)

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.

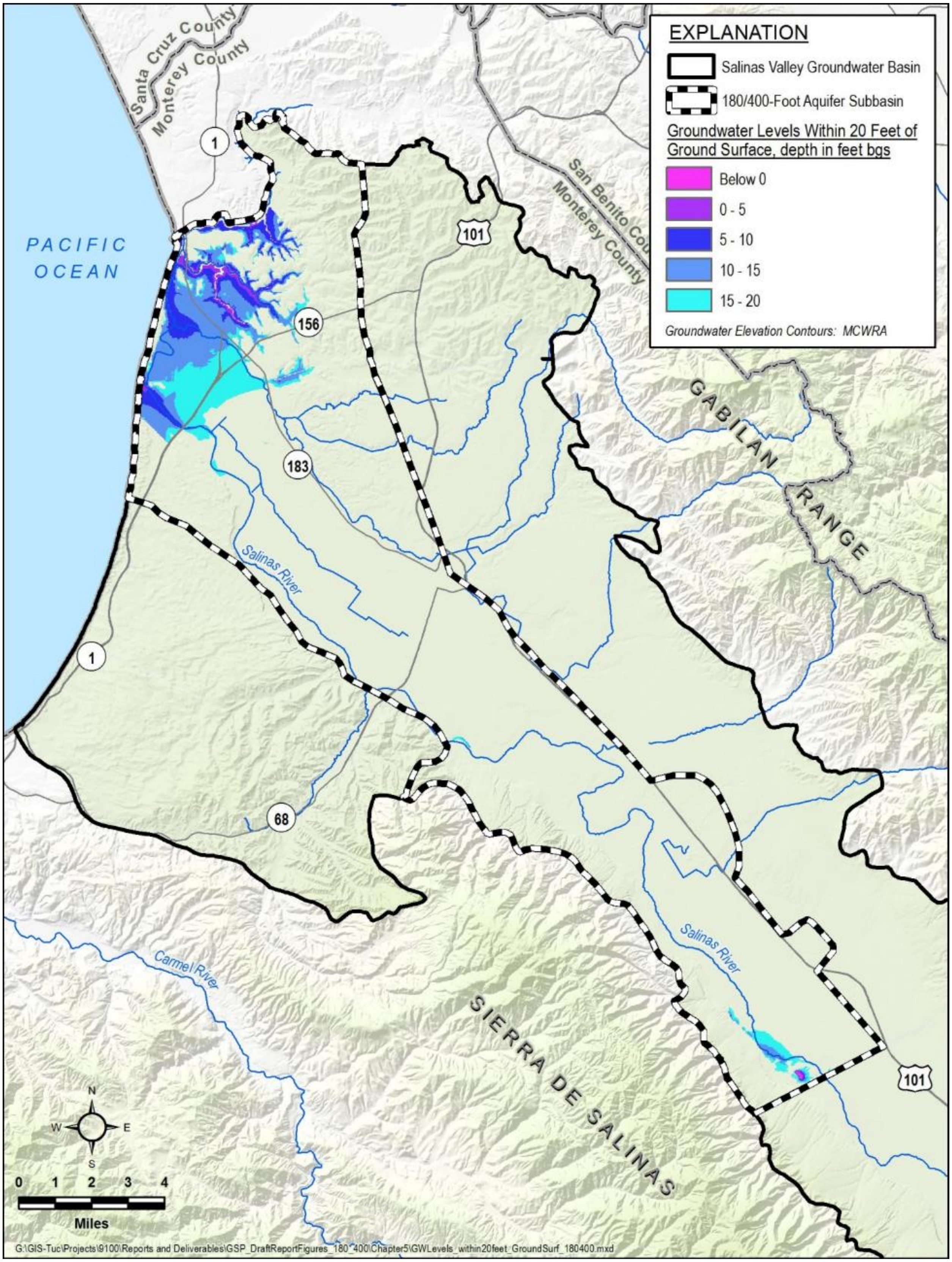


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Figure 5-37. Groundwater Within 20 Feet of Land Surface

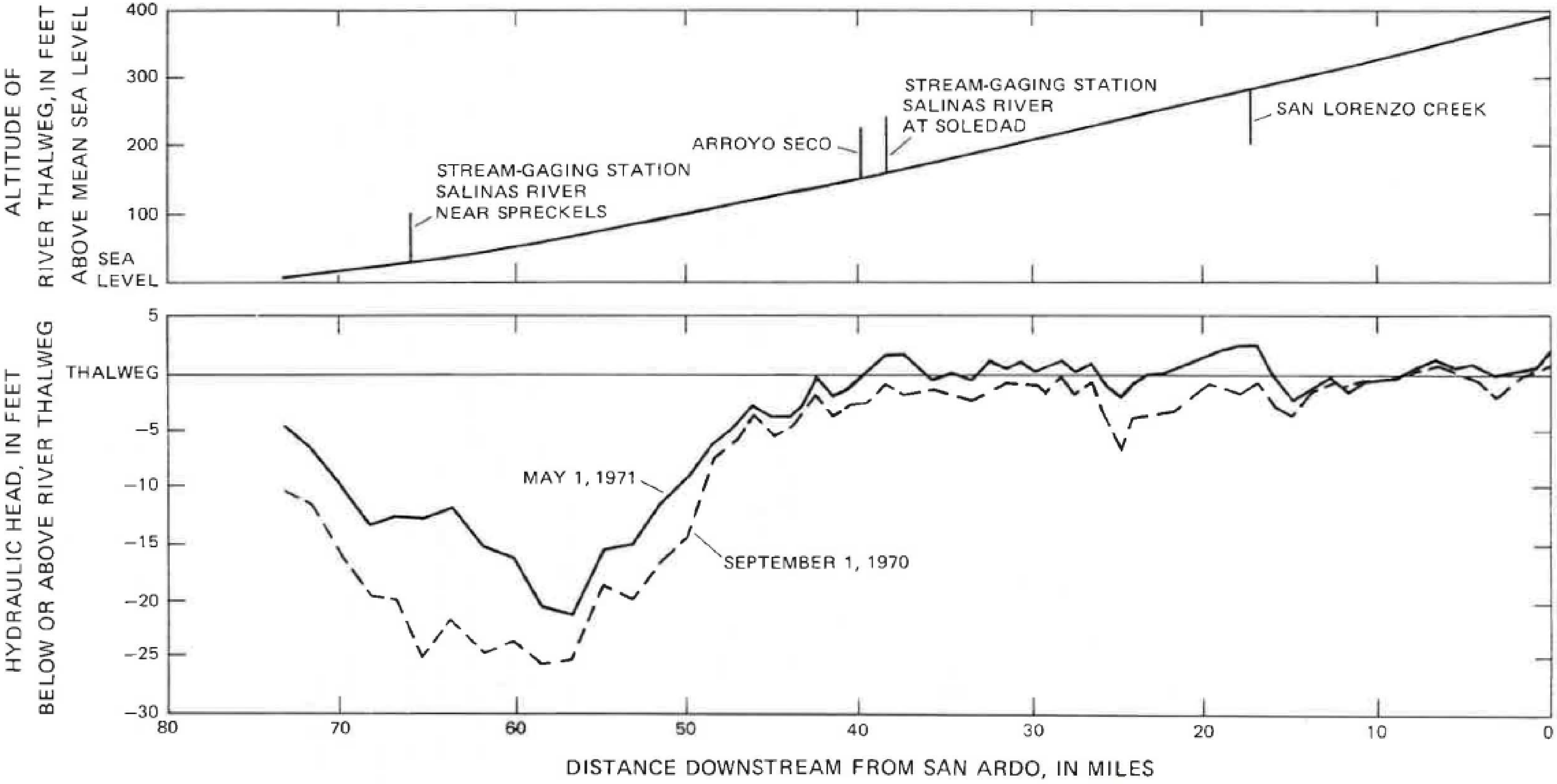

Figure 5-38. Groundwater Profiles Computed by Two-Dimensional Groundwater Model and Thalweg Profile Along the Salinas River
(Durbin, et al., 1978)

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).

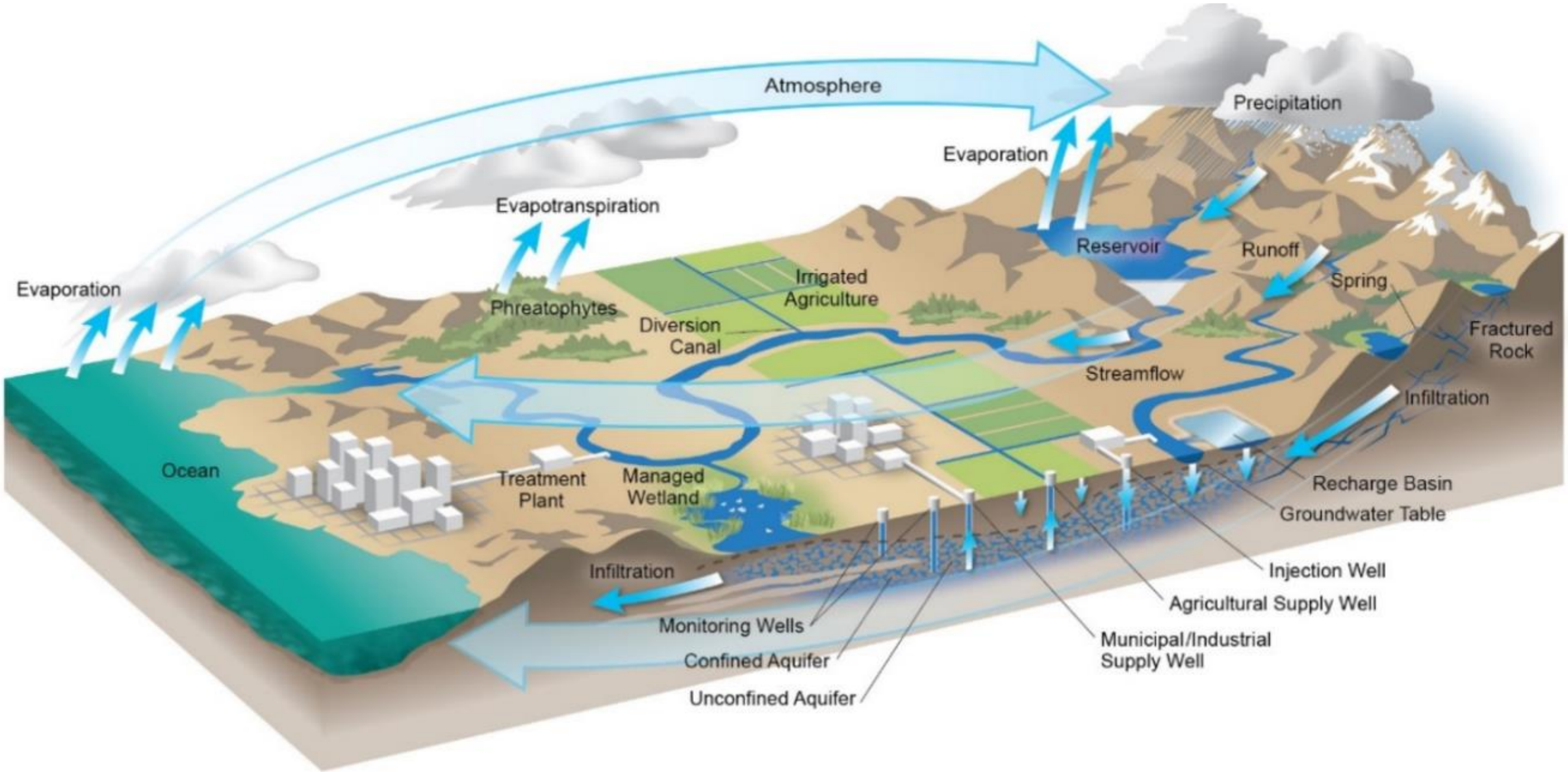

Figure 6-1. Schematic Hydrologic Cycle
(from DWR, 2016b)

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.

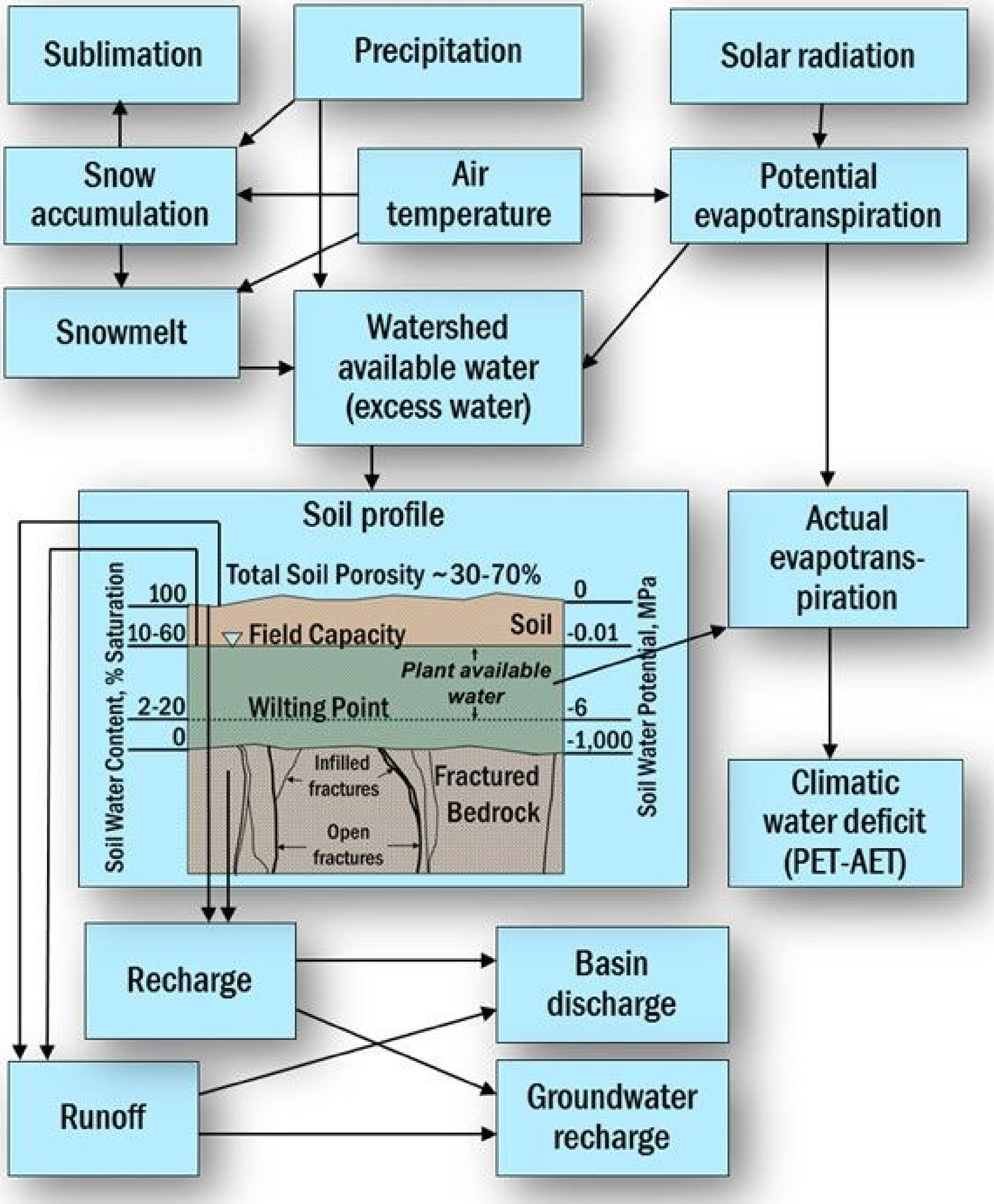

Figure 6-2. Basin Characterization Model Schematic
(Source: Flint, et al., 2013)

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.

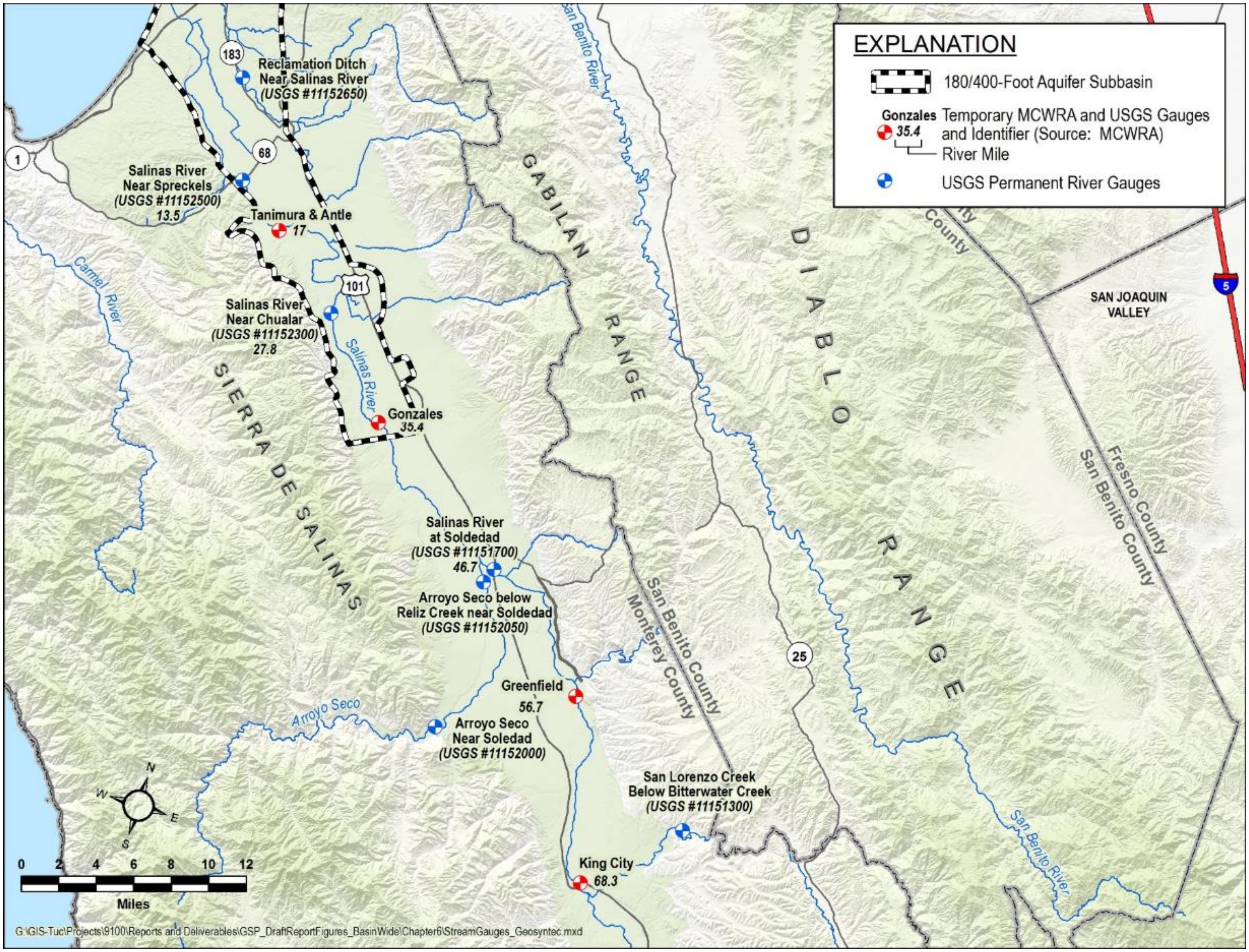

Figure 6-3. USGS Stream Gauge Locations

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

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.

6.6.2 Riparian Evapotranspiration

Due to the seasonal release of water from the Nacimiento and San Antonio reservoirs, the Salinas River has been transformed from an ephemeral to a perennial river that supports extensive strands of non-native riparian vegetation. The non-native riparian vegetation represents a significant loss of water from the basin through evapotranspiration (ET). In particular, *Arundo donax* is an invasive reed that has spread throughout California and other states. The ET rate of *Arundo donax* is highly variable but is estimated to be up to 20 AF/yr./acre (E. Zefferman, County of Monterey Resource Conservation District, personal communication, 2019). The California Department of Fish and Wildlife Biogeographic Information and Observation System GIS database indicates that there are approximately 800 acres of *Arundo donax* in the 180/400-Foot Aquifer Subbasin. For the historical and current water budgets, ET by *Arundo donax* was assumed to be 16 AF/yr./acre. The riparian ET occurs at the interface between the surface water and groundwater budgets and could be incorporated into either budget. For the historical and current water budgets, the riparian ET is included in the groundwater budget. Table 6-14 presents the constant riparian ET rate used in the historical and current water budgets.

Table 6-14. Riparian Evapotranspiration in Historical and Current Water Budgets

	Average Acre-Feet/Year for the Historical Water Budget	Average Acre-Feet/year for the Current Water Budget	Notes
Riparian Evapotranspiration	12,000	12,000	Estimated acreage and ET rate

6.6.3 Subsurface Outflows to Adjacent Subbasins

Based on groundwater flow directions at the Subbasin boundaries, subsurface outflow from the Subbasin occurs at the Eastside and Langley Subbasin boundaries. The combined outflow to these two subbasins has been estimated at approximately 8,000 AF/yr. (Montgomery Watson, 1997). In addition, at the northern boundary groundwater flows toward the Pajaro Valley Basin. The rate of subsurface flow from the Subbasin to the Pajaro Basin is estimated at 1,500 AF/yr. based on modeling analysis reported by USGS (Hanson, et al., 2014b). The estimated values are assumed constant for the historical and current budgets. The boundary flows can be reassessed when the calibrated historical SVIHM is available. Table 6-15 summarizes the subsurface inflow components from the historical and current water budgets.

Table 6-15. Subsurface Outflow to Adjacent Subbasins/Basin in Historical and Current Water Budgets

	Average for the Historical Water Budget (AF/yr.)	Average for the Current Water Budget (AF/yr.)	Notes
Eastside/Langley Subbasins	8,000	8,000	Brown and Caldwell (2015)
Pajaro Valley Basin	1,500	1,500	Hanson et al., (2014b)
Total Subsurface Outflow	9,500	9,500	

6.7 Change in Storage Data

6.7.1 Groundwater Elevation Fluctuations

The change in groundwater storage estimated from observed change in groundwater elevations is described in Section 5.2. The change in the volume of groundwater in storage is based on fall water levels collected by MCWRA, which are the best available data. Conversion of the measured groundwater elevation changes to estimated groundwater storage changes requires an estimate of the storage coefficient and area of the Subbasin. The storage coefficient is dependent on the material properties of the aquifer and the degree to which the aquifer is confined by an overlaying aquitard. Brown and Caldwell estimated the storage coefficient in the 180/400-Foot Aquifer Subbasin to be 0.04 (Brown and Caldwell, 2015).

As noted in Section 5.2.2, the long-term change in storage since 1944 is an average annual loss of approximately 1,200 AF/yr. The average change in storage due to groundwater elevation fluctuations during the historical period, based on fall water measurements, is a loss of approximately 650 AF/yr. The average change in storage due to groundwater elevation fluctuations during the current period is a loss of approximately 1,000 AF/yr.

6.7.2 Seawater Intrusion

As reported in Section 5.2, seawater intrusion has occurred and is occurring in response to groundwater pumping in the 180/400-Foot Aquifer Subbasin. The 10,500 AF/yr. estimated rate of seawater intrusion into the 180/400-Foot Aquifer Subbasin presented in Section 5.2 is used as a constant value for both the Historical and Current Water Budget (Table 6-16). This estimate may be improved based on access to the calibrated SVIHM.

Table 6-16. Seawater Intrusion in Historical and Current Water Budgets

	Average for the Historical Water Budget (AF/yr.)	Average for the Current Water Budget (AF/yr.)	Notes
Seawater Intrusion	-10,500	-10,500	Estimated from previous studies (Section 5.2)

6.8 Historical and Current Water Budgets

The historical water budget is based on 20 years of historical data covering 1995 to 2014. The 20-year period of 1995 to 2014 was selected as the period for the historical water budget because:

- Relatively complete pumping rates from most wells in the Subbasin were available from MCWRA,
- A relatively complete climatic cycle occurred, and
- The current water supply management system was in place for a significant amount of time.

The current water budget is based on the average of conditions between 2015 and 2017, the most recent years for which complete data are available. Because the current water budget represents a relatively short time period, it cannot be directly compared to the historical water budget. The historical water budget is designed to reflect average historical conditions. The current water budget reflects a snapshot in time that is susceptible to short-term climatic conditions.

6.8.1 Surface Water Budget

The surface water inflow and outflow components described in Sections 6.3 and 6.4 are combined to generate annual surface water budgets for the historical and current water budget periods.

Table 6-17 summarizes the average, minimum, and maximum annual values for each component of the historical surface water budget. Table 6-18 summarizes the average, minimum, and maximum annual values for each component of the current surface water budget. The minimum and maximum of total inflows and outflows are not equal to the sum of the sectors because the timing of sector extremes is not coincident.

Table 6-17. Summary of Historical Surface Water Budget

Inflow			Average (AF/yr.)	Minimum (AF/yr.)	Maximum (AF/yr.)
	Surface Water Inflows				
		Salinas River from Forebay Subbasin	312,100	5,000	1,155,600
		Tributaries from Eastside Subbasin	2,300	0	11,800
	Precipitation Runoff		1,100	0	9,400
	Irrigation Return Flow		10,000	5,000	16,400
TOTAL INFLOW			325,500	10,000	1,186,800
Outflow			**Average (AF/yr.)**	**Minimum (AF/yr.)**	**Maximum (AF/yr.)**
	Surface Water Outflows				
		Salinas River Diversions	8,000	6,500	9,200
		Salinas River Outflow to Monterey Bay	240,800	0	1,251,400
		Other Outflows to Monterey Bay	10,000	5,000	16,400
	Net Percolation of Streamflow to Groundwater System		76,800	5,000	90,000
TOTAL OUTFLOW			335,600	18,900	1,359,400

Table 6-18. Summary of Current Surface Water Budget

Inflow			Average (AF/yr.)	Minimum (AF/yr.)	Maximum (AF/yr.)
	Surface Water Inflows				
		Salinas River from Forebay Subbasin	163,700	3,300	477,900
		Tributaries from Eastside Subbasin	900	0	2,600
	Precipitation Runoff		1,700	200	3,200
	Irrigation Return Flow		18,000	8,700	30,800
TOTAL INFLOW			184,300	13,700	511,400
Outflow			**Average (AF/yr.)**	**Minimum (AF/yr.)**	**Maximum (AF/yr.)**
	Surface Water Outflows				
		Salinas River Diversions	7,900	7,600	8,300
		Salinas River Outflow to Monterey Bay	103,400	0	310,300
		Other Outflows to Monterey Bay	18,000	8,700	30,800
	Net Percolation of Streamflow to Groundwater System		34,400	3,300	90,000
TOTAL OUTFLOW			163,700	20,300	438,900

The surface water budget components are highly variable. Figure 6-4 illustrates the annual inflow and outflow components for the historical budget period. The diagram uses stacked bar height to illustrate the magnitude of budget components for each year, with inflows shown on the positive y-axis and outflows on the negative y-axis. The inflow and outflow components for each year are tabulated in Appendix 6A.

Figure 6-4 shows that streamflow percolation remains relatively stable over the historical period, with a drastic decrease during the 2014 dry year, when the reservoirs did not release as much water into the Salinas River as in previous years. The Salinas River flows are highly managed and depend on the Nacimiento and San Antonio Reservoir operations. Thus, they are generally kept constant through reservoir management. The other components of the surface water budget are dependent on the varying climate and correlate to the water year types.

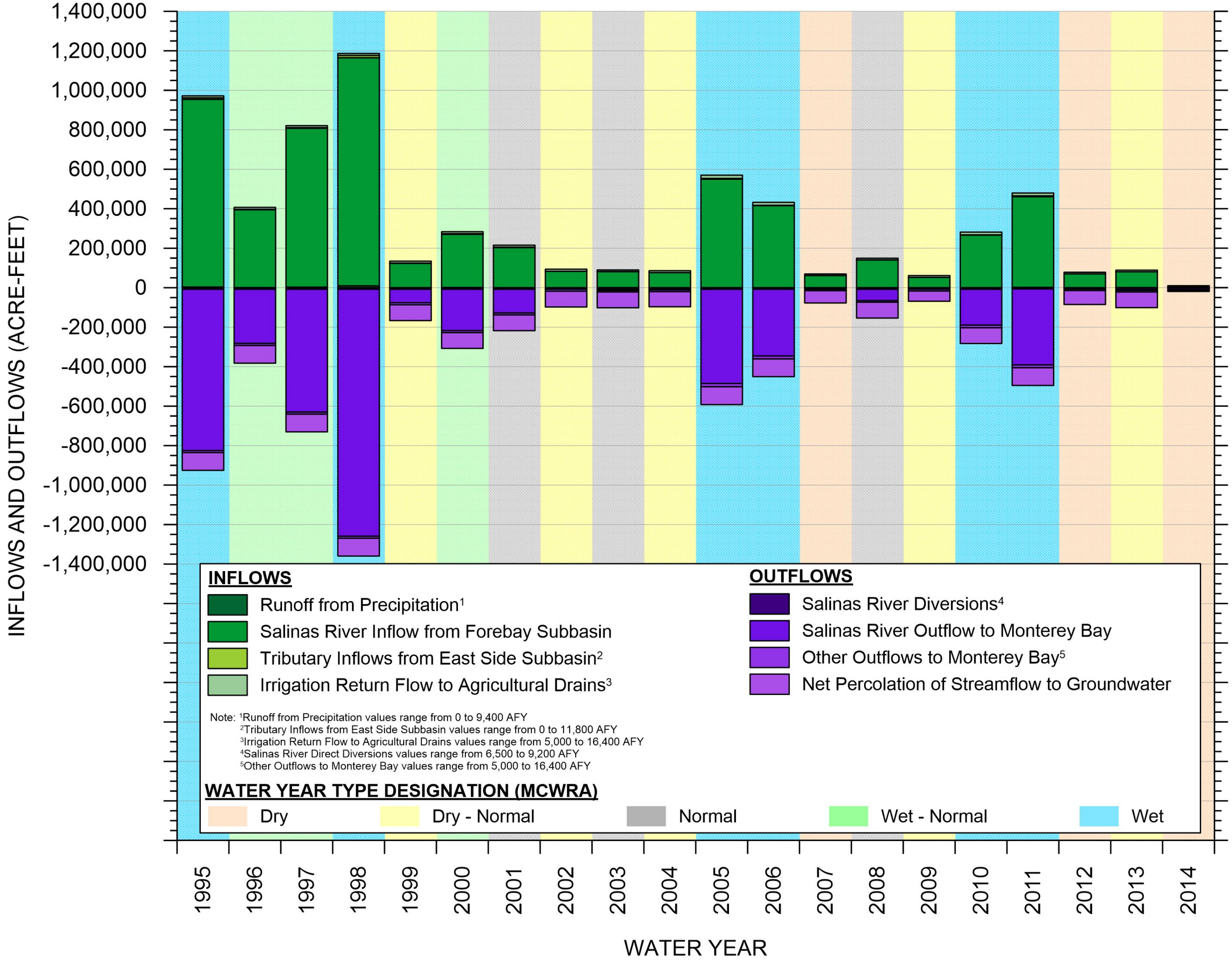

Figure 6-4. Historical Surface Water Budget

6.8.2 Groundwater Budget

The groundwater inflow and outflow components described in Sections 6.5 and 6.6 are combined to generate annual groundwater budgets for the historical and current budget periods. The groundwater system encompasses all groundwater that exists in the shallow sediments as well as the principal aquifers, as described in Chapter 4 of this GSP.

Table 6-19 summarizes the average, minimum, and maximum annual values for each component of the historical groundwater budget. Table 6-20 summarizes the average, minimum, and maximum annual values for each component of the current groundwater budget. The minimum and maximum of total inflows and outflows are not equal to the sum of the sectors because the timing of sector extremes is not coincident.

Table 6-19. Summary of Historical Groundwater Budget

Inflow			**Average (AF/yr.)**	**Minimum (AF/yr.)**	**Maximum (AF/yr.)**
	Net Percolation of Streamflow to Groundwater System		76,800	5,000	90,000
	Deep Percolation of Precipitation and Excess Irrigation		19,900	9,700	69,400
	Subsurface Inflows from Adjacent Subbasins		20,000	20,000	20,000
TOTAL INFLOW			116,700	43,300	179,400
Outflow			**Average (AF/yr.)**	**Minimum (AF/yr.)**	**Maximum (AF/yr.)**
	Pumping - Total Subbasin		108,100	92,900	130,800
		Agricultural	89,000	76,200	110,800
		Urban	18,900	14,000	27,500
		Rural Domestic	200	200	200
	Riparian Evapotranspiration		12,000	12,000	12,000
	Subsurface Outflows to Adjacent Subbasins/Basin		9,500	9,500	9,500
TOTAL OUTFLOW			129,600	114,400	152,300
Difference Between Inflows and Outflows			**Average (AF/yr.)**		
	Difference Between Inflows and Outflows		-12,900		

Table 6-20. Summary of Current Groundwater Budget

Inflow		Average (AF/yr.)	Minimum (AF/yr.)	Maximum (AF/yr.)
	Net Percolation of Streamflow to Groundwater System	34,400	3,300	90,000
	Deep Percolation of Precipitation and Excess Irrigation	10,400	-6,400	18,900
	Subsurface Inflows from Adjacent Subbasins	20,000	20,000	20,000
TOTAL INFLOW		64,800	42,200	103,600

Outflow			Average (AF/yr.)	Minimum (AF/yr.)	Maximum (AF/yr.)
	Pumping - Total Subbasin		109,100	108,200	111,100
		Agricultural	91,900	89,000	97,700
		Urban	17,000	12,900	19,000
		Rural Domestic	200	200	200
	Riparian Evapotranspiration		12,000	12,000	12,000
	Subsurface Outflows to Adjacent Subbasins/Basin		9,500	9,500	9,500
TOTAL OUTFLOW			130,600	129,700	132,400

Difference Between Inflows and Outflows		Average (AF/y.)		
	Difference Between Inflows and Outflows	-65,800		

[1] Deep percolation is equal to the amount of deep percolation from precipitation plus applied irrigation water minus crop consumption and flow in the Blanco Drain and Rec Ditch. In 2017, flows were extremely high, which results in a negative value for this year. The total recharge from both irrigation and precipitation is correct.

The annual groundwater system budget components are variable, although not as variable as the surface water budget components. Figure 6-5 illustrates the annual inflow and outflow components for the historical budget period. The diagram uses stacked bar height to illustrate the magnitude of budget components for each year, with inflows shown on the positive y-axis and outflows on the negative y-axis. The inflow and outflow components for each year are tabulated in Appendix 6A.

Figure 6-5 shows that groundwater pumping in the Subbasin is not directly correlated to the amount of inflow to the principal aquifers. For example, during the 2014 dry year, when the inflows decreased drastically due to very little streamflow percolation from the Salinas River, total groundwater system pumping remained similar to the previous year, where streamflow percolation was more in line with average years.

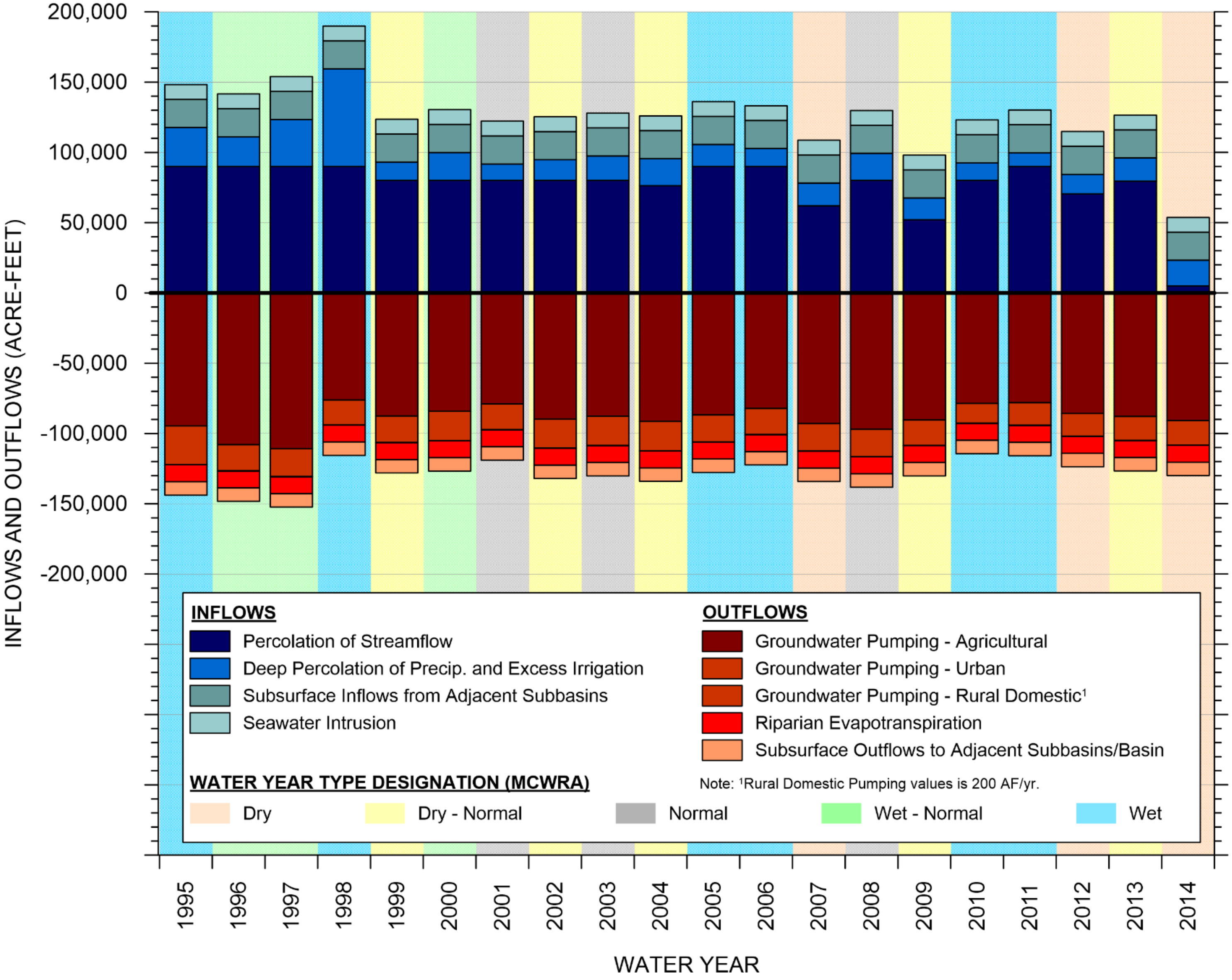

Figure 6-5. Historical Groundwater Budget

6.8.3 Subbasin Water Supply Reliability

A review of water supply sources in the 180/400-Foot Aquifer Subbasin shows that surface water supplies, as measured by the San Antonio and Nacimiento Reservoir releases to the Salinas River, allow for a reliable, yet small supply in wet and normal years. The reservoir releases also supply a stable supply of surface water in the first year of a drought by taking advantage of carry-over storage (Figure 6-6). However, the current operations do not allow for reliability in multi-year drought periods as shown in the 2002-2004 and 2007-2009 droughts. More recently, during the 4-year drought from 2012 to 2015, no water was released from the reservoirs in the last 2 years of the drought. Although no water was released, agricultural groundwater pumping did not substantially increase in those years.

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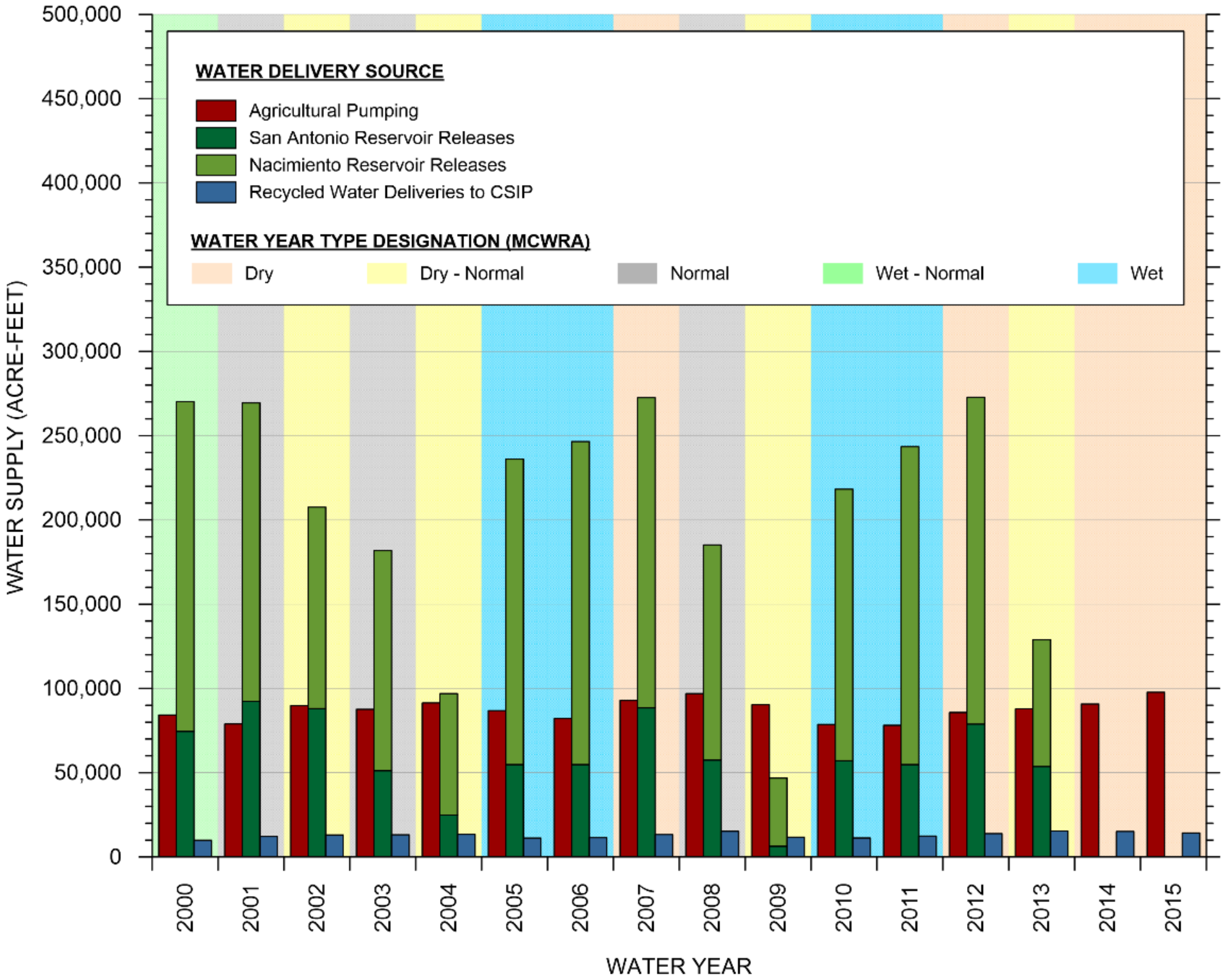


Figure 6-6. Water Supply Reliability

6.8.4 Subbasin Water Budget Summary

Figure 6-7 provides a diagram illustrating the interrelationship of the surface water and groundwater budget components. Average rates for these components over the historical water budget period are included in the diagram.

6.8.5 Sustainable Yield

The historical and current 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. The sustainable yield can be estimated based on the average annual values of the following components of the historical water budget:

- Total pumping
- Change in groundwater system storage, including seawater intrusion

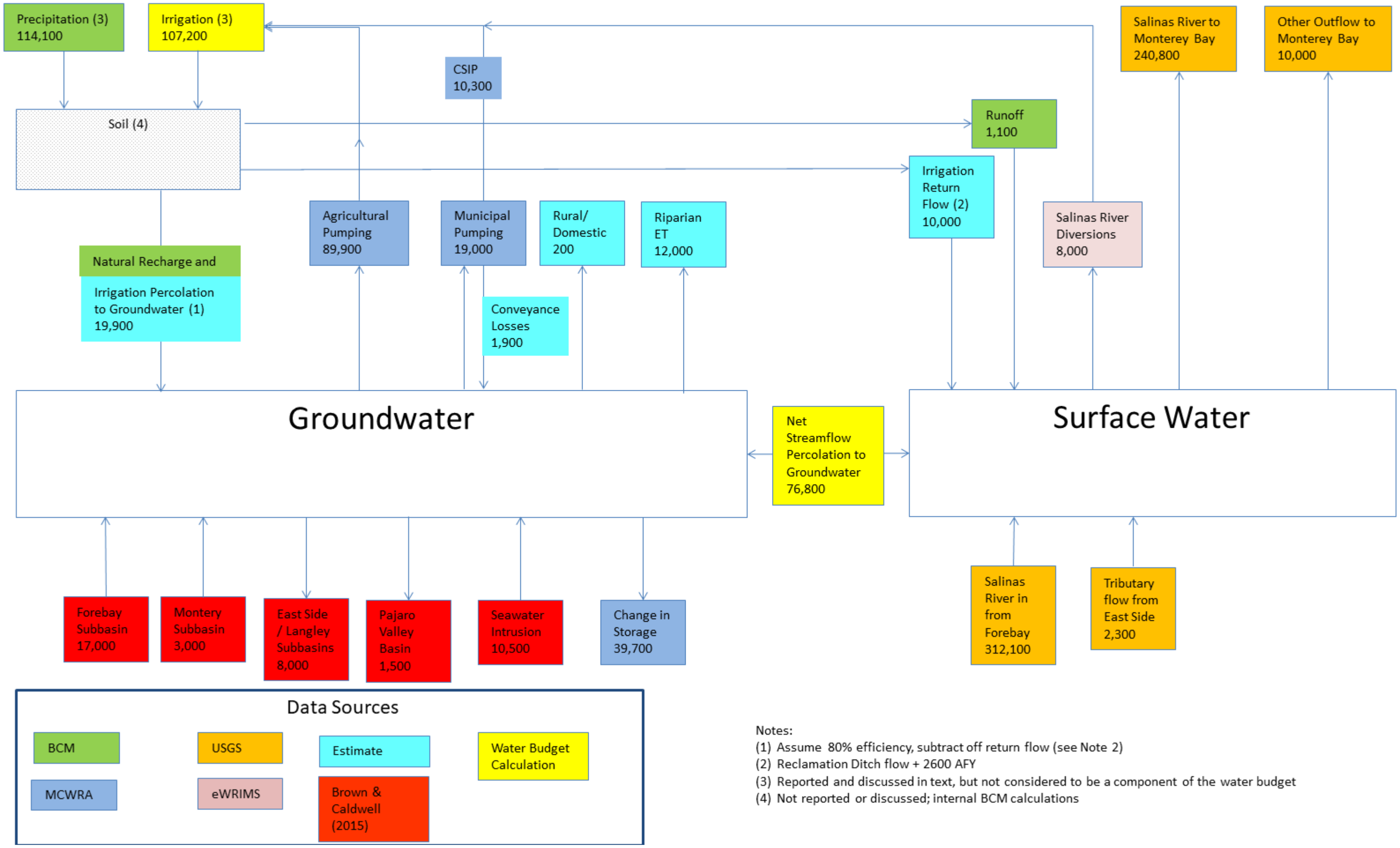
The sustainable yield is computed as:

Sustainable yield = pumping - change in storage

Table 6-21 summarizes the estimated historical sustainable yield for the 180/400-Foot Aquifer Subbasin. Negative values in Table 6-21 represent a loss of groundwater storage. The quantification of overdraft is the sum of the change in storage and seawater intrusion. Based on the water budget components, the historical sustainable yield of the Subbasin is 97,200 AF/yr., which represents a 10% reduction in total pumping relative to the average annual historical pumping rate. The current sustainable yield of the Subbasin is 98,000 AF/yr. The values in Table 6-21 are estimates only. The sustainable yield value will be modified and updated as more data are collected and more analyses are conducted.

Table 6-21. Estimated Historical and Current Sustainable Yield for the 180/400-Foot Aquifer Subbasin

	Average for the Historical Water Budget (AF/yr.)	Average for the Current Water Budget (AF/yr.)
Total Subbasin Pumping	108,100	109,100
Change in Storage (Groundwater Elevations)	-400	-600
Seawater Intrusion	-10,500	-10,500
Estimated Historical Sustainable Yield	97,200	98,000



Notes:
(1) Assume 80% efficiency, subtract off return flow (see Note 2)
(2) Reclamation Ditch flow + 2600 AFY
(3) Reported and discussed in text, but not considered to be a component of the water budget
(4) Not reported or discussed; internal BCM calculations

Figure 6-7. Annual Average Historical Total Water Budget

6.9 Uncertainties in Historical and Current Water Budget Calculations

As described in Section 6.1, the level of accuracy and certainty is highly variable between water budget components. The water budget uncertainty will be reduced over time as the GSP monitoring programs are implemented and the resulting data are used to check and improve the budgets.

Although the uncertainty of each component has not been quantified, the net uncertainty in the groundwater budget can be assessed based on a comparison between calculated and estimated change in storage. This difference provides a quantitative estimate of how well the water budget matches observed conditions. Although this measure doesn't quantify uncertainty in the components of the budgets, it allows an assessment of whether the net sum of the components is reasonable.

Since there are no significant surface water storage reservoirs within the Subbasin, the uncertainty in the surface water budget is the difference between inflows and outflows. Table 6-22 shows that the historical surface water budget has an uncertainty of -10,100 AF/yr., which is 3% of the historical outflow. By contrast, the current surface water budget has an uncertainty of 20,600 AF/yr., which is 13% of the outflow.

Table 6-23 compares the difference between estimated groundwater inflows and outflow to the calculated change in groundwater storage for the historical and current time periods. The difference between groundwater inflows and outflows for the historical groundwater budget is 12,900 AF/yr. This 12,900 AF/yr. is an estimate of the annual storage loss if all inflows and outflows are perfectly known. The MCWRA calculations of storage loss only account for storage losses due to change in groundwater elevations. To compare the budget estimate of storage loss to the MCWRA estimate, storage loss is reduced by the 10,500 AF of annual storage loss attributed to for seawater intrusion. The annual storage change for the historical period based on the difference between inflows and outflows is therefore a loss of 2,400 AF/yr. The calculated change in storage from groundwater elevations is a storage loss of 400 AF/yr. The difference between these two estimates of storage loss is 2,000 AF/yr., which is equivalent to 2% of the average water budget (average of inflows and outflows).

In the current groundwater budget, Table 6-23 indicates that the difference between inflows and outflows is a storage loss of 65,800 AF/yr. Accounting for a reduction of 10,500 AF due to seawater intrusion, the annual storage change for the current period is -55,300 AF/yr. The calculated change in storage from groundwater elevations is a storage loss of 600 AF/yr. for the current groundwater budget. The difference between these two estimates of storage loss is 54,700 AF/yr., which is equivalent to 42% of the average water budget.

As noted in Section 6.4.1, double-counting of water used for irrigation in the SWRCB diversion data and the MCWRA groundwater pumping results in an over-estimate of the amount of water used for irrigation for the historical and current groundwater budgets. This accounts for some of the error on the water budget. This error will be removed when the SVIHM becomes available.

Table 6-22. Estimated Historical and Current Surface Water Budget Uncertainties

	Historical Budget	Current Budget
Budget Average Annual Inflow (AF/yr.)	325,500	184,300
Budget Average Annual Outflow (AF/yr.)	335,600	163,700
Difference Between Inflow and Outflow (AF/yr.)	-10,100	20,600
Difference Between Budget and Estimated (% of Outflow)	3%	13%

Table 6-23. Estimated Historical and Current Groundwater Budget Uncertainties

	Historical Budget	Current Budget
Budget Average Annual Inflow (AF/yr.)	116,700	64,800
Budget Average Annual Outflow (AF/yr.)	129,600	130,600
Difference Between Inflow and Outflow (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 Avg Water Budget)	-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 historical groundwater budget uncertainty of 2% is relatively small. The current ground budget uncertainty of 42% is significant. These estimates will be changed and refined when the SVIHM is made available.

6.10 Projected Water Budget

The projected water budget is extracted from the SVIHM, incorporating projected hydrologic conditions and climate change. Two projected water budgets are presented, one incorporating estimated 2030 climate change projections and one incorporating estimated 2070 climate change projections. The projected water budget represents 47 years of future conditions including projected climate change and sea level rise. The future water budget simulations do not simulate a 47-year projected future, but rather simulate 47 likely hydrologic events that may occur in 2030, and 47 likely hydrologic events that may occur in 2070.

The climate change projections are based on the available climate change data provided by DWR (2018). Projected water budgets will be useful for showing that sustainability will be achieved in the 20-year implementation period and maintained over the 50-year planning and implementation horizon.

6.10.1 Assumptions Used in Projected Water Budget Development

6.10.1.1 General SVIHM Characteristics

The SVIHM is a numerical groundwater-surface water model that was constructed using the code MODFLOW-OWHM (Hanson, et al., 2014a). This code is a version of the USGS groundwater flow code MODFLOW that includes a focus on the agricultural supply and demand system, through the Farm Process. The model grid consists of 976 rows, 272 columns, and 9 layers, covering the Salinas Valley Groundwater Basin from the Monterey-San Luis Obispo County Line in the south to the Pajaro Valley Basin in the north, including the offshore extent of the major water supply aquifers. The model includes operations of the San Antonio and Nacimiento reservoirs that supply the Salinas Valley Groundwater Basin.

6.10.1.2 SVIHM Assumptions and Modifications to Simulate Future Conditions

The assumptions incorporated into the SVIHM for the projected water budget simulations include the following:

- **Land Use**: The land use is assumed to be static, aside from a semi-annual change to represent crop seasonality. The annual pattern is repeated every year in the model. Land use in the model reflects the 2014 land use, which is the most recent crop and land use data in the available model. This assumption is consistent with the GSP Regulations that state “Projected water demand shall utilize the most recent land use, evapotranspiration, and crop coefficient information as the baseline condition for estimating future water demand”.
- **Urban Growth**: No urban growth is included in this simulation to remain consistent with the USGS assumptions. If urban growth is infill, this assumption may result in an underestimate of net pumping increases and an underestimate of the Subbasin’s future overdraft. If urban growth replaces agricultural irrigation, the impact may be minimal.
- **Reservoir Operations**: The reservoir operations reflect the current approach to reservoir management taken by MCWRA. Therefore, the projected surface water supply reflects the current and most recent water supply information.
- **Stream Diversions**: The SVIHM explicitly simulates only two stream diversions in the Salinas Valley Groundwater Basin: Clark Colony and the SRDF. The Clark Colony

diversion is located along Arroyo Seco, and diverts water to an adjacent agricultural area. The SRDF came online in 2010, and diverts water from the Salinas River to the CSIP area. Clark Colony diversions are repeated from the historical record to match the water year. SRDF diversions are made throughout the duration of the Operational SVIHM whenever reservoir storage and streamflow conditions allow.

- **Recycled Water Deliveries**: Recycled water has been delivered to the CSIP area since 1998 as irrigation supply. The SVIHM includes recycled water deliveries throughout the duration of the model.

6.10.1.2.1 Future Projected Climate Assumptions

Several modifications were made to the SVIHM in accordance with recommendations made by DWR in their *Guidance for Climate Change Data Use During Groundwater Sustainability Plan Development* (DWR, 2018). Three types of datasets were modified to account for 2030 and 2070 projected climate change: climate data, streamflow, and sea level.

Climate Data

DWR has provided gridded change factors for 2030 and 2070 climate conditions. These change factors are derived from the statewide gridded datasets for the Variable Infiltration Capacity (VIC) hydrologic model and are provided as monthly gridded values that can be multiplied by historical data between 1915 and 2011 to produce a dataset of climate inputs for each climate change scenario. Because the change factors are only available through December 2011 and the SVIHM uses a climate time series through December 2014, monthly change factors were estimated for January 2012 to December 2014. Historical data were analyzed from the Salinas Airport precipitation gauge record to identify years from 1968 to 2011 that were most similar to conditions in 2012, 2013 and 2014. As a result, projected climate data from 1981, 2002, and 2004 were applied as the climate inputs for 2012, 2013, and 2014, respectively.

The modified gridded monthly climate data for the entire model period were applied as inputs to the model, which reads precipitation and ET_0 data on a monthly basis.

Streamflow

DWR has provided monthly change factors for unimpaired streamflow throughout California. For the Salinas Valley Groundwater Basin and other areas outside of the Central Valley, these change factors are provided as a single time series for each major watershed. Streamflows along the margins of the Subbasin were modified by the monthly change factors. As with the climate data, an assumption was made to extend the streamflow change factor time series through December 2014. The similarity in rainfall years at the Salinas Airport rainfall gauge could reasonably be expected to produce similar amounts of streamflow; therefore, the same years of 1981, 2002, and 2004 were repeated to represent the 2012, 2013, and 2014 streamflows, respectively.

Sea Level Rise

DWR guidance recommends using a constant rate of sea level rise for each of the climate change scenarios (DWR, 2018). For the 2030 climate change scenario, a sea level rise value of 15 centimeters (5.9 inches) was used. For the 2070 climate change scenario, a sea level rise value of 45 centimeters (17.7 inches) was used.

6.10.2 Projected Water Budget Overview

Although the physical processes simulated by the SVIHM are similar to the processes discussed in the historical and current water budget discussion, the SVIHM output provides slightly different water budget components than those in the historical and current water budgets. The SVIHM includes various calculations that can produce three types of water budgets:

- Land surface water budget
- Groundwater system budget
- Surface water budget

The land surface water budget is not required by the SGMA Regulations, but it does provide important information that informs how water is managed in the Salinas Valley Groundwater Basin. Therefore, information from the land surface budget is included in this GSP. The land surface water budget was used to differentiate water budget components related to crop water use and groundwater system recharge.

The surface water budget cannot readily be extracted from the SVIHM output, and further work is necessary to develop it once the SVIHM is available. The surface water budget will be provided after the model post-processing analysis is completed as part of GSP implementation.

6.10.3 Land Surface Water Budget

The land surface water budget quantifies flows into and out of the land surface and root zone of agricultural areas. The components of the land surface water budget are as follows:

- Water budget inflow components into the crop/land surface:
    - Precipitation.
    - Recycled water deliveries.
    - Surface water deliveries.
    - Agricultural application of pumped groundwater.
    - Evaporation from groundwater. This is effectively a pass-through value with the evaporation entering the soil column from below and leaving the top of the soil column.

    - Transpiration from groundwater. This is effectively a pass-through value with the transpiration entering the crop roots from below and leaving the crops into the atmosphere.
- Water budget outflow components out of the crop/land surface:
    - Evaporation of irrigation water.
    - Evaporation from precipitation.
    - Evaporation from groundwater. This is effectively a pass-through value with the evaporation entering the soil column from below and leaving the top of the soil column.
    - Transpiration of irrigation water.
    - Transpiration from precipitation.
    - Transpiration from groundwater. This is effectively a pass-through value with the transpiration entering the crop roots from below and leaving the crops into the atmosphere.
    - Overland runoff onto surrounding non-agricultural areas.
    - Deep percolation.
    - Surface water returns: Unused surface water deliveries that are returned to the stream system.

Land surface water budget inflow and outflow data for the 47-year future simulation period with 2030 climate change assumptions and the 2070 climate change assumptions are detailed in Table 6-24 and Table 6-25, respectively.

Table 6-24. Average Land Surface Water Budget Inflows

Projected Climate Change Timeframe	2030 (AF/yr.)	2070 (AF/yr.)
Precipitation	135,700	141,200
Recycled Water Deliveries	4,400	4,400
Surface Water Deliveries	8,300	8,500
Agricultural Pumping	94,800	99,500
Evaporation from Groundwater	6,500	6,800
Transpiration from Groundwater	29,600	30,800
Total Inflows	279,300	291,200

Table 6-25. Average Land Surface Water Budget Outflows

Projected Climate Change Timeframe	2030 (AF/yr.)	2070 (AF/yr.)
Evaporation from Irrigation	14,100	14,800
Evaporation from Precipitation	38,700	38,600
Evaporation from Groundwater	6,500	6,800
Transpiration from Irrigation	64,300	67,200
Transpiration from Precipitation	32,500	32,300
Transpiration from Groundwater	29,600	30,800
Overland Runoff	25,200	27,500
Deep Percolation	77,000	82,300
Surface Water Returns	500	400
Total Outflows	288,400	300,700

6.10.4 Groundwater Budget

The inflow components of the projected groundwater budget include:

- Stream leakage
- Deep percolation of precipitation and irrigation
- Inflow from the Monterey Subbasin
- Inflow from the Eastside Subbasin
- Inflow from the Langley Subbasin
- Inflow from the Forebay Subbasin
- Inflow from the Pajaro Valley

The simulated average water budget inflow components for each of the 47 years in the future simulation with 2030 and 2070 climate change projections are quantified in Table 6-26.

Table 6-26. Average Groundwater Inflow Components for Projected Climate Change Conditions

Projected Climate Change Timeframe	2030 (AF/yr.)	2070 (AF/yr.)
Stream leakage	71,500	71,700
Deep Percolation	76,300	81,800
Interflow in Wells	20,400	20,900
Inflow from Monterey Subbasin	10,900	11,500
Inflow from Eastside Subbasin	9,800	10,400
Inflow from Forebay Subbasin	5,300	5,300
Inflow from Langley Subbasin	1,800	1,800
Mountain front recharge	2,600	2,700
Underflow from Pajaro Valley Basin	100	100
Total Inflows	198,700	206,200

The outflow components of the projected groundwater budget include:

- Total groundwater extraction including municipal, agricultural, and rural domestic pumping.
- Flow to agricultural drains.
- Stream gains from groundwater.
- Outflow to the Monterey Subbasin.
- Outflow to the Eastside Subbasin.
- Outflow to the Langley Subbasin.
- Outflow to the Forebay Subbasin.
- Outflow to the Pajaro Valley Basin.
- Outflow to Ocean.

The simulated water budget inflow components for each of the 47 years in the future simulation with 2030 and 2070 climate change projections are quantified in Table 6-27.

Table 6-27. Average Groundwater Outflow Components for Projected Climate Change Conditions

Projected Climate Change Timeframe	2030 (AF/yr.)	2070 (AF/yr.)
Pumping	135,800	141,600
Drain Flows	7,100	8,000
Flow to Streams	1,800	1,900
Groundwater ET	35,100	36,700
Outflow to Ocean	800	700
Outflow to Monterey Subbasin	5,400	5,300
Outflow to Eastside Subbasin	17,000	16,600
Outflow to Forebay Subbasin	300	300
Outflow to Langley Subbasin	100	100
Outflow to Upland Areas	900	900
Outflow to Pajaro	1,000	1,000
Total Outflows	205,300	213,100

As with the historical and current groundwater budgets, groundwater storage change consists of both groundwater elevation changes and seawater intrusion. The total change in groundwater storage is shown in Table 6-28.

Table 6-28. Change in Groundwater Storage for Projected Groundwater Budgets

Component	2030 (AF/yr.)	2070 (AF/yr.)
Groundwater Elevation Change	-4,600	-4,700
Seawater Intrusion	-3,500	-3,900
Total	-8,100	-8,600

6.10.4.1 Groundwater Budget Summary

The total groundwater inflows and outflows, along with the model error, are shown in Table 6-29. The total in and total out flows are derived from Table 6-26 and Table 6-27. The total error and percent error are calculated as

$$Error = (Inflows + Outlfows) - Change\ in\ Storage$$

$$\%Error = \frac{Error}{\left(\frac{Inflows - Outflows}{2}\right)} x100$$

Unlike the historical and current water budgets, these water budgets have acceptably small budget uncertainty errors as a percentage of the total water budget.

Table 6-29. Total Groundwater Inflows and Outflows for Projected Groundwater Budgets

Projected Climate Change Timeframe	2030 (AF/yr.)	2070 (AF/yr.)
Total In	198,700	206,200
Total Out	-205,300	-213,100
Total Change in Storage	-8,100	-8,600
Error	1,500	1,700
% Error	0.74%	0.81%

Combining the land surface and groundwater budgets, groundwater pumping by water use sector can be summarized, as shown in Table 6-30.

Table 6-30. Projected Annual Groundwater Pumping by Water Use Sector

Water Use Sector	2030 Average	2070 Average
Agricultural	94,800	99,500
Urban (total pumping minus agricultural)	20,500	21,100
Rural-Domestic (not simulated in model, considered minimal)	0	0
Total Pumping	135,800	141,600

6.10.5 Projected Sustainable Yield

The projected sustainable yield is the amount of long-term pumping that can be sustained over the planning horizon once all undesirable results have been addressed. It is not the amount of pumping needed to stop undesirable results. For example, the sustainable yield calculated in this chapter assumes zero seawater intrusion, but it does not account for temporary pumping reductions that may be necessary to achieve the higher groundwater elevations that help mitigate seawater intrusion. The SVBGSA recognizes that, dependent on the success of various proposed projects and management actions, there may be a number of years when pumping might be held at a lower level to achieve necessary rises in groundwater elevation. The actual amount of allowable pumping from the Subbasin will be adjusted in the future based on the success of projects and management actions.

The projected sustainable yield for 2030 and 2070 can be calculated in a similar way to the historical sustainable yield calculated in Table 6-21. The projected sustainable yield can be estimated by summing all of the average groundwater extractions and subtracting the average seawater intrusion and the average change in storage. The projected sustainable yields are quantified in Table 6-31. The net pumping shown on this table is the total pumping in Table 6-27 less the well interflow shown in Table 6-26. Well interflow is water that flows through an inactive well from one aquifer to another. The model calculates this flow as extraction from one aquifer and injection to another aquifer, thus adding to the total extraction and total injection in the model. The extraction portion of this well interflow must be subtracted from total model extraction to calculate the correct amount of water that is pumped out of the Subbasin. This table estimates that pumping reductions of between 7.0% and 7.1% will be needed to reduce Subbasin pumping to the sustainable yield. The quantification of overdraft is the sum of seawater intrusion and change in storage.

Table 6-31 includes the estimate of historical sustainable yield for comparison purposes. However, because of the significant differences in the estimated components between the historical and projected water budgets, the projected sustainable yield should not be directly compared to the historical sustainable yield. For example, the total pumping used to calculate the historical sustainable yield is 108,100 AF/yr., while the pumping used to estimate the projected sustainable yields varies between 115,300 and 120,600 AF/yr. Additionally, the values in Table 6-31 are estimates only. The sustainable yield value will be modified and updated as more data are collected and more analyses are performed.

It is important to recall that simply reducing pumping to within the sustainable yield is not proof of sustainability, which must be demonstrated by achieving the SMC that are outlined in Chapter 8. While the sustainable yield estimates in Table 6-31 assume zero seawater intrusion, they do not account for temporary pumping reductions that may be necessary to help mitigate seawater intrusion.

Table 6-31. Projected Sustainable Yields

	2030 Projected Sustainable Yield	2070 Projected Sustainable Yield	Historical Sustainable Yield
Net Pumping	115,300	120,600	108,100
Seawater Intrusion	-3,500	-3,900	-10,500
Change in Storage	-4,600	-4,700	-400
Projected Sustainable Yield	107,200	112,000	97,200
% Pumping Reduction	7.0%	7.1%	10.0%

6.10.6 Projected Surface Water Budget

A surface water budget was not available at the time of this writing because it could not be easily extracted from the SVIHM during the short time the SVIHM was available to the SVBGSA. A surface water budget will be included as soon as available.

6.11 Uncertainties in Projected Water Budget Simulations

As shown in Table 6-29, the calculated error in the projected water budget is acceptably small. This is in contrast to the current water budget, which had significantly larger errors due to uncertain data and less rigorous analytical methods. However, even with the small calculated error, there is inherent uncertainty involved in projecting water budgets with projected climate change based on the available scenarios and methods. The scenarios that were used to develop the projected water budgets with the SVIHM provide what might be considered the most likely future conditions; there is an approximately equal likelihood that actual future conditions will be more stressful or less stressful than those described by the recommended scenarios (DWR, 2018).

Further, as stated in DWR (2018):

> *Although it is not possible to predict future hydrology and water use with certainty, the models, data, and tools provided (by DWR) are considered current best available science and, when used appropriately should provide GSAs with a reasonable point of reference for future planning.*
>
> *All models have limitations in their interpretation of the physical system and the types of data inputs used and outputs generated, as well as the interpretation of outputs. The climate models used to generate the climate and hydrologic data for use in water budget development were recommended by the DWR Climate Change Technical Advisory Group (CCTAG) for their applicability to California water resources planning (DWR, 2018).*

Finally, there is also inherent uncertainty in groundwater flow modeling itself, since mathematical (or numerical) models can only approximate physical systems and have limitations in how they compute data. As stated by DWR (2018):

> *Models are inherently inexact because the mathematical depiction of the physical system is imperfect, and the understanding of interrelated physical processes incomplete. However, mathematical (or numerical) models are powerful tools that, when used carefully, can provide useful insight into the processes of the physical system.*

7 MONITORING NETWORKS

This chapter describes the monitoring networks that will be used to monitor the sustainable management criteria (SMCs) for the 180/400-Foot Aquifer Subbasin. The SMCs are described in Chapter 8 and are established based on the monitoring networks described herein. This description of the monitoring network has been prepared in accordance with the GSP Regulations §354.32 to include monitoring objectives, monitoring protocols, and data reporting requirements.

7.1 Introduction

7.1.1 Monitoring Objectives

SGMA requires monitoring networks be 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 monitoring networks are intended to:

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

The measurable objectives and minimum thresholds monitored by the networks are described in Chapter 8.

7.1.2 Approach to Monitoring Networks

Monitoring networks are developed for each of the six sustainability indicators that are relevant to the GSP area:

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

In accordance with GSP Regulations, the monitoring networks presented in this chapter are primarily based on existing monitoring sites. The monitoring networks are limited to data points and locations that are publicly available and not confidential.

The SVBGSA determined the density of monitoring sites and frequency of measurements required in order to demonstrate short-term, seasonal, and long-term trends. These trends are also based on the amount of current and projected groundwater use, aquifer characteristics and other physical characteristics that affect groundwater flow, impacts to beneficial uses and users of groundwater and land uses and property interests affected by groundwater production (including adjacent subbasins that could affect the ability of the subbasin to meet the sustainability goal), and the adequacy of long-term existing monitoring results.

For some sustainability indicators, it is necessary to expand the existing monitoring systems. Data gaps are identified for each monitoring system; filling these data gaps and developing more extensive and complete monitoring systems will improve the SVBGSA's ability to demonstrate sustainability and refine the existing conceptual and numerical hydrogeologic models. Chapter 10 provides a plan and schedule for data gap resolution. The SVBGSA will review the monitoring network in each 5-year assessment, including a determination of uncertainty and whether there are data gaps that could affect the ability of the Plan to achieve the sustainability goal for the Subbasin.

7.1.3 Management Areas

The regulations require that if management areas are established, the quantity and density of monitoring sites in those areas shall be sufficient to evaluate conditions of the Subbasin setting and sustainable management criteria specific to that area. At this time, management areas have not been defined for the 180/400-Foot Aquifer Subbasin.

7.2 Groundwater Elevation Monitoring Network

The sustainability indicator for chronic lowering of groundwater levels is evaluated by monitoring groundwater elevations in designated monitoring wells. The regulations require a network of monitoring wells sufficient to demonstrate groundwater occurrence, flow directions, and hydraulic gradients between principal aquifers and surface water features.

7.2.1 Relevance of CASGEM Program

In November 2009, the State amended the Water Code to mandate statewide groundwater elevation monitoring through collaboration between local agencies and the Department of Water Resources (DWR). In response, DWR created the California Statewide Groundwater Elevation Monitoring (CASGEM) program wherein local agencies upload available water elevation data and DWR maintains the database in a format that is readily and widely available to the public.

The goal of the CASGEM program is to collect and store groundwater elevation data such that current and future groundwater management programs can draw upon the data to assess seasonal and long-term trends in local groundwater conditions.

The CASGEM program was therefore specifically intended to serve the purpose that is now required of the groundwater elevation monitoring network under SGMA. A CASGEM network has already been established by MCWRA for the 180/400-Foot Aquifer Subbasin (MCWRA, 2015b) This GSP will base its network for monitoring chronic lowering of groundwater elevations on the existing CASGEM network. After incorporating the CASGEM network into the GSP groundwater elevation monitoring network, no future CASGEM reporting will be necessary. All groundwater elevation data will continue to be collected by MCWRA for consistency with previous CASGEM efforts and will be reported to DWR through the monitoring module of the SGMA GSP upload tool.

7.2.2 Current CASGEM Network

The current CASGEM monitoring network consists of 23 wells with publicly available data within the 180/400-Foot Aquifer Subbasin. The CASGEM monitoring network was created to ensure adequate understanding of aquifer response. As a voluntary program, MCWRA based the CASGEM network on wells that were owned and monitored by MCWRA prior to initiation of the CASGEM program.

Table 7-1 summarizes the distribution of CASGEM wells by aquifer designation.

Table 7-1. CASGEM Well Network – Summary of Wells by Aquifer

Aquifer Designation	Number of Wells in Network
180-Foot Aquifer	12
400-Foot Aquifer	10
Deep	1

The wells in the water level monitoring network are listed in Table 7-2 and shown by aquifer depth on Figure 7-1, Figure 7-2, and Figure 7-3. The distribution of wells in the existing network and the need for additional wells is discussed below in Section 7.2.4. Appendix 7A presents well construction information and historical hydrographs for each CASGEM well.

Table 7-2. Existing 180/400-Foot Aquifer CASGEM Well Network

State Well Number	CASGEM Well Number	Local Well Designation	Well Use	Total Well Depth	Latitude (NAD 83)	Longitude (NAD 83)	Period of Record (years)
180-Foot Aquifer							
14S02E03F004M	367454N1217393W001	ESPA22636	Observation	205	36.74539	-121.739313	14.7
13S02E21Q001M	367816N1217514W001	SELA22633	Observation	157	36.781644	-121.751387	12.7
14S02E27A001M	366933N1217294W001	MCFD22632	Observation	293	36.693296	-121.729435	13.0
14S03E30G008M	366869N1216785W001	MKTC22650	Observation	293	36.68688	-121.678517	14.7
14S02E26H001M	366889N1217079W001	AMST22651	Observation	339	36.688875	-121.707934	13.0
16S04E08H004M	365550N1215466W001	CHEA21208	Observation	140	36.555022	-121.546557	13.0
17S05E06C002M	364883N1214684W001	GZWA21202	Observation	115	36.488323	-121.468395	12.7
14S03E18C001M	367207N1216806W001	BORA15009	Observation	225	36.720721	-121.680556	13.0
14S02E12B002M	367343N1216958W001	RODA14455	Observation	265	36.734316	-121.69585	13.0
15S03E16M001M	366250N1216532W001	1359	Irrigation	Confidential	36.624978	-121.653213	3.4
16S04E15D001M	365444N1215220W001	BRME10389	Unknown	384	36.544406	-121.522009	4.4
15S03E17M001M	366265N1216692W001	1480	Irrigation	271	36.62654	-121.669184	3.4
400-Foot Aquifer							
14S02E12Q001M	367221N1216965W001	1707	Residential	619	36.722108	-121.696473	3.4
14S02E08M002M	367275N1217803W001	239	Irrigation	500	36.727523	-121.78025	3.4
14S02E12B003M	367343N1216959W001	RODB14456	Observation	390	36.734282	-121.695864	15.0
17S05E06C001M	364883N1214684W002	GZWB21201	Observation	300	36.488323	-121.468404	13.0
14S02E03F003M	367455N1217395W001	ESPB22635	Observation	455	36.74548	-121.739492	14.7
13S02E32A002M	367653N1217636W001	10161	Irrigation	600	36.765339	-121.763589	3.4
14S03E18C002M	367207N1216805W001	BORB15010	Observation	395	36.720735	-121.680531	14.7
15S03E16F002M	366292N1216474W001	1862	Irrigation	592	36.629202	-121.647449	3.4
13S02E21N001M	367847N1217618W001	2432	Irrigation	550	36.784731	-121.761804	3.4
16S04E08H003M	365550N1215465W001	CHEB21205	Observation	295	36.555032	-121.546545	10.7
Deep Aquifers							
13S02E19Q003M	367808N1217847W001	75	Irrigation	1562	36.780798	-121.784687	3.4

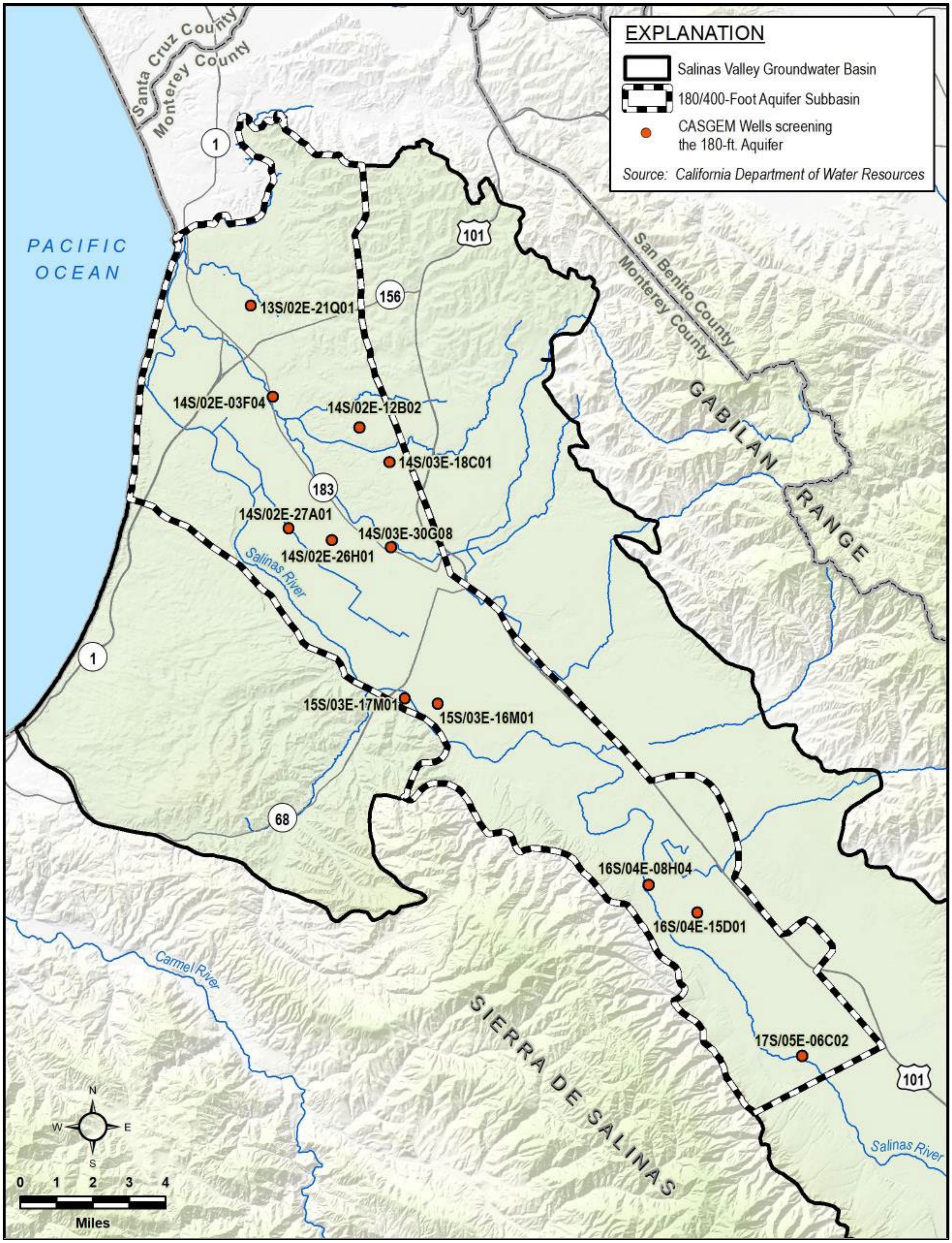


Figure 7-1. Current 180-Foot Aquifer CASGEM Monitoring Network for Water Levels

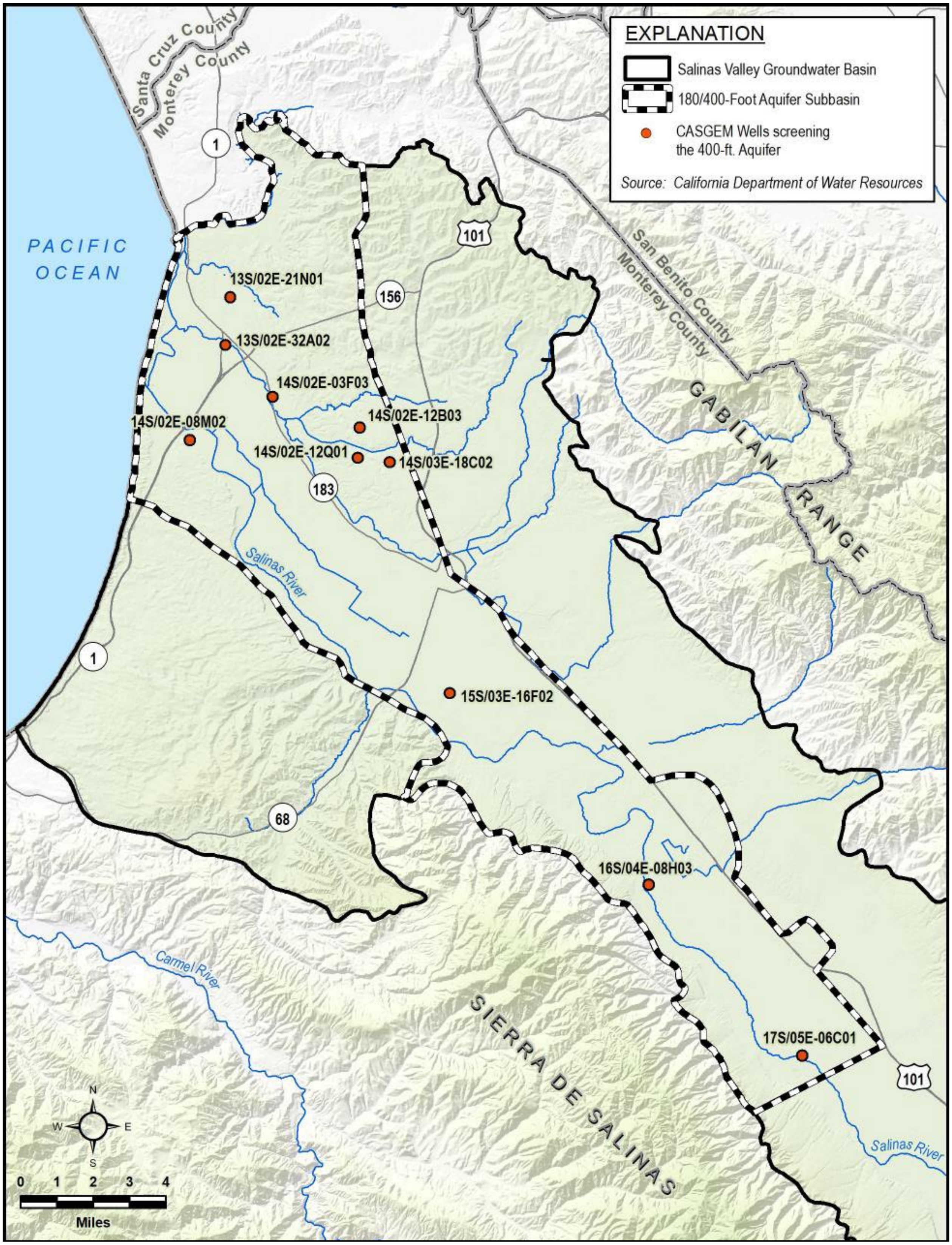


Figure 7-2. Current 400-Foot Aquifer CASGEM Monitoring Network for Water Levels

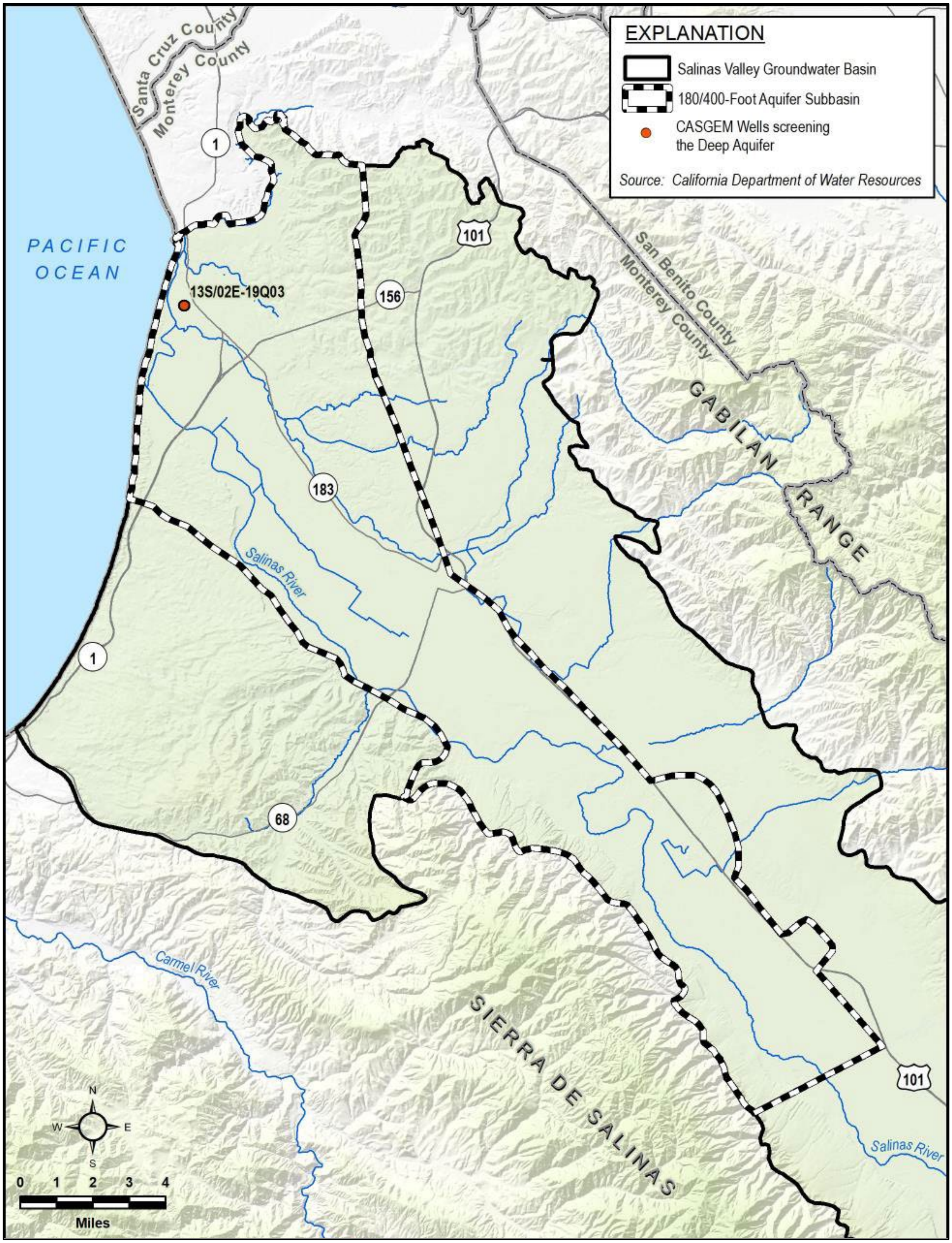


Figure 7-3. Current Deep Aquifers CASGEM Monitoring Network for Water Levels

7.2.3 Groundwater Elevation Monitoring Protocols

Chapter 4 of the MCWRA CASGEM monitoring plan includes a description of the monitoring procedures (MCWRA, 2015b). The CASGEM groundwater elevation monitoring protocols established by MCWRA are adopted by this GSP for groundwater elevation monitoring. The monitoring protocols are included in Appendix 7B. Groundwater elevation measurements will be collected at least two times per year to represent seasonal low and seasonal high groundwater conditions, as described in Appendix 7B. Groundwater elevation data are currently collected both by hand and using automated pressure transducers. The monitoring protocols established by MCWRA cover multiple monitoring methods for collection of data by hand and by automated pressure transducers. These protocols are consistent with data and reporting standards described in SGMA Regulation §352.4.

7.2.4 Groundwater Elevation Monitoring Network Data Gaps

Based on the SGMA regulations and the BMPs published by DWR on monitoring networks (DWR, 2016b), a visual analysis of the existing monitoring network was performed using professional judgment to evaluate whether there are data gaps in the groundwater elevation monitoring network.

While there is no definitive requirement on monitoring well density, the BMP cites several studies (Heath, 1976; Sophocleous, 1983; Hopkins, 1984) that recommend 0.2 to 10 wells per 100 square miles. The BMP notes that professional judgement should be used to design the monitoring network to account for high-pumping areas, proposed projects, and other subbasin-specific factors.

The 180/400-Foot Aquifer Subbasin encompasses 132 square miles. If the BMP guidance recommendations are applied to the three aquifers in the Subbasin, the well network should include between 1 and 13 wells in each of the 180-Foot, 400-Foot, and Deep Aquifers. The current network includes 12 wells in the 180-Foot aquifer, 10 wells in the 400-Foot aquifer, and 1 well in the Deep Aquifers. The CASGEM wells in the 180-Foot, 400-Foot, and Deep Aquifers therefore fall within the range of the BMP guidance. However, visual inspection of the geographic distribution of the well network indicates that additional wells are necessary to adequately characterize the Subbasin. A higher density of monitoring wells may also be recommended in areas of potential subsidence, groundwater withdrawal, and seawater intrusion.

Figure 7-4 through Figure 7-6 show the locations of existing groundwater elevation monitoring wells and the generalized locations of proposed monitoring wells for the 180-Foot, 400-Foot, and Deep Aquifers. The generalized locations for new wells were based on addressing the criteria listed in the monitoring BMP including:

- Monitoring every principal aquifer

- Providing adequate data to produce seasonal potentiometric maps
- Providing adequate data to map groundwater depressions and recharge areas
- Providing adequate data to estimate change in groundwater storage
- Demonstrating conditions at Subbasin boundaries

The data gap areas shown for each aquifer on Figure 7-4, Figure 7-5, and Figure 7-6 will be addressed in the future by either identifying an existing well in each area that meets the criteria for a valid monitoring well, or drilling a new well in each area, as further described in Chapter 10. Some of the data gaps in the Deep Aquifers will likely be filled in response to Monterey County Urgency Ordinance 5302. This ordinance, adopted in 2018, limits the number of wells that can be drilled into the Deep Aquifers and requires that all new wells in the Deep Aquifers meter groundwater extractions, monitor groundwater elevations and quality, and submit all data to MCWRA and SVBGSA.

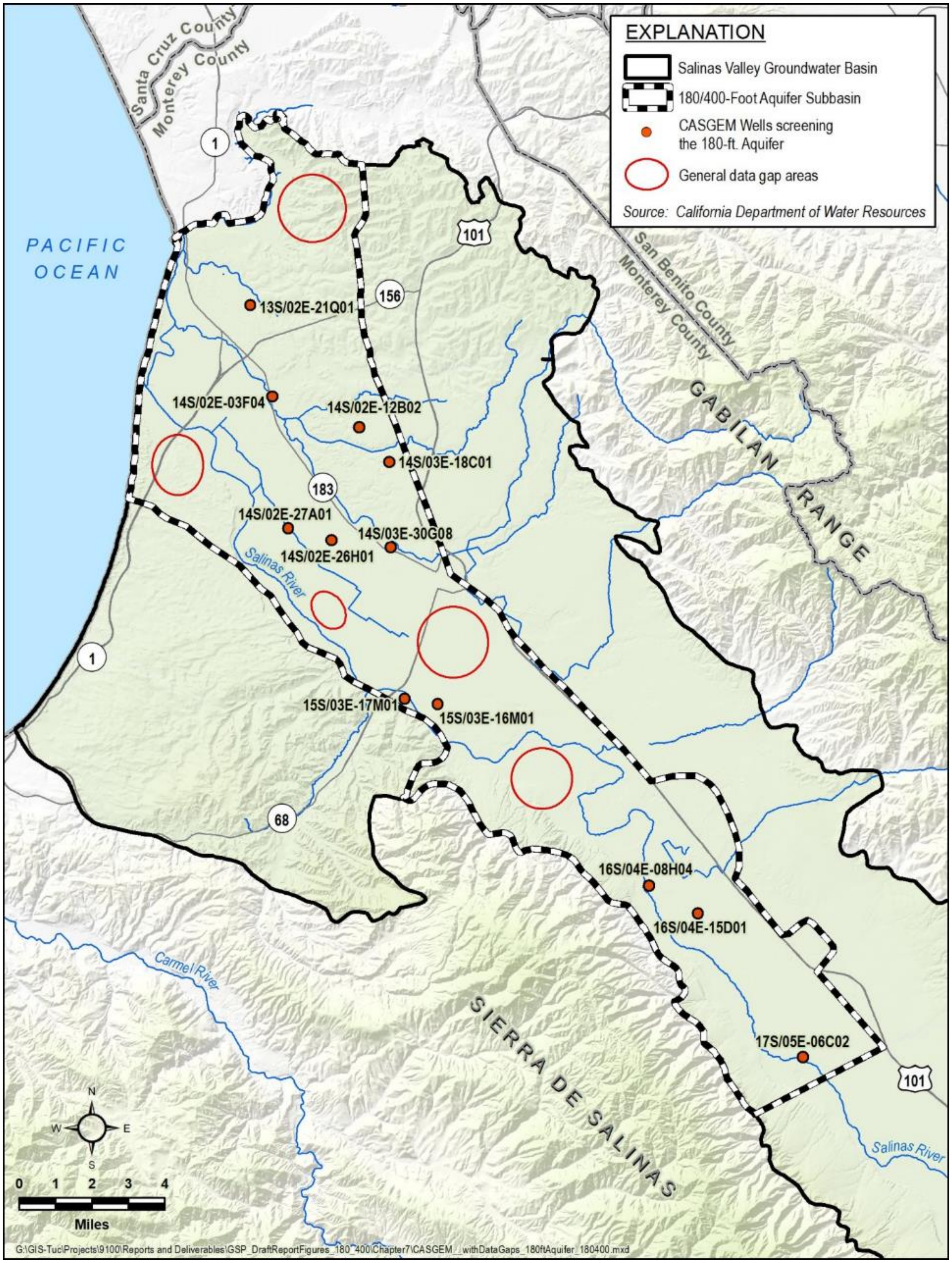


Figure 7-4. Proposed Locations for Additional Groundwater Elevation Monitoring Wells in the 180 Foot Aquifer

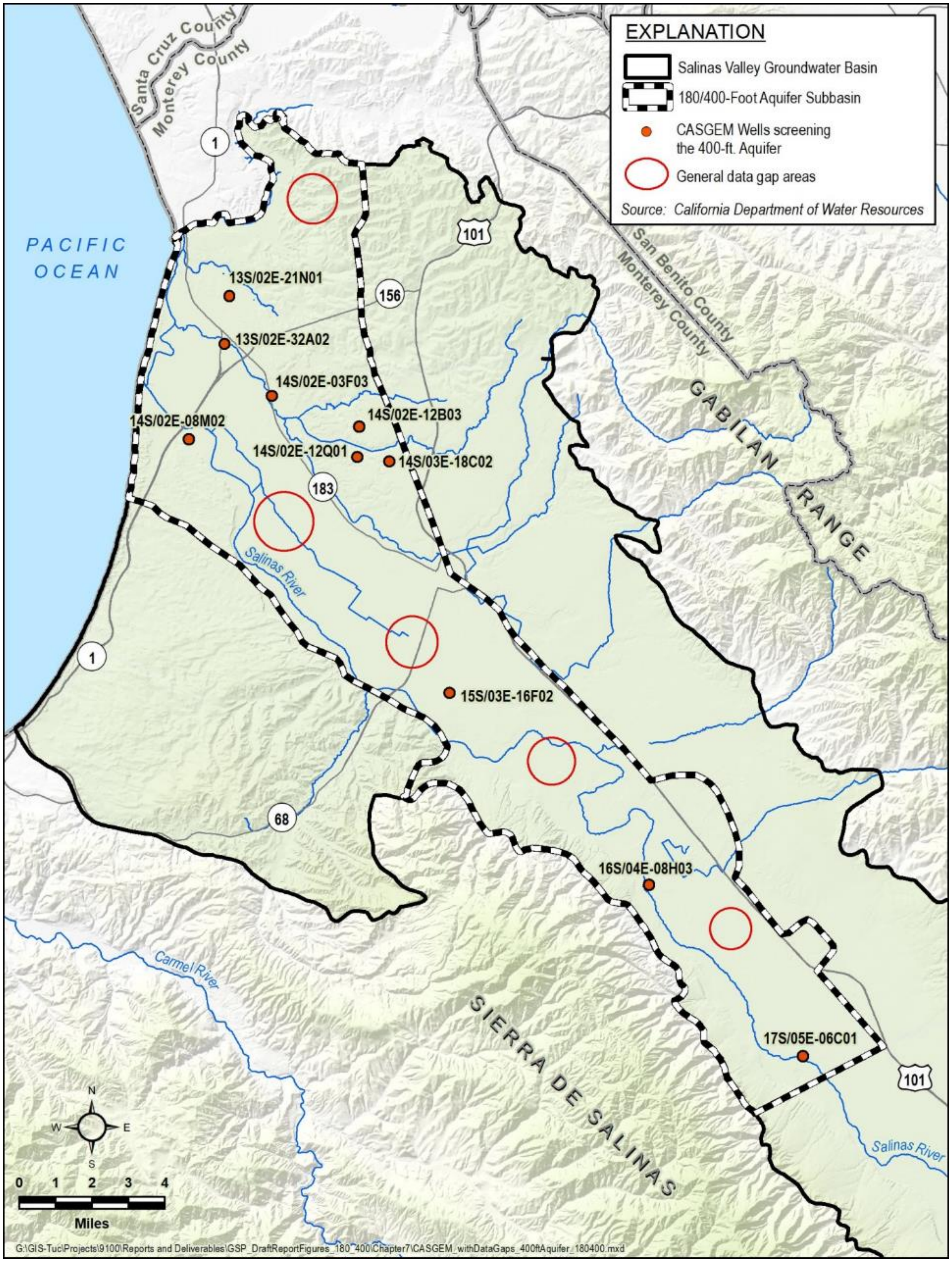


Figure 7-5. Proposed Locations for Additional Groundwater Elevation Monitoring Wells in the 400 Foot Aquifer

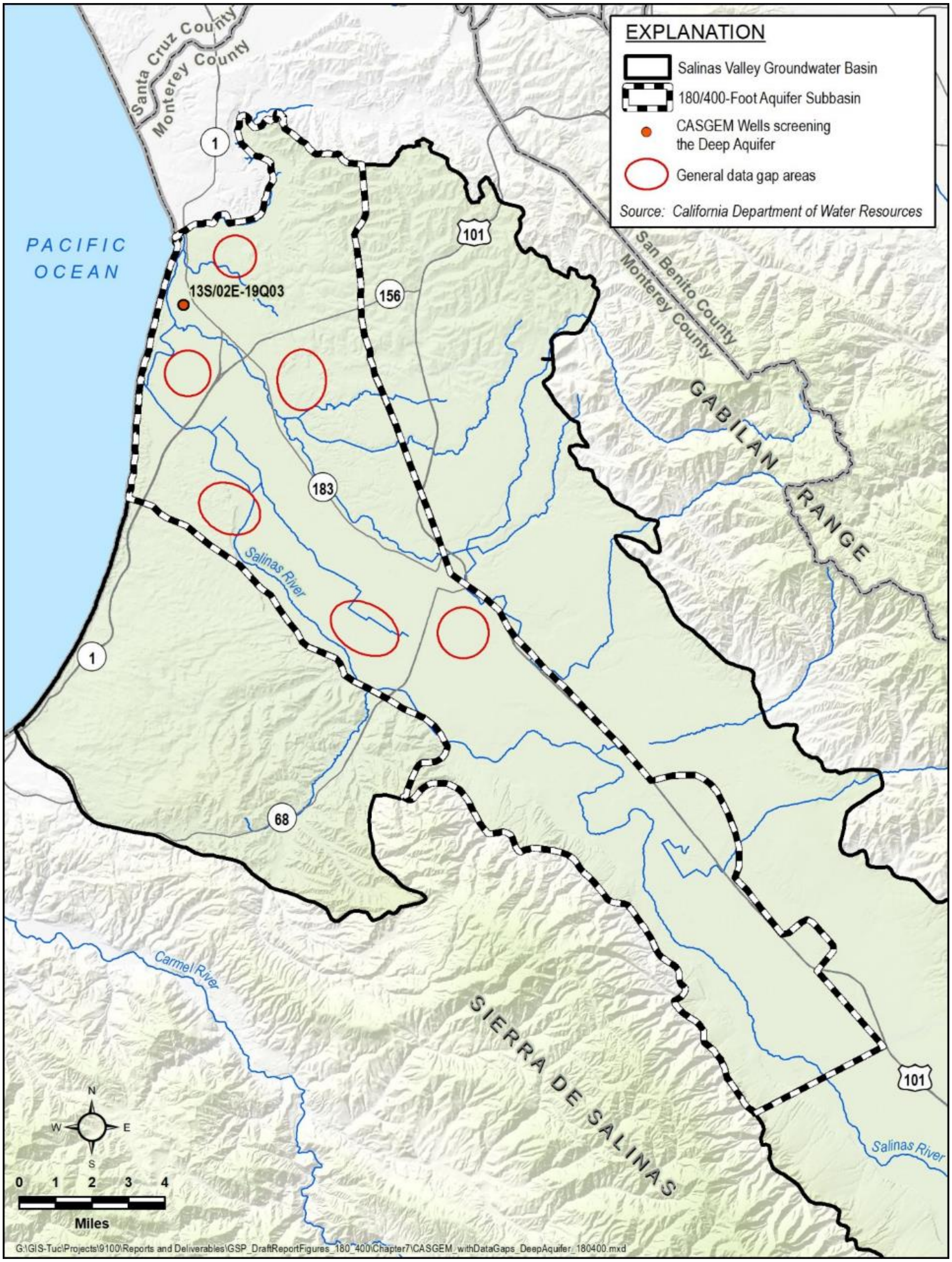


Figure 7-6. Proposed Locations for Additional Groundwater Elevation Monitoring Wells in the Deep Aquifers

7.3 Groundwater Storage Monitoring Network

In accordance with the change in groundwater storage minimum thresholds, the sustainability indicator for reduction of groundwater in storage is an amount of annual groundwater pumping. The total amount of groundwater withdrawn from the basin will be measured in a number of ways:

- Municipal groundwater users and small water systems, defined as systems with at least 15 connections or serving at least 25 people, are required to measure their groundwater usage and report it to the State of California. These data are available on the State's Drinking Water Information Clearinghouse website. These data will be used to quantify municipal and small system pumping.
- Agricultural pumping will be collected in one of two ways:
  - Most agricultural pumpers comply with the existing Monterey County Water Resources Agency Ordinance 3717 that requires groundwater users to report total pumping rates annually to the MCWRA. Groundwater wells with a discharge pipe less than 3 inches in diameter are exempt from this requirement. These lower production wells will be accounted for separately. SVBGSA will work with MCWRA to obtain the Ordinance 3717 data through a coordinated reporting program such that wells owners can provide a single annual reporting to fulfill the requirements of both the GSP and the existing County ordinance 3717.
  - For agricultural users that do not report their pumping annually, pumping will be estimated using Monterey County crop data and crop duty estimates, times a multiplier. The crop duty and multipliers are a data gap as described in Section 7.3.1.
- Domestic pumping, including water systems small enough to not require reporting to the State, will be estimated by multiplying the estimated number of domestic users by a water use factor. The initial water use factor will be 0.39 AF/yr./dwelling unit. The 0.39 AF/yr./dwelling unit is consistent with the value used in the historical and current water budgets in Chapter 6. This factor may be revised in the future if SVBGSA obtains information to justify a change.

The density of monitoring sites and frequency of measurements required from these sources will enable the agency to demonstrate short-term, seasonal, and long-term trends.

7.3.1 Groundwater Storage Monitoring Protocols

Groundwater storage monitoring will be accomplished through the use of existing monitoring programs performed by other agencies. For municipal groundwater users and small water systems, SVBGSA will download data directly from the State's Drinking Water Information Clearinghouse website. No other protocols are required.

For agricultural groundwater users, SVBGSA will work with MCWRA to develop a protocol for sharing data that is currently reported under County Ordinance 3717. SVBGSA will consider the value of developing protocols for flowmeter calibration. These protocols are consistent with data and reporting standards described in SGMA Regulation §352.4.

7.3.2 Groundwater Storage Monitoring Data Gaps

Accurate assessment of the amount of pumping requires an accurate count of the number of municipal, agricultural, and domestic wells in the GSP area. During implementation, the SVBGSA will finalize a database of existing and active groundwater wells in the 180/400-Foot Aquifer Subbasin. This database will draw from the existing MCWRA database, DWR's OWSCR database, and the Monterey County Health Department database of small water systems. As part of the assessment, the SVBGSA will verify well completion information and location, and whether the well is active, abandoned, or destroyed.

A potential data gap is the accuracy and reliability of reported groundwater pumping. SVBGSA will work with MCWRA to evaluate methods currently in place to assure data reliability. Based on the results of that evaluation, the protocols for monitoring may be revised and a protocol for well meter calibration may be developed. In addition, crop data and crop duty multipliers for estimating unreported pumping must be developed in areas where agricultural groundwater pumping is not reported. These crop duty multipliers will be used to estimate groundwater pumping, based on crop type and acreage.

7.4 Seawater Intrusion Monitoring Network

The sustainability indicator for Seawater Intrusion is evaluated using the location of a chloride isocontour, based on chloride concentration measured at an existing network of monitoring wells. MCWRA currently develops biennial maps of the 500 mg/L chloride isocontour (Figures 5-7a and 5-7b). However, those maps are based in part on confidential information obtained from private wells. The seawater intrusion monitoring network will include only wells where the data can be made publicly available.

Tables 7-3 and 7-4 list the wells currently used by MCWRA to monitor seawater intrusion. Figure 7-7 and Figure 7-8 show the locations of these wells in the 180-Foot and 400-Foot Aquifers. There is currently no seawater intrusion mapping in the Deep Aquifers. This is a data gap that is addressed below.

Table 7-3. MCWRA Seawater Intrusion Network with Publicly Available Data

Aquifer Designation	Number of Wells in Network
180-Foot Aquifer	17
400-Foot Aquifer	31
Deep	0

Table 7-4. 180/400-Foot Aquifer Seawater Intrusion Well Network

State Well Number	Total Well Depth	Latitude (NAD 83)	Longitude (NAD 83)
180-Foot Aquifer			
13S/02E-21Q01	205	36.79763	-121.7288605
14S/01E-24L02	157.4	36.7816493	-121.7514003
14S/01E-24L03	205	36.7453955	-121.7393269
14S/01E-24L04	250	36.737132	-121.7098186
14S/01E-24L05	100	36.7371266	-121.7097372
14S/02E-03F03	265	36.7343205	-121.6958626
14S/02E-11A02	280	36.7156293	-121.6980266
14S/02E-11A03	339.3	36.6888803	-121.7079471
14S/02E-11A04	292.7	36.6933013	-121.729448
14S/02E-12B02	225	36.7207266	-121.6805693
14S/02E-12B03	260	36.7183481	-121.6865932
14S/02E-13F02	293	36.6868846	-121.6785298
14S/02E-13F03	130	36.5551669	-121.5474146
14S/02E-26H01	140	36.5550273	-121.5465705
14S/02E-27A01	115	36.4891675	-121.4676728
14S/03E-18C01	Unknown	36.4883286	-121.4684084
14S/03E-18C02	205	36.79763	-121.7288605
400-Foot Aquifer			
13S/02E-15R02	585	36.7976336	-121.7288114
14S/02E-01C01	591	36.7505714	-121.6975633
14S/02E-02A02	810	36.7513598	-121.70755
14S/02E-02C03	835	36.7499731	-121.7192889
14S/02E-03F03	455	36.7454852	-121.7395058
14S/02E-03H01	800	36.7465666	-121.7288185
14S/02E-03R02	638	36.7400975	-121.7277911
14S/02E-04G02	620	36.746502	-121.7493753
14S/02E-09D04	610	36.7364032	-121.7600966
14S/02E-09K02	610	36.7287081	-121.7515143
14S/02E-10E02	717	36.7305044	-121.7426612
14S/02E-10H01	640	36.7314208	-121.7309841
14S/02E-11A04	490	36.7371694	-121.7098984
14S/02E-11B01	822	36.7360994	-121.7142361

State Well Number	Total Well Depth	Latitude (NAD 83)	Longitude (NAD 83)
14S/02E-11M03	660	36.7275465	-121.7207546
14S/02E-12B03	390	36.7342872	-121.6958768
14S/02E-13F02	480	36.7156078	-121.6980344
14S/02E-14A01	532	36.7193809	-121.7105053
14S/02E-14L03	612	36.7142507	-121.7197337
14S/02E-15A01	623	36.7211569	-121.7296572
14S/02E-15C02	550	36.7216387	-121.7378289
14S/02E-16G01	610	36.7179115	-121.7493994
14S/02E-22B01	670	36.7076668	-121.7318719
14S/02E-22L01	680	36.7013362	-121.7359514
14S/03E-18C02	395	36.7207409	-121.6805442
14S/03E-18E04	495	36.7183349	-121.6865671
16S/04E-08H02	295	36.5551431	-121.547419
16S/04E-08H03	295	36.5550375	-121.5465589
16S/05E-31P01	300	36.4891598	-121.4676964
17S/05E-06C01	Unknown	36.4883278	-121.4684169
13S/02E-15R02	585	36.7976336	-121.7288114

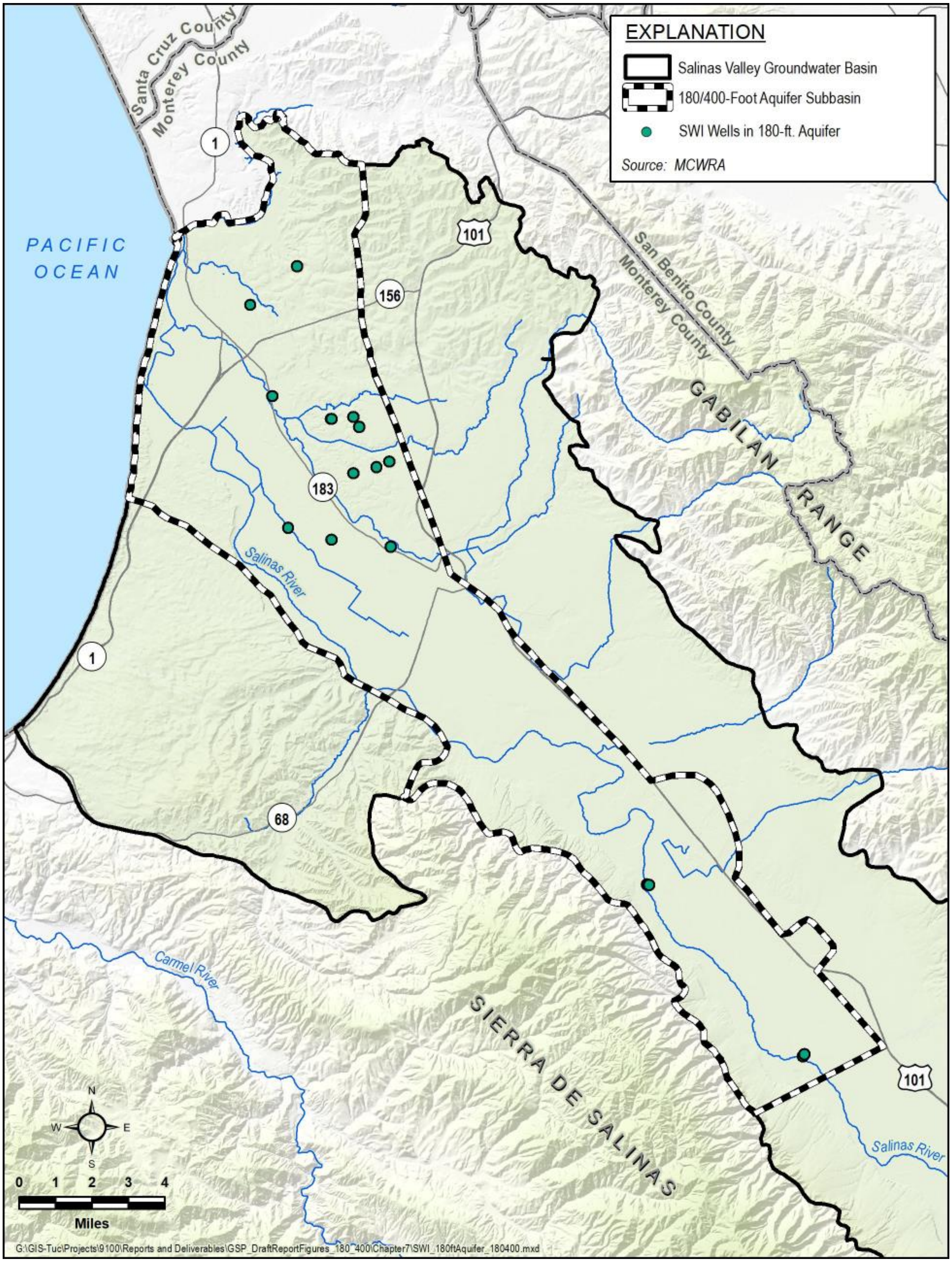


Figure 7-7. 180-Foot Aquifer Monitoring Network for Seawater Intrusion

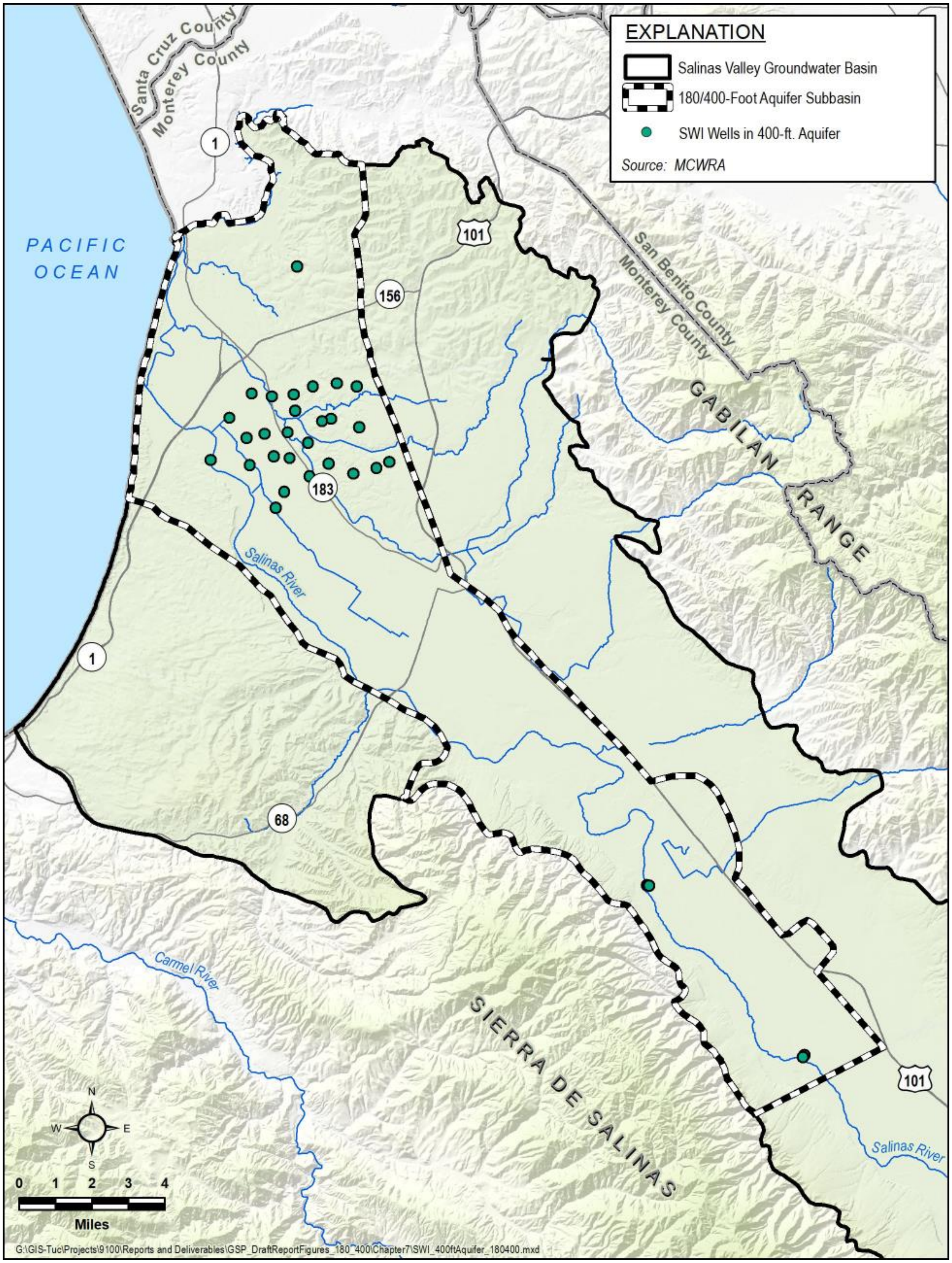


Figure 7-8. 400-Foot Aquifer Monitoring Network for Seawater Intrusion

7.4.1 Seawater Intrusion Monitoring Protocols

Seawater intrusion monitoring has been on-going activity since the MCWRA formed in 1947. The protocols established by MCWRA for collecting groundwater quality data from monitoring wells and analyzing those data for seawater intrusion are adopted by this GSP. The groundwater quality data monitoring protocols are available in the Monterey County Quality Assurance Project Plan (QAPP) and included in Appendix 7C. MCWRA also established chloride data contouring protocols to establish the isocontour map, provided in Appendix 7D. These protocols are consistent with data and reporting standards described in SGMA Regulation §352.4.

7.4.2 Seawater Intrusion Monitoring Data Gaps

The network of wells with publicly available data for monitoring chloride concentrations includes an adequate number and distribution of wells in the 180-Foot and the 400-Foot Aquifers (Figure 7-7 and Figure 7-8). However, the distribution of wells in the Deep Aquifers is inadequate and considered a data gap. As described in Section 7.2, additional wells will be identified in the Deep Aquifers for water level monitoring. The data gap for seawater intrusion monitoring in the Deep Aquifers will be addressed by using the same set of new monitoring wells identified in the water level monitoring network.

Some of the data gaps in the Deep Aquifers will likely be filled in response to Monterey County Urgency Ordinance 5302. This ordinance, adopted in 2018, limits the number of wells that can be drilled into the Deep Aquifers and requires that all new wells in the Deep Aquifers meter groundwater extractions, monitor groundwater elevations and quality, and submit all data to MCWRA and SVBGSA.

7.5 Water Quality Monitoring Network

The sustainability indicator for Degraded Water Quality is evaluated by monitoring groundwater quality at a network of existing water supply wells. The regulations require sufficient spatial and temporal data from each applicable principal aquifer to determine groundwater quality trends for water quality indicators to address known water quality issues.

As described in Chapter 8, separate minimum thresholds are set for agricultural constituents of concern and public supply well constituents of concern. Therefore, although there is a single groundwater quality monitoring network, different wells in the network will be reviewed for different constituents. Constituents of concern for drinking water will be assessed at public water supply wells and on-farm domestic wells. Constituents of concern for crop health will be assessed at agricultural supply wells.

The municipal public water system supply wells included in the monitoring network were identified by reviewing data from the State Water Resources Control Board (SWRCB) Division of Drinking Water. This is the same as the Public Water Systems category in the Safe Drinking

Water Plan for California. It includes municipal systems; community water systems; non-transient, non-community water systems; and non-community water systems that provide drinking water to at least 15 service connections or serve an average of at least 25 people for at least 60 days a year. Wells were selected that had at least one of the constituents of concern reported from 2015 or more recently, and totaled 51 wells (Burton and Wright, 2018). These wells are listed in Appendix 7E and shown on Figure 7-9.

Small public water systems wells, regulated by Monterey County Department of Public Health, will eventually add another136 wells to the monitoring network. These include both state small water systems that serve 5-14 connections and local water systems that serve 2-4 service connections. The limitation of this dataset is that the well location coordinates and construction information are currently missing; this is a data gap. SVBGSA work with the County to fill this data gap. When location and well construction data become available, these wells will be added to the monitoring network and included in Appendix 7E and Figure 7-9.

The domestic wells and agricultural supply wells included in the monitoring network will be a subset of those that have been sampled through the ILRP by the CCGC. The CCGC has conducted groundwater monitoring under the ILRP since 2013, sampling more than 1,200 domestic and irrigation supply wells on Coalition member ranches within the agricultural region (CCGC, 2017).

In 2017, Ag. Order 3.0 was issued and provides a “temporary 3-year order, in anticipation of a comprehensive order anticipated for adoption in 2020”. Under the anticipated 2020 Ag. Order 4.0, a long-term groundwater quality monitoring program will be put in place. The SVBGSA will use the data developed under this monitoring program to determine if domestic on-farm supply wells have constituents of concern above drinking water limits. In addition, the data will be reviewed to assess if agricultural supply wells are impacted by constituents that are detrimental to crops and could impair the agricultural beneficial use. The SVBGSA will identify a select number of domestic and irrigation ILRP wells as representative sites after Ag Order 4.0 is issued; not all wells sampled under Ag Oder 4.0 will be included in the GSP’s agricultural water quality monitoring network. Figure 7-10 shows the locations of all wells in the current ILRP groundwater quality monitoring network that were sampled under the temporary orders. The SVBGSA assumes that Ag Order 4.0 will have a similar representative geographic distribution of wells within the Subbasin. However, this network cannot be finalized until Ag Order 4.0 is issued, sometime in 2020.

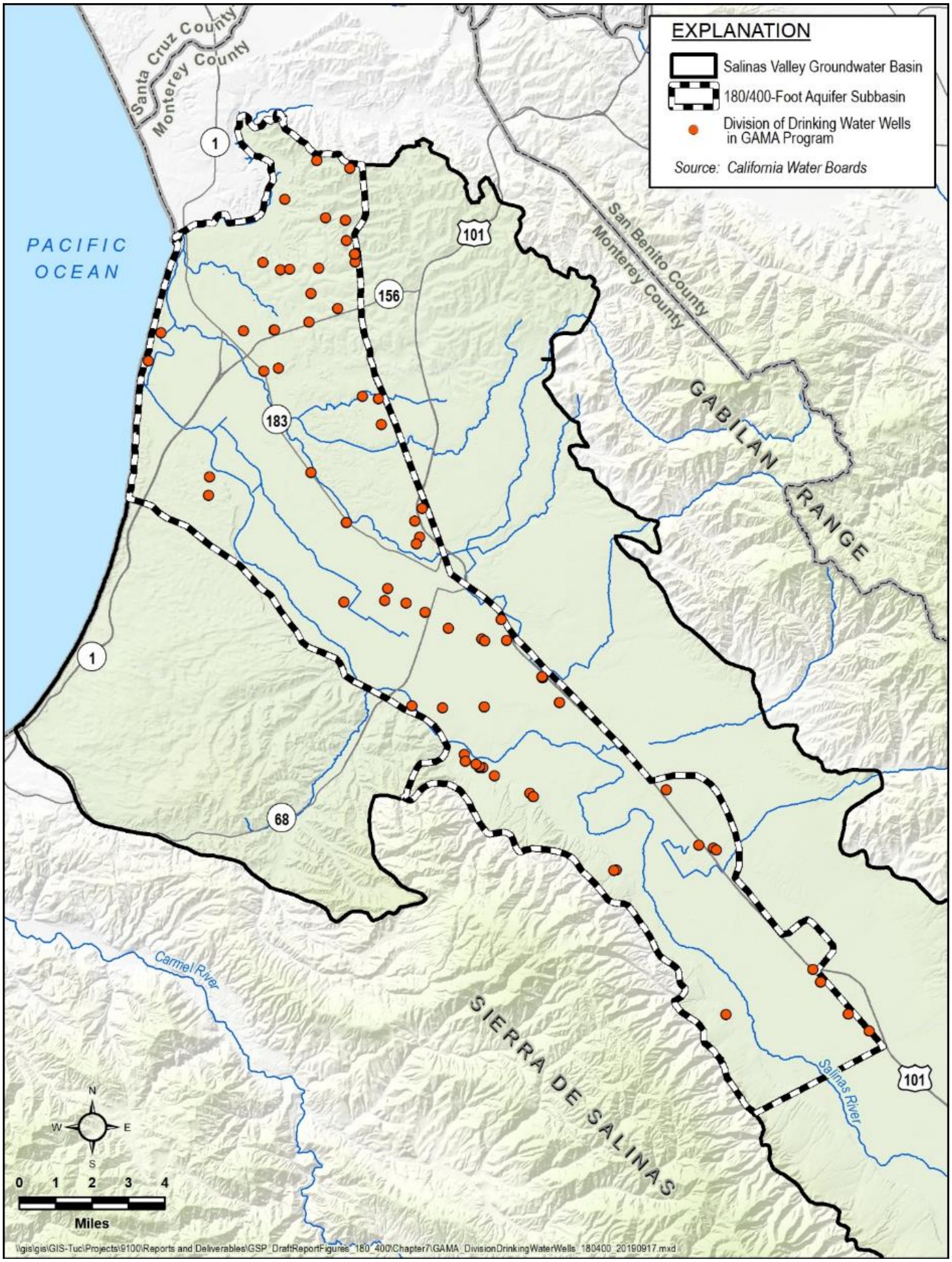


Figure 7-9. Locations of Wells in the Groundwater Quality Monitoring Network for Public Water Supply Wells

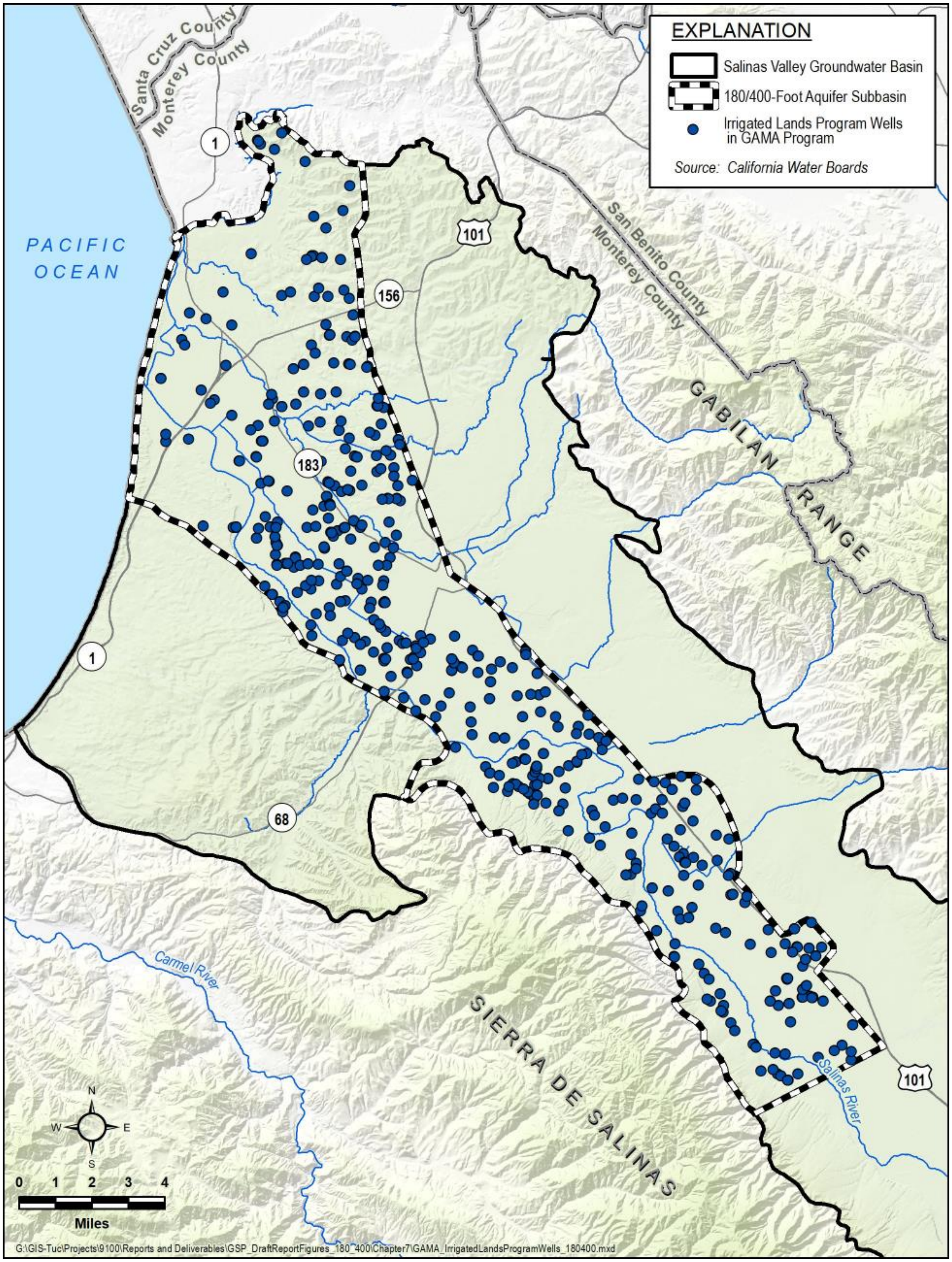


Figure 7-10. Locations of ILRP Wells Monitored under Ag Order 3.0

7.5.1 Groundwater Quality Monitoring Protocols

Water quality samples are currently being collected according to SWRCB and ILRP requirements. Water quality data from public water systems are collected, analyzed, and reported in accordance with protocols that are reviewed and approved by the SWRCB, Division of Drinking Water, in accordance with the state and federal Safe Drinking Water Acts. Monitoring protocols may vary by agency.

ILRP data are currently collected under Central Coast RWQCB Ag Order 3.0. ILRP samples are collected under the Tier 1, Tier 2, or Tier 3 monitoring and reporting programs. Copies of these monitoring and reporting programs are included in Appendix 7F, and incorporated herein as monitoring protocols. These protocols will continue to be followed during GSP implementation for the groundwater quality monitoring. These protocols are consistent with data and reporting standards described in SGMA Regulation §352.4.

7.5.2 Groundwater Quality Monitoring Data Gaps

There is adequate spatial coverage to assess impacts to beneficial uses and users. The primary data gap is that well construction information for many wells in the monitoring network is not known. The missing well construction data will be collected during plan implementation, as described in Chapter 10.

7.6 Land Subsidence Monitoring Network

As described in Section 5.4, DWR has, and will be, collecting land subsidence data using InSAR satellite data, and will make these data available to GSAs. This subsidence dataset represents the best available science for the 180/400-Foot Aquifer Subbasin and will therefore be used as the subsidence monitoring network.

7.6.1 Land Subsidence Monitoring Protocols

Land Subsidence monitoring protocols are the ones used by DWR for InSAR measurements and interpretation. If the annual monitoring indicates subsidence is occurring at a rate greater than the minimum thresholds, then additional investigation and monitoring may be warranted. In particular, the GSAs will implement a study to assess if the observed subsidence can be correlated to groundwater elevations, and whether a reasonable causality can be established. These protocols are consistent with data and reporting standards described in SGMA Regulation §352.4.

7.6.2 Land Subsidence Data Gaps

There are no data gaps associated with the subsidence monitoring network.

7.7 Interconnected Surface Water Monitoring Network

As described in Section 5.6 and Chapter 4 of this GSP, there is little direct connection between surface water and the 180-Foot, 400-Foot, or Deep Aquifers in the Subbasin. However, the Salinas River is potentially in connection with groundwater in the shallow water-bearing sediments that do not constitute a principal aquifer. The shallow sediments are not used for any significant extraction and have very little monitoring data. This analysis of locations of interconnected surface water is based on best available data; however, the level of interconnection is unclear. As mentioned in Chapter 4, the Salinas Valley 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). Additional data are needed to reduce uncertainty and refine the map of interconnected surface waters.

The primary tool for assessing depletions of interconnected surface waters due to pumping will be the SVIHM. The SVIHM will supply surface water discharge, surface water head, baseflow contributions, location of ephemeral or intermittent flowing streams. It will also provide temporal changes in conditions due to variations in stream discharge and regional groundwater extraction, as well as other factors that may be necessary to identify adverse impacts on beneficial uses of the surface water.

Chapter 8 describes the use of the SVIHM model to develop minimum thresholds for the depletion of interconnected surface water. This approach is in accordance with the Monitoring Networks BMP which states [emphasis added]:

> *Monitoring of the interconnected surface water depletions requires the use of tools, **commonly modeling approaches**, to estimate the depletions associated with groundwater extraction. Models require assumptions be made to constrain the numerical model solutions. These assumptions should be based on empirical observations determining the extent of the connection of surface water and groundwater systems, the timing of those connections, the flow dynamics of both the surface water and groundwater systems, and hydrogeologic properties of the geologic framework connecting these systems.* [emphasis added]

7.7.1 Interconnected Surface Water Monitoring Protocols

Monitoring protocols for interconnected surface water will be developed when the SVIHM is available and when shallow wells are installed. The protocols will be consistent MCWRA’s current groundwater elevation monitoring protocols, and with data and reporting standards described in SGMA Regulation §352.4.

7.7.2 Interconnected Surface Water Data Gaps

There is very little monitoring data in the shallow sediments, and the level of interconnection to the 180/400-Foot Aquifer is unclear, as described in section 5.6. To address this data gap and develop the needed empirical data regarding the extent and timing of hydrologic connection, the SVBGSA will install two shallow wells along the Salinas River in the 180/400-Foot Aquifer Subbasin, as discussed in Chapter 10. Data from these wells will be used in conjunction with the SVIHM to address the data gap in interconnected surface water.

7.8 Representative Monitoring Sites

Representative monitoring sites (RMS) are defined in the regulations as a subset of monitoring sites that are representative of conditions in the Subbasin. All of the monitoring sites shown in figures and tables in this Chapter are considered RMS (except where noted).

7.9 Data Management System and Data Reporting

The SVBGSA has developed a Data Management System (DMS) that is used to store, review, and upload data collected as part of the GSP development and implementation. The DMS adheres to the following SGMA regulations:

- Article 3, Section §352.6: Each Agency shall develop and maintain a data management system that is capable of storing and reporting information relevant to the development or implementation of the Plan and monitoring of the Subbasin.
- Article 5, Section §354.40: Monitoring data shall be stored in the data management system developed pursuant to Section 352.6. A copy of the monitoring data shall be included in the Annual Report and submitted electronically on forms provided by the Department.

The SVBGSA DMS consists of two SQL databases. The HydroSQL database stores information about each well and water level and extraction time-series data. Fields in the HydroSQL database include:

- Subbasin
- Cadastral coordinates
- Planar coordinates
- Well owner

- Well name
- Well status
- Well depth
- Screened interval top and bottom
- Well type
- Water level elevation
- Annual pumping volume

Streamflow gauge data from the USGS is stored in the HydroSQL similarly to the well water level information.

Water quality data are stored in the EnviroData SQL database, which is linked to the HydroSQL for data management purposes. EnviroData SQL contains fields such as:

- Station
- Parameter
- Sample Date
- Detection (detect or non-detect)
- Value
- Unit

The data used to populate the SVBGSA DMS are listed in Table 7-5. Categories marked with an X indicate datasets that are publicly accessible or available from MCWRA and other sources that were used in populating the DMS. Additional datasets will be added in the future as appropriate, such as recharge or diversion data.

Table 7-5. Datasets Available for Use in Populating the DMS

Data Sets	Data Category						
	Well and Site Information	Well Construction	Aquifer Properties and Lithology (Data to be Added when Available)	Water Level	Pumping (Data to be Added when Available)	Streamflow	Water Quality
DWR (CASGEM)	X	X		X			
MCWRA	X	X		X	X		X
GeoTracker GAMA	X						X
USGS Gage Stations						X	

Data were compiled and reviewed to comply with quality objectives. The review included the following checks:

- Identifying outliers that may have been introduced during the original data entry process by others.
- Removing or flagging questionable data being uploaded in the DMS. This applies to historical water level data and water quality data.

The data were loaded into the database and checked for errors and missing data. The error tables identify water level and/ or well construction data as missing. Another quality check was completed with the water level data by plotting each well hydrograph to identify and remove anomalous data points.

In the future, well log information will be entered for selected wells and other information will be added as needed to satisfy the requirements of the SGMA regulations.

The DMS also includes a publicly accessible web-map hosted on the SVBGSA website; accessed at https://svbgsa.org/gsp-web-map-and-data/. This web-map gives interested parties access to technical information used in the development of the GSP and includes public well data, and analysis such as water level contour maps, seawater intrusion, as well as various local administrative boundaries. In addition, the web-map has functionalities to graph time series of water levels and search for specific wells in the database. This web-map will be regularly updated as new information is made available to the SVBGSA.

8 SUSTAINABLE MANAGEMENT CRITERIA

This chapter defines the conditions that constitute sustainable groundwater management, discusses the process by which the SVBGSA will characterize undesirable results, and establishes minimum thresholds and measurable objectives for each sustainability indicator.

This is the fundamental chapter in the GSP that defines sustainability in the 180/400-Foot Aquifer Subbasin and addresses significant regulatory requirements. The measurable objectives, minimum thresholds, and undesirable results detailed in this chapter define the Subbasin's future conditions and commits the GSA to actions that will meet these criteria. Defining these SMC requires a significant level of analysis and scrutiny, and this chapter includes adequate data to explain how SMC were developed and how they influence all beneficial uses and users.

This chapter is structured to address all of the SGMA regulations regarding SMC. The SGMA regulations are extensive. To retain an organized approach, this chapter follows the same structure for each sustainability indicator. The result is somewhat repetitive, but is complete when addressing the regulations. The SMC are grouped by sustainability indicator. Each section follows a consistent format that contains the information required by Section 354.22 *et. seq* of the regulations and outlined in the SMC BMP (DWR, 2017; CCR, 2016). Each SMC section includes a description of:

- How locally defined significant and unreasonable conditions were developed
- How minimum thresholds were developed, including:
    - The information and methodology used to develop minimum thresholds (§354.28 (b)(1))
    - The relationship between minimum thresholds and the relationship of these minimum thresholds to other sustainability indicators (§354.28 (b)(2))
    - The effect of minimum thresholds on neighboring basins (§354.28 (b)(3))
    - The effect of minimum thresholds on beneficial uses and users (§354.28 (b)(4))
    - Relevant federal, state, or local standards (§354.28 (b)(5))
    - The method for quantitatively measuring minimum thresholds (§354.28 (b)(6))
- How measurable objectives were developed, including:
    - The methodology for setting measurable objectives (§354.30)
    - Interim milestones (§354.30 (a), §354.30 (e), §354.34 (g)(3))
- How undesirable results were developed, including:
    - The criteria for defining undesirable results (§354.26 (b)(2))

  - The potential causes of undesirable results (§354.26 (b)(1))
  - The effects of these undesirable results on the beneficial users and uses (§354.26 (b)(3))

8.1 Definitions

The SGMA legislation and GSP Regulations contain a number of new terms relevant to the SMC. These terms are defined below using the definitions included in the GSP Regulations. Where appropriate, additional explanatory text is added in italics. This explanatory text is not part of the official definitions of these terms.

- **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.

  Interconnected surface waters are sections of streams, lakes, or wetlands where the groundwater table is at or near the ground surface.

- **Interim milestone** refers to a target value representing measurable groundwater conditions, in increments of 5 years, set by an Agency as part of a Plan.

  Interim milestones are targets such as groundwater elevations that will be achieved every five years to demonstrate progress towards sustainability.

- **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.

- **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.

  Measurable objectives are goals that the GSP is designed to achieve.

- **Minimum threshold** refers to a numeric value for each sustainability indicator used to define undesirable results.

  Minimum thresholds are indicators of an unreasonable condition. For example, the level of a pump in a well may be a minimum threshold because groundwater levels dropping below the pump level would be an unreasonable condition.

- **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.

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

  The six sustainability indicators relevant to this subbasin include chronic lowering of groundwater levels; reduction of groundwater storage; degraded water quality; land subsidence; seawater intrusion; and depletion of interconnected surface waters.

- **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.

- **Undesirable Result**

  Undesirable Result is not defined in the Regulations. However, the description of undesirable result states that it should be a quantitative description of the combination of minimum threshold exceedances that cause significant and unreasonable effects in the subbasin. An example undesirable result is more than 10% of the measured groundwater elevations being lower than the minimum thresholds. Undesirable results should not be confused with significant and unreasonable conditions. Significant and unreasonable conditions are physical conditions to be avoided; an undesirable result is a quantitative assessment based on minimum thresholds.

8.2 Sustainability Goal

Per Section §354.24 of the GSP Regulations (CCR, 2016), the sustainability goal for the Subbasin has three parts:

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

The goal of this GSP is to manage the groundwater resources of the 180/400-Foot Aquifer Subbasin for long-term community, financial, and environmental benefits to the Subbasin's residents and businesses. This GSP will ensure long-term viable water supplies while maintaining the unique cultural, community, and business aspects of the Subbasin. It is the express goal of this GSP to balance the needs of all water users in the Subbasin.

A number of projects and management actions are included in this GSP and detailed in Chapter 9. Not all of these projects and actions will be implemented. However, some combination of these will be implemented to ensure the Subbasin is operated within its sustainable yield and achieves sustainability. These management actions and project types include:

Management Actions:

- Agricultural land and pumping allowance retirement
- Outreach and education for agricultural BMPs
- Nacimiento and San Antonio Reservoirs Reoperation
- Restrict Pumping in CSIP Area
- Support and strengthen MCWRA restrictions on additional wells in the Deep Aquifers
- Convene a seawater intrusion working group

Projects:

- In-lieu recharge through direct surface water delivery for irrigation
- Direct recharge through recharge basins and injection wells
- Indirect recharge through decreased evapotranspiration (e.g., removal of invasive species) or increased percolation (e.g., stormwater capture)
- Hydraulic barrier to control seawater intrusion

For each of these project types, a number of priority projects with specific conceptual designs are described in Chapter 9.

The management actions and projects are designed to achieve sustainability within 20 years by one or more of the following means:

- Educating stakeholders and prompting changes in behavior to improve chances of achieving sustainability.
- Increasing awareness of groundwater pumping impacts to promote voluntary reductions in groundwater use through improved water use practices or fallowing crop land.
- Increasing basin recharge by capturing surface water under approved or modified permits.
- Developing new renewable water supplies for use in the Subbasin to offset groundwater pumping.

- Working with MCWRA to effectively re-operate surface water reservoirs to benefit groundwater sustainability.
- Develop a barrier that halts seawater intrusion on the coast.

8.3 General Process for Establishing Sustainable Management Criteria

The SMC presented in this chapter were developed using publicly available information, feedback gathered during public meetings, hydrogeologic analysis, and meetings with SVBGSA staff and Advisory Committee members. The general process included:

- Presentations to the Board of Directors on the SMC requirements and implications.
- Presentations to the Advisory Committee and Subbasin Specific working groups outlining the approach to developing SMC and discussing initial SMC ideas. The Advisory Committee and working groups provided feedback and suggestions for the development of initial SMC.
- Discussions with GSA staff and various Board Members.
- Modifying minimum thresholds and measurable objectives based on input from GSA staff and Board Members.

This general process resulted in the SMC presented in this chapter.

8.4 Management Areas

SGMA allows for the establishment of management areas within a basin or subbasin to distinguish different monitoring and management criteria and facilitate implementation of the GSP. Management areas have not been established in the Subbasin.

8.5 Sustainable Management Criteria Summary

Table 8-1 provides a summary of the SMC for each of the six sustainability indicators. The rationale and background for developing these criteria are described in detail in the following sections. The SMC are individual criteria that will each be met simultaneously, rather than in an integrated manner. For example, the groundwater elevation and seawater intrusion SMCs are two independent SMC that will be achieve simultaneously. The groundwater elevation SMC do not hinder the seawater intrusion SMC, but also, they do not ensure the halting of seawater intrusion by themselves. SMC are developed for all principal aquifers that have sufficient data. Where insufficient data exists, SMC will be developed when data gaps are filled.

Table 8-1. Sustainable Management Criteria Summary

Sustainability Indicator	Minimum Threshold	Measurement	Measurable Objective	Undesirable Result	Interim Milestones
Chronic lowering of groundwater levels	Water level minimum thresholds set to 1 foot above 2015 groundwater elevations. See Table 8-2 for wells in the 180- and 400- Foot aquifers	Measured through monitoring well network	Water level measurable objectives set to 2003 groundwater elevations	Over the course of any 1 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.	See Table 8-3
Reduction in groundwater storage	Minimum threshold set to the estimated long-term future sustainable yield of 112,000 AF/yr. for the entire 180/400-Foot Aquifer Subbasin	Measured through total groundwater extractions. Municipal users and small systems report groundwater extractions to the state. Agricultural pumping will either be collected by MCWRA, or estimated based on crop data	Measurable objective is Identical to the minimum threshold. Pumping is set to the estimated long-term future sustainable yield of 112,000 AF/yr. for the entire 180/400-Foot Aquifer Subbasin	During average hydrogeologic conditions, and as a long-term average over all hydrogeologic conditions, the total groundwater pumping shall not exceed the minimum threshold.	Set to 112,000 AF/yr.
Seawater intrusion	Minimum threshold is the 2017 extent of the 500 mg/L chloride isocontour as developed by MCWRA for the 180- and 400- Foot Aquifers. The minimum threshold is the line defined by Highway 1 for the Deep Aquifers.	Seawater intrusion maps developed by MCWRA	Measurable objective is the line defined by Highway 1 for the 180-Foot, 400-Foot, and Deep Aquifers	On average in any 1 year there shall be no mapped seawater intrusion beyond the 2017 extent of the 500 mg/L chloride isocontour.	5-Year: identical to current conditions 10-year: one-third of the way to the measurable objective 15-year: two-thirds of the way to the measurable objective

Sustainability Indicator	Minimum Threshold	Measurement	Measurable Objective	Undesirable Result	Interim Milestones
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. Exceedances are only measured in supply wells that regularly test for the parameters. See Tables 8-2 and 8-3 for the list of constituents.	Groundwater quality data downloaded annually from state and local sources.	Measurable objective is identical to the minimum threshold. Zero additional exceedances of groundwater quality constituents of concern known to exist in the Subbasin above drinking water or agricultural limits.	On average during any 1 year, no groundwater quality minimum threshold shall be exceeded as a direct result of projects or management actions taken as part of GSP implementation.	Identical to current conditions
Subsidence	To account for InSAR errors, the minimum threshold is no more than 0.1 foot per year of estimated land movement, resulting in zero net long-term subsidence	Measured using DWR provided InSAR data.	Measurable objective is identical to the minimum threshold, resulting in Zero net long-term subsidence.	In any 1 year, there will be zero exceedances of minimum thresholds for subsidence.	Zero long-term subsidence averaged over every 5-year period.
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 AF/yr. for future conditions including climate change.	Estimated using the SVIHM integrated model	Identical to the minimum threshold. Set to the estimated average rate of stream depletion of 69,700 AF/yr. for future conditions including climate change	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.	Average annual depletion rate set to 69,700 AF/yr. for every 5-year period.

8.6 Chronic Lowering of Groundwater Elevations SMC

8.6.1 Locally Defined Significant and Unreasonable Conditions

Locally defined significant and unreasonable conditions were determined based on public meetings and discussions with GSA staff. Significant and unreasonable groundwater elevations in the Subbasin are those that:

- Are at or below the lowest observed groundwater elevations. Public and stakeholder input identified historically low groundwater elevations as significant and unreasonable.
- Cause significant financial burden to local agricultural interests.
- Interfere with other sustainability indicators.

8.6.2 Minimum Thresholds

Section §354.28(c)(1) of the GSP Regulations states that "The minimum threshold for chronic lowering of groundwater elevations shall be the groundwater elevation indicating a depletion of supply at a given location that may lead to undesirable results" (CCR, 2016).

8.6.2.1 Information and Methodology Used to Establish Minimum Thresholds and Measurable Objectives

The development of minimum thresholds and measurable objectives follow a similar process and are described concurrently in this section. The information used for establishing the chronic lowering of groundwater elevations measurable objectives and minimum thresholds include:

- Feedback from discussions with local stakeholders on challenges and goals.
- Feedback about significant and unreasonable conditions gathered during public meetings.
- Historical groundwater elevation data from wells monitored by the Monterey County Water Resources Agency (MCWRA).
- Maps of current and historical groundwater elevation data.

The general steps for developing minimum thresholds and measurable objectives were:

- Use MCWRA-generated average groundwater elevation change hydrographs to select representative years that represent minimum thresholds and measurable objectives for the Subbasin.

- Use the MCWRA-generated groundwater elevation contour map from the appropriate years to identify minimum threshold and measurable objective values for each monitoring network well.
- Plot the minimum thresholds and measurable objectives on the respective monitoring well hydrographs.
- Visually inspect each hydrograph to check if the minimum threshold and measurable objective are appropriate according to the actual water levels measured during the representative years selected from the groundwater elevation change hydrographs.
- Manually adjust the minimum thresholds and measurable objectives as needed, to better represent conditions at each well.

Each of these steps is described in more detail below.

The MCWRA provided hydrographs of average cumulative groundwater elevation changes for the Pressure Subarea, which covers the 180/400-Foot Aquifer Subbasin. Based on this period of record, a representative climatic cycle from 1967 to 1998 was used to develop values for minimum thresholds and measurable objectives. This representative period also corresponds to important water management milestones for the Salinas Valley Groundwater Basin; water year 1967 marks the beginning of operations at San Antonio Reservoir, with first water releases in November 1966. The Castroville Seawater Intrusion Project (CSIP) began operating in 1998.

The groundwater elevation change hydrograph with preliminary minimum threshold and measurable objectives lines for the Pressure Subarea are shown on Figure 8-1. The Pressure Subarea represents both the 180/400-foot Aquifer Subbasin and the Monterey Subbasin. The average 2015 and 2016 groundwater elevations in the Pressure Subarea are considered significant and unreasonable. The minimum thresholds were therefore set above the 2015 and 2016 groundwater elevations. When looking at the groundwater elevation changes within the representative climatic cycle (Figure 8-1), the historical lowest elevations occurred in 1991 and 1992, at one foot above the 2015 level. Therefore, the Pressure Area minimum thresholds were set one foot above 2015 groundwater elevations.

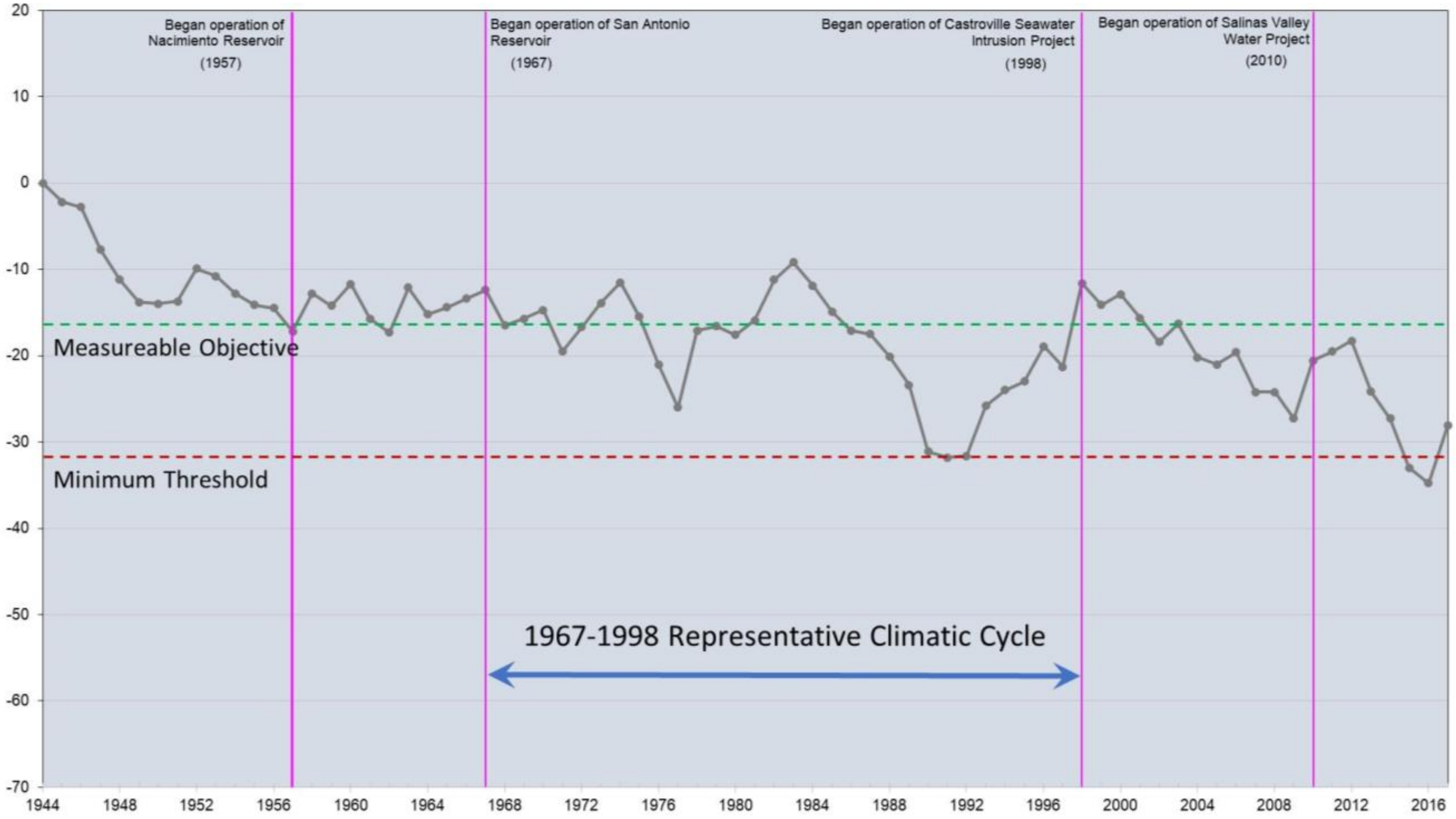
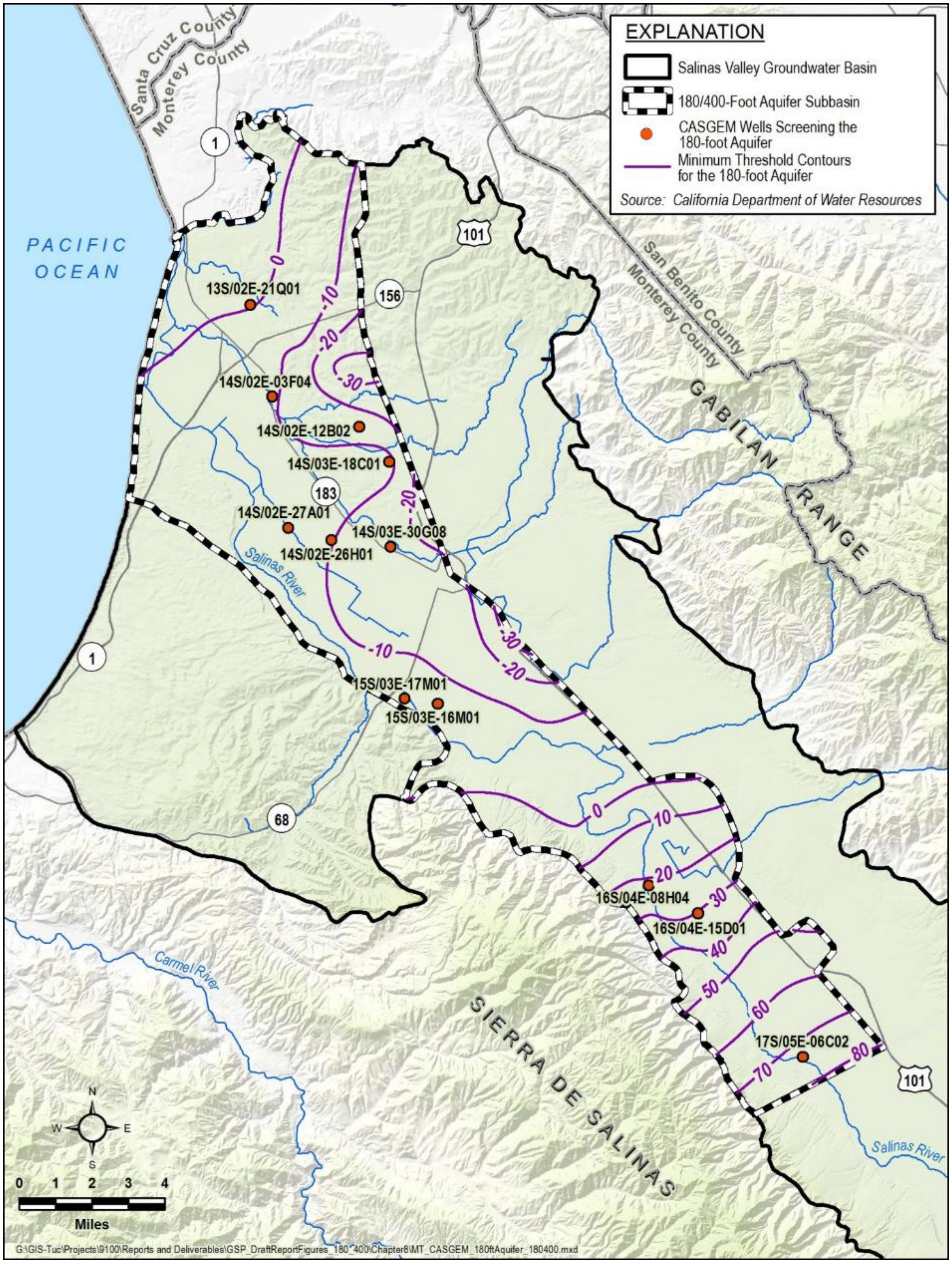


Figure 8-1. Cumulative Groundwater Elevation Change Hydrograph with Selected Measurable Objective and Minimum Threshold for the Pressure Subarea

After the years representing both minimum thresholds and measurable objectives were selected, MCWRA-provided groundwater elevation contour maps for the fall water level measurements of these years were digitized. An additional 1-foot adjustment factor was added to the 2015 map to establish minimum thresholds. Separate maps were created for both the 180-Foot Aquifer and for the 400-Foot Aquifer. No groundwater elevation contour maps currently exist for the Deep Aquifers due to a lack of monitoring data. This is a data gap that will be filled during GSP implementation, and when MCWRA produces a more detailed analysis of the Deep Aquifers.

The minimum threshold contour maps along with the monitoring network wells are shown on Figure 8-2 for the 180-Foot Aquifer and on Figure 8-3 for the 400-Foot Aquifer.



Source: California Department of Water Resources

Figure 8-2. Groundwater Elevation Minimum Threshold Contour Map for the 180-Foot Aquifer

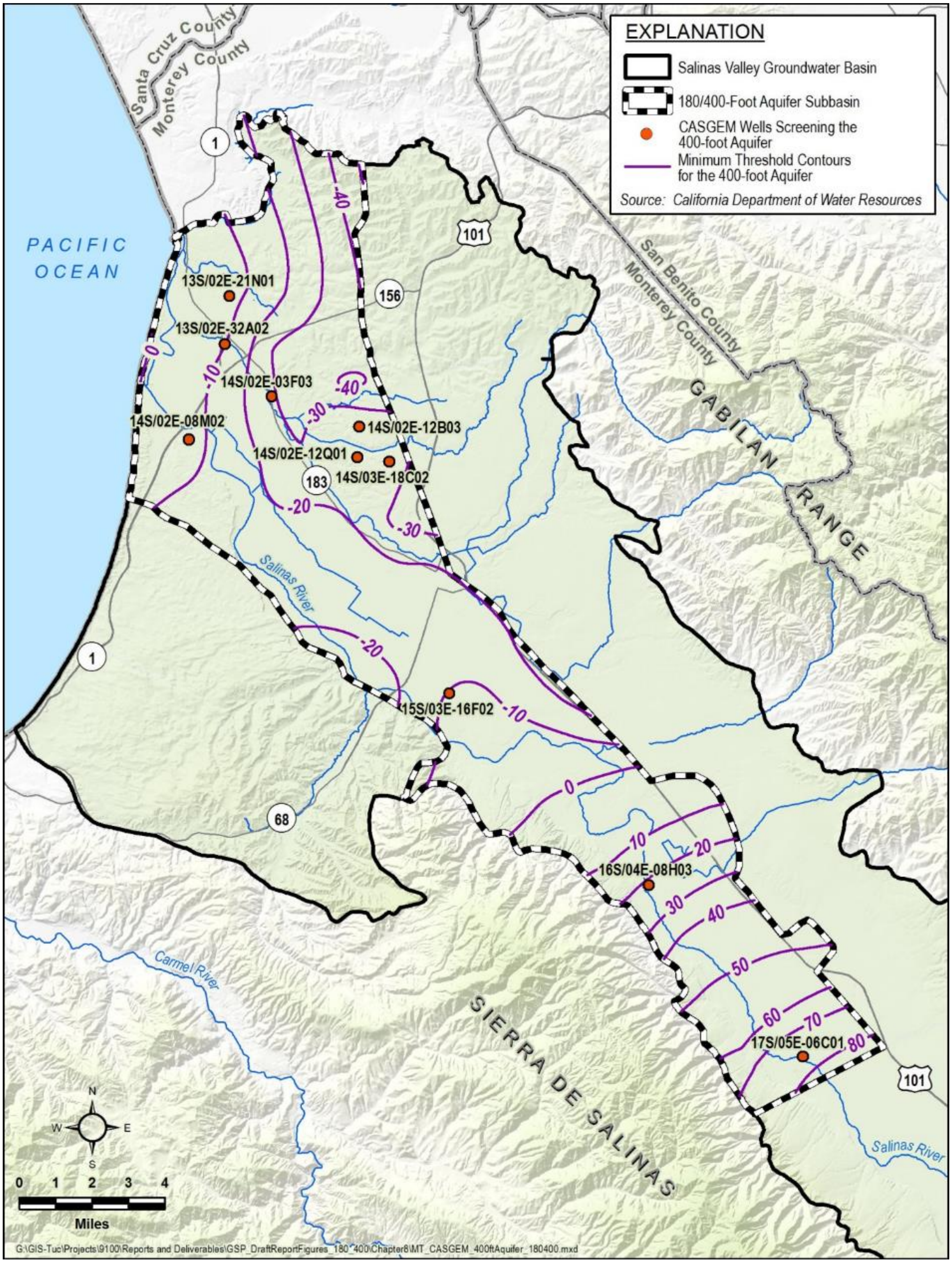


Figure 8-3. Groundwater Elevation Minimum Threshold Contour Map for the 400 Foot Aquifer

The monitoring network well locations were intersected with the contour map to establish the initial minimum threshold for each RMS for chronic lowering of groundwater levels. The initial minimum threshold values were plotted on the respective RMS groundwater elevation hydrographs to visually inspect the applicability of these values for each well. In some cases, the values were not adequate for various reasons including:

- Wells located outside of contour maps
- Deep wells with no contour map available
- Wells located in foothill area where contour maps do not apply
- Interpolated values on the contour maps did not match the individual RMS well values adequately for the month of October and designated year

A detailed review of minimum thresholds and measurable objectives at each RMS well, comparison to the actual measured values at the designated years in October, and professional judgment resulted in a revised set of minimum thresholds and measurable objectives at each RMS well. October was used as the month at which values for minimum thresholds and measurable objectives are established because this is the fall measurement that MCWRA takes every year. Future water levels in October will be compared to these values.

Hydrographs and minimum thresholds for each RMS with well completion information are included in Appendix 8A. These minimum thresholds are selected to avoid the significant and unreasonable conditions outlined above. The minimum threshold values for each well within the groundwater elevation monitoring network are provided in Table 8-2 .

Table 8-2. Chronic Lowering of Groundwater Elevations Minimum Thresholds and Measurable Objectives

Monitoring Site	Aquifer	Minimum Threshold (ft)	Measurable Objective (ft)
13S/02E-21Q01	180-ft Aquifer	3	8
14S/02E-03F04	180-ft Aquifer	-12	-7.1
14S/02E-12B02	180-ft Aquifer	-19	-11.9
14S/02E-26H01	180-ft Aquifer	-25	-18
14S/02E-27A01	180-ft Aquifer	-18.7	-10.7
14S/03E-18C01	180-ft Aquifer	5	10
14S/03E-30G08	180-ft Aquifer	-29	-3.5
15S/03E-16M01	180-ft Aquifer	-16	-4.1
15S/03E-17M01	180-ft Aquifer	-17.2	2.9
16S/04E-08H04	180-ft Aquifer	30	54.8
16S/04E-15D01	180-ft Aquifer	26	55
17S/05E-06C02	180-ft Aquifer	73.5	94.1
13S/02E-21N01	400-ft Aquifer	-15	-7.6
13S/02E-32A02	400-ft Aquifer	-9.9	-5
14S/02E-03F03	400-ft Aquifer	-40	-19.4
14S/02E-08M02	400-ft Aquifer	-12	-5.9
14S/02E-12B03	400-ft Aquifer	-54	-43
14S/02E-12Q01	400-ft Aquifer	-26.3	-13.5
14S/03E-18C02	400-ft Aquifer	-38	-17.4
15S/03E-16F02	400-ft Aquifer	-20	1.2
16S/04E-08H03	400-ft Aquifer	19	48
17S/05E-06C01	400-ft Aquifer	77	89.6
13S/02E-19Q03	Deep Aquifers	-10	5

8.6.2.2 Minimum Thresholds Impact on Domestic Wells

Minimum thresholds for groundwater elevations are compared to the range of domestic well depths in the Subbasin using DWR's Online System for Well Completion Reports (OSWCR) database. This check was done to assure that the minimum thresholds maintain operability in a reasonable percentage of domestic wells. The proposed minimum thresholds for groundwater elevation do not necessarily protect all domestic wells because it is impractical to manage a groundwater basin in a manner that fully protects the shallowest wells. The average computed depth of domestic wells in the Subbasin is 316.6 feet for the domestic wells in the OSWCR database.

The comparison showed the following:

- In the 180-Foot Aquifer, 89% of all domestic wells will have at least 25 feet of water in them as long as groundwater elevations remain above minimum thresholds; and 91% of all domestic wells will have at least 25 feet of water in them when measurable objectives are achieved.
- In the 400-Foot Aquifer, 79% of all domestic wells will have at least 25 feet of water in them provided groundwater elevations remain above minimum thresholds; and 82% of all domestic wells will have at least 25 feet of water in them when measurable objectives are achieved.

8.6.2.3 Relationship between Individual Minimum Thresholds and Relationship to Other Sustainability Indicators

Section 354.28 of the GSP Regulations requires that the description of all minimum thresholds include a discussion about the relationship between the minimum thresholds for each sustainability indicator. In the SMC BMP (DWR, 2017), DWR has clarified this requirement. First, the GSP must describe the relationship between each sustainability indicator's minimum threshold (i.e., describe why or how a water level minimum threshold set at a particular representative monitoring site is similar to or different from water level thresholds in nearby representative monitoring sites). Second, the GSP must describe the relationship between the selected minimum threshold and minimum thresholds for other sustainability indicators (e.g., describe how a water level minimum threshold would not trigger an undesirable result for land subsidence).

The groundwater elevation minimum thresholds are derived from smoothly interpolated groundwater elevations in the Subbasin. Therefore, the minimum thresholds are unique at every well, but when combined represent a reasonable and potentially realistic groundwater elevation map. Because the underlying groundwater elevation map is a reasonably achievable condition, the individual minimum thresholds at RMSs do not conflict with each other.

Groundwater elevation minimum thresholds can influence other sustainability indicators. The groundwater elevation minimum thresholds are selected to avoid undesirable results for other sustainability indicators.

- **Change in groundwater storage**. A significant and unreasonable condition for change in groundwater storage is pumping in excess of the sustainable yield for an extended period of years. Pumping at or less than the sustainable yield will maintain or raise average groundwater elevations in the Subbasin. The groundwater elevation minimum thresholds are set at or above recent groundwater elevations, consistent with the practice of pumping at or less than the sustainable yield. Therefore, the groundwater elevation minimum thresholds will not result in long term significant or unreasonable change in groundwater storage.

- **Seawater intrusion**. A significant and unreasonable condition for seawater intrusion is seawater intrusion in excess of the extent delineated by MCWRA in 2017. Lower groundwater elevations, particularly in the 180- and 400-Foot Aquifers, could cause seawater to advance inland. The groundwater elevation minimum thresholds are set at or above recent groundwater elevations. Therefore, the groundwater elevation minimum thresholds are intended to not exacerbate, and may help control, the rate of seawater intrusion.
- **Degraded water quality**. A significant and unreasonable condition for degraded water quality is exceeding regulatory limits for constituents of concern in production wells due to actions proposed in the GSP. Water quality could be affected through two processes:
  1. Low groundwater elevations in an area could cause deep poor-quality groundwater to flow upward to levels where supply wells pump groundwater. Because the groundwater elevation minimum thresholds are at or above recent groundwater elevations, there is no mechanism for triggering any new upward flow of deep groundwater. Therefore, the groundwater elevation minimum thresholds are set to avoid deep poor-quality water from impacting shallower production wells.
  2. Changes in groundwater elevation due to actions implemented to achieve sustainability could change groundwater gradients, which could cause poor quality groundwater to flow towards production wells that would not have otherwise been impacted. These groundwater gradients, however, are only dependent on differences between groundwater elevations, not on the groundwater elevations themselves. Therefore, the minimum threshold groundwater elevations do not directly lead to a significant and unreasonable degradation of groundwater quality in production wells.
- **Subsidence**. A significant and unreasonable condition for subsidence is any measurable long-term inelastic subsidence that damages existing infrastructure. Subsidence is caused by dewatering and compaction of clay-rich sediments in response to lowering groundwater elevations. The groundwater elevation minimum thresholds are set at or above recent groundwater elevations. Because future groundwater elevations will be higher than current groundwater elevations, they will not induce additional dewatering of clay-rich sediments; and thus, will not induce additional subsidence.
- **Depletion of interconnected surface waters.** A significant and unreasonable condition for the depletion of interconnected surface waters is groundwater pumping-induced depletion of flow in the Salinas River or its major tributaries in excess of current depletion rates. Lowering average groundwater elevations in areas adjacent to interconnected surface water bodies will increase depletion rates. Because the groundwater elevation minimum thresholds are set at or above recent elevations, future groundwater elevations will not induce additional depletion of interconnected surface

waters. Therefore, the groundwater elevation minimum thresholds will not result in a significant or unreasonable depletion of interconnected surface waters, including groundwater-dependent ecosystems.

8.6.2.4 Effect of Minimum Thresholds on Neighboring Basins and Subbasins

The 180/400-Foot Aquifer Subbasin has four neighboring subbasins within the Salinas Valley Groundwater Basin:

- The Langley Subbasin to the north
- The Eastside Subbasin to the northeast
- The Forebay Subbasin to the south
- The Monterey Subbasin to the West

The SVBGSA is either the exclusive GSA, or is one of two coordinating GSAs for the adjacent Langley, Eastside, Forebay, and Monterey Subbasins. Because the SVBGSA covers all of these subbasins, the GSA Board of Directors opted to develop the minimum thresholds and measurable objectives for all of these neighboring subbasins in a single process that is coordinated with the 180/400-Foot Aquifer Subbasin. These neighboring subbasins are in the process of GSP development for submittal in January 2022. Minimum thresholds for the 180/400-Foot Aquifer Subbasin will be reviewed relative to information developed during the preparation of neighboring subbasins' GSPs and will be updated, as appropriate, to ensure that these minimum thresholds will not prevent the neighboring subbasins from achieving sustainability.

In addition, the Pajaro Valley Basin lies directly to the north of the Subbasin. Because the minimum thresholds in the 180/400-Foot Aquifer Subbasin are above historical low groundwater elevations, it is likely that the minimum thresholds will not prevent the Pajaro Basin from achieving and maintaining sustainability. The SVBGSA will coordinate closely with the Pajaro Valley Water Agency to ensure that the basins do not prevent each other from achieving sustainability.

8.6.2.5 Effects on Beneficial Users and Land Uses

The groundwater elevation minimum thresholds may have several effects on beneficial users and land uses in the Subbasin.

Agricultural land uses and users. The groundwater elevation minimum thresholds prevent continued lowering of groundwater elevations in the Subbasin. This may have the effect of limiting the amount of groundwater pumping in the Subbasin. Limiting the amount of groundwater pumping may limit the amount and type of crops that can be grown in the Subbasin. The groundwater elevation minimum thresholds could therefore limit expansion of the

Subbasin's agricultural economy. This could have various effects on beneficial users and land uses:

- Agricultural land currently under irrigation may become more valuable as bringing new lands into irrigation becomes more difficult and expensive.
- Agricultural land not currently under irrigation may become less valuable because it may be too difficult and expensive to irrigate.

Urban land uses and users. The groundwater elevation minimum thresholds may reduce the amount of groundwater pumping in the Subbasin. This may limit urban growth, or result in urban areas obtaining alternative sources of water. This may result in higher water costs for municipal water users.

Domestic land uses and users. The groundwater elevation minimum thresholds are intended to protect most domestic wells. Therefore, the minimum thresholds will likely have an overall beneficial effect on existing domestic land uses by protecting the ability to pump from domestic wells. However, extremely shallow domestic wells may become dry, requiring owners to drill deeper wells. Additionally, the groundwater elevation minimum thresholds may limit the number of new domestic wells that can be drilled in order to limit future declines in groundwater elevations caused by more domestic pumping.

Ecological land uses and users. Groundwater elevation minimum thresholds may limit the amount of groundwater pumping in the Subbasin and may limit both urban and agricultural growth. This outcome may benefit ecological land uses and users by curtailing the conversion of native vegetation to agricultural or domestic uses, and by reducing pressure on existing ecological land caused by declining groundwater elevations.

8.6.2.6 Relevant Federal, State, or Local Standards

No federal, state, or local standards exist for chronic lowering of groundwater elevations.

8.6.2.7 Method for Quantitative Measurement of Minimum Thresholds

Groundwater elevation minimum thresholds will be directly measured from the monitoring well network. The groundwater elevation monitoring will be conducted in accordance with the monitoring plan outlined in Chapter 7. Furthermore, the groundwater elevation monitoring will meet the requirements of the technical and reporting standards included in the GSP Regulations.

As noted in Chapter 7, the current groundwater elevation monitoring network in the Subbasin across aquifers includes 23 wells. Data gaps were identified in Chapter 7 and will be resolved during implementation of this GSP.

8.6.3 Measurable Objectives

The measurable objectives for chronic lowering of groundwater levels represent target groundwater elevations that are higher than the minimum thresholds. These measurable objectives provide operational flexibility to ensure that the Subbasin can be managed sustainably over a reasonable range of hydrologic variability. Measurable objectives for the chronic lowering of groundwater levels are summarized in Table 8-2. The measurable objectives are also shown on the hydrographs for each RMS in Appendix 8A.

8.6.3.1 Methodology for Setting Measurable Objectives

The methodology for establishing measurable objectives is described in detail in Section 8.6.2.1 and summarized below.

Figure 8-1 shows that there was only a slow downward trend in average groundwater elevations through 2003. Since 2003, water elevations have consistently decreased at a more rapid rate. To ensure that measurable objectives are achievable, a year from the relatively recent past was selected. Groundwater elevations from 2003 were selected as representative of the measurable objectives for the 180/400-Foot Aquifer Subbasin.

The measurable objective contour maps along with the monitoring network wells are shown on Figure 8-4 for the 180-Foot Aquifer, and on Figure 8-5 for the 400-Foot Aquifer.

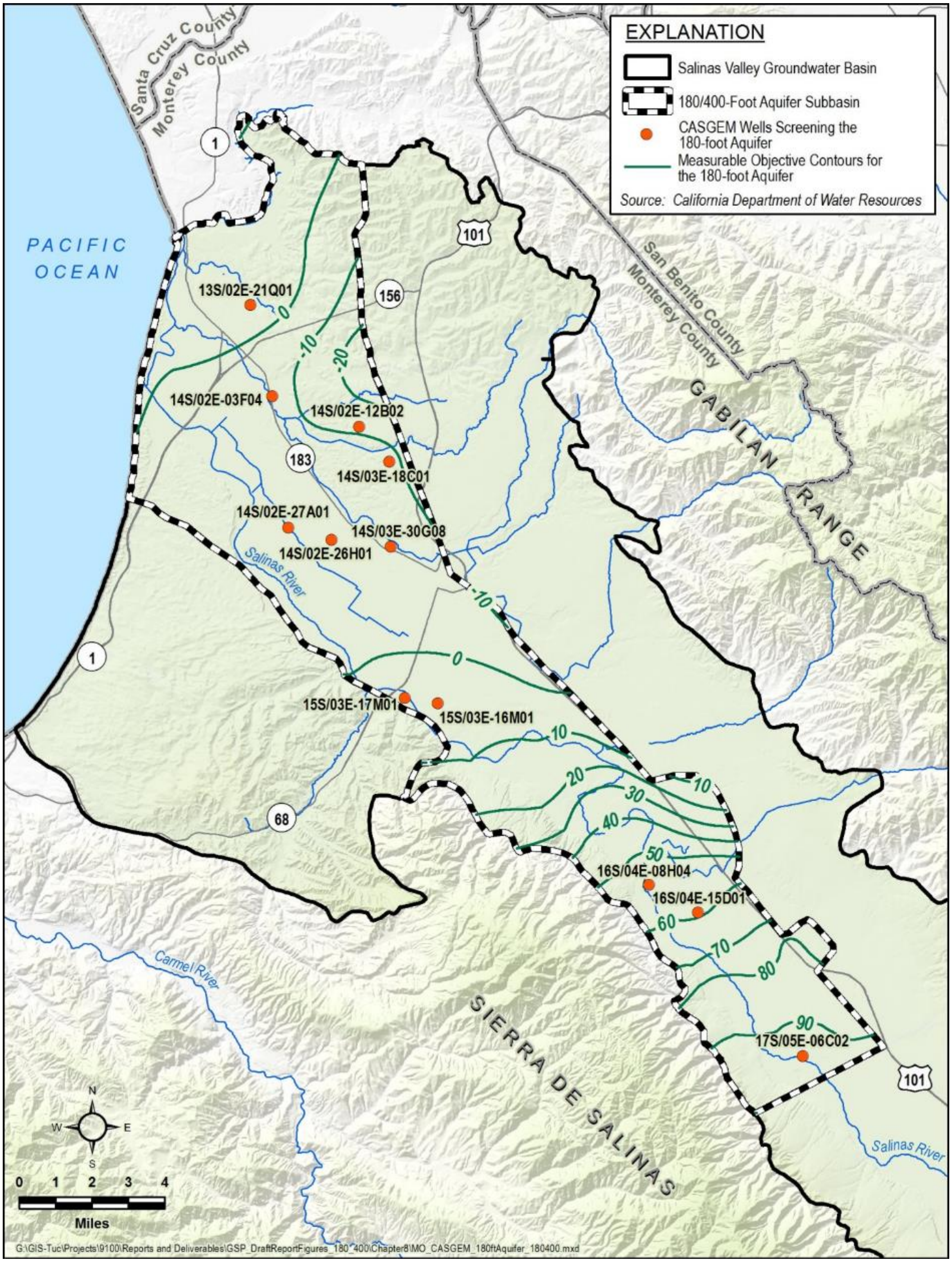


Figure 8-4. Groundwater Elevation Measurable Objective Contour Map for the 180-Foot Aquifer

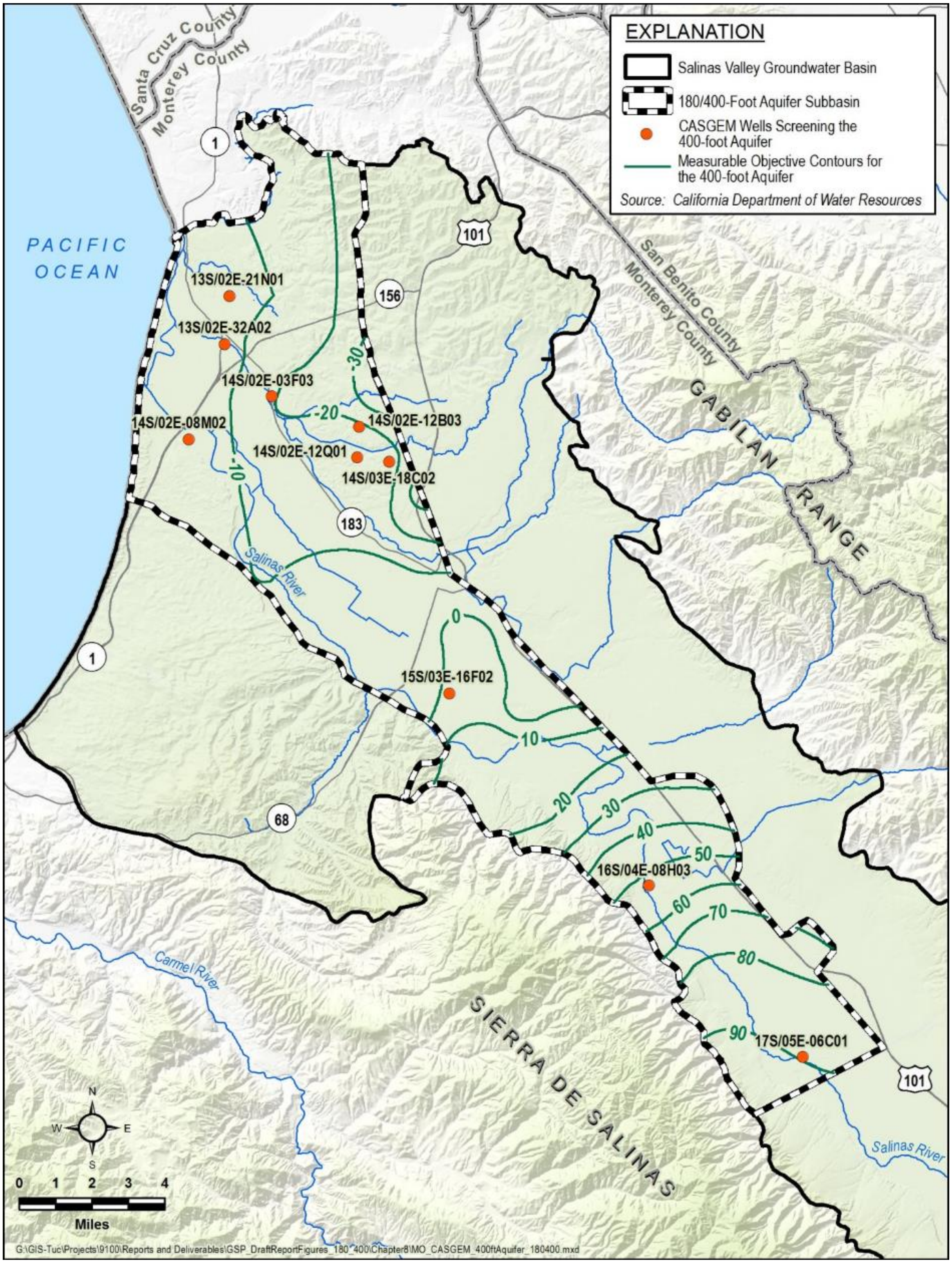


Figure 8-5. Groundwater Elevation Measurable Objective Contour Map for the 400-Foot Aquifer

8.6.3.2 Interim Milestones

Interim milestones for groundwater elevations are shown in Table 8-3. These are only initial estimates of interim milestones. Interim milestones for groundwater elevations will be modified once the SVIHM is available for use.

Table 8-3. Groundwater Elevation Interim Milestones

Monitoring Site	Aquifer	Current Groundwater Elevation ft (assume at 2020)	Interim Milestone at Year 2025 (ft)	Interim Milestone at Year 2030 (ft)	Interim Milestone at Year 2035 (ft)	Measurable Objective (ft) (goal to reach at 2040)
13S/02E-21Q01	180-ft Aquifer	6.2	6.7	7.1	7.6	8
14S/02E-03F04	180-ft Aquifer	-6.2	-6.4	-6.7	-6.9	-7.1
14S/02E-12B02	180-ft Aquifer	-8.3	-9.2	-10.1	-11.0	-11.9
14S/02E-26H01	180-ft Aquifer	-11.8	-13.4	-14.9	-16.5	-18
14S/02E-27A01	180-ft Aquifer	-9.6	-9.9	-10.2	-10.4	-10.7
14S/03E-18C01	180-ft Aquifer	11.9	11.4	11.0	10.5	10
14S/03E-30G08	180-ft Aquifer	-16.3	-13.1	-9.9	-6.7	-3.5
15S/03E-16M01	180-ft Aquifer	-12.4	-10.3	-8.3	-6.2	-4.1
15S/03E-17M01	180-ft Aquifer	-13.2	-9.2	-5.2	-1.1	2.9
16S/04E-08H04	180-ft Aquifer	41	44.5	47.9	51.4	54.8
16S/04E-15D01	180-ft Aquifer	43.06	46.0	49.0	52.0	55
17S/05E-06C02	180-ft Aquifer	78.7	82.6	86.4	90.3	94.1
13S/02E-21N01	400-ft Aquifer	-14.4	-12.7	-11.0	-9.3	-7.6
13S/02E-32A02	400-ft Aquifer	-6.6	-6.2	-5.8	-5.4	-5
14S/02E-03F03	400-ft Aquifer	-13.72	-15.1	-16.6	-18.0	-19.4
14S/02E-08M02	400-ft Aquifer	-12	-10.5	-9.0	-7.4	-5.9
14S/02E-12B03	400-ft Aquifer	-29.6	-33.0	-36.3	-39.7	-43
14S/02E-12Q01	400-ft Aquifer	-24.7	-21.9	-19.1	-16.3	-13.5
14S/03E-18C02	400-ft Aquifer	-18.9	-18.5	-18.2	-17.8	-17.4
15S/03E-16F02	400-ft Aquifer	-16.5	-12.1	-7.7	-3.2	1.2
16S/04E-08H03	400-ft Aquifer	38.5	40.9	43.3	45.6	48
17S/05E-06C01	400-ft Aquifer	54.3	63.1	72.0	80.8	89.6
13S/02E-19Q03	Deep Aquifers	-10.8	-6.9	-2.9	1.1	5

8.6.4 Undesirable Results

8.6.4.1 Criteria for Defining Chronic Lowering of Groundwater Levels Undesirable Results

The chronic lowering of groundwater levels undesirable result is a quantitative combination of groundwater elevation minimum threshold exceedances. For the Subbasin, the groundwater elevation undesirable result is:

> *Over the course of any one year, no more than 15% of the groundwater elevation minimum thresholds shall be exceeded in any single aquifer. Additionally, the minimum threshold in any one well shall not be exceeded for more than two sequential years.*

Undesirable results provide flexibility in defining sustainability. Increasing the percentage of allowed minimum threshold exceedances provides more flexibility but may lead to significant and unreasonable conditions for a number of beneficial users. Reducing the percentage of allowed minimum threshold exceedances ensures strict adherence to minimum thresholds but reduces flexibility due to unanticipated hydrogeologic conditions. The undesirable result was set at 15% to balance the interests of beneficial users with the practical aspects of groundwater management under uncertainty.

The 15% limit on minimum threshold exceedances in the undesirable result allows for four exceedances in the 23 existing monitoring wells: two in the 180-Foot Aquifer and two in the 400-Foot Aquifer. As the monitoring system grows, additional exceedances will be allowed. One additional exceedance will be allowed for approximately every seven new monitoring wells. This was considered a reasonable number of exceedances given the hydrogeologic uncertainty of the Subbasin.

8.6.4.2 Potential Causes of Undesirable Results

An undesirable result for chronic lowering of groundwater levels does not currently exist, since groundwater elevation in 22 out of 23 of the existing monitoring wells (95.7%) in the Subbasin were above the minimum threshold in the most recent Fall groundwater elevation measurements. Conditions that may lead to an undesirable result include the following:

- **Localized pumping clusters**. Even if regional pumping is maintained within the sustainable yield, clusters of high-capacity wells may cause excessive localized drawdowns that lead to undesirable results.
- **Expansion of *de-minimis* pumping**. Individual *de-minimis* pumpers do not have a significant impact on groundwater elevations. However, many *de-minimis* pumpers are often clustered in specific residential areas. Pumping by these *de-minimis* users is not regulated under this GSP. Adding additional domestic *de-minimis* pumpers in these areas may result in excessive localized drawdowns and undesirable results.

- **Extensive, unanticipated drought**. Minimum thresholds were established based on historical groundwater elevations and reasonable estimates of future groundwater elevations. Extensive, unanticipated droughts may lead to excessively low groundwater elevations and temporary undesirable results.

8.6.4.3 Effects on Beneficial Users and Land Uses

The primary detrimental effect on beneficial users from allowing multiple exceedances occurs if more than one exceedance occurs in a small geographic area. Allowing 15% exceedances is reasonable as long as the exceedances are spread out across the Subbasin, and as long as any one well does not regularly exceed its minimum threshold. If the exceedances are clustered in a small area, it will indicate that significant and unreasonable effects are being born by a localized group of landowners. To avoid this, the monitoring system is designed to have broad geographic coverage; ensuring that minimum threshold exceedances cannot be clustered in a single area.

8.7 Reduction in Groundwater Storage SMC

8.7.1 Locally Defined Significant and Unreasonable Conditions

Locally defined significant and unreasonable conditions were determined based on public meetings, and discussions with GSA staff. Significant and unreasonable changes in groundwater storage in the Subbasin are those that:

- Lead to long-term reduction in groundwater storage, or
- Interfere with other sustainability indicators.

8.7.2 Minimum Thresholds

Section §354.28(c)(2) of the GSP Regulations states that "The minimum threshold for reduction of groundwater storage shall be a total volume of groundwater that can be withdrawn from the subbasin without causing conditions that may lead to undesirable results" (CCR, 2016).

As noted in the regulatory definition of minimum thresholds quoted above, the reduction in groundwater storage minimum threshold is established for the Subbasin as a whole, not for individual aquifers. Therefore, one minimum threshold is established for the entire Subbasin.

The total volume of groundwater that can be annually withdrawn from the Subbasin without leading to a long-term reduction in groundwater storage or interfering with other sustainability indicators is the calculated sustainable yield of the Subbasin. As discussed in Chapter 6, the future long-term sustainable yield of the Subbasin under reasonable climate change assumptions is 112,000 AF/yr. This sustainable yield represents an approximately 7% reduction in groundwater pumping from the projected pumping volumes.

Public and stakeholder input on the significant and unreasonable conditions for groundwater storage suggested a preference for increasing groundwater storage, but not a preference for restricting average year pumping. Therefore, the minimum threshold is set at the long-term future sustainable yield of 112,000 AF/yr.

While the sustainable yield calculated in chapter 6 assumes zero seawater intrusion, it does not account for temporary pumping reductions that may be necessary to achieve the higher groundwater elevations that help mitigate seawater intrusion. Because the minimum thresholds represent long-term management criteria, any temporary pumping reductions needed to raise groundwater elevations are not explicitly incorporated into the thresholds. However, the SVBGSA recognizes that, dependent on the success of various proposed projects and management actions, there may be a number of years when pumping might be held below the minimum threshold to achieve necessary rises in groundwater elevation. The actual amount of allowable pumping from the Subbasin will be adjusted in the future based on the success of projects designed to halt seawater intrusion.

The minimum threshold applies to pumping of natural recharge only. Natural recharge includes items such as recharge from precipitation and percolation of excess irrigation water. Pumping of intentionally recharged water that is not part of the natural recharge is not considered when compared against the minimum threshold. Intentionally recharged water refers to water recharged through injection wells or percolation ponds, with the sole intent of adding water to the aquifer to increase storage and raise water levels.

8.7.2.1 Information and Methodology Used to Establish Minimum Thresholds

The calculations used to estimate the sustainable yield, and the subsequent minimum threshold for reduction in groundwater storage are detailed in Chapter 6. These calculations acknowledge and account for current land use, future urban growth, and anticipated reasonable climate change.

8.7.2.2 Relationship between Individual Minimum Thresholds and Relationship to Other Sustainability Indicators

The minimum threshold for reduction in groundwater storage is a single value for the entire Subbasin. Therefore, the concept of potential conflict between minimum thresholds is not applicable.

The reduction in groundwater storage minimum threshold could influence other sustainability indicators. The reduction in groundwater storage minimum threshold is selected to avoid undesirable results for other sustainability indicators, as outlined below.

- **Chronic lowering of groundwater levels**. Pumping at or below the sustainable yield will maintain or raise average groundwater elevations in the Subbasin. Therefore, the minimum threshold for reduction in groundwater storage will not result in a significant or unreasonable lowering of groundwater elevations.

- **Seawater intrusion**. Pumping at or below the sustainable yield will maintain or raise average groundwater elevations in the Subbasin. Therefore, the minimum threshold for reduction in groundwater storage will not result in a significant or unreasonable increase in seawater intrusion. However, pumping at the minimum threshold may not, by itself, stop all seawater intrusion. The seawater intrusion minimum thresholds do not depend on the change in storage minimum threshold: exceedance of both minimum thresholds will be avoided independently.
- **Degraded water quality**. Groundwater quality could be affected through two processes:
    1. Low groundwater elevations could result in poor-quality groundwater being drawn upward into production wells from Deep Aquifers. The reduction in storage minimum threshold is set to prevent any reduction in storage, and therefore prevent lower groundwater elevations. Therefore, the reduction in storage minimum threshold will not draw additional poor-quality water from Deep Aquifers towards production wells.
    2. Changes in groundwater elevations could cause changes in groundwater gradients, which could cause poor quality water to flow towards production wells that would not have otherwise been impacted. These groundwater gradients, however, are only dependent on differences between groundwater elevations, not on the groundwater elevations themselves. Therefore, the minimum threshold for reduction in groundwater storage does not directly lead to a significant and unreasonable degradation of groundwater quality in production wells.
- **Subsidence**. The reduction in storage minimum threshold is established to prevent any reduction in storage, and therefore prevent lowering of groundwater elevations. Because future groundwater elevations will be at or higher than existing groundwater elevations, they will not induce any additional dewatering of clay-rich sediments; and will not induce additional subsidence.
- **Depletion of interconnected surface waters**. The reduction in storage minimum threshold is established to prevent further reduction in storage, and therefore prevent lowering of groundwater elevations. Therefore, the change in storage minimum threshold will not induce additional depletion of interconnected surface waters and will not result in a significant or unreasonable depletion of interconnected surface waters.

8.7.2.3 Effect of Minimum Thresholds on Neighboring Basins and Subbasins

The 180/400-Foot Aquifer Subbasin has four neighboring subbasins within the Salinas Valley Groundwater Basin:

- The Langley Subbasin to the north

- The Eastside Subbasin to the northeast
- The Forebay Subbasin to the south
- The Monterey Subbasin to the West

The SVBGSA is either the exclusive GSA, or is one of two coordinating GSAs for the adjacent Langley, Eastside, Forebay, and Monterey Subbasins. Because the SVBGSA covers all of these subbasins, the GSA Board of Directors opted to develop the minimum thresholds and measurable objectives for all of these neighboring subbasins in a single process that is coordinated with the 180/400-Foot Aquifer Subbasin. These neighboring subbasins are in the process of GSP development for submittal in January 2022. Minimum thresholds for the 180/400-Foot Aquifer Subbasin will be reviewed relative to information developed during the preparation of neighboring subbasins' GSPs and will be updated, as appropriate, to ensure that these minimum thresholds will not prevent the neighboring subbasins from achieving sustainability.

In addition, the Pajaro Valley Basin occurs directly to the north. Because the minimum thresholds in the 180/400-Foot Aquifer Subbasin are set at the long-term future sustainable yield, it is likely that the minimum thresholds will not prevent the Pajaro Basin from achieving and maintaining sustainability. The SVBGSA will coordinate closely with the Pajaro Valley Water Agency as it sets minimum thresholds to ensure that the basins do not prevent each other from achieving sustainability.

8.7.2.4 Effect on Beneficial Uses and Users

The reduction in groundwater storage minimum threshold of maintaining pumping at the Subbasin's calculated sustainable yield requires a restriction on the amount of groundwater pumping in the Subbasin. Restricting pumping may impact the beneficial uses and users of the Subbasin.

Agricultural land uses and users. Restricting the amount of groundwater pumping may limit or reduce agricultural production in the Subbasin by reducing the amount of available water. Agricultural lands that are currently not irrigated may be particularly impacted because the additional groundwater pumping needed to irrigate these lands will increase the Subbasin pumping beyond the sustainable yield, violating the minimum threshold.

Urban land uses and users. Restricting the amount of groundwater pumping may increase the cost of water for municipal users in the Subbasin because municipalities may need to find other, more expensive water sources.

Domestic land uses and users. Domestic groundwater users may generally benefit from this minimum threshold. Many domestic groundwater users are *de-minimis* users whose pumping may not be restricted by the projects and management actions adopted in this GSP. By restricting the amount of groundwater that is pumped from the Subbasin, the *de-minimis* users are protected from overdraft that could impact their ability to pump groundwater.

Ecological land uses and users. Environmental groundwater uses may generally benefit from this minimum threshold. Restricting the amount of groundwater that is pumped from the Subbasin, maintains groundwater supplies at levels similar to present levels which can be used for environmental purposes.

8.7.2.5 Relation to State, Federal, or Local Standards

No federal, state, or local standards exist for reductions in groundwater storage.

8.7.2.6 Method for Quantitative Measurement of Minimum Threshold

The total amount of groundwater withdrawn from the Subbasin will be measured in a number of ways:

- Municipal public water systems and small water systems report their measured groundwater usage to the State of California. These data are available on the State's Drinking Water Information Clearinghouse website. These data will be used to quantify municipal and small system pumping on an annual basis.
- Agricultural pumping will be collected in one of two ways:
    1. Agricultural pumpers may report their pumping directly to the SVBGSA
    2. Pumping will be estimated for agricultural pumpers that do not report their pumping. The annual pumping will be estimated using Monterey County crop data and crop duty estimates, times a multiplier. The multiplier is included in these calculations to disincentivize growers from pumping more than the crop duties, yet only being assessed based on the crop duties used by Monterey County.
- Domestic pumping will be estimated by multiplying the estimated number of domestic users by a water use factor. The current water use factor is assumed to be 0.39 AF/yr. dwelling unit.

The impact of groundwater withdrawals on the amount of groundwater in storage will be checked using the updated SVIHM model. At a minimum, the model will be updated every 5 years with new data and the amount of pumping that occurred in the previous 5 years will be checked against the simulated change in groundwater storage. These verifications will indicate whether reducing pumping to the sustainable yield will result in no net reduction in groundwater storage under average hydrologic conditions, or whether the sustainable yield should be reevaluated.

8.7.3 Measurable Objectives

The measurable objectives for reduction in groundwater storage is the same as the minimum threshold. The measurable objective is set at the long-term future sustainable yield of 112,000 AF/yr.

8.7.3.1 Method for Setting Measurable Objectives

As discussed in Section 8.7, input from stakeholders suggested that they would prefer more groundwater in storage. However, stakeholders also suggested that they would prefer not to attain this increase in groundwater storage by reducing existing pumping during average years. Instead, they prefer to increase groundwater storage through improving local recharge or by other means.

By regulation, the metric used to assess reductions in groundwater storage is an amount of pumping. Therefore, although increases in groundwater storage are preferred, attaining this measurable objective should not be achieved through future pumping reductions. Therefore, the measurable objective is set at the same level as the minimum threshold of 112,000 AF/yr. of pumping.

8.7.3.2 Interim Milestones

The reduction in storage interim milestone is set to 112,000 AF/yr. for each of the 5-year intervals, consistent with the minimum threshold and the measurable objective.

8.7.4 Undesirable Results

8.7.4.1 Criteria for Defining Reduction in Groundwater Storage Undesirable Results

The reduction in groundwater storage undesirable result is a quantitative combination of reduction in groundwater storage minimum threshold exceedances. However, there is only one reduction in groundwater storage minimum threshold. Therefore, no minimum threshold exceedances are allowed to occur and the reduction in groundwater storage undesirable result is:

> *During average hydrogeologic conditions, and as a long-term average over all hydrogeologic conditions, the total groundwater pumping shall not exceed the minimum threshold, which is equivalent to the long-term sustainable yield of the aquifers in the Subbasin.*

8.7.4.2 Potential Causes of Undesirable Results

Conditions that may lead to an undesirable result for the reduction in groundwater storage sustainability indicator include the following:

- **Expansion of agricultural or municipal pumping**. Additional agricultural or municipal pumping may result in exceedance of the long-term sustainable yield, an undesirable result.
- **Expansion of *de-minimis* pumping**. Pumping by *de-minimis* users is not regulated under this GSP. Adding domestic *de-minimis* pumpers in the Subbasin may result in excessive pumping and exceedance of the long-term sustainable yield, an undesirable result.
- **Extensive, unanticipated drought**. Minimum thresholds are established based on reasonable anticipated future climatic conditions. Extensive, unanticipated droughts may lead to excessively low groundwater recharge and unanticipated high pumping rates that could cause an exceedance of the long-term sustainable yield.

8.7.4.3 Effects on Beneficial Users and Land Use

The practical effect of the reduction in groundwater storage undesirable result is no net change in groundwater storage during average hydrologic conditions and over the long-term. Therefore, during average hydrologic conditions and over the long-term, beneficial uses and users will have access to the same amount of water in storage that currently exists, and the undesirable result will not have a negative effect on the beneficial users and uses of groundwater. However, pumping at the long-term sustainable yield during dry years will temporarily reduce the amount of groundwater in storage. If this occurs, there could be short-term impacts from a reduction in groundwater in storage on all beneficial users and uses of groundwater. In particular, groundwater pumpers that rely on water from shallower wells may be temporarily impacted as the amount of groundwater in storage drops and water levels in their wells decline.

8.8 Seawater Intrusion SMC

8.8.1 Locally Defined Significant and Unreasonable Conditions

Locally defined significant and unreasonable conditions were determined based on public meetings, and discussions with GSA staff. Significant and unreasonable seawater intrusion in the Subbasin is:

- Seawater intrusion in excess of the seawater intrusion line defined by MCWRA in 2017.

8.8.2 Minimum Thresholds

Section §354.28(c)(3) of the Regulations states that "The minimum threshold for seawater intrusion shall be defined by a chloride concentration isocontour for each principal aquifer where seawater intrusion may lead to undesirable results" (CCR, 2016).

The 2017 extent of the 500 mg/L chloride concentration isocontour as mapped by MCWRA is adopted as the seawater intrusion minimum threshold for both the 180- and 400-Foot Aquifers.

Separate minimum thresholds are defined for the 180-Foot Aquifer and the 400-Foot Aquifer. The line defined by Highway 1 is adopted as the seawater intrusion minimum threshold for the Deep Aquifers.

8.8.2.1 Information and Methodology Used to Establish Minimum Thresholds and Measurable Objectives

The GSP Regulations (CCR, 2016) require the following supporting information when setting the seawater intrusion minimum threshold at a chloride isocontour:

- Section §354.28(c)(3)(A): *Maps and cross-sections of the chloride concentration isocontour that defines the minimum threshold and measurable objective for each principal aquifer.*

- Section §354.28(c)(3)(B): *A description of how seawater intrusion minimum threshold considers the effects of current and projected sea levels.*

Seawater intrusion minimum thresholds are based on seawater intrusion maps developed by the MCWRA. 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. These maps are developed through analysis and contouring of the values measured at privately-owned wells and dedicated monitoring wells near the coast, as shown on Figure 7-7 for the 180-Foot aquifer and on Figure 7-8 for the 400-Foot aquifer. The maps and cross sections of seawater intrusion used to develop the minimum thresholds are included in Chapter 5.

The groundwater model that will be used to assess the effectiveness of projects and management actions on seawater intrusion specifically incorporates assumptions for future sea level rise. Therefore, the minimum thresholds and actions to avoid undesirable results will address sea level rise.

Figure 8-6 presents minimum thresholds for seawater intrusion in the 180-Foot Aquifer and Figure 8-7 presents minimum thresholds for seawater intrusion in the 400-Foot Aquifer, represented by the 500 mg/L chloride concentration isocontour.

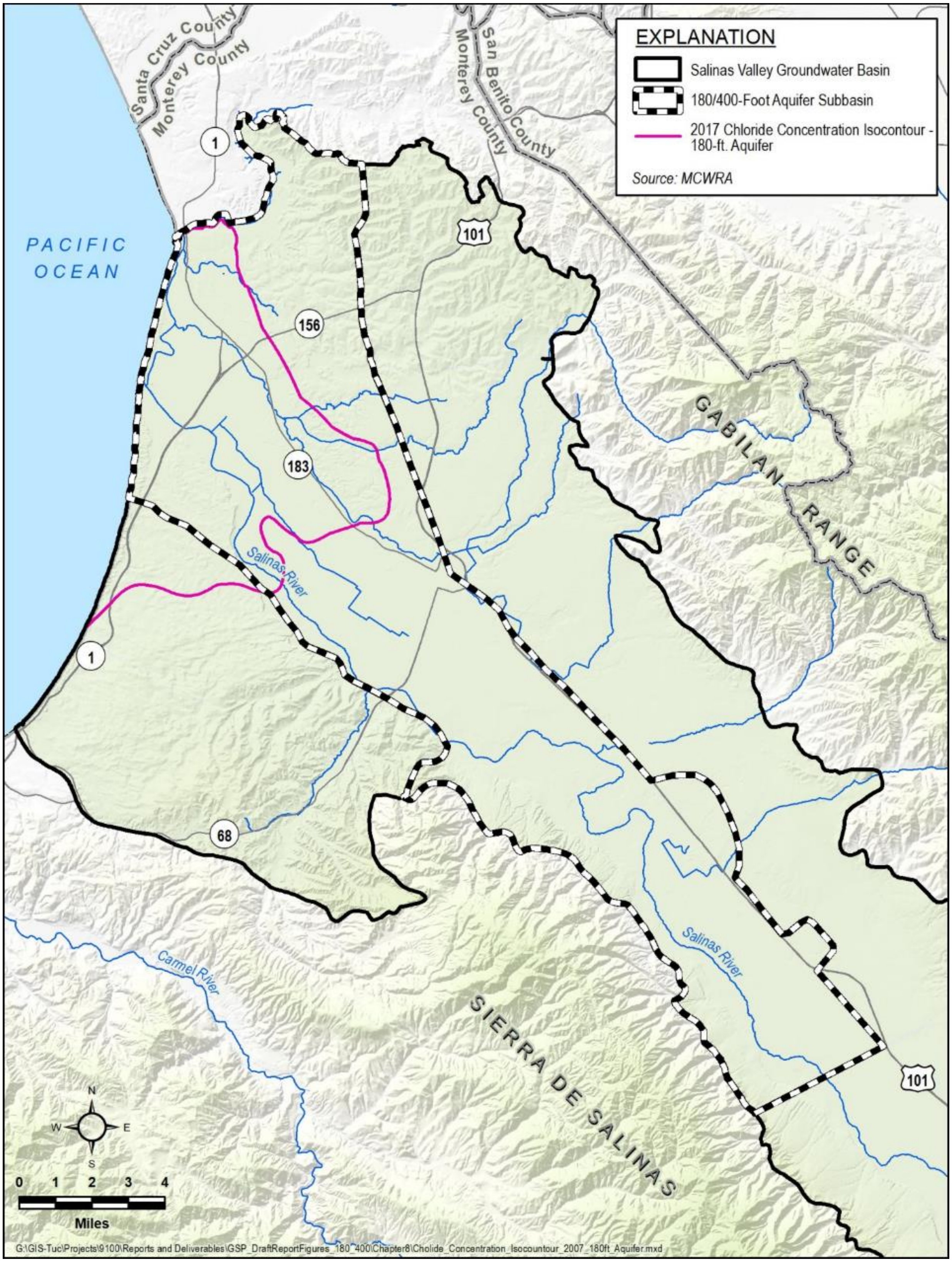


Figure 8-6. Minimum Thresholds for Seawater Intrusion in the 180-Foot Aquifer

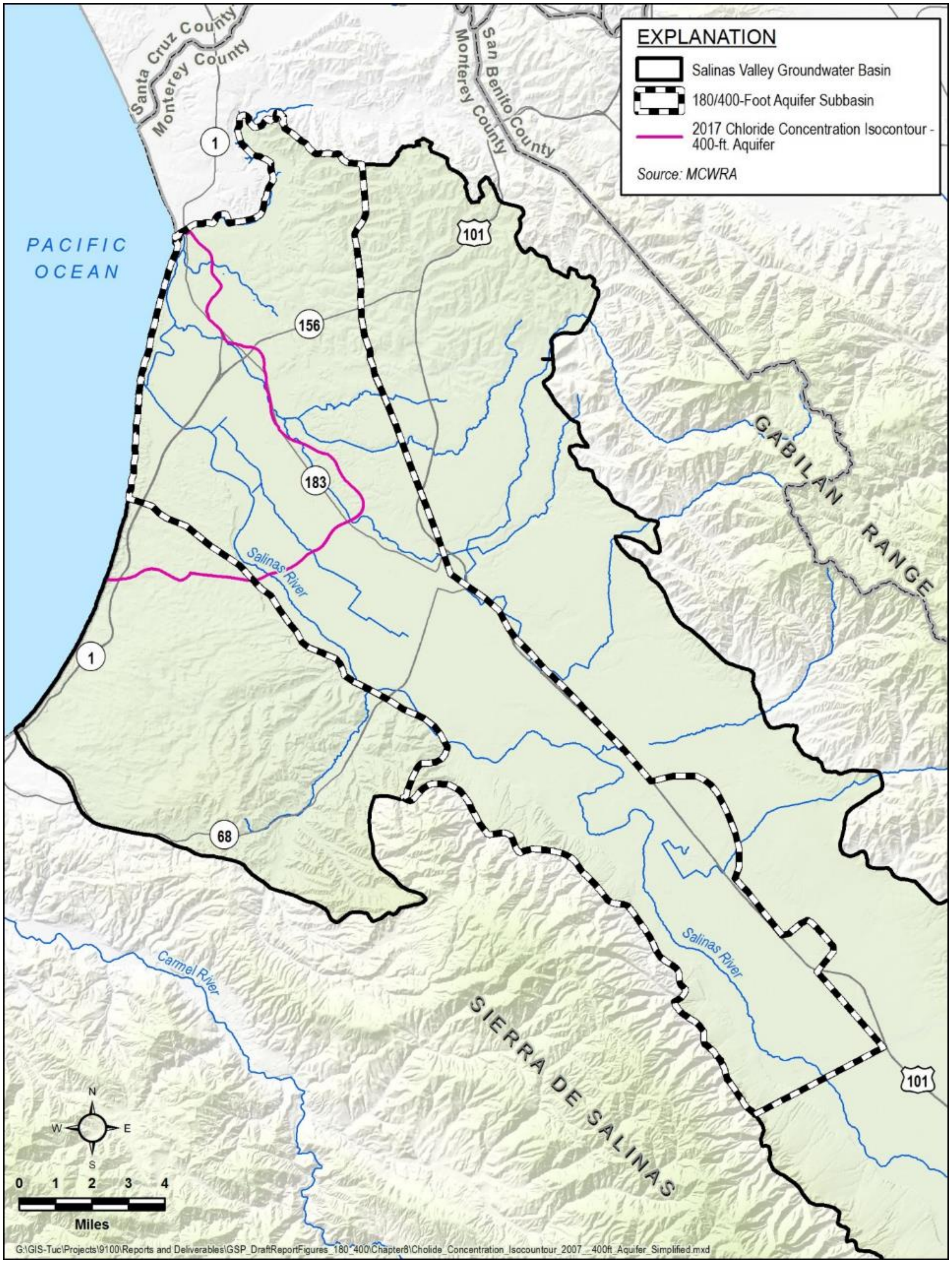


Figure 8-7. Minimum Thresholds for Seawater Intrusion in the 400-Foot Aquifer

8.8.2.2 Relationship between Individual Minimum Thresholds and Relationship to Other Sustainability Indicators

The minimum threshold for seawater intrusion is a single value for each aquifer. The minimum thresholds are set at mapped extend of 2017 seawater intrusion, meaning that the minimum thresholds are currently and simultaneously met in all three aquifers. Therefore, no conflict exists between minimum thresholds measured in various aquifers within the Subbasin.

The seawater intrusion minimum threshold could influence other sustainability indicators as follows:

- **Chronic lowering of groundwater levels**. Groundwater elevations will not be affected by the seawater intrusion minimum thresholds.
- **Change in groundwater storage**. Groundwater storage, as measured by pumping, will not be affected by the seawater intrusion minimum thresholds.
- **Degraded water quality**. The seawater intrusion minimum thresholds may have a beneficial impact on groundwater quality by preventing increases in chloride concentrations in supply wells.
- **Inelastic subsidence**. Inelastic subsidence will not be affected by the seawater intrusion minimum thresholds.
- **Depletion of interconnected surface water**. Interconnected surface water will not be affected by the seawater intrusion minimum thresholds.

8.8.2.3 Effect of Minimum Threshold on Neighboring Basins and Subbasin

The 180/400-Foot Aquifer Subbasin has two neighboring subbasins with seawater intrusion concerns:

- The Monterey Subbasin to the west
- The Pajaro Valley Basin to the north

The SVBGSA is one of two coordinating GSAs for the adjacent Monterey Subbasin. The minimum thresholds and measurable objectives for seawater intrusion was developed in a single process that is coordinated the 180/400-Foot Aquifer Subbasin with the Monterey Subbasin. The Monterey Subbasin is in the process of GSP development for submittal in January 2022. Minimum thresholds for the 180/400-Foot Aquifer Subbasin will be reviewed relative to information developed during the preparation of the Monterey Subbasin GSP and will be updated, as appropriate, to ensure that these minimum thresholds will not prevent the Monterey Subbasin from achieving sustainability.

The Pajaro Valley Basin has submitted an alternative submittal. Because the minimum thresholds in the 180/400-Foot Aquifer Subbasin is no further intrusion, it is likely that the minimum threshold will not prevent the Pajaro Basin from achieving and maintaining sustainability. The SVBGSA will coordinate closely with the Pajaro Valley Water Agency as it sets minimum thresholds to ensure that the basins do not prevent each other from achieving sustainability.

8.8.2.4 Effects on Beneficial Users and Land Uses

Agricultural land uses and users. The seawater intrusion minimum thresholds generally provide positive benefits to the Subbasin's agricultural water users. Preventing additional seawater intrusion ensures that a supply of usable groundwater will exist for beneficial agricultural use.

Urban land uses and users. The seawater intrusion minimum thresholds generally provide positive benefits to the Subbasin's urban water users. Preventing additional seawater intrusion will help ensure an adequate supply of groundwater for municipal supplies.

Domestic land uses and users. The seawater intrusion minimum thresholds generally provide positive benefits to the Subbasin's domestic water users. Preventing additional seawater intrusion will help ensure an adequate supply of groundwater for domestic supplies.

Ecological land uses and users. Although the seawater intrusion minimum thresholds do not directly benefit ecological uses, it can be inferred that the seawater intrusion minimum thresholds provide generally positive benefits to the Subbasin's ecological water uses. Preventing additional seawater intrusion will help prevent unwanted high salinity levels by the coast from impacting ecological groundwater uses.

8.8.2.5 Relevant Federal, State, or Local Standards

No federal, state, or local standards exist for seawater intrusion.

8.8.2.6 Method for Quantitative Measurement of Minimum Threshold

Chloride concentrations are measured in groundwater samples collected from the MCWRA's seawater intrusion monitoring network. These samples are used to develop the inferred location of the 500 mg/L chloride isocontour. The methodology and protocols for collecting samples and developing the 500 mg/L isocontour are detailed in Appendix 7C and Appendix 7D.

8.8.3 Measurable Objectives

8.8.3.1 Method for Setting Measurable Objectives

In the 180/400-Foot Aquifer Subbasin, the measurable objective for the seawater intrusion SMC is to move the 500 mg/L chloride isocontour to the line defined by Highway 1. This will improve the Subbasin's groundwater quality and provide access to usable groundwater to additional beneficial users. This measurable objective may be modified as the projects and actions to address seawater intrusion are refined.

8.8.3.2 Interim Milestones

The interim milestones for seawater intrusion are:

- 5-Year: identical to current conditions
- 10-year: one-third of the way to the measurable objective
- 15-year: two-thirds of the way to the measurable objective

These are only our initial estimates of interim milestones. Interim milestones for seawater intrusion will be modified once the SVIHM is available for use.

8.8.4 Undesirable Results

8.8.4.1 Criteria for Defining Seawater Intrusion Undesirable Results

The seawater intrusion undesirable result is a quantitative combination of chloride concentrations minimum threshold exceedances. There is only one minimum threshold for each of the three aquifers. Because even localized seawater intrusion is not acceptable, the basinwide undesirable result is zero exceedances of minimum thresholds. For the Subbasin, the seawater intrusion undesirable result is:

> *On average in any one year there shall be no exceedances of any minimum threshold.*

8.8.4.2 Potential Causes of Undesirable Results

Conditions that may lead to an undesirable result include the following:

- Increased coastal pumping that could draw seawater more inland.
- Unanticipated high sea level rise.

8.8.4.3 Effects on Beneficial Users and Land Use

The primary detrimental effect on beneficial users and land uses from allowing seawater intrusion to continue or occur in the future is that the pumped groundwater may become saltier and thus impact domestic and municipal wells and associated land uses. Allowing seawater intrusion to continue or occur in the future may also impact agriculture. Chloride moves readily within soil and water and is taken up by the roots of plants. It is then transported to the stems and leaves. Sensitive berries and avocado rootstocks can tolerate only up to 120 mg/L of chloride, while grapes can tolerate up to 700 mg/L or more (University of California Agriculture and Natural Resources, 2002).

8.9 Degraded Water Quality SMC

8.9.1 Locally Defined Significant and Unreasonable Conditions

Locally defined significant and unreasonable conditions were determined based on public meetings, and discussions with GSA staff. Significant and unreasonable changes in groundwater quality in the Subbasin are increases in a chemical constituent that either:

- Results in groundwater concentrations in a public supply well above an established MCL or SMCL, or
- Leads to reduced crop production.

8.9.2 Minimum Thresholds

Section §354.28(c)(2) of the GSP Regulations states that “The minimum threshold shall be based on the number of supply wells, a volume of water, or a location of an isocontour that exceeds concentrations of constituents determined by the Agency to be of concern for the basin” (CCR, 2016). The GSP Regulations allow three options for setting degraded water quality minimum thresholds. In this Subbasin, minimum thresholds are based on a number of supply wells that exceed concentrations of constituents determined to be of concern for the Subbasin. The definition of supply wells for constituents of concern that have an MCL or SMCL are public water system wells, small water system wells, and domestic wells. The definition of supply wells for constituents of concern that may lead to reduced crop production are agricultural irrigation supply wells.

As noted in Section 354.28 (c)(4) of the GSP Regulations, minimum thresholds are based on a degradation of groundwater quality, not an improvement of groundwater quality (CCR, 2016). Therefore, this GSP is designed to avoid taking any action that may inadvertently move groundwater constituents that have already been identified in the Subbasin in such a way that the constituents have a significant and unreasonable impact that would not otherwise occur. Constituents of concern must meet two criteria:

1. They must have an established level of concern such as an MCL or SMCL, or a level known to affect crop production.
2. They must have been found in the Subbasin at levels above the level of concern.

Based on the review of groundwater quality in Chapter 5, a variety of constituents of concern (COCs) were identified that may affect both agricultural wells and drinking water supply wells. The constituents of concern for drinking water supply wells include:

- 1,2,3-trichloropropane
- arsenic
- cadmium
- chloride
- fluoride
- hexavalent chromium
- iron
- manganese
- methyl tert-butyl ether (MTBE)
- nitrate
- perchlorate
- thallium
- total dissolved solids (TDS)

Since hexavalent chromium does not currently have an actionable limit, it was eliminated from this list. Should the state of California establish an MCL or SMCL for hexavalent chromium, it will be added to the list of parameters monitored in the drinking water supply wells.

The constituents of concern for agricultural wells include:

- boron
- chloride
- iron
- manganese

These constituents are monitored with the ILRP wells and are known to cause reductions in crop production when irrigation water includes them in concentrations above agricultural water quality objectives.

As discussed in Chapter 7, wells for 3 separate water quality monitoring networks were reviewed and used for developing SMCs:

- Municipal public water system wells, regulated by the SWRCB Department of Drinking Water.
- Small public water system wells, regulated by Monterey County Department of Public Health, which include both state small water systems and local small water systems.
- Agricultural and domestic wells, monitored as part of ILRP by the CCGC. This dataset was obtained from the SWRCB through the GAMA online portal. The data were separated into two data sets, one for domestic wells and the other for agricultural wells for purposes of developing initial draft minimum thresholds and measurable objectives for each type of well and associated beneficial use. Some rural residential wells in the northern part of the Subbasin with groundwater quality problems may not be reporting under the ILRP, and this may constitute a data gap that could be addressed if these landowners begin reporting under the ILRP. However, the SVBGSA will not initiate new sampling of these wells.

Each of these well networks are monitored for different purposes and overseen by different entities, and therefore include different types of water quality parameters. Furthermore, some groundwater quality impacts are detrimental to only certain networks. For example, high nitrates are detrimental to municipal and small water supply systems but are not detrimental to agricultural irrigation wells. Therefore, different sets of groundwater quality parameters are monitored at each monitoring network based on which parameters are reported in the network and which parameters are detrimental to the network (see Table 8-4).

- The municipal public water system wells are sampled for the full suite of 12 COCs. Minimum thresholds are set for these 12 COCs in the municipal public supply wells.
- The small public water system wells are only sampled for arsenic, nitrate and hexavalent chromium. Both arsenic and nitrate have established MCLs. Minimum thresholds are set for these two COC’s in the small public water supply wells systems.
- The ILRP wells are sampled for general cations and anions, as well as nitrate and salinity. Minimum thresholds are established in the ILRP wells for both drinking water standards to protect domestic wells, and for agricultural irrigation water quality objectives.

Table 8-4. Summary of Constituents Monitored at Each Well Network

Constituent	Municipal	Small System	Domestic	Agricultural
1,2,3-TCP	✓			
Arsenic	✓	✓		
Boron				✓
Cadmium	✓			
Chloride	✓		✓	✓
Fluoride	✓			
Iron	✓		✓	✓
Manganese	✓		✓	✓
MTBE	✓			
Nitrate	✓	✓	✓	
Perchlorate	✓			
Thallium	✓			
TDS	✓		✓	

The bases for establishing minimum thresholds for each constituent of concern in the 180/400-Foot Aquifer Subbasin are listed in Table 8-5. All MCL and SMCL values reflect California drinking water standards. The agricultural water quality objectives are listed in the Water Quality Control Plan for the Central Coastal Basin (SWRCB, 2017). This table does not identify the numerical minimum thresholds, but rather identifies the foundation for how many additional wells will be allowed to exceed the level of concern. Wells that already exceed this limit are not counted against the minimum thresholds.

Table 8-5. Groundwater Quality Minimum Thresholds Bases

Constituent of Concern	Minimum Threshold Based on Number of Production Wells
Municipal Wells in Monitoring Program	
1,2,3-trichloropropane	Zero additional municipal production wells that are in the GSP monitoring area shall exceed the 1,2,3-trichloropropane MCL of 0.005 ug/L.
Arsenic	Zero additional municipal production wells that are in the GSP monitoring area shall exceed the arsenic MCL of 0.010 mg/L.
Cadmium	Zero additional municipal production wells that are in the GSP monitoring area shall exceed the cadmium MCL of 0.005 mg/L.
Chloride	Zero additional municipal production wells that are in the GSP monitoring program shall exceed the chloride Recommended SMCL of 250 mg/L.
Fluoride	Zero additional municipal production wells that are in the GSP monitoring area shall exceed the fluoride SMCL of 2 mg/L.
Iron	Zero additional municipal production wells that are in the GSP monitoring program shall exceed the iron SMCL of 0.3 mg/L
Manganese	Zero additional municipal or domestic production wells that are in the GSP monitoring program shall exceed the manganese SMCL of 0.05 mg/L
MTBE	Zero additional municipal production wells that are in the GSP monitoring area shall exceed the MTBE MCL of 0.013 mg/L.
Nitrate	Zero additional municipal production wells that are in the GSP monitoring program shall exceed the nitrate MCL of 10 mg/L, measured as nitrogen.
Perchlorate	Zero additional municipal production wells that are in the GSP monitoring program shall exceed the perchlorate MCL of 0.006 mg/L.
Thallium	Zero additional municipal production wells that are in the GSP monitoring area shall exceed the thallium MCL of 0.002 mg/L.
TDS	Zero additional municipal production wells that are in the GSP monitoring program shall exceed the TDS Recommended SMCL of 500 mg/L.
Small Water System Wells in Monitoring Program	
Arsenic	Zero additional small system production wells that are in the GSP monitoring area shall exceed the arsenic MCL of 0.010 mg/L.
Nitrate	Zero additional small system production wells that are in the GSP monitoring program shall exceed the nitrate MCL of 10 mg/L, measured as nitrogen.
ILRP Wells in Monitoring Program - Domestic Well Constituents and Minimum Thresholds	
Chloride	Zero additional ILRP wells that are in the GSP monitoring program shall exceed the chloride MCL of 250 mg/L.
Iron	Zero additional ILRP wells that are in the GSP monitoring program shall exceed the iron SMCL of 0.3 mg/L.
Manganese	Zero additional municipal or ILRP wells that are in the GSP monitoring program shall exceed the manganese SMCL of 0.05 mg/L.
Nitrate	Zero additional ILRP production wells that are in the GSP monitoring program shall exceed the nitrate MCL of 10 mg/L, measured as nitrogen.
Sulfate	Zero additional ILRP wells that are in the GSP monitoring program shall exceed the sulfate Upper SMCL of 500 mg/L.
TDS	Zero additional ILRP wells that are in the GSP monitoring program shall exceed the TDS Recommended SMCL of 500 mg/L.

Constituent of Concern	**Minimum Threshold Based on Number of Production Wells**
ILRP Wells in Monitoring Program – Agricultural Irrigation Constituents and Minimum Thresholds	
Boron	Zero additional ILRP wells that are in the GSP monitoring program shall exceed the boron agricultural water quality objective of 0.75 mg/L.
Chloride	Zero additional ILRP wells that are in the GSP monitoring program shall exceed the chloride agricultural water quality objective of 350 mg/L.
Iron	Zero additional ILRP wells that are in the GSP monitoring program shall exceed the iron agricultural water quality objective 5 mg/L.
Manganese	Zero additional ILRP wells that are in the GSP monitoring program shall exceed the manganese agricultural water quality objective 0.2 mg/L.

8.9.2.1 Municipal Production Wells

The minimum thresholds for degraded water quality for the municipal production wells are based on the goal of zero additional exceedances in existing wells shown in Table 8-5. However, some exceedances already exist in those wells, and these exceedances will likely continue into the future. The minimum threshold for the number of allowed exceedances is therefore equal to the current number of exceedances. Based on the number of municipal production wells in the existing water quality monitoring network that is described in Chapter 7, the number of existing exceedances from 2015 to February, 2019 for each constituent is shown in Table 8-6.

In addition, exceedances are based on existing wells only. The well networks will be re-assessed every 5 years to identify any new wells that should be added to the monitoring networks. According to the GSP Regulations, the Minimum Thresholds are based on the same number of wells to have exceedances, not necessarily the same wells. An average of water quality samples is used for wells that are measured more than once a year.

Table 8-6. Minimum Thresholds for Degradation of Groundwater Quality for the Municipal Supply Wells Under the Current Monitoring Network (Data from 2015-February, 2019)

Constituent of Concern (COC)	Regulatory Exceedance Standard	Standard Units	Number of Wells in Monitoring Network Sampled for COC	Minimum Threshold - Number of Wells Exceeding Regulatory Standard
123-Trichloropropane	0.005	ug/L	60	2
Arsenic	10	ug/L	58	1
Cadmium	5	ug/L	61	0
Chloride	250	mg/L	41	2
Fluoride	2	mg/L	60	0
Iron	300	ug/L	43	8
Manganese	50	ug/L	42	3
MTBE (Methyl tert-butyl ether	13	ug/L	65	1
Nitrate	10	mg/l	74	9
Perchlorate	6	ug/L	59	0
Thallium	2	ug/L	61	0
Total Dissolved Solids	500	mg/l	41	18

8.9.2.2 Small Public Water Systems Wells

The small water systems monitoring data are based on the County of Monterey Public Health Department routine monitoring of both Local and State Small Water Systems; and cover the period from 2015-2017 in a total of 136 wells. As described in Chapter 7, this network is not currently included in the water quality monitoring network for this GSP due to a lack of well construction and location information. However, an initial analysis on the water quality data for the current network was conducted to establish interim minimum thresholds and measurable objectives that will be updated once the data gap is lifted and a better assessment of this monitoring network can be established. The water quality data set used for this preliminary analysis was derived from an existing online GIS data compilation (Ostermayer, 2017).

The minimum thresholds for degraded water quality for the small public water supply system wells are similarly based on the goal of zero additional exceedances in existing wells shown in Table 8-5. Following a similar process as that of the municipal production wells, the minimum thresholds for degraded water quality in small public water systems is shown in Table 8-7. As with the municipal production wells, exceedances are based on existing wells only. The well networks will be re-assessed during the 5-year GSP Update development to identify any wells that should be included in the monitoring network for small public supply systems.

Table 8-7. Minimum Thresholds for Degradation of Groundwater for the Small Systems Supply Wells Under the Current Monitoring Network (Data from 2015-2017)

Constituent of Concern (COC)	Regulatory Exceedance Standard	Standard Units	Number of Wells in Monitoring Network Sampled for COC from 2015-2017	Minimum Threshold - Number of Wells Exceeding Regulatory Standard
Arsenic	0.01	mg/L	47	1
Nitrate	10	mg/l	136	22

8.9.2.3 Agricultural and Domestic Wells – ILRP

As described in Chapter 7, this network is not currently included in the water quality monitoring network for this GSP because a revised monitoring network under Ag Order 4.0 will be established in 2020. However, an initial analysis of the water quality data for the current ILRP network was conducted to establish interim minimum thresholds and measurable objectives that will be updated once Ag Order 4.0 is finalized and a better assessment of this monitoring network can be established.

The minimum thresholds for degraded water quality for the ILRP wells are similarly based on the goal of zero additional exceedances shown in Table 8-5. Following the same process as that of the municipal production wells, the minimum thresholds for degraded water quality is shown in Table 8-8 for domestic drinking water wells, and in Table 8-9 for agricultural irrigation wells. Based on the number of ILRP wells in the existing water quality monitoring network that is described in Chapter 7, the number of existing exceedances for each constituent is shown for constituents monitored at wells since 2012 to represent recent measurements.

The monitoring well network for the ILRP will change in 2020 with the adoption of Ag Order 4.0. At that time, the new ILRP monitoring network will be incorporated into this GSP, replacing the current network, for water quality monitoring.

Table 8-8. Minimum Thresholds for Degradation of Groundwater Quality for ILRP Domestic Wells Under the Current Monitoring Network (Data from 2012-2018)

Constituent of Concern (COC)	Regulatory Exceedance Standard	Standard Units	Number of Wells in Monitoring Network Sampled for COC from 2012-2018	Minimum Threshold - Number of Wells Exceeding Regulatory Standard
Chloride	250	mg/L	172	29
Iron	0.3	mg/L	37	12
Manganese	0.05	mg/L	37	4
Nitrate	10	mg/l	179	51
Sulfate	500	mg/l	172	43
TDS	500	mg/l	148	111

Table 8-9. Minimum Thresholds for Degradation of Groundwater Quality for Agricultural Use in ILRP Wells Under the Current Monitoring Network (Data from 2012-2018)

Constituent of Concern (COC)	Agricultural Usage Water Quality Objective	Water Quality Objective Units	Number of Wells in Monitoring Network Sampled for COC from 2012-2018	Minimum Threshold - Number of Wells Exceeding Water Quality Objective
Boron	0.75	mg/L	95	0
Chloride	350	mg/L	311	28
Iron	5	mg/L	90	3
Manganese	0.2	mg/L	90	2

8.9.2.4 Information and Methodology Used to Establish Water Quality Minimum Thresholds and Measurable Objectives

The exceedances shown in Table 8-6, Table 8-7, Table 8-8, and Table 8-9 were based on a review of recent datasets. The information used for establishing the degradation of groundwater quality minimum thresholds includes:

- Historical groundwater quality data from municipal, small systems, agricultural, and domestic production wells in the Subbasin
- Federal and State drinking water quality standards
- Central Coast Basin Plan assessment of water quality objectives for agricultural water use
- Feedback from GSA staff members and public members

The historical groundwater quality data used to establish groundwater quality minimum thresholds are presented in Chapter 5. Based on the reviews of historical and current groundwater quality data, federal and state drinking water standards, and irrigation water quality needs, the SVBGSA agreed that these standards are appropriate to define groundwater quality minimum thresholds.

8.9.2.5 Relationship between Individual Minimum Thresholds and Relationship to Other Sustainability Indicators

Because SGMA does not require projects or actions to improve groundwater quality, there will be no direct actions under the GSP associated with the groundwater quality minimum thresholds. Therefore, there are no actions that directly influence other sustainability indicators. However, preventing migration of poor groundwater quality may limit activities needed to achieve minimum thresholds for other sustainability indicators.

- **Chronic lowering of groundwater levels**. Groundwater quality minimum thresholds could influence groundwater elevation minimum thresholds by limiting the types of water that can be used for recharge to raise groundwater elevations. Water used for recharge cannot exceed any of the groundwater quality minimum thresholds. In addition, a change in groundwater elevations may cause a change in groundwater flow direction which in turn could cause poor water quality to migrate into areas of good water quality.
- **Change in groundwater storage**. Nothing in the groundwater quality minimum thresholds promotes pumping in excess of the sustainable yield. Therefore, the groundwater quality minimum thresholds will not result in an exceedance of the groundwater storage minimum threshold.
- **Seawater intrusion**. Nothing in the groundwater quality minimum thresholds promotes additional pumping that could exacerbate seawater intrusion. Therefore, the groundwater quality minimum thresholds will not result in an exceedance of the seawater intrusion minimum threshold.
- **Subsidence**. Nothing in the groundwater quality minimum thresholds promotes additional pumping that could cause subsidence. Therefore, the groundwater quality minimum thresholds will not result in an exceedance of the subsidence minimum threshold.
- **Depletion of interconnected surface waters.** Nothing in the groundwater quality minimum thresholds promotes additional pumping or lower groundwater elevations adjacent to interconnected surface waters. Therefore, the groundwater quality minimum thresholds will not result in a significant or unreasonable depletion of interconnected surface waters.

8.9.2.6 Effect of Minimum Thresholds on Neighboring Basins and Subbasins

The anticipated effect of the degraded groundwater quality minimum thresholds on each of the neighboring subbasins is addressed below.

The 180/400-Foot Aquifer Subbasin has four neighboring subbasins within the Salinas Valley Groundwater Basin:

- The Langley Subbasin to the north
- The Eastside Subbasin to the northeast
- The Forebay Subbasin to the south
- The Monterey Subbasin to the West

The SVBGSA is either the exclusive GSA, or is one of two coordinating GSAs for the adjacent Langley, Eastside, Forebay, and Monterey Subbasins. Because the SVBGSA covers all of these subbasins, the GSA Board of Directors opted to develop the minimum thresholds and measurable objectives for all of these neighboring subbasins in a single process that is coordinated with the 180/400-Foot Aquifer Subbasin. These neighboring subbasins are in the process of GSP development for submittal in January 2022. Minimum thresholds for the 180/400-Foot Aquifer Subbasin will be reviewed relative to information developed during the preparation of neighboring subbasins' GSPs and will be updated, as appropriate, to ensure that these minimum thresholds will not prevent the neighboring subbasins from achieving sustainability. In addition, the Pajaro Valley Basin lies directly to the north of the Subbasin. Because the minimum thresholds in the 180/400-Foot Aquifer Subbasin are to prevent migration of poor-quality water, it is likely that the minimum thresholds will not prevent the Pajaro Basin from achieving and maintaining sustainability. The SVBGSA will coordinate closely with the Pajaro Valley Water Agency as it sets minimum thresholds to ensure that the basins do not prevent each other from achieving sustainability.

8.9.2.7 Effect on Beneficial Uses and Users

Agricultural land uses and users. The degradation of groundwater quality minimum thresholds generally provides positive benefits to the Subbasin's agricultural water users. Preventing additional agricultural supply wells from exceeding levels that could reduce crop production ensures that a supply of usable groundwater will exist for beneficial agricultural use.

Urban land uses and users. The degradation of groundwater quality minimum thresholds generally provides positive benefits to the Subbasin's urban water users. Preventing constituents of concern in additional drinking water supply wells from exceeding MCLs or SMCLs ensures an adequate supply of groundwater for municipal supplies.

Domestic land uses and users. The degradation of groundwater quality minimum thresholds generally provides positive benefits to the Subbasin's domestic water users. Preventing constituents of concern in additional drinking water supply wells from exceeding MCLs or SMCLs ensures an adequate supply of groundwater for domestic supplies.

Ecological land uses and users. Although the groundwater quality minimum thresholds do not directly benefit ecological uses, it can be inferred that the degradation of groundwater quality minimum thresholds provide generally positive benefits to the Subbasin's ecological water uses. Preventing constituents of concern from migrating will prevent unwanted contaminants from impacting ecological groundwater uses.

8.9.2.8 Relation to State, Federal, or Local Standards

The degradation of groundwater quality minimum thresholds specifically incorporates state and federal standards for drinking water.

8.9.2.9 Method for Quantitative Measurement of Minimum Thresholds

Degradation of groundwater quality minimum thresholds will be directly measured from existing or new municipal, domestic, or agricultural supply wells. Groundwater quality will be measured through existing monitoring programs.

- Exceedances of MCLs and SMCLs will be monitored from annual water quality reports submitted to the California Division of Drinking Water and the County of Monterey by municipalities and small water systems.
- Exceedances of crop production based minimum thresholds will be monitored as part of the ILRP as discussed in Chapter 7.

Initially, the review of MCLs and SMCLs will be centered around the constituents of concern identified above. If during review of the water quality data additional constituents appear to exceed MCLs and SMCLs, minimum thresholds and measurable objectives will be developed for these additional constituents.

8.9.3 Measurable Objectives

The measurable objectives for degradation of groundwater quality represent target groundwater quality distributions in the Subbasin. SGMA does not mandate the improvement of groundwater quality. Therefore, the SVBGSA has set the measurable objectives identical to the minimum thresholds, as defined in Table 8-6, Table 8-7, Table 8-8, and Table 8-9.

8.9.3.1 Method for Setting Measurable Objectives

As described above, measurable objectives are set to be identical to the minimum thresholds and therefore follow the same method as detailed in Section 8.7.2.4.

8.9.3.2 Interim Milestones

Interim milestones show how the GSA anticipates the Subbasin will gradually move from current conditions to meeting the measurable objectives over the next 20 years of implementation. Interim milestones are set for each 5-year interval following GSP adoption.

The measurable objectives for degradation of groundwater quality are set at current conditions; there is no anticipated degradation of groundwater quality during GSP implementation that results from the implementation of projects and actions as described in Chapter 9. Therefore, the expected interim milestones are identical to current conditions.

8.9.4 Undesirable Results

8.9.4.1 Criteria for Defining Undesirable Results

By regulation, the degradation of groundwater quality undesirable result is a quantitative combination of groundwater quality minimum threshold exceedances. For the Subbasin, any groundwater quality degradation is unacceptable as a direct result of GSP implementation. Some groundwater quality changes are expected to occur independent of SGMA activities; because these changes are not related to SGMA activities they do not constitute an undesirable result. Therefore, the degradation of groundwater quality undesirable result is:

> *During any one year, no groundwater quality minimum threshold shall be exceeded when computing annual averages at each well, as a direct result of projects or management actions taken as part of GSP implementation.*

8.9.4.2 Potential Causes of Undesirable Results

Conditions that may lead to an undesirable result include the following:

- **Required Changes to Subbasin Pumping**. If the location and rates of groundwater pumping change as a result of projects implemented under the GSP, these changes could alter hydraulic gradients and associated flow directions, and cause movement of one of the constituents of concern towards a supply well at concentrations that exceed relevant standards.
- **Groundwater Recharge**. Active recharge of imported water or captured runoff could modify groundwater gradients and move one of the constituents of concern towards a supply well in concentrations that exceed relevant limits.

- **Recharge of Poor-Quality Water**. Recharging the Subbasin with water that exceeds an MCL, SMCL, or level that reduces crop production will lead to an undesirable result.

8.9.4.3 Effects on Beneficial Users and Land Use

The undesirable result for degradation of groundwater quality is avoiding groundwater degradation due to actions directly resulting from GSP implementation. Therefore, the undesirable result will not impact the use of groundwater and will not have a negative effect on the beneficial users and uses of groundwater. This undesirable result, however, only applies to groundwater quality changes directly caused by projects or management actions implemented as part of this GSP. This undesirable result does not apply to groundwater quality changes that occur due to other causes.

8.10 Subsidence SMC

8.10.1 Locally Defined Significant and Unreasonable Conditions

Locally defined significant and unreasonable conditions were assessed based on public meetings and discussions with GSA staff. Significant and unreasonable rates of land subsidence in the Subbasin are those that lead to a permanent subsidence of land surface levels that impact infrastructure. Significant and unreasonable subsidence in the Subbasin is defined as follows:

- Any inelastic land subsidence that impacts infrastructure and is caused by lowering of groundwater elevations occurring in the Subbasin is significant and unreasonable.

Subsidence can be elastic or inelastic. Inelastic subsidence is generally irreversible. Elastic subsidence is the small, reversible lowering and rising of the ground surface. This SMC only concerns inelastic subsidence. Currently, InSAR data provided by DWR shows that no inelastic subsidence has been measured in the 180/400-Foot Aquifer Subbasin.

8.10.2 Minimum Thresholds

Section 354.28(c)(5) of the Regulations states that “The minimum threshold for land subsidence shall be the rate and extent of subsidence that substantially interferes with surface land uses and may lead to undesirable results” (CCR, 2016). Because it is difficult to assess a-priori where subsidence may interfere with surface land uses and where it may not, a single minimum threshold is set for the entire Subbasin.

Based on an analysis of potential measurement errors in the InSAR data, as discussed in the following section, the subsidence minimum threshold is that the InSAR measured subsidence between June of one year and June of the subsequent year shall be no more than 0.1 foot, resulting in zero long-term subsidence.

8.10.2.1 Information Used and Methodology for Establishing Subsidence Minimum Thresholds

Minimum thresholds were established using InSAR data available from DWR. The general minimum threshold is for no long-term irreversible subsidence in the Subbasin. The InSAR data provided by DWR, however, is subject to measurement error. DWR has stated that, on a statewide level, for the total vertical displacement measurements between June 2015 and June 2018, the errors are as follows (Brezing, personal communication):

1. The error between InSAR data and continuous GPS data is 16 mm (0.052 feet) with a 95% confidence level
2. The measurement accuracy when converting from the raw InSAR data to the maps provided by DWR is 0.048 feet with 95% confidence level.

By simply adding the errors 1 and 2, the combined error is 0.1 foot. While this is not a robust statistical analysis, it does provide an estimate of the potential error in the InSAR maps provided by DWR. A land surface change of less than 0.1 feet is therefore within the noise of the data and is not dispositive of subsidence in the Subbasin.

Additionally, the InSAR data provided by DWR reflects both elastic and inelastic subsidence. While it is difficult to compensate for elastic subsidence, visual inspection of monthly changes in ground elevations suggest that elastic subsidence is largely seasonal. Figure 8-8 shows the ground level changes at a randomly selected point in the Subbasin (Latitude 36.69318, Longitude -121.72295). This figure demonstrates the general seasonality of the elastic subsidence. To minimize the influence of elastic subsidence on the assessment of long-term, permanent subsidence, changes in ground level will only be measured annually from June of one year to June of the following year.

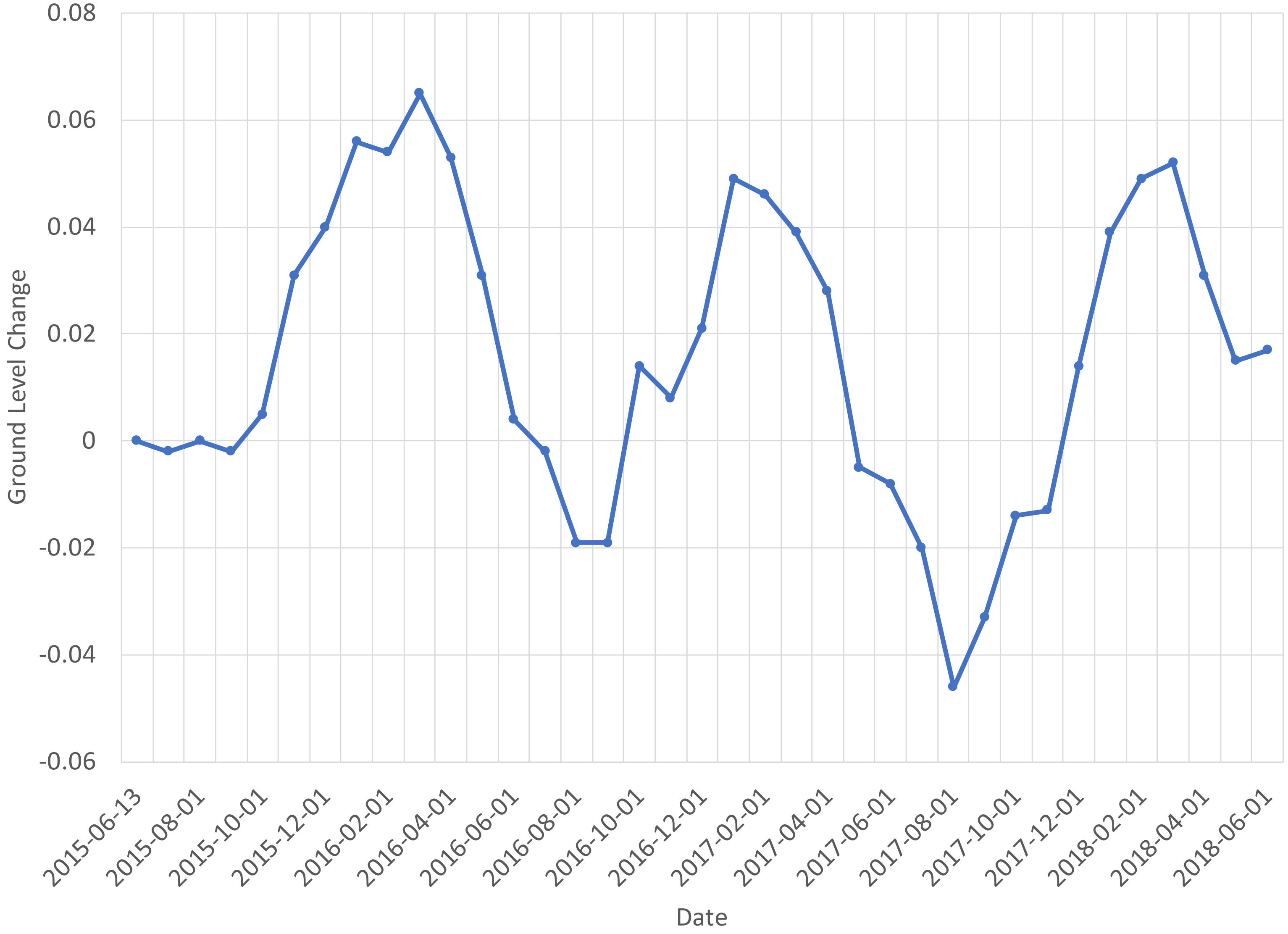


Figure 8-8. Seasonal Ground Surface Change at Point 36.69318, -121.72295

8.10.2.2 Relationship between Individual Minimum Thresholds and Relationship to Other Sustainability Indicators

Subsidence minimum thresholds have little or no impact on other minimum thresholds, as described below.

- **Chronic lowering of groundwater levels**. Subsidence minimum thresholds will not result in significant or unreasonable groundwater elevations.
- **Change in groundwater storage**. The subsidence minimum thresholds will not change the amount of pumping and will not result in a significant or unreasonable change in groundwater storage.
- **Seawater intrusion**. The subsidence minimum thresholds will not induce additional advancement of seawater intrusion along the coast.
- **Degraded water quality**. The subsidence minimum thresholds will not change the groundwater flow directions or rates, and therefore and will not result in a significant or unreasonable change in groundwater quality.
- **Depletion of interconnected surface waters**. The ground level subsidence minimum thresholds will not change the amount or location of pumping and will not result in a significant or unreasonable depletion of interconnected surface waters.

8.10.2.3 Effect of Minimum Thresholds on Neighboring Basins and Subbasins

The 180/400-Foot Aquifer Subbasin has four neighboring subbasins within the Salinas Valley Groundwater Basin:

- The Langley Subbasin to the north
- The Eastside Subbasin to the northeast
- The Forebay Subbasin to the south
- The Monterey Subbasin to the West

The SVBGSA is either the exclusive GSA, or is one of two coordinating GSAs for the adjacent Langley, Eastside, Forebay, and Monterey Subbasins. Because the SVBGSA covers all of these subbasins, the GSA Board of Directors opted to develop the minimum thresholds and measurable objectives for all of these neighboring subbasins in a single process that is coordinated with the 180/400-Foot Aquifer Subbasin. These neighboring subbasins are in the process of GSP development for submittal in January 2022. Minimum thresholds for the 180/400-Foot Aquifer Subbasin will be reviewed relative to information developed during the preparation of neighboring subbasins' GSPs and will be updated, as appropriate, to ensure that these minimum thresholds will not prevent the neighboring subbasins from achieving sustainability. In addition, the Pajaro Valley Basin lies directly to the north of the Subbasin. Because the minimum thresholds in the 180/400-Foot Aquifer Subbasin is zero subsidence, it is likely that the minimum thresholds will not prevent the Pajaro Basin from achieving and maintaining sustainability. The SVBGSA will coordinate closely with the Pajaro Valley Water Agency as it sets minimum thresholds to ensure that the basins do not prevent each other from achieving sustainability.

8.10.2.4 Effects on Beneficial Uses and Users

The subsidence minimum thresholds are set to prevent any long-term inelastic subsidence that could harm infrastructure. Available data indicate that there is currently no long-term subsidence occurring in the Subbasin that affects infrastructure, and reductions in pumping are already required by minimum thresholds for other sustainability indicators. Therefore, the subsidence minimum thresholds do not require any additional reductions in pumping and there is no negative impact on any beneficial user.

8.10.2.5 Relation to State, Federal, or Local Standards

There are no federal, state, or local regulations related to subsidence.

8.10.2.6 Method for Quantitative Measurement of Minimum Threshold

Minimum thresholds will be assessed using DWR-supplied InSAR data.

8.10.3 Measurable Objectives

The measurable objectives for ground surface subsidence represents target subsidence rates in the Subbasin. Because the minimum thresholds of zero net long-term subsidence are the best achievable outcome, the measurable objectives are identical to the minimum thresholds.

8.10.3.1 Method for Setting Measurable Objectives

The measurable objectives are set to the groundwater elevations that result in zero long-term subsidence. These groundwater elevations are identical to the minimum threshold groundwater elevations.

8.10.3.2 Interim Milestones

Subsidence measurable objectives are set at current conditions of no long-term subsidence. There is no change between current conditions and sustainable conditions. Therefore, the interim milestones are identical to current conditions of keeping groundwater elevations above historical lows.

8.10.4 Undesirable Results

8.10.4.1 Criteria for Defining Undesirable Results

By regulation, the ground surface subsidence undesirable result is a quantitative combination of subsidence minimum threshold exceedances. For the 180/400-Foot Subbasin, no long-term subsidence that impacts infrastructure is acceptable. Therefore, the ground surface subsided undesirable result is:

> *In any one year, there will be zero exceedances of the minimum thresholds for subsidence.*

Should potential subsidence be observed, the SVBGSA will first assess whether the subsidence may be due to elastic subsidence. If the subsidence is not elastic, the SVBGSA will undertake a program to correlate the observed subsidence with measured groundwater elevations.

8.10.4.2 Potential Causes of Undesirable Results

Conditions that may lead to an undesirable result include a shift in pumping locations. Shifting a significant amount of pumping to an area that is susceptible to subsidence could trigger subsidence that has not been observed before.

8.10.4.3 Effects on Beneficial Users and Land Use

The undesirable result for subsidence does not allow any subsidence to occur in the Subbasin. Therefore, there is no negative effect on any beneficial uses and users.

8.11 Depletion of Interconnected Surface Water SMC

Areas exist in the Subbasin where shallow groundwater may be connected to the surface water system. There is evidence that shallow sediments occur above the confined 180-Foot aquifer that are connected to the surface water system. However, there is almost no groundwater pumping in this area and it is not identified as a principal aquifer.

8.11.1 Locally Defined Significant and Unreasonable Conditions

Locally defined significant and unreasonable conditions were assessed based on public meetings, and discussions with GSA staff. Significant and unreasonable depletion of interconnected surface water in the Subbasin is depletion of interconnected surface water flows that may prevent the MCWRA from meeting biological flow requirements in the Salinas River, or would induce an unreasonable impact on other beneficial uses and users such as surface water rights holders. The GSA does not have authority to manage reservoir releases and is not required to manage surface waters.

The U.S. Army Corps of Engineers has re-initiated consultation with the National Marine Fisheries Service (NMFS) on the Biological Opinion for the Salinas Valley Water Project (NMFS, 2007). Therefore, no biological opinion currently regulates environmental flows in the Salinas River. MCWRA, however, continues to manage flows in the Salinas River under the previous, 2007 biological opinion as a safe harbor practice. Until a new biological opinion is developed, and a Habitat Conservation Plan (HCP) is drafted by MCWRA, this GSP will use the 2007 biological opinion as guidance to establish the effects of stream depletion due to groundwater pumping.

The 2007 NMFS biological opinion was developed using measured streamflows between 1995 and 2005. The measured streamflows used in the biological opinion reflect current surface water depletion rates, and therefore current depletion rates are already incorporated into the river management plan. Furthermore, releases from Nacimiento Reservoir and San Antonio Reservoir are designed to maintain required environmental flows with current groundwater pumping. Because steelhead flow requirements were being met under the 2007 biological opinion, surface water depletion rates were not unreasonable with regards to maintaining environmental flow requirements. This assessment will be revisited after the new HCP is drafted by MCWRA.

In addition to managing the river for environmental needs, the Salinas River is managed to maintain adequate water supply for other beneficial uses. The Nacimiento and San Antonio reservoirs provide flood control benefits as well as groundwater recharge benefits through its sandy channels, where water rights holders along the river can pump out water according to their water rights.

Currently, there is significant leakage from the Salinas River to the underlying groundwater, but it is not considered unreasonable with regards to riparian rights holders. To the extent that groundwater pumping depletes surface water flows, these depletions, and the potential surface water limitations, would be injurious only if the surface water right holders held rights senior to the groundwater pumpers. Riparian rights holders and groundwater pumpers both have correlative rights to the common water pool. As stated in the SVWC v. MCWRA Report of Referee (SWRCB Referee, 2019):

> *The common source doctrine applies to groundwater and surface waters that are hydrologically connected and integrates the relative priorities of the rights without regard to whether the diversion is from surface or groundwater.*

Because groundwater pumping rights and riparian surface water rights are correlative under this finding, groundwater pumping-induced depletions that limit surface water rights are considered potentially significant, but not unreasonable.

8.11.2 Minimum Thresholds

Section 354.28(c)(6) of the Regulations states that "The minimum threshold for depletions of interconnected surface water shall be the rate or volume of surface water depletions caused by groundwater use that has adverse impacts on beneficial uses of the surface water and may lead to undesirable results" (CCR, 2016). Minimum thresholds only apply to the interconnected stream reaches.

As stated in Chapter 6, the estimated average future surface water depletion rate in the 180/400-Foot Aquifer Subbasin is approximately 69,700 AF/yr. based on the SVIHM. This is considered a reasonable estimate of the current surface water depletion. However, without good historical data or a numerical model, it is difficult to assess whether and where the stream is connected to underlying groundwater. Furthermore, without simulating a no-pumping scenario and comparing it to a current pumping scenario, it is not possible to determine how much of the surface water depletion is due to pumping.

As stated above, the current rate of stream depletion from pumping is not considered significant and unreasonable. Therefore, the minimum threshold for depletion of interconnected surface water is currently set to the current average rate of 69,700 AF/yr. This estimate will be modified when the SVIHM becomes available. As soon as the model is available, new depletions will be computed based on more complete analysis, and new minimum threshold will be set during implementation of the GSP.

8.11.2.1 Information Used and Methodology for Establishing Depletion of Interconnected Surface Water Minimum Thresholds

The minimum thresholds for depletion of interconnected surface water are developed using the definition of significant and unreasonable conditions described above, public information about critical habitat, public information about water rights described below, and the Subbasin water budget analysis.

A summary of surface water diversions by riparian water rights holders on the Salinas River and its tributaries within the 180/400-Foot Aquifer Subbasin is provided in Table 8-10. The diversion data were obtained from queries of the DWR eWRIMS water rights management system and represent all surface water diversions as self-reported by water-rights holders with points of diversion located within the Subbasin boundaries. Some of the diversions shown in Table 8-10 may be reported to MCWRA as groundwater pumping, resulting in a double counting of these extractions.

Table 8-10. Surface Water Diversions on the Salinas River and its Tributaries in the 180/400-Foot Aquifer Subbasin

	2010	2011	2012	2013	2014	2015	2016	2017
Diversions (Acre-Feet)	6,359	6,498	7,277	9,579	8,689	8,164	8,065	7,431

Figure 8-9 presents the average monthly total diversions on the Salinas River for the period 2010 to 2017. In the 180/400-Foot Aquifer Subbasin, the largest diversions occur in the summer months, as expected, to satisfy agricultural irrigation needs.

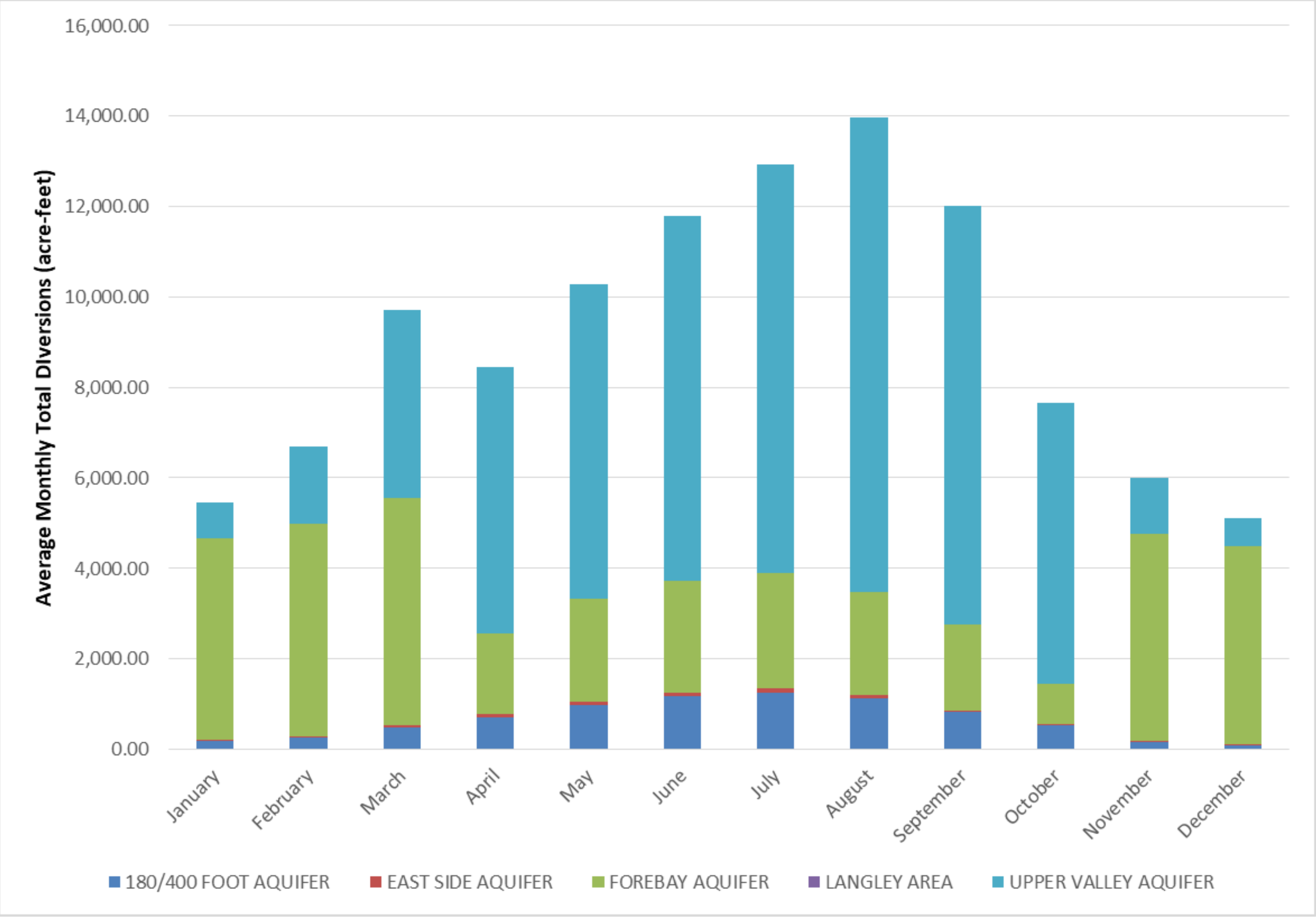


Figure 8-9. Average Monthly Total Salinas River Diversions by Subbasin

8.11.2.2 Relationship between Individual Minimum Thresholds and Relationship to Other Sustainability Indicators

The minimum threshold for depletion of surface water is a single value for the entire Subbasin. Therefore, no conflict exists between minimum thresholds measured at various locations within the Subbasin.

The depletion of surface water minimum threshold could influence other sustainability indicators as follows:

- **Chronic lowering of groundwater levels**. Capping the amount of surface water depletion could limit the amount of natural streamflow percolation that would otherwise maintain groundwater elevations. However, the surface water depletion minimum thresholds do not directly influence the chronic lowering of groundwater elevations minimum thresholds
- **Change in groundwater storage**. The depletion of surface water minimum threshold may limit the amount of pumping near rivers and streams. This limitation on pumping could also limit losses of groundwater storage. The depletion of surface water minimum threshold is therefore consistent with the change in groundwater storage minimum threshold.
- **Seawater intrusion**. Seawater intrusion will not be affected by the depletion of surface water minimum thresholds.
- **Degraded water quality**. Water quality will not be affected by the depletion of surface water minimum thresholds.
- **Inelastic subsidence**. Inelastic subsidence will not be affected by the depletion of surface water minimum thresholds.

8.11.2.3 Effect of Minimum Thresholds on Neighboring Basins and Subbasins

The 180/400-Foot Aquifer Subbasin has four neighboring subbasins within the Salinas Valley Groundwater Basin:

- The Langley Subbasin to the north
- The Eastside Subbasin to the northeast
- The Forebay Subbasin to the south
- The Monterey Subbasin to the West

The SVBGSA is either the exclusive GSA, or is one of two coordinating GSAs for the adjacent Langley, Eastside, Forebay, and Monterey Subbasins. Because the SVBGSA covers all of these subbasins, the GSA Board of Directors opted to develop the minimum thresholds and measurable objectives for all of these neighboring subbasins in a single process that is coordinated with the 180/400-Foot Aquifer Subbasin. These neighboring subbasins are in the process of GSP development for submittal in January 2022. Minimum thresholds for the 180/400-Foot Aquifer Subbasin will be reviewed relative to information developed during the preparation of neighboring subbasins' GSPs and will be updated, as appropriate, to ensure that these minimum thresholds will not prevent the neighboring subbasins from achieving sustainability. In addition, the Pajaro Valley Basin occurs directly to the north. There is no surface water connection between the Pajaro Valley and the 180/400-Foot Aquifer Subbasin, and therefore the minimum thresholds for depletion of interconnected surface waters does not influence the ability of Pajaro Valley to achieve sustainability.

8.11.2.4 Effect on Beneficial Uses and Users

Table 3-9 of the *Salinas River Long-Term Management Plan* (MCWRA, 2019) includes a list of 18 different designated beneficial uses on certain reaches of the river. In general, the major beneficial uses on the Salinas River are:

- Surface water diversions for agricultural, urban/industrial and domestic supply
- Groundwater pumping from recharged surface water
- Freshwater habitat
- Rare, threated or endangered species, such as the Steelhead Trout
- CSIP diversions

The depletion of surface water minimum thresholds may have varied effects on beneficial users and land uses in the Subbasin.

Agricultural land uses and users. The depletion of surface water minimum threshold prevents lowering of groundwater elevations adjacent to certain parts of streams and rivers. This has the effect of limiting the amount of groundwater pumping in these areas. Limiting the amount of groundwater pumping may limit the quantity and type of crops that can be grown in these adjacent to streams and rivers.

Urban land uses and users. The depletion of surface water minimum threshold prevents lowering of groundwater elevations adjacent to certain parts of streams and rivers. This may limit the amount of urban pumping near rivers and streams, which could limit urban growth in these areas. Also, if pumping is limited, municipalities may have to obtain alternative sources of water to achieve urban growth goals. If this occurs, this may result in higher water costs for municipal water users.

Domestic land uses and users. The depletion of surface water minimum threshold may benefit existing domestic land users and uses by maintaining shallow groundwater elevations near streams and protecting the operability of relatively shallow domestic wells. However, these minimum thresholds may limit the number of new domestic wells that can be installed near rivers or streams in order to limit the additional drawdown from the new wells.

Ecological land uses and users. The depletion of surface water minimum thresholds prevents further degradation of ecological impacts from groundwater pumping.

8.11.2.5 Relation to State, Federal, or Local Standards

The minimum thresholds are developed in accordance with NMFS streamflow requirements.

8.11.2.6 Method for Quantitative Measurement of Minimum Threshold

The updated SVIHM will serve as the primary approach for monitoring depletion of surface water when it becomes available. At a minimum, the model will be updated every 5 years and the amount of surface water depletion that occurred in the previous 5 years will be estimated.

The model's ability to estimate surface water depletion relies on it reasonably simulating shallow groundwater elevations adjacent to interconnected surface water bodies. Therefore, additional shallow wells will be installed adjacent to interconnected stream reaches to verify the representativeness of the updated SVIHM. Further details on the number and locations of these shallow wells are included in Chapter 7.

8.11.3 Measurable Objectives

The measurable objective for depletion of surface water is the same as the minimum threshold. The measurable objective is set at the long-term depletion rate of 69,700 AF/yr.

8.11.3.1 Method for Setting Measurable Objectives

Discussions with GSA staff and stakeholder suggested that stakeholder prefer improving the health of the Salinas River during times of natural flow, but agree that summer flows are reservoir dominated and do not necessarily mimic the natural flow system. Stakeholders showed no preference for reducing leakage from river flows that are meant to intentionally recharge the groundwater basin. Therefore, there is no need to set a measurable objective different than the minimum threshold.

8.11.3.2 Interim Milestones

Depletion of interconnected surface water measurable objectives are set at current conditions; there is no anticipated increase or decrease in surfaced water depletion during GSP implementation. Therefore, the expected interim milestones are identical to current conditions. The interim milestones for the total calculated depletion of interconnected surface water is shown in Table 8-11.

Table 8-11. Depletion of Interconnected Surface Water Interim Milestones

5-Year Depletion Rate (AF/yr.)	10-Year Depletion Rage (AF/yr.)	15-Year Depletion Rate (AF/yr.)
69,700	69,700	69,700

8.11.4 Undesirable Results

8.11.4.1 Criteria for Defining Undesirable Results

By regulation, the depletion of interconnected surface water undesirable result is a quantitative combination of minimum threshold exceedances. There is only one reduction in depletion of interconnected surface water minimum threshold. Therefore, no minimum threshold exceedances are allowed to occur and the reduction in groundwater storage undesirable result is:

> *During average hydrogeologic conditions, and as a long-term average over all hydrogeologic conditions, the depletion of interconnected surface waters shall not exceed the single minimum threshold.*

8.11.4.2 Potential Causes of Undesirable Results

Conditions that may lead to an undesirable result for the depletion of interconnected surface waters include the following:

- **Localized pumping increases**. Even if the Subbasin is adequately managed at the Subbasin scale, increases in localized pumping near interconnected surface water bodies could unreasonably increase surface water depletion.
- **Expansion of riparian water rights**. Riparian water rights holders often pump from wells adjacent to the Salinas River. Pumping by these riparian water rights holder users is not regulated under this GSP. Additional riparian pumpers near interconnected reaches of rivers and streams may result in excessive localized surface water depletion.
- **Changes in Nacimiento and San Antonio Reservoir Releases**. Since the Salinas River is dependent on reservoir releases for sustained summer flows, when diversions are at the highest level, any decrease in reservoir flows during that time could be detrimental to the interconnected surface waters by increases depletions and could cause undesirable results to beneficial users.

- **Extensive, unanticipated drought**. Minimum thresholds were established based on anticipated future climatic conditions. Extensive, unanticipated droughts may lead to excessively low groundwater elevations that increase surface water depletion rates.

8.11.4.3 Effects on Beneficial Users and Land Use

The depletion of surface water undesirable result is to have no net change in surface water depletion during average hydrologic conditions and over the long-term. Therefore, during average hydrologic conditions and over the long-term, the undesirable result will not have a negative effect on the beneficial users and uses of groundwater. However, pumping during dry years could temporarily increase rates of surface water depletions. Therefore, there could be short-term impacts on all beneficial users and uses of the surface water during dry years.