Salinas Valley: Forebay 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

TABLE OF CONTENTS

5 GROUNDWATER CONDITIONS 5-1

5.1 Groundwater Elevations 5-1

5.1.1 Data Sources 5-1
5.1.2 Groundwater Elevation Contours and Horizontal Groundwater Gradients 5-1
5.1.3 Hydrographs 5-7
5.1.4 Vertical Groundwater Gradients 5-13

5.2 Change in Groundwater Storage 5-15

5.2.1 Data Sources 5-15
5.2.2 Change in Groundwater Storage 5-15

5.3 Groundwater Quality Distribution and Trends 5-19

5.3.1 Data Sources 5-19
5.3.2 Point Sources of Groundwater Contaminants 5-19
5.3.3 Distribution and Concentrations of Diffuse or Natural Groundwater Constituents 5-21
5.3.4 Groundwater Quality Summary 5-26

5.4 Subsidence 5-27

5.4.1 Data Sources 5-27
5.4.2 Subsidence Mapping 5-27

5.5 Interconnected Surface Water 5-29

5.5.1 Data Sources 5-30
5.5.2 Evaluation of Surface Water and Groundwater Interconnection 5-30

6 WATER BUDGETS 6-1

6.1 Overview of Water Budget Development 6-1

6.1.1 Water Budget Components 6-2
6.1.2 Water Budget Time Frames 6-6

6.2 Overview of Model Assumptions for Water Budget Development 6-8

6.3 Historical and Current Water Budgets 6-11

6.3.1 Historical and Current Surface Water Budget 6-11
6.3.2 Historical and Current Groundwater Budget 6-15
6.3.3 Historical and Current Groundwater Budget Summary 6-21
6.3.4 Historical and Current Sustainable Yield 6-23

6.4 Projected Water Budgets 6-24

6.4.1 Assumptions Used in Projected Water Budget Development 6-24
6.4.2 Projected Surface Water Budget 6-26
6.4.3 Projected Groundwater Budget 6-27
6.4.4 Projected Sustainable Yield 6-29
6.4.5 Uncertainties in Projected Water Budget Simulations 6-30

6.5 Subbasin Water Supply Reliability 6-30

6.6 Historical and Current Water Budgets for Arroyo Seco Cone Management Area 6-30
6.6.1 Historical and Current Surface Water Budget for Arroyo Seco Cone Management Area 6-31
6.6.2 Historical and Current Groundwater Budget for Arroyo Seco Cone Management Area 6-33
6.6.3 Historical and Current Groundwater Budget Summary for Arroyo Seco Cone Management Area 6-39
6.6.4 Historical and Current Sustainable Yield for Arroyo Seco Cone Management Area....... 6-40
6.7 Projected Water Budgets for Arroyo Seco Cone Management Area 6-41
6.7.1 Assumptions and Overview of Projected Water Budget in Arroyo Seco Cone Management Area 6-41
6.7.2 Projected Surface Water Budget for Arroyo Seco Cone Management Area.................. 6-41
6.7.3 Projected Groundwater Budget for Arroyo Seco Cone Management Area..................... 6-41
6.7.4 Projected Sustainable Yield for Arroyo Seco Cone Management Area 6-43
6.7.5 Uncertainties in Projected Water Budget Simulations for Arroyo Seco Cone Management Area 6-45
6.8 Uncertainties in Water Budget Calculations 6-45
7 MONITORING NETWORKS.. 7-1
7.1 Introduction.. 7-1
7.1.1 Monitoring Network Objectives.. 7-1
7.1.2 Approach to Monitoring Networks... 7-1
7.1.3 Management Areas 7-2
7.2 Groundwater Level Monitoring Network.. 7-2
7.2.1 Groundwater Level Monitoring Protocols.. 7-8
7.2.2 Groundwater Level Monitoring Network Data Gaps 7-8
7.3 Groundwater Storage Monitoring Network 7-11
7.4 Groundwater Quality Monitoring Network... 7-11
7.4.1 Groundwater Quality Monitoring Protocols 7-14
7.4.2 Groundwater Quality Monitoring Data Gaps... 7-14
7.5 Land Subsidence Monitoring Network 7-14
7.5.1 Land Subsidence Monitoring Protocols 7-14
7.5.2 Land Subsidence Data Gaps... 7-15
7.6 Interconnected Surface Water Monitoring Network 7-15
7.6.1 Interconnected Surface Water Monitoring Protocols 7-17
7.6.2 Interconnected Surface Water Data Gaps... 7-17
7.7 Other Monitoring Networks 7-17
7.7.1 Groundwater Extraction.. 7-17
7.7.2 Salinas River Watershed Diversions 7-18
7.8 Data Management System and Data Reporting 7-19

8 SUSTAINABLE MANAGEMENT CRITERIA 8-1
8.1 Definitions 8-1
8.2 Sustainability Goal 8-2
8.3 Maintaining Long-Term Sustainability 8-3
8.4 General Process for Establishing Sustainable Management Criteria 8-4
8.5 Sustainable Management Criteria Summary 8-5
8.6 Chronic Lowering of Groundwater Levels SMC 8-8
8.6.1 Locally Defined Significant and Unreasonable Conditions 8-8
8.6.2 Minimum Thresholds 8-8
8.6.3 Measurable Objectives 8-17
8.6.4 Undesirable Results 8-20
8.7 Reduction in Groundwater Storage SMC 8-22
8.7.1 Locally Defined Significant and Unreasonable Conditions 8-22
8.7.2 Minimum Thresholds 8-22
8.7.3 Measurable Objectives 8-25
8.7.4 Undesirable Results 8-25
8.8 Degraded Water Quality SMC 8-27
8.8.1 Locally Defined Significant and Unreasonable Conditions 8-27
8.8.2 Minimum Thresholds 8-27
8.8.3 Measurable Objectives 8-34
8.8.4 Undesirable Results 8-34
8.9 Land Subsidence SMC 8-37
8.9.1 Locally Defined Significant and Unreasonable Conditions 8-37
8.9.2 Minimum Thresholds 8-37
8.9.3 Measurable Objectives 8-39
8.9.4 Undesirable Results 8-40
8.10 Depletion of Interconnected Surface Water SMC 8-41
8.10.1 Locally Defined Significant and Unreasonable Conditions 8-41
8.10.2 Minimum Thresholds 8-42
8.10.3 Measurable Objectives 8-47
8.10.4 Undesirable Results 8-48
REFERENCES R-1

LIST OF FIGURES

Figure 5-1. Spring 2019 Groundwater Elevation Contours 5-3
Figure 5-2. Fall 2019 Groundwater Elevation Contours 5-4
Figure 5-3. Spring 1995 Groundwater Elevation Contours 5-5
Figure 5-4. Fall 1995 Basin Fill Groundwater Elevation Contours 5-6

Figure 5-5. Map of Example Hydrographs 5-8
Figure 5-6. Locations of Representative Monitoring Wells with Hydrographs Included in Appendix 5A 5-9
Figure 5-7. Cumulative Groundwater Elevation Change Graph for the Forebay Subbasin....................... 5-11
Figure 5-8. MCWRA Management Subareas 5-12
Figure 5-9. Vertical Gradients 5-14
Figure 5-10. Annual and Cumulative Change in Groundwater Storage and Total Groundwater Extraction in the Forebay Subbasin, Based on Groundwater Elevations 5-17
Figure 5-11. Change in Groundwater Storage from Fall 1995 to Fall 2019 5-18
Figure 5-12. Active Cleanup Sites 5-20
Figure 5-13. Estimated Nitrate Concentrations 5-22
Figure 5-14. Nitrate Concentrations, 1950 to 2007 5-23
Figure 5-15. Estimated Average Annual InSAR Subsidence in Subbasin 5-28
Figure 5-16. Conceptual Representation of Interconnected Surface Water 5-29
Figure 6-1. Schematic Hydrogeologic Conceptual Model (from DWR, 2020d) 6-3
Figure 6-2. Zone and Boundary Conditions for the Salinas Valley Integrated Hydrologic Model 6-4
Figure 6-3. Climate and Precipitation for Historical and Current Water Budget Time Periods 6-7
Figure 6-4. Surface Water Network in Forebay Aquifer Subbasin from the Salinas Valley Integrated Hydrologic Model 6-12
Figure 6-5. Historical and Current Surface Water Budget 6-13
Figure 6-6. SVIHM Simulated Inflows to the Groundwater System 6-16
Figure 6-7. SVIHM Simulated Outflows from the Groundwater System 6-17
Figure 6-8. SVIHM Simulated Groundwater Pumping by Water Use Sector 6-19
Figure 6-9. SVIHM Simulated Subsurface Inflows and Outflows from Watershed Areas and Neighboring Subbasin 6-20
Figure 6-10. SVIHM Simulated Historical and Current Groundwater Budget 6-22
Figure 6-11. SVIHM Estimated Historical and Current Surface Water Budget for Arroyo Seco Cone Management Area 6-32
Figure 6-12. SVIHM Estimated Groundwater Inflows to Arroyo Seco Cone Management Area 6-34
Figure 6-13. SVIHM Estimated Groundwater Outflows from Arroyo Seco Cone Management Area 6-35
Figure 6-14. SVIHM Estimated Groundwater Pumping by Water Use Sector in Arroyo Seco Cone Management Area 6-37
Figure 6-15. SVIHM Simulated Subsurface Inflows and Outflows for Arroyo Seco Cone Management Area 6-38
Figure 6-16. SVIHM Estimated Groundwater Budget for Arroyo Seco Cone Management Area 6-39
Figure 7-1. Forebay Aquifer Monitoring Network for Groundwater Levels 7-4
Figure 7-2. Forebay Aquifer Representative Monitoring Network for Groundwater Levels 7-5
Figure 7-3. Data Gaps in the Groundwater Level Monitoring Network 7-10
Figure 7-4. DDW Public Water System Supply Wells in the Groundwater Quality Monitoring Network 7-12
Figure 7-5. ILRP Wells in the Groundwater Quality Monitoring Network 7-13
Figure 7-6. Interconnected Surface Water Monitoring Network 7-16
Figure 8-1. Groundwater Level Minimum Threshold Contour Map 8-10

Figure 8-2. Cumulative Groundwater Elevation Change Hydrograph with Selected Minimum Threshold and Measureable Objective for the Forebay Aquifer Subbasin 8-13
Figure 8-3. Groundwater Level Measurable Objective Contour Map 8-18

LIST OF TABLES

Table 5-1. Figures Showing Current and Historical Groundwater Elevation Contours........ 5-2
Table 5-2. Active Cleanup Sites 5-19
Table 5-3. Water Quality Constituents of Concern and Exceedances 5-25
Table 5-4. Average SVIHM Simulated Depletion of Interconnected Surface Waters (AF/yr)........ 5-31
Table 6-1. Summary of Historical and Current Water Budget Time Periods........ 6-7
Table 6-2. Summary of Water Budget Component Data Source from the Salinas Valley Integrated Hydrologic Model 6-10
Table 6-3. SVIHM Simulated Surface Water Budget Summary (AF/yr) 6-13
Table 6-4. SVIHM Simulated Net Flow Between Surface Water and Groundwater for Selected Streams (AF/yr)........ 6-14
Table 6-5. SVIHM Simulated Net Flow Between Surface Water and Groundwater for Salinas River for Reservoir Release Periods (AF/yr)........ 6-14
Table 6-6. SVIHM Simulated Groundwater Inflows Summary (AF/yr) 6-16
Table 6-7. SVIHM Simulated and Adjusted Groundwater Outflows Summary (AF/yr)........ 6-17
Table 6-8. SVIHM Simulated and Adjusted Groundwater Pumping by Water Use Sector (AF/yr)........ 6-19
Table 6-9. SVIHM Simulated Net Subbasin Boundary Flows (AF/yr) 6-20
Table 6-10. Summary of Groundwater Budget (AF/yr) 6-23
Table 6-11. Historical Sustainable Yield for the Forebay Aquifer Subbasin Derived from GEMS and Adjusted Change in Storage (AF/yr) 6-23
Table 6-12. SVOM Simulated Average Surface Water Inflow and Outflow Components for Projected Climate Change Conditions (AF/yr)........ 6-26
Table 6-13. SVOM Simulated Net Flow Between Surface Water and Groundwater for Reservoir Release Periods for the Projected Climate Change Conditions (AF/yr) 6-26
Table 6-14. SVOM Simulated Average Groundwater Inflow Components for Projected Climate Change Conditions (AF/yr) 6-27
Table 6-15. SVOM Simulated and Adjusted Average Groundwater Outflow Components for Projected Climate Change Conditions (AF/yr)........ 6-27
Table 6-16. SVOM Simulated and Adjusted Average Annual Groundwater Budget for Projected Climate Change Conditions (AF/yr)........ 6-28
Table 6-17. SVOM Simulated Projected and Adjusted Annual Groundwater Pumping by Water Use Sector (AF/yr)........ 6-29
Table 6-18. Projected Sustainable Yields with Pumping Adjusted Based on GEMS Data (AF/yr)........ 6-29
Table 6-19. SVIHM Estimated Surface Water Budget Summary for Arroyo Seco Cone Management Area (AF/yr) 6-31

Table 6-20. SVIHM Estimated Net Flow Between Surface Water and Groundwater by Stream Zone for Arroyo Seco Cone Management Area (AF/yr) 6-32
Table 6-21. SVIHM Simulated Groundwater Inflows Budget Summary in Arroyo Seco Cone Management Area (AF/yr) 6-34
Table 6-22. SVIHM Simulated and Adjusted Groundwater Outflows Budget Summary in Arroyo Seco Cone Management Area (AF/yr)........ 6-35
Table 6-23. SVIHM Estimated and Adjusted Groundwater Pumping by Water Use Sector in Arroyo Seco Cone Management Area (AF/yr) 6-37
Table 6-24: Summary of Groundwater Budget for Arroyo Seco Cone Management Area (AF/yr)........ 6-40
Table 6-25. Historical Sustainable Yield for the Arroyo Seco Cone Management Area Derived from GEMS and Adjusted Change in Storage (AF/yr) 6-41
Table 6-26. SVOM Simulated Average Surface Water Inflow and Outflow Components for Projected Climate Change Conditions for the Arroyo Seco Cone Management Area (AF/yr) 6-41
Table 6-27. SVOM Simulated Average Groundwater Inflow Components for Projected Climate Change Conditions in Arroyo Seco Cone Management Area (AF/yr) 6-42
Table 6-28. SVOM Simulated and Adjusted Average Groundwater Outflow Components for Projected Climate Change Conditions in Arroyo Seco Cone Management Area (AF/yr) 6-42
Table 6-29. SVOM Simulated and Adjusted Average Annual Groundwater Budget for Projected Climate Change Conditions in Arroyo Seco Cone Management Area (AF/yr) 6-43
Table 6-30. Projected SVOM Simulated and Adjusted Annual Groundwater Pumping by Water Use Sector in Arroyo Seco Cone Management Area (AF/yr)........ 6-43
Table 6-31. Projected Sustainable Yields in Arroyo Seco Cone Management Area with Pumping Adjusted Based on GEMS Data (AF/yr)........ 6-44
Table 7-1. Forebay Aquifer Groundwater Level Representative Monitoring Site Network 7-6
Table 7-2. Datasets Available for Use in Populating the DMS........ 7-20
Table 8-1. Sustainable Management Criteria Summary 8-6
Table 8-2. Chronic Lowering of Groundwater Levels Minimum Thresholds and Measurable Objectives 8-9
Table 8-3. Chronic Lowering of Groundwater Levels Interim Milestones........ 8-19
Table 8-4. Reduction in Groundwater Storage Interim Milestones........ 8-25
Table 8-5. Degradation of Groundwater Quality Minimum Thresholds and Measurable Objectives 8-28
Table 8-6. Summary of Constituents Monitored in Each Well Network........ 8-30
Table 8-7. Reported Annual Surface Water Diversions in the Forebay Aquifer Subbasin 8-44

ACRONYMS AND ABBREVIATIONS

$/AF	dollar per acre-foot
AF	acre-foot or acre-feet
AF/yr	acre-feet per year
ASCMA	Arroyo Seco Cone Management Area
ASGSA	Arroyo Seco Groundwater Sustainability Agency
Basin	Salinas Valley Groundwater Basin
Basin Plan	Water Quality Control Plan for the Central Coast Basin
BLM	U.S. Bureau of Land Management
BMPs	Best Management Practices
CASGEM	California Statewide Groundwater Elevation Monitoring
CCGC	Central Coast Groundwater Coalition
CCRWQCB	Central Coast Regional Water Quality Control Board
CEQA	California Environmental Quality Act
COC	constituents of concern
CPE Actions	Communication and Engagement Actions
CSD	Community Services District
CCGC	Central Coast Groundwater Coalition
CCRWQCB	Central Coast Regional Water Quality Control Board
CEQA	California Environmental Quality Act
COC	constituents of concern
CPE Actions	communication and public engagement actions
CSD	Castroville Community Services District
CSIP	Castroville Seawater Intrusion Project
DACs	Disadvantaged Communities
DDW	Division of Drinking Water
DEM	Digital Elevation Model
DMS	Data Management System
D-TAC	Drought Advisory Technical Committee
DTSC	The California Department of Toxic Substances Control
DWR	California Department of Water Resources
EIR	Environmental Impact Report
EPA	Environmental Protection Agency
ET	evapotranspiration
eWRIMS	Electronic Water Rights Information Management System
GAMA	Groundwater Ambient Monitoring and Assessment Program
GDE	groundwater-dependent ecosystem
GEMS	Monterey County Groundwater Extraction Management System
GIS	Geographic Information Systems
GMP	Groundwater Management Plan

GSA	Groundwater Sustainability Agency/Agencies
GSP or Plan	Groundwater Sustainability Plan
HCM	hydrogeologic conceptual model
HCP	Habitat Conservation Plan
ILRP	Irrigated Lands Regulatory Program
InSAR	Interferometric Synthetic Aperture Radar
IRWMP	Integrated Regional Water Management Plan
ISW	interconnected surface water
JPA	Joint Powers Authority
MCLs	Maximum Contaminant Levels
MCWRA	Monterey County Water Resources Agency
NAVD88	North American Vertical Datum of 1988
NCCAG	Natural Communities Commonly Associated with Groundwater
NEPA	National Environmental Policy Act
NMFS	National Marine Fisheries Service
O&M	operations and maintenance fees
OWSCR	Online System for Well Completion Reports Database
RCDMC	Resource Conservation District of Monterey
RMS	Representative Monitoring Sites
RWMG	Greater Monterey County Regional Water Management Group
SAGBI	Soil Agricultural Groundwater Banking Index
SDACs	Severely Disadvantaged Communities
SGMA	Sustainable Groundwater Management Act
SMC	Sustainable Management Criteria
SMCLs	Secondary Maximum Contaminant Levels
SMC TAC	Sustainable Management Criteria Technical Advisory Committee
SMP	Salinas River Stream Maintenance Program
SRDF	Salinas River Diversion Facility
Subbasin	Forebay Aquifer Subbasin
SVBGSA	Salinas Valley Basin Groundwater Sustainability Agency
SVIHM	Salinas Valley Integrated Hydrologic Model
SVOM	Salinas Valley Operational Model
SWRCB	State Water Resources Control Board
TAC	Technical Advisory Committee
TDS	total dissolved solids
URCs	Underrepresented Communities
USACE	U.S. Army Corps of Engineers
USFWS	U.S. Fish and Wildlife Service
USGS	U.S. Geological Survey
UWMP	Urban Water Management Plan

5 GROUNDWATER CONDITIONS

This chapter describes the current and historical groundwater conditions in the Forebay Subbasin in accordance with the GSP Regulations §354.16. In this GSP, current conditions are any conditions occurring after January 1, 2015. 2019 was chosen as the representative current year where possible. 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 maintain 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. As described in Chapter 4, the Forebay Subbasin contains the ASCMA. This chapter does not separate the ASCMA from the greater Forebay Subbasin. Instead, groundwater conditions are discussed for the entire Subbasin to reflect the single sustainability goal for the Subbasin.

This chapter is organized to align the groundwater conditions descriptions with the 5 sustainability indicators relevant to this Subbasin, including:

1. Chronic lowering of groundwater levels
2. Changes in groundwater storage
3. Subsidence
4. Groundwater quality
5. Depletion of ISW

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. MCWRA's monitoring programs are described in Chapter 3.

5.1.2 Groundwater Elevation Contours and Horizontal Groundwater Gradients

Groundwater elevation data are analyzed and presented with 3 sets of graphics:

Maps of groundwater elevation contours show the geographic distribution of groundwater elevations at a specific time. These contours represent the elevation of the groundwater in feet, using the NAVD88. 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 next blue line (Figure 5-1 through Figure 5-4). Hydrographs of individual wells show the variations in groundwater elevations at individual wells over an extended period of time (Figure 5-5). Vertical hydraulic gradients in a single location assess the potential for vertical groundwater flow direction, as discussed in Section 5.1.4.

MCWRA annually produces groundwater elevation contour maps for the Salinas Valley Groundwater Basin using data from their annual fall measurement program that takes place from mid-November to December. MCWRA uses fall groundwater elevations because these measurements are taken after the end of the irrigation season and before seasonal recharge from winter precipitation increases groundwater levels. The fall measurements represent seasonal low conditions in the Subbasin in this GSP. MCWRA does not produce groundwater elevation contour maps in the spring. Therefore, new maps of spring groundwater levels were developed for this GSP. Spring groundwater elevation maps were developed from data collected between January and March for 2019 and 1995. The period from January to March usually reflects seasonal high groundwater levels in the Salinas Valley Groundwater Basin (MCWRA, 2015). The MCWRA Quarterly Salinas Valley Water Conditions report demonstrates that in 2019, the seasonal high groundwater elevations occurred in February (MCWRA, 2019a). In 1995, data collected in March were more representative of seasonal high groundwater elevations.

The following 8 maps present the Current (2019) and Historical (1995) groundwater elevation contours derived from MCWRA data.

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

Figure #	Year	Season
Figure 5-1	Current (2019)	Spring
Figure 5-2	Current (2019)	Fall
Figure 5-3	Historical (1995)	Spring
Figure 5-4	Historical (1995)	Fall

The groundwater elevation contours only cover the portions of the Subbasin monitored by MCWRA and do not always extend to Subbasin margins. Contours are reflective of the groundwater elevations for the entire Basin Fill Aquifer as described in the HCM in Chapter 4.

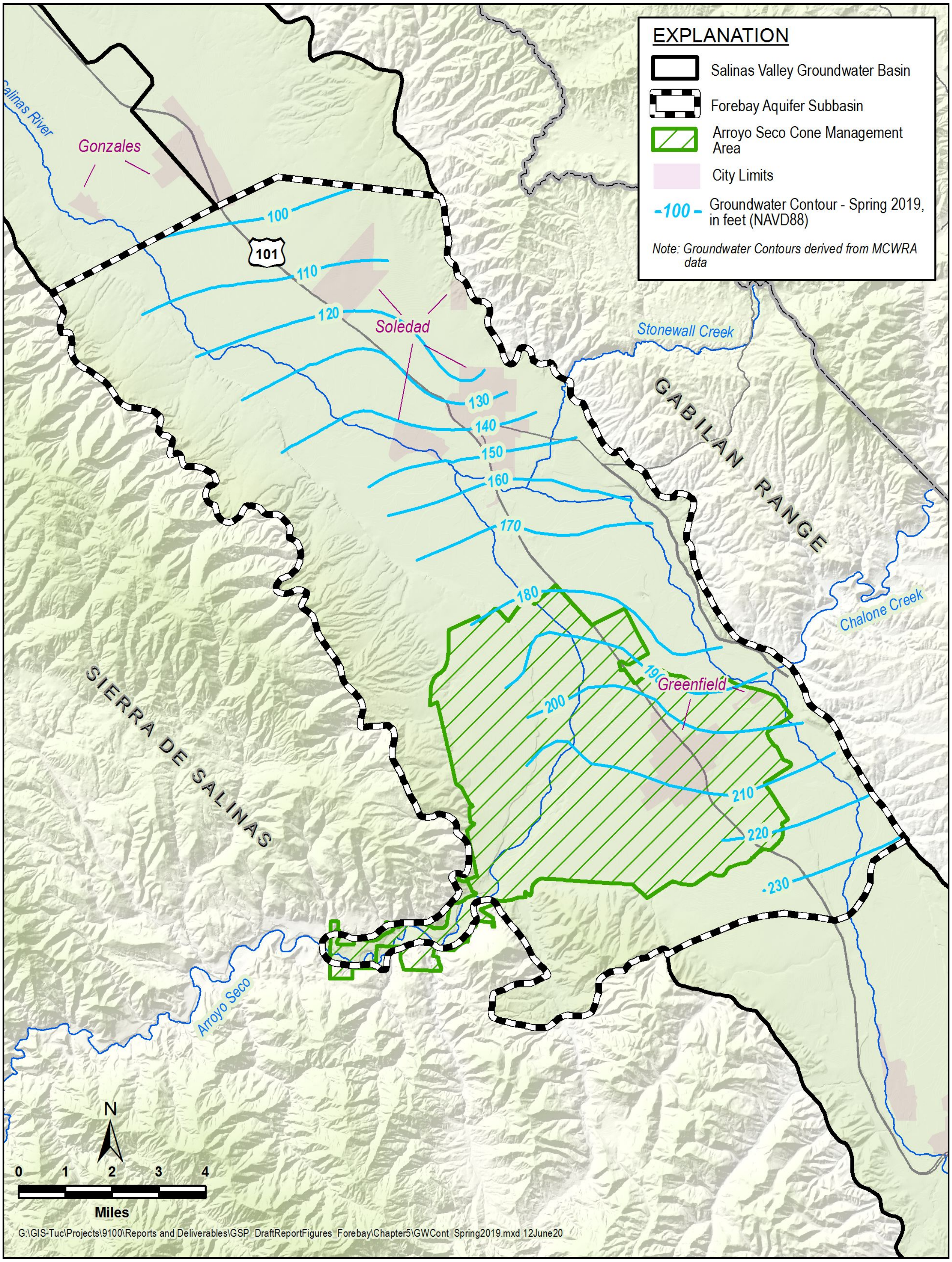


Figure 5-1. Spring 2019 Groundwater Elevation Contours

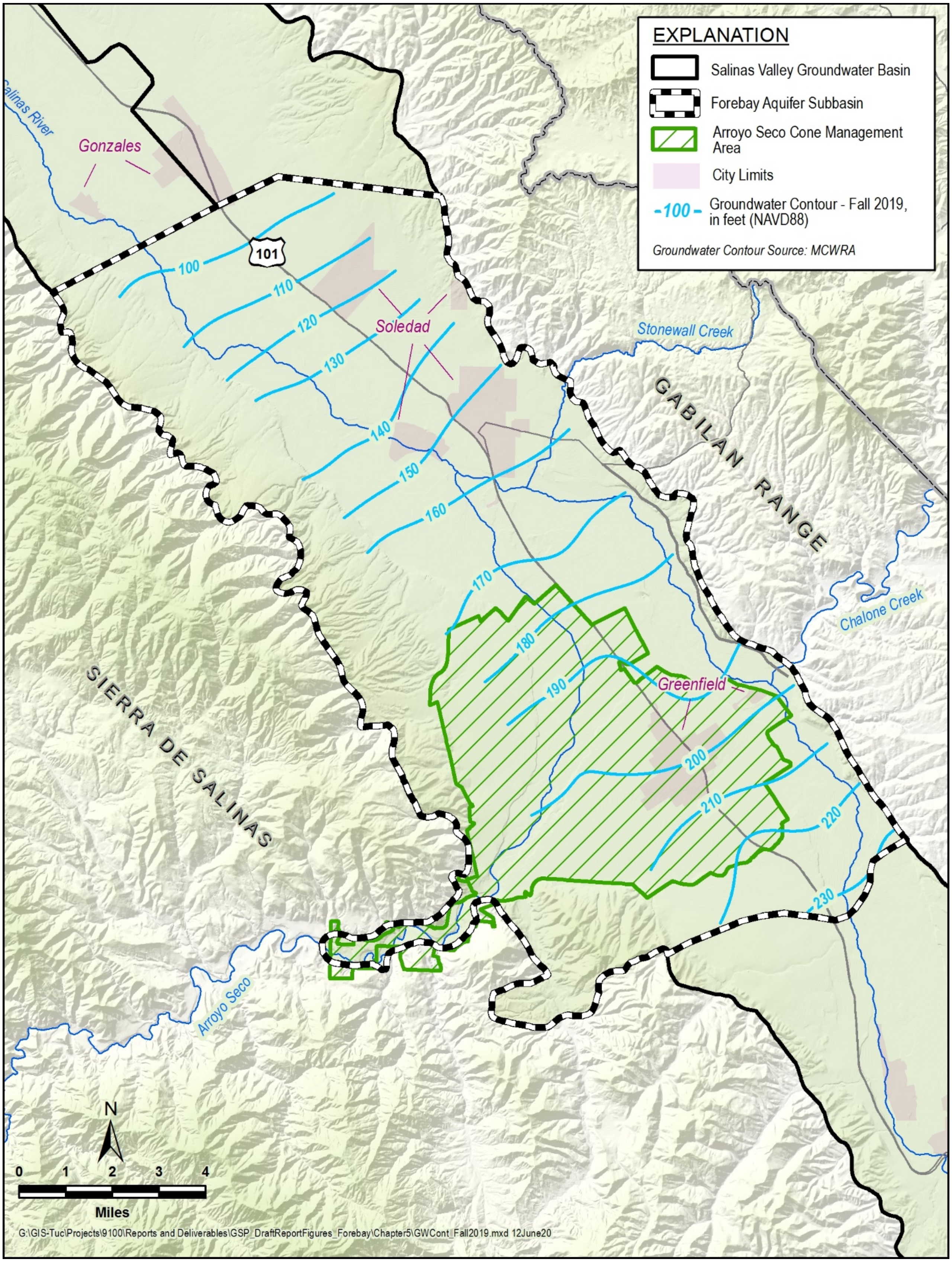


Figure 5-2. Fall 2019 Groundwater Elevation Contours

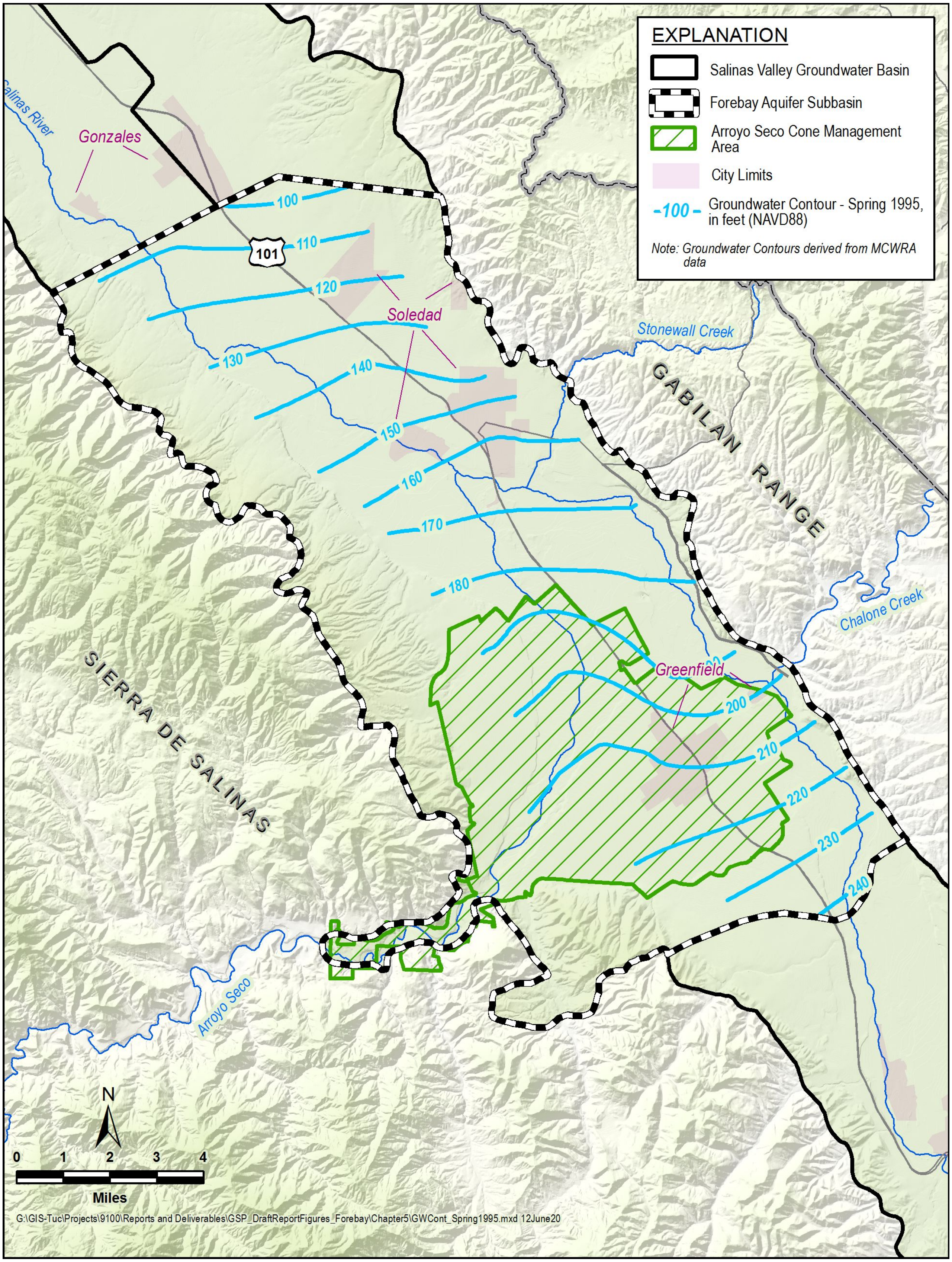


Figure 5-3. Spring 1995 Groundwater Elevation Contours

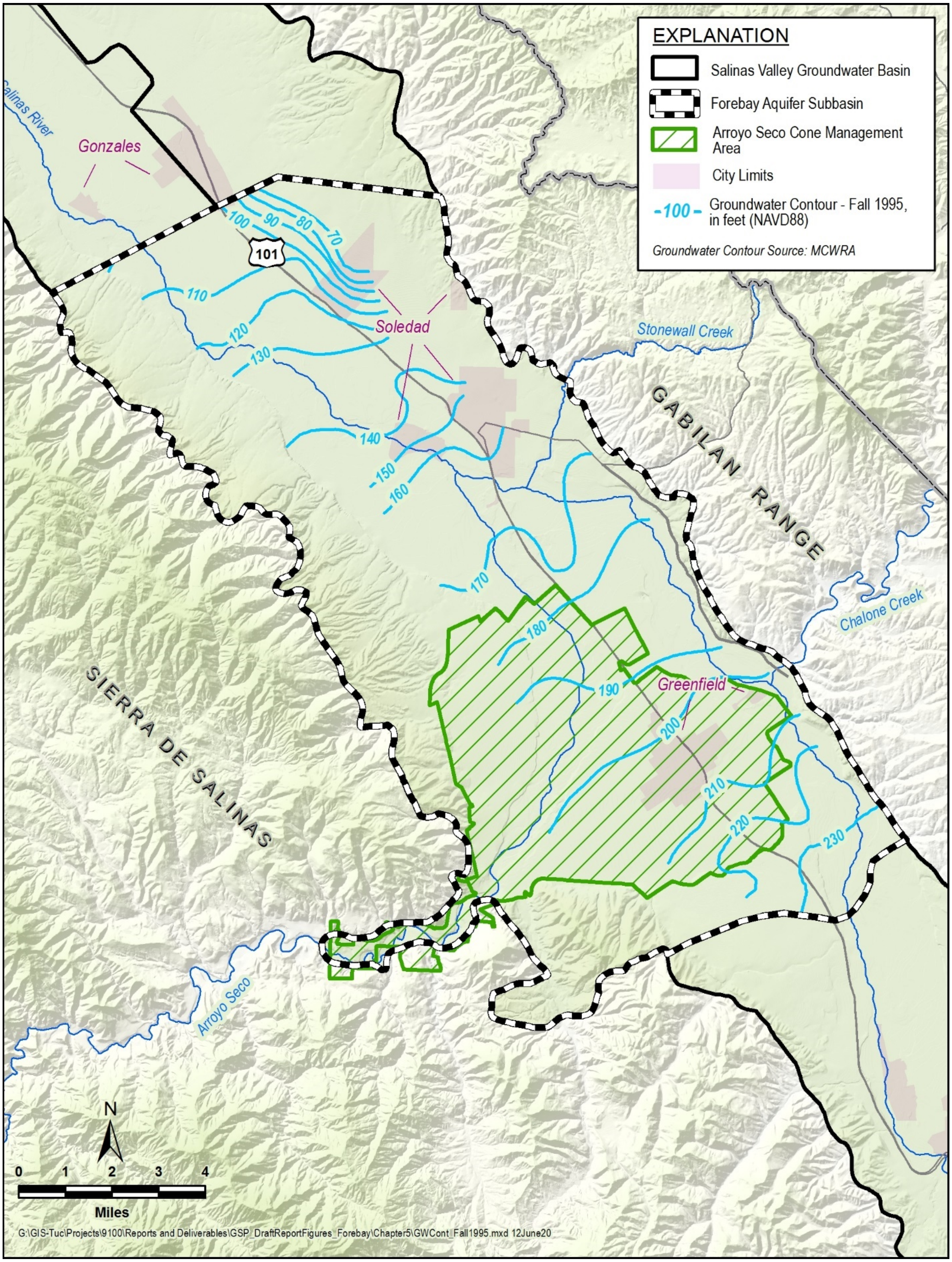


Figure 5-4. Fall 1995 Basin Fill Groundwater Elevation Contours

Groundwater in the Forebay Subbasin generally flows from south-southeast to north-northwest. The lowest groundwater elevations in the Subbasin occur along the boundary with the 180/400-Foot Aquifer and Eastside Subbasins near Gonzales. The minimum groundwater elevations are approximately 100 feet NAVD88 during both the spring and fall 2019 measurements. The hydraulic gradient across the Basin Fill Aquifer was approximately 0.0011 feet/feet, or 6 feet/mile during the spring 2019. Groundwater elevations in the Subbasin generally increase toward the boundary with the Upper Valley Subbasin, with groundwater elevations greater than 230 feet NAVD88 at the Subbasin boundary in the spring 2019. Under the historical conditions of 1995, a similar flow pattern to that of current conditions was present in the Forebay Subbasin. Examples of historical groundwater elevation changes at specific wells are presented in Section 6.3.

The groundwater elevation contours reflect conditions in the single Basin Fill Aquifer. If individual aquifers are delineated in the future, separate groundwater contour maps will be developed for each aquifer.

5.1.3 Hydrographs

Representative temporal trends in groundwater elevations can be assessed with hydrographs, which 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 5-5 depicts the locations and hydrographs of example monitoring wells in the Subbasin. Larger versions of the hydrographs for these wells, as well as all representative monitoring wells, are included in Appendix 5A. The locations of all the representative monitoring wells are shown on Figure 5-6. . Chapter 7 provides more information specific to the wells and the monitoring system.

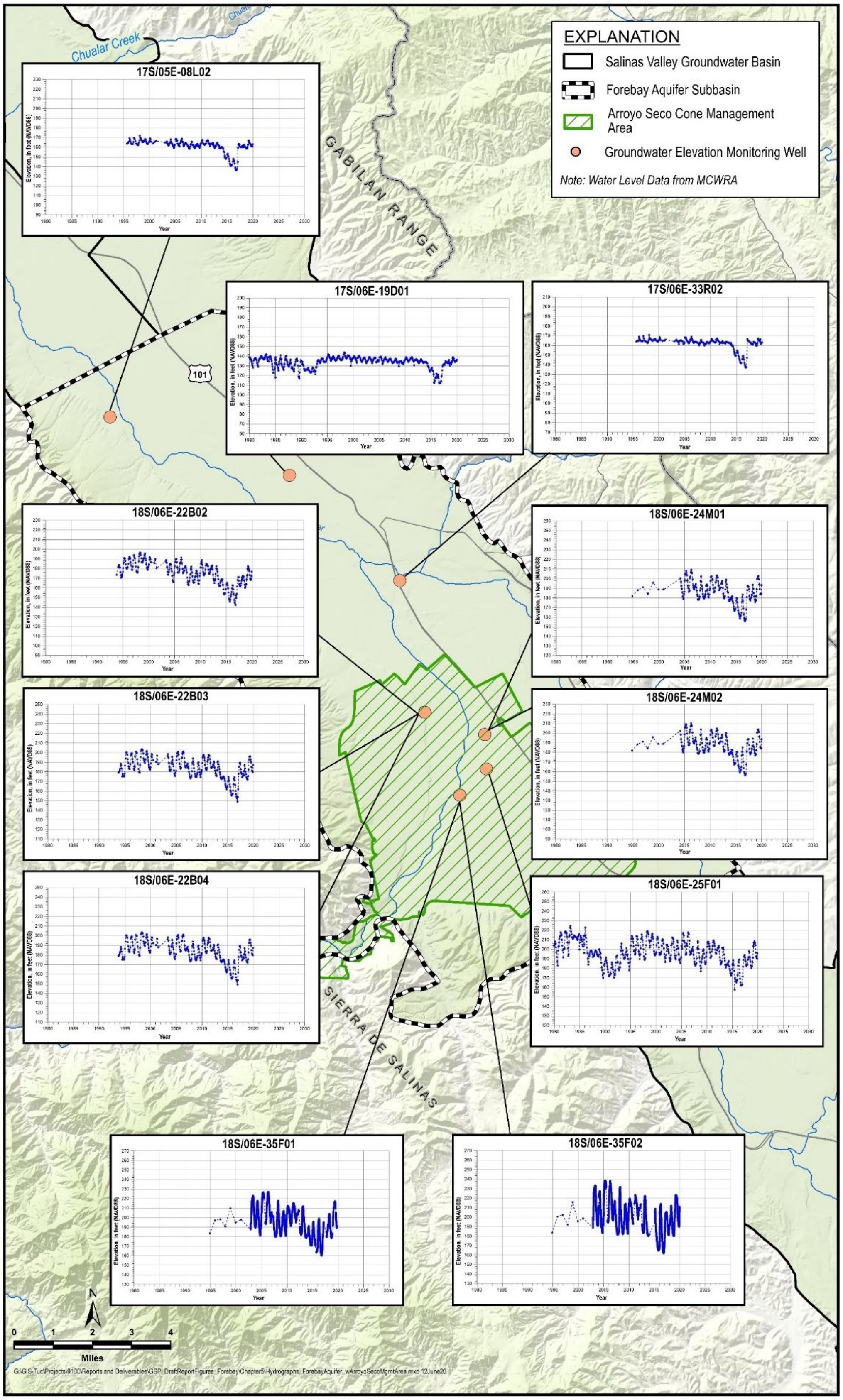


Figure 5-5. Map of Example Hydrographs

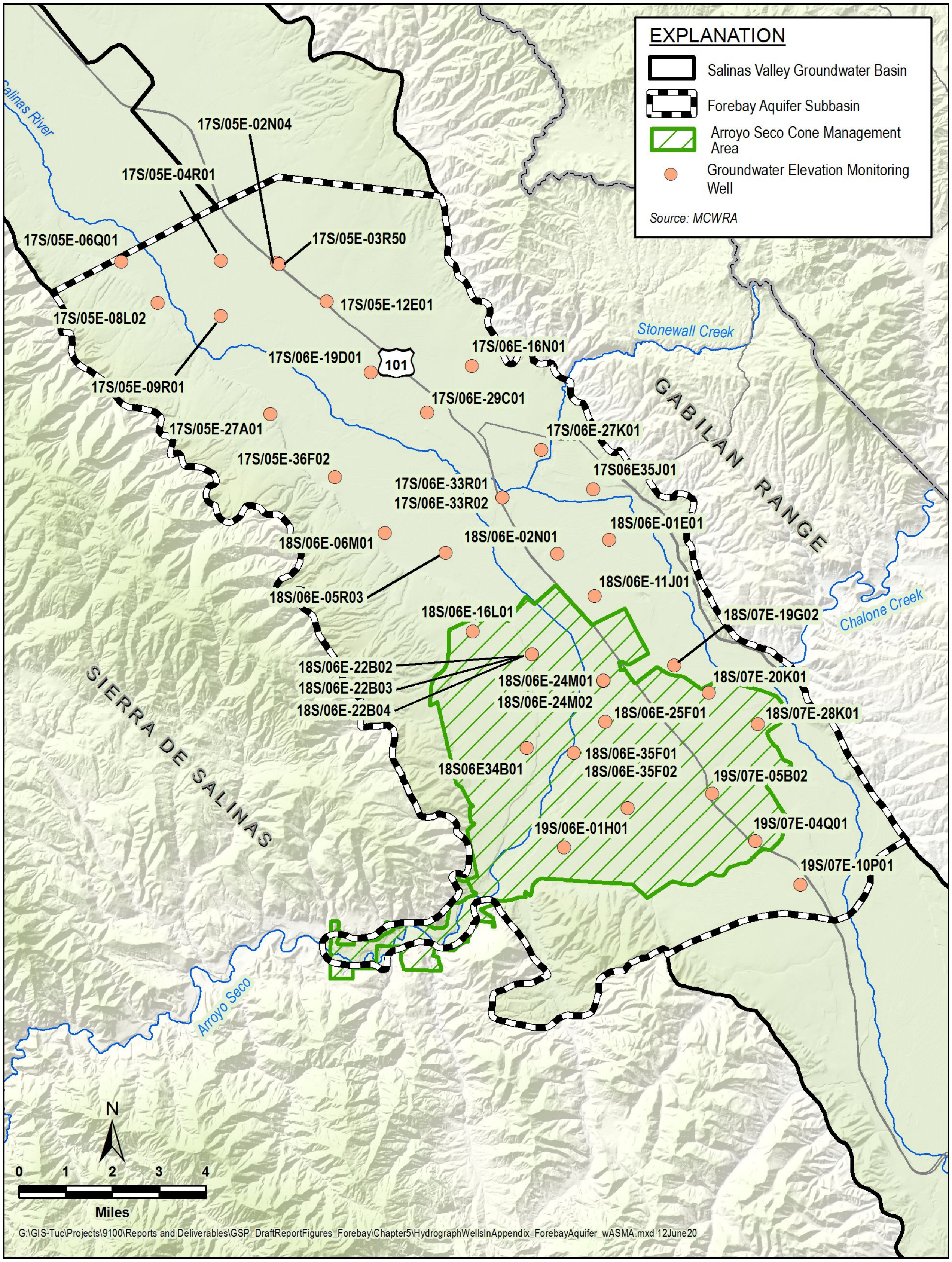


Figure 5-6. Locations of Representative Monitoring Wells with Hydrographs Included in Appendix 5A

Figure 5-7 presents a graph of cumulative groundwater elevation change for the Forebay Subbasin. The graph was initially developed by MCWRA and is based on averaged change in fall groundwater elevations for designated wells in the Forebay Subarea each year. The Forebay subarea overlaps the Forebay Subbasin, as well as small portions of the 180/400-Foot Aquifer and the Eastside Subbasins, as shown on Figure 5-8. The figure was adapted to reflect the cumulative change in groundwater elevations specific to the Forebay Subbasin.

Fall measurements occur at the end of the irrigation season and before groundwater levels increase due to seasonal recharge by winter rains. These measurements record annual changes in storage reflective of groundwater recharge and withdrawals in the Subbasin. The cumulative groundwater elevation change plot is therefore an estimated average hydrograph for wells in the Subbasin. Although this plot does not reflect the groundwater elevation change at any specific location, it provides a general illustration of how the average groundwater elevation in the Subbasin changes in response to climatic cycles, groundwater extraction, and water-resources management at the subbasin scale.

The cumulative elevation change graph and the specific hydrographs presented in Appendix 5A show that groundwater elevations in the Subbasin have been relatively constant in part of the Subbasin near the Salinas River, but show a slight declining trend since the late 1990s in other parts of the Subbasin.

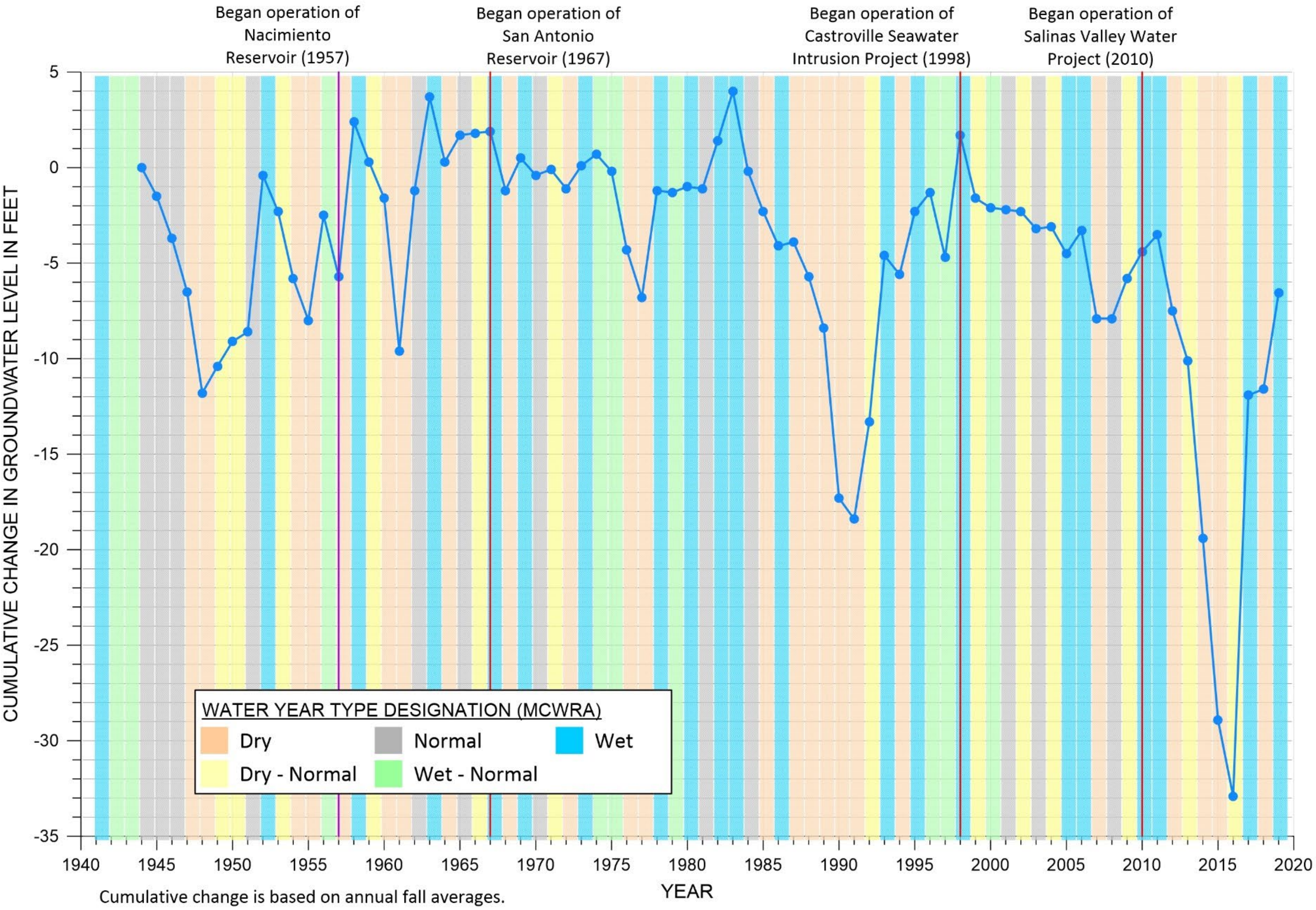


Figure 5-7. Cumulative Groundwater Elevation Change Graph for the Forebay Subbasin (adapted from MCWRA, 2018a, personal communication)

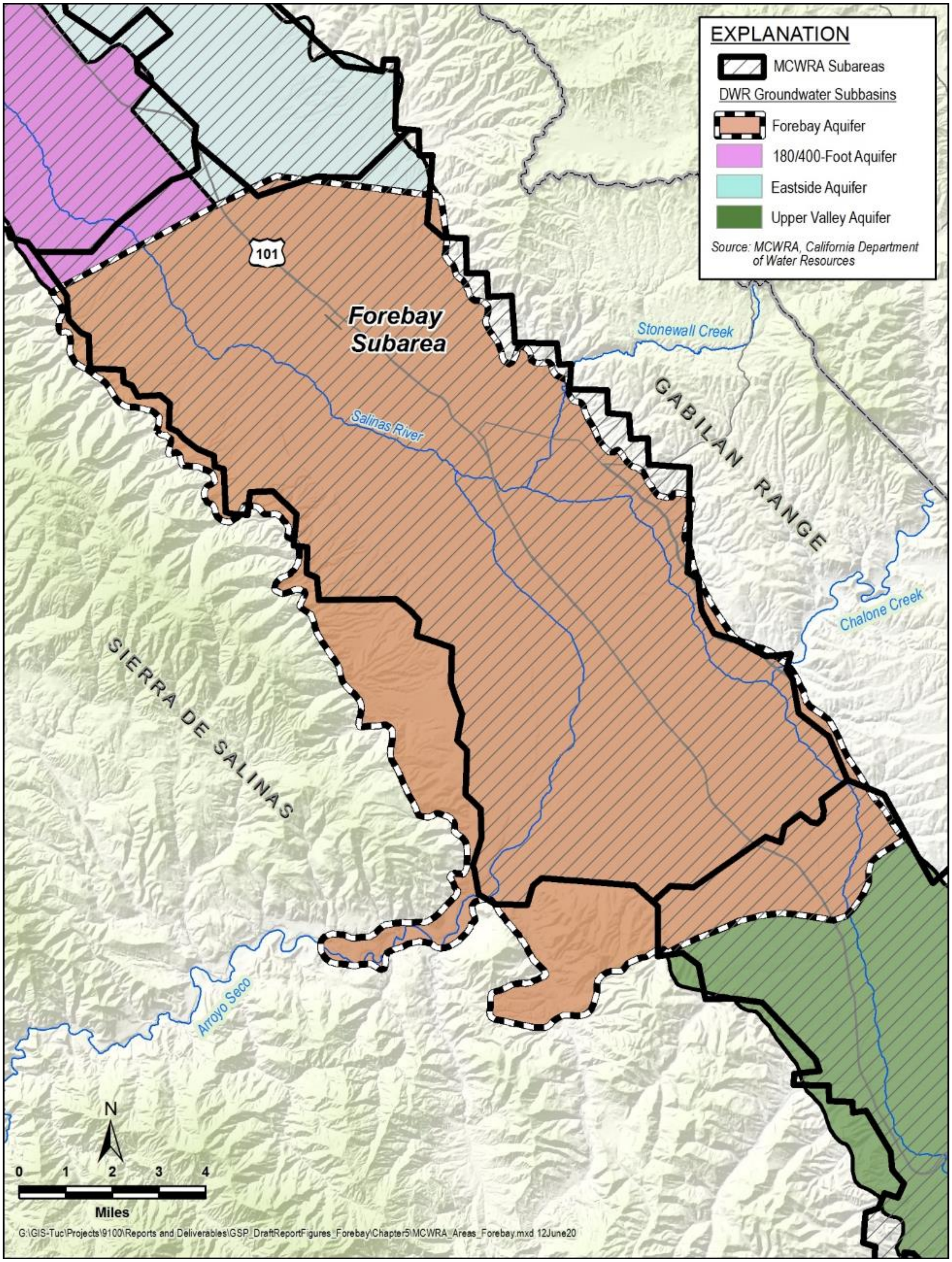


Figure 5-8. MCWRA Management Subareas

5.1.4 Vertical Groundwater Gradients

As discussed in Chapter 4, the Forebay Subbasin has a single principal aquifer—the Basin Fill Aquifer. It is lithologically similar to the 400-Foot and Deep Aquifers in the neighboring 180/400-Foot Aquifer Subbasin. However, the presence and continuity of the aquitard that separates these aquifers in the 180/400-Foot Subbasin is largely unknown in the Forebay Subbasin. Figure 5-9 shows groundwater elevations at 3 well pairs in the Subbasin. The well pairs consist of 2 adjacent wells with different well depths, one shallow and the other deep. The northernmost well pair consists of a shallow well (17S/05E-02N04) and a deep well that is potentially tapping into the deeper sediments of the Basin Fill Aquifer (17S/05E-03R50). The similarity in groundwater elevations suggests that these 2 wells are hydraulically connected. The middle well pair consists of wells that are likely in the Basin Fill Aquifer which is reflected in the similar trends in groundwater elevations of the shallow well (17S/06E-33R02) and deep well (17S/06E-33R01). The southernmost well pair is within the ASCMA. The vertical extent of the Arroyo Seco Cone is unknown, as its relationship with the deepest sediments in the subbasin. For this well pair groundwater elevations in the shallow well (18S/06E-35F02) are generally the same as the groundwater elevations in the deep well (18S/06E-35F01). The noticeably similar trends in groundwater elevations at the 2 depths suggests that these wells are also hydraulically connected despite the difference in depths.

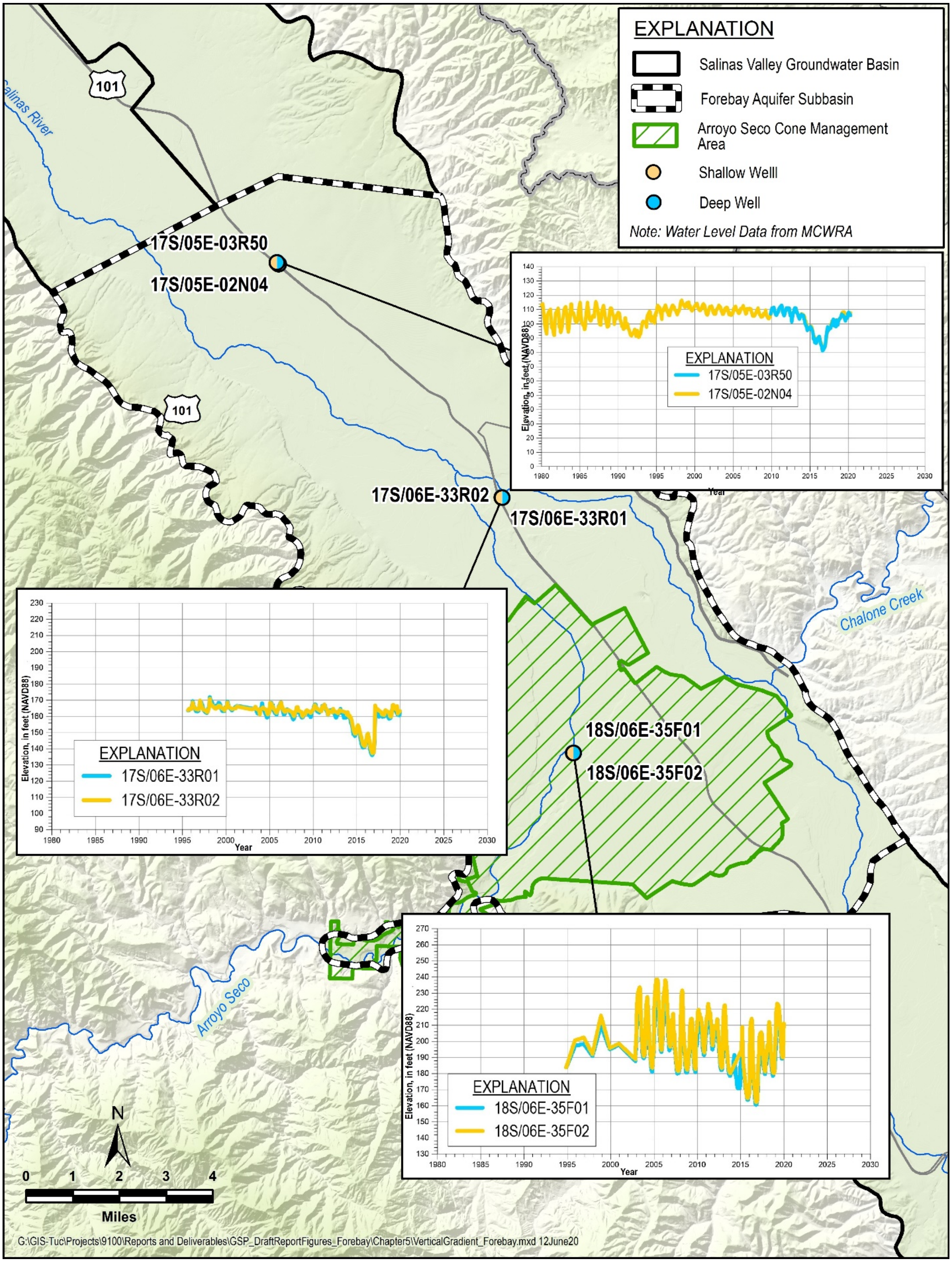


Figure 5-9. Vertical Gradients

5.2 Change in Groundwater Storage

5.2.1 Data Sources

Change in storage is developed based on MCWRA's fall groundwater elevation measurements. This includes historical groundwater elevation measurements used to develop the cumulative change in groundwater elevation graph (Figure 5-7) that is used to estimate cumulative change in groundwater storage over time. Groundwater elevation measurements are also used to create fall groundwater elevation contour maps; MCWRA's fall 1995 and fall 2019 contour maps are used to determine the spatial distribution of storage change. Fall groundwater elevation contour maps were used rather than spring contour maps to retain consistency with the cumulative change in the groundwater elevation graph.

5.2.2 Change in Groundwater Storage

Change in groundwater storage is derived from change in groundwater elevations in the Subbasin in 2 ways: (1) using the cumulative subbasin-wide average change in groundwater elevations and (2) subtracting the fall 1995 from the and fall 2019 groundwater elevation maps. Both approaches rely on observed groundwater elevation changes that provide a measure of the gain and loss of groundwater in storage each year. The change in storage is 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 storage coefficient for the Forebay Subbasin was estimated at 0.12 based on the State of the Basin Report (Brown and Caldwell, 2015). The area of the Forebay Subbasin is approximately 94,000 acres.

Both approaches for calculating the change in storage using groundwater elevation changes are based on 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)

Figure 5-10 shows estimated cumulative change in groundwater storage in the Forebay Subbasin from 1944 through 2019. This graph is based on the cumulative change in groundwater elevation data (Figure 5-7). The magnitudes of the groundwater storage changes are calculated by multiplying the annual groundwater elevation change by the storage coefficient and size of the Subbasin.

Figure 5-11 shows that the Forebay 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 Forebay Subbasin between 1944 and 2019 is approximately 970 AF/yr, most of which occurred after the mid-1980s. Groundwater elevations have fluctuated over this time period. The change in storage calculation is a reflection of groundwater elevations in the start and end years, which captures the chronic lowering of groundwater levels in the Subbasin. Figure 5-10 also shows the annual change in storage and annual groundwater extractions.

Figure 5-11 shows the estimated change in groundwater storage calculated by subtracting the fall 2019 and fall 1995 groundwater elevation maps (Figure 5-2 and Figure 5-4, respectively). The change in groundwater storage map was calculated over an area of about 53,000 acres rather than the total Subbasin area because that is the approximate area of the Subbasin that is contoured. The greatest loss in groundwater storage in the Subbasin occurred adjacent to the city of Soledad and Greenfield. Around Soledad the loss in storage ranged between 0.5 to 1 AF per acre over an area of approximately 11,900 acres (Figure 5-11). Near Greenfield the loss in storage ranged between 0.5 to 1 AF per acre over an area of approximately 6,600 acres (Figure 5-11). This loss in storage is minimal and does not indicate that the Subbasin is unsustainable, especially as groundwater elevations are not in chronic decline and rebound after wet years.

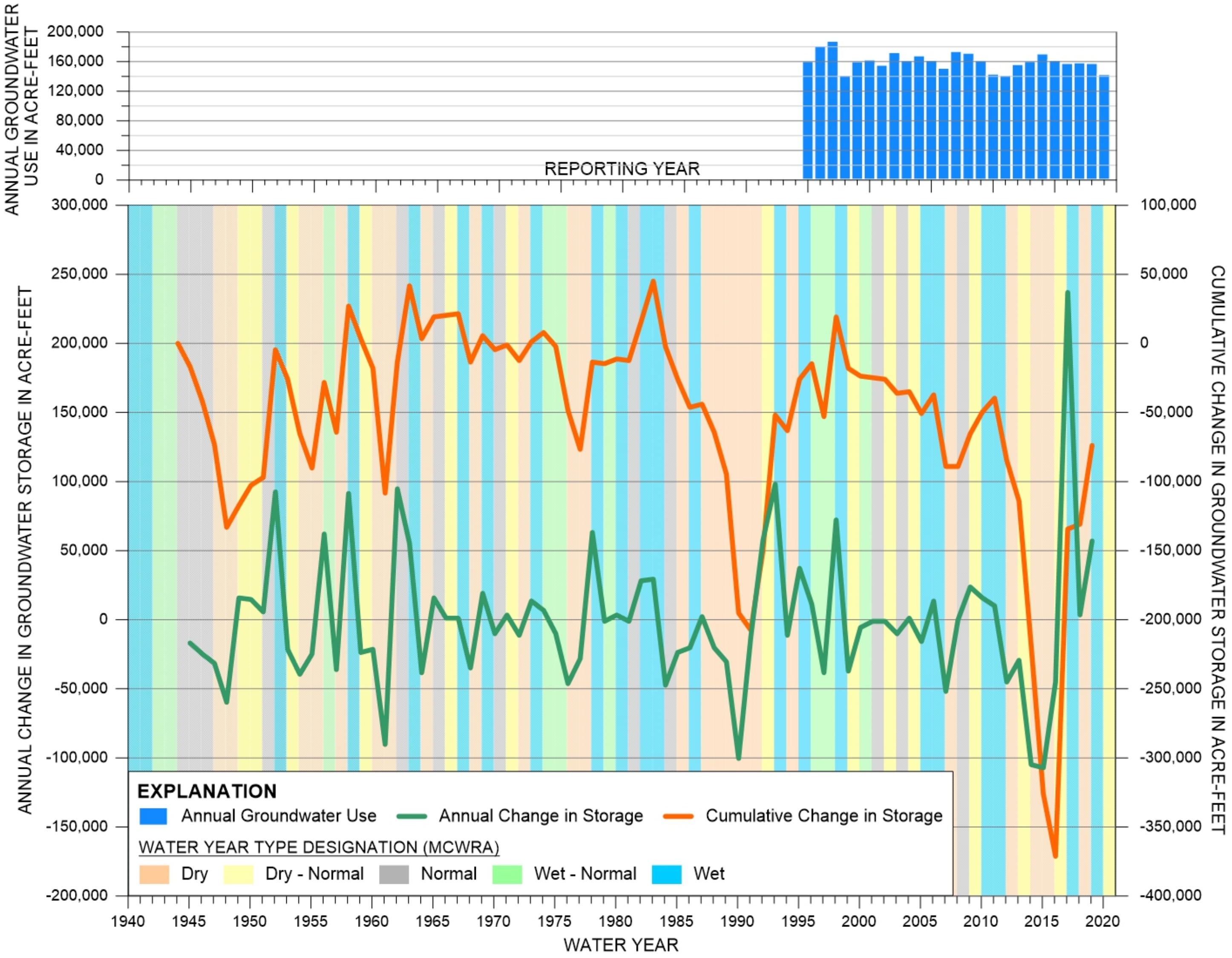


Figure 5-10. Annual and Cumulative Change in Groundwater Storage and Total Groundwater Extraction in the Forebay Subbasin, Based on Groundwater Elevations (Adapted from MCWRA, 2018a, personal communication)

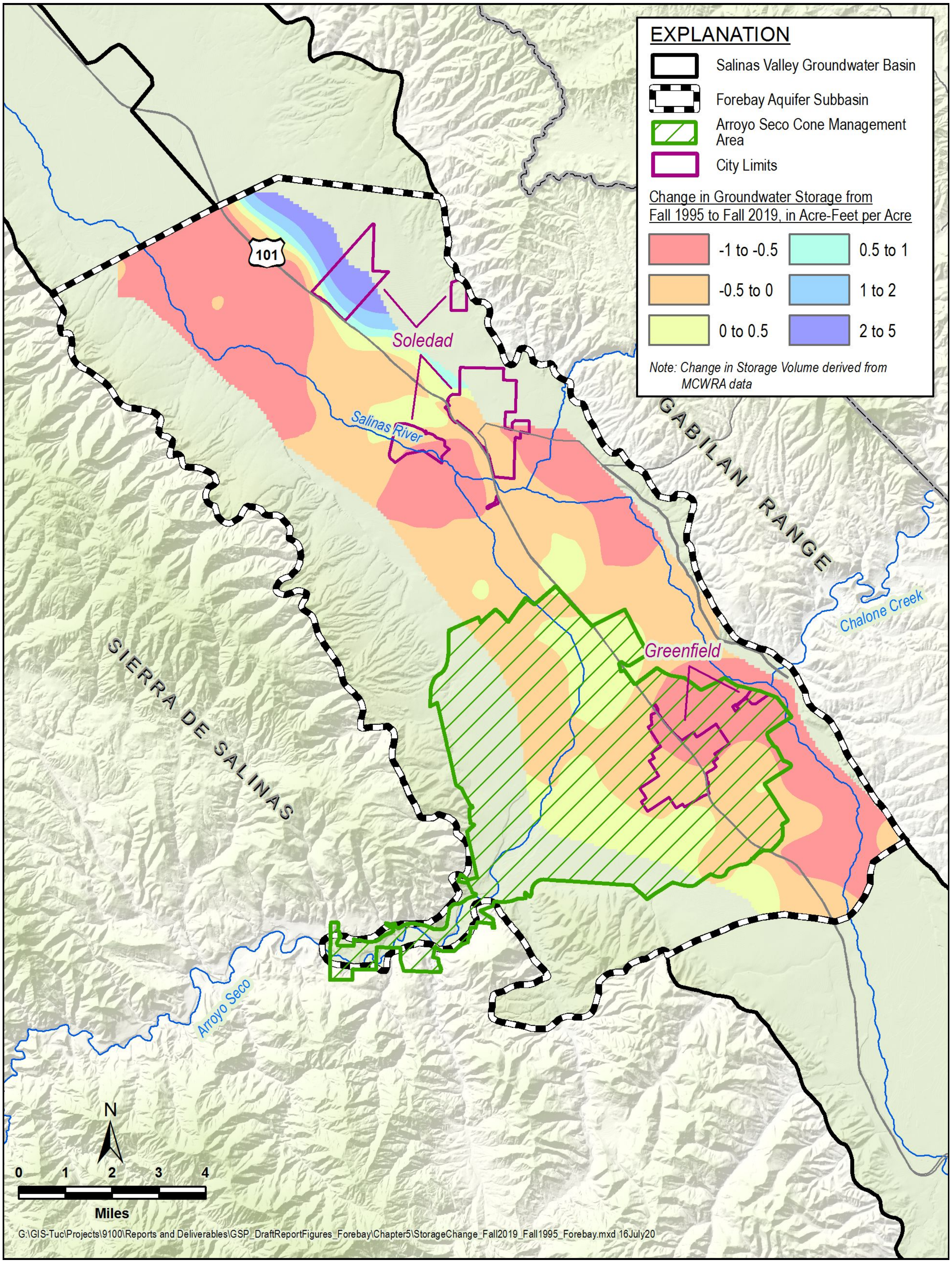


Figure 5-11. Change in Groundwater Storage from Fall 1995 to Fall 2019

5.3 Groundwater Quality Distribution and Trends

The SVBGSA does not have sole 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.

5.3.1 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. Groundwater quality data for this GSP were collected from:

- The Northern Counties Groundwater Characterization report (CCGC, 2015)
- The USGS's Groundwater Ambient Monitoring and Assessment Program (GAMA) reports (Kulongoski and Belitz, 2005; Burton and Wright, 2018)
- SWRCB's GeoTracker Data Management System (SWRCB, 2020a)
- SWRCB's GAMA Groundwater Information System (SWRCB, 2020b)
- The California DTSC's EnviroStor data management system (DTSC, 2020)

5.3.2 Point Sources of Groundwater Contaminants

Clean-up and monitoring of point source pollutants may be under the responsibility of either the CCRWQCB or the Department of Toxic Substances Control (DTSC). The locations of these clean-up sites are visible in SWRCB's GeoTracker database map, publicly available at: https://geotracker.waterboards.ca.gov/. The GeoTracker database is linked to the DTSC's EnviroStor data management system that is used to track clean-up, permitting, and investigation efforts.

Table 5-2 and Figure 5-12 provide a summary and map of the 1 active clean-up site within the Subbasin. They do not include sites that have leaking underground storage tanks, which are not overseen by DTSC or the CCRWQCB.

Table 5-2. Active Cleanup Sites

Site Name	Site Type	Status	Constituents of Concern (COCs)	Address	City
Reconstruction of Mary Chapa and El Camino Real Schools Site	School	Active	Metals, organochlorine pesticides, petroleum, polychlorinated biphenyls (PCBs), polynuclear aromatic hydrocarbons, volatile organics (VOCs)	490 El Camino Real	Greenfield

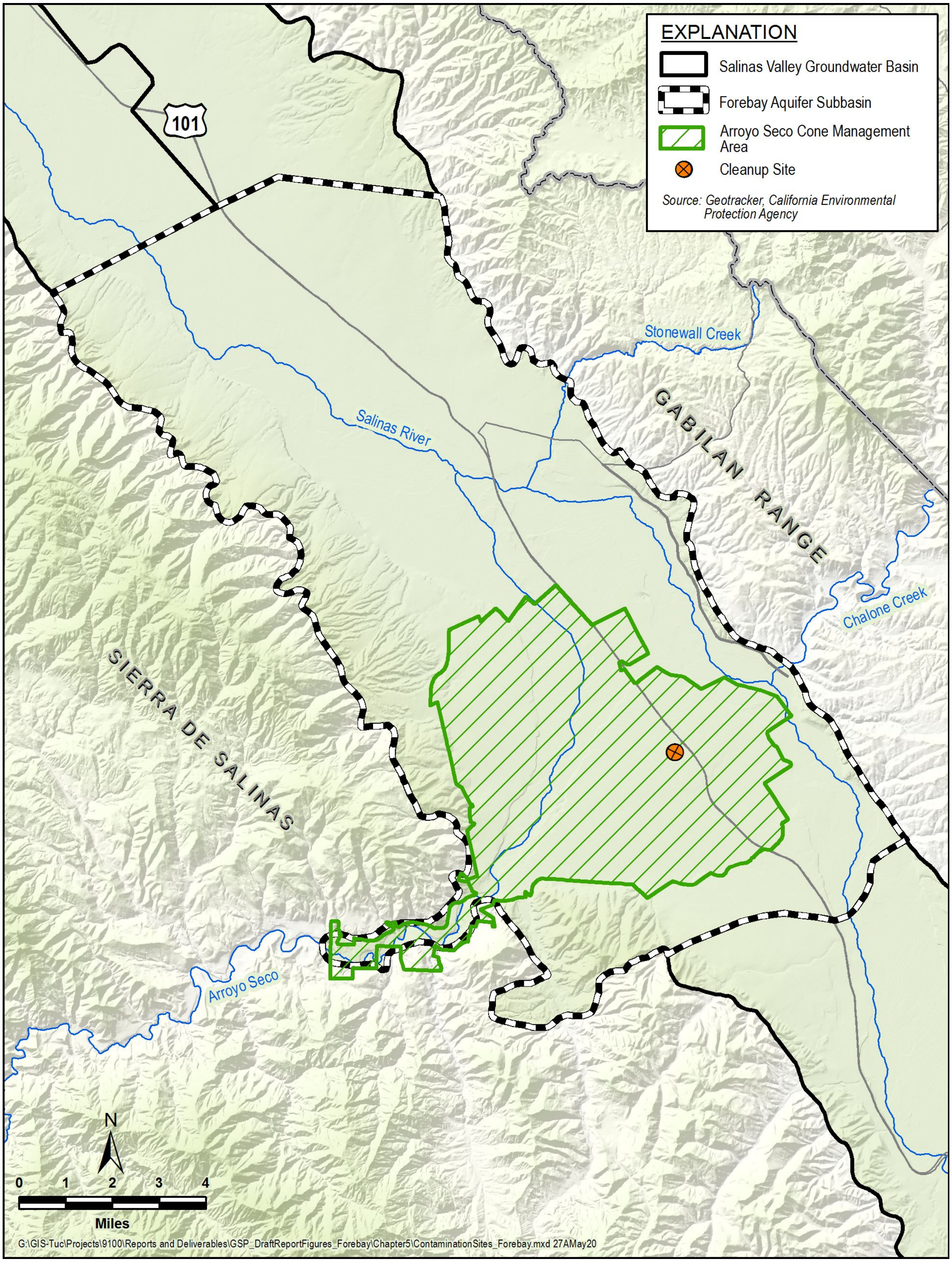


Figure 5-12. Active Cleanup Sites

5.3.3 Distribution and Concentrations of Diffuse or Natural Groundwater Constituents

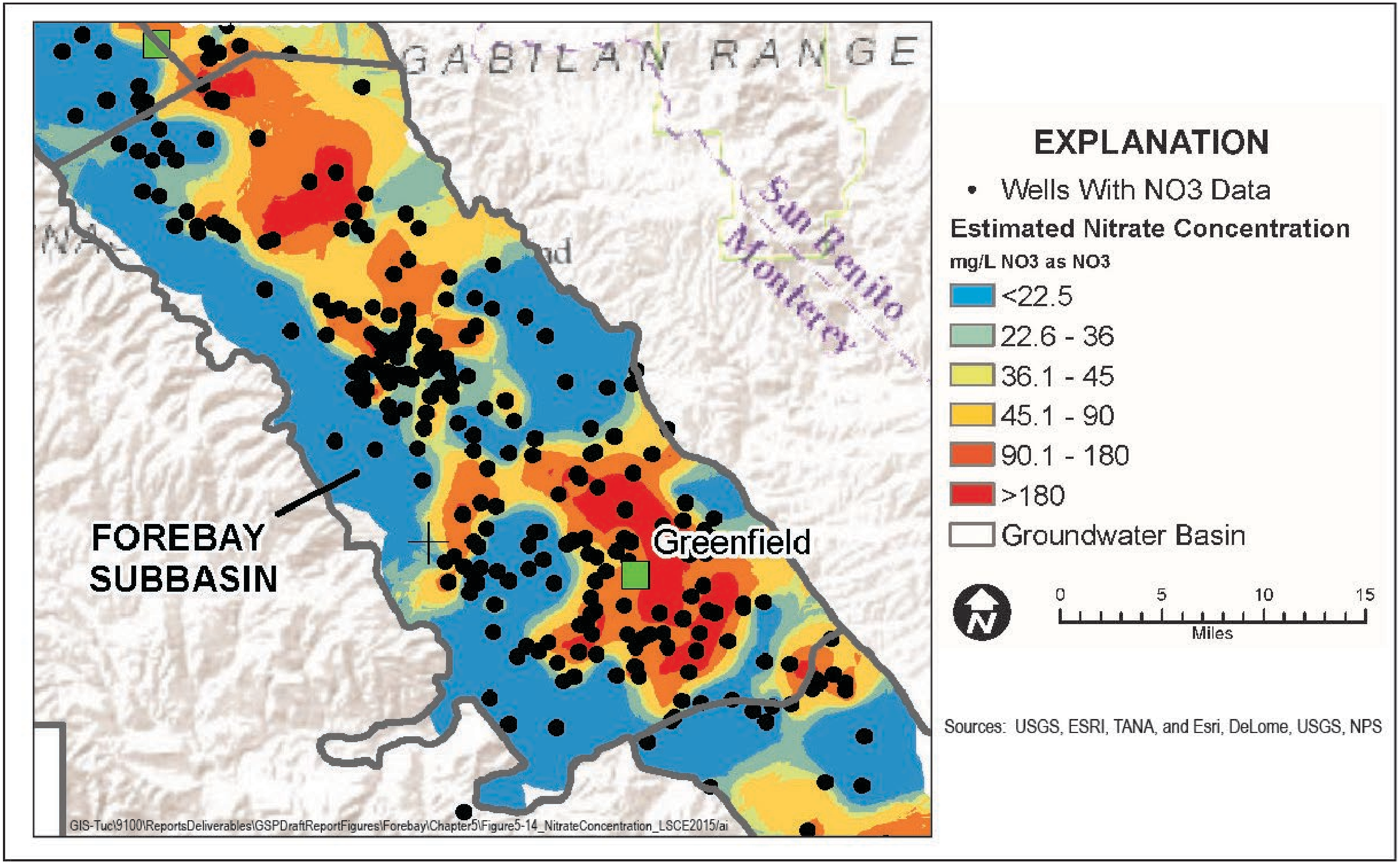
In addition to the single point source of groundwater contamination described above, the CCRWQCB monitors and regulates activities and discharges that can contribute to non-point pollutants that are released to groundwater over large areas. In the Subbasin, the most prevalent non-point water quality 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 5-13 shows a map of nitrate distribution in the Subbasin prepared by CCGC. The orange and red areas shown on the figure illustrate the portions of the Subbasin where groundwater has nitrate concentrations above the drinking water MCL of 45 mg/L NO_3.

Figure 5-14 shows maps of measured nitrate concentration from 6 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 in the 1960s, but significantly increased in 1970s and 1980s. Extensive distribution of nitrate concentrations above the drinking water MCL, as shown on Figure 5-13, has been present in the Forebay Subbasin for 20 to 30 years.

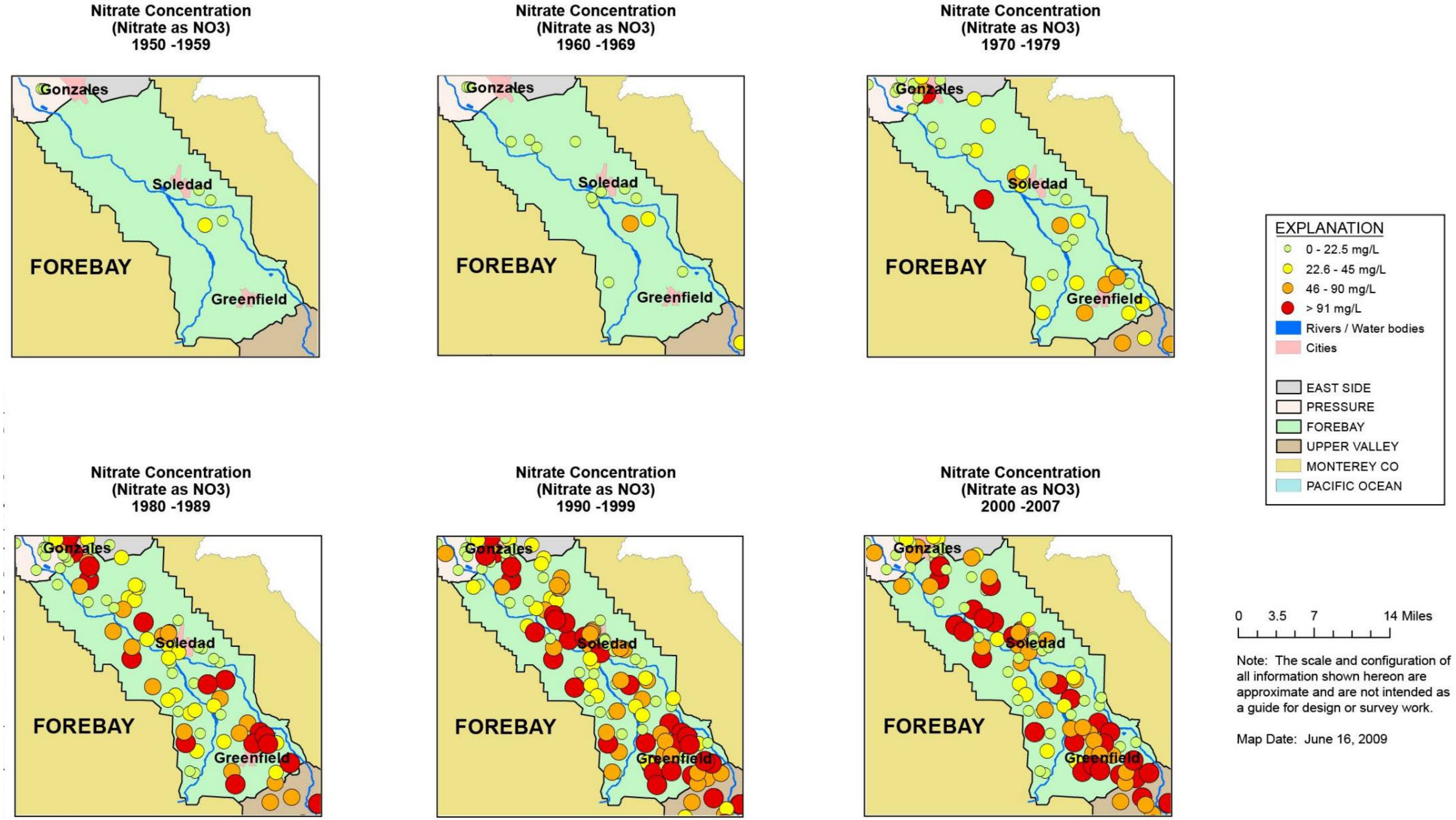
A May 2018 staff report to the CCRWQCB included a summary of nitrate concentrations throughout the Central Coast Region, including the Salinas Valley Groundwater Basin. The staff report includes data from 2008 to 2018 collected at 2,235 wells in the Salinas Valley Groundwater Basin, during Agricultural Orders 2.0 and 3.0 sampling events. The report states that 66% of on-farm domestic wells in the Forebay Subbasin exceeded the drinking water MCL with a mean concentration of 112.0 mg/L NO_3. In addition, 45% of irrigation supply wells in the Subbasin exceeded this MCL with a mean concentration of 66.0 mg/L NO_3 (CCRWQCB, 2018).

Some COC can be concentrated at various aquifer depths. Nitrate is a surficial constituent derived from such sources as fertilizer, livestock, and septic systems. Because the sources are all near the surface, nitrate is usually highest near ground surface, and decreases with depth. Raising groundwater levels may mobilize additional nitrate. By contrast, arsenic concentrations usually increase with depth, and lowering groundwater levels may mobilize additional arsenic. The distribution and concentrations of COC can be further complicated by location and rate of groundwater pumping. The extent to which pumping affects groundwater quality depends on aquifer properties, distance to contamination, constituent characteristics and transport rate, and the time at which contaminants entered the subsurface. These general relationships have not been analyzed in this Subbasin.



Sources: USGS, ESRI, TANA, and Esri, DeLome, USGS, NPS

Figure 5-13. Estimated Nitrate Concentrations
(from CCGC, 2015)


Nitrate Concentration (Nitrate as NO3) 1950 -1959

Nitrate Concentration (Nitrate as NO3) 1960 -1969

Nitrate Concentration (Nitrate as NO3) 1970 -1979

Nitrate Concentration (Nitrate as NO3) 1980 -1989

Nitrate Concentration (Nitrate as NO3) 1990 -1999

Nitrate Concentration (Nitrate as NO3) 2000 -2007

Note: The scale and configuration of all information shown hereon are approximate and are not intended as a guide for design or survey work.

Map Date: June 16, 2009

Figure 5-14. Nitrate Concentrations, 1950 to 2007
(modified from MCWRA data)

Additional groundwater quality conditions in the Basin are summarized in 2 USGS water quality studies in the Salinas Valley. The USGS 2005 GAMA study characterized deeper groundwater resources used for public water supply (Kulongoski and Belitz, 2005). The USGS 2018 GAMA study focused on domestic well water quality (Burton and Wright, 2018). The source data used in these 2 studies and additional publicly available water quality data can be accessed through the SWRCB GAMA groundwater information system database at https://gamagroundwater.waterboards.ca.gov/gama/datadownload.

The GAMA groundwater information system database includes groundwater quality data for public water system supply wells from the SWRCB DDW, and on-farm domestic wells and irrigation supply wells from CCRWQCB's ILRP. This GSP relies on established thresholds for COC: MCLs and Secondary Maximum Contaminant Levels (SMCLs) established by the State's Title 22 drinking water standards for public water system supply wells and on-farm domestic wells, and COC levels that may lead to reduced crop production for irrigation supply wells, as outlined in the CCRWQCB's Basin Plan (CCRWQCB, 2019).

Table 5-3 reports the COC in the Forebay Subbasin based on GAMA groundwater information system data up to December 31, 2019. The number of wells that exceed the regulatory standard for any given COC is based on the latest sample for each well in the monitoring network. Not all wells have been sampled for all COC. Therefore, the percentage of wells with exceedances is the number of wells that exceed the regulatory standard divided by the total number of wells that have ever been sampled for that COC. Additionally, Table 5-3 does not report all of the constituents that are monitored under Title 22 or the Basin Plan, it only includes the constituents that exceed a regulatory standard. The total list of constituents sampled in the water quality monitoring network are listed in Table 8-6. Maps with the locations of wells that exceeded the regulatory standard for any of the COC listed in Table 5-3 from 2013 to 2019 are provided in Appendix 5B.

Table 5-3. Water Quality Constituents of Concern and Exceedances

Constituent of Concern	Regulatory Exceedance Standard	Standard Units	Number of Wells Sampled for COC	Number of Wells Exceeding Regulatory Standard in Latest Sample	Percentage of Wells with Exceedances
DDW Wells (Data from January 1983 to December 2019)					
1,2 Dibromo-3-chloropropane	**0.2**	**UG/L**	**24**	**3**	**13%**
1,2,3-Trichloropropane	0.005	UG/L	36	2	6%
Beryllium	4	UG/L	35	1	3%
Chloride	500	MG/L	34	1	3%
Di(2-ethylhexyl) phthalate	4	UG/L	30	1	3%
Dinoseb	7	UG/L	34	3	9%
Iron	300	UG/L	32	6	19%
Lindane	0.2	UG/L	23	1	4%
Manganese	50	UG/L	32	4	13%
Nitrate (as nitrogen)	10	MG/L	42	5	12%
Polychlorinated Biphenyls	0.5	MG/L	19	1	5%
Specific Conductance	1600	UMHOS/CM	36	1	3%
Sulfate	500	MG/L	33	1	3%
Thallium	2	UG/L	35	1	3%
Total Dissolved Solids	1000	MG/L	33	4	12%
Vinyl Chloride	0.5	UG/L	36	4	11%
ILRP On-Farm Domestic Wells (Data from October 2012 to December 2019)					
Iron	**300**	**UG/L**	**38**	**8**	**21%**
Manganese	50	UG/L	38	2	5%
Nitrate (as nitrogen)	10	MG/L	251	162	65%
Nitrate + Nitrite (sum as nitrogen)	10	MG/L	111	62	56%
Nitrite	1	MG/L	158	1	1%
Specific Conductance	1600	UMHOS/CM	261	71	27%
Sulfate	500	MG/L	261	34	13%
Total Dissolved Solids	1000	MG/L	231	90	39%
ILRP Irrigation Supply Wells (Data from July 2012 to December 2019)					
Iron	**5**	**MG/L**	**48**	**1**	**2%**
Manganese	0.2	MG/L	48	2	4%

5.3.4 Groundwater Quality Summary

Based on the water quality information for the DDW and ILRP wells from GAMA groundwater information system, the following are the COC for drinking water supply wells in the Subbasin and will be included in the GSP monitoring program:

- 1,2 dibromo-3-chloropropane
- 1,2,3-trichloropropane
- beryllium
- chloride
- di(2-ethylhexyl) phthalate
- dinoseb
- iron
- lindane
- manganese
- nitrate (as nitrogen)
- nitrate + nitrite (sum as nitrogen)
- nitrite
- polychlorinated biphenyls
- specific conductance
- sulfate
- thallium
- total dissolved solids (TDS)
- vinyl chloride

The COC for irrigation supply wells that occur in the Subbasin and are known to cause reductions in crop production when irrigation water includes them in concentrations above agricultural water quality objectives include:

- iron
- manganese

The COC for active cleanup site listed in Table 5-2 are not part of the monitoring network described in Chapter 7. However, the status of the constituents at this site will continue to be monitored by the DTSC or the CCRWQCB. Furthermore, the COC at this site that have a regulatory standard under Title 22 for drinking water wells, or the Basin Plan for irrigation supply wells will be monitored in the DDW and ILRP wells that are part of the monitoring network.

This GSP relies on data from existing monitoring programs to measure changes in groundwater quality. Therefore, the GSA is dependent on the monitoring density and frequency of the DDW and ILRP. The monitoring system is further defined in Chapter 7.

5.4 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. Elastic subsidence consists of small lowering and rising of the ground surface that is reversible, while inelastic subsidence is generally irreversible and is the focus of this GSP.

5.4.1 Data Sources

To estimate subsidence, DWR has made Interferometric Synthetic Aperture Radar (InSAR) satellite data available on their SGMA Data Viewer web map: https://sgma.water.ca.gov/webgis/?appid=SGMADataViewer#landsub. These are the only data used for estimating subsidence in this GSP.

5.4.2 Subsidence Mapping

Figure 5-15 presents a map showing the average annual InSAR subsidence data in the Forebay Subbasin between June 2015 and June 2019 (DWR, 2020c). The yellow area on the map shows measured changes in ground elevation of between -0.1 and 0.1 feet per year. As discussed in Section 8.8.2.1, because of measurement error in this methodology, any measured ground level changes between -0.1 and 0.1 feet per year are not considered 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 Subbasin.

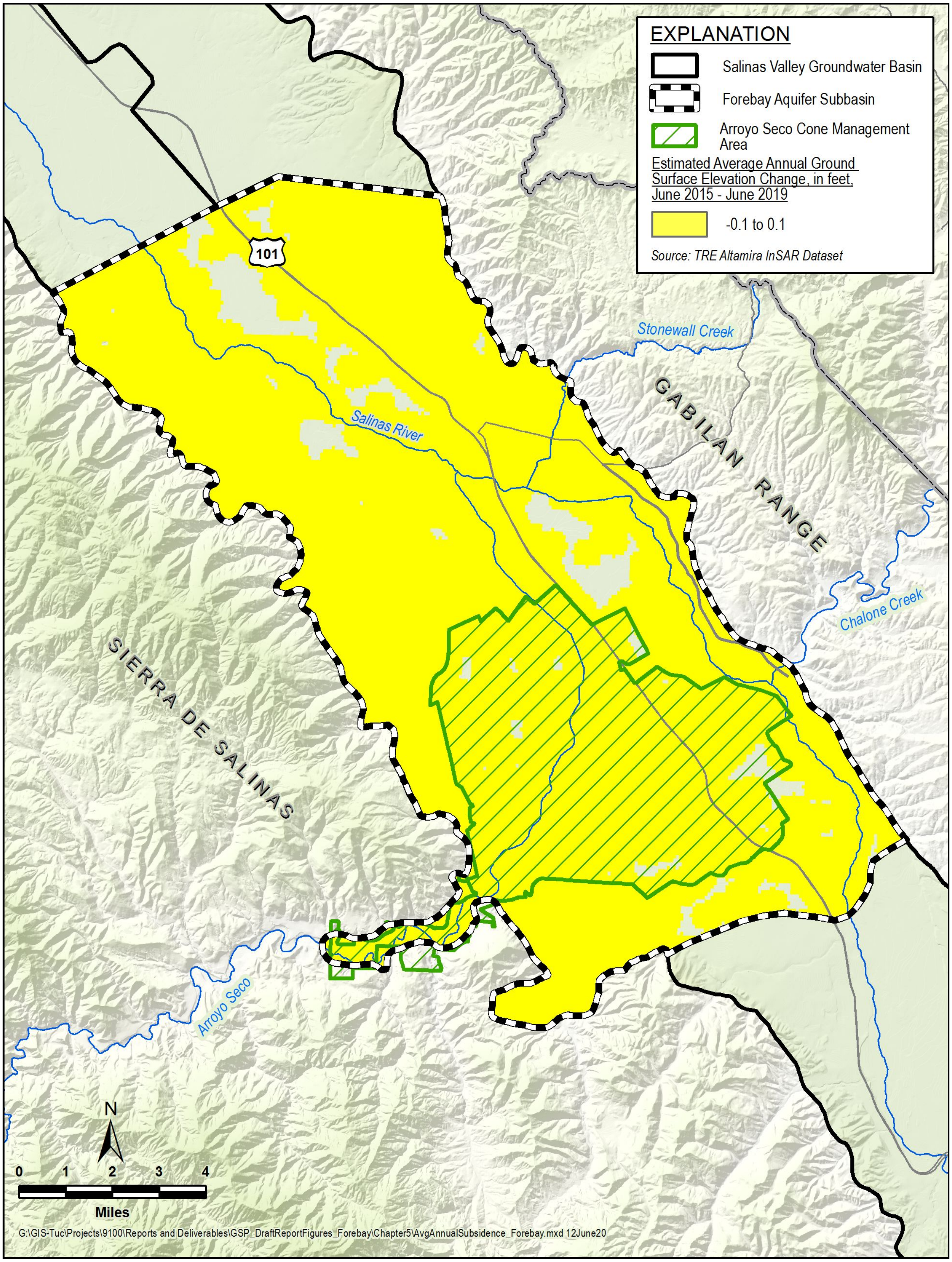


Figure 5-15. Estimated Average Annual InSAR Subsidence in Subbasin

5.5 Interconnected Surface Water

Interconnected surface water is 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 completed. If groundwater elevations are higher than the water level in the stream, the stream is said to be a gaining stream because it gains water from the surrounding 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. 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 5-16.

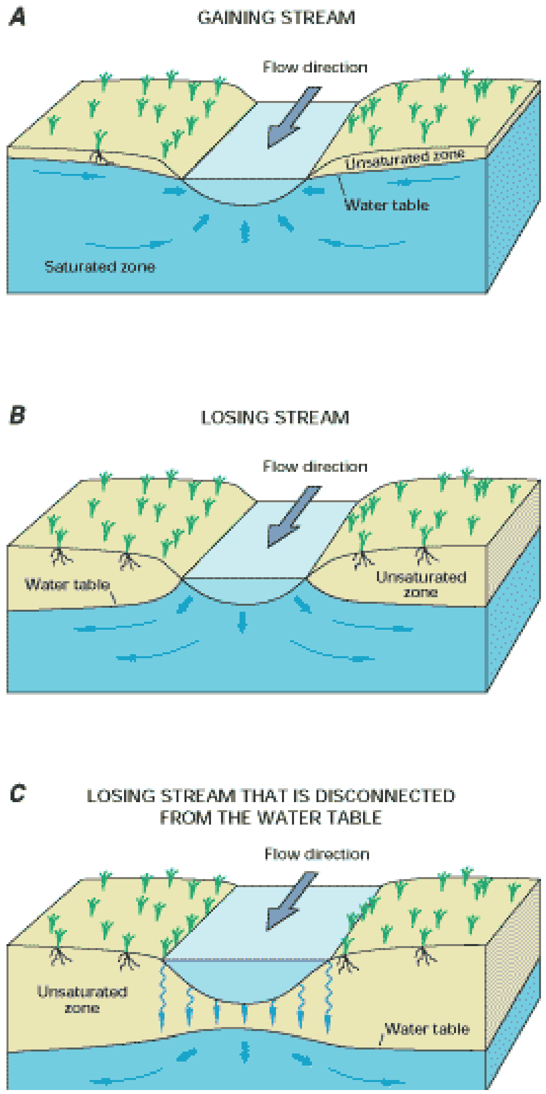


Figure 5-16. Conceptual Representation of Interconnected Surface Water (Winter, et al., 1999)

5.5.1 Data Sources

The preliminary SVIHM is used to map the potential locations of interconnected surface water (ISW), as described in Chapter 4 and shown in Figure 4-14. There is no data that verifies the location and extent of surface water connection to groundwater, nor the extent to which groundwater extraction depletes surface water. Therefore, this section describes the hydraulic principles that establish the relationship between surface water and groundwater, upon which the current conditions and monitoring network are based.

5.5.2 Evaluation of Surface Water and Groundwater Interconnection

Groundwater extraction can alter flows between surface water and groundwater. Flow changes related to interconnected surface and groundwater could be due to reductions in groundwater discharge to surface water or increases in surface water recharge to groundwater. These 2 changes together constitute the change in the amount of surface water depletion.

Depletion of ISW is estimated by evaluating the change in the modeled stream leakage with and without pumping (i.e., water flowing from the stream into the groundwater system). A model simulation without any groundwater pumping in the model (i.e., SVIHM with no pumping) was compared to the model simulation with groundwater pumping (i.e., SVIHM with pumping). The difference in stream depletion between the 2 models is the depletion caused by the groundwater pumping. This comparison was undertaken for the entire area of the Salinas Valley included in the model and also for the Subbasin. The stream depletion differences are only estimated for the interconnected segments identified in Figure 4-14. The methodology for quantifying stream depletion is described in detail by Barlow and Leake (2012).

This analysis uses the “peak” conservation release period from June to September that reflects when most conservation releases are made, not the full April to October MCWRA conservation release period when releases can be made. Depletion of interconnected sections of the Salinas River is estimated separately for the peak conservation release period of June through September, and the non-peak conservation release period of October through May. Depletion of interconnected sections of other surface water bodies is estimated for the entire year. Table 5-4 shows the estimated annual average depletion of the interconnected surface water along the stream segments shown in Figure 4-14 due to groundwater pumping.

Table 5-4. Average SVIHM Simulated Depletion of Interconnected Surface Waters (AF/yr)

	Peak Conservation Release Period	**Non-Peak Conservation Release Period**
Salinas River	9,300	20,400
Other Surface Waters	**2,100**	

Note: provisional data subject to change[1]

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[1] These data (model and/or model results) are preliminary or provisional and are subject to revision. This model and model results are being provided to meet the need for timely best science. The model has not received final approval by the U.S. Geological Survey (USGS). No warranty, expressed or implied, is made by the USGS or the U.S. Government as to the functionality of the model and related material nor shall the fact of release constitute any such warranty. The model is provided on the condition that neither the USGS nor the U.S. Government shall be held liable for any damages resulting from the authorized or unauthorized use of the model."

6 WATER BUDGETS

This chapter summarizes the estimated water budgets for the Forebay Subbasin, including information required by the GSP Regulations and information that is important for developing an effective plan to maintain sustainability. In accordance with the GSP 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 basin, including historical, current, and projected water budget conditions, and the change in the volume of groundwater in storage. Water budgets are reported in graphical and tabular formats, where applicable.

Water budgets are developed for the entire Forebay Subbasin and for the ASCMA. The ASCMA water budget is a subset of the Forebay Subbasin water budget. The Forebay Subbasin water budgets are subdivided into 2 sections: (1) historical and current water budgets, and (2) future water budgets. Within each section both a surface water budget and a groundwater budget are presented. Following the Subbasin-wide water budgets, 2 separate sections present the water budgets of the ASCMA.

6.1 Overview of Water Budget Development

The water budgets are presented in 2 subsections: (1) historical and current water budgets, and (2) future water budgets. Within each subsection a surface water budget and groundwater budget are presented.

Historical and current water budgets are developed using a provisional version of the SVIHM, developed by the USGS. The SVIHM is a numerical groundwater-surface water model that was constructed using version 2 of the MODFLOW-OWHM code (Boyce *et al*., 2020). This code is a version of the USGS groundwater flow code MODFLOW that estimates the agricultural supply and demand, through the Farm Process.

The model area covers the Salinas Valley Groundwater Basin from the Monterey-San Luis Obispo County Line in the south to the Pajaro Basin in the north, including the offshore extent of the major aquifers. The model includes operations of the San Antonio and Nacimiento reservoirs. The SVIHM is supported by 2 sub models: a geologic model known as the Salinas Valley Geologic Model (SVGM) and a watershed model known as the Salinas Valley Watershed Model (SVWM) which uses the Hydrologic Simulation Program – Fortran (HSPF) code. The SVIHM is not yet released by the USGS. Details regarding source data, model construction and calibration, and results for historical and current water budgets will be summarized in more detail once the model and associated documentation are available. Appendix 6A includes an overview of the development and progress of the SVIHM.

The USGS has not yet submitted modeling files or documentation to Salinas Valley stakeholders for review. During the GSP development process, stakeholders who reviewed model output discovered apparent errors or inaccuracies relating to pumping amounts, groundwater storage changes, and simulated Arroyo Seco percolation. Some of the apparent errors are discussed in this chapter, and they are of a magnitude that could potentially affect conclusions or proposed management actions. Although the model was used to estimate some water budget items for this chapter, it needs more review and broader acceptance by stakeholders before it will be suitable for designing and evaluating management actions or projects.

Future water budgets are being developed using an evaluation version of the Salinas Valley Operational Model (SVOM), developed by the USGS and MCWRA. The SVOM is a numerical groundwater-surface water model constructed with the same framework and processes as the SVIHM. However, the SVOM is designed for simulating future scenarios and includes complex surface water operations in the Surface Water Operations module. The SVOM is not yet released by the USGS. Specifics regarding source data, model construction and calibration, and results for future budgets will be summarized in more detail once the model and associated documentation are available. Appendix 6A includes an overview of the SVOM, its development, and inputs.

In accordance with GSP Regulations § 354.18, a complete groundwater budget is developed for each principal aquifer, and for each water budget period. Groundwater in the Forebay Subbasin is pumped from only 1 single principal aquifer.

In addition, the ASGSA provided independent estimates of various historical water budget components. The ASGSA selected water years 1996-2009 as a representative timeframe for developing water budget component estimates. Analysis by ASGSA shows that during this period, average annual Arroyo Seco discharge and precipitation at Greenfield were close to the long-term averages.

ASGSA used 2 linked modeling tools to estimate historical water budget components. A rainfall-runoff-recharge (RRR) model simulated hydrologic processes related to soil moisture budgets on a daily basis for small zones of uniform land use, rainfall, soil type, etc. For agricultural zones, the calculations included estimates of applied water for irrigation. Where the irrigation source is groundwater, those estimates were passed to the FFM18 groundwater flow model as estimates of agricultural groundwater pumping. The RRR model simulated daily hydrology during water years 1949-2015 in 317 recharge zones ranging in size from 1.3 to 3,980 acres.

6.1.1 Water Budget Components

The water budget is an inventory of surface water and groundwater inflows and outflows from the Subbasin. A few components of the water budget can be measured, such as groundwater pumping from a metered wells and streamflow at a gaging station. Other components of the water budget are simulated by the groundwater models, such as recharge from precipitation and applied irrigation, and change of groundwater in storage.

Figure 6-1 presents a general schematic diagram of the hydrologic cycle that is included in the water budget (DWR, 2020d).

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

- **Lateral boundaries.** The perimeter of the Forebay Subbasin within the SVIHM is shown on Figure 6-2. The model zone for the ASCMA is also shown on this figure.
- **Bottom.** The base of the groundwater subbasin is described in the HCM and is defined as the base of the usable and productve unconsolidated sediments (Durbin *et al.* 1978). This ranges from 200 feet below ground surface along the Gabilan Range to almost 3,000 feet deep along the Sierra de Salinas. The water budget is not sensitive to the exact definition of this base elevation because the base is defined as a depth below where there is not significant inflow, outflow, or change in storage.
- **Top.** The top of the water budget area is above the ground surface, so that surface water is included in the water budget.

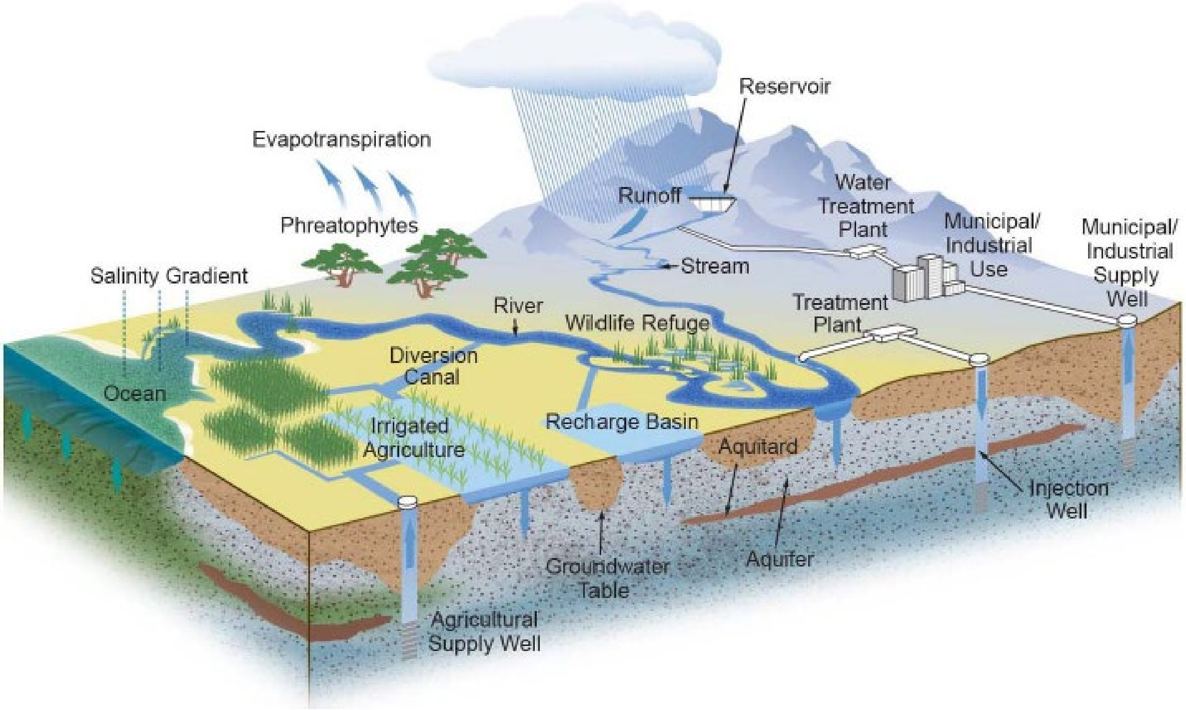


Figure 6-1. Schematic Hydrogeologic Conceptual Model (from DWR, 2020d)

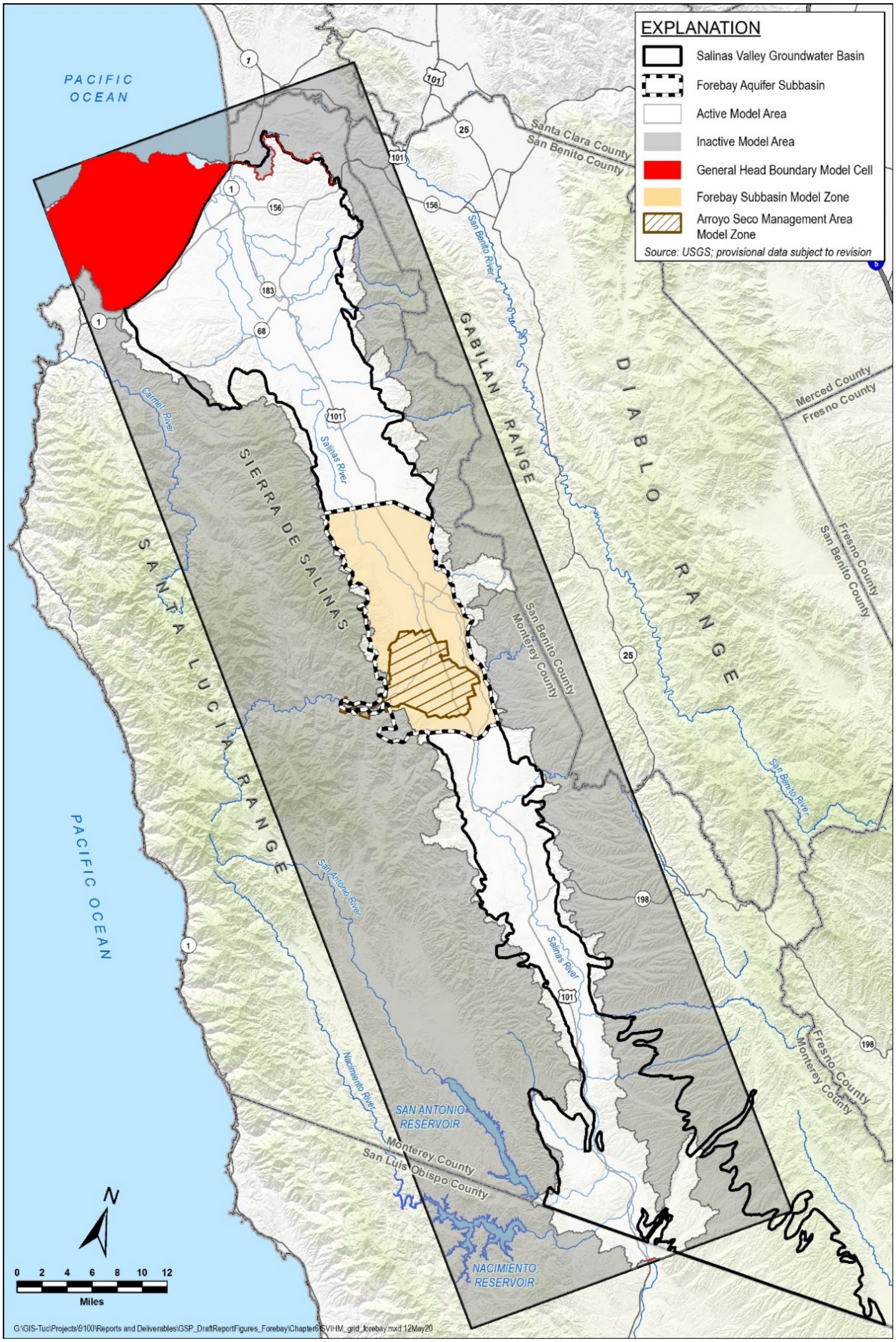


Figure 6-2. Zone and Boundary Conditions for the Salinas Valley Integrated Hydrologic Model

The Forebay Subbasin water budget includes the following components:

Surface Water Budget:

- Inflows
  - Surface water inflows from streams that enter the subbasin, including the Salinas River, Arroyo Seco, Chalone Creek, Stonewall Creek, and other smaller streams that enter the Subbasin. Reservoir operations influence Salinas River inflow; however, reservoir operations are not under the purview of the GSA.
  - Groundwater discharge to streams
- Outflows
  - Surface water outflow to neighboring subbasins along Salinas River and other smaller streams
  - Streambed recharge to groundwater
  - Direct diversions

Groundwater Budget:

- Inflows

  Deep percolation from precipitation and applied irrigation

  Streambed recharge to groundwater

  Subsurface inflows including:

    - Inflow from the Upper Valley Subbasin
    - Inflow from surrounding watershed that are not in other DWR subbasins
- Outflows
  - Crop and riparian ET
  - Groundwater pumping, including both urban and agricultural
  - Groundwater discharge to streams
  - Subsurface outflows including :
    - Outflow to the Eastside Subbasin
    - Outflow to the 180/400-Foot Aquifer Subbasin

The difference between groundwater inflows and outflows is equal to the change of groundwater in storage.

6.1.2 Water Budget Time Frames

Time periods must be specified for each of the 3 required water budgets. The GSP Regulations require water budgets for historical conditions, current conditions, and projected conditions, as follows:

- The historical water budget is intended to evaluate how past land use and water supply availability has affected aquifer conditions and the ability of groundwater users to operate within the sustainable yield. GSP Regulations require that the historical water budget include at least the most recent 10 years of water budget information. DWR's Water Budget BMP document further states that the historical water budget should help develop an understanding of how historical conditions concerning hydrology, water demand, and surface water supply availability or reliability have impacted the ability to operate the basin within the sustainable yield. Accordingly, historical conditions should include the most reliable historical data that are available for GSP development and water budgets calculations.
- The current water budget is intended to allow the GSA and DWR to understand the existing supply, demand, and change in storage under the most recent population, land use, and hydrologic conditions. Current conditions are generally the most recent conditions for which adequate data are available and that represent recent climatic and hydrologic conditions. Current conditions are not well defined by DWR but can include an average over a few recent years with various climatic and hydrologic conditions.
- The projected water budget is intended to quantify the estimated future baseline conditions. The projected water budget estimates the future baseline conditions concerning hydrology, water demand, and surface water supply over a 50-year planning and implementation horizon. It is based on historical trends in hydrologic conditions which are used to project forward 50 years while considering projected climate change and sea level rise if applicable.

Although there is a significant seasonal variation between wet and dry seasons, the GSP does not consider seasonal water budgets for the groundwater budget. All water budgets are developed for complete water years. Selected time periods for the historical and current water budgets are summarized in Table 6-1 and Figure 6-3 and described in Sections 6.1.2.1 and 6.1.2.2.

Table 6-1. Summary of Historical and Current Water Budget Time Periods

Time Period	Proposed Date Range	Water Year Types Represented in Time Period	Rationale
Historical	Water Years 1980 through 2016	Dry: 11 Dry-Normal: 7 Normal: 5 Wet-Normal: 3 Wet: 11	Provides insights on water budget response to a wide range of variations in climate and groundwater use over an extensive period of record. 2017 excluded due to potential limitations of the preliminary SVIHM for that year.
Current	Water Year 2016	Dry-Normal: 1	Best reflection of current land use and water use conditions based on best available data.

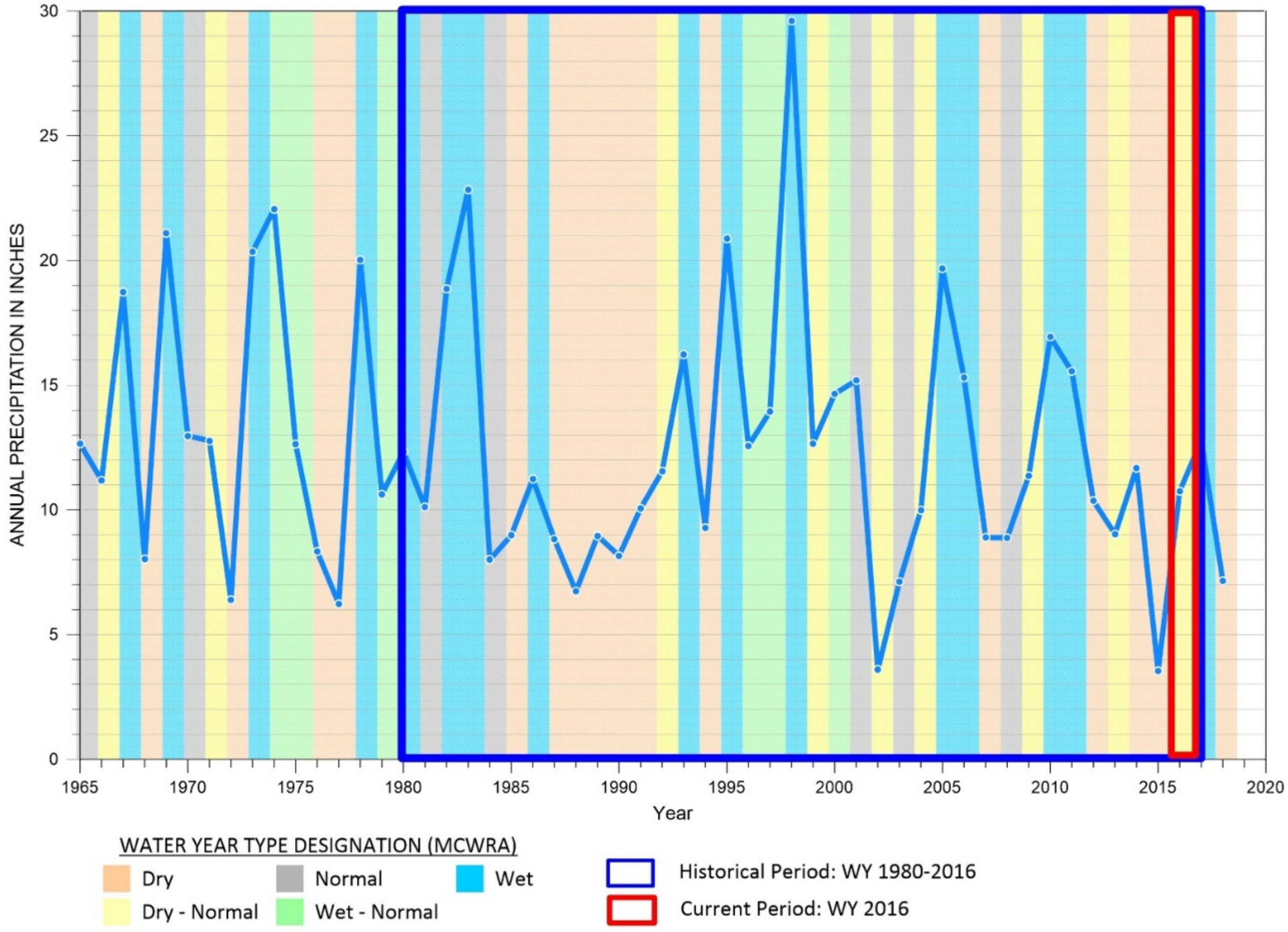


Figure 6-3. Climate and Precipitation for Historical and Current Water Budget Time Periods

6.1.2.1 Historical Water Budget Time Period

GSP Regulations §354.18 require that the historical water budget be based on at least 10 years of data. The water budget is computed using results from the SVIHM numerical model for the period from October 1980 through September 2016. Although the SVIHM simulation covers water years 1967 through 2017, model results for years prior to 1980 and the year 2017 were not used for this water budget due to potential limitations and uncertainties in the provisional SVIHM. Water years 1980 through 2016 comprise a representative time period with both wet and dry periods in the Subbasin (Table 6-1, Figure 6-3).

6.1.2.2 Current Water Budget Time Period

The current water budget time period is also computed using the SVIHM numerical model and is based on water year 2016. Water Year 2016 is classified as dry-normal and is reflective of current and recent patterns of groundwater use and surface water use. Although Water Year 2016 appropriately meets the regulatory requirement for using the "…most recent hydrology, water supply, water demand, and land use information" (23 California Code of Regulations §354.18 (c)(1)), it is noted that water year 2016 was preceded by multiple dry or dry-normal years.

6.1.2.3 Future Projected Water Budgets Time Period

Future projected conditions are based on model simulations using the SVOM numerical flow model, using current reservoir operations rules, projected climate-change scenarios, and estimated sea level rise. The projected water budget represents 47 years of future conditions. Following DWR guidance on implementing climate change factors, 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.

6.2 Overview of Model Assumptions for Water Budget Development

Table 6-2 provides the detailed water budget components and known model assumptions and limitations for each. A few water budget components are directly measured, but most water budget components are either estimated as input to the model or simulated by the model. Both estimated and simulated values in the water budgets are underpinned by certain assumptions. These assumptions can lead to uncertainty in the water budget. However, inputs to the preliminary SVIHM were carefully selected by the USGS and cooperating agencies using best available data, reducing the level of uncertainty.

In addition to the model assumptions, additional uncertainty stems from any model's imperfect representation of natural condition and level of calibration. The water budgets for the Forebay Subbasin are based on a preliminary version of the SVIHM, with limited documentation of model construction. The model is in internal review at the USGS, and a final version will likely not be released to the SVBGSA until after the GSP is submitted. Nonetheless, the SVIHM's calibration error is within reasonable bounds. Therefore, the model is the best available tool for estimating water budgets for the GSP.

As GSP implementation proceeds, the SVIHM will be updated and recalibrated with new data to better inform model simulations of historical, current, and projected water budgets. Model assumptions and uncertainty will be described in future updates to this chapter after model documentation is released by the USGS.

Table 6-2. Summary of Water Budget Component Data Source from the Salinas Valley Integrated Hydrologic Model

Water Budget Component	Source of Model Input Data	Limitations
Precipitation	Incorporated in calibrated model as part of land use process	Estimated for missing years
Surface Water Inflows		
Inflow from Streams Entering Basin	Simulated from calibrated model for all creeks	Not all creeks are gauged
Groundwater Discharge to Streams	Simulated from calibrated model	Based on calibration of streamflow to available data from gauged creeks
Overland Runoff	Simulated from calibrated model	Based on land use, precipitation, and soils specified in model
Surface Water Outflows		
Streambed Recharge to Groundwater	Simulated from calibrated model	Based on calibration of streamflow to available data from gauged creeks and groundwater level data from nearby wells
Diversions	Model documentation not available at this time	Based on calibration of streamflow to available data from gauged creeks
Outflow to Streams Leaving Basin	Simulated from calibrated model for all creeks	Not all creeks are gauged
Groundwater Inflows		
Streambed Recharge to Groundwater	Simulated from calibrated model	Based on calibration of streamflow to available data from gauged creeks and groundwater level data from nearby wells
Deep percolation of irrigation water	Simulated from demands based on crop, acreage, temperature, and soil zone processes	No measurements available; based on assumed parameters for crops and soils
Subsurface Inflow from Adjacent basins	Simulated from calibrated model	Limited groundwater calibration data at adjacent subbasin boundaries
Subsurface Inflow from surrounding watershed other than neighboring basins	Simulated from calibrated model	Limited groundwater calibration data at adjacent subbasin boundaries
Groundwater Outflows		
Groundwater Pumping	Reported data for historical municipal and agricultural pumping, and some small water systems. Model documentation not available at this time.	Water budget pumping reported herein is from the SVIHM and might contain errors. Domestic pumping not simulated in model
Groundwater Discharge to Streams	Simulated from calibrated model	Based on calibration of streamflow to available data from gauged creeks and groundwater level data from nearby wells
Subsurface Outflow to Adjacent Basins	Simulated from calibrated model	Limited calibration data at adjacent subbasin boundaries
Riparian ET	Simulated from calibrated model	Based on representative plant group and uniform extinction depth

6.3 Historical and Current Water Budgets

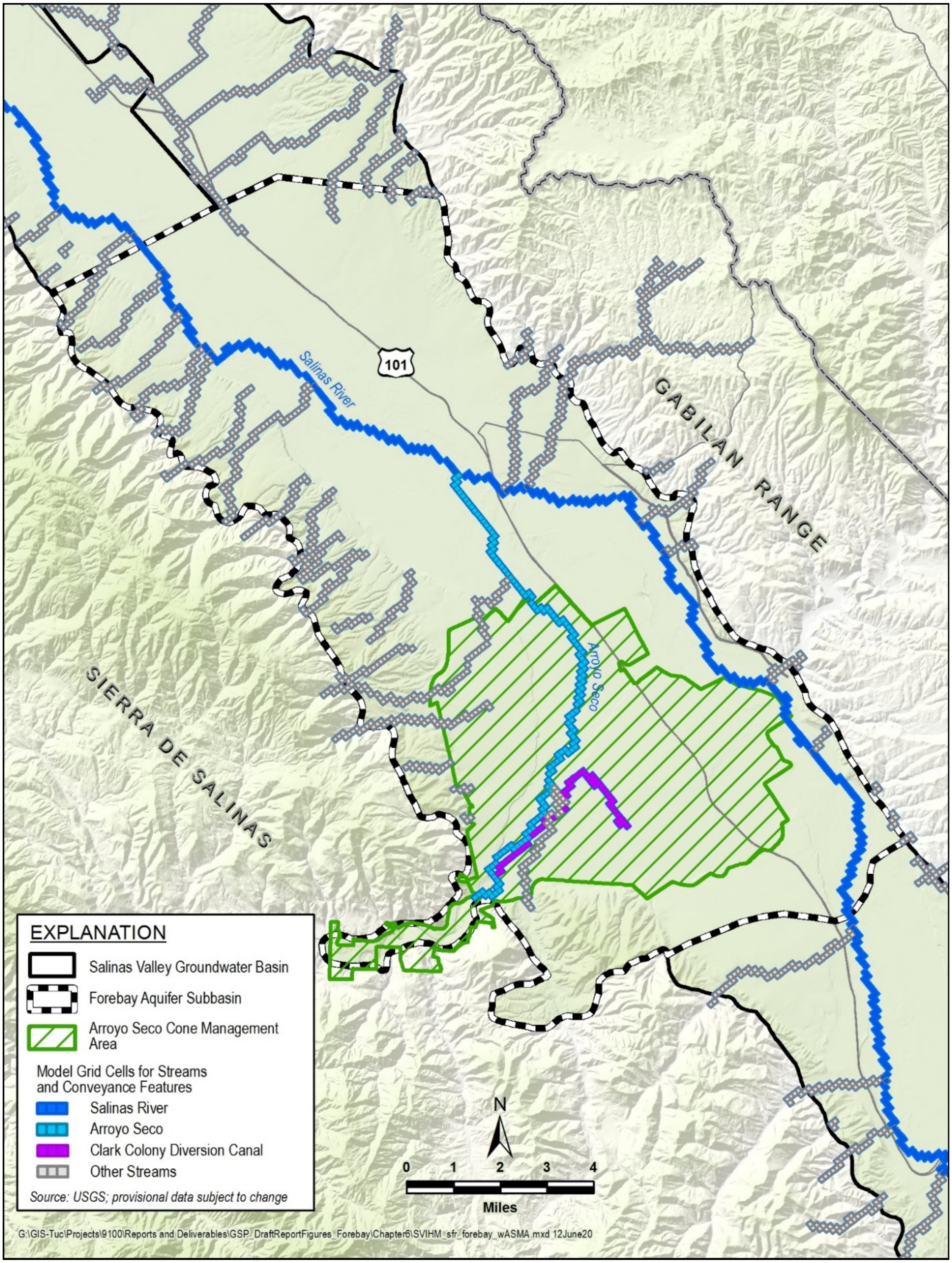
Water budgets for the historical and current periods are presented below. The surface water budgets are presented first, followed by the groundwater budgets. These results are based on the provisional SVIHM and are subject to change in the future. Water budgets will be updated in future GSP updates after the SVIHM is formally released by the USGS.

6.3.1 Historical and Current Surface Water Budget

The surface water budget accounts for the inflows and outflows for the streams within the Subbasin. This includes streamflows of rivers and tributaries entering and exiting the Subbasin, overland runoff to streams, diversions from streams, and stream-aquifer interactions. ET by riparian vegetation along stream channels is estimated by the provisional SVIHM as part of the groundwater system and is accounted for in the groundwater budget.

Figure 6-4 shows the surface water network simulated in the provisional SVIHM. The network includes the Salinas River, Arroyo Seco, and other streams in the Subbasin. For this water budget, boundary inflows and outflows are the sum of all locations that cross the Subbasin boundary.

Figure 6-5. shows the surface water budget for the historical period, which also includes the current period. Table 6-3 shows the average values for components of the surface water budget for the historical and current periods, respectively. Positive values are inflows into the stream system, and negative values are outflows from the stream system. Boundary inflows and outflows dominate the surface water budget in all but the driest years. The flow between surface water and groundwater in the Subbasin is generally net negative, which indicates more seepage from the streams to groundwater, rather than discharge of groundwater to streams.



Source: USGS; provisional data subject to change

Figure 6-4. Surface Water Network in Forebay Aquifer Subbasin from the Salinas Valley Integrated Hydrologic Model

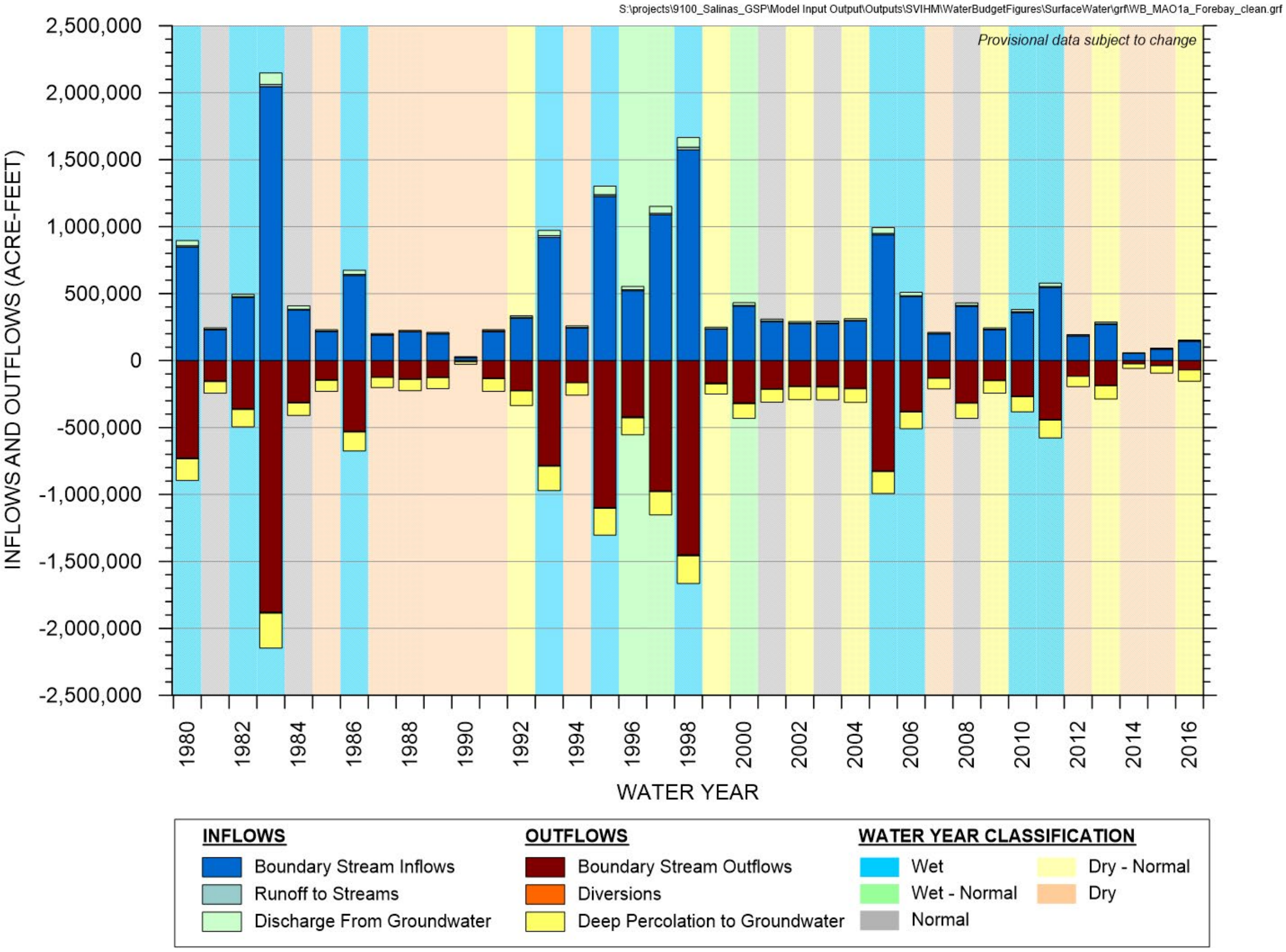


Figure 6-5. Historical and Current Surface Water Budget

Table 6-3. SVIHM Simulated Surface Water Budget Summary (AF/yr)

	Historical Average (WY 1980-2016)	Current (WY 2016)
Overland Runoff to Streams	6,800	5,100
Boundary Stream Inflows	465,200	143,500
Net Flow between Surface Water and Groundwater	-90,300	-77,800
Boundary Stream Outflows	-377,400	-69,500
Diversions from Streams	-4,200	-1,300

Note: provisional data subject to change.

Table 6-4 summarizes the average net flow between surface water and groundwater along selected streams in the Subbasin. Selected streams include the Salinas River, Arroyo Seco, Clark Colony canal, and the sum of all other smaller streams that are primarily along the basin margins. According to provisional results of the SVIHM, most streambed seepage occurs along the Salinas River and Arroyo Seco channels, with relatively minor amounts of seepage from Clark Colony diversions or other streams.

Table 6-4. SVIHM Simulated Net Flow Between Surface Water and Groundwater for Selected Streams (AF/yr)

	Historical Average (WY 1980-2016)	Current (WY 2016)
Salinas River	-71,700	-49,100
Arroyo Seco	-18,400	-20,700
Clark Colony Diversion	0	0
Other Streams	-200	-8,000

Note: provisional data subject to change.

Table 6-6 summarizes the average net flow between surface water and groundwater along the Salinas River for periods of reservoir releases during the water year. June through September (4 months) is when peak conservation releases from the reservoirs occur and the majority of the flow in the river during this period are due to conservation releases. Flows during the non-peak conservation release period of October through May (8 months) are generally not associated with conservation releases; however, conservation releases can be made from April to October. Conservation releases are releases made to supply the basin with groundwater recharge and the SRDF. The estimated historical average rate of flow from surface water to groundwater (seepage along the Salinas River channel) is about 6,000 AF/month during both reservoir release periods. However, the current rate of seepage to groundwater is larger during the non-conservation release period than the conservation release period: 4,900 AF/month and 2,500 AF/month, respectively. It is important to note that these results are provisional and uncertain and are subject to change in future GSP updates after the SVIHM is released by the USGS.

Table 6-5. SVIHM Simulated Net Flow Between Surface Water and Groundwater for Salinas River for Reservoir Release Periods (AF/yr)

Reservoir Release Period	Historical Average (WY 1980-2016)	Current (WY 2016)
Peak Conservation Release Period (June through September)	-23,100	-9,800
Non-Peak Conservation Release Period (October through May)	-48,600	-39,200

Note: provisional data subject to change.

6.3.2 Historical and Current Groundwater Budget

The groundwater budget accounts for the inflows and outflows to and from the Subbasin's aquifers, based on results from the SVIHM. This includes inflows and outflows of groundwater at the Subbasin boundaries, recharge, pumping, ET, and net flow between surface water and groundwater.

SVIHM estimated annual inflows to the groundwater system for the historical and current time periods are shown on Figure 6-6. Table 6-6 provides average groundwater inflows for the historical and current period. Total inflow varies greatly year to year, principally due to variations in streambed seepage. In every year of the historical period except for water year 1990, the largest source of groundwater inflow in the Forebay Subbasin is streambed seepage.

Figure 6-7 shows the SVIHM estimated outflows from the groundwater system for the historical and current time periods. Outflows vary from year to year; however, the annual variation is dampened compared to the inflows. Groundwater pumping, which includes municipal, industrial, and agricultural water, is the largest outflow in the subbasin. Table 6-7 provides annual averages for SVIHM estimated groundwater outflows of the historical and current period. Subsurface outflows and agricultural pumping for the current period are similar to the historical average; however, the decrease in estimated discharge to streams and ET from riparian vegetation suggests that groundwater levels along the streams are lower during the current period than historical average conditions.

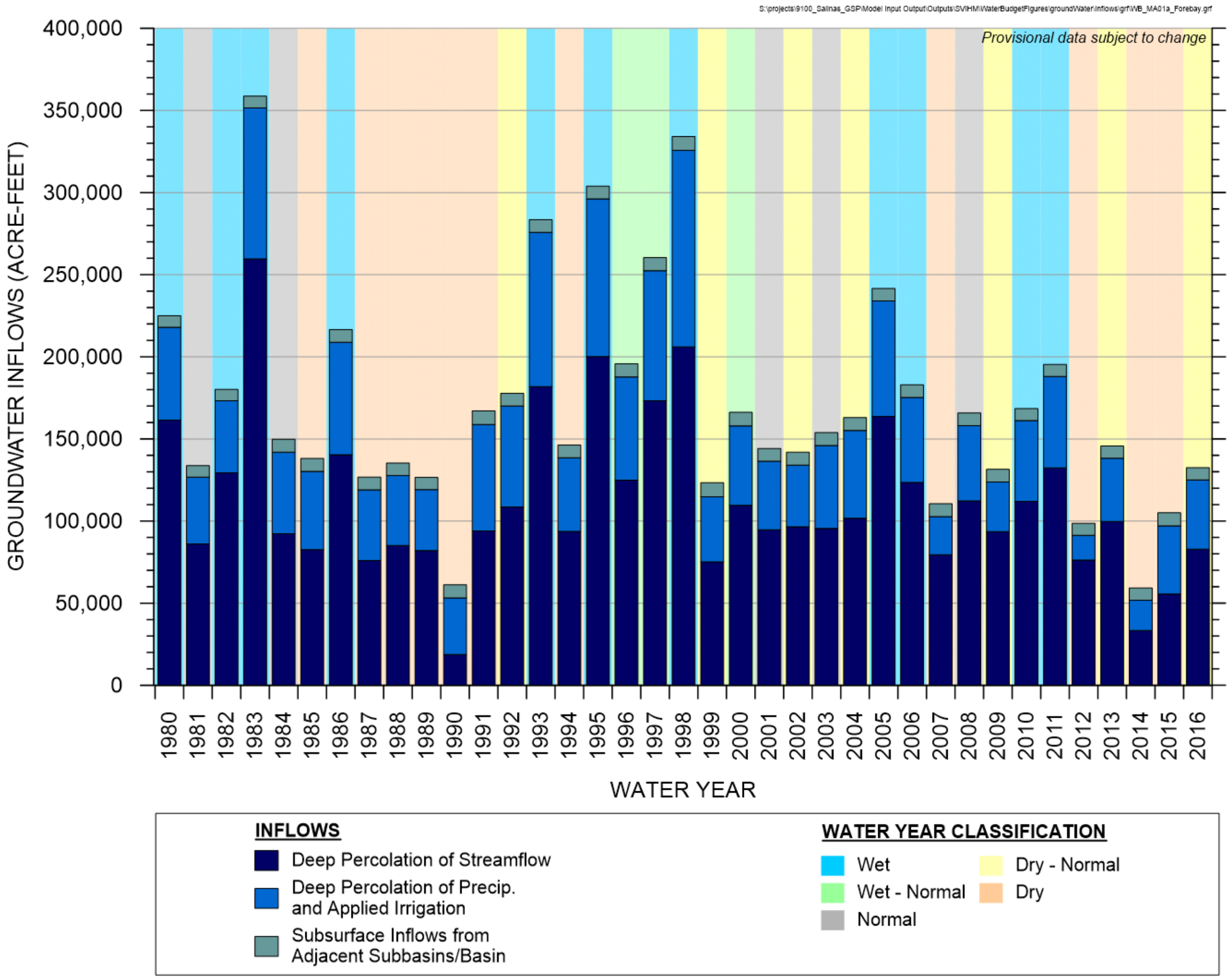


Figure 6-6. SVIHM Simulated Inflows to the Groundwater System

Table 6-6. SVIHM Simulated Groundwater Inflows Summary (AF/yr)

	Historical Average (WY 1980-2016)	Current (WY 2016)
Deep Percolation of Precipitation and Applied Water	52,200	42,200
Deep Percolation of Streamflow	111,700	82,800
Subsurface Inflow from Adjacent Subbasin	7,700	7,600

Note: provisional data subject to change.

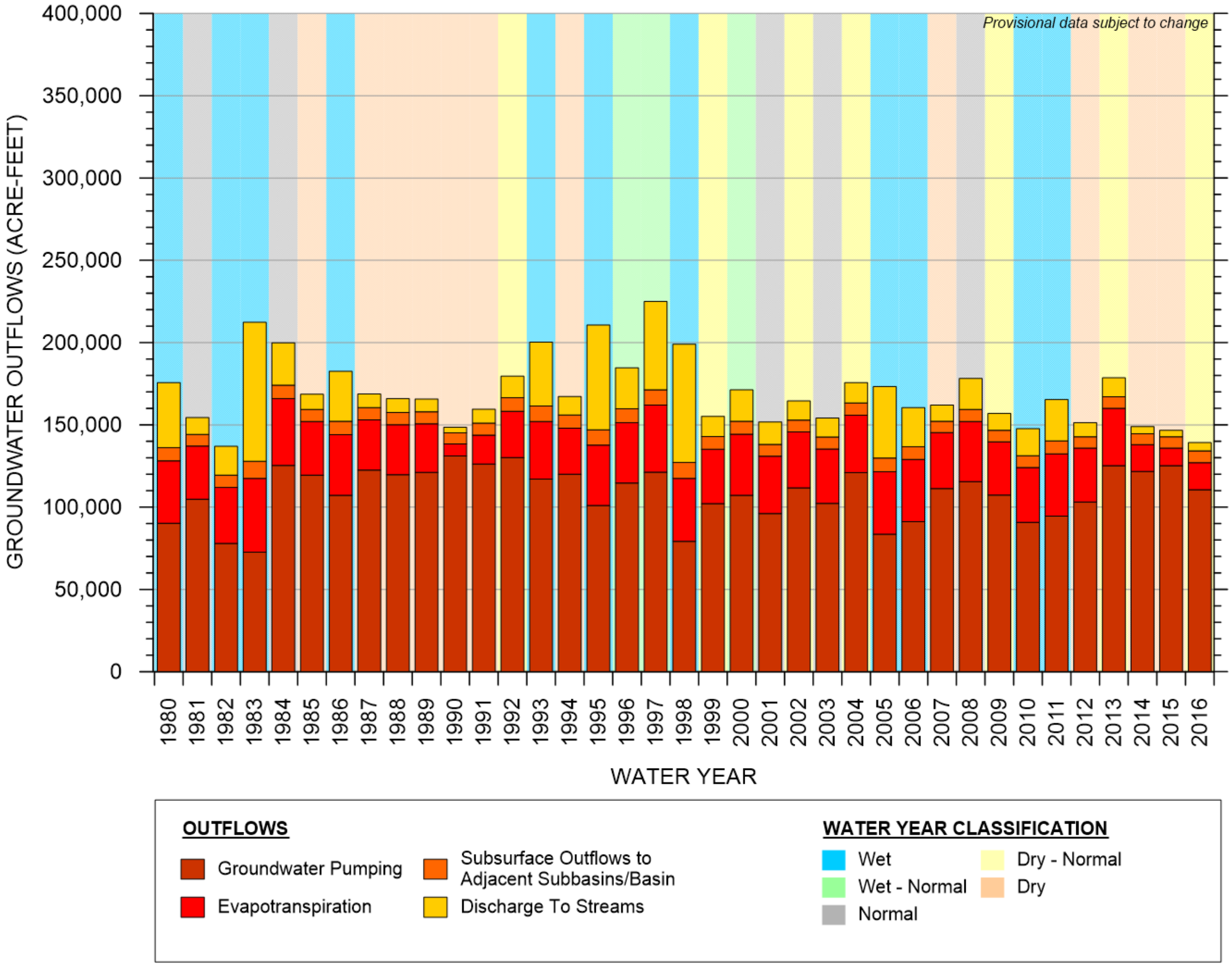


Figure 6-7. SVIHM Simulated Outflows from the Groundwater System

Table 6-7. SVIHM Simulated and Adjusted Groundwater Outflows Summary (AF/yr)

	Simulated		Adjusted	
	Historical Average (WY 1980-2016)	Current (WY 2016)	Historical Average (WY 1980-2016)	Current (WY 2016)
Groundwater Pumping	-108600	-110,700	-167,100	-170,300
Groundwater Evapotranspiration	-32,100	-16,400	-32,100	-16,400
Subsurface Outflow to Adjacent Subbasins/Basin	-7,800	-7,200	-7,800	-7,200
Discharge to Streams	-21,400	-5,100	-21,400	-5,100

Note: Provisional data subject to change.
Adjusted pumping is described below.

ASGSA modeling estimated the annual agricultural applied water in the Forebay Subbasin averaged 149,124 AF/yr during water years 1996-2009. This includes 6,287 AF/yr of surface water delivered by CCWC in the ASCMA. Subtracting this surface water from the 149,124 AF/yr yields 142,837 AF/yr of groundwater pumping for irrigation in the Subbasin.

Comparing SVIHM and ASGSA data to GEMS data reveals that, on average, the preliminary SVIHM estimates only approximately 65% of the pumping reported in the GEMS database for the Subbasin between 1995 and 2016. The ASGSA model estimates of pumping were more accurate than the SVIHM estimates, accounting for approximately 90% of the annual average 158,400 AF/yr of agricultural pumping recorded in the GEMS database between 1996 and 2009.

The GEMS data are likely more representative of historical conditions than the model generated pumping numbers; however, reliable GEMS data are only available since 1995. To accurately estimate groundwater extraction for the full historical period, this 65% ratio was applied to the SVIHM estimated historical pumping shown in Table 6-8, yielding an estimated historical average pumping rate of 167,100 AF/yr. The average 1995-2016 extraction in the GEMS database is 158,400 AF/yr. Pumping values from the SVIHM and GEMS are shown on Table 6-8, along with the adjusted pumping values used for the sustainable yield estimates.

Figure 6-8 and Table 6-8 show SVIHM simulated groundwater pumping by water use sector. These show that more than 90% of pumped groundwater is used for agricultural purposes. Municipal and agricultural pumping are simulated in the SVIHM; however, domestic pumping, including *de minimis* pumping, is not included in the model. The SVIHM does not simulate domestic pumping because it is a relatively small portion of overall groundwater pumping in the larger Salinas Valley Basin. Thus, domestic use from privately owned wells is assumed to be negligible and is not included in the model for the Subbasin. Current municipal and industrial pumping is less than the historical average. Table 6-8shows this trend in the simulated data and the GEMS data, respectively. The simulated historical average in Table 6-8 is not strictly comparable to the GEMS historical average because the time periods used to calculate the averages are different; however, the ratio between these values is used to adjust simulated pumping to be more consistent with GEMS data.

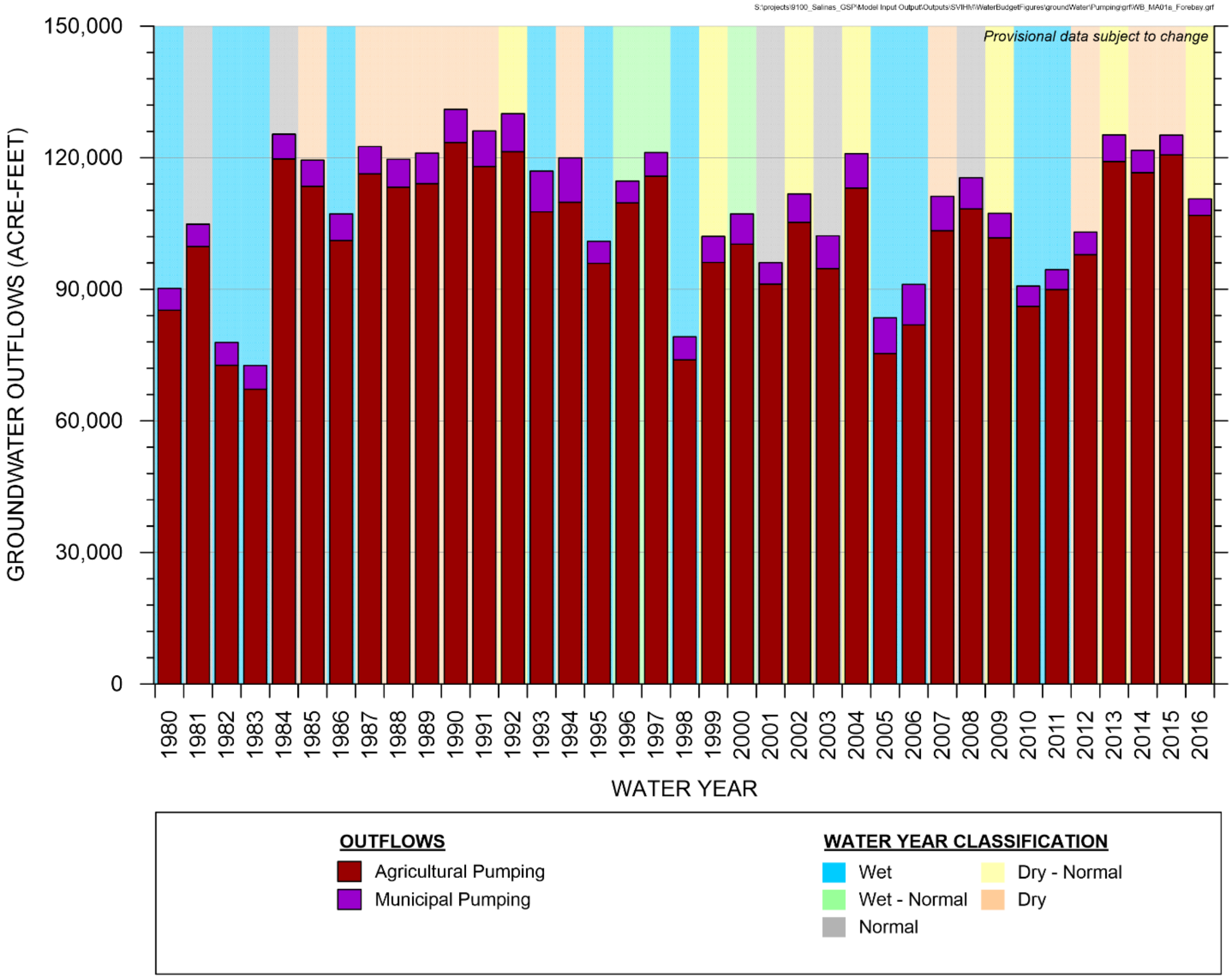


Figure 6-8. SVIHM Simulated Groundwater Pumping by Water Use Sector

Table 6-8. SVIHM Simulated and Adjusted Groundwater Pumping by Water Use Sector (AF/yr)

	Simulated		GEMS		Adjusted	
	Historical Average (WY 1980-2016)	Current (WY 2016)	Historical Average (WY 1995-2016)	Current (WY 2016)	Historical Average (WY 1980-2016)	Current (WY 2016)
Municipal and Industrial	-6,300	-3,800	-7,000	-4,900	9,700	5,800
Agricultural	-102,300	-106,900	-155,600	-153,500	157,400	164,500
Total Pumping	-108,600	-110,700	-162,600	-158,400	-167,100	-170,300

Note: SVIHM data are provisional and subject to change.

Adjusted agricultural pumping is based on the ratio between SVIHM and GEMS agricultural pumping, as described in text above.

Figure 6-9 shows SVIHM estimated net subsurface flows entering and exiting the Subbasin by watershed and neighboring subbasins. Table 6-9 shows SVIHM estimated historical mean and current year subsurface flows. Subsurface inflows and outflows in the Subbasin are about equal. The largest source of inflow is from the Upper Valley Subbasin and the largest sink for outflow is the 180/400-Foot Aquifer Subbasin.

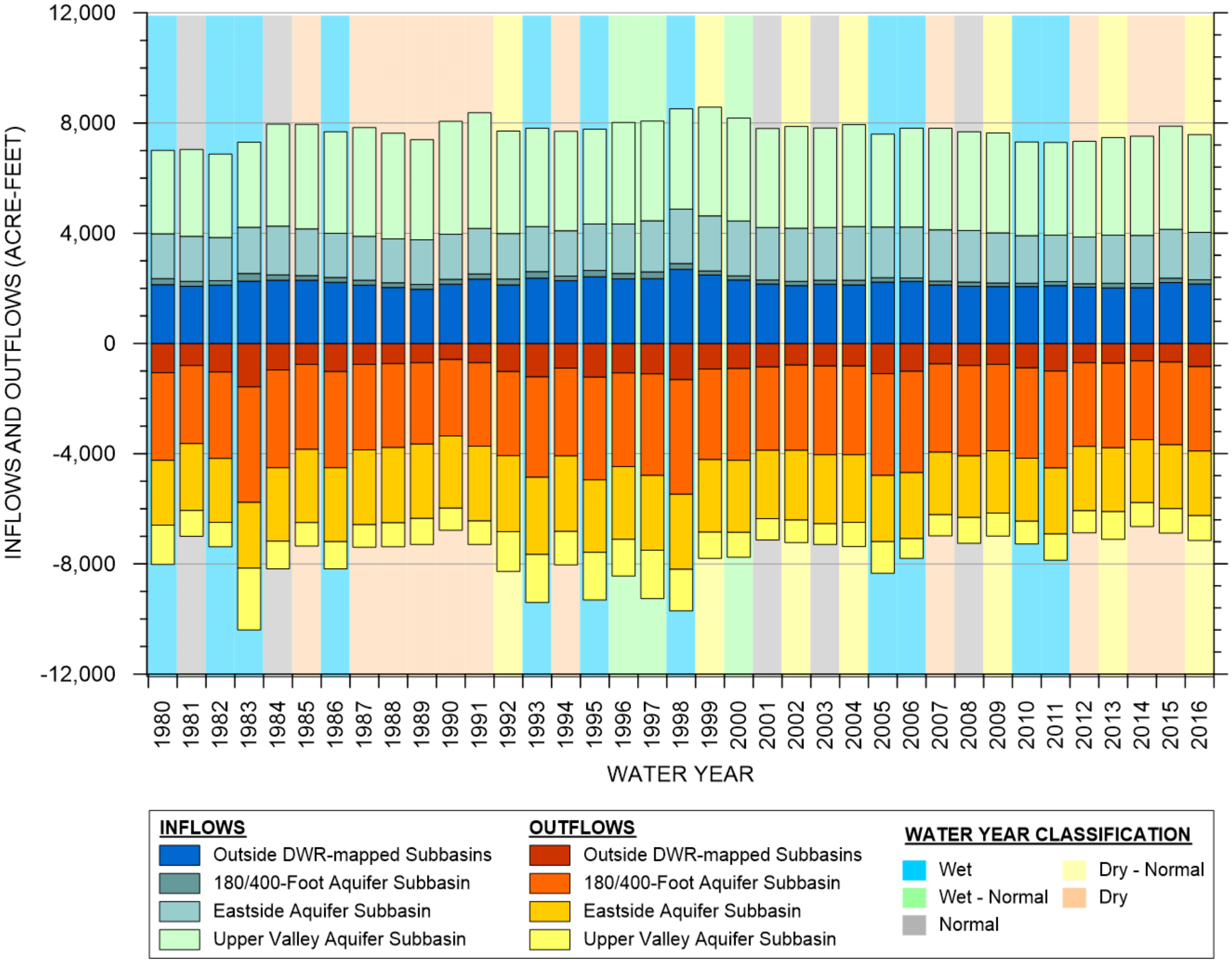


Figure 6-9. SVIHM Simulated Subsurface Inflows and Outflows from Watershed Areas and Neighboring Subbasin

Table 6-9. SVIHM Simulated Net Subbasin Boundary Flows (AF/yr)

	Historical Average (WY 1980-2016)	Current (WY 2016)
Upper Valley Subbasin	2,500	2,600
Eastside Subbasin	-800	-600
180/400-Foot Aquifer Subbasin	-3,100	-2,900
Outside Areas	1,300	1,300

Note: provisional data subject to change

Change in groundwater storage is equal to inflow to storage minus outflows from storage. A negative change in groundwater storage value indicates groundwater storage depletion associated with lower groundwater levels; while a positive value indicates groundwater storage accretion associated with higher groundwater levels. Averaged over the historical period, the preliminary SVIHM estimates that the Forebay Subbasin has a surplus of groundwater of about 1,800 AF/yr; however, simulated change in storage contains significant variability and uncertainty. Figure 6-9 shows considerable variability in change in storage from one year to the next. In water year 2016, outflows exceeded inflows by more than 6,600 AF, while in 1983 inflows exceeded outflows by roughly 147,000 AF. These results are provisional and subject to change in future updates of the GSP after the SVIHM is officially released to the public. ASGSA used the FFM18 model to develop an alternative estimate of storage change. During 1996-2009, the FFM18 model it calculated an average annual storage change of -3,729 AF/yr for the entire Forebay Subbasin.

The cumulative simulated change in storage line on Figure 6-10 shows that during the 37-year historical period, the basin was in overdraft during only 3 years, and there is no observable trend indicating a chronic decline in groundwater storage. Therefore, although estimated change in storage from observed groundwater level indicate historical annual overdraft, as described in Section 5.2.2, and the SVIHM estimated historical change in storage indicates annual surplus, the Subbasin is not considered to have been historically in overdraft, and this GSP considers the historical average change in storage to be zero.

6.3.3 Historical and Current Groundwater Budget Summary

The main groundwater inflows into the subbasin are: (1) the percolation of precipitation and applied agricultural irrigation water and (2) streambed recharge. Groundwater pumping is the predominant groundwater outflow. The smaller outflow terms are ET, discharge to streams, and subsurface outflows to adjacent subbasins.

Figure 6-10 shows the entire groundwater water budget from the SVIHM and includes the annual change in groundwater storage. Changes in groundwater storage are strongly correlated with changes in deep percolation of precipitation, applied irrigation water, and streamflow. For example, 1983 and 1998 were comparatively very wet years and represent the greatest increase in deep percolation (recharge) and, correspondingly, the greatest increase in groundwater storage over the historical period. Estimated cumulative groundwater storage increased in response to wet periods and declined in response to dry periods.

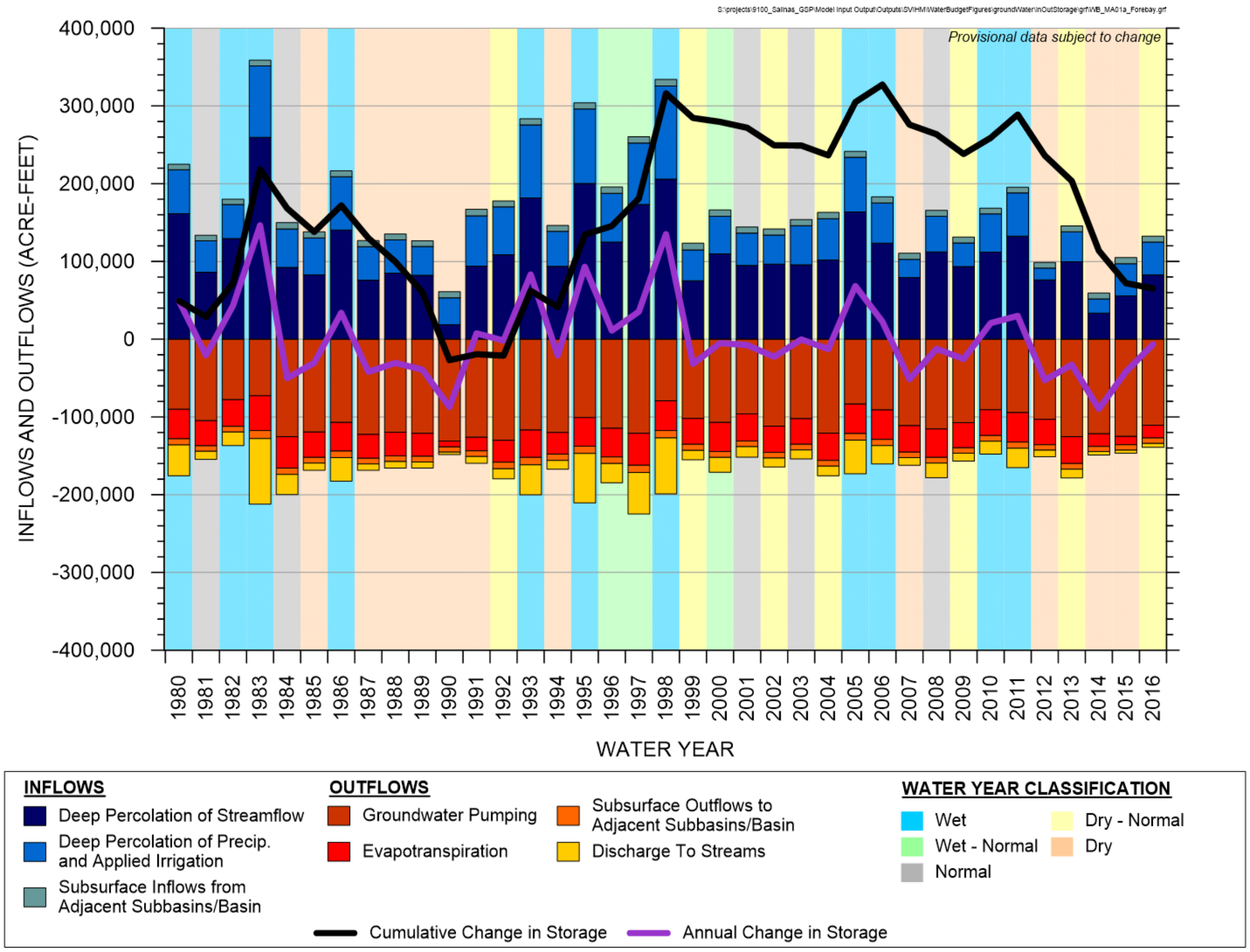


Figure 6-10. SVIHM Simulated Historical and Current Groundwater Budget

The SVIHM estimated the historical annual gain in storage to be 1,800 AF/yr. However, this surplus is no consistent with measured groundwater levels, and this GSP considers the average annual historical change in storage to be zero, as explained above.

A comparison of the historical and current groundwater budgets is shown in Table 6-10. The values in the table are based on the inflows and outflows presented in previous tables. This table is informative in showing the relative magnitude of various water budget components; however, these results are based on a provisional model that might contain errors. The results will be updated in future updates to this GSP after the SVIHM is completed and released by the USGS.

Table 6-10. Summary of Groundwater Budget (AF/yr)

	Historical Average (WY 1980-2016)	Current (WY 2016)
Groundwater Pumping	-167,100	-170,300
Flows to Drains	0	0
Net Stream Exchange (gain from streams)	90,300	77,800
Deep Percolation	52,200	42,200
Net flow to Adjacent Subbasins/Basin	0	400
Groundwater Evapotranspiration	-32,100	-16,400
Net Storage Gain (+) or Loss (-)	0	-6,600

Note: provisional data subject to change. The historical average net storage value is the estimated historical overdraft, as described in Section 6.3.2. Water budget error, as reflected in change in storage, for the historical average period is 33%, which is considered unreasonably large and will be addressed and improved in future updates to the GSP.

6.3.4 Historical and Current Sustainable Yield

The historical and current sustainable yields reflect the amount of Subbasin-wide pumping reduction needed to balance the water budget, resulting in no net decrease in storage. The sustainable yield can be estimated as:

Sustainable yield = pumping + change in storage

For this sustainable yield discussion and associated computations, groundwater pumping outflows are reported as positive values, which is opposite of how the values are reported in the water budget tables.

Table 6-11 provides estimates of the historical sustainable yield using the GEMS derived historical pumping. The cumulative change in storage line on Figure 6-10 shows that during the 37-year historical period, the basin was in overdraft during only three 3 years, and there is no observable trend indicating a chronic decline in groundwater storage. Therefore, the Subbasin has historically not been in overdraft, and the average change in storage for the calculations in Table 6-11 is set to zero.

Because the Subbasin has not historically been in overdraft, it is impossible to estimate the historical sustainable yield. Therefore, Table 6-11 presents a likely range of sustainable yields. This range represents plus and minus 1 standard deviation around the average GEMS reported pumping between 1995 and 2016. These values are the likely range of the minimum sustainable yield of the subbasin. This GSP adopts the range of likely minimum sustainable yields as the best estimate for the Subbasin.

Table 6-11. Historical Sustainable Yield for the Forebay Aquifer Subbasin Derived from GEMS and Adjusted Change in Storage (AF/yr)

	Low Historical Average (WY 1995-2016)	High Historical Average (WY 1995-2016)
Total Subbasin Pumping	150,900	174,300
Change in Storage	0	0
Estimated Sustainable Yield	150,900	174,300

Note: Pumping is shown as positive value for this computation.

6.4 Projected Water Budgets

Projected water budgets are extracted from the SVOM, which simulates future hydrologic conditions with assumed climate change. Two projected water budgets are presented, 1 incorporating estimated 2030 climate change projections and 1 incorporating estimated 2070 climate change projections.

The climate change projections are based on data provided by DWR (2018). Projected water budgets are useful for showing that sustainability will be maintained for the 20-year implementation period and maintained over the 50-year planning and implementation horizon. The projected water budgets are based on a provisional version of the SVOM and are subject to change. Model information and assumptions summarized in this section of the report are based on provisional documentation on the model. Additional information will be provided in future GSP updates after the model is released by the USGS.

6.4.1 Assumptions Used in Projected Water Budget Development

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

- 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 specified in the model by USGS reflects the 2014 land use.
- No urban growth is included in this simulation to remain consistent with 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 extraction. If urban growth replaces agricultural irrigation, the impact may be minimal because the urban growth will replace existing agricultural water use.
- Reservoir Operations: The reservoir operations reflect MCWRA’s current approach to reservoir management, as described in MCWRA’s Nacimiento Dam Operation Policy (MCWRA, 2018b).
- Stream Diversions: The SVOM explicitly simulates only 2 stream diversions in the Salinas Valley Basin: Clark Colony and the Salinas River Diversion Facility (SRDF). The Clark Colony diversion is located along Arroyo Seco, and diverts stream water to an agricultural area nearby. The SRDF came online in 2010, and diverts water from the Salinas River to the Castroville Seawater Intrusion Project (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 SVOM whenever reservoir storage and streamflow conditions allow during the months of April through October.

- Recycled Water Deliveries: Recycled water has been delivered to the CSIP area since 1998 as irrigation supply. The SVOM includes recycled water deliveries throughout the duration of the model but may not include all sources of recycled water.

6.4.1.1 Future Projected Climate Assumptions

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

Climate Data. This GSP uses the climate change datasets provided by DWR for use by GSAs. The climate scenarios were derived by taking the historical interannual variability from 1915 through 2011 and increasing or decreasing the magnitude of events based on projected changes in precipitation and temperature from general circulation models. These datasets of climate projections for 2030 and 2070 conditions were derived from a selection of 20 global climate projections recommended by the Climate Change Technical Advisory Group as the most appropriate projections for California water resources evaluation and planning. Because the DWR climate datasets are only available through December 2011, and the SVOM uses a climate time series through December 2014, monthly change factors for January 2012 to December 2014 are assumed. DWR provided climate datasets for central tendency scenarios, as well as extreme wet and dry scenarios; the future water budgets described herein are based on the DWR central tendency scenarios for 2030 and 2070. 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 are applied as the climate inputs for 2012, 2013, and 2014, respectively.

The modified monthly climate data for the entire model period are applied as inputs to the model, which reads precipitation and potential ET data on a monthly basis.

Streamflow. DWR provided monthly change factors for unimpaired streamflow throughout California. For the Salinas Valley 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 Basin are modified by the monthly change factors. As with the climate data, an assumption is required to extend the streamflow change factor time series through December 2014. It is assumed that 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 (1981, 2002, and 2004) are repeated to represent the 2012, 2013, and 2014 streamflows.

Sea Level. DWR guidance recommends using a single static value of sea level rise for each of the climate change scenarios (DWR, 2018). For the 2030 climate change scenario, the DWR-recommended sea level rise value of 15 centimeters is used. For the 2070 climate change scenario, the DWR-recommended sea level rise value of 45 centimeters is used. The amount of sea level rise is assumed to be static throughout the duration of each of the climate change scenarios.

6.4.2 Projected Surface Water Budget

Average projected surface water budget inflows and outflows for the simulation period with 2030 and 2070 climate change assumptions are quantified in Table 6-12. As with the historical period, the largest components projected surface water budget are boundary outflows and inflows.

Table 6-12. SVOM Simulated Average Surface Water Inflow and Outflow Components for Projected Climate Change Conditions (AF/yr)

Projected Climate Change Timeframe	2030	2070
Overland Runoff to Streams	7,100	7,700
Boundary Inflows	516,100	564,200
Diversions from Streams	-4,000	-4,100
Net Flow between surface water and groundwater	-103,200	-105,700
Boundary Outflows	-416,000	-462,200

Note: provisional data subject to change.

Table 6-13 summarizes the average net flow between surface water and groundwater along the Salinas River and tributaries for simulation period with 2030 and 2070 climate change assumptions for the reservoir release periods previously described. Streambed seepage during the non-peak conservation release period is projected to be about the same as current rates; however, the seepage rate during peak conservation release period is projected to substantially increase as compared to the current rate. It is important to note that these results are provisional and uncertain and are subject to change in future GSP updates after the SVIHM is released by the USGS.

Table 6-13. SVOM Simulated Net Flow Between Surface Water and Groundwater for Reservoir Release Periods for the Projected Climate Change Conditions (AF/yr)

Reservoir Release Period	2030	2070
Peak Conservation Release Period (June through September)	-29,600	-30,400
Non-Peak Conservation Release Period (October through May)	-73,200	-74,900

Note: provisional data subject to change.

6.4.3 Projected Groundwater Budget

Average projected groundwater budget inflows for the simulation period with 2030 and 2070 climate change assumptions are quantified in Table 6-14. In both the 2030 and 2070 simulations, the biggest contributor to groundwater inflows is projected to be deep percolation of streamflow.

Table 6-14. SVOM Simulated Average Groundwater Inflow Components for Projected Climate Change Conditions (AF/yr)

Projected Climate Change Timeframe	2030	2070
Deep Percolation of Streamflow	104,600	107,000
Deep Percolation of Precipitation and Irrigation	53,100	57,500
Underflow from Eastside Subbasin	1,800	2,000
Underflow from Surrounding Watersheds	2,000	2,200
Underflow from 180/400-Foot Aquifer Subbasin	200	200
Underflow from Upper Valley Subbasin	2,800	2,800
Total Inflow	164,500	171,700

Note: provisional data subject to change.

Average SVOM projected groundwater budget outflows for the simulation period with 2030 and 2070 climate change assumptions are quantified in Table 6-15. As in the historical groundwater budget, the largest outflow is pumping. Negative values are shown in Table 6-15 to represent outflows.

Table 6-15. SVOM Simulated and Adjusted Average Groundwater Outflow Components for Projected Climate Change Conditions (AF/yr)

	Simulated		Adjusted	
Projected Climate Change Timeframe	**2030**	**2070**	**2030**	**2070**
Groundwater Pumping	-111,500	-117,800	-171,500	-181,200
Discharge to Streams	-1,400	-1,400	-1,400	-1,400
Groundwater Evapotranspiration	-33,900	-35,100	-33,900	-35,100
Underflow to Eastside Subbasin	-2,400	-2,500	-2,400	-2,500
Underflow to Surrounding Watersheds	-800	-800	-800	-800
Underflow to 180/400-Foot Aquifer Subbasin	-2,600	-2,600	-2,600	-2,600
Underflow to Upper Valley Subbasin	-1,300	-1,500	-1,300	-1,500
Total Outflow	-153,900	-161,700	-213,900	-225,100

Note: provisional data subject to change.
Adjusted pumping is based on the ratio between historical average SVIHM and GEMS agricultural pumping, as described in Section 6.3.2.

As described for the historical water budget, the Subbasin is not considered to be in overdraft. Even though, the SVOM projects 9,900 AF/yr and 9,600 AF/yr gain in storage for 2030 and 2070 respectively, the historical estimated change in storage is used with the adjusted pumping estimates to provide a likely more reasonable estimate for projected sustainable yield. The model includes increased precipitation from climate change; however, it does not account for the frequency and magnitude of storm events. If storm events concentrate precipitation within short periods, more water may run off than infiltrate. More analysis needs to be done with regards to future recharge. Therefore, this projected water budget adopts the historical annual change in storage as the most reasonable estimate, assuming extraction continues. This is reflected in the adjusted average change in storage in Table 6-16, which is set to zero AF/yr.

Combining Table 6-14 and Table 6-15 yields the SVOM simulated net groundwater inflow and outflow data for the future simulation with 2030 and 2070 climate change assumptions. These net flows are shown in Table 6-16. Negative values indicate outflows or depletions of groundwater.

Table 6-16. SVOM Simulated and Adjusted Average Annual Groundwater Budget for Projected Climate Change Conditions (AF/yr)

	Simulated		Adjusted	
Projected Climate Change Timeframe	**2030**	**2070**	**2030**	**2070**
Groundwater Pumping	-111,500	-117,800	-171,500	-181,200
Net Stream Exchange	103,200	105,700	103,200	105,700
Deep Percolation	53,100	57,500	53,100	57,500
Net flow from Eastside Subbasin	-700	-500	-700	-500
Net Flow from Outside Areas	1,200	1,400	1,200	1,400
Net flow from Upper Valley Subbasin	1,400	1,400	1,400	1,400
Net flow from 180/400-Foot Aquifer Subbasin	-2,400	-2,300	-2,400	-2,300
Groundwater Evapotranspiration	-33,900	-35,100	-33,900	-35,100
Net Storage Gain (+) or Loss (-)	9,900	9,600	0	0

Note: provisional data subject to change.
Based on the adjusted change in storage, which is the historical average decline as described in the text, water budget error is 30% for 2030 and 31% for 2070; these error values are unreasonably large and will be addressed and improved in future updates to the GSP.
Adjusted pumping is based on the ratio between historical average SVIHM and GEMS agricultural pumping, as described in Section 6.3.2.

SVOM projected groundwater pumping by water use sector is summarized in Table 6-17. . Because the model assumes no urban growth, future municipal pumping was assumed to be equal to current municipal pumping. Future agricultural pumping is then calculated as the total projected pumping minus the current pumping for municipal and industrial use. The 2030 and 2070 model simulations predict that agriculture will account for more than 95% of pumping. Similar to the SVIHM, domestic pumping is not included in the SVOM future projections simulation.

Table 6-17. SVOM Simulated Projected and Adjusted Annual Groundwater Pumping by Water Use Sector (AF/yr)

	Simulated		Adjusted	
Water Use Sector	**2030 Average**	**2070 Average**	**2030**	**2070**
Agricultural	-107,700	-114,000	-165,700	-175,400
Municipal & Industrial	-3,800	-3,800	-5,800	-5,800
Total Pumping	**-111,500**	**-117,800**	**-171,500**	**-181,200**

Note: provisional data subject to change.

6.4.4 Projected Sustainable Yield

Projected sustainable yield is the long-term pumping that can be sustained once all undesirable results have been addressed. However, it is not the amount of pumping needed to stop undesirable results before sustainability is reached. The SVBGSA recognizes that, dependent on the success of various proposed management actions and projects, there may be some years when pumping must 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 management actions and projects.

To retain consistency with the historical sustainable yield, projected sustainable yield can be estimated by summing all the average groundwater extractions and subtracting the average change in storage. This represents the change in pumping that results in no change in storage, assuming no other projects or management actions are implemented. For this sustainable yield discussion and associated computations, groundwater pumping outflows are reported as positive values, which is opposite of how the values are reported in the water budget tables.

Table 6-18. provides estimates of the future sustainable yield using estimated future pumping calculated in Table 6-17. As with the historical sustainable yield, the model estimated change in storage is within the model error, and the average change in storage for the calculations in Table 6-18 is set to zero.

Table 6-18. Projected Sustainable Yields with Pumping Adjusted Based on GEMS Data (AF/yr)

	2030 Projected Sustainable Yield	2070 Projected Sustainable Yield	Historical Sustainable Yield Range
Groundwater Pumping	171,500	181,200	150,900 to 174,300
Change in Storage	0	0	0
Projected Sustainable Yield	171,500	181,200	150,900 to 174,300

Table 6-18 includes the GEMS database estimate of historical sustainable yield for comparison purposes. Although the sustainable yield values provide guidance for maintaining sustainability, simply reducing pumping to within the sustainable yield is not proof of sustainability.

Sustainability must be demonstrated through the SMC. The sustainable yield value will be modified and updated as more data are collected, and more analyses are performed.

6.4.5 Uncertainties in Projected Water Budget Simulations

Models are mathematical representations of physical systems. They have limitations in their ability to represent physical systems exactly and due to limitations in the data inputs used. 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. However, DWR (2018) recognizes that although models are not exact representations of physical systems because mathematical depictions are imperfect, they are powerful tools that can provide useful insights.

There is additional inherent uncertainty involved in projecting water budgets with projected climate change based on the available scenarios and methods. The recommended 2030 and 2070 central tendency scenarios that are used to develop the projected water budgets with the SVIHM provide a dataset that can be interpreted as 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).

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."*

6.5 Subbasin Water Supply Reliability

Water is not imported into the Forebay Subbasin from other basins. Uncertainties include future precipitation and land use.

6.6 Historical and Current Water Budgets for Arroyo Seco Cone Management Area

The ASCMA was established to account for the unique hydrogeologic, water quality and water supply characteristics of the Arroyo Seco Cone region that are discussed in Chapter 4. The water budgets for the ASCMA are a subset of the greater Forebay Subbasin water budgets. The water budgets for both the ASCMA and the greater Forebay Subbasin are developed using the identical SVIHM and SVOM models, and identical techniques for refining model results with measured data. Although the water budgets are presented separately, management of the ASCMA and the greater Forebay Subbasin will be coordinated to meet the sustainability goal of the entire Subbasin.

Water budgets for the historical and current periods for the ASCMA are presented below. The surface water budgets are presented first, followed by the groundwater budgets. These results are based on the provisional SVIHM and are subject to change in the future. Water budgets will be updated in future GSP updates after the SVIHM is formally released by the USGS.

6.6.1 Historical and Current Surface Water Budget for Arroyo Seco Cone Management Area

The surface water budget accounts the inflows and outflows for the streams within the ASCMA. This includes streamflows of rivers and tributaries entering and exiting the ASCMA, overland runoff to streams, diversions from streams, and stream-aquifer interactions. ET by riparian vegetation along stream channels is estimated by the provisional SVIHM as part of the groundwater system and is accounted for in the groundwater budget.

Figure 6-4 shows the surface water network simulated in the provisional SVIHM. The network includes the Salinas River, Arroyo Seco, Clark Colony canal, and other streams within the ASCMA. For this water budget, boundary inflows and outflows are the sum of all locations that cross the ASCMA boundary.

Figure 6-11 shows the surface water budget for the historical period, which also includes the current period. Table 6-19 shows the average surface water budget for the historical and current periods. Positive values are inflows into the stream system, and negative values are outflows from the stream system. The net flow between surface water and groundwater is negative for both the historical and current periods, indicating more stream leakage to groundwater rather than groundwater discharge to streams. Boundary inflows and outflows dominate the surface-water budget in all but the driest years.

Table 6-19. SVIHM Estimated Surface Water Budget Summary for Arroyo Seco Cone Management Area (AF/yr)

	Historical Average (WY 1980-2016)	Current (WY 2016)
Overland Runoff to Streams	800	500
Boundary Stream Inflows	440,000	125,400
Diversions from Streams	-4,200	-1,300
Net Flow between Surface Water and Groundwater	-15,600	-16,500
Boundary Stream Outflows	-420,900	-108,100

Note: provisional data subject to change.

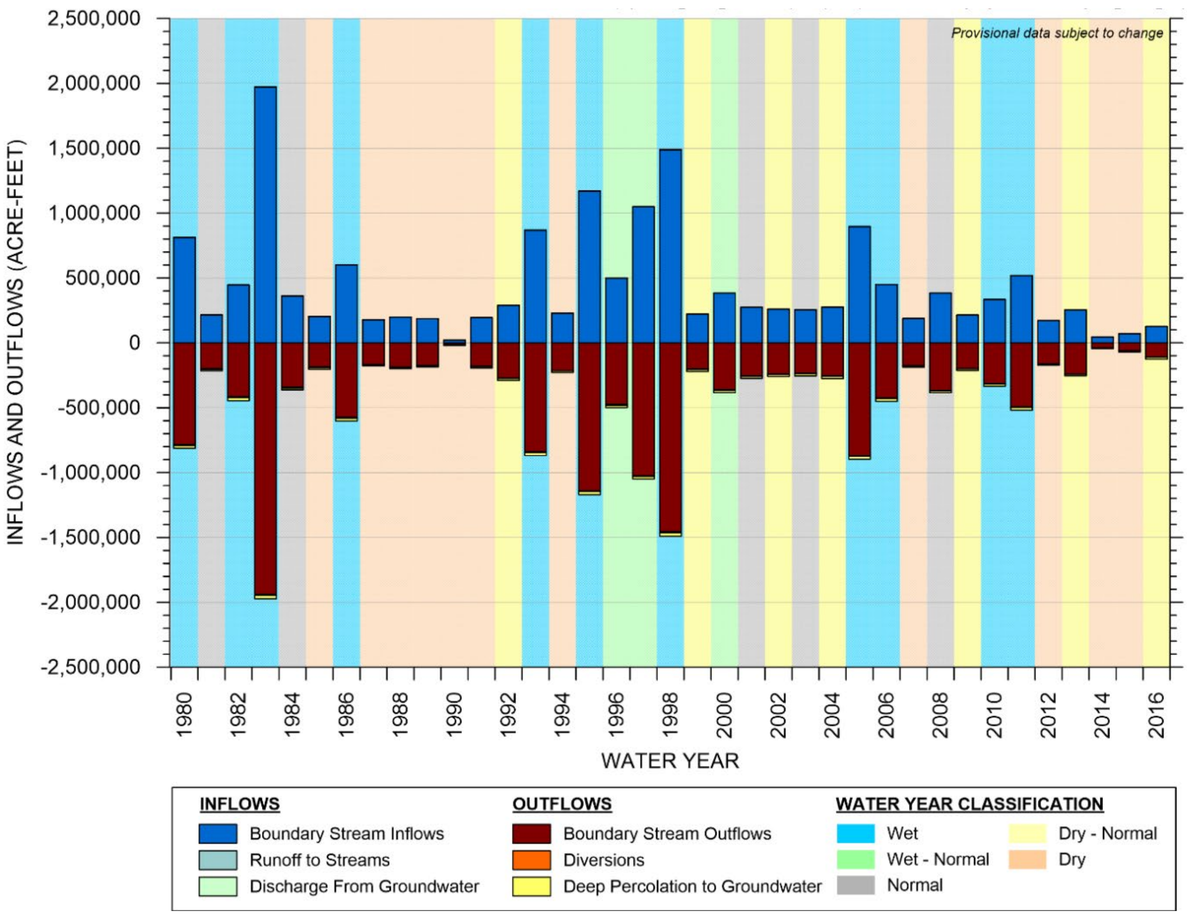


Figure 6-11. SVIHM Estimated Historical and Current Surface Water Budget for Arroyo Seco Cone Management Area

Table 6-20 summarizes the average net flow between surface water and groundwater along Salinas River, Arroyo Seco, Clark Colony canal, and the sum of all other smaller streams. The vast majority of flow between surface water and groundwater occurs along the Arroyo Seco where streamflow quickly percolates down into the coarse-grained streambed. Flow between surface water and groundwater from the Salinas River is small because only a small stretch of the Salinas River intersects the ASCMA.

Table 6-20. SVIHM Estimated Net Flow Between Surface Water and Groundwater by Stream Zone for Arroyo Seco Cone Management Area (AF/yr)

	Historical Average (WY 1980-2016)	Current (WY 2016)
Salinas River	-700	-900
Arroyo Seco	-14,400	-15,300
Clark Colony Diversion	0	0
Other Streams	-500	-300

Note: provisional data subject to change.

The ASGSA used the FFM18 model to develop an independent estimate of percolation from the Arroyo Seco. The FFM18 model simulated an average annual percolation rate of 23,150 AF/yr between 1996 and 2009.

Both the SVIHM and FFM18 models appear to underestimate percolation from the Arroyo Seco into groundwater. A rigorous differential stream gauge analysis conducted by the ASGSA established that the average annual recharge from the Arroyo Seco between 1995 and 2018 was 36,100 AF/yr: more than twice what was estimated by the SVIHM. The same analysis estimated that the annual average Arroyo Seco percolation between 1996 and 2009 was 41,000 AF/yr, compared to the 23,200 AF/yr estimated by the FFM18 model. The Arroyo Seco recharge should be refined in the SVIHM during GSP implementation

6.6.2 Historical and Current Groundwater Budget for Arroyo Seco Cone Management Area

The groundwater budget includes inflows and outflows of groundwater at the ASCMA's boundaries, recharge, pumping, ET, and net flow between surface water and groundwater. Annual inflows to the groundwater system for the historical and current time periods estimated by the SVIHM are shown on Figure 6-12. Inflows vary substantially from year to year. Table 6-21 provides average groundwater inflows for the historical and current period. Generally, each of the 3 inflows contribute roughly equally to the annual total inflow.

Figure 6-13 shows the SVIHM estimated outflows from the groundwater system for the historical and current time periods. Outflows vary from year to year; however, groundwater pumping, including municipal, industrial, and agricultural water, is consistently the largest outflow from the ASCMA. Table 6-22 provides annual averages for groundwater outflows of the historical and current period. Subsurface outflows and agricultural pumping for the current period are similar to the historical average.

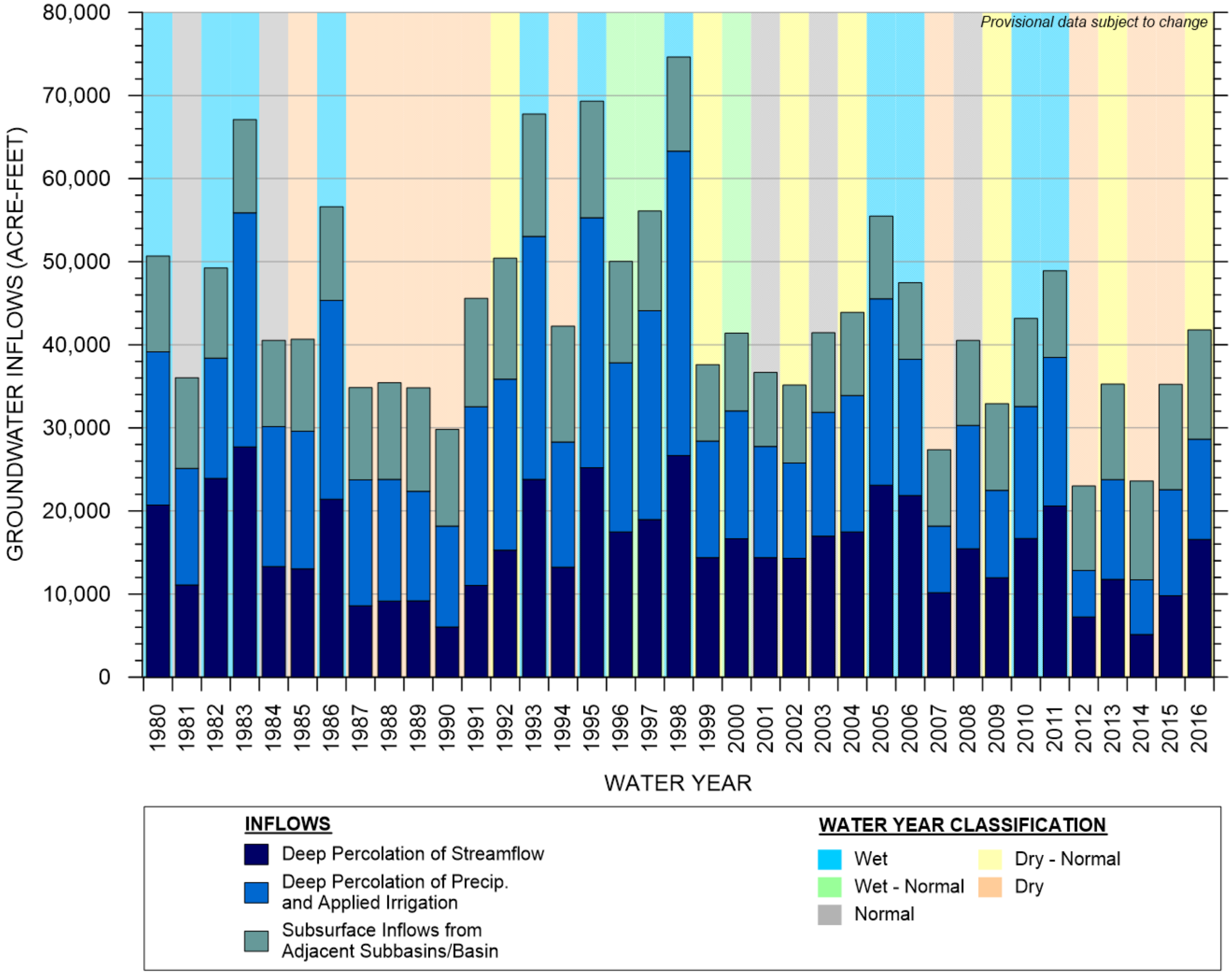


Figure 6-12. SVIHM Estimated Groundwater Inflows to Arroyo Seco Cone Management Area

Table 6-21. SVIHM Simulated Groundwater Inflows Budget Summary in Arroyo Seco Cone Management Area (AF/yr)

	Historical Average (WY 1980-2016)	Current (WY 2016)
Deep Percolation of Streamflow	15,700	16,600
Deep Percolation of Precipitation and Applied Water	16,900	12,100
Subsurface Inflow from Adjacent Subbasins/Basin	11,200	13,100

Note: provisional data subject to change.

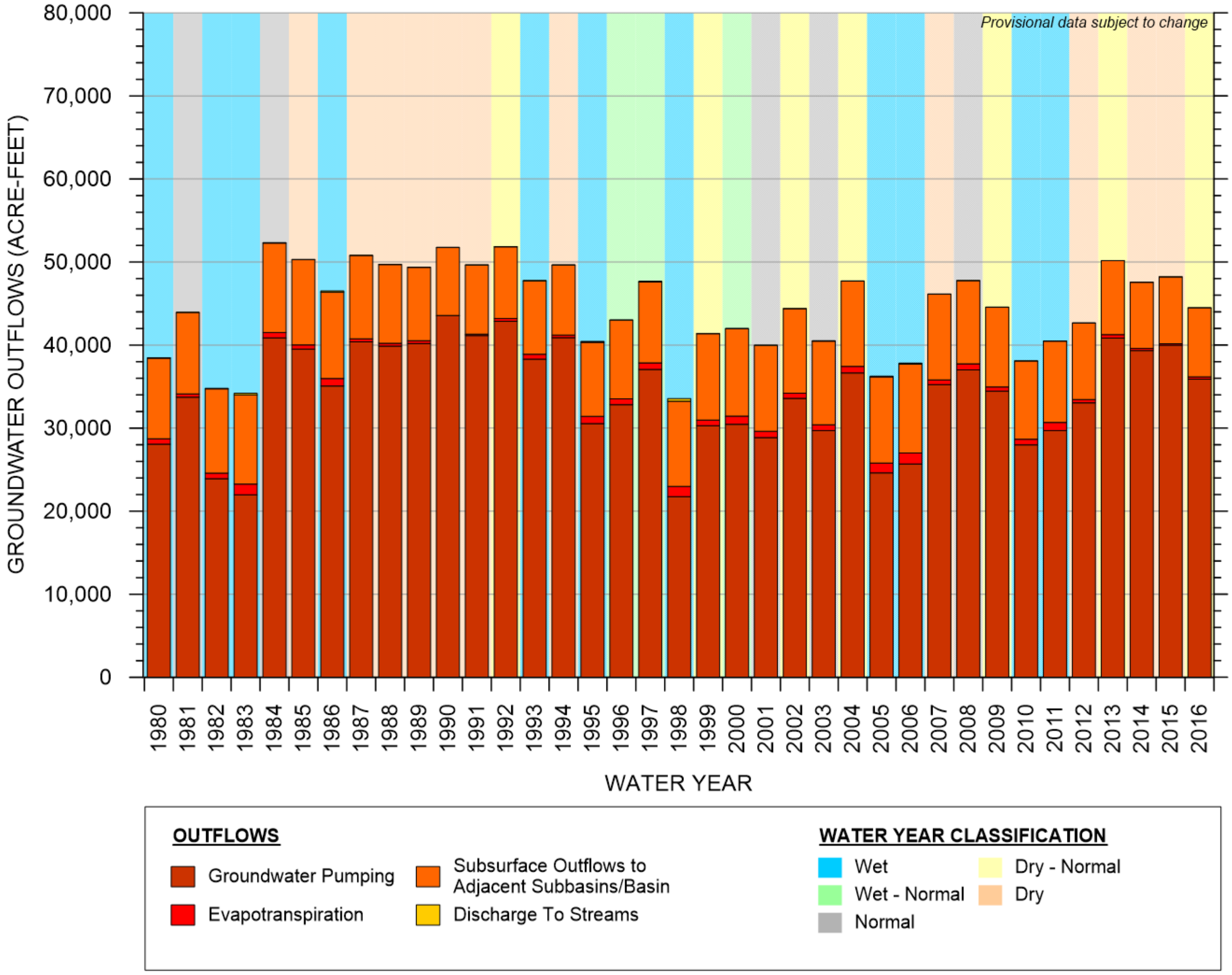


Figure 6-13. SVIHM Estimated Groundwater Outflows from Arroyo Seco Cone Management Area

Table 6-22. SVIHM Simulated and Adjusted Groundwater Outflows Budget Summary in Arroyo Seco Cone Management Area (AF/yr)

	Simulated		Adjusted	
	Historical Average (WY 1980-2016)	Current (WY 2016)	Historical Average (WY 1980-2016)	Current (WY 2016)
Groundwater Pumping	-34,200	-35,900	-51,100	-53,500
Groundwater Evapotranspiration	-600	-300	-600	-300
Subsurface Outflow to Forebay	-9,600	-8,300	-9,600	-8,300
Discharge to Streams	-100	0	-100	0

Note: provisional data subject to change.
Adjusted pumping is described below.

ASGSA modeling estimated that 39,087 AF/yr is applied for irrigation in the ASCMA. Of the total applied irrigation, 6,287 AF/yr of surface water was delivered by CCWC. Subtracting this from the 39,087 yields an estimate of 32,800 AF/yr of groundwater pumping for irrigation.

Comparing SVIHM and ASGSA data to GEMS data reveals that, on average, the preliminary SVIHM estimates only approximately 67% of the pumping reported in the GEMS database for the Subbasin between 1995 and 2016.

The ASGSA model estimates of pumping were similar to the SVIHM estimates, accounting for approximately 70% of the annual average 47,000 AF/yr of agricultural pumping in the ASCMA recorded in the GEMS database between 1996 and 2009.

These GEMS data are likely more representative of historical conditions than the model generated pumping numbers, however, reliable GEMS data are only available since 1995. To accurately estimate groundwater extraction for the full historical period, this 67% ratio was applied to the SVIHM estimated historical pumping shown in Table 6-22, yielding an estimated historical average pumping rate of 51,100 AF/yr.

SVIHM estimated groundwater pumping by water use sector is summarized on Figure 6-14 and Table 6-23. These show that more than 90% of pumped groundwater goes toward agricultural use. Domestic pumping, including *de minimis* pumping, from privately owned wells is assumed to be negligible and is not included in the model for the ASCMA.

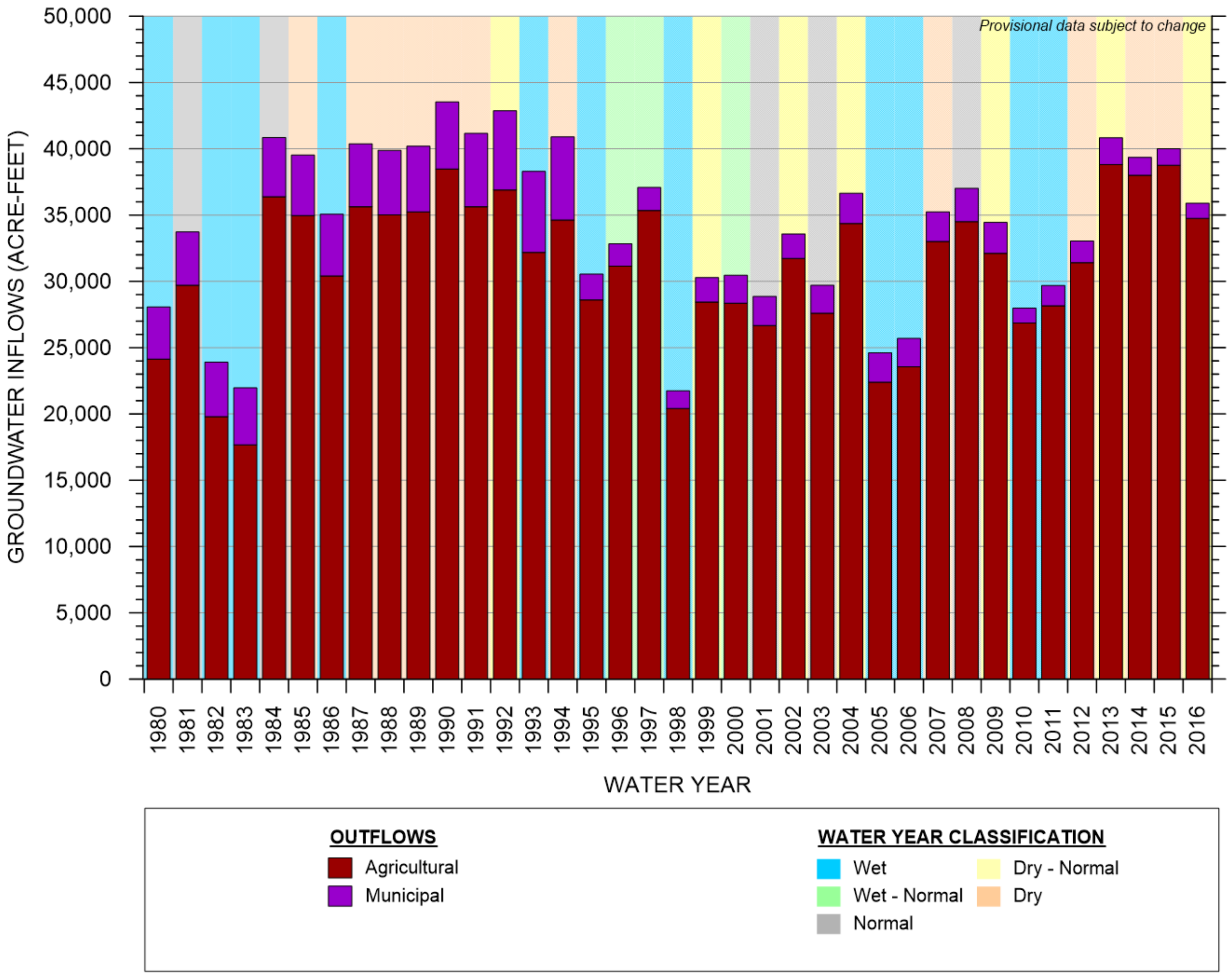


Figure 6-14. SVIHM Estimated Groundwater Pumping by Water Use Sector in Arroyo Seco Cone Management Area

Table 6-23. SVIHM Estimated and Adjusted Groundwater Pumping by Water Use Sector in Arroyo Seco Cone Management Area (AF/yr)

	Simulated		GEMS		Adjusted	
	Historical Average (WY 1980-2016)	Current (WY 2016)	Historical Average (WY 1995-2016)	Current (WY 2016)	Historical Average (WY 1980-2016)	Current (WY 2016)
Municipal and Industrial	-3,100	-1,100	-2,200	-1,800	-4,700	-1,600
Agricultural	-31,100	-34,800	-46,500	-45,800	-46,400	-51,900
Total Pumping	-34,200	-35,900	-48,700	-47,600	-51,100	-53,500

Note: provisional data subject to change.
Adjusted pumping is based on the ratio between historical average SVIHM and GEMS agricultural pumping, as described in above in text.

Figure 6-15 shows the SVIHM simulated net subsurface flows entering and exiting the ASCMA from the greater Forebay Subbasin. On average, the ASCMA receives about 1,600 AF more in subsurface inflows per year than it loses to subsurface outflows.

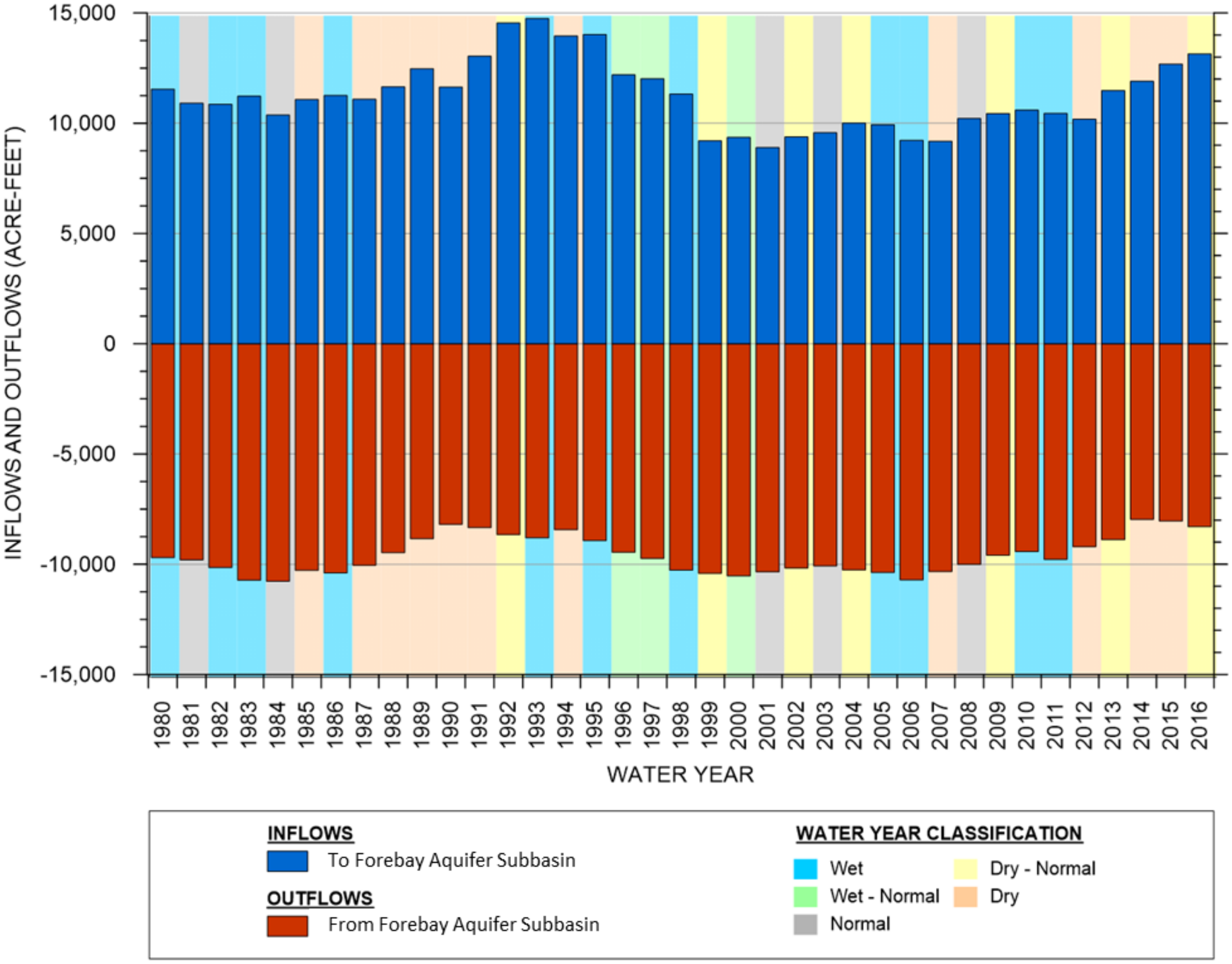


Figure 6-15. SVIHM Simulated Subsurface Inflows and Outflows for Arroyo Seco Cone Management Area

Change in groundwater storage is equal to total inflows to storage (such as deep percolation) minus total outflows from storage (such as pumping). A negative change in groundwater storage value indicates groundwater storage depletion associated with lower groundwater levels; while a positive value indicates groundwater storage accretion associated with higher groundwater levels. Averaged over the historical period, the preliminary SVIHM estimates that the ASCMA loses about 600 AF/yr. However, simulated overdraft contains significant variability and uncertainty. Figure 6-16 shows considerable variability in change in storage from one year to the next. ASGSA used the FFM18 model to develop an alternative estimate of storage change. During 1996-2009, the FFM18 model it calculated an average annual storage change of -1,360 AF/yr for the entire ASCMA.

The cumulative simulated change in storage line on Figure 6-16 shows that during the 37-year historical period, the ASCMA was in overdraft during only 9 years, and there is no observable trend indicating a chronic decline in groundwater storage. Therefore, although the SVIHM estimated historical overdraft of 600 AF/yr, the Subbasin is not considered to have been historically in overdraft, and this GSP considers the historical average change in storage to be zero.

6.6.3 Historical and Current Groundwater Budget Summary for Arroyo Seco Cone Management Area

Figure 6-16 shows the entire groundwater water budget and includes the annual change in groundwater storage. Changes in groundwater storage are strongly correlated with changes in deep percolation of precipitation, applied irrigation water, and streamflow. For example, 1983 and 1998 were comparatively very wet years and represent the greatest increase in deep percolation (recharge) and, correspondingly, groundwater storage over the historical period. Estimated cumulative groundwater storage increased in response to wet periods and declined in response to dry periods.

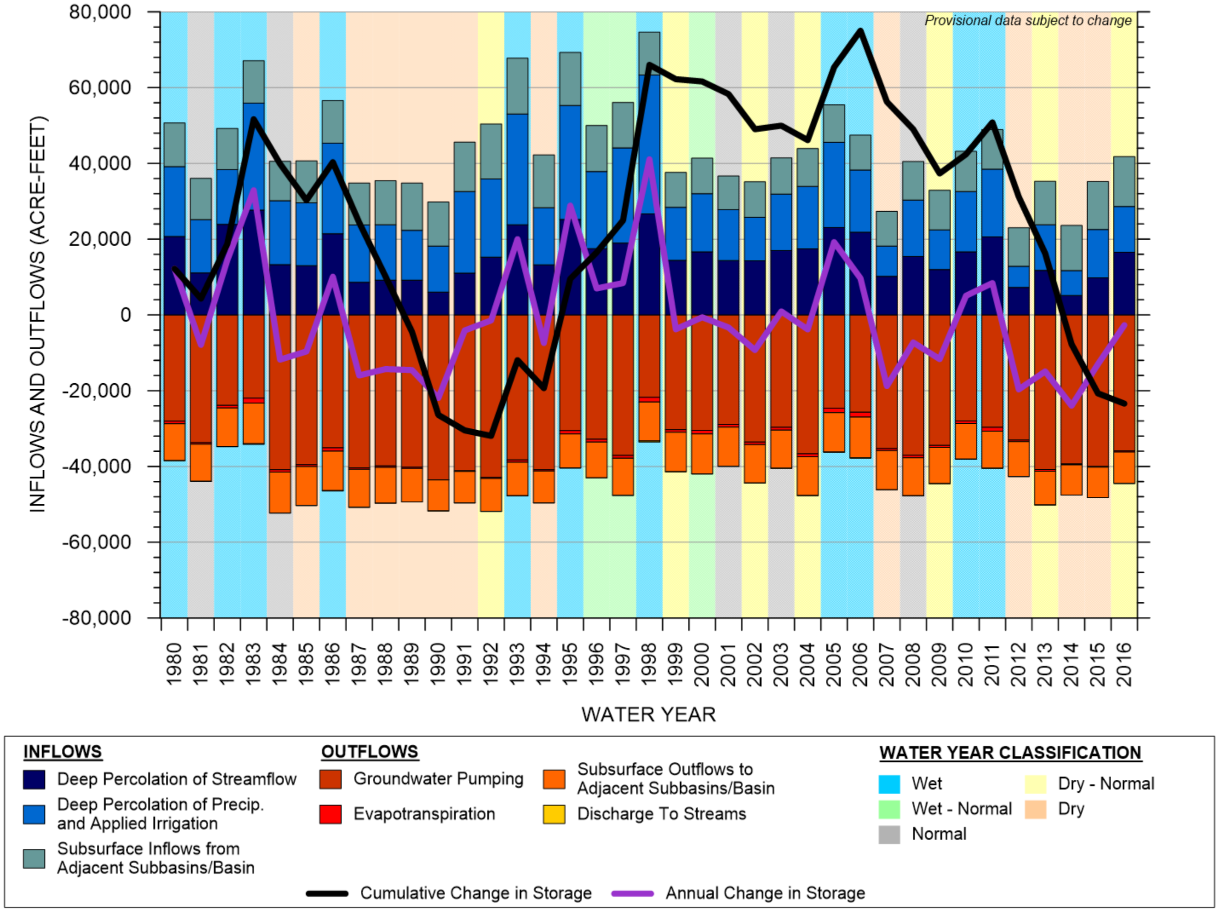


Figure 6-16. SVIHM Estimated Groundwater Budget for Arroyo Seco Cone Management Area

Combining Table 6-21 and Table 6-22 yields the net groundwater inflow and outflow data for the historical period. These net flows are shown in Table 6-24. This table is informative in showing the relative magnitude of various water budget components; however, these results are based on a provisional model which might contain errors. The results will be updated in future updates to this chapter after the SVIHM is completed and released by the USGS.

Table 6-24. Summary of Groundwater Budget for Arroyo Seco Cone Management Area (AF/yr)

	Historical Average (WY 1980-2016)	Current (WY 2016)
Groundwater Pumping	-51,100	-53,500
Net Stream Exchange	15,600	16,500
Deep Percolation	16,900	12,100
Net flow from Adjacent Subbasins/Basin	1,600	4,800
Groundwater Evapotranspiration	-600	-300
Net Storage Gain (+) or Loss (-)	0	-2,700

Note: provisional data subject to change.
The net storage value is the estimated historical overdraft based on observed groundwater levels, as described in Sections 5.2.2 and 6.3.2.
Water budget error, as reflected in change in storage, for the historical average period is 40%, which is considered unreasonably large and will be addressed and improved in future updates to the GSP.

6.6.4 Historical and Current Sustainable Yield for Arroyo Seco Cone Management Area

For this sustainable yield discussion and associated computations, groundwater pumping outflows are reported as positive values, which is opposite of how the values are reported in the water budget tables.

Table 6-25 provides estimates of the ASCMA historical sustainable yield using the GEMS derived historical pumping. The cumulative change in storage line on Figure 6-16 shows that during the 37-year historical period, the ASCMA was in overdraft during only 9 years, and there is no observable trend indicating a chronic decline in groundwater storage. Therefore, the ASCMA has historically not been in overdraft, and the average change in storage for the calculations in Table 6-25 is set to zero.

Because the ASCMA has not historically been in overdraft, it is impossible to estimate the historical sustainable yield. Therefore, Table 6-25 presents a likely range of sustainable yields. This range represents plus and minus 1 standard deviation around the average GEMS reported pumping between 1995 and 2016. These values are the likely range of the minimum sustainable yield of the subbasin. This GSP adopts the range of likely minimum sustainable yields as the best estimate for the Subbasin.

Table 6-25. Historical Sustainable Yield for the Arroyo Seco Cone Management Area Derived from GEMS and Adjusted Change in Storage (AF/yr)

	Low Historical Average (WY 1995-2016)	High Historical Average (WY 1995-2016)
Total Subbasin Pumping	44,400	53,000
Change in Storage	0	0
Estimated Sustainable Yield	44,400	53,000

6.7 Projected Water Budgets for Arroyo Seco Cone Management Area

Projected water budgets are extracted from the SVOM, which simulates projected hydrologic conditions with climate change simulations. This is the same model used for projected water budgets in Forebay Subbasin.

6.7.1 Assumptions and Overview of Projected Water Budget in Arroyo Seco Cone Management Area

The projected water budget in ASCMA makes the same assumptions and has the same organizational structure as the projected water budget in the greater Forebay Subbasin.

6.7.2 Projected Surface Water Budget for Arroyo Seco Cone Management Area

Average SVOM projected surface water budget inflows and outflows for the future simulation period with 2030 and 2070 climate change assumptions are quantified in Table 6-26. Boundary inflows and outflows and net streamflow seepage are projected to be larger than current rates for both climate change scenarios.

Table 6-26. SVOM Simulated Average Surface Water Inflow and Outflow Components for Projected Climate Change Conditions for the Arroyo Seco Cone Management Area (AF/yr)

Projected Climate Change Timeframe	2030	2070
Overland Runoff to Streams	900	1,000
Boundary Inflows	492,000	537,700
Diversions from Streams	-4,000	-4,100
Net Flow between surface water and groundwater	-23,800	-23,800
Boundary Outflows	-465,100	-510,800

Note: provisional data subject to change.

6.7.3 Projected Groundwater Budget for Arroyo Seco Cone Management Area

Average SVOM projected groundwater budget inflows for the future simulation period with 2030 and 2070 climate change assumptions are quantified in Table 6-27. Inflow is relatively evenly distributed between the water sources. Based on the comparison of simulated stream leakage and historical measured stream leakage discussed in Section 6.6.1, it is likely that the projected deep percolation of streamflow is underestimated by the SVOM.

Table 6-27. SVOM Simulated Average Groundwater Inflow Components for Projected Climate Change Conditions in Arroyo Seco Cone Management Area (AF/yr)

Projected Climate Change Timeframe	2030	2070
Deep Percolation of Streamflow	23,800	23,800
Deep Percolation of Precipitation and Applied Water	16,800	18,100
Subsurface Inflow	11,200	12,000
Total Inflow	**51,800**	**53,900**

Note: provisional data subject to change.

Average SVOM projected groundwater budget outflows for the future simulation period with 2030 and 2070 climate change assumptions are quantified in Table 6-28. The greatest outflow component is groundwater pumping. Projected pumping is summarized below in Section 6.7.4.

Table 6-28. SVOM Simulated and Adjusted Average Groundwater Outflow Components for Projected Climate Change Conditions in Arroyo Seco Cone Management Area (AF/yr)

	Simulated		Adjusted	
Projected Climate Change Timeframe	2030	2070	2030	2070
Pumping	-34,900	-37,100	-52,000	-55,300
Discharge to Streams	0	0	0	0
Groundwater Evapotranspiration	-1,500	-1,500	-1,500	-1,500
Subsurface Outflow	-13,400	-13,400	-13,400	-13,400
Total Outflow	**-49,800**	**-52,000**	**-66,900**	**-70,200**

Note: provisional data subject to change.
Adjusted pumping is based on the ratio between historical average SVIHM and GEMS agricultural pumping, as described in Section 6.6.2.

As described for the historical water budget, the ASCMA is not considered to be in overdraft. Even though, the SVOM projects 1,700 AF/yr and 1,600 AF/yr gain in storage for 2030 and 2070 respectively, the historical estimated change in storage is used with the adjusted pumping estimates to provide a likely more reasonable estimate for projected sustainable yield. Therefore, this projected water budget adopts the historical annual change in storage as the most reasonable estimate, assuming extraction continues. This is reflected in the adjusted average change in storage in Table 6-29. , which is set to zero AF/yr.

Combining Table 6-27 and Table 6-28 yields the SVOM projected net groundwater inflow and outflow data for the future simulation with 2030 and 2070 climate change assumptions. These net flows are shown in Table 6-29. Negative values indicate outflows or depletions.

Table 6-29. SVOM Simulated and Adjusted Average Annual Groundwater Budget for Projected Climate Change Conditions in Arroyo Seco Cone Management Area (AF/yr)

Projected Climate Change Timeframe	Simulated		Adjusted	
	2030	2070	2030	2070
Groundwater Pumping	**-34,900**	**-37,100**	**-52,000**	**-55,300**
Net Subsurface Flow	-2,200	-1,500	-2,200	-1,500
Deep Percolation of Precipitation and Applied Water	15,300	16,600	15,300	16,600
Groundwater Evapotranspiration	-1,500	-1,500	-1,500	-1,500
Net Stream Exchange	23,800	23,800	23,800	23,800
Net Storage Gain (+) or Loss (-)	1,700	1,600	0	0

Note: provisional data subject to change.
Based on the adjusted change in storage, which is the historical average decline as described in the text, water budget error is 32% for 2030 and 33% for 2070; these error values are unreasonably large and will be addressed and improved in future updates to the GSP.
Adjusted pumping is based on the ratio between historical average SVIHM and GEMS agricultural pumping, as described in Section 6.6.2.

SVOM projected groundwater pumping by water use sector is summarized in Table 6-30. Because the model assumes no urban growth, future municipal pumping was assumed to be equal to current municipal pumping. Future agricultural pumping is then calculated as total projected pumping minus the current pumping for municipal and industrial use. The 2030 and 2070 model simulations predict that agriculture will account for more than 95% of pumping in the ASCMA.

Table 6-30. Projected SVOM Simulated and Adjusted Annual Groundwater Pumping by Water Use Sector in Arroyo Seco Cone Management Area (AF/yr)

	Simulated		Adjusted	
Water Use Sector	2030	2070	2030	2070
Agricultural	-33,800	-36,000	-50,400	-53,700
Urban	-1,100	-1,100	-1,600	-1,600
Total Pumping	-34,900	-37,100	-52,000	-55,300

Note: provisional data subject to change.
Adjusted pumping is based on the ratio between historical average SVIHM and GEMS agricultural pumping, as described in Section 6.6.2.

6.7.4 Projected Sustainable Yield for Arroyo Seco Cone Management Area

Projected sustainable yield is the long-term pumping that can be sustained once all undesirable results have been addressed. However, it is not the amount of pumping needed to stop undesirable results before sustainability is reached. Dependent on the success of various proposed management actions and projects, there may be some years when pumping must 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 management actions and projects.

To retain consistency with the historical sustainable yield, SVOM projected sustainable yield can be estimated by summing all the average groundwater extractions and subtracting the average change in storage. This represents the change in pumping that results in no change in storage, assuming no other projects or management actions are implemented. Projected sustainable yield estimates are quantified in Table 6-31. For this sustainable yield discussion and associated computations, groundwater pumping outflows are reported as positive values, which is opposite of how the values are reported in the water budget tables. These results indicate that the projected future sustainable yield is larger than the projected future groundwater pumping. The difference between historical pumping and the calculated sustainable yield is within the model's range of error, and therefore the values in Table 6-31 should be used cautiously. The general conclusion from Table 6-31 is that the ASCMA can be managed within its sustainable yield in the future. The sustainable yield value will be updated in future GSP updates as more data are collected and additional analyses are conducted.

Table 6-31 provides estimates of the future sustainable yield using estimated future pumping calculated in Table 6-29. As with the historical sustainable yield, the model estimated change in storage is within the model error, and the average change in storage for the calculations in Table 6-31 is set to zero.

Table 6-31. Projected Sustainable Yields in Arroyo Seco Cone Management Area with Pumping Adjusted Based on GEMS Data (AF/yr)

	2030 Projected Sustainable Yield	2070 Projected Sustainable Yield	Historical Sustainable Yield Range
Groundwater Pumping	52,000	55,300	44,400 to 53,000
Change in Storage	0	0	0
Projected Sustainable Yield	52,000	55,300	44,400 to 53,000

Table 6-31 includes the GEMS database estimate of historical sustainable yield for comparison purposes. Although the sustainable yield values provide guidance for maintaining sustainability, simply reducing pumping to within the sustainable yield is not proof of sustainability. Sustainability must be demonstrated through the SMC. The sustainable yield value will be modified and updated as more data are collected, and more analyses are performed.

6.7.5 Uncertainties in Projected Water Budget Simulations for Arroyo Seco Cone Management Area

As with the greater Forebay Subbasin water budget, there is inherent uncertainty involved in projecting water budgets with projected climate change based on the available scenarios and methods. For a full description, see Section 6.4.5.

6.8 Uncertainties in Water Budget Calculations

The level of accuracy and certainty is highly variable between water budget components. A few water budget components are directly measured, but most water budget components are either estimated inputs to the model or simulated by the model. Additional model uncertainty stems from an imperfect representation of natural condition and is reflected in model calibration error. However, inputs to the models are carefully selected using best available data, the model's calculations represent established science for groundwater flow, and the model calibration error is within acceptable bounds. Therefore, the models are the best available tools for estimating water budgets. The model results are provisional and subject to change in future GSP updates after the models are released by the USGS.

The following list groups water budget components in increasing order of uncertainty:

- Measured: metered municipal, agricultural, and some small water system pumping
- Estimated: domestic pumping, including depth, rate, and location
- Simulated primarily based on climate data: precipitation, ET, irrigation pumping
- Simulated based on calibrated model: all other water budget components

Simulated components based on calibrated model have the most uncertainty because those simulated results encompass uncertainty of other water budget components used in the model in addition to model calibration error.

7 MONITORING NETWORKS

This chapter describes the networks that will monitor the SMC explained further in Chapter 8. This description of the monitoring network has been prepared in accordance with the GSP Regulations § 354.32 *et seq.* to include monitoring objectives, monitoring protocols, and data reporting requirements.

7.1 Introduction

7.1.1 Monitoring Network Objectives

SGMA requires monitoring networks to collect 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.

7.1.2 Approach to Monitoring Networks

Monitoring networks are developed for each of the 5 sustainability indicators that are relevant to the Subbasin:

1. Chronic lowering of groundwater levels
2. Reduction in groundwater storage
3. Degraded water quality
4. Land subsidence
5. Depletion of ISW

Other monitoring networks, such as groundwater extraction, that are necessary to comply with GSP Regulations are also included in this chapter. Representative Monitoring Sites (RMS) are a subset of the monitoring network and are limited to sites with data that are publicly available and not confidential.

The SVBGSA estimated the density of monitoring sites and the frequency of measurements required to demonstrate short-term, seasonal, and long-term trends. If the required monitoring site density does not currently exist, the SVBGSA will expand monitoring networks during GSP implementation. Filling data gaps and developing more extensive and complete monitoring networks 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 resolving data gaps. The SVBGSA will review the monitoring network in each 5-year assessment, including a determination of uncertainty and whether there are remaining data gaps that could affect the ability of the Plan to achieve the sustainability goal for the Subbasin.

7.1.3 Management Areas

The Forebay Subbasin includes the ASCMA that is designated to be managed by the ASGSA. The remaining area of the Subbasin will be managed by the SVBGSA in accordance with the Forebay Subbasin Groundwater Sustainability Plan Implementation Agreement (Forebay Implementation Agreement, 2021). Both implementation areas will be managed consistent to a single GSP for the entire Subbasin and will consist of the same monitoring network for each sustainability indicator. The quantity and density of monitoring sites in both implementation areas shall be sufficient to evaluate conditions of the Subbasin setting and to establish SMC to reach the sustainability goal of the Subbasin in accordance with GSP Regulation § 354.34 (d).

7.2 Groundwater Level 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.

Figure 7-1 shows 59 wells in the Subbasin monitored by MCWRA for groundwater elevations that are used to develop groundwater elevation contours and have publicly available data on the SVBGSA Web Map.

Of the wells shown on Figure 7-1, 39 are selected for inclusion in the groundwater level monitoring network as RMS wells, and are shown on Figure 7-2. Criteria for selecting wells as part of the RMS network include:

- RMS wells must have known depths and well completion data.
- RMS wells should have a relatively long period of historical data.
- Hydrographs of RMS wells should be visually representative of the hydrographs from surrounding wells. Appendix 5A includes the hydrograph comparisons used to establish that RMS wells are representative of surrounding wells.

- RMS locations must cover the basin and provide data near basin boundaries.
- RMS should be selected for each aquifer. There is only 1 aquifer in the Forebay Subbasin.
- Data from RMS wells is public data and will be used for groundwater elevation maps and analysis. SVBGSA notified well owner of intent to include well in monitoring network.

The RMS wells in the water level monitoring network are listed in Table 7-1. The need for any additional wells is discussed in Section 7.2.2. Appendix 5A presents well construction information and historical hydrographs for each RMS well.

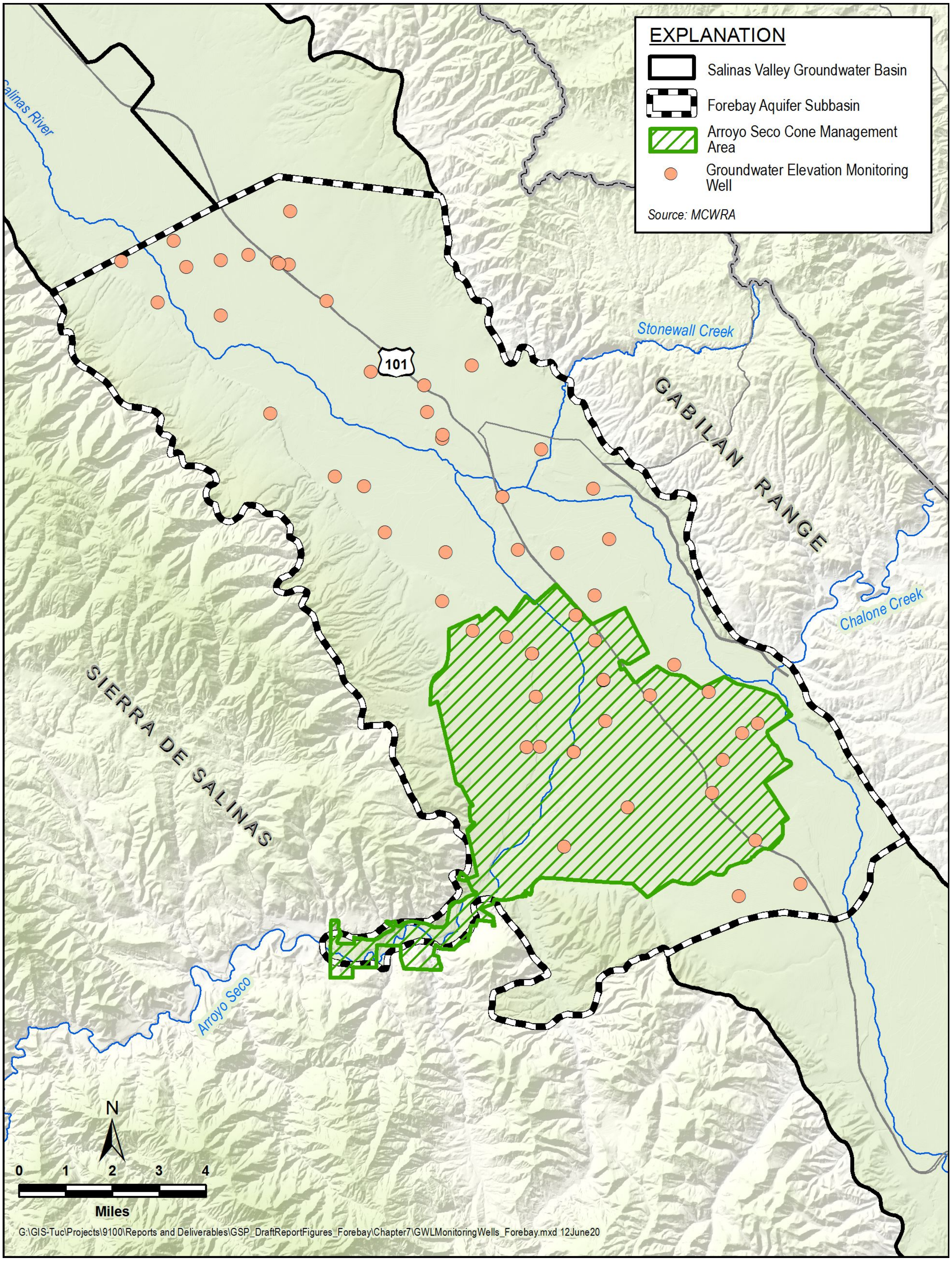


Figure 7-1. Forebay Aquifer Monitoring Network for Groundwater Levels

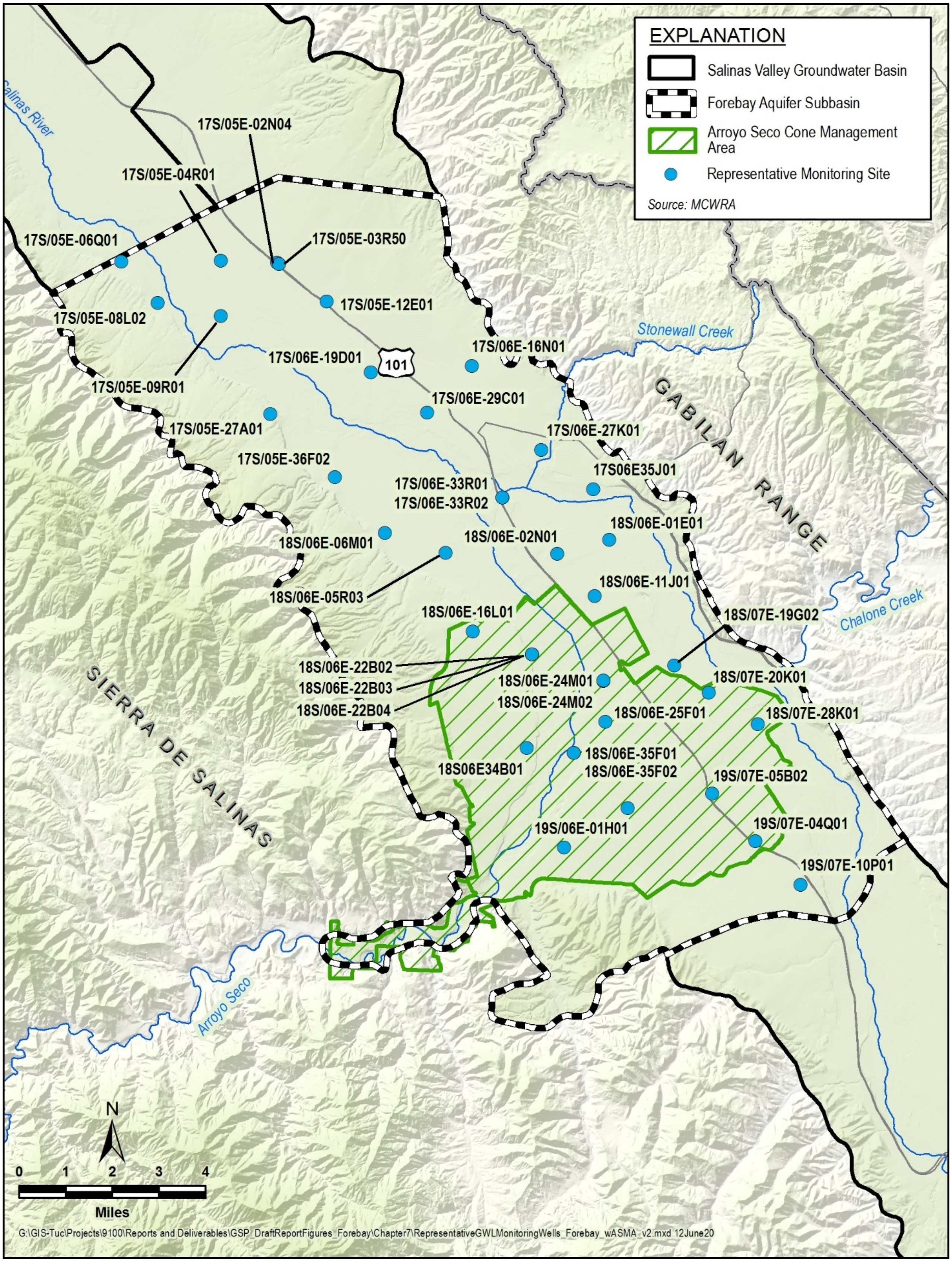


Figure 7-2. Forebay Aquifer Representative Monitoring Network for Groundwater Levels

Table 7-1. Forebay Aquifer Groundwater Level Representative Monitoring Site Network

State Well Number	CASGEM Well Number	Local Well Designation	Well Use	Total Well Depth (ft)	Reference Point (ft, NAVD88)	Latitude (NAD 83)	Longitude (NAD 83)	Period of Record (years)
17S/05E-02N04	N/A	2489	Irrigation	630	165.0	36.47610	-121.40500	60
17S/05E-03R50	N/A	2420	Irrigation	810	165.0	36.47559	-121.40434	10
17S/05E-04R01	N/A	534	Irrigation	442	138.0	36.47621	-121.42677	62
17S/05E-06Q01	N/A	719	Irrigation	170	117.0	36.47510	-121.46499	67
17S/05E-08L02	N/A	22926	Irrigation	830	140.6	36.46259	-121.45070	12
17S/05E-09R01	N/A	513	Irrigation	210	136.1	36.45902	-121.42618	75
17S/05E-12E01	N/A	180	Irrigation	602	171.0	36.46438	-121.38563	58
17S/05E-27A01	N/A	1201	Domestic/Irrigation	265	263.0	36.42894	-121.40611	59
17S/05E-36F02	N/A	914	Irrigation	234	162.0	36.40985	-121.38080	68
17S/06E-16N01	N/A	2310	Irrigation	626	232.4	36.44544	-121.32919	46
17S/06E-19D01	364424N1213682W001	1485	Irrigation	252	170.0	36.44240	-121.36820	88
17S/06E-27K01	N/A	1248	Irrigation	250	240.0	36.41980	-121.30167	70
17S/06E-29C01	N/A	1441	Irrigation	303	178.0	36.43063	-121.34578	59
17S/06E-33R01	364048N1213162W001	VidaDeep21209	Observation	260	194.4	36.40480	-121.31620	24
17S/06E-33R02	364047N1213162W001	VidaShallow21210	Observation	120	194.6	36.40470	-121.31620	24
17S/06E-35J01	N/A	404	Irrigation	144	192.0	36.40803	-121.28131	75
18S/06E-01E01	N/A	1001	Irrigation	218	211.0	36.39234	-121.27469	64
18S/06E-02N01	N/A	1000	Irrigation	274	202.8	36.38769	-121.29443	75
18S/06E-05R03	N/A	1335	Irrigation	279	193.0	36.38715	-121.33755	47
18S/06E-06M01	N/A	1771	Irrigation	350	195.1	36.39280	-121.36102	75
18S/06E-11J01	N/A	788	Irrigation	235	216.0	36.37481	-121.27980	75
18S/06E-16L01	N/A	24	Irrigation	444	304.4	36.36278	-121.32634	59
18S/06E-22B02	363562N1213033W003	LosCochesC18449	Observation	590	224.4	36.35620	-121.30330	61
18S/06E-22B03	363562N1213033W002	LosCochesB21066	Observation	280	225.5	36.35620	-121.30330	17
18S/06E-22B04	363562N1213033W001	LosCochesA21314	Observation	95	224.8	36.35620	-121.30330	17
18S/06E-24M01	363485N1212755W001	HUDB18467	Observation	253	229.6	36.34850	-121.27560	61
18S/06E-24M02	363485N1212756W001	HUDA21067	Observation	130	229.6	36.34850	-121.27560	14

State Well Number	CASGEM Well Number	Local Well Designation	Well Use	Total Well Depth (ft)	Reference Point (ft, NAVD88)	Latitude (NAD 83)	Longitude (NAD 83)	Period of Record (years)
18S/06E-25F01	363359N1212745W001	1495	Irrigation	120	254.5	36.33590	-121.27450	66
18S/06E-34B01	N/A	2308	Irrigation	300	347.1	36.32699	-121.30453	87
18S/06E-35F01	363259N1212863W001	THNB18502	Observation	258	262.6	36.32590	-121.28630	15
18S/06E-35F02	363258N1212864W001	THNA21068	Observation	N/A	262.7	36.32580	-121.28640	66
18S/07E-19G02	N/A	403	Irrigation	265	210.0	36.35373	-121.24851	54
18S/07E-20K01	N/A	1886	Irrigation	200	220.0	36.34565	-121.23498	62
18S/07E-28K01	N/A	1415	Irrigation	120	240.0	36.33610	-121.21584	75
19S/06E-01H01	N/A	333	Irrigation	300	320.0	36.30902	-121.26509	58
19S/06E-11C01	N/A	10004	Irrigation	320	375.3	36.29639	-121.28924	75
19S/07E-04Q01	N/A	1813	Irrigation	342	259.0	36.29969	-121.21579	64
19S/07E-05B02	N/A	10010	Irrigation	420	261.0	36.31416	-121.23271	59
19S/07E-10P01	N/A	10011	Domestic	245	315.0	36.28651	-121.19807	88

7.2.1 Groundwater Level Monitoring Protocols

Chapter 4 of the MCWRA CASGEM monitoring plan includes a description of existing groundwater elevation monitoring procedures (MCWRA, 2015). The CASGEM groundwater elevation monitoring protocols established by MCWRA are adopted by this GSP and are included in Appendix 7A. Groundwater elevation measurements will be collected at least 2 times per year to represent seasonal low and seasonal high groundwater conditions. The monitoring protocols described in Appendix 7A cover multiple monitoring methods for collecting data by hand and by automated pressure transducers. These protocols are consistent with data and reporting standards described in GSP Regulations § 352.4.

7.2.2 Groundwater Level Monitoring Network Data Gaps

Based on the GSP Regulations and 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 level monitoring network.

While there is no definitive requirement on monitoring well density, the BMP cites several studies (Heath, 1976; Sophocleous, 1983; Hopkins and Anderson, 2016) that recommend 0.2 to 10 wells per 100 square miles. The BMP notes that professional judgment should be used to design the monitoring network to account for high-pumping areas, proposed projects, and other subbasin-specific factors.

The Forebay Subbasin encompasses 147 square miles. If the BMP guidance recommendations are applied to the Subbasin, the well network should include between 1 and fifteen wells. The current network includes 39 wells. The number of groundwater elevation monitoring wells in the Subbasin exceeds the range of the BMP guidance. However, visual inspection of the geographic distribution of the well network indicates that there is a data gap along the Arroyo Seco, as shown on Figure 7-3. The data gap area shown on Figure 7-3 will be filled with a new monitoring well, as discussed in Chapter 10. This data gap also applies to the interconnected surface water monitoring network, described in Section 7.6.2, thus a new well in this area will fill the data gap in both networks. The generalized locations for new monitoring wells were based on addressing the criteria listed in the monitoring BMP including:

- 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

Additionally, groundwater elevation measurements for some of the monitoring wells in the Subbasin occur only once a year. SVBGSA will work with MCWRA to have groundwater levels collected at least twice a year as outlined in Section 7.2.1. Furthermore, some of the wells in the monitoring network have unknown well construction information and that is a data gap that will be addressed during GSP implementation.

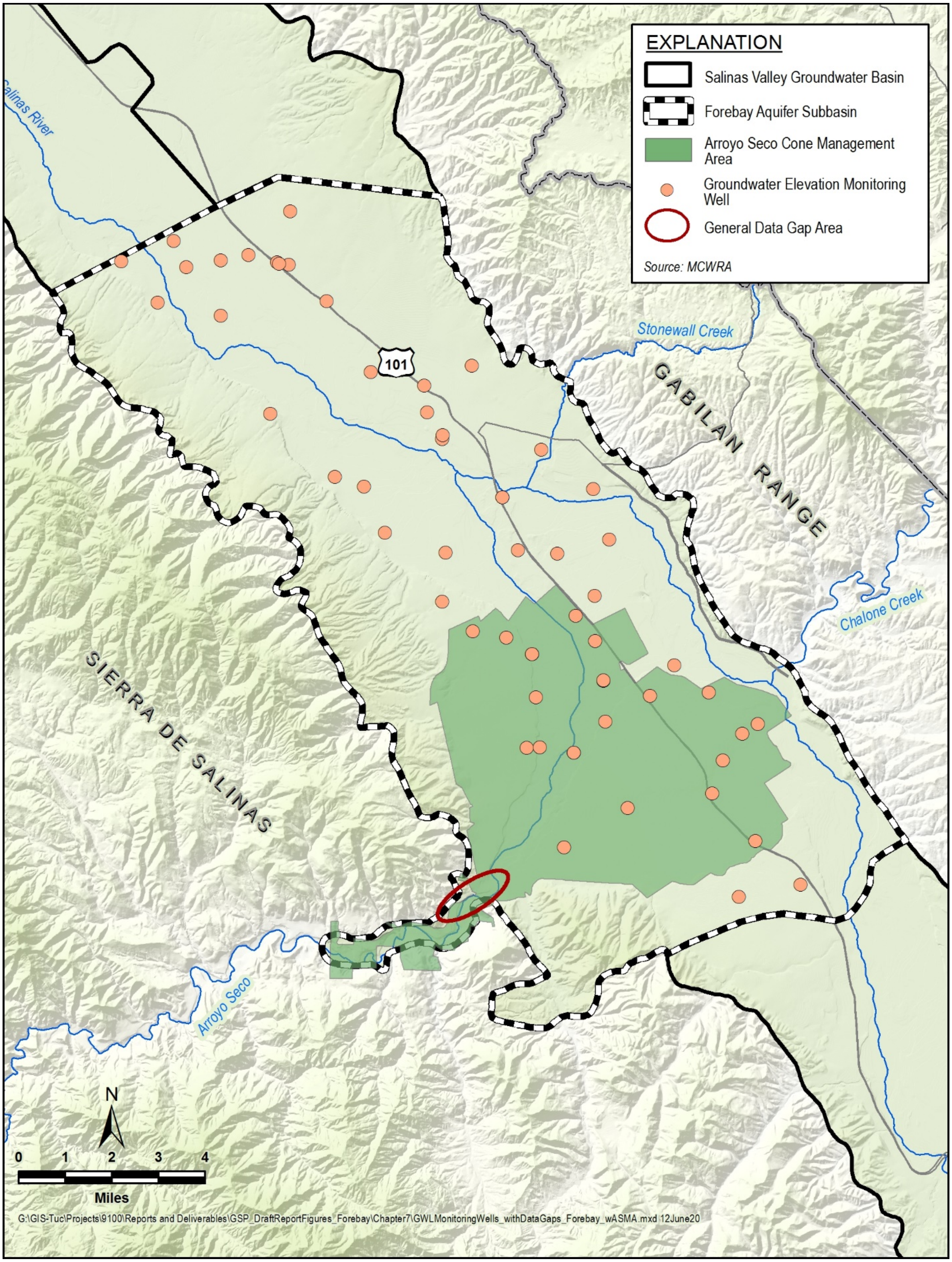


Figure 7-3. Data Gaps in the Groundwater Level Monitoring Network

7.3 Groundwater Storage Monitoring Network

As discussed in Chapter 8, the sustainability indicator for reduction of groundwater storage is measured using groundwater elevations to calculate change in storage. Thus, the groundwater storage monitoring network is the same as the groundwater level monitoring network.

7.4 Groundwater Quality Monitoring Network

The sustainability indicator for degraded water quality is evaluated by adopting the SWRCB, DDW, and CCRWQCB ILRP groundwater quality networks. The water quality monitoring network for the Subbasin is composed of public water system supply wells monitored under DDW, and on-farm domestic wells and irrigation supply wells monitored under ILRP.

As described in Chapter 8, separate minimum thresholds are set for the COC for public water system supply wells, on-farm domestic wells, and irrigation supply wells. Therefore, although there is a single groundwater quality monitoring network, different wells in the network are reviewed for different constituents. COC for drinking water are assessed at public water supply wells and on-farm domestic wells, and COC for crop health are assessed at irrigation supply wells. The COC for the 3 sets of wells are listed in Chapter 5.

The public water system supply wells included in the monitoring network were identified by reviewing data from the SWRCB DDW. The SWRCB collects data for 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. The RMS network consists of 45 DDW wells, as shown on Figure 7-4 and listed in Appendix 7B.

All on-farm domestic wells and irrigation supply wells that have been sampled through the CCRWQCB's ILRP are included in the RMS network. Under the existing, Ag Order, 619 ILRP wells, consisting of 323 irrigation supply wells and 296 on-farm domestic wells that are all part of the RMS network. The locations of these wells are shown on

Figure 7-5and listed in Appendix 7B. The SVBGSA assumes that Ag Order 4.0 will have a similar representative geographic distribution of wells within the Subbasin. The agricultural groundwater quality monitoring network will be revisited and revised when the Ag Order 4.0 monitoring network is finalized.

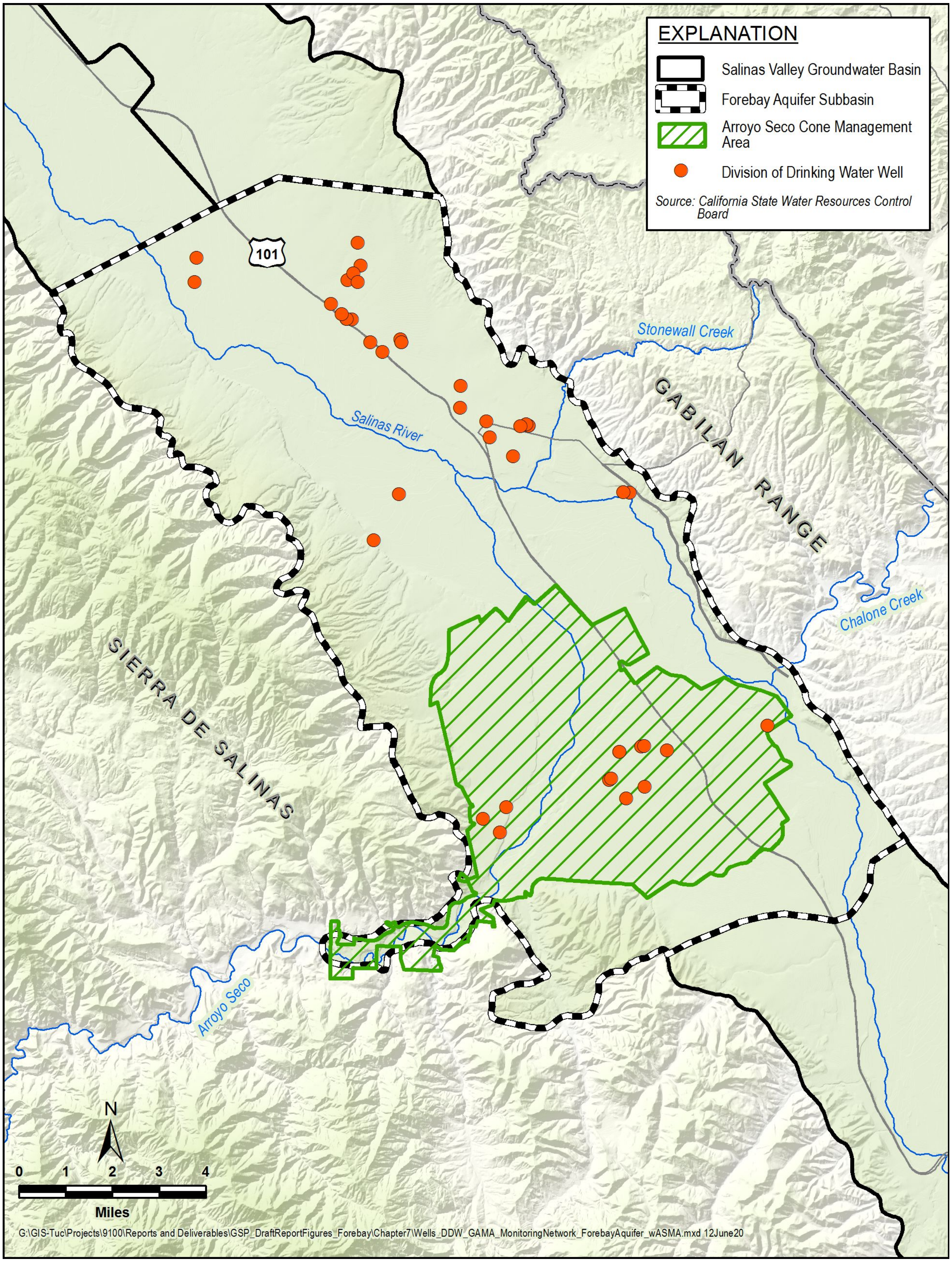


Figure 7-4. DDW Public Water System Supply Wells in the Groundwater Quality Monitoring Network

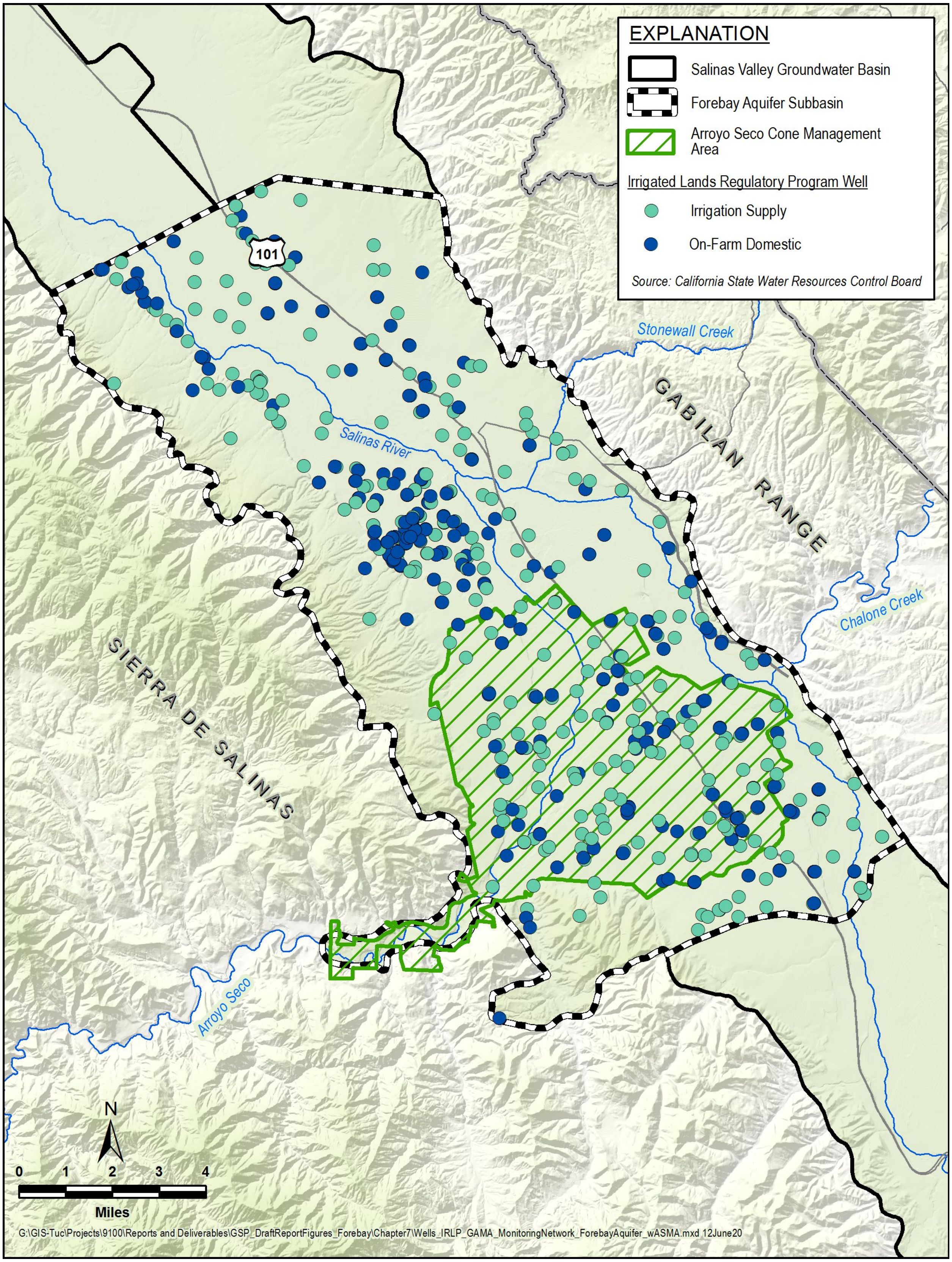


Figure 7-5. ILRP Wells in the Groundwater Quality Monitoring Network

7.4.1 Groundwater Quality Monitoring Protocols

The SVBGSA does not independently sample wells for any COC. Instead, the GSA analyzes water quality data that are collected through the DDW and ILRP. Therefore, the GSA is dependent on the monitoring density and frequency of DDW and ILRP.

Water quality data from public water systems are collected, analyzed, and reported in accordance with protocols that are reviewed and approved by the SWRCB DDW, in accordance with the state and federal Safe Drinking Water Acts. Monitoring protocols may vary by agency.

ILRP data are currently collected under CCRWQCB Ag Order 3.0. ILRP samples are collected under the Tier 1, Tier 2, or Tier 3 monitoring and reporting programs. Under Ag Order 4.0, ILRP data will be collected in 3 phases and each groundwater basin within the Central Coast Region has been assigned to one or more of these phases. The designated phase for each ILRP well is provided in SWRCB's GeoTracker database and is publicly accessible at: https://geotracker.waterboards.ca.gov/. Ag Order 4.0 will take effect in the Subbasin beginning in 2023. Copies of the Ag Orders 3.0 and 4.0 monitoring and reporting programs are included in Appendix 7C and are incorporated into this GSP. These protocols are consistent with data and reporting standards described in GSP Regulations § 352.4.

7.4.2 Groundwater Quality Monitoring Data Gaps

The DDW and ILRP monitoring network provide sufficient spatial and temporal data to determine groundwater quality trends for water quality indicators to address known water quality issues. Additionally, there is adequate spatial coverage in the water quality monitoring network to assess impacts to beneficial uses and users.

7.5 Land Subsidence Monitoring Network

As described in Section 5.4, DWR collects land subsidence data using InSAR satellite data and makes these data available to the GSAs. This subsidence dataset represents the best available science for the Forebay Subbasin and is therefore used as the subsidence monitoring network.

7.5.1 Land Subsidence Monitoring Protocols

Land Subsidence monitoring protocols are the ones used by DWR for InSAR measurements and interpretation. DWR adapted their methods to measure subsidence on hard surfaces only and interpolate between them to minimize the change in land surface elevation captures in soft surfaces that are likely not true subsidence. The cell size of this interpolated surface is 302 feet by 302 feet. 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 GSP Regulations § 352.4.

7.5.2 Land Subsidence Data Gaps

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

7.6 Interconnected Surface Water Monitoring Network

The primary tool for assessing depletion of ISW due to pumping will be shallow monitoring wells adjacent to the Salinas River, the Arroyo Seco, and other streams in the Subbasin. Figure 7-6 shows the existing wells from MCWRA's groundwater monitoring programs that will be added to the ISW monitoring network and the location of a proposed new monitoring well. Existing wells were chosen based on the locations of ISW determined by the preliminary SVIHM, well depth, and proximity to the Salinas River and Arroyo Seco. Furthermore, the wells are also located in vicinity of to a USGS stream gauge or MCWRA River Series measurement site shown on Figure 7-6. This allows for monitoring of groundwater elevations near the rivers in the Subbasin and may provide insight on the relationship between streamflow and groundwater elevations. Additionally, the combined use of groundwater elevation and streamflow data will allow SVBGSA to assess 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 as discussed in Chapter 8. All ISW monitoring wells are RMS. More information on the development of the ISW monitoring network is provided in Appendix 7D.

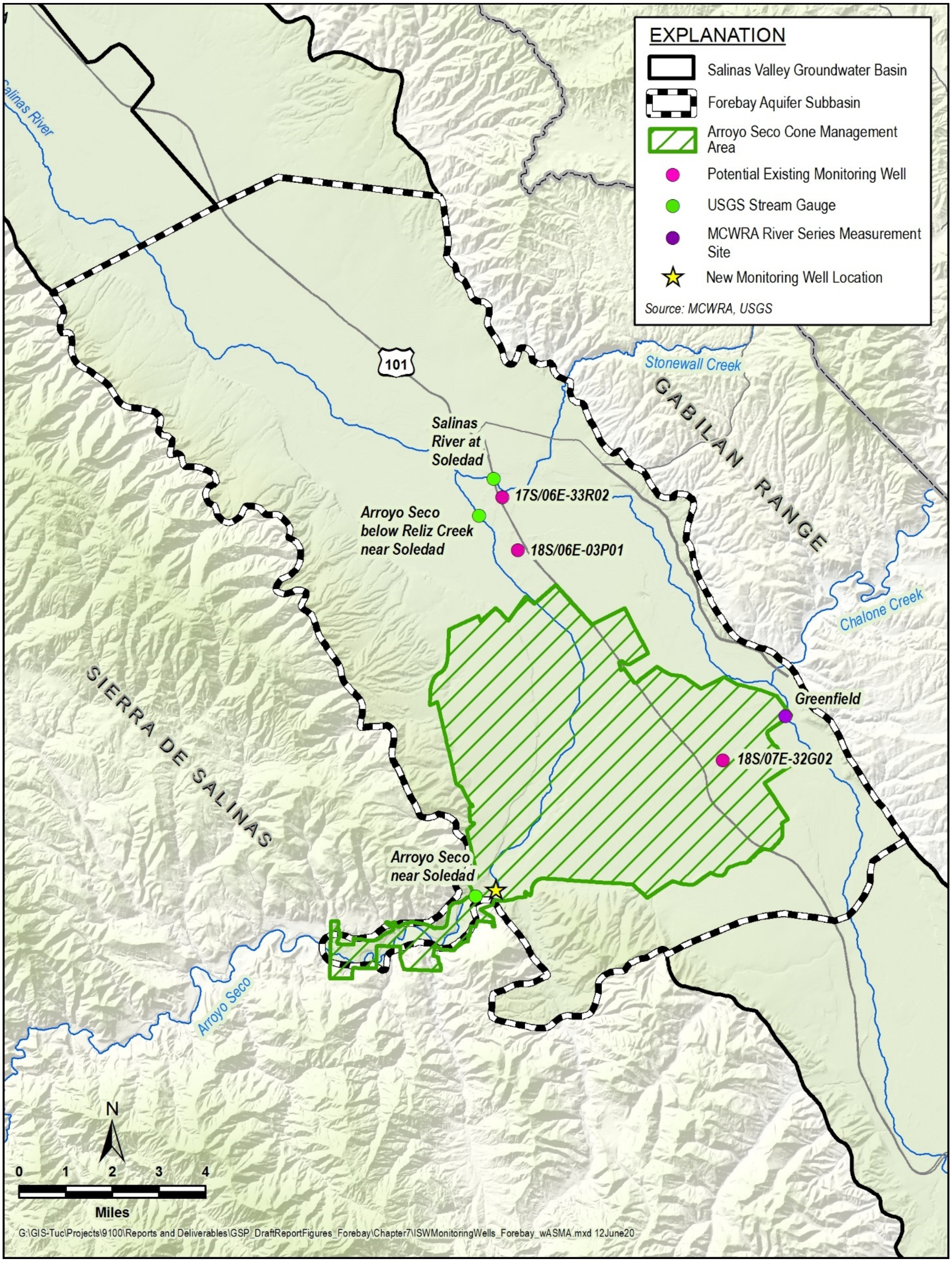


Figure 7-6. Interconnected Surface Water Monitoring Network

7.6.1 Interconnected Surface Water Monitoring Protocols

Monitoring protocols for shallow wells monitoring ISW will be identical to MCWRA's current groundwater elevation monitoring protocols, included in Appendix 7A. These protocols are consistent with data and reporting standards described in GSP Regulations § 352.4. Additionally, each well that is added to the monitoring network will be equipped with a data logger that will allow SVBGSA to access if seasonal pumping is resulting in streamflow depletions.

7.6.2 Interconnected Surface Water Data Gaps

As shown in Figure 7-6, the data gap in the ISW monitoring network will be filled with a new well added along the Arroyo Seco. This well will fill the data gap in this monitoring network and the one in the groundwater elevation monitoring network, as discussed in Chapter 10. The new shallow well will be added to MCWRA's groundwater elevation monitoring program.

7.7 Other Monitoring Networks

SGMA requires that annual reports include annual groundwater extractions and surface water diversions in order to report total water use for the Subbasin; thus, the following monitoring networks are needed in addition to the monitoring networks outlined above for sustainability indicators.

7.7.1 Groundwater Extraction

MCWRA's GEMS will be used to monitor urban and agricultural extraction in the Subbasin. Under Monterey County Ordinance No. 3717, public water systems and agricultural pumpers using wells with an internal discharge pipe greater than 3 inches within Zones 2, 2A, and 2B report extractions annually to GEMS. Extraction is self-reported by well owners or operators. Agricultural wells report their data based on MCWRA's reporting year that runs from November 1 through October 31. Urban and industrial wells report extraction on a calendar year basis. When extraction data is summarized annually, MCWRA combines industrial and urban extractions into a single urban water use. As depicted in Figure 3-3, these zones provide sufficient coverage of the Forebay Subbasin.

SVBGSA will work with MCWRA to obtain the GEMS 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 Ordinances No. 3717 and No. 3718.

7.7.1.1 Groundwater Extraction Monitoring Protocols

Groundwater extraction monitoring is accomplished using the GEMS data provided by MCWRA. Existing GEMS protocols are consistent with data and reporting standards described in GSP Regulations §352.4.

7.7.1.2 Groundwater Extraction 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. As proposed in Chapter 9, SVBGSA will undertake well registration during implementation to develop a database of existing and active groundwater wells. This database will draw from the existing MCWRA database, DWR's OSWCR database, and the Monterey County Health Department database of state small and local 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 as is discussed further in Chapter 9.

The accuracy and reliability of groundwater pumping reported through GEMS is constantly being updated. 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. SVBGSA will work with MCWRA to consider the value of developing protocols for flowmeter calibration and other potential enhancements to the GEMS programs that are discussed in Chapter 9.

7.7.2 Salinas River Watershed Diversions

Salinas River watershed monthly diversion data are collected annually in the SWRCB's Electronic Water Rights Information Management System (eWRIMS). eWRIMS is used track information of water rights in the state and is publicly accessible at: https://ciwqs.waterboards.ca.gov/ciwqs/ewrims/reportingDiversionDownloadPublicSetup.do. These data include diversions from tributaries of the Salinas River, such as CCWC's diversion from the Arroyo Seco.

As mentioned in Chapter 3, 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. Comparing surface water diversion data to groundwater pumping data is complicated by the fact that diversions and pumping are reported on different schedules. To estimate the quantity that is potentially double counted and reported as both groundwater extraction and surface water diversions, an initial analysis was undertaken by matching unique locations and monthly diversion amounts summed by the GEMS reporting year (November 1 through October 31) to reported annual pumping data as shown in Figure 3-4.

7.7.2.1 Salinas River Watershed Diversions Monitoring Protocols

Salinas River watershed diversion monitoring protocols are those that the SWRCB has established for the collection of water right information. These protocols are consistent with data and reporting standards described in GSP Regulations § 352.4.

7.7.2.2 Salinas River Watershed Diversions Monitoring Data Gaps

These data are lagged by a year because the reporting period does not begin until February of the following year.

7.8 Data Management System and Data Reporting

The SVBGSA has developed a DMS in adherence to GSP Regulations § 352.6 and § 354.40 that is used to store, review, and upload data collected as part of the GSP development and implementation.

The SVBGSA DMS consists of 2 SQL databases. The HydroSQL database stores information about each well and time-series data for water level and extraction. 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

Well owner and annual pumping information will be stored in HydroSQL; however, neither will be publicly accessible due to confidentiality requirements.

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

Water quality data are stored in the EnviroSQL database, which is linked to the HydroSQL database for data management purposes. Fields in the EnviroSQL database include:

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

The data used to populate the SVBGSA DMS are listed in Table 7-2. Categories marked with an X indicate datasets that were used in populating the DMS, including data that are publicly accessible or that are available to SVBGSA from MCWRA. Some data, such as groundwater extraction is confidential, and cannot be made publicly accessible by SVBGSA unless aggregated. Additional datasets will be added in the future as appropriate, such as recharge or diversion data.

Table 7-2. Datasets Available for Use in Populating the DMS

	Data Category					
Data Sets	**Well and Site Information**	**Well Construction**	**Water Level**	**Pumping[1]**	**Streamflow**	**Water Quality**
DWR (CASGEM)	X	X				
MCWRA	X	X	X	X		
GAMA Groundwater Information System	X					X
USGS Gage Stations					X	

[1] Pumping data not publicly accessible

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

- Removing or flagging questionable data being uploaded in the DMS. This includes identifying outliers that may have been introduced during the original data entry process and plotting each well hydrograph to identify and remove anomalous data points.
- Loading into the database and checking for errors and missing data.

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 GSP Regulations.

The DMS also includes a publicly accessible web-map hosted on the SVBGSA website; accessible at https://svbgsa.org/gsp-web-map-and-data/. This web-map gives interested parties access to non-confidential technical information used in the development of the GSP and annual reports and includes public well data and analysis such as water level contour maps and 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; and establishes minimum thresholds, measurable objectives, and undesirable results for each sustainability indicator. The minimum thresholds, measurable objectives, and undesirable results detailed in this chapter define the Subbasin's future conditions and commit the GSA to actions that will meet these criteria. This chapter includes adequate data to explain how SMC were developed and how they influence all beneficial uses and users.

The chapter is structured to address all the GSP Regulations regarding SMC. To retain an organized approach, the SMC are grouped by sustainability indicator. The discussion of each sustainability indicator follows a consistent format that contains all the information required by the GSP Regulations, and as further clarified in the SMC BMP (23 California Code of Regulations §354.22 *et seq.*; DWR, 2017).

The Forebay Subbasin includes the ASCMA. The ASCMA is managed by the ASGSA, and the remaining area of the Subbasin managed by the SVBGSA in accordance with the Forebay Subbasin Groundwater Sustainability Plan Implementation Agreement (Forebay Implementation Agreement, 2021). The Management Area was established to account for the unique hydrogeologic, water quality and water supply characteristics of the Arroyo Seco Cone region as described in Chapter 4. Although the ASCMA and the greater Forebay Subbasin are managed by different GSAs, both areas will be managed cooperatively to meet the sustainability goal of the entire Subbasin. The undesirable results for all sustainability indicators are defined consistently throughout the Subbasin.

8.1 Definitions

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

- **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 5 sustainability indicators relevant to this subbasin include chronic lowering of groundwater levels; reduction of groundwater storage; degraded water quality; land subsidence; and depletion of ISW.

- **Significant and Unreasonable**

  Significant and unreasonable is not defined in the Regulations. However, the definition of undesirable results states, "Undesirable results occur when significant and unreasonable *effects … are caused by groundwater conditions….” This GSP adopts the phrase significant and unreasonable to be the qualitative description of undesirable conditions due to inadequate groundwater management. Minimum thresholds are the quantitative measurement of the significant and unreasonable conditions.*

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

  Minimum thresholds are indicators of an unreasonable condition.

- **Measurable objective** refers to a 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.

- **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 5 years to demonstrate progress toward sustainability.

- **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 qualitative descriptions of conditions to be avoided; an undesirable result is a quantitative assessment based on minimum thresholds.

8.2 Sustainability Goal

The sustainability goal of the Forebay Subbasin is to manage groundwater resources for long-term community, financial, and environmental benefits to the Subbasin’s residents and businesses. The goal of this GSP is to 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.

Several management actions and projects that will allow the SVBGSA to maintain sustainability are included in this GSP and detailed in Chapter 9. It is not necessary to implement all projects and actions listed in this GSP to maintain sustainability. However, some combination of these may be implemented throughout the planning and implementation horizon to ensure the

Subbasin continues to operate within its sustainable yield and meet the sustainability goal. This includes the option of 7 management actions, including the establishment of the Forebay SMC TAC, conservation and agricultural BMPs, improving rural residential water quality within the ASCMA, watershed protection policy for the Arroyo Seco River, land fallowing, and 2 potential management actions that would result in the reoperation of the San Antonio and Nacimiento Reservoirs. The Chapter also includes 2 potential recharge projects that involve multi-benefit stream channel improvements and large recharge basins. Finally, Chapter 9 includes implementation actions that do not directly help meet the SMC, but contribute to GSP implementation through data collection, assistance to groundwater users, and collaboration with partner agencies. This suite of management actions and projects provide sufficient options to maintain sustainability in the Forebay Subbasin throughout GSP implementation. The management actions and projects are designed to maintain sustainability for the next 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
- Developing new alternative water supplies for use in the Subbasin to offset groundwater pumping

8.3 Maintaining Long-Term Sustainability

The GSP addresses long-term groundwater sustainability. Correspondingly, the SVBGSA intends to develop SMC to avoid undesirable results under future hydrologic conditions. The understanding of future conditions is based on historical precipitation, ET, streamflow, and reasonable anticipated climate change, which have been estimated on the basis of the best available climate science (DWR, 2018). These parameters underpin the estimated future water budget over the planning horizon (see Section 6.4). The average hydrologic conditions include reasonably anticipated wet and dry periods. Groundwater conditions that are the result of extreme climatic conditions and are worse than those anticipated do not constitute an undesirable result. However, SMC may be modified in the future to reflect observed future climate conditions.

The GSA will track hydrologic conditions during GSP implementation. These observed hydrologic conditions will be used to develop a value for average hydrologic conditions, which will be compared to predicted future hydrologic conditions. This information will be used to interpret the Subbasin’s performance against SMC. Year-by-year micro-management is not the intent of this GSP; this GSP is developed to avoid undesirable results with long-term, deliberate groundwater management. For example, groundwater extractions may experience variations caused by reasonably anticipated hydrologic fluctuations. However, under average hydrologic conditions, there will be no chronic depletion of groundwater storage.

Further, since the GSP addresses long-term groundwater sustainability, exceedance of some SMC during an individual year does not constitute an undesirable result. Pursuant to SGMA regulations (California Water Code § 10721(w)(1)), "Overdraft during a period of drought is not sufficient to establish a chronic lowering of groundwater levels if extractions and groundwater recharge are managed as necessary to ensure that reductions in groundwater levels or storage during a period of drought are offset by increases in groundwater levels or storage during other periods." Therefore, groundwater levels may temporarily exceed minimum thresholds during prolonged droughts, which could be more extreme than those that have been anticipated based on historical data and anticipated climate change conditions. Such temporary exceedances do not constitute an undesirable result.

The SMC presented in this chapter are developed on the basis of historically observed hydrologic conditions and, in most cases, reasonably anticipated climate change. These SMC may be updated in future drafts to reflect changes in anticipated climate conditions and climate change based upon groundwater modeling results.

8.4 General Process for Establishing Sustainable Management Criteria

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

- Presenting to Forebay Subbasin Committee and ASGSA Advisory Committee on the general SMC requirements and implications. These presentations outlined the approach to developing SMC and discussed initial SMC ideas.
- Gathering feedback from discussions with subbasin committee and the ASGSA Advisory Committee on challenges and goals.
- Providing supplemental data to the subbasin committees to guide the approach to setting SMC.
- Polling and receiving feedback from the subbasin committees to establish preferences for establishing SMC.
- Selecting approach and criteria for setting SMC in the subbasin committee.
- Developing joint ASGSA and SVBGSA recommendations for SMC.

- Soliciting feedback on joint approach from the Forebay Subbasin Committee and the ASGSA Advisory Committee.
- Obtaining additional input on SMC from with GSA staff and GSA Board Members.
- Modifying minimum thresholds and measurable objectives based on input from the public, GSA staff, and GSA Board Members, if needed.

8.5 Sustainable Management Criteria Summary

Table 8-1 provides a summary of the SMC for each of the 5 sustainability indicators. Measurable objectives are the goals that reflect the Subbasin's desired groundwater conditions for each sustainability indicator. These provide operational flexibility above the minimum thresholds. The minimum thresholds are quantitative indicators of the Subbasin's locally defined significant and unreasonable conditions. The undesirable result is a combination of minimum threshold exceedances that show a significant and unreasonable condition across the Subbasin as a whole. This GSP is designed to not only avoid undesirable results, but to achieve the sustainability goals within 20 years, along with interim milestones every 5 years that show progress. The management actions and projects provide sufficient options for reaching the measurable objectives within 20 years and maintaining those conditions for 30 years for all 5 sustainability indicators. The rationale and background for developing these criteria are described in detail in the following sections. The SMC are identical for the ASCMA and the Greater Forebay Subbasin. 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 interconnected surface water SMC are 2 independent SMC that will be achieved simultaneously. The groundwater elevation SMC do not hinder the interconnected surface water SMC, but also, they do not prevent the degradation of interconnected surface water by themselves. The SMC presented in Table 8-1 are part of the GSA's 50-year management plan: SGMA allows for 20 years to reach sustainability and requires the Subbasin have no undesirable results for the subsequent 30 years.

Table 8-1. Sustainable Management Criteria Summary

Sustainability Indicator	Measurement	Minimum Threshold	Measurable Objective	Undesirable Result
Chronic lowering of groundwater levels	Measured through groundwater level representative monitoring well network	Minimum thresholds are set to December 2015 groundwater elevations. See Table 8-2 .	Measurable objectives are set to 2015 groundwater elevations plus 75% of the difference between 2015 and 1998 groundwater elevations.	More than 15% of groundwater elevation minimum thresholds are exceeded. Allows 5 exceedances in the Forebay Subbasin.
Reduction in groundwater storage	Measured from groundwater elevation contour maps.	Minimum threshold is set to 267,000 AF below the measurable objective. This reduction is based on the groundwater level minimum thresholds. This number will be refined as additional data are collected and other projects are implemented.	Measurable objective is set to zero when the groundwater elevations are held at the groundwater level measurable objectives. Since the goal is to manage to the measurable objective, additional water in storage is needed until groundwater elevations are at their measurable objectives.	There is an exceedance of the minimum threshold.
Degraded groundwater quality	Groundwater quality data downloaded annually from GeoTracker GAMA groundwater information system.	Minimum thresholds are zero additional exceedances of the regulatory drinking water standard (potable supply wells) or Basin Plan objective (irrigation supply wells) beyond those observed on December 31, 2019 for groundwater quality constituents of concern. Exceedances are only measured in public water system supply wells and ILRP on-farm domestic and irrigation supply wells. See Table 8-5.	Measurable objectives are identical to the minimum threshold.	Future or new minimum thresholds exceedances are caused by a direct result of GSA groundwater management action(s), including projects or management actions and regulation of groundwater extraction.

Sustainability Indicator	Measurement	Minimum Threshold	Measurable Objective	Undesirable Result
Land subsidence	Measured using DWR provided InSAR data.	Minimum threshold is 0.133 feet per year. This is the rate that results in less than 1 foot of cumulative subsidence over a 30-year implementation horizon, plus 0.1 feet per year of estimated land movement to account for InSAR measurement errors.	Measurable objective is 0.1 feet per year. This is a long-term rate of zero feet per year plus 0.1 feet per year of estimated land movement to account for InSAR measurement errors.	There is an exceedance of the minimum threshold for subsidence due to lowered groundwater elevations that surpass historical lows.
Depletion of interconnected surface water (ISW)	Groundwater elevations in shallow wells adjacent to locations of ISW identified using the SVIHM.	Minimum thresholds are established by proxy using shallow groundwater elevations observed in December 2015 near locations of ISW.	Measurable objectives are established by proxy using shallow groundwater elevations near locations of ISW and are set to 75% of the distance between 2015 and 1998 shallow groundwater elevations.	There is an exceedance of the minimum threshold in a shallow groundwater monitoring well used to monitor ISW.

8.6 Chronic Lowering of Groundwater Levels SMC

8.6.1 Locally Defined Significant and Unreasonable Conditions

Locally defined significant and unreasonable groundwater elevations in the Subbasin are those that:

- Are at or below the observed groundwater elevations in December 2015. Public and stakeholder input identified these historical groundwater elevations as significant and unreasonable.
- Cause significant financial burden to local agricultural interests.
- Interfere with other sustainability indicators.

These significant and unreasonable conditions were determined based on input collected during ASGSA Advisory Committee meetings, SVBGSA Subbasin Committee meetings, and discussions with GSA staff.

8.6.2 Minimum Thresholds

> *The minimum thresholds for chronic lowering of groundwater levels are set to December 2015 groundwater elevations.*

The minimum threshold values for each well within the groundwater level monitoring network are provided on Table 8-2. The minimum threshold contour map, along with the RMS well locations for the single principal aquifer in the Forebay Subbasin, are shown on Figure 8-1.

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

Monitoring Site	Minimum Threshold (feet)	Measurable Objective (feet)
17S/05E-02N04	89.7	108.5
17S/05E-03R50	89.7	111.5*
17S/05E-04R01	82.7	101.8
17S/05E-06Q01	76.7	97.9
17S/05E-08L02	92.5	109.4*
17S/05E-09R01	93.1	112.8*
17S/05E-12E01	95.9*	105.2
17S/05E-27A01	116.9	134.6
17S/05E-36F02	120.9	136.6
17S/06E-16N01	75.3*	109.4
17S/06E-19D01	118.6	135.5
17S/06E-27K01	137.9	156.2
17S/06E-29C01	129.9	144.8
17S/06E-33R01	141.9	160.7
17S/06E-33R02	142.0	159.7
17S/06E-35J01	151.5	171.2
18S/06E-01E01	149.3	174.1
18S/06E-02N01	142.2	164.0
18S/06E-05R03	136.1	154.0
18S/06E-06M01	144.8	162.6
18S/06E-11J01	154.4	177.1
18S/07E-19G02	151.2	175.7
19S/07E-10P01	204.5	227.8
Arroyo Seco Cone Management Area		
18S/06E-16L01	140.4	168.4
18S/06E-22B02	153.2	180.8
18S/06E-22B03	157.2	183.8
18S/06E-22B04	156.2	182.4
18S/06E-24M01	161.9	187.4
18S/06E-24M02	162.0	187.4
18S/06E-25F01	167.9	199.0
18S/06E-34B01	167.2	199.5
18S/06E-35F01	165.9	198.9
18S/06E-35F02	166.5	203.6
18S/07E-20K01	160.6	183.7
18S/07E-28K01	176.0	199.3
19S/06E-01H01	181.3	207.0
19S/06E-11C01	175.6	206.3
19S/07E-04Q01	207.1	223.9
19S/07E-05B02	189.2	210.0

*Groundwater elevation was estimated.

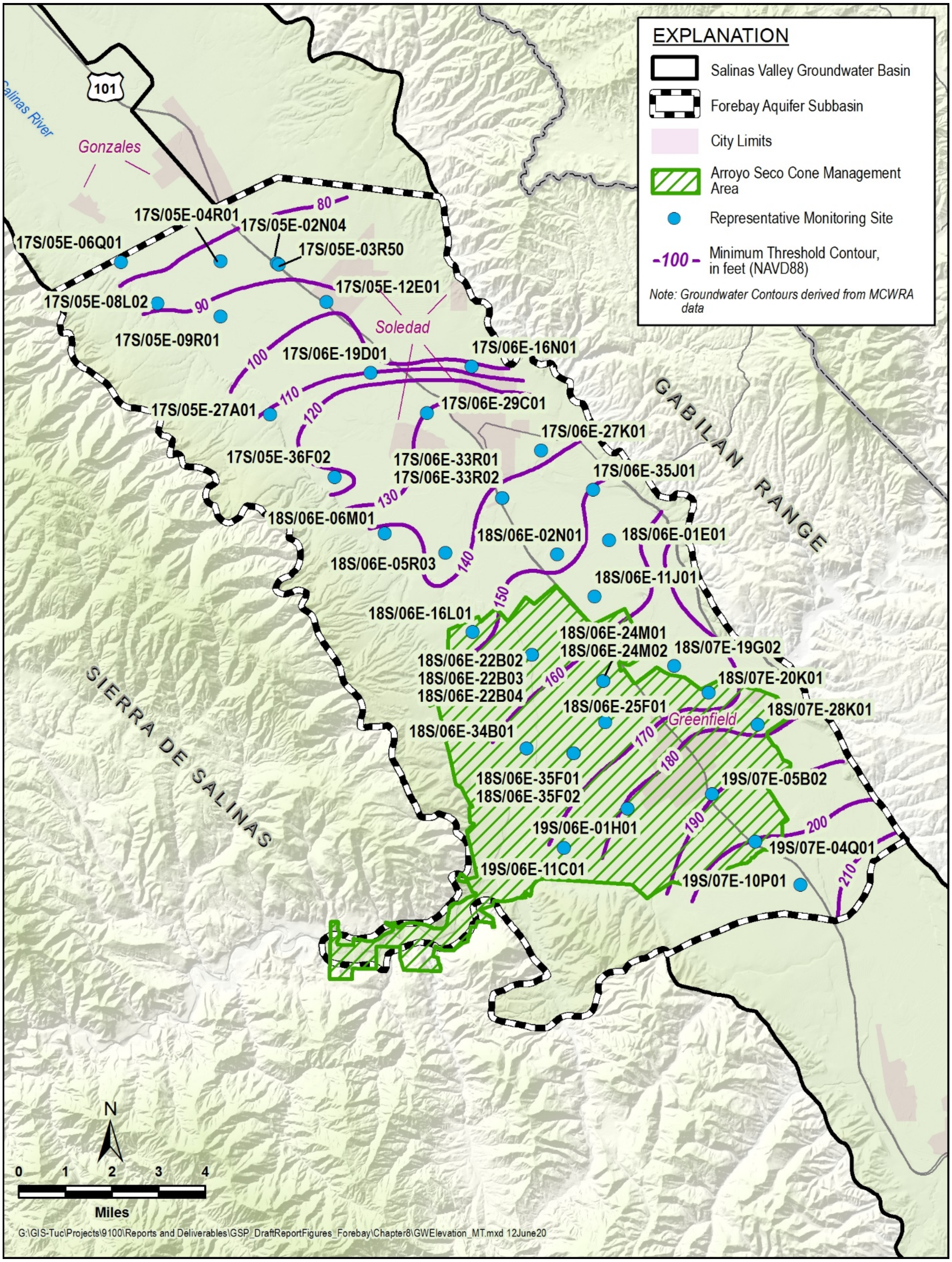


Figure 8-1. Groundwater Level Minimum Threshold Contour Map

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

The development of minimum thresholds and measurable objectives followed similar processes and are described concurrently in this section. The information used includes:

- Feedback from discussions with the Subbasin Committee and the ASGSA Advisory Committee on challenges and goals
- Historical groundwater elevation data and hydrographs from wells monitored by the MCWRA
- Maps of current and historical groundwater elevation data
- Analysis of the impact groundwater elevations on domestic wells

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

1. The ASGSA Advisory Committee and the Subbasin Committee selected approaches and criteria for setting the groundwater level minimum thresholds and measurable objectives.
2. The ASGSA and SVBGSA consultants reviewed and compared information from the various committee recommendations, tentatively agreeing on December 2015 as the minimum threshold.
3. The ASGSA reviewed hydrographs and estimated that groundwater elevations have historically been held approximately 75% of the way up from December 1995 elevations to the relatively high elevations recorded in 1998. This was tentatively chosen as the measurable objective.
4. SVBGSA reviewed the cumulative change in groundwater levels from all years, shown on Figure 8-2, to verify if the minimum threshold and measurable objective were realistic criteria for the Subbasin. The minimum threshold listed above is about 4 feet above the lowest groundwater levels experienced by the Subbasin and is therefore a reasonable criterion. The measurable objective chosen falls within the representative climatic cycle shown on Figure 8-2 meaning that it is an achievable goal under reasonably expected climatic conditions.
5. SVBGSA verified the minimum threshold and measurable objective with the Subbasin Committee Stakeholders.
6. SVBGSA and ASGSA plotted the appropriate minimum thresholds and measurable objectives on the respective monitoring well hydrographs. Each hydrograph was visually inspected to check if the minimum threshold and measurable objective was reasonable. If an RMS did not have measurements from the minimum threshold or measurable objective years, the SMC were interpolated from the groundwater

elevation contours. The RMS location was intersected with groundwater elevation contour maps to estimate the minimum thresholds and measurable objectives. The interpolated minimum thresholds and measurable objectives are indicated by an asterisk in Table 8-2. Additionally, if December measurements were unavailable November measurements were used.

Hydrographs with well completion information showing minimum thresholds for each RMS are included in Appendix 8A.

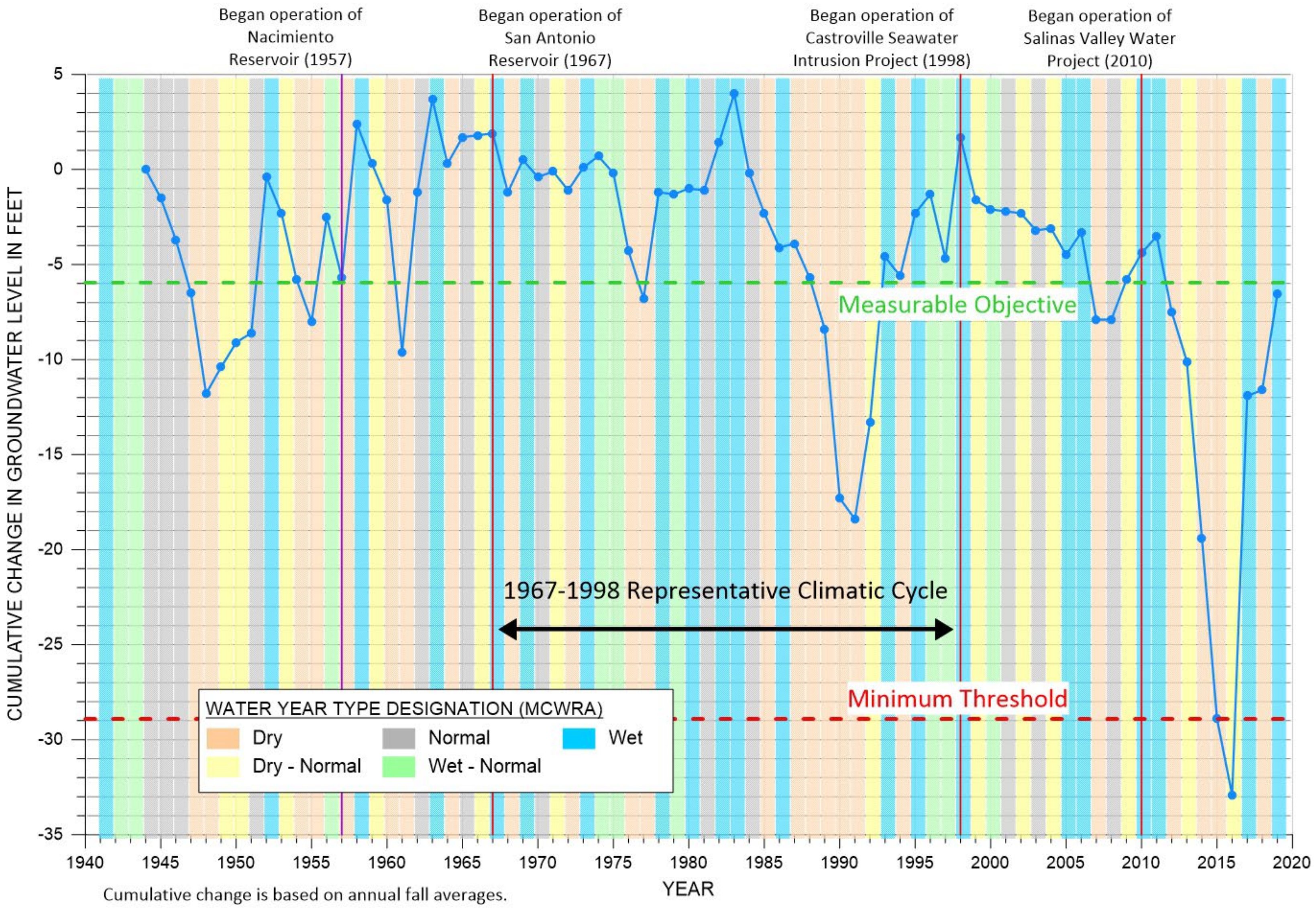


Figure 8-2. Cumulative Groundwater Elevation Change Hydrograph with Selected Minimum Threshold and Measureable Objective for the Forebay Aquifer Subbasin

8.6.2.2 Minimum Thresholds Impact on Domestic Wells

To address the human right to water, minimum thresholds for groundwater levels are compared to the range of domestic well depths in the Subbasin using DWR's 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 levels 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 281 feet using the Public Land Survey System sections data in the OSWCR database.

While this approach is reasonable, there are some adjustments that had to be made to improve the accuracy of the analysis. These include:

- Only wells that had accurate locations were included, since some wells in the OSWCR database are not accurately located, it could lead to inaccurate estimations of depth to water in the wells.
- The depth to water is derived from a smoothly interpolated groundwater elevation contour map. Errors in the map may result in errors in groundwater elevation at the selected domestic wells.

Given the limitations listed above, the analysis only included 8 domestic wells out of the total 154 domestic wells in the OSWCR database. In the Forebay Subbasin, 100% of all domestic wells will have at least 25 feet of water in them as long as groundwater elevations remain above minimum thresholds; and 100% of all domestic wells will have at least 25 feet of water in them when measurable objectives are achieved. These percentages were considered reasonable despite the limitations of this analysis. Since data for the analysis is limited, further assessment may be done when more data becomes available.

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

The SVBGSA compared minimum thresholds between RMS to understand the relationship between RMSs (i.e., describe why or how a water level minimum threshold set at a particular RMS is similar to or different from water level thresholds in nearby RMS). 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 level minimum thresholds can influence other sustainability indicators. SVBGSA reviewed the groundwater level minimum thresholds' relationship with each of the other sustainability indicators' minimum thresholds to ensure a groundwater level minimum threshold would not trigger an undesirable result for any of the other sustainability indicators. The groundwater level minimum thresholds are selected to avoid undesirable results for other sustainability indicators.

- **Reduction in groundwater storage.** The chronic lowering of groundwater levels' minimum thresholds is identical to the groundwater storage minimum thresholds. Thus, the groundwater level minimum thresholds will not result in an undesirable loss of groundwater storage.
- **Degraded water quality.** The chronic lowering of groundwater levels minimum could affect groundwater quality through 2 processes:
    1. Changes in groundwater elevation could change groundwater gradients, which could cause poor quality groundwater to flow toward production and domestic 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 levels do not directly lead to a significant and unreasonable degradation of groundwater quality in production and domestic wells.
    2. Decreasing groundwater elevations can mobilize COC that are concentrated at depth, such as arsenic. The groundwater level minimum thresholds are near or above historical lows. Therefore, any depth dependent constituents have previously been mobilized by historical groundwater levels. Maintaining groundwater elevations above the minimum thresholds assures that no new depth dependent COC are mobilized and are therefore protective of beneficial uses and users.
- **Land subsidence.** The chronic lowering of groundwater levels' minimum thresholds is set at or above recent low groundwater elevations. Thus, avoiding the dewatering and compaction of clay-rich sediments that causes subsidence in response to lowering groundwater elevations.
- **Depletion of ISW.** The chronic lowering of groundwater levels' minimum thresholds is identical to the ISW minimum thresholds. Therefore, the groundwater level minimum thresholds will not result in a significant or unreasonable depletion of ISW including GDEs.

8.6.2.4 Effect of Minimum Thresholds on Neighboring Basins and Subbasins

The Forebay Subbasin has 3 neighboring subbasins within the Salinas Valley Groundwater Basin:

- The Eastside Subbasin to the northeast

- The Upper Valley Subbasin to the south
- The 180/400-Foot Aquifer Subbasin to the northwest

The SVBGSA is either the exclusive GSA or is one of the coordinating GSAs for the adjacent Subbasins. Because the SVBGSA covers all these subbasins, the SVBGSA is coordinating the development of the minimum thresholds and measurable objectives for all these subbasins. The 180/400-Foot Aquifer Subbasin submitted a GSP in 2020 and the Eastside and Upper Valley Subbasins are in the process of GSP development for submittal in January 2022. Minimum thresholds for the Forebay Subbasin will be reviewed relative to information developed for the neighboring subbasins' GSPs to ensure that these minimum thresholds will not prevent the neighboring subbasins from achieving or maintaining sustainability.

8.6.2.5 Effects on Beneficial Users and Land Uses

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

Agricultural land uses and users. The groundwater level 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 level 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 level minimum thresholds may limit 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 public drinking water system users.

Domestic land uses and users. The groundwater level 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 level minimum thresholds may limit the number of new domestic wells that can be drilled to limit future declines in groundwater elevations caused by more domestic pumping.

Ecological land uses and users. The groundwater level minimum thresholds may limit the amount of groundwater pumping in the Subbasin and may limit both urban and agricultural growth. This 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 levels.

8.6.2.7 Method for Quantitative Measurement of Minimum Thresholds

Groundwater level minimum thresholds will be directly measured from the representative monitoring well network. The groundwater elevation monitoring will be conducted according to 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 level monitoring network in the Subbasin across aquifers includes 39 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.

> *The measurable objectives for the chronic lowering of groundwater levels are set to 2015 groundwater elevations plus 75% of the difference between 2015 and 1998 groundwater elevations.*

These measurable objectives 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

Groundwater levels minimum thresholds are set to 2015 elevations, and 1998 groundwater elevations were considered the highest reasonable groundwater elevation. To provide adequate operational flexibility during droughts and to mimic historical hydrograph patterns, the measurable objective was set 75% of the way up from 2015 groundwater elevations rather than halfway between 2015 and 1998 groundwater elevations. The measurable objective contour maps along with the representative monitoring network wells are shown on Figure 8-3 for the Forebay Subbasin.

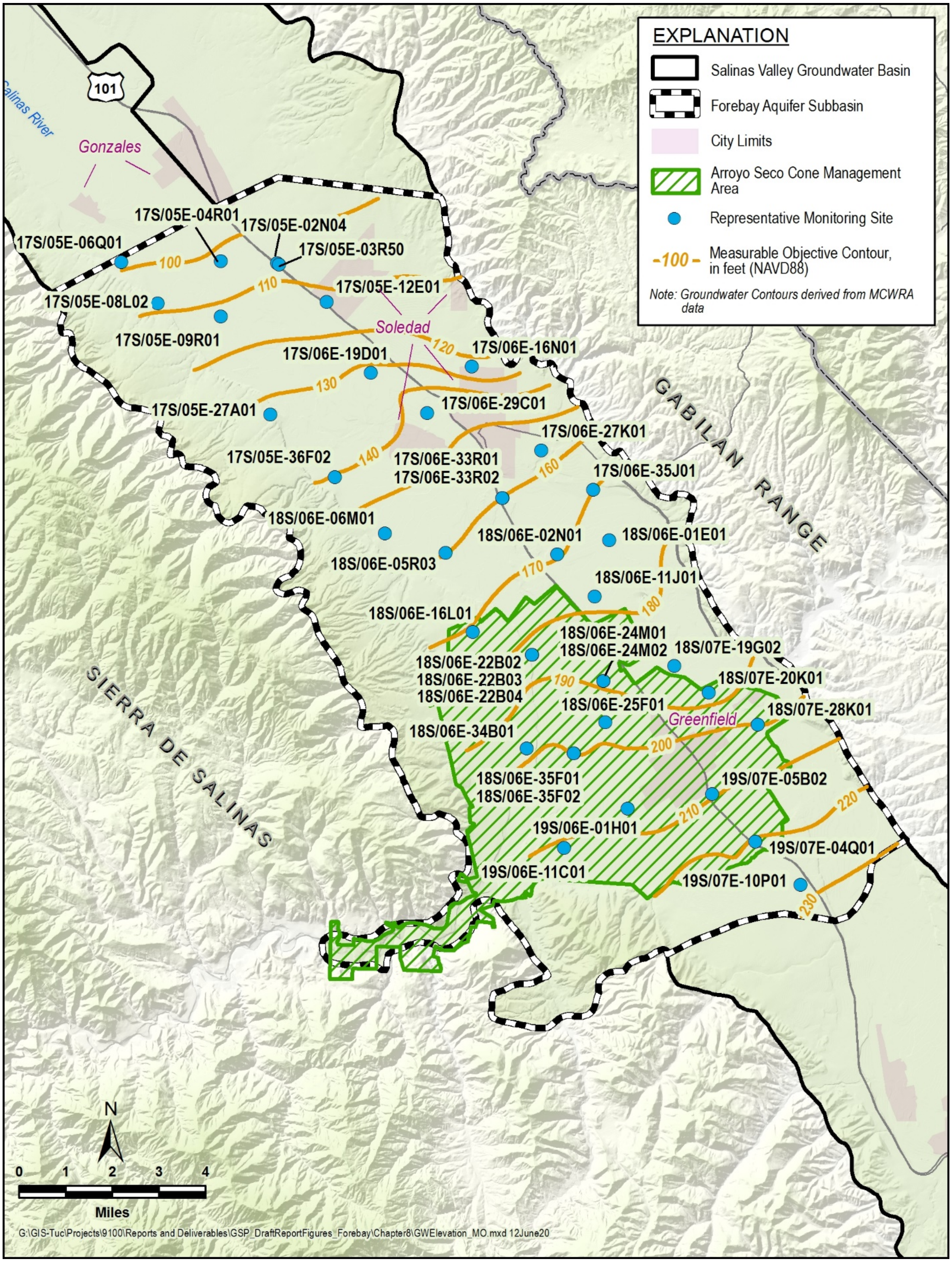


Figure 8-3. Groundwater Level Measurable Objective Contour Map

8.6.3.2 Interim Milestones

Interim milestones for groundwater levels are shown in Table 8-3. These are only initial estimates of interim milestones. Interim milestones for groundwater levels will be modified as better data, analyses, and project designs become available.

Table 8-3. Chronic Lowering of Groundwater Levels Interim Milestones

Monitoring Site	Current Groundwater Elevation (feet)	Interim Milestone at Year 2027 (feet)	Interim Milestone at Year 2032 (feet)	Interim Milestone at Year 2037 (feet)	Measurable Objective (feet) (goal to reach at 2042)
17S/05E-02N04	106.3	106.8	107.4	107.9	108.5
17S/05E-03R50	107.4	108.4	109.5	110.5	111.5*
17S/05E-04R01	101.9	101.9	101.8	101.8	101.8
17S/05E-06Q01	98.1	98.0	98.0	97.9	97.9
17S/05E-08L02	112.6	111.8	111.0	110.2	109.4*
17S/05E-09R01	112.6	112.6	112.7	112.7	112.8*
17S/05E-12E01	105.7	105.6	105.5	105.3	105.2
17S/05E-27A01	135.3	135.1	135.0	134.8	134.6
17S/05E-36F02	137.9	137.6	137.2	136.9	136.6
17S/06E-16N01	96.8	99.9	103.1	106.2	109.4
17S/06E-19D01	136.3	136.1	135.9	135.7	135.5
17S/06E-27K01	159.0	158.3	157.6	156.9	156.2
17S/06E-29C01	147.8	147.0	146.3	145.5	144.8
17S/06E-33R01	163.2	162.6	161.9	161.3	160.7
17S/06E-33R02	163.3	162.4	161.5	160.6	159.7
17S/06E-35J01	174.3	173.5	172.7	171.9	171.2
18S/06E-01E01	172.7	173.0	173.4	173.7	174.1
18S/06E-02N01	167.4	166.5	165.7	164.8	164.0
18S/06E-05R03	156.7	156.0	155.3	154.6	154.0
18S/06E-06M01	163.5	163.3	163.0	162.8	162.6
18S/06E-11J01	182.4	181.1	179.8	178.4	177.1
18S/07E-19G02	175.2	175.3	175.5	175.6	175.7
19S/07E-10P01	229.1	228.8	228.4	228.1	227.8

Monitoring Site	Current Groundwater Elevation (feet)	Interim Milestone at Year 2027 (feet)	Interim Milestone at Year 2032 (feet)	Interim Milestone at Year 2037 (feet)	Measurable Objective (feet) (goal to reach at 2042)
Arroyo Seco Cone Management Area					
18S/06E-16L01	167.7	167.9	168.0	168.2	168.4
18S/06E-22B02	176.9	177.9	178.9	179.8	180.8
18S/06E-22B03	187.2	186.4	185.5	184.7	183.8
18S/06E-22B04	183.5	183.2	183.0	182.7	182.4
18S/06E-24M01	193.3	191.8	190.4	188.9	187.4
18S/06E-24M02	193.5	192.0	190.4	188.9	187.4
18S/06E-25F01	195.8	196.6	197.4	198.2	199.0
18S/06E-34B01	192.5	194.2	196.0	197.7	199.5
18S/06E-35F01	189.2	191.6	194.1	196.5	198.9
18S/06E-35F02	203.2	203.3	203.4	203.5	203.6
18S/07E-20K01	187.0	186.2	185.4	184.5	183.7
18S/07E-28K01	202.7	201.8	201.0	200.1	199.3
19S/06E-01H01	203.4	204.3	205.2	206.1	207.0
19S/06E-11C01	204.0	204.6	205.1	205.7	206.3
19S/07E-04Q01	224.6	224.4	224.3	224.1	223.9
19S/07E-05B02	210.2	210.1	210.1	210.0	210.0

*Groundwater elevations was estimated.

8.6.4 Undesirable Results

Criteria for Defining Chronic Lowering of Groundwater Levels Undesirable Results

The chronic lowering of groundwater level undesirable result is a quantitative combination of groundwater level minimum threshold exceedances. The undesirable result is:

> *More than 15% of the groundwater elevation minimum thresholds are exceeded.*

Since the GSP addresses long-term groundwater sustainability, exceedances of groundwater levels minimum thresholds during a drought do not constitute an undesirable result. Pursuant to SGMA Regulations (California Water Code § 10721(w)(1)), "Overdraft during a period of drought is not sufficient to establish a chronic lowering of groundwater levels if extractions and groundwater recharge are managed as necessary to ensure that reductions in groundwater levels or storage during a period of drought are offset by increases in groundwater levels or storage during other periods." Therefore, groundwater levels may temporarily exceed minimum thresholds during droughts, and do not constitute an undesirable result, as long as groundwater levels rebound.

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 some beneficial users. Reducing the percentage of allowed minimum threshold exceedances ensures strict adherence to minimum thresholds but reduces flexibility due to unanticipated hydrologic 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 5 exceedances in the 39 existing representative monitoring wells. This was considered a reasonable number of exceedances given the hydrogeologic uncertainty of aquifer characteristics of the Subbasin. As the monitoring system grows, additional exceedances will be allowed. One additional exceedance will be allowed for approximately every 7 new monitoring wells.

8.6.4.1 Potential Causes of Undesirable Results

An undesirable result for chronic lowering of groundwater levels does not currently exist, since groundwater elevations in all 39 existing representative monitoring wells in the Subbasin were above the minimum threshold in the December 2019 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.
- **Departure from the GSP's climatic assumptions, including extensive, unanticipated drought.** Minimum thresholds were established based on historical groundwater elevations and reasonable estimates of future climatic conditions and groundwater elevations. Departure from the GSP's climatic assumptions or extensive, unanticipated droughts may lead to excessively low groundwater elevations and undesirable results.

8.6.4.2 Effects on Beneficial Users and Land Uses

The primary detrimental effect on beneficial users from allowing multiple exceedances occurs if more than 1 exceedance take place in a small geographic area. Allowing 15% exceedances is reasonable if the exceedances are spread out across the Subbasin, and as long as any 1 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 borne by a localized group of landowners.

8.7 Reduction in Groundwater Storage SMC

8.7.1 Locally Defined Significant and Unreasonable Conditions

Locally defined significant and unreasonable conditions in groundwater storage in the Subbasin are those that:

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

These significant and unreasonable conditions were determined based on input collected during ASGSA Advisory Committee meetings, SVBGSA Subbasin Committee meetings, and discussions with GSA staff.

8.7.2 Minimum Thresholds

> *The minimum threshold for reduction in groundwater storage is 267,000 acre-feet below the measurable objective. This reduction is based on the groundwater level minimum thresholds. This number will be refined as additional data are collected and other projects are implemented.*

Although not the metric for establishing change in groundwater storage, the GSAs are committed to pumping at or less than the Subbasin's long-term sustainable yield. SGMA allows 20 years to reach sustainability.

8.7.2.1 Information and Methodology Used to Establish Minimum Thresholds

The general relationship between groundwater storage and groundwater elevations is described in greater detail in Chapter 4, Section 4.4.2. The minimum threshold groundwater elevation contours, shown on Figure 8-1, were used to estimate the amount of groundwater in storage when groundwater elevations are held at the minimum threshold levels. The estimated elevation of the bottom of the aquifer in Chapter 4 (Figure 4-4) was subtracted from the minimum threshold groundwater elevation maps to estimate the total aquifer volume at these groundwater elevations. The aquifer volume was multiplied by an estimated specific yield of 0.12 to estimate the total amount of water in storage at the minimum threshold (Brown and Caldwell, 2015).

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 at different locations 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.** The reduction in storage minimum threshold is calculated from the groundwater level minimum thresholds. Therefore, the minimum threshold for reduction in groundwater storage is consistent with, and will not result in, a significant or unreasonable impact on groundwater elevations.
- **Degraded water quality.** The reduction in storage minimum threshold is established to maintain groundwater elevations above historical lows. The change in storage minimum threshold will not directly lead to any additional degradation of groundwater quality.
- **Land subsidence.** The reduction in storage minimum threshold is established to maintain groundwater elevations above historical lows. Therefore, the change in storage minimum threshold will not induce any additional dewatering of clay-rich sediments; and will not induce additional subsidence.
- **Depletion of ISW.** The reduction in storage minimum threshold is established to maintain groundwater elevations above historical lows. Therefore, the change in storage minimum threshold will not induce additional depletion of ISW.

8.7.2.3 Effect of Minimum Thresholds on Neighboring Basins and Subbasins

The Forebay Subbasin has 3 neighboring subbasins within the Salinas Valley Groundwater Basin:

- The Eastside Subbasin to the northeast
- The Upper Valley Subbasin to the south
- The 180/400-Foot Aquifer Subbasin to the northwest

The SVBGSA is either the exclusive GSA or is one of the coordinating GSAs for the adjacent Subbasins. Because the SVBGSA covers all these subbasins, the SVBGSA is coordinating the development of the minimum thresholds and measurable objectives for all these subbasins. The 180/400-Foot Aquifer Subbasin submitted a GSP in 2020 and the Eastside and Upper Valley Subbasins are in the process of GSP development for submittal in January 2022. Minimum thresholds for the Forebay Subbasin will be reviewed relative to information developed for the neighboring subbasins’ GSPs to ensure that these minimum thresholds will not prevent the neighboring subbasins from achieving or maintaining sustainability.

8.7.2.4 Effect on Beneficial Uses and Users

The reduction in groundwater storage minimum thresholds might limit the amount of groundwater pumping in the Subbasin. Limiting pumping may impact the beneficial uses and users of the Subbasin.

Agricultural land uses and users. Limiting the amount of groundwater pumping may limit agricultural production or restrict options for crops that can be grown 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 could remove groundwater from storage until it is below minimum thresholds

Urban land uses and users. Limiting 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. The change in storage minimum thresholds are based on groundwater level minimum thresholds that 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.

Ecological land uses and users. Limiting the amount of pumping may generally benefit the environmental groundwater uses. Maintaining historical amounts of groundwater in the Subbasin maintains groundwater supplies for environmental purposes at levels similar to historical levels.

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 amount of groundwater in storage will be calculated by calculating the change between groundwater elevation contour maps. The change in storage estimates will also be checked every 5 years when the SVIHM model is updated.

8.7.3 Measurable Objectives

> *The measurable objective for reduction in groundwater storage measurable objective is 0 when the groundwater elevations are held at the groundwater level measurable objectives.*

Since the goal is to manage to the measurable objective, additional water in storage is needed until groundwater elevations are at their measurable objectives.

8.7.3.1 Methodology for Setting Measurable Objectives

The measurable objective groundwater elevation contours, shown on Figure 8-2, were used to estimate the amount of groundwater in storage when groundwater elevations are held at the measurable objective levels. The estimated elevation of the bottom of the aquifer in Chapter 4 (Figure 4-4) was subtracted from the measurable objective groundwater elevation maps to estimate the total aquifer volume at these groundwater elevations. The aquifer volume was multiplied by an estimated specific yield of 0.12 to estimate the total amount of water in storage at the measurable objective (Brown and Caldwell, 2015).

8.7.3.2 Interim Milestones

The reduction in storage interim milestones is shown in Table 8-4 for each of the 5-year intervals, consistent with the minimum threshold and the measurable objective. At current 2019 groundwater elevations, the groundwater in storage is about 780 AF below the measurable objective, to reach the measurable objective a gain of 260 AF in groundwater storage needs to occur every 5 years until 2042.

Table 8-4. Reduction in Groundwater Storage Interim Milestones

	At Current Conditions	At Interim Milestone Year 2027	At Interim Milestone Year 2032	At Interim Milestone Year 2037	At Measurable Objective Year 2042
Gain in Storage needed to Reach Measurable Objective (AF)	780	260	260	260	0

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:

> *There is an exceedance of the minimum threshold.*

Since the GSP addresses long-term groundwater sustainability, exceedances of groundwater storage minimum thresholds during a drought do not constitute an undesirable result. Pursuant to SGMA Regulations (California Water Code § 10721(w)(1)), "Overdraft during a period of drought is not sufficient to establish a chronic lowering of groundwater levels if extractions and groundwater recharge are managed as necessary to ensure that reductions in groundwater levels or storage during a period of drought are offset by increases in groundwater levels or storage during other periods." Therefore, groundwater storage may temporarily exceed minimum thresholds during droughts, and do not constitute an undesirable result, as long as groundwater levels rebound.

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 lowered groundwater elevations that reduce groundwater storage to 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 low groundwater levels that reduce the groundwater storage below to an undesirable result.
- **Departure from the GSP's climatic assumptions, including extensive, unanticipated drought.** The undesirable result is established based on reasonable anticipated future climatic conditions and groundwater elevations. Departure from the GSP's climatic assumptions or extensive, unanticipated droughts may lead to excessively low groundwater recharge and unanticipated high pumping rates that could reduce groundwater in storage to an undesirable result.

8.7.4.3 Effects on Beneficial Users and Land Use

The practical effect of the reduction in groundwater storage undesirable result is no chronic, long-term net change in groundwater storage. Therefore, beneficial uses and users will have access to a similar amount of water in storage that currently exists, and the undesirable result will not have an additional negative effect on the beneficial users and uses of groundwater.

8.8 Degraded Water Quality SMC

8.8.1 Locally Defined Significant and Unreasonable Conditions

Locally defined significant and unreasonable changes in groundwater quality in the Subbasin are increases in a COC caused by a direct result of a GSA groundwater management action that either:

- Result in groundwater concentrations in a potable water supply well above an established MCL or SMCL, or
- Lead to significantly reduced crop production.

These significant and unreasonable conditions were determined based on input collected during ASGSA Advisory Committee meetings, SVBGSA Subbasin Committee meetings, and discussions with GSA staff.

8.8.2 Minimum Thresholds

> *The minimum thresholds for degraded water quality are zero additional exceedances of the regulatory drinking water standards (potable supply wells) or Basin Plan objectives (irrigation supply wells) beyond those observed on December 31, 2019, for groundwater quality constituents of concern.*

The minimum thresholds for DDW public water system supply wells and ILRP on-farm domestic wells reflect California's Title 22 drinking water standards. The minimum thresholds for irrigation supply wells are based on the water quality objectives listed in the Water Quality Basin Plan for the Central Coastal Basin (CCRWQCB, 2019). The minimum threshold values for the COC for all 3 sets of wells are provided in Table 8-5 and are based on data up to December 31, 2019. Full discussion of these current conditions is included in Chapter 5. Because the minimum thresholds reflect no additional exceedances, the minimum thresholds are set to the number of existing exceedances. Surpassing the number of existing exceedances for any of the listed constituents will lead to an undesirable result. Not all wells in the monitoring network are sampled for every COC.

Table 8-5. Degradation of Groundwater Quality Minimum Thresholds and Measurable Objectives

Constituent of Concern (COC)	Minimum Threshold/ Measurable Objective – Number of Wells Exceeding Regulatory Standard from latest sample (August 1986 to December 2019)
DDW Wells	
1,2 Dibromo-3-chloropropane	3
1,2,3-Trichloropropane	2
Beryllium	1
Chloride	1
Di(2-ethylhexyl) phthalate	1
Dinoseb	3
Iron	6
Lindane	1
Manganese	4
Nitrate (as nitrogen)	5
Polychlorinated Biphenyls	1
Specific Conductance	1
Sulfate	1
Thallium	1
Total Dissolved Solids	4
Vinyl Chloride	4
ILRP On-Farm Domestic Wells	
Iron	8
Manganese	2
Nitrate (as nitrogen)	162
Nitrate + Nitrite (sum as nitrogen)	62
Nitrite	1
Specific Conductance	71
Sulfate	34
Total Dissolved Solids	90
ILRP Irrigation Supply Wells	
Iron	1
Manganese	2

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

As noted in the GSP Regulations, minimum thresholds are based on a degradation of groundwater quality, not an improvement of groundwater quality (23 CCR §354.28 (c)(4)). Therefore, this GSP is designed to avoid taking any action that may inadvertently move groundwater constituents already in the Subbasin in such a way that the constituents have a significant and unreasonable impact that would not otherwise occur. COC must meet 2 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, the COC that may affect drinking water supply wells include those for DDW and ILRP on-farm domestic wells listed in Table 8-5. The COC that are known to cause reductions in crop production are those for ILRP irrigation supply wells listed in Table 8-5.

As discussed in Chapter 7, 3 existing water quality monitoring networks were reviewed and used for developing SMC:

- Public water system supply wells are regulated by the SWRCB DDW.
- On-farm domestic wells monitored as part of CCRWQCB ILRP. This dataset was obtained from the SWRCB through the GAMA groundwater information system. The ILRP data were separated into 2 data sets, 1 for on-farm domestic wells and the other for irrigation supply wells (discussed below) for purposes of developing initial draft minimum thresholds and measurable objectives for each type of well. The monitoring well network for the ILRP will change when the monitoring network for Ag Order 4.0 is finalized. At that time, the new ILRP on-farm domestic monitoring network will be incorporated into this GSP, replacing the current network, for water quality monitoring.
- Irrigation supply wells monitored as part of ILRP. As mentioned above, this dataset was obtained from the SWRCB through the GAMA groundwater information system. Like the on-farm domestic well dataset, the IRLP irrigation supply monitoring network will change when Ag Order 4.0 is finalized.

Each of these well networks are monitored for a different set of water quality parameters. Furthermore, some groundwater quality impacts are detrimental to only certain networks. For example, high nitrates are detrimental to public water system supply wells and on-farm domestic wells but are not detrimental to irrigation supply wells. The constituents monitored in each well network are indicated by an X in Table 8-6. An X does not necessarily indicate that the constituents have been found above the regulatory standard in that monitoring network.

Table 8-6. Summary of Constituents Monitored in Each Well Network

Constituent	Public Water System Supply	On-Farm Domestic[1]	Irrigation Supply
Boron	X	X	X
Chloride	X	X	X
Iron	X	X	X
Manganese	X	X	X
Nitrite	X	X	X
Nitrate (as nitrogen)	X	X	X
Nitrate + Nitrite (sum as nitrogen)		X	X
Specific Conductance	X	X	X
Sulfate	X	X	X
Total Dissolved Solids	X	X	X
Silver	X		
Aluminum	X		
Alachlor	X		
Arsenic	X		
Atrazine	X		
Barium	X		
Beryllium	X		
Lindane	X		
Di(2-ethylhexyl) phthalate	X		
Bentazon	X		
Benzene	X		
Benzo(a)Pyrene	X		
Toluene	X		
Cadmium	X		
Chlordane	X		
Chlorobenzene	X		
Cyanide	X		
Chromium	X		
Carbofuran	X		
Carbon Tetrachloride	X		
Copper	X		
Dalapon	X		
1,2 Dibromo-3-chloropropane	X		
1,1-Dichloroethane	X		
1,2-Dichloroethane	X		
1,2-Dichlorobenzene	X		
1,4-Dichlorobenzene	X		
1,1-Dichloroethylene	X		
cis-1,2-Dichloroethylene	X		
trans-1,2-Dichloroethylene	X		
Dichloromethane (a.k.a. methylene chloride)	X		
1,2-Dichloropropane	X		

Constituent	Public Water System Supply	On-Farm Domestic[1]	Irrigation Supply
Dinoseb	X		
Diquat	X		
Di(2-ethylhexyl) adipate	X		
Ethylbenzene	X		
Endrin	X		
Fluoride	X		
Trichlorofluoromethane	X		
1,1,2-Trichloro-1,2,2-Trifluoroethane	X		
Foaming Agents (MBAS)	X		
Glyphosate	X		
Hexachlorocyclopentadiene	X		
Hexachlorobenzene	X		
Heptachlor	X		
Mercury	X		
Molinate	X		
Methyl-tert-butyl ether (MTBE)	X		
Methoxychlor	X		
Nickel	X		
Oxamyl	X		
1,1,2,2-Tetrachloroethane	X		
Perchlorate	X		
Polychlorinated Biphenyls	X		
Tetrachloroethene	X		
Pentachlorophenol	X		
Picloram	X		
Antimony	X		
Selenium	X		
2,4,5-TP (Silvex)	X		
Simazine	X		
Styrene	X		
1,1,1-Trichloroethane	X		
1,1,2-Trichloroethane	X		
1,2,4-Trichlorobenzene	X		
Trichloroethene	X		
1,2,3-Trichloropropane	X		
Thiobencarb	X		
Thallium	X		
Toxaphene	X		
Vinyl Chloride	X		
Xylenes	X		
Zinc	X		

[1] Basin plan states domestic wells are monitored for Title 22 constituents; however, GAMA groundwater information system only provides data for the constituents listed above.

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

Preventing degradation of groundwater quality may affect other sustainability indicators or may limit activities needed to achieve minimum thresholds for other sustainability indicators as described below:

- **Chronic lowering of groundwater levels.** The degradation of groundwater quality minimum thresholds could influence groundwater level minimum thresholds by limiting the types of water that can be used for recharge to maintain or raise groundwater elevations. Water used for recharge cannot exceed any groundwater quality standards.
- **Reduction in groundwater storage.** The degradation of groundwater quality minimum thresholds do not promote lower groundwater elevations. Therefore, the groundwater quality minimum thresholds will not result in an exceedance of the groundwater storage minimum threshold.
- **Land subsidence.** The degradation of groundwater quality minimum thresholds do not promote 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 ISW.** The degradation of groundwater quality minimum thresholds do not promote additional pumping or lower groundwater elevations adjacent to ISW. Therefore, the groundwater quality minimum thresholds will not result in a significant or unreasonable depletion of ISW.

8.8.2.3 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 Forebay Subbasin has 3 neighboring subbasins within the Salinas Valley Groundwater Basin:

- The Eastside Subbasin to the northeast
- The Upper Valley Subbasin to the south
- The 180/400-Foot Aquifer Subbasin to the northwest

The SVBGSA is either the exclusive GSA or is one of the coordinating GSAs for the adjacent Subbasins. Because the SVBGSA covers all these subbasins, the SVBGSA is coordinating the development of the minimum thresholds and measurable objectives for all these subbasins. The 180/400-Foot Aquifer Subbasin submitted a GSP in 2020 and the Eastside and Upper Valley

Subbasins are in the process of GSP development for submittal in January 2022. Minimum thresholds for the Forebay Subbasin will be reviewed relative to information developed for the neighboring subbasins' GSPs to ensure that these minimum thresholds will not prevent the neighboring subbasins from achieving sustainability.

8.8.2.4 Effect on Beneficial Uses and Users

Agricultural land uses and users. The groundwater quality minimum thresholds generally provide positive benefits to the Subbasin's agricultural water users. Preventing any GSA actions that would result in additional agricultural supply wells 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 groundwater quality minimum thresholds generally provide positive benefits to the Subbasin's urban water users. Preventing any GSA actions that would result in COC in additional drinking water supply wells exceeding MCLs or SMCLs ensures adequate groundwater quality for public water system supplies.

Domestic land uses and users. The groundwater quality minimum thresholds generally provide positive benefits to the Subbasin's domestic water users. Preventing any GSA actions that would result in COC in additional drinking water supply wells exceeding MCLs or SMCLs ensures adequate groundwater quality for on-farm 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 any GSA actions that would result in COC migrating will prevent unwanted contaminants from impacting ecological groundwater uses.

8.8.2.5 Relation to State, Federal, or Local Standards

The groundwater quality minimum thresholds specifically incorporate state and federal standards for drinking water and Basin Plan objectives.

8.8.2.6 Method for Quantitative Measurement of Minimum Thresholds

Degradation of groundwater quality minimum thresholds will be directly measured from existing public water system supply wells, on-farm domestic wells, and irrigation supply wells. Groundwater quality will be measured with SWRCB GAMA groundwater information system data submitted through existing monitoring programs—DDW and ILRP—as discussed in Chapter 7.

- Exceedances of MCLs and SMCLs in public water system supply wells will be monitored with annual water quality data submitted to the DDW.

- Exceedances of MCLs and SMCLs in on-farm domestic wells will be monitored with ILRP data.

Initially, the review of drinking water MCLs, SMCLs, and water quality objectives that maintain adequate crop production will be centered around the COC identified above. If during review of the water quality data additional constituents appear to exceed any of the regulatory standards, these additional constituents will be added to the list of COC for the Subbasin.

8.8.3 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 measurable objectives are based on no groundwater quality degradation, and are identical to the minimum thresholds, as defined in Table 8-5.

> *The measurable objectives for degraded water quality are zero additional exceedances of the regulatory drinking water standards (potable supply wells) or Basin Plan objectives (irrigation supply wells) beyond those observed on December 31, 2019, for groundwater quality constituents of concern.*

8.8.3.1 Methodology 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 8.8.2.1.

8.8.3.2 Interim Milestones

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.

8.8.4 Undesirable Results

8.8.4.1 Criteria for Defining Undesirable Results

The degradation of groundwater quality becomes an undesirable result when a quantitative combination of groundwater quality minimum thresholds is exceeded. For the Subbasin, the exceedance of minimum thresholds 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, nor GSA management, they do not constitute an undesirable result. Additionally, SGMA states that GSAs are not responsible for addressing water quality degradation that was present before January 1, 2015 (California Water

Code § 10727.2(b)(4)). Therefore, the degradation of groundwater quality reaches an undesirable result when:

> *Future or new minimum thresholds exceedances are caused by a direct result of GSA groundwater management action(s), including projects or management actions and regulation of groundwater extraction.*

The groundwater level SMC is designed and intended to help protect groundwater quality. Setting the groundwater level minimum thresholds at or above historical lows assures that no new depth dependent constituents of water quality concern are mobilized. The GSAs may pursue projects or management actions to ensure that groundwater levels do not fall below groundwater level minimum thresholds.

This undesirable result recognizes there is an existing regulatory framework in the form of the California Porter Cologne Act and the federal Clean Water Act that addresses water quality management; and considers existing federal, state, and local groundwater quality standards, which were used in the development of minimum thresholds in the GSP. SVBGSA is not responsible for enforcing drinking water requirements or for remediating violations of those requirements that were caused by others (Moran and Belin, 2019). The existing regulatory regime does not require nor obligate the SVBGSA nor ASGSA to take any affirmative actions to manage or control existing groundwater quality. However, SVBGSA and ASGSA are committed to monitoring and disclosing changes in groundwater quality and ensuring its groundwater management actions do not cause drinking water or irrigation water to be unusable.

SVBGSA and ASGS will work closely with the Central Coast Regional Water Quality Control Board and other entities that have regulatory authority over water quality. SVBGSA will lead the Water Quality Coordination Group, as described in Chapter 9, which includes meeting annually with these partner agencies to review the status of water quality data and discuss any action needed to address water quality degradation.

If the GSA has not implemented any groundwater management actions in the Subbasin, including projects, management actions, or pumping management, no such management actions constitute an undesirable result. If minimum thresholds are exceeded after the GSA has implemented actions in the Subbasin, the GSA will review groundwater quality and groundwater gradients in and around the project areas to assess if the exceedance resulted from GSA actions to address sustainability indicators or was independent of GSA activities. Both the implementation of actions and assessment of exceedances will occur throughout the GSP timeframe of 50 years as required by SGMA. The general approach to assess if a minimum threshold exceedance is due to GSA action will include:

- If no projects, management actions, or other GSP implementation actions have been initiated in a subbasin, or near the groundwater quality impact, then the impact was not caused by any GSA action.
- Many projects will likely include a new monitoring network. If data from the project-specific monitoring network do not show groundwater quality impacts, this will suggest that the impact was not caused by any GSA actions.
- If a GSA undertakes a project that changes groundwater gradients, moves existing constituents, or results in the exceedance of minimum thresholds, SVBGSA will undertake a more rigorous technical study to assess local, historical groundwater quality distributions, and the impact of the GSA activity on that distribution.

For SGMA compliance, undesirable results for groundwater quality are not caused by (1) lack of action; (2) GSA required reductions in pumping; (3) exceedances in groundwater quality minimum thresholds that occur, if there are fewer exceedances than if there had been a lack of management; (4) exceedances in groundwater quality minimum thresholds that would have occurred independent of projects or management actions implemented by the GSA; (5) past harm.

8.8.4.2 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 COC toward 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 COC toward 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.

8.8.4.3 Effects on Beneficial Users and Land Use

The undesirable result for degradation of groundwater quality is avoiding groundwater degradation caused by a direct result of a GSA groundwater management action. 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 does not apply to groundwater quality changes that occur due to other causes.

8.9 Land Subsidence SMC

8.9.1 Locally Defined Significant and Unreasonable Conditions

Locally defined 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 or
- Any inelastic subsidence that causes an increase of flood risk.

These significant and unreasonable conditions were determined based on input collected during ASGSA Advisory Committee meetings, SVBGSA Subbasin Committee meetings, and discussions with GSA staff.

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.

8.9.2 Minimum Thresholds

> *The minimum threshold for land subsidence is 0.133 feet per year. This is the rate that results in less than 1 foot of cumulative subsidence over a 30-year implementation horizon, plus 0.1 feet per year of estimated land movement to account for InSAR measurement errors.*

8.9.2.1 Information Used and Methodology for Establishing Subsidence Minimum Thresholds

Significant and unreasonable impacts from subsidence include loss of canal and drainage ditch capacity due to overflowing, increased flooding extent and duration near stream channels, reduced gradients in sewers, storm drains and other gravity flow pipelines, degradation of leveling in laser-leveled fields, and damage to well casings due to compaction of clay layers adjacent to the casing. Example standards for flooding and drainage include:

- Ground floor elevations are recommended or required to be at least 1 foot above the Base Flood Elevation in some jurisdictions (see for example Federal Emergency Management Agency [no date]; City of Temecula [no date]).
- The minimum freeboard along roadside ditches is often required to be 1 foot above the maximum anticipated water level (see for example City of Morgan Hill [no date]).

Therefore, any more than 1 foot of cumulative subsidence over the implementation horizon was considered significant and unreasonable because of the potential impact on infrastructure.

The InSAR data provided by DWR are subject to measurement error. DWR stated that, on a statewide level, for the total vertical displacement measurements between June 2015 and June 2019, the errors are as follows (DWR, 2019, 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 adding 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.

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. 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.

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

The subsidence minimum threshold has little or no impact on other minimum thresholds, as described below.

- **Chronic lowering of groundwater levels.** The land subsidence minimum threshold will not decrease groundwater elevations and therefore will not result in significant or unreasonable groundwater elevations.
- **Reduction in groundwater storage.** The land subsidence minimum threshold will not change the amount of pumping and therefore will not result in a significant or unreasonable change in groundwater storage.
- **Degraded water quality.** The land subsidence minimum threshold does not promote decreasing groundwater elevations that lead to exceedance of groundwater quality minimum thresholds and therefore will not result in significant of unreasonable degradation of water quality.
- **Depletion of ISW.** The land subsidence minimum threshold does not promote additional pumping or lower groundwater elevations adjacent to ISW. Therefore, the subsidence minimum threshold will not result in a significant or unreasonable depletion of ISW.

8.9.2.3 Effect of Minimum Thresholds on Neighboring Basins and Subbasins

The Forebay Subbasin has 3 neighboring subbasins within the Salinas Valley Groundwater Basin:

- The Eastside Subbasin to the northeast
- The Upper Valley Subbasin to the south
- The 180/400-Foot Aquifer Subbasin to the northwest

The SVBGSA is either the exclusive GSA or is one of the coordinating GSAs for the adjacent Subbasins. Because the SVBGSA covers all these subbasins, the SVBGSA is coordinating the development of the minimum thresholds and measurable objectives for all these subbasins. The 180/400-Foot Aquifer Subbasin submitted a GSP in 2020 and the Eastside and Upper Valley Subbasins are in the process of GSP development for submittal in January 2022. Minimum thresholds for the Forebay Subbasin will be reviewed relative to information developed for the neighboring subbasins' GSPs to ensure that these minimum thresholds will not prevent the neighboring subbasins from achieving or maintaining sustainability.

8.9.2.4 Effects on Beneficial Uses and Users

The subsidence minimum threshold is set to prevent any long-term inelastic subsidence. Available data indicate that there is currently no long-term subsidence occurring in the Subbasin, and therefore the minimum threshold has no impact on current pumping rates. The subsidence minimum threshold does not impact infrastructure and does not require any additional reductions in pumping, and there is no negative impact on any beneficial user. Increased pumping, however, could initiate subsidence and require pumping restrictions.

8.9.2.5 Relation to State, Federal, or Local Standards

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

8.9.2.6 Method for Quantitative Measurement of Minimum Threshold

The minimum threshold will be assessed using DWR-supplied InSAR data.

8.9.3 Measurable Objectives

The measurable objective for ground surface subsidence represents a target annual subsidence rate in the Subbasin.

> *The measurable objective for land subsidence is 0.1 foot per year. This is a long-term rate of zero feet per year plus 0.1 foot per year of estimated land movement to account for InSAR measurement errors.*

8.9.3.1 Methodology for Setting Measurable Objectives

The measurable objective will be assessed using DWR-supplied InSAR data.

8.9.3.2 Interim Milestones

The subsidence measurable objective is 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 zero long-term subsidence, and annual measurements of no more than 0.1 foot of subsidence per year.

8.9.4 Undesirable Results

8.9.4.1 Criteria for Defining Undesirable Results

By regulation, the ground surface subsidence undesirable result is a quantitative combination of subsidence minimum threshold exceedances. No rate of subsidence that results in greater than 1 foot of cumulative subsidence, and that is directly caused by lowered groundwater elevations, is acceptable. Therefore, the land subsidence undesirable result is:

> *There is an exceedance of the minimum threshold for land subsidence due to lowered groundwater elevations that surpass historical lows.*

Should potential subsidence be observed, the SVBGSA and ASGSA will first assess whether the subsidence may be due to elastic subsidence. If the subsidence is not elastic, the GSAs will undertake a program to assess whether the subsidence is caused by lowered groundwater elevations. The first step in the assessment will be to check if groundwater elevations have dropped below historical lows. If groundwater elevations remain above historical lows, the GSAs shall assume that any observed subsidence was not caused by lowered groundwater levels. If groundwater levels have dropped below historical lows, the GSAs will attempt to correlate the observed subsidence with measured groundwater elevations. Additionally, if the Subbasin experiences subsidence in multiple consecutive years that are due to InSAR measurement error, the GSAs will confirm if the error is not actually net long-term subsidence.

8.9.4.2 Potential Causes of Undesirable Results

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

8.9.4.3 Effects on Beneficial Users and Land Use

The undesirable result for subsidence allows for no more than 1 foot of cumulative subsidence in the Subbasin. This has limited to no impact on infrastructure. Therefore, there is no negative effect on any beneficial uses and users.

8.10 Depletion of Interconnected Surface Water SMC

Areas with ISW occur where shallow groundwater may be connected to the surface water system. This SMC applies only to locations of ISW, as shown on Figure 4-14.

The SVIHM is used to identify the locations of ISW and to develop an estimate of the quantity and timing of stream depletions due to pumping during current and historical groundwater conditions. Shallow groundwater and surface water levels simulated by the SVIHM are used to identify the location of interconnection and evaluate the frequency with which different stream reaches are connected with groundwater in the underlying aquifer. The magnitude of stream depletions in relation to shallow groundwater elevations in interconnected reaches are evaluated in Chapter 5.

8.10.1 Locally Defined Significant and Unreasonable Conditions

Locally defined significant and unreasonable depletion of ISW in the Subbasin is defined as:

- Depletions from groundwater extraction that would result in a significant and unreasonable impact on other beneficial uses and users such as riparian water rights holders, appropriative surface water rights holders, ecological surface water users, and recreational surface water uses.
- Depletion from groundwater extraction more than observed in December 2015, as measured by shallow groundwater elevations near locations of interconnected surface water. While a documented determination of whether past depletions was significant is not available, staying above December 2015 depletions was determined to be a reasonable balance for all the beneficial uses and users.

These significant and unreasonable conditions were determined based on input collected during ASGSA Advisory Committee meetings, SVBGSA Subbasin Committee meetings, and discussions with GSA staff. There is currently no data that determines what level of depletion from groundwater extraction has a significant adverse effect on steelhead trout or other beneficial use or user of ISW. Should there be a determination regarding what level of depletion from groundwater extraction is significant, SVBGSA will take that into consideration as it reviews how it locally defines significant and unreasonable conditions for the SMC in the 5-Year Update.

8.10.2 Minimum Thresholds

The minimum thresholds are established to maintain consistency with the chronic lowering of groundwater elevation and reduction in groundwater storage minimum thresholds, which are also established based on groundwater elevations.

> *The minimum thresholds for depletion of interconnected surface water are established by proxy using shallow groundwater elevations observed in December 2015 near locations of interconnected surface water.*

No minimum thresholds are established for times when flow in a river is due to conservation releases from a reservoir. One purpose for these conservation releases is to recharge the Salinas Valley groundwater basin. Therefore, depletion of conservation releases is a desired outcome, and the minimum thresholds and measurable objectives do not apply to these flows.

The locations of ISW identified with the SVIHM are based on best available data but contain uncertainty, which is discussed in Chapters 4, 5, and 6. Additional stream and groundwater level data are needed to reduce uncertainty, verify with observed conditions, and track changes over time. The shallow groundwater monitoring wells, USGS stream gauges, and MCWRA River Series measurement sites will be used to supplement the analysis of locations of connectivity provided by the SVIHM. These monitoring points will also become part of the ISW monitoring network that is discussed in Chapter 7. Data from the ISW monitoring network will be used to monitor and evaluate the interconnection through time.

As discussed in Chapter 7, a monitoring network for ISW composed of shallow groundwater monitoring wells is in the process of development. Existing shallow wells will be added to the monitoring network where possible and will be supplemented with new shallow wells if needed. The monitoring network is dependent on the location and magnitude of stream reaches determined by the SVIHM. Once the monitoring network is fully established, SMC will be determined using the wells' groundwater elevations during the minimum threshold and measurable objective years, or interpolated values from the groundwater elevation contour maps for wells that do not have shallow groundwater elevation measurements for those years.

8.10.2.1 Information Used and Methodology for Establishing Depletion of Interconnected Surface Water Minimum Thresholds and Measurable Objectives

8.10.2.1.1 Establishing Groundwater Elevations as Proxies

The GSP Regulations § 354.28(d) states that: "an Agency may establish a representative minimum threshold for groundwater elevation to serve as the value for multiple sustainability indicators, where the Agency can demonstrate that the representative value is a reasonable proxy for multiple individual minimum thresholds as supported by adequate evidence."

The evaluation of ISW in the Salinas Valley Groundwater Basin is based on an approach recommended by the Environmental Defense Fund (EDF, 2018) that uses groundwater elevations as surrogates for streamflow depletion rates caused by groundwater use. Basic hydraulic principles state that groundwater flow is proportional to the difference between groundwater elevations at different locations along a flow path. Using this basic principle, groundwater flow to a stream, or conversely seepage from a stream to the underlying aquifer, is proportional to the difference between water elevation in the stream and groundwater elevations at locations away from the stream. Assuming the elevation in the stream is relatively stable, changes in interconnectivity between the stream and the underlying aquifer is determined by changes in groundwater levels in the aquifer. Thus, the change in hydraulic gradient between stream elevation and surrounding groundwater elevations is representative of change in interconnection between surface water and groundwater. Monitoring the hydraulic gradient in the aquifer adjacent to the stream monitors the interconnectivity between stream and aquifer. Therefore, the gradient can be monitored by measuring and evaluating groundwater elevations at selected shallow monitoring wells near streams. No existing estimations of the quantity and timing of depletions of ISW exist, nor data available to make estimations, so the hydraulic principles provide the best available information.

8.10.2.1.2 Review of Beneficial Uses and Users of Surface Water

The various beneficial uses and users of surface waters were addressed when setting the ISW depletion minimum thresholds. The classes of beneficial uses and users that were reviewed include riparian rights holders, appropriative rights holders, ecological surface water users, and recreational surface water users. This is not a formal analysis of public trust doctrine, but it is a reasonable review of all uses and users in an attempt to balance all interests. This is not an assessment about what constitutes a reasonable beneficial use under Article X, Section 2 of the California Constitution. The minimum thresholds for depletion of ISW are developed using the definition of significant and unreasonable conditions described above, public information about critical habitat, locations of ISW derived from the SVIHM, and public information about water rights described below.

Riparian water rights holders and Pre-1914 water rights holders. Table 8-7 provides a summary of water diversions reported to the SWRCB by riparian water rights holders and pre-1914 water rights holders on the Salinas River and its tributaries within the Subbasin. The diversion data were obtained from queries of the SWRCB eWRIMS water rights management system and represent water diversions self-reported by water-rights holders with points of diversion located within the Subbasin boundaries. Riparian rights holders are not differentiated from pre-1914 rights holders in the eWRIMS query results, and therefore diversions by riparian rights holders are lumped with the pre-1914 right diversions by Clark Colony. The reported surface water diversions are not a determination of water rights and may not include all pre 1914 water rights. Some of the diversions shown in Table 8-7 are also reported to MCWRA as groundwater pumping.

The SVBGSA is not aware of any current water rights litigation or water rights enforcement acts along the Salinas River in the Subbasin. Furthermore, 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. Lack of enforcement complaints suggest that historical depletions have not resulted in substantial and unreasonable impact.

Table 8-7. Reported Annual Surface Water Diversions in the Forebay Aquifer Subbasin

Diversions (Acre-Feet)	2011	2012	2013	2014	2015	2016	2017	2018	2019
Appropriation per Permit	84,270	33,708	0	0	0	0	0	0	0
Statement of Diversion and Use including Clark Colony and Reported Riparian Diversions	17,692	30,782	9,914	9,929	16,624	12,358	16,440	13,032	12,327
Total	101,962	64,490	9,914	9,929	16,624	12,358	16,440	13,032	12,327

Appropriative water rights holders. The one permitted appropriative water right holder in the Forebay Subbasin, shown in Table 8-7, is MCWRA. The reported surface water diversion is not a determination of water rights. In addition to this one diversion, MCWRA releases water from upstream appropriative diversions, the Nacimiento Reservoir and San Antonio Reservoir, which flows through the Subbasin. MCWRA has not filed any action noting illegal use of these appropriated waters. Therefore, current levels of depletion are assumed to not infringe on their appropriative water right from the reservoir releases.

The SVBGSA is not aware of any current water rights litigation or water rights enforcement acts along the Salinas River in the Subbasin. Therefore, SVBGSA assumes that the current level of depletion has not injured any appropriative water rights holders in the Subbasin.

Ecological surface water users. Review of MCWRA's Nacimiento Dam Operation Policy (MCWRA, 2018b) and MCWRA's water rights indicates MCWRA operates the Dam in a manner that meets downstream demands and considers ecological surface water users. Since the reservoir operations consider ecological surface water users and reflect reasonable existing surface water depletion rates, this GSP infers that stream depletion from existing groundwater pumping is not unreasonable. If further river management guidelines are developed to protect ecological surface water users, the SMC in this GSP will be revisited.

Recreational surface water users. No recreational activities such as boating regularly occur on surface water bodies in the Subbasin.

As shown by the analysis above, the current rate of surface water depletion is not having an unreasonable impact on the various surface water uses and users in the Subbasin. Therefore, the minimum thresholds are set based on 2015 groundwater elevations.

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

The minimum thresholds for depletion of ISW are set to December 2015 groundwater elevations in the shallow monitoring wells within the Subbasin. The minimum thresholds all reference the same historical year and have existed simultaneously in the past. Therefore, no conflict exists between minimum thresholds measured at various locations within the Subbasin.

The depletion of ISW minimum thresholds could influence other sustainability indicators as follows:

- **Chronic lowering of groundwater levels.** The depletion of ISW minimum thresholds is identical to the groundwater level minimum thresholds. Therefore, the ISW minimum thresholds will not result in chronic lowering of groundwater elevations.
- **Reduction in groundwater storage.** The depletion of ISW minimum threshold is identical to the groundwater elevation minimum thresholds. The change in groundwater storage minimum threshold require groundwater elevations be held at the minimum thresholds set for the chronic lowering of groundwater indicator. Thus, the ISW minimum threshold is therefore consistent with the change in groundwater storage minimum threshold.
- **Degraded water quality.** The depletion of ISW minimum thresholds does not promote decreasing groundwater elevations that lead to exceedance of groundwater quality minimum thresholds. Therefore, groundwater quality will not be affected by the ISW minimum thresholds.
- **Land subsidence.** The depletion of ISW minimum thresholds does not promote additional pumping that could cause subsidence. Therefore, subsidence will not be affected by the ISW minimum thresholds.

8.10.2.3 Effect of Minimum Thresholds on Neighboring Basins and Subbasins

The Forebay Subbasin has 3 neighboring subbasins within the Salinas Valley Groundwater Basin:

- The Eastside Subbasin to the northeast

- The Upper Valley Subbasin to the south
- The 180/400-Foot Aquifer Subbasin to the northwest

The SVBGSA is either the exclusive GSA or is one of the coordinating GSAs for the adjacent Subbasins. Because the SVBGSA covers all these subbasins, the SVBGSA is coordinating the development of the minimum thresholds and measurable objectives for all these subbasins. The 180/400-Foot Aquifer Subbasin submitted a GSP in 2020 and the Eastside and Upper Valley Subbasins are in the process of GSP development for submittal in January 2022. Minimum thresholds for the Forebay Subbasin will be reviewed relative to information developed for the neighboring subbasins' GSPs to ensure that these minimum thresholds will not prevent the neighboring subbasins from achieving or maintaining sustainability.

8.10.2.4 Effect on Beneficial Uses and Users

Table 3-9 of the *Salinas River Long-Term Management Plan* (MCWRA, 2019b) 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, threatened, or endangered species, such as the Steelhead Trout

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

Agricultural land uses and users. The depletion of ISW minimum thresholds prevents lowering of groundwater elevations adjacent to certain parts of streams and rivers beyond historical lows. While the measurable objectives are higher, this leaves flexibility for needed groundwater extraction during droughts or periods of low reservoir releases. If the minimum thresholds were higher than these historical levels, it might affect the quantity and type of crops that can be grown in the land adjacent to streams and the ability of crops to withstand droughts.

Urban land uses and users. The depletion of ISW minimum thresholds prevents lowering of groundwater elevations adjacent to certain parts of streams and rivers beyond historical lows. While the measurable objective is higher, this leaves flexibility for needed groundwater extraction during droughts or periods of low reservoir releases. If the minimum thresholds were higher than these historical levels, it may limit the amount of urban pumping near rivers and streams, which could limit urban growth in these areas to historical levels. Also, if pumping is limited beyond historical levels, 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 ISW minimum thresholds protects existing domestic land users and uses near locations of interconnected surface water from groundwater elevation declines below historical lows by maintaining shallow groundwater elevations near streams and protecting the operability of relatively shallow domestic wells.

Ecological land uses and users. The depletion of ISW minimum thresholds addresses ecological uses and users by preventing depletion of interconnected surface water from groundwater pumping beyond what was historically experienced. Additionally, by setting future groundwater levels at or above recent lows, there should be less impact to ecological users than has been seen to date.

8.10.2.5 Relation to State, Federal, or Local Standards

There are no explicit federal, state, or local standards for depletion of ISW. However, both state and federal provisions call for the protection and restoration of conditions necessary for endangered and threatened species.

8.10.2.6 Method for Quantitative Measurement of Minimum Threshold

The SVIHM is used to preliminarily identify areas of ISW and will help determine when any flow in a river is primarily due to conservation releases from Nacimiento and San Antonio reservoirs. Groundwater elevations measured in shallow wells adjacent to these areas of ISW will serve as the primary approach for monitoring depletion of ISW. As discussed in Chapter 7, an existing shallow well will be added, or a new shallow well will be installed to monitor groundwater elevations adjacent to surface water bodies during GSP implementation.

The new shallow monitoring well installed pursuant to the GSP will not have data from 2015. A minimum threshold for that well will be estimated by either correlation with nearby deeper wells with water-level records that include 2015, or from groundwater model results.

8.10.3 Measurable Objectives

The measurable objectives for depletion of ISW target groundwater elevations that are higher than the minimum thresholds. The measurable objectives are established to maintain consistency with the chronic lowering of groundwater elevation and reduction in groundwater storage minimum thresholds, which are also established based on groundwater elevations.

> *The measurable objectives for depletion of interconnected surface water are established by proxy using shallow groundwater elevations near locations of interconnected surface water and are set to 75% of the distance between 2015 and 1998 shallow groundwater elevations.*

8.10.3.1 Methodology for Setting Measurable Objectives

The 2015 groundwater elevations are the minimum thresholds, and 1998 groundwater levels were considered the highest reasonable groundwater elevation. To provide adequate operational flexibility during droughts and to mimic historical hydrograph patterns, the measurable objective was set 75% of the way up from 2015 groundwater elevations.

8.10.3.2 Interim Milestones

The interim milestones leading to the depletion of ISW measurable objectives will be added when the monitoring network is established.

8.10.4 Undesirable Results

8.10.4.1 Criteria for Defining Undesirable Results

By regulation, the depletion of ISW undesirable result is a quantitative combination of minimum threshold exceedances. The undesirable result for depletion of ISW is:

> *There is an exceedance of the minimum threshold in a shallow groundwater monitoring well used to monitor interconnected surface water.*

Streamflow depletion in the Subbasin is complicated by many factors, such as reservoir releases, recharge of the aquifer from streamflow, losses to vegetation, and ET. The ISW SMC applies to depletion of ISW from groundwater use. For SGMA compliance purposes, the default assumption is that any depletions of surface water beyond the level of depletion that occurred prior to December 2015, as evidenced by reduction in groundwater levels, represent depletions that are significant and unreasonable. Any additional depletions of surface water flows caused by groundwater conditions in excess of conditions as they were in December 2015 would likely be an undesirable result that must be addressed under SGMA. There is currently no biological opinion or habitat conservation plan that indicates additional protection is needed for species protected under the Endangered Species Act; however, if it is determined that additional protection is needed and streamflow loss is due to groundwater extraction not surface water flows, SVBGSA will adapt as necessary to adhere to environmental laws.

8.10.4.2 Potential Causes of Undesirable Results

Conditions that may lead to an undesirable result for the depletion of ISW include the following:

- **Localized pumping increases**. Even if the Subbasin is adequately managed at the Subbasin scale, increases in localized pumping near ISW 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 flows, releases at low levels could cause undesirable results. The ability to avoid undesirable results for interconnected surface waters is partially dependent on reservoir releases.
- **Departure from the GSP's climatic assumptions, including extensive, unanticipated drought**. Minimum thresholds were established based on anticipated future climatic conditions. Departure from the GSP's climatic assumptions or extensive, unanticipated droughts may lead to excessively low groundwater elevations that increase surface water depletion rates.

8.10.4.3 Effects on Beneficial Users and Land Use

The depletion of ISW undesirable result is to have no net increase in surface water depletion due to groundwater use beyond December 2015 levels, as determined by shallow groundwater elevations. The effects of undesirable results on beneficial users and land use are the same as the effects of minimum thresholds on beneficial uses and users, as described in Section 8.10.2.4.

SVBGSA will work with National Marine Fisheries Service and MCWRA to further evaluate the effects of the ISW measurable objectives, minimum thresholds, and undesirable results on surface water flows and beneficial users.

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