4 BASIN SETTING BASED ON NEW INFORMATION

This section evaluates the basin setting based on new information or changes in basin water use within the 180/400 Subbasin. As a preface to the SMC, Section 2.1 describes the basin conditions that impact water use and summary of water use and supply changes. This section builds on that by describing updates to the understanding of the basin setting, including the HCM, groundwater conditions, water budget, and groundwater flow modeling.

4.1 Updated Hydrogeologic Conceptual Model

SVBGSA updated the HCM with new data that became available during the evaluation period. The Salinas Valley Deep Aquifers Study (M&A, 2024a) included data collection that mapped the extent of the Deep Aquifers and analyzed hydrogeological relationships. In addition, new AEM data, aquifer property data, and analysis of water chemistry informed a revised understanding of the Subbasin's HCM that largely filled the HCM data gaps identified in the GSP.

4.1.1 Salinas Valley Deep Aquifers Study

The Deep Aquifers increasingly provide vital groundwater resources for drinking water, irrigation, and industrial use in the Salinas Valley. When shallower wells become intruded with seawater, replacement wells have been drilled into the Deep Aquifers. While only 5% of water use in the 180/400 Subbasin comes from the Deep Aquifers, the communities of Castroville, Marina, and Salinas all depend significantly on the Deep Aquifers for their drinking water supplies. Groundwater elevations in the coastal Deep Aquifers area have declined significantly over the past 2 decades. Previous studies have pointed to the need to monitor and manage the Deep Aquifers due to declining groundwater elevations and resulting risk of seawater intrusion (Feeney and Rosenburg 2003, MCWRA 2017, MCWRA 2020).

The Salinas Valley Deep Aquifers, completed in April 2024, focused on key questions about the HCM to inform management. It developed the first definition of what constitutes the Deep Aquifers, collected additional AEM data, and brought together multiple types of data to delineate the extent of the Deep Aquifers. The Deep Aquifers definition was primarily based on the presence of a continuous aquitard between the 400-Foot Aquifer or its stratigraphic equivalent and the Deep Aquifers. The Study found the Deep Aquifers extends into 6 subbasins of the Salinas Valley.

Using the best available groundwater flow models, the Study completed the first water budget of the Deep Aquifers, dividing them into 3 regions based on geology, water chemistry, a groundwater level divide, and amount of available data. Most extraction occurs in either the Seaside Subbasin or the coastal 180/400 and Monterey Subbasins, in part due to seawater intrusion in the overlying aquifers. Very little extraction occurs, and limited data has been collected, from the Deep Aquifers south of the City of Salinas.

While there is likely subsurface inflow and outflow with adjacent and overlying aquifers, the rate of flow is slow. The Study collected and analyzed isotope data and found no evidence of modern-day (post-1953) surficial recharge reaching the Deep Aquifers. A previous 2002 study (Hanson *et al.*, 2002) age-dated coastal Deep Aquifers water near the City of Marina at 25,000 years old.

SVBGSA presented the findings to the Boards of agencies with jurisdiction over the Deep Aquifers, including the Boards of the SVBGSA, Marina Coast Water District GSA, MCWRA, and the County of Monterey Board of Supervisors. These agencies have formed a Deep Aquifers Agencies Working Group to develop recommended actions to manage the Deep Aquifers. The Study provides 12 pieces of guidance aimed at halting further degradation and improving groundwater elevations to prevent seawater intrusion and subsidence. These focus on providing science-based principles to guide management where there is sufficient data for managing the Deep Aquifers. The guidance does not extend to policy decisions, the type of management actions or projects to implement, or how the guidance should be applied, as those are beyond the Study scope. The working group is planning to bring policy and implementation recommendations to their respective Boards in 2025, as well as recommendations for refining the existing monitoring networks to track trends, identify changes, and enhance the understanding of groundwater conditions.

4.1.2 Geology, Extents, and Hydrogeology Updates

During this evaluation period, SVBGSA focused on filling data gaps and updating the hydrostratigraphic framework section of the HCM in the 180/400 and other subbasins. SVBGSA reviewed new data and identified priorities for further analysis. Multiple data sources were brought together to refine the understanding of the extents, thicknesses, and connectivity between the aquifers. The effort brought data sources together in the 3D visualization software Leapfrog to enable refinement of groundwater flow model layers.

Data included in hydrostratigraphic framework update analysis:

- Published reports – further review of reports including the Fort Ord Investigation (Harding ESE, 2001), the El Toro Groundwater Study (Geosyntec, 2007), Toro Study Follow up Cross-Sections (GeoSyntec, 2010), Deep Aquifers Tech Memo (Feeney and Rosenberg, 2003), North Salinas Valley Hydrostratigraphy (Kennedy/Jenks, 2004), the Monterey Bay Seismic Study (Maier, *et al.*, 2016), and the Hydrological Report of the Deep Aquifers (Thorup, 1976-1983).
- Geophysical data – AEM surveys including DWR Survey Area 1, DWR Survey Area 8, and the Salinas Valley Deep Aquifers Study

- Offshore geophysical data – USGS 2016 Seismic Data in Monterey Bay
- Well completion reports, lithologic logs, and borehole geophysical logs

To update the aquifer and aquitard extents, data were reviewed together in Leapfrog to compare and adjust stratigraphy. Previous groundwater flow model layers were compared to and adjusted based on the new data. Lithologic logs were analyzed and juxtaposed with other geologic data to refine specific areas of the subsurface. Additional studies were also incorporated, such as MCWRA's mapping of thin spots and holes in the 180/400 Aquitard. Groundwater model layers were adjusted and smoothed within Leapfrog based on selection of data to anchor revisions.

Key results include:

- Offshore bedrock and hydrostratigraphy was refined based on updated surface geology maps that showed outcrops of the geologic formations in the Monterey Canyon, the 2016 USGS Seismic study, and current bathymetry.
- The bedrock surface, which includes the Monterey Shale and/or crystalline rocks, was improved based on the 2016 USGS Seismic study and oil exploration well borings, which included data points down the axis of the Valley.
- The lateral and vertical extent of the 400/Deep Aquitard and Deep Aquifers was refined based on the AEM data and lithologic log analysis. The Deep Aquifers extends across most of the Subbasin, and the 400/Deep Aquitard is deeper than previously mapped in the southern part of the Subbasin.
- Holes and thin spots in the 180/400 Aquitard that had been mapped by MCWRA (2017) were included in the layering refinements, as they may impact the relationship of seawater intrusion across or between the 180-Foot and 400-Foot Aquifers.
- Coastal aquitard extents and depths were revised working together with MCWD GSA, and transition zones were noted for modeling in areas of uncertainty between data points.
- The Salinas Valley Aquitard (SVA) extent was updated with new data, and laterally equivalent clays from other sources were also analyzed, to better represent where clays inhibit connectivity between surface water and the 180-Foot Aquifer.
- Some refinements in areas outside of the 180/400 Subbasin also affected the understanding of groundwater conditions within the Subbasin, such as the granite bedrock being shallower in the northern Eastside Subbasin than previously documented and bedrock uplift that separates groundwater in the El Toro part of the Corral de Tierra Management Area from the Toro Park and 180/400 Subbasin.

The data, methods, and findings of the aquifer framework update are attached in Appendix 5A.

4.1.3 Aquifer Properties Updates

During this evaluation period, existing aquifer property data were compiled from literature, agencies, and regional numerical groundwater flow models for the Salinas Valley. In addition, 2 aquifer tests were conducted for the Deep Aquifers Study. The deep wells that were tested were located just outside the 180/400 Subbasin boundary with the Eastside Subbasin; however, the test results still provide information for aquifer properties at similar depths and adjacent to the Deep Aquifers in the 180/400 Subbasin. Additional aquifer test data were compiled from DWR, the CSIP wells, and from previous studies for developing and calibrating the Salinas Valley Seawater Intrusion Model (M&A, 2023).

Hydraulic conductivity measurements vary within aquifers both horizontally and vertically. Measurements within a single aquifer can range by multiple orders of magnitude. Hydraulic conductivity measurements range from less than 1 to about 1,400 feet/day for the 180-Foot Aquifer, from less than 1 to about 500 feet/day for the 400-Foot Aquifer, and from 2 to 44 feet/day for the Deep Aquifers, based on values reported in the Seawater Intrusion Model report (M&A, 2023), the Deep Aquifers Study report (M&A, 2024a), and the well installation report for the new monitoring wells previous described in Section 1 (M&A, 2024b). This updated information is useful for updating groundwater models and evaluating impacts of PMAs.

4.1.4 Groundwater Chemistry Updates

In the 2020 GSP and GSP Amendment 1, the HCM included general mineral chemistry for the Subbasin, undifferentiated by aquifers. Building on the analysis in the Deep Aquifers Study, the HCM update completed for this GSP 2025 Evaluation develops a dataset of the groundwater chemistry by aquifer.

Figure 4-1 shows a trilinear diagram for the most recent sample in selected wells across the 180-Foot, 400-Foot, and Deep Aquifers. Analysis of water chemistry type according to the major cations and anions shows that the groundwater in the 180-Foot and 400-Foot Aquifers are of similar composition. The Deep Aquifers groundwater chemistry is generally distinct from the overlying aquifers, except for in a few wells that have similar composition to the overlying aquifers. Groundwater in each principal aquifer is generally of a mixed water type since they do not fit discretely within a single water type classification. There are some key differences between the 180-Foot and 400-Foot Aquifers as compared to the Deep Aquifers. The chemical compositions in both the overlying aquifers are relatively high in calcium and low in sodium concentrations compared to the Deep Aquifers. Differences in chemistry is due to the differing geochemistry of the aquifer sediments, amount of mixing between aquifers, and the residence time for groundwater interactions with the aquifer sediments. These results suggest greater mixing between the 180-Foot and 400-Foot Aquifers than with the Deep Aquifers; however, there may be some limited mixing of Deep Aquifers groundwater, such as where there is either leakage across the aquitard clays or hydraulic connection with adjacent aquifers.

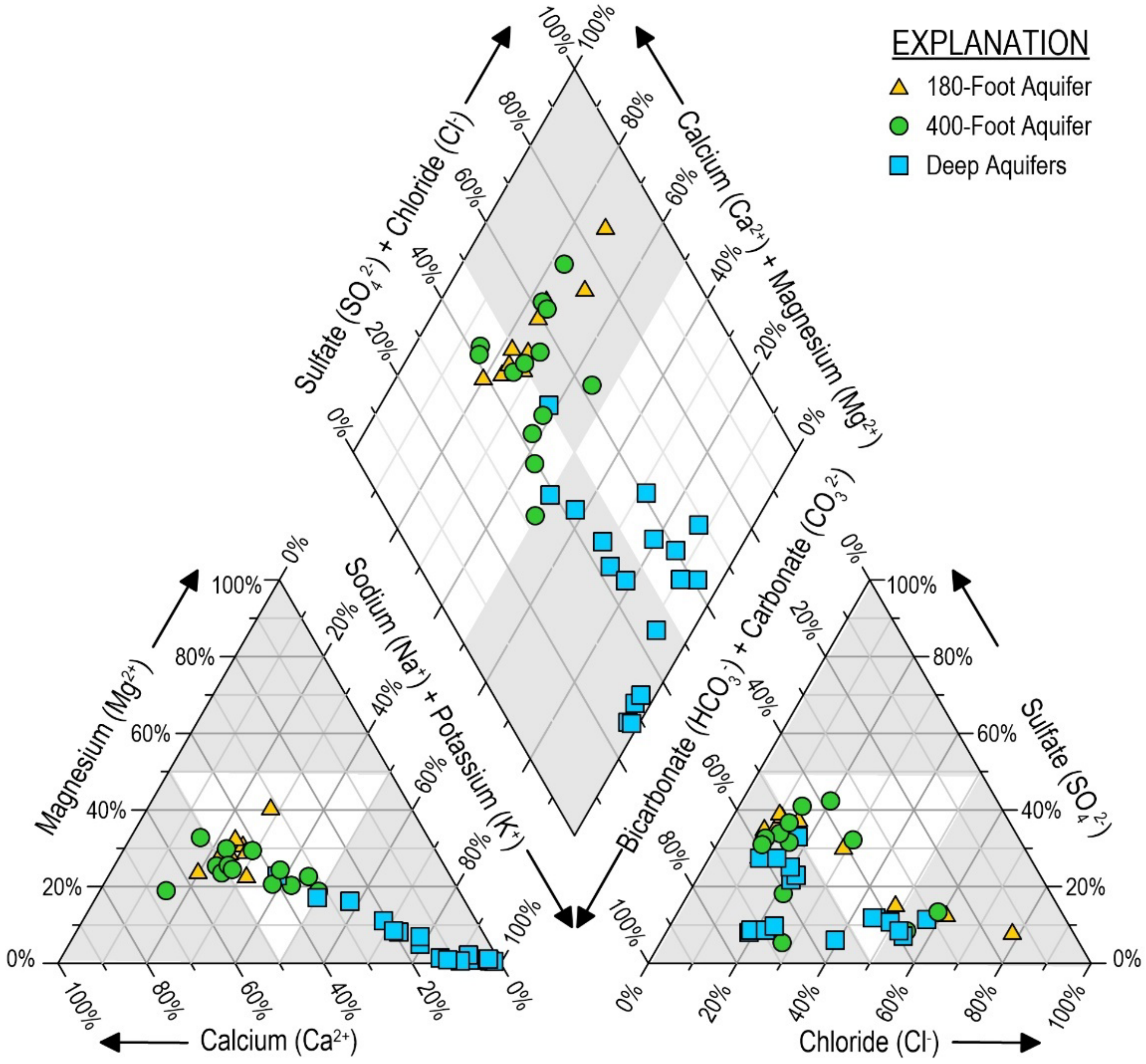

Figure 4-1. Trilinear Diagram for Most Recent Groundwater Samples in Select Wells in the 180-Foot, 400-Foot, and Deep Aquifers

4.2 Updated Groundwater Conditions

During the evaluation period, SVBGSA worked to improve the understanding of regional groundwater conditions. Efforts are underway to reconcile groundwater quality sources and field verify GDEs.

4.2.1 Groundwater Quality

The understanding of regional groundwater quality conditions has not significantly changed in the past 5 years.

In 2024, 2 new MCLs were published that have bearing on the Subbasin's groundwater quality monitoring. In the WY 2022 Annual Report, hexavalent chromium was identified as a COC, its minimum threshold was established using the preliminary maximum contaminant level (MCL) of 10 µg/L for drinking water. In April 2024, the State adopted the concentration of 10 µg/L as the MCL for hexavalent chromium. Furthermore, PFAS had MCLs established by the U.S. Environmental Protection Agency (EPA) in April 2024. Public water systems are required to monitor for PFAS and have until 2027 to complete initial monitoring, followed by ongoing compliance monitoring. PFAS will be added as a COC and concentrations will be reported in the WY 2024 Annual Report. No other new COCs have been identified.

4.2.2 Groundwater Dependent Ecosystems

The 2020 GSP identified potential GDEs through Natural Communities Commonly Associated with Groundwater (NCCAG) Dataset. GSP Amendment 1 included a more robust section (Section 4.4.5.2) that added information summarizing known information about GDEs within the Salinas Valley.

As described in 2.1.3, DWR Recommended Corrective Action 3 asked SVBGSA to clarify its plan to conduct necessary field reconnaissance for GDE identification and report on the results. CCWG has further developed a methodology for SVBGSA to identify, assess, and monitor potential GDEs. GDE Identification and a GDE Monitoring Standard Operating Procedures (SOP) are attached as Appendix 5B. The NCCAG dataset was filtered to reflect local habitat and groundwater conditions. Areas were excluded that were disconnected from the principal aquifers by the Salinas Valley Aquitard. Areas were also excluded if groundwater levels were considered too deep to be a water source for overlying vegetation (30 feet below ground surface for most vegetation, 80 feet below groundwater surface for Oak-dominated habitats). Specific vegetated areas were not excluded if they were identified by the community as ecosystems of importance that should be monitored regardless of their water source. While ecosystems are categorized as GDEs, they likely rely on surface water sources in addition to groundwater.

GDEs were categorized into "GDE Units" based on similar underlying hydrogeology. To determine which GDEs have the greatest habitat value it is recommended to identify which GDEs are drought refugia, have recent observations of threatened and endangered species, and/or are nominated as ecologically important by local subject matter experts (Rohde *et al.*, 2024).

Drought refugia are areas of habitat that stay wet and/or green for longer than their surroundings. By staying wet and green for longer these refugia continue to provide quality habitat for species when the surrounding areas have become too dry to be suitable habitat, thus providing a resource for maintaining sensitive species' populations through periods of drought. Researchers have developed a robust methodology for identifying drought refugia across California and have made their findings publicly available (Rhode *et al.*, 2024). Wherever drought refugia in this dataset overlap with identified GDEs, those GDEs were included in the subset for additional field-based monitoring. In 2024, CCWG conducted field-based monitoring at 4 sites in the Subbasin (with 16 sites to be monitored by the end of 2024) that sets a baseline to which future field assessments are compared, and if potential GDEs are found to be in decline it would trigger a groundwater assessment of whether and to what extent the decline is likely due to groundwater conditions.

Future monitoring of identified GDEs will consist of a desktop-based component, where vegetation vigor is monitored for all GDEs using satellite imagery, and a field-based component, where the habitat condition of a subset of GDEs will be assessed using the California Rapid Assessment Method (CRAM). Within the GDE Units, locations were selected for CRAM based on ecological importance and proximity to existing monitoring well, if applicable.

Remote sensing of vegetation will determine if it is uncharacteristically water stressed. An initial SOP for monitoring using remote sensing is proposed by CCWG, and it will be updated in 2025 to include water stress factors for areas of drought refugia and additional factors to be considered for the main stem of the Salinas River, including releases form Nacimiento and San Antonio reservoirs. CRAM scores will be tracked with an emphasis on the Biological Structure attribute of the tool, as that is expected to be most reflective of changes in the water supply available to support vegetation. Any substantial decrease in CRAM scores should not automatically be attributed as an adverse impact due to groundwater management, and instead be considered a flag to investigate the root cause of the decrease.

Additionally, locations for additional shallow groundwater table monitoring wells will be recommended. These additional wells will ideally be located next to GDEs with CRAM assessments to help determine if there is a relationship between habitat condition and groundwater levels. GDEs for which monitoring indicates a negative impact threshold has been crossed will be flagged for additional investigation into whether this impact was caused by groundwater management activities. The location of GDEs, the monitoring methods, and assessment impact thresholds will be updated iteratively as additional information becomes available and pilot monitoring and assessment efforts are completed.

4.3 Model Updates

Since GSP development, the development and updates of local groundwater flow models have advanced significantly, providing improved tools to assess and plan for actions to reach sustainability. SVBGSA uses 2 groundwater flow models for the 180/400 Subbasin: the SVIHM, including its predictive version the SVOM, and the Salinas Valley Seawater Intrusion Model

(Seawater Intrusion Model). The 2 models have separate and distinct purposes. The SVIHM and SVOM are regional models used for surface water and groundwater planning throughout the Salinas Valley. The Seawater Intrusion Model focuses on managing seawater intrusion and covers the north end of the Salinas Valley.

During the evaluation period, the USGS released additional provisional versions of the SVIHM and SVOM, and SVBGSA and the County of Monterey completed development of, and updates to, the Seawater Intrusion Model. Figure 4-2 shows the extent of the models in relation to the 180/400 Subbasin.

The USGS is nearing completion of the SVIHM and SVOM. During the evaluation period, the USGS released several provisional model versions. For drafting GSP Amendment 1, SVBGSA used a preliminary version of the SVIHM that was consistent with the version used for the 2022 Eastside, Forebay, Langley, and Upper Valley Subbasin GSPs. Details on the SVIHM and SVOM can be found in the USGS Progress Report: Overview of Salinas Valley Models (2021), GSP Amendment 1 Appendix 6A. The USGS are on track to release the final version in February 2025. The most recent version was released in May 2024 and was used to draft the water budget for this GSP 2025 Evaluation. Key model revisions addressed in the most recent version, compared to the version used in the GSP, include the following:

- There is improved calibration of groundwater elevations.
- There is an improved match to reported agricultural pumping. The SVIHM does not include specified agricultural pumping, and instead dynamically estimates agricultural pumping based on land use and climate data.
- There are modifications to specified municipal and industrial pumping.

SVBGSA applied for and received SGM Implementation Grant Funding for SVIHM revisions, anticipated to be completed in 2025. Development of the SVIHM predated GSP development, and key revisions will improve the model for groundwater management purposes. In addition, SVBGSA plans to update the SVIHM according to the Deep Aquifers Study and HCM Updates.

SVBGSA and the County of Monterey funded development of the variable density Seawater Intrusion Model to better assess and address future seawater intrusion. M&A completed the initial version of the Seawater Intrusion Model in March 2023 and an update in November 2024. Details of model development and calibration can be found at: https://svbgsa.org/resources/seawater-intrusion/salinas-valley-seawater-intrusion-model/. During the evaluation period, M&A completed 2 updates that accomplished the following:

- Improved the groundwater elevation calibration
- Better reflected lack of observed seawater intrusion in the Seaside Subbasin

- Incorporated the Deep Aquifers Study findings and HCM updates, including working with MCWD GSA to reach agreement on stratigraphy

SVBGSA has begun to use the provisional SVOM and Seawater Intrusion Model for project feasibility studies.

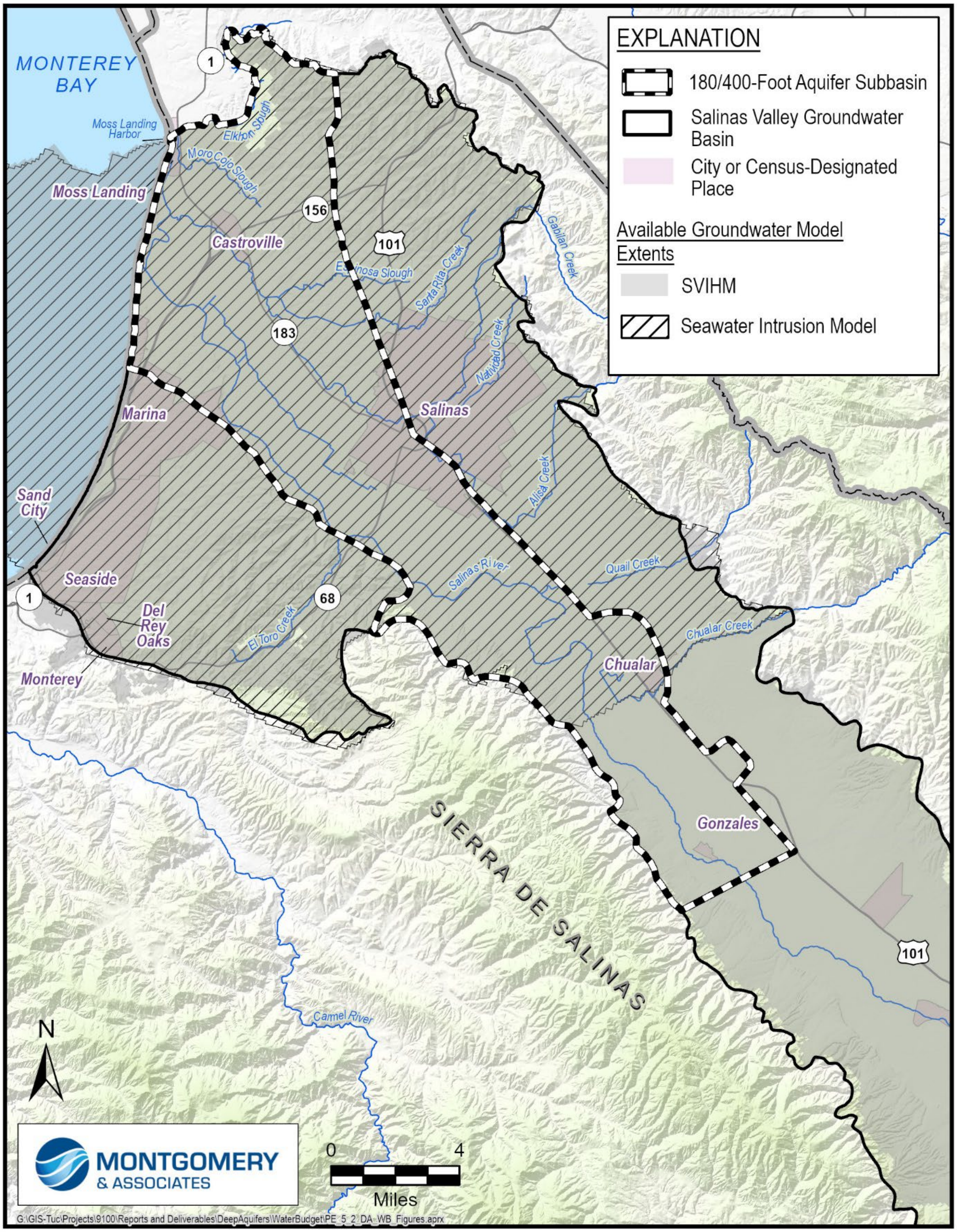

Figure 4-2. Groundwater Flow Model Areas

4.4 Water Budget and Comparison to Water Use

SVBGSA updated the water budgets for the 180/400 Subbasin with the most recent provisional version of the SVIHM for the historical and current water budgets, and used the SVOM for the projected water budget. These are the only models that cover the entire Subbasin. The updated historical, current, and projected water budgets are included in Appendix 5C, and are summarized in the sections below. As noted in Section 4.3, these are developed with versions of the SVIHM and SVOM that are more recent than the models used in GSP Amendment 1. SVBGSA plans to update the SVIHM and SVOM in 2025, and therefore, while these are the most accurate water budgets, they should be considered interim.

4.4.1 Updated Historical and Current Water Budget

SVBGSA develops historical and current water budgets by running the Valley-wide SVIHM and assessing groundwater inflows and outflows in the 180/400 Subbasin. Similar to water budgets developed with previous model versions, it shows that while inflows and outflows vary year to year, the Subbasin is in overdraft on average, leading to a long-term decline of groundwater in storage.

The historical water budget time period is 1980-2018 and the current water budget time period is the last 2 years of the SVIHM, 2017-2018. Of note, 2017 had significantly more precipitation than 2016, resulting in more recharge and less groundwater pumping. Therefore, the current water budget change in groundwater storage is much higher than the long-term average change in storage. Appendix 5C details the historical and current water budget.

The main groundwater inflows into the Subbasin are deep percolation of precipitation and irrigation water, subsurface inflow from adjacent groundwater basins and subbasins, and stream recharge. The predominant groundwater outflows are groundwater pumping, subsurface outflow, and evapotranspiration. Discharge to streams is too small to be seen on the figure below.

Figure 4-3 shows the entire historical groundwater water budget from the SVIHM, including annual change in groundwater storage shown by the purple line. The black line on this figure is the cumulative change in storage. As shown by the purple line, annual changes in groundwater storage are strongly correlated with changes in deep percolation of precipitation. For example, 1983 and 1998 were comparatively very wet years with significant precipitation and stream percolation. These years correspondingly show the greatest increases in groundwater storage during the historical period. Estimated cumulative change in groundwater storage has steadily declined over time with slight increases in response to wet periods.

The change in storage shown on Figure 4-3 only represents change in storage due to groundwater level change. As noted earlier, the change in storage SMC accounts for change in storage from both groundwater level change and seawater intrusion.

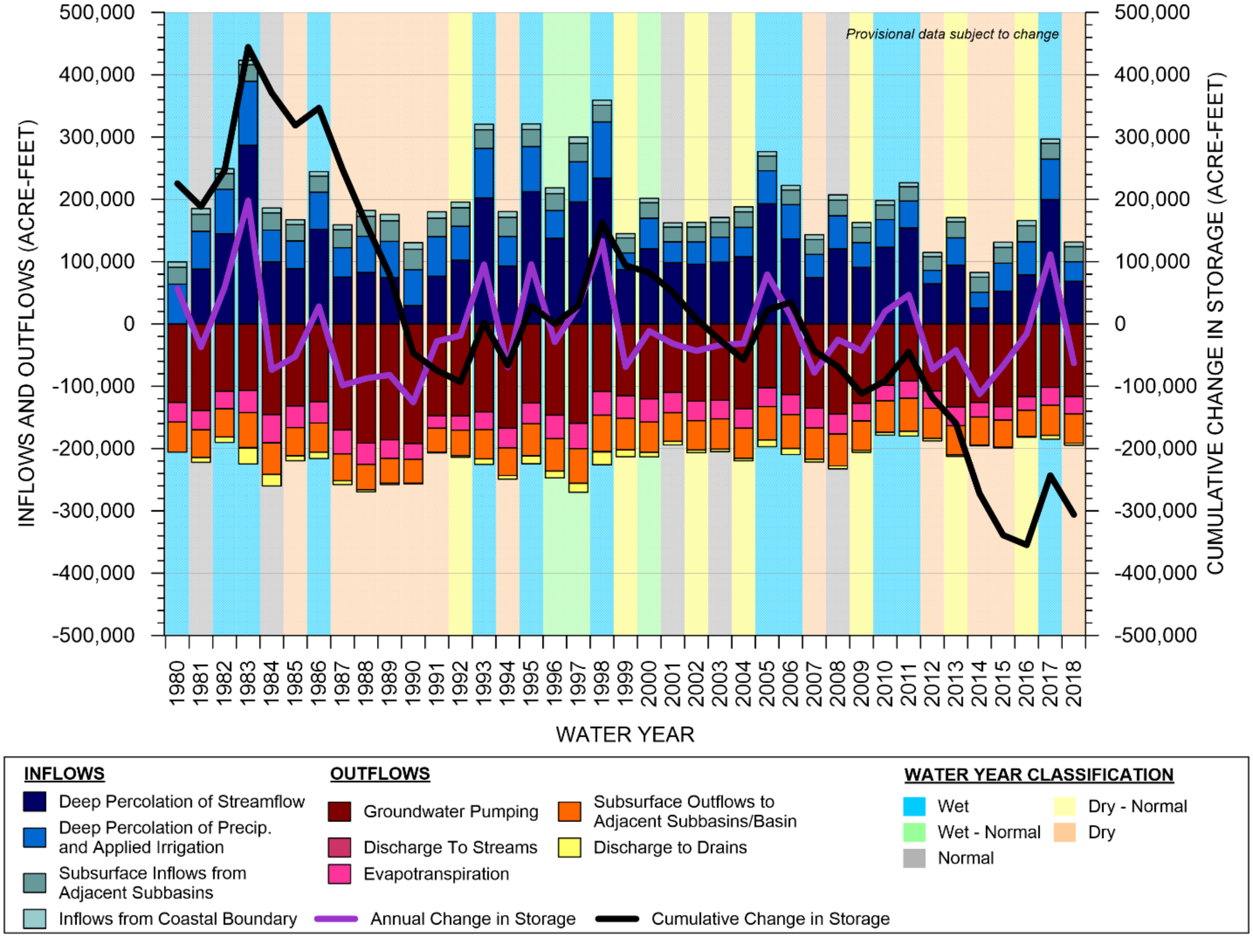

Figure 4-3. SVIHM Simulated Historical and Current Groundwater Budget

The SVIHM estimated the historical average annual decline in storage due to change in groundwater levels was 10,100 AF/yr, which is significantly greater than estimated using measured groundwater level data, as calculated in GSP Amendment 1. Storage estimates will be refined with future model improvements.

A comparison of the historical and current groundwater budgets is shown in Table 4-1. Negative values indicate outflows or depletions. Historical average decline in storage (overdraft) due to groundwater elevations was 10,100 AF/yr. Groundwater flow across the coastline is shown in Table 4-1 as an inflow; however, the SVIHM does not account for water quality. This inflow of saline groundwater into the Subbasin contributes to the loss in usable storage within the subbasin. This table helps show the relative magnitude of various water budget components; however, these results are based on a provisional model and will be updated after the SVIHM is completed and released by the USGS.

The current water budget change in storage is significantly higher than the historical average due to WY 2017 being a wet water year after the 2014-2016 drought. It is not indicative of a change in the average trend of declining groundwater in storage.

Table 4-1. Summary of Groundwater Budget

	Historical Average (WY 1980-2018) (AF/yr)	Current (WY 2017-2018) (AF/yr)
Net Inflows		
Net Stream Exchange (Deep Percolation of Streamflow – Discharge to Streams)	120,700	138,200
Deep Percolation of Precipitation and Applied Irrigation	52,200	48,200
Net Coastal Inflow	7,800	6,900
Net Outflows		
Groundwater Pumping	-131,400	-109,100
Net Flow from Adjacent Subbasins/Basin	-21,200	-22,800
Discharge to Drains	-7,200	-4,500
Groundwater Evapotranspiration	-31,200	-28,500
Net Change In Storage (overdraft)		
Change in Storage due to Groundwater Levels	-10,100	28,700

Note: provisional data subject to change. This groundwater model does not factor in loss of usable storage due to seawater intrusion. The water budget does not balance exactly due to a combination of model error and presenting rounded water budget components.

Sustainable yield is the amount of Subbasin-wide pumping that results in no undesirable results. For this GSP 2025 Evaluation, sustainable yield is estimated by balancing the water budget, resulting in no net decrease in storage of usable groundwater, including both due to groundwater levels and seawater intrusion. This estimate of sustainable yield can guide groundwater management on a subbasin level. However, outflows may need to be reduced or inflows need to be increased in localized areas to meet the sustainability goal. Furthermore, sustainable yield does not account for water budget changes that may be needed to address seawater intrusion.

The sustainable yield can be estimated as:

Sustainable yield = pumping + change in storage due to groundwater levels + change in storage due to seawater intrusion

Table 4-2 provides an estimate of sustainable yield based on results from the SVIHM. The simulated change in groundwater storage is used for this calculation, as well as an estimate of seawater intrusion described in Appendix 5C. The total estimated loss of useable storage for the Subbasin is 22,700 AF/yr, which is the sum of seawater intrusion (12,600 AF/yr loss) and net storage loss due to groundwater level changes (10,100 AF/yr). Using this estimate of loss in storage, the best estimate of sustainable yield for the Subbasin is 108,700 AF/yr. There is uncertainty in this estimate. In addition to the caveats listed above, and the inherent uncertainty that exists in all numerical models, this estimate is based on results from a provisional version of the SVIHM. Sustainable yield estimates will be refined and improved upon when the final version of the SVIHM is released, and subsequently updated.

Table 4-2. Historical Sustainable Yield within the 180/400 from Simulated Pumping and Change in Storage, and Mapped Seawater Intrusion Areas

	Historical Average (WY 1980-2018) (AF/yr)
Total Subbasin Pumping	131,400
Change in Storage due to Groundwater Levels	-10,100
Change in Storage due to Seawater Intrusion	-12,600
Estimated Sustainable Yield	108,700

Note: Pumping is shown as positive value for this computation. Change in storage and pumping values are based on the SVIHM and seawater intrusion is based on mapped areas of intrusion, as previously described in the text.

4.4.2 Updated Projected Water Budget

An updated version of the SVOM was used to develop the 2070 projected water budget. It shows anticipated conditions by the end of the 50-year GSP planning and implementation horizon if current management and land use continues. It may be used to help plan projects and management actions, along with other tools and analyses. These future baseline conditions include hydrology, water demand, and surface water supply over 51 years of potential future conditions. Following DWR guidance on incorporating climate change, the projected water budget is the average of 51 simulated likely hydrologic years that may occur in 2070. Similar to water budgets developed with previous model versions, it shows that while inflows and outflows vary year to year, the Subbasin will continue to be in overdraft on average, unless additional projects and management actions are undertaken.

Appendix 5C details the projected water budget.

The main groundwater inflows into the Subbasin are deep percolation of precipitation and irrigation water, subsurface inflow from adjacent groundwater basins and subbasins, and stream recharge. The predominant groundwater outflows are groundwater pumping and evapotranspiration.

The SVOM estimated the 2070 average annual decline in groundwater in storage due to change in groundwater levels to be -2,300 AF/yr. This is less than in the historical water budget, likely due to additional precipitation and recharge associated with the applied climate change assumptions. Storage estimates will be refined with future model improvements.

The projected groundwater budget is shown in Table 4-1. Negative values indicate outflows or depletions. Projected average decline in storage (overdraft) due to groundwater elevations is -2,300 AF/yr. Average annual loss of groundwater storage due to changes in groundwater levels is less in the projected water budget than in the historical water budget, even though there is no change in land use. Loss of annual groundwater storage is likely due primarily to the applied climate change assumptions. The DWR climate change scenario generally includes warmer and wetter conditions, which has greater precipitation and streamflow and increases agricultural groundwater pumping due to higher evapotranspiration.

Groundwater flow across the coastline is shown as an inflow; however, the SVIHM does not account for water quality. This inflow of saline groundwater into the Subbasin contributes to the loss in usable storage within the Subbasin, but is different from the advancement of the 500 mg/L chloride isocontour that typically denotes seawater intrusion. This table helps show the relative magnitude of various water budget components; however, these results are based on a provisional model and will be updated after the SVOM is completed and released by the USGS.

Table 4-3. Average SVOM Projected Annual Groundwater Budget with Climate Change Conditions

	2070 Projected Groundwater Budget Components (AF/yr)
Net Inflows	
Net Stream Exchange	127,900
Deep Percolation of Precipitation and Applied Irrigation	71,600
Net Coastal Inflow	8,000
Net Outflows	
Groundwater Pumping	-147,300
Net Flow from Adjacent Subbasins/Basin	-20,200
Flow to Drains	-8,600
Groundwater Evapotranspiration	-36,800
Net Change In Storage (overdraft)	
Change in Storage due to Groundwater Levels	-2,300

Note: provisional data subject to change. The water budget does not balance exactly due to a combination of model error and presenting rounded water budget components.

Similar to the historical sustainable yield, the projected sustainable yield is the amount of Subbasin-wide pumping that results in no undesirable results. For this GSP 2025 Evaluation, sustainable yield is estimated by balancing the water budget, resulting in no net decrease in storage of useable groundwater, including both due to groundwater levels and due to seawater intrusion. This estimate of sustainable yield can guide groundwater management on a subbasin level. However, outflows may need to be reduced or inflows increased in localized areas to meet the sustainability goal. Furthermore, sustainable yield does not account for water budget changes that may be needed to address seawater intrusion.

The sustainable yield can be estimated as:

$$\textit{Sustainable yield} = \textit{pumping} + \textit{change in storage due to groundwater levels} + \textit{change in storage due to seawater intrusion}$$

Table 4-2 provides an estimate of the average annual 2070 sustainable yield based on results from the SVOM. The simulated change in groundwater storage is used for this calculation, as well as an estimate of seawater intrusion described in Appendix 5C. The total estimated loss of useable storage for the Subbasin is 10,400 AF/yr, which is the sum of seawater intrusion (8,100 AF/yr loss) and net storage loss due to groundwater level changes (2,300 AF/yr). Using this estimate of loss in storage, the best estimate of sustainable yield for the Subbasin is 136,700 AF/yr. There could be significant uncertainty in this estimate. In addition to the caveats listed above, and the inherent uncertainty that exists in all numerical models, this estimate is based on results from a provisional version of the SVOM. Sustainable yield estimates will be refined and improved upon when the final version of the SVOM is released and subsequently updated.

Table 4-4. Average Annual Sustainable Yield for Historical and Projected 2070 with Climate Change Water Budgets

	2070 Projected Sustainable Yield (AF/yr)	Historical Average (WY 1980-2018) (AF/yr)
Total Subbasin Pumping	147,300	131,400
Change in Storage due to Groundwater Levels	-2,300	-10,100
Change in Storage due to Seawater Intrusion	-8,100	-12,600
Estimated Sustainable Yield	136,700	108,700

Note: Pumping is shown as positive value for this computation. Change in storage and pumping values are based on the SVIHM and seawater intrusion is based on mapped areas of intrusion, as previously described in the text.

4.4.3 Comparison of Simulated Water Use to Reported Water Use

The SVIHM does not extend into the evaluation period; however, a comparison of simulated and reported extraction shows they are similar. Table 4-5 shows simulated and reported extraction for a variety of timespans: the historical water budget period (1980-2018), the historical water budget period for which there is reported extraction data (1995-2018), and the current water budget period (2017-2018). It also shows the reported extraction for the evaluation period (2019-2023) and the simulated extraction for the 2070 projected water budget. 2017 was a wet water year, so extraction was lower than average and not indicative of long-term trends in water use. The SVIHM calibration of extraction is considerably improved from prior model versions; however, it slightly underestimates historical pumping in the Subbasin. Future model versions will refine simulated pumping further. In general, the model simulates pumping accurately enough for the purpose of developing water budgets.

Prior to 1998, all water used in the Subbasin came from groundwater extraction. In 1998, CSIP began delivering a combination of recycled water and groundwater for irrigation in the coastal area of the Subbasin. In 2010, surface water diversions were added to the CSIP supply. The shift in supply contributed to the decline in extraction from the full historical period to more recent years. Increases in efficiency also contribute to changes in water use.

The 2070 water budget is simulated with no change to urban pumping and no change in agricultural land use. Agricultural pumping makes up most of the water use in the Subbasin. However, in the SVIHM and SVOM, agricultural pumping is not specified and is dynamically simulated using the Farm Process (Boyce S.E., 2022) based on land use and crop and climate data. Table 4-5 shows that without changes to land use and due to a warmer climate, projected water use is expected to be greater than it is currently, based on the DWR 2070 recommended climate scenario. The SVOM incorporates current reservoir operational rules, with the reservoirs and CSIP functioning as they currently do. These future pumping estimates do not include actions that are taken to achieve groundwater sustainability, and it does not imply the projected level of pumping is sustainable.

Table 4-5. Comparison of Observed and Simulated Groundwater Extraction

	Observed (AF/yr)	Simulated (AF/yr)	Commentary
Historical Water Budget (1980-2018)	-	131,400	CSIP began delivering recycled water for irrigation in 1998, and added surface water diversions in 2010. Prior to then, groundwater fulfilled irrigation needs in the CSIP area.
Historical Compared to GEMS (1995-2018)	125,000	121,200	
Current Water Budget (2017-2018)	114,000	109,100	2017 was a wet water year with lower than average extraction
2019-2023 5-year Average	118,000	-	
2070 Projected Water Budget	-	147,300	Simulated with the DWR 2070 recommended climate change scenario

4.4.4 Updated Summary of Mitigation of Overdraft

The updated models provide revised estimates of overdraft and improve the ability to assess efforts to reach sustainability. The 180/400 Subbasin has historically been in overdraft, and it is projected to remain in overdraft throughout the GSP planning horizon unless PMAs are implemented. The long-term overdraft in the Subbasin without PMAs is projected to be 10,400 AF/yr; therefore, PMAs need to be implemented to raise groundwater levels and address seawater intrusion to reach sustainability and then mitigate this long-term overdraft mitigated after sustainability is reached. This updated assessment of overdraft is slightly less than projected in GSP Amendment 1; therefore, the PMAs included as options to mitigate overdraft are still sufficient.

The overdraft can be mitigated by reducing pumping or recharging the Subbasin, either through direct or in-lieu means. The potential projects and management actions identified in GSP Amendment 1 are sufficient to mitigate existing overdraft. These include demand management if other PMAs do not reach sustainability goals and mitigate overdraft. The selected PMAs will ensure that the chronic lowering of groundwater levels or depletion of supply during periods of drought is offset by increases in groundwater levels or storage during other periods. Mitigation of overdraft is not sufficient to reach sustainability because balancing the water budget will not prevent future seawater intrusion. The amount of water needed to mitigate seawater intrusion depends on the approach taken. Furthermore, mitigation of overdraft is an average number based on inflows, outflows, and seawater intrusion across the Subbasin and does not relay depth or spatial variation. Sustainability must be reached across all 6 sustainability indicators.