

The Plan Area participants recognize that there is insufficient data to identify changes in groundwater storage that do not result in subsidence. New lower aquifer monitoring sites are included in the representative groundwater level monitoring network, and data collected during GSP implementation will be used in the future to help calculate volumetric changes in storage.

5.1.3.3 Seawater Intrusion

Legal Requirements:

§354.34(c)(3) Seawater Intrusion. Monitor seawater intrusion using chloride concentrations, or other measurements convertible to chloride concentrations, so that the current and projected rate and extent of seawater intrusion for each applicable principal aquifer may be calculated.

Given the distance separating the Plan Area from the Pacific Ocean, seawater intrusion from the ocean into the freshwater aquifer is not a concern. In addition, there are no saline water lakes in or near the GSA. As a result, seawater intrusion is not discussed hereafter in this chapter.

5.1.3.4 Water Quality

Legal Requirements:

§354.34(c)(4) Degraded Water Quality. Collect sufficient spatial and temporal data from each applicable principal aquifer to determine groundwater quality trends for water quality indicators, as determined by the Agency, to address known water quality issues.

Water quality monitoring is an important aspect of groundwater management in the area and serves the following purposes:

- Spatially characterize water quality according to soil types, soil salinity, geology, surface water quality, and land use
- Compare constituent levels at a specific well over time (i.e., years and decades)
- Assess the extent of groundwater quality problems in specific areas
- Identify groundwater quality protection and enhancement needs
- Assess water treatment needs
- Identify impacts of recharge and surface water use on water quality
- Monitor the migration of contaminant plumes

The questions guiding the Grassland Plan Area Technical Working Group's process for developing the representative water level monitoring network were repeated for the representative water quality network:

Temporal:

- Of the wells within the Grassland Plan Area, which have measurements from at least three years within the period of 2000 to present?
- If a public agency monitors the well, is the responsible agency anticipated to continue to monitor this site?
- Is the well accessible for monitoring?
- Is the well perforated in the primary source aquifer in order to better monitor Grassland Plan Area participants' impacts on the hydrogeology through the implementation period?

Spatial:

- Does the proposed network provide spatial coverage of 1 well per 75 square miles, as recommended in Hopkins and Anderson (2016)?
- Does the proposed network recognize both the upper aquifer and the lower aquifer?

Spatial Coverage

The water quality spatial coverage criteria mimics that of the water level network and exceeds the recommendation under Hopkins and Anderson (2016)) for a minimum density of one monitoring site per 75 square miles. **Figure 5-1** depicts the spatial coverage of the network, which is adequate considering that groundwater pumping within the Grassland Plan Area is significantly less than 100,000 AF and covers the spatial extent of approximately 163 square miles. Additionally, the groundwater level network includes coverage of both the upper and lower aquifer, which will improve data quality and quantity after monitoring of the new or previously unmonitored sites during GSP implementation. The water quality monitoring spatial coverage equals one well per 54 square miles in the upper aquifer and one well per 41 square miles in the lower aquifer.

Supplemental Monitoring

GWD, in cooperation with USBR, the Department of Fish and Wildlife (CDFW), and the United States Fish and Wildlife Service, has implemented a Real-Time Water Quality Monitoring Program (RTWQMP). The RTWQMP currently consists of 30 stations located at major points of acceptance, delivery, canal system confluences, and drainages of the Plan Area. The RTWQMP continuously monitors stage, flow, temperature, pH and salinity (EC). Real-time water quality monitoring data is proofed on a weekly basis through a Quality Assurance Program Plan (QAPP). The QAPP includes site visitations where technicians conduct sensor maintenance, calibration, and instantaneous and redundant flow and EC measurements to ensure that the data is representative and comprehensive. Surface water flow monitoring is evaluated at delivery points depicted in **Figure 5-5**.

5.1.3.5 Land Subsidence

Legal Requirements:

§354.34(c)(5) Land Subsidence. Identify the rate and extent of land subsidence, which may be measured by extensometers, surveying, remote sensing technology, or other appropriate method.

Although significant subsidence has been measured within the Delta-Mendota Subbasin, it has occurred outside of the Grassland Plan Area and has been associated with pumping from the lower aquifer beneath the Corcoran Clay (see this GSP **Section 3.3.3.1**). The upper aquifer serves as the primary source aquifer for the Grassland Plan Area with an insignificant amount of pumping from below the Corcoran Clay. Therefore, groundwater pumping activities within the Plan Area are not expected to contribute to land subsidence, although there is still a need to monitor subsidence that influences the Grassland Plan Area.

The USBR uses a variety of data described in detail in this section for its regional subsidence monitoring network in and around the Plan Area as well as conducts annual ground-truthing activities. USBR utilizes this information to develop subsidence contours. The USBR's subsidence survey benchmarks in the Plan Area and beyond are shown in **Figure 5-4**. Three of these USBR survey benchmarks that are within and adjacent to the Plan Area were identified for the representative monitoring network.

Supplemental Monitoring

See **Figure 5-4** for a compilation of subsidence monitoring locations that may provide supplemental data for the representative subsidence monitoring network identified in **Figure 5-3**. A more detailed discussion of the available subsidence data sources is outlined below.

Subsidence Monitoring Methods and Technology

Several methods for measuring subsidence are available and are discussed below:

Continuous Global Positioning System. Subsidence can be measured using continuous global positioning system (CGPS) data. Various USGS studies obtain CGPS data from the NAVSTAR UNAVCO Plate Boundary Observatory (PBO) network of continuously operating GPS stations. The PBO is the geodetic component of UNAVCO, a consortium of research institutions whose focus is measuring vertical and horizontal plate boundary deformation across the western United States using high-precision measurement techniques. CGPS data is measured to one hundredth of a millimeter with a relatively low standard deviation.

Extensometers. Extensometers measure compaction and expansion of the aquifer system. As the surrounding soils move, the distances between reference points change, which allow for continuous measurement of subsidence. Extensometers are costly to install and require frequent maintenance and calibration. In the 1950s and 1960s, the USGS, DWR, and other agencies installed several borehole extensometers in the San Joaquin Valley. There are presently no known extensometers within the Plan Area. Extensometers have a relative accuracy of approximately 1/100th of a foot.

InSAR. During the last decade, the USGS and other groups have been using data from radar-emitting satellites in a technique called InSAR (interferometric synthetic-aperture radar). This form of remote sensing compares radar images from each pass of an InSAR satellite over a study area to determine changes in the elevation of the land surface. InSAR has a relative accuracy within fractions of an inch.

LiDAR. DWR and USBR utilize Light Detection and Ranging (LiDAR) coupled with land elevation surveys to monitor subsidence. LiDAR utilizes a laser device that is flown above the earth's surface. LiDAR is known to be accurate down to less than a tenth of

a foot as measured in root-mean-square deviation, an accuracy level very similar to that of surveying.

Surveying. In the past, subsidence measurement has relied upon optical (spirit level) surveying devices and laser and global positioning satellite (GPS) survey equipment. This type of measurement is still done today, usually along established highways and water conveyance facilities such as levees and canals. The relative accuracy of GPS surveying is approximately +/- 1 inch.

Subsidence Monitoring Programs

Measurement and monitoring for subsidence are performed by a variety of agencies including USGS, DWR, USBR, USACE, NAVSTAR UNAVCO, and various private contractors.

Continuous Global Positioning System Stations. There are two CGPS Stations near the Plan Area. The CGPS stations provide daily horizontal and vertical data at these locations with records starting as early as 2004. The CGPS stations also show subsidence or uplift at locations near the Plan Area. The PBO and the Scripps Orbit and Permanent Array Center (SOPAC) upload and process the data from the network of CGPS stations and produce graphs depicting the horizontal and vertical change in a point's location through time. The nearest CGPS stations are in Los Banos and Gustine with none within the Plan Area boundary. Information on CGPS stations can be found at the following website: <https://www.unavco.org/instrumentation/networks/status/pbo/gps>

NASA Monitoring Network. NASA obtains subsidence data by comparing satellite images of Earth's surface over time. For the last few years, InSAR observations from satellites and aircraft have been used to produce the subsidence maps. More information can be found on their website: <https://www.nasa.gov/jpl/nasa-california-drought-causing-valley-land-to-sink>

San Joaquin River Restoration Program. Currently, USBR in conjunction with DWR, USGS, and USACE obtains subsidence data twice yearly and has published maps of the results in July and December since 2012 as part of the San Joaquin River Restoration Program (SJRRP). The subsidence areas shown in these maps cover the entire Plan Area. The USBR has been monitoring subsidence along the river and bypass levees as part of the restoration effort. More information can be found on their website: <http://www.restoresjr.net/monitoring-data/subsidence-monitoring/>

USGS Monitoring Network. A subsidence monitoring network consisting of 31 extensometers was installed by the USGS in the 1950s to quantify the subsidence occurring in the San Joaquin Valley. By the 1980s, the land subsidence monitoring efforts had decreased. Since then, a new monitoring network has been developed. The new network includes refurbished extensometers from the old network, CGPS stations, and InSAR. More information can be found on the USGS website: https://ca.water.usgs.gov/land_subsidence/california-subsidence-measuring.html

Section Five: Monitoring Network Grassland GSA Groundwater Sustainability Plan

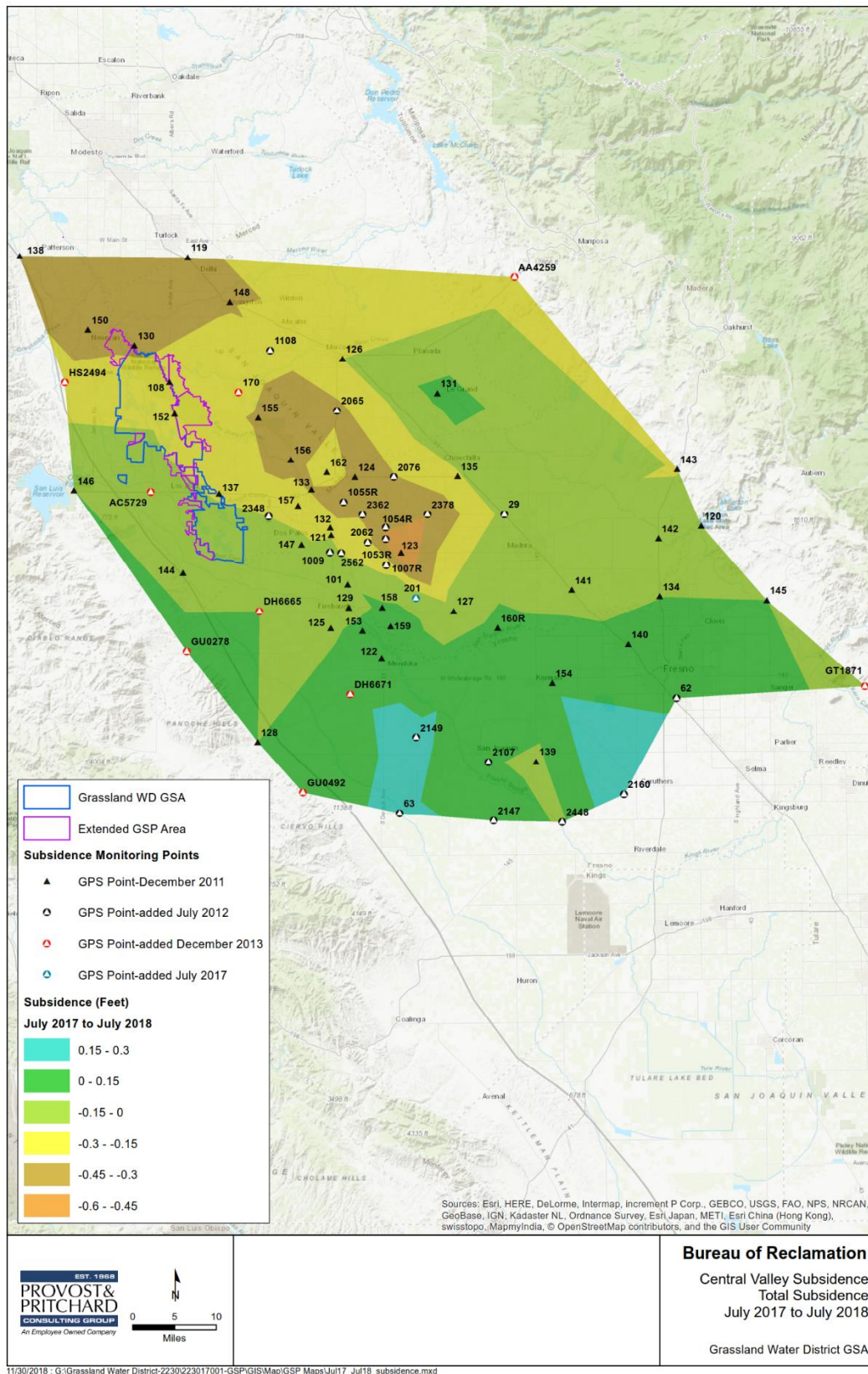


Figure 5-4: Supplemental Subsidence Monitoring Network

5.1.3.6 Depletion of Interconnected Surface Water

Legal Requirements:

§354.34(c)(6) Depletions of Interconnected Surface Water. Monitor surface water and groundwater, where interconnected surface water conditions exist, to characterize the spatial and temporal exchanges between surface water and groundwater, and to calibrate and apply the tools and methods necessary to calculate depletions of surface water caused by groundwater extractions. The monitoring network shall be able to characterize the following:

- (A) Flow conditions including surface water discharge, surface water head, and baseflow contribution.
- (B) Identifying the approximate date and location where ephemeral or intermittent flowing streams and rivers cease to flow, if applicable.
- (C) Temporal change in conditions due to variations in stream discharge and regional groundwater extraction.
- (D) Other factors that may be necessary to identify adverse impacts on beneficial uses of the surface water.

The Plan Area is adjacent to the San Joaquin River (SJR) along the northern edge of the San Luis National Wildlife Refuge, also referred to as Reach 5 of the SJR. Water level maps indicate the potential for groundwater to discharge to the San Joaquin River from the upper aquifer.

Water level maps indicate that the SJR has historically experienced a net inflow from the Grassland Plan Area. This can be attributed to historically high groundwater levels and requirements to sustain a large land area in wetland habitat conservation. The analysis of Grassland Plan Area impacts on interconnected surface water will be evaluated by assessing groundwater levels across the Plan Area in the representative water level monitoring network depicted in

Figure 5-2. See **Chapter 4.8** and **Appendix A** – Common Chapter Table CC-23 for more information on assessing interconnected surface water SMCs.

The understanding of the flow conditions, period of flow, variations, and other factors in the SJR stretch adjacent to the Grassland Plan Area will further be evaluated using available supplemental data. The water budget analysis required for annual reporting in the Plan Area will be further understood by analyzing depth to water measurements and upper aquifer groundwater contours developed from the representative water level monitoring network, monitoring by other GSP groups in the Delta-Mendota Subbasin, and the Grassland GSP participants' supplemental monitoring efforts.

Supplemental Monitoring

San Joaquin River Restoration Program

The SJRRP has installed a network of shallow monitoring wells to monitor the relationship between groundwater and stream flow in this area. Most Plan Area participants are beneficial users of surface water; however, surface water is also delivered from sources other than the SJR as described in **Chapter 2**. Although surface and groundwater in the Plan Area flow toward the SJR, most surface water in the Plan Area is delivered within the GGSA and to state and federal wildlife areas in the MCDMGSA. Non-CVP water is also routinely delivered to adjacent agricultural and habitat areas. Due to the relatively minimal pumping and the depth and distance of wells from the river, there has been no observation that pumping has impacted surface water intended for other users along the SJR. The SJRRP monitoring network data will be reviewed to assess this assumption.

Surface water flow in the San Joaquin River adjacent to the Plan Area is monitored at the San Joaquin River near Stevenson (SJS) station and at the Freemont Ford Bridge (FFB) station. Surface water flow rates and stage levels are monitored by DWR and USGS respectively. Data is available on the California Data Exchange Center (CDEC) website. The Plan Area members are currently coordinating with the SJRRP and will continue to do so in order to monitor groundwater-surface water interactions and river flow losses in the adjacent reaches of the river to ensure that surface water is unimpaired by groundwater users.

Grassland Water District

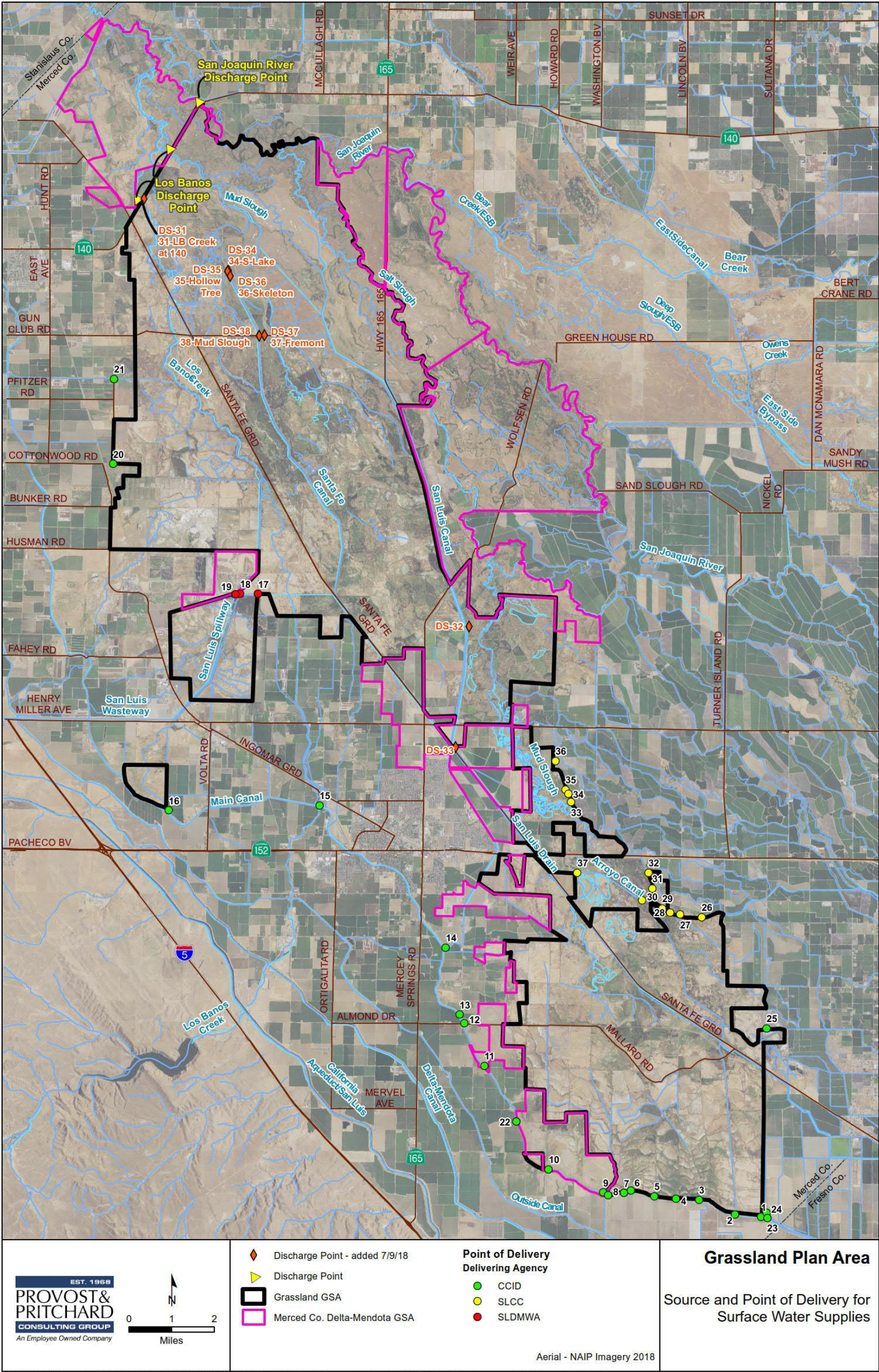
All CVP contract water delivered to and by GWD is monitored and measured by USBR or its contractual wheeling agents. GWD's inflow, internal flow and outflow measurements, and recording procedures were established under the direction of GWD's General Manager and are currently being accounted for by GWD's Water Department and Watermaster. All water delivery is based on a water year beginning March 1 and ending on the last day of February of the following year.

GWD, in cooperation with USBR, the CDFW, and the USFWS, has implemented a Real-Time Water Quality Monitoring Program (RTWQMP). Surface water flow is evaluated at the water delivery points depicted in **Figure 5-5**. The QAPP includes site visitations where technicians conduct sensor maintenance, calibration, and measurements of EC and instantaneous and redundant flow to ensure that the data is representative and comprehensive.

MCDMGSA State and Federal Refuges

This vast network of freshwater marshes (permanent, semi-permanent, and seasonal wetlands), upland grasslands, and riparian corridors in the MCDMGSA's state and federal refuges is the result of decades of wetland preservation, restoration, and collaborative conservation agreements between private wetlands, California State Parks, CDFW, the Wildlife Conservation Board, the Natural Resources Conservation Service, and USFWS.

These land managers partner with several wetland-related conservation organizations that provide direct services, including the protection and enhancement of wetland water supply, construction and maintenance of wetland conveyance and facilities, and habitat restoration and improvements.



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Figure 5-5: Supplemental Surface Water Monitoring Points

5.1.4 Adequacy of Monitoring Network

Legal Requirements:

§354.34(d) The monitoring network shall be designed to ensure adequate coverage of sustainability indicators. If management areas are established, the quantity and density of monitoring sites in those areas shall be sufficient to evaluate conditions of the basin setting and sustainable management criteria specific to that area.

The subbasin-level monitoring networks are a compilation of the representative monitoring networks developed by each GSP Group. The monitoring networks for each applicable sustainability indicator for each GSP Group were developed in accordance with the GSP Regulations Article 5 Plan Contents, Subarticle 4 Monitoring Networks (§ 354.21 – 354.40). DWR's Best Management Practices for the *Sustainable Management of Groundwater Monitoring Protocols, Standards, and Sites BMP* (2016b) and *Monitoring Networks and Identification of Data Gaps BMP* (2016a) documents were used when and where applicable at the discretion of each GSP group in developing monitoring networks and monitoring protocols. For more information on the subbasin-level monitoring networks, see the Delta-Mendota Subbasin **Common Chapter (Appendix A)**.

For additional information regarding the Grassland Plan Area's representative monitoring networks, see **Section 5.1.5**, **Section 5.1.6**, and **Section 5.4**.

5.1.5 Density of Monitoring Sites and Frequency of Measurements

Legal Requirements:

§354.34(f) The Agency shall determine the density of monitoring sites and frequency of measurements required to demonstrate short-term, seasonal, and long-term trends based upon the following factors:

- (1) Amount of current and projected groundwater use.
- (2) Aquifer characteristics, including confined or unconfined aquifer conditions, or other physical characteristics that affect groundwater flow.
- (3) Impacts to beneficial uses and users of groundwater and land uses and property interests affected by groundwater production, and adjacent basins that could affect the ability of that basin to meet the sustainability goal.
- (4) Whether the Agency has adequate long-term existing monitoring results or other technical information to demonstrate an understanding of aquifer response.

The density or spatial coverage of monitoring sites is discussed above in **sections 5.1.3.1** and **5.1.3.4**. The density and frequency of monitoring was influenced by the determinations made below:

- The amount of current and projected groundwater use (**Chapter 3.3.4 Current, Historical, and Projected Water Budget**)
- Aquifer characteristics (**Chapter 3.2 Current and Historical Groundwater Conditions**)
- Potential impacts to beneficial users (**4.3.4. Effects on Beneficial Users**)
- Data coverage sufficient to demonstrate an understanding of aquifer response (**Section 5.5.2**)

Each GSP Group will utilize agreed-upon protocols, (i.e., industry standards and best management practices) to ensure the collection of comparable data using comparable methods. Additionally, the following minimum monitoring frequency for each applicable sustainability indicator was agreed upon by the Delta-Mendota Subbasin Coordination Committee and

Technical Working Group (see **Common Chapter Section 6.1.2**) at a meeting on June 18, 2019:

Chronic lowering of groundwater levels/reduction in groundwater storage – Twice per year, with seasonal high groundwater elevation data collected between February and April and seasonal low groundwater elevation data collected between September and October.

Degraded groundwater quality – Once per year between May and July.

Depletions of interconnected surface water – Twice per year in conjunction with groundwater level monitoring

Subsidence – Publicly available subsidence data will be used along with locally-collected data; three data points at minimum will be collected annually during the first five years of GSP implementation. The Grassland GSP participants have selected three USBR sites that historically have reported data annually.

The monitoring periods are summarized in **Table 5-5: Delta-Mendota Subbasin Monitoring Frequency**

It may be that more information will be needed to monitor specific areas in and near the Plan Area. If additional monitoring points or frequencies are necessary, they will be recognized in the 5-year Plan update. See the Delta-Mendota Subbasin **Common Chapter Section 6** for more information and a map of the Delta-Mendota Subbasin representative monitoring networks.

Table 5-5: Delta-Mendota Subbasin Monitoring Frequency

Delta-Mendota Subbasin Coordinated Monitoring Frequency		
Monitoring Parameter	Frequency	Period of Measurement Notes
Groundwater Levels	Bi-Annually (spring & fall)	Spring: February 1 st and April 30 th Fall: September 1 st to October 31 st
Water Quality	Annually	May 1 st to July 31 st

¹The Delta-Mendota Subbasin GSP participants agree to coordinate collecting three data points within the first five years of GSP implementation, at a minimum. The Grassland GSP participants identified three USBR monitoring sites that historically report data annually.

5.1.6 Monitoring Network Information

Legal Requirements:

§354.34(g) Each Plan shall describe the following information about the monitoring network:

5.1.6.1 Rationale for Site Selection

Legal Requirements:

§354.34(g)(1) Scientific rationale for the monitoring site selection process.

Groundwater Levels and Quality

The scientific rationale for the groundwater level monitoring network includes the following:

- The network meets the minimum density goal of 1 well per 75 square miles
- Aquifer conditions are represented. Wells have been chosen to monitor various types of influences such as agricultural land uses, wetland areas, and boundary conditions
- Wells have known construction information
- Wells have quality long-term historical data

The following scientific rationale will be used to add new wells:

- Avoid wells perforated across multiple aquifers where feasible
- Select dedicated monitoring wells over production wells where feasible
- Select wells with available construction information (i.e., depth, perforated interval)

Land Subsidence

As stated previously, the USBR, DWR, USGS, USBR, USACE, UNAVCO, and various local entities including the SLDMWA and San Joaquin River Exchange Contractor Water Authority maintain land subsidence monitoring programs. The Plan Area participants will continue to follow the results of this established monitoring program and collaborate with the aforementioned agencies.

If additional monitoring locations are added, the following scientific rationale will be used:

- Add sites that are showing obvious signs of subsidence based on regional contour data
- Add sites that can be easily surveyed and tied back to a nearby monument
- Add sites where the ground surface is unlikely to be modified by future construction and will remain undisturbed
- Add sites in areas where the geology and soil types present the greatest potential for subsidence

Depletion of Interconnected Surface Water

The scientific rationale for the representative water level network applies to the analysis for depletion of interconnected surface water. Water level contour maps indicate the SJR has historically experienced a significant net inflow from the Grassland Plan Area, partially due to water supplies imported into the subbasin by the CVP. The historically high groundwater levels and requirements to sustain a large land area in wetland habitat conservation also facilitate the

significant net inflow to the SJR. The SMC analysis of Grassland Plan Area management impacts on interconnected surface water will be evaluated by assessing the groundwater levels across the Plan Area in the representative water level monitoring network depicted in **Figure 5-2**. See **Chapter 4.5** for more information on assessing interconnected surface water SMCs. SMCs for interconnected surface water will be further refined as data gaps are filled.

5.1.6.2 Consistency with Data and Reporting Standards

Legal Requirements:

§354.34(g)(2) Consistency with data and reporting standards described in Section 352.4. If a site is not consistent with those standards, the Plan shall explain the necessity of the site to the monitoring network, and how any variation from the standards will not affect the usefulness of the results obtained.

The data gathered through the monitoring networks is consistent with the standards identified in Section 352.4 of the California Code of Regulations related to Groundwater Sustainability Plans.

- Data reporting units (e.g., Water volumes shall be reported in acre-feet, etc.)
- Monitoring site information (e.g., Site identification number, description of site location, etc.)
- Well attribute reporting (e.g., CASGEM well identification number, casing perforations, etc.)
- Map standards (e.g., Data layers, shapefiles, geodatabases shall be submitted in accordance with the procedures described in Article 4, etc.)
- Hydrograph requirements (e.g., Hydrographs shall use the same datum and scaling to the greatest extent practical, etc.)

5.1.6.3 Corresponding Sustainability Indicator, Minimum Threshold, Measurable Objective, and Interim Goals

Legal Requirements:

§354.34(g)(3) For each sustainability indicator, the quantitative values for the minimum threshold, measurable objective, and interim goals that will be measured at each monitoring site or representative monitoring sites established pursuant to Section 354.36.

The quantitative values for minimum thresholds, measurable objectives, and interim goals that will be measured at the representative monitoring network sites associated with water levels, groundwater storage, and interconnected surface water are described in **Chapter 4, Table 4-2**. Those associated with the subsidence monitoring network are described in **Chapter 4, Table 4-8**, and those associated with the water quality monitoring network are described in **Chapter 4, Table 4-10**.

5.2 Monitoring Locations Map

Legal Requirements:

§354.34(h) The location and type of each monitoring site within the basin displayed on a map, and reported in tabular format, including information regarding the monitoring site type, frequency of measurement, and the purposes for which the monitoring site is being used.

The location of the representative monitoring network specific sites across the entire Delta-Mendota Subbasin are depicted in the **Common Chapter (Appendix A)**. The location of representative monitoring sites for the Plan Area are depicted in **Figures 5-1, 5-2, and 5-3** above, and are described in **Tables 5-2, 5-3, and 5-4**. Measurement frequencies are shown in **Table 5-5**.

5.3 Monitoring Protocols

Legal Requirements:

§354.34(i) The monitoring protocols developed by each Agency shall include a description of technical standards, data collection methods, and other procedures or protocols pursuant to Water Code Section 10727.2(f) for monitoring sites or other data collection facilities to ensure that the monitoring network utilizes comparable data and methodologies.

Groundwater level, groundwater quality, and land subsidence monitoring will follow the protocols identified in the *Monitoring Protocols, Standards, and Sites BMP* (DWR, 2016b). Existing groundwater monitoring plans will also continue to be followed.

The following comments and exceptions to the BMP should be noted:

- SGMA regulations require that groundwater levels be measured to the nearest 0.1 feet. The BMP suggests measurements to the nearest 0.01 feet; however, this is not feasible for most measurement methodologies. In addition, this level of accuracy would have little value since groundwater contours maps typically have 10-or-more-foot intervals, and storage calculations are based on groundwater levels rounded to the nearest foot. The accuracy of groundwater level measurements will vary based on the well type and condition.
- If used in a well suspected of contamination or if there are obvious signs of contamination, well sounding equipment will be decontaminated after use.
- Wells will be surveyed to a horizontal accuracy of 0.1 feet.
- The BMP states that measurements each spring and fall should be taken “preferably within a 1- to 2-week period.” This is likely not feasible due to the large number of wells in the GSA. The monitoring periods defined in this Chapter identify a period in which the seasonal high and low will be reflected.
- If a vacuum or pressure release is observed, then water level measurements will be re-measured every 5 minutes until they have stabilized.
- In the field, water level measurements will be compared to previous records; if there is a significant difference, then the measurement will be verified.
- When monitoring for water quality, field parameters for pH, electrical conductivity, and temperature will also be monitored. A run time before sampling will be calculated to determine whether a well has been purged adequately to allow monitoring.

5.4 Representative Monitoring

Legal Requirements:

§354.36 Each Agency may designate a subset of monitoring sites as representative of conditions in the basin or an area of the basin, as follows:

See the figures in **Section 5.1.3** for the representative monitoring in the Grassland Plan Area (The Delta-Mendota Subbasin Common Chapter includes more information on the Subbasin-wide monitoring network, which is a compilation of the six Delta-Mendota GSP group's respective representative monitoring networks):

- **Figure 5-1** for the representative water quality monitoring network
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- **Figure 5-2** for the representative water level monitoring network
- **Figure 5-3** for the representative subsidence Monitoring network

5.4.1 Description of Representative Sites

Legal Requirements:

§354.36(a) Representative monitoring sites may be designated by the Agency as the point at which sustainability indicators are monitored, and for which quantitative values for minimum thresholds, measurable objectives, and interim goals are defined.

DWR has referred to representative monitoring as utilizing a subset of wells or monitoring points in a management area. The representative monitoring sites identified are spatially dispersed to represent any variability in groundwater conditions across the Plan Area. See **Chapter 3** for more information on the spatial variety of groundwater conditions. Based on existing conditions, DWR's Monitoring Network BMP's, and Hopkins and Anderson (2016) the Plan Area well network is sufficient to monitor groundwater and will continue to use available water level data to assess groundwater conditions.

For water level, water quality, interconnected surface water, subsidence, and groundwater storage, the representative monitoring sites were identified based on the following criteria:

1. At least three years' worth of data to develop a meaningful minimum threshold or measurable objective
2. Of the available data, at least three of the measurements occurred within the historical period to present
3. There is enough spatial coverage within the Plan Area to represent the variability in groundwater conditions

Despite not meeting all the criteria identified above, additional sites were identified for inclusion in the representative monitoring networks with the intention of monitoring during GSP implementation. The data obtained during the implementation period will be used to develop meaningful SMCs and improve hydrologic understanding.

See **Section 5.1.3** for a description and maps of the representative monitoring networks. See **Chapter 4** for more information on defining minimum thresholds, measurable objectives, and interim goals.

5.4.2 Use of Groundwater Elevations as Proxy for Other Sustainability Indicators

Legal Requirements:

§354.36(b) Groundwater elevations may be used as a proxy for monitoring other sustainability indicators if the Agency demonstrates the following:

- (1) Significant correlation exists between groundwater elevations and the sustainability indicators for which groundwater elevation measurements serve as a proxy.
- (2) Measurable objectives established for groundwater elevation shall include a reasonable margin of operational flexibility taking into consideration the basin setting to avoid undesirable results for the sustainability indicators for which groundwater elevation measurements serve as a proxy.

The Grassland Plan Area is using groundwater elevation monitoring as a proxy in conjunction with subsidence data to evaluate groundwater storage and interconnected surface water.

Upper Aquifer Groundwater Storage

Water elevations will be used as a proxy for groundwater storage volume in the upper aquifer once sufficient data is collected from designated monitoring sites (until that time, subsidence data will be used to help determine groundwater storage for the lower aquifer). The volume of groundwater storage will be quantified on an annual basis using a larger network of hydrographs (where data exists) and contour maps as described in **Chapter 3.3– Water Budget** and in the Common Chapter (**Appendix A**) using changes in groundwater elevation, specific yield of the aquifer, and acreage of the Plan Area.

Interconnected Surface Water

The Grassland Plan Area has historically maintained shallow depth to water throughout the area. The Plan Area is the lowest-lying area in the Subbasin and all upper aquifer flow contours lead to and through the Plan Area and then on to the SJR. Additionally, the “No Net Loss” wetland legal mandate and other protections for wetlands identified in **Section 4.3** would result in the Grassland Plan Area continuing to sustain shallow groundwater in the wetland areas, producing a significant net positive flow to the SJR. The upper aquifer groundwater gradient in the Plan Area is currently understood as the primary influencer to the SJR connection adjacent to the Plan Area (see **Section 3.3**).

The Grassland GSP participants made the decision to use water level SMCs across the Plan Area and represent a variety of land uses to evaluate gradient influences as an appropriate interim proxy for interconnected surface water, until a volume of rate or flow can be established for the Subbasin. There are few monitoring locations along the SJR and the high groundwater levels and direction of groundwater flow within the entire Plan Area produce a net outflow to the SJR (see **Section 3.2.2.2** and **Figure 3-15**).

5.5 Assessment and Improvement of Monitoring Network

5.5.1 Review and Evaluation of Monitoring Network

Legal Requirements:

§354.38(a) Each Agency shall review the monitoring network and include an evaluation in the Plan and each five-year assessment, including a determination of uncertainty and whether there are data gaps that could affect the ability of the Plan to achieve the sustainability goal for the basin.

The monitoring network will continue to be developed and refined as data is gathered and analyzed. The GSAs will review the monitoring network annually to ensure that the monitoring points identified represent the regional conditions within the Plan Area. Any proposed changes will be noted in the annual report and implemented prior to the next measurement period to the extent feasible. It should be noted that the effectiveness of the monitoring network may not be apparent for several reporting periods.

5.5.2 Identification of Data Gaps

Legal Requirements:

§354.38(b) Each Agency shall identify data gaps wherever the basin does not contain a sufficient number of monitoring sites, does not monitor sites at a sufficient frequency, or utilizes monitoring sites that are unreliable, including those that do not satisfy minimum standards of the monitoring network adopted by the Agency.

There are three general types of data gaps to consider for monitoring networks:

1. **Temporal:** Insufficient frequency of monitoring
2. **Spatial:** Insufficient number or density of monitoring sites in a specific area
3. **Insufficient quality of data:** Data may be available but of poor or questionable accuracy. Poor data could lead to incorrect assumptions or biases. The data may not appear consistent with other data in the area or with past readings at the monitoring site. The monitoring site may not meet all the desired criteria to provide reliable data. Past experiences have shown that well location information on well construction reports is often poor, making it difficult or impossible to match wells with their well logs

Following are discussions on data gaps in each existing monitoring network:

Groundwater Levels and Groundwater Storage

Temporal Data Gaps: Temporal data gaps caused the most inconsistency in monitoring historical trends in the Plan Area. Most groundwater monitoring in the Plan Area began within the past ten years. Another limitation to temporal data was a lack of regular monitoring during the transition from the Water Data Library to the CASGEM program.

Spatial Data Gaps: There is a historical lack of groundwater level monitoring in the lower aquifer, primarily due to the small number of lower aquifer wells in the Plan Area. Additional lower aquifer data will be acquired through the implementation phase. Representative well site spatial coverage meets recommended densities, includes both the upper and lower aquifer, and is representative of various locations within the Plan Area; therefore, it is not seen as a data gap going forward.

Quality of Data: Wells with historical data have no construction information for depth and perforated interval. When well construction information is available, it is often hard to match with specific wells, limiting the usefulness of historical data. These wells do not provide ideal data points, but the Plan Area participants will continue to collect well construction logs and other data, including conducting video surveys.

Groundwater Quality

Temporal Data Gaps: Entities in the Plan Area including the GWD and CDFW have collected a substantial amount of groundwater quality data from the upper aquifer and will continue to do so under ongoing monitoring programs and as part of SGMA implementation.

Spatial Data Gaps: There is a historical lack of groundwater quality monitoring in the lower aquifer, primarily due to the small number of lower aquifer wells in the Plan Area. Additional lower aquifer data will be acquired through the implementation phase. The Groundwater Quality Monitoring Network's spatial coverage meets recommended densities, includes both the upper and lower aquifer, and is representative of various locations within the Plan Area.

Quality of Data: The Plan participants use modern technology and laboratory analysis to collect and report water quality monitoring data, which will continue. This is not considered a data gap.

Land Subsidence

Temporal Data Gaps: The USBR and others have been collecting subsidence data from many monitoring points within the Central Valley for many years; however, the comprehensive data used for the USBR's study is limited to data from 2011 to present. Data prior to 2011 has been deemed unnecessary, as metadata is rare and summaries may not cover the area of interest or may contain large temporal gaps. There is limited historical subsidence data within the Plan Area boundaries to compare with current rates of subsidence at newly installed monitoring points.

Spatial Data Gaps: Although three representative subsidence monitoring points are identified in the Grassland Plan Area, the understanding of subsidence can be improved by assessing at a regional scale. The Plan Area participants will review subsidence data outside of the Plan Area in order to supplement this understanding.

Quality of Data: Although several subsidence monitoring points exist within and adjacent to the Plan Area, there are currently no extensometers or other devices that can physically measure aquifer compaction, because subsidence has not caused undesirable results in the Plan Area. If funding is made available, an extensometer could be installed to better monitor subsidence.

Depletion of Interconnected Surface Water

Temporal, Spatial, and Data Quality Gaps: There is limited historical groundwater level monitoring data available from directly along the SJR within the Grassland Plan Area, which is a temporal, spatial, and data quality gap. However, there are very few groundwater wells located in this part of the Plan Area. The influence of management activities on the interconnection of the SJR in this specific reach is best analyzed by assessing the greater Plan Area and adjacent Merced Subbasin. The representative water level monitoring network will also serve as the monitoring network for interconnected surface water.

5.5.3 Plans to Fill Data Gaps

Legal Requirements:

§354.38(c) If the monitoring network contains data gaps, the Plan shall include a description of the following:

- (1) The location and reason for data gaps in the monitoring network.
- (2) Local issues and circumstances that limit or prevent monitoring.
- (d) Each Agency shall describe steps that will be taken to fill data gaps before the next five-year assessment, including the location and purpose of newly added or installed monitoring sites.

Historical collections of the data for groundwater levels, groundwater storage, groundwater quality, land subsidence monitoring networks, and depletion of interconnected surface water contain many temporal gaps. Efforts will be made to gain better access to any available historical data sets for incorporation into the data management system to assist in developing a greater understanding of changing groundwater conditions in order to more accurately generate projections of future trends. With the establishment of representative monitoring networks and adoption of monitoring frequencies under this GSP, future temporal data gaps are not anticipated.

To address spatial data gaps in the lower aquifer, multi-completion monitoring wells have been installed throughout the Plan Area, and a number of newly established lower aquifer monitoring sites will be monitored during the implementation period. The lower aquifer data gaps will be filled as data is acquired through the implementation phase associated with the representative monitoring sites.

5.5.4 Monitoring Frequency and Density

Legal Requirements:

§354.38(e) Each Agency shall adjust the monitoring frequency and density of monitoring sites to provide an adequate level of detail about site-specific surface water and groundwater conditions and to assess the effectiveness of management actions under circumstances that include the following:

- (1) Minimum threshold exceedances.
- (2) Highly variable spatial or temporal conditions.
- (3) Adverse impacts to beneficial uses and users of groundwater.
- (4) The potential to adversely affect the ability of an adjacent basin to implement its Plan or impede achievement of sustainability goals in an adjacent basin.

The frequency and density of the proposed monitoring programs are discussed in previous sections. The programs are considered adequate to provide sufficient monitoring data to satisfy SGMA requirements according to the provided criteria. The monitoring network may be modified or enhanced if deemed necessary when groundwater conditions are compared to sustainability goals.

5.6 Reporting Monitoring Data to the Department

Legal Requirements:

§354.40 Monitoring data shall be stored in the data management system developed pursuant to Section 352.6. A copy of the monitoring data shall be included in the Annual Report and submitted electronically on forms provided by the Department.

GGSA has an internal monitoring and reporting system that will serve as a supplemental data management system (DMS) to the Delta-Mendota Subbasin DMS (DMSDMS). The GGSA DMS and DMSDMS will facilitate annual reporting. GGSA will coordinate with MCDMGSA and other plan participants to coordinate monitoring efforts and gather necessary data as defined in this chapter. Data will be entered into the DMS by staff and consultants as measurements are recorded or received. Data necessary for coordination with the Delta-Mendota Subbasin will be submitted to the SLDMWA for entry in the DMSDMS. Data relative to the GSP development can be made available for review upon request.

6 Projects and Management Actions to Achieve Sustainability

As demonstrated in the Basin Setting Chapter, the Grassland Plan Area is currently sustainable and not experiencing any undesirable results. The following section is provided to demonstrate projects currently being implemented by GGSA to maintain sustainability and also to demonstrate GGSA's work to facilitate regional projects for the good of the Plan Area, agencies within the DM Subbasin, and other Basins.

Legal Requirements:

§ 354.44. Projects and Management Actions

(a) Each Plan shall include a description of the projects and management actions the Agency has determined will achieve the sustainability goal for the basin, including projects and management actions to respond to changing conditions in the basin.

(b) Each Plan shall include a description of the projects and management actions that include the following:

(1) A list of projects and management actions proposed in the Plan with a description of the measurable objective that is expected to benefit from the project or management action. The list shall include projects and management actions that may be utilized to meet interim milestones, the exceedance of minimum thresholds, or where undesirable results have occurred or are imminent. The Plan shall include the following:

(A) A description of the circumstances under which projects or management actions shall be implemented, the criteria that would trigger implementation and termination of projects or management actions, and the process by which the Agency shall determine that conditions requiring the implementation of particular projects or management actions have occurred.

(B) The process by which the Agency shall provide notice to the public and other agencies that the implementation of projects or management actions is being considered or has been implemented, including a description of the actions to be taken.

(2) If overdraft conditions are identified through the analysis required by Section 354.18, the Plan shall describe projects or management actions, including a quantification of demand reduction or other methods, for the mitigation of overdraft.

(3) A summary of the permitting and regulatory process required for each project and management action.

(4) The status of each project and management action, including a time-table for expected initiation and completion, and the accrual of expected benefits.

(5) An explanation of the benefits that are expected to be realized from the project or management action, and how those benefits will be evaluated.

(6) An explanation of how the project or management action will be accomplished. If the projects or management actions rely on water from outside the jurisdiction of the Agency, an explanation of the source and reliability of that water shall be included.

(7) A description of the legal authority required for each project and management action, and the basis for that authority within the Agency.

(8) A description of the estimated cost for each project and management action and a description of how the Agency plans to meet those costs.

(9) A description of the management of groundwater extractions and recharge to ensure that 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.

(c) Projects and management actions shall be supported by best available information and best available science.

(d) An Agency shall take into account the level of uncertainty associated with the basin setting when developing projects or management actions.

6.1 Project 1 – North Grassland Water Conservation and Water Quality Control Project (NGWCWQCP)

6.1.1 Project Description

The North Grassland Water Conservation and Water Quality Control Project (NGWCWQCP or Project) aims to develop additional surface water to assist GWD in meeting its water demand within the GSA. High-quality water from the District's water conveyance system and maintenance flows from managed wetlands in the northern portion of the District will be captured prior to leaving GWD during fall and early winter. Recovered water will be recirculated and returned to GWD's conveyance system to meet a portion of fall and winter demand. The amount of surface water available for recirculation through the NGWCWQCP facilities is expected to vary based on Level 2 CVP refuge water supply allocations, with an estimated 11,700 to 16,000 acre-feet per year available in years with 100% allocation (125,000 AF) and an estimated minimum of 5,200 acre-feet per year available in years with reduced Level 2 allocations (75% allocation: 93,750 AF). Based on the historical reliability of Level 2 water supplies, it is estimated that the average annual yield of the project will be approximately 14,000 acre-feet per year.

Implementation of the NGWCWQCP requires improvements to two existing District conveyances and the construction of two pipelines, three pump stations, and various water control structures to capture and recirculate water that would otherwise leave the District. Real-time monitoring stations will also be installed to allow the District to better control the quantity and quality of water entering and leaving the District's wetland complex. Annual project operation is expected to begin during the wetland flood-up in late September and continue through early February of the following year. Other benefits of the Project include improved District operational flexibility, improved aquifer sustainability, reduction in groundwater extractions, and better management of water resources, such as wetlands drawdown discharge into the San Joaquin River.

6.1.2 Measurable Objectives

The main objective of this project is to capture and recirculate an average of 14,000 acre-feet per year of high-quality water from District conveyance systems and maintenance flows from managed wetlands. The amount of recovered water will vary each year between an estimated 5,200 and 16,000 acre-feet based on Level 2 CVP refuge water supply allocations. Captured and recirculated flow rates, volumes, and quality will be measured at multiple Project real-time monitoring stations for monitoring and reporting purposes and to ensure water quality standards are continuously being met. The Project will allow for better water management within the District by improving the ability to manage wetland drawdown and discharges into the San Joaquin River while also improving basin sustainability.

6.1.3 Circumstances for Implementation

The NGWCWQCP is currently under construction by the District and is anticipated to become operational in the fall of 2019. The Project was initiated after drought resulted in reduced surface water supplies for the District in 2014 and 2015. The Project is being implemented to develop additional surface water supplies to assist GWD in meeting its water demands within the GSA while improving basin sustainability. The Project will help ensure that adequate water

supplies are available to meet wetland habitat requirements, especially in the spring and summer.

6.1.4 Permitting and Regulatory Process

The Project is currently under construction, and thus all associated construction and environmental permits have been completed. No additional permits are needed for Project operation, but all recovered and recirculated water must meet all existing and any new water quality standards, including TDS, boron, and selenium concentration limits.

6.1.5 Project Schedule

The Project is currently under construction and is expected to be operational by fall of 2019.

6.1.6 Project Benefits

The NGWCWQCP will recover and recirculate up to 16,000 acre-feet per year of high-quality water from District conveyance systems and maintenance flows from managed wetlands. This amount will vary based on Level 2 CVP refuge water supply allocations from an estimated 5,200 acre-feet per year at 75% allocation up to 16,000 acre-feet per year at 100% allocation. Water that would otherwise flow out of the District will be recovered and recirculated under this project and will be used to meet fall and winter water demands within the District. Recirculated water could be used to supplement District water demands in years of insufficient Incremental Level 4 water allocations. There will be a small amount of groundwater recharge from conveyance system seepage losses, which could have a positive effect on groundwater levels and quality since the recovered water will typically be of higher quality than the groundwater. Additionally, the water supply generated from this project will extend the inundation period and provide additional spring irrigations on up to 16,000 acres of seasonal wetland, further improving recharge in GSP area CVPIA wetlands.

6.1.7 Project Implementation

This project will be implemented by GWD as an integral piece of the District's operations and overall effort to improve basin sustainability. It will be implemented, managed, and operated by GWD. Project implementation includes improvements to two existing District conveyances along with the construction of two pipelines, three pump stations, and various water control structures to capture and recirculate water that would otherwise leave the District. The Project also includes continuous monitoring of Project flow rates, volumes, and water quality.

6.1.8 Legal Authority

Grassland Water District will own, operate, and manage all Project facilities.

6.1.9 Project Cost Estimate/Acre-Foot of Yield

The cost of Project implementation is approximately \$17.7 million. Assuming an average annual yield of 14,000 acre-feet and an additional \$20,000 every 5 years for operations and maintenance, this equates to a cost of \$65 per acre-foot of permanent water supply over a 20-year period.

6.1.10 Management of Groundwater Extractions and Recharge

There are no groundwater extractions as part of this Project. Groundwater extractions in the District could be reduced by meeting water demands with recirculated water instead of through groundwater pumping. Indirect groundwater recharge will occur in any unlined conveyance systems being constructed as part of the Project.

6.2 Project 2 – North Valley Regional Recycled Water Program (NVRWP)

6.2.1 Project Description

The North Valley Regional Recycled Water Program (NVRWP or Project) will ultimately convey tertiary treated municipal and industrial wastewater, or recycled water, from the Cities of Modesto, Ceres, and Turlock to the DMC using new pump stations and pipelines. The pump station and the 6.5-mile, 54-inch diameter pipeline from the City of Modesto's wastewater treatment plant to the DMC has already been constructed and is in operation. The 7-mile, 42-inch pipeline from the City of Turlock's wastewater treatment plant to the City of Modesto's wastewater treatment plant is currently under construction. Recycled Project water is metered at the DMC inlet facility and is delivered to DPWD and south-of-Delta public wildlife refuge areas within the GGSA and MCDMGSA. In 2018, the City of Modesto delivered approximately 14,700 acre-feet of recycled water through the Project facilities. CVPIA refuges within the GGSA and surrounding public wetlands within MCDMGSA took delivery of approximately 5,500 acre-feet of the available recycled water. The total Project yield, once the Turlock component is constructed, is estimated to be up to 26,000 AFY. Adjusted for urban growth projections, the future Project yield is estimated to be up to 59,000 AFY.

Long-term Water Service Agreements (WSAs) were executed between DPWD and the Cities of Modesto and Turlock in October 2015 and May 2016, respectively, that give DPWD exclusive rights to Project water through 2060 with a renewal option and acknowledgement of DPWD's right to deliver Project water to refuges. In addition, DPWD executed a Water Acquisition and Exchange Agreement with the USBR in 2016 that will last through 2060 with an option to renew. The agreement gives the USBR rights to acquire and deliver 20% of Project water from DPWD to CVPIA refuges. After adjusting for urban growth projections, the 20% of Project water available for refuges is estimated to be 11,800 acre-feet per year. The remaining 80% of DPWD's Project water will be exchanged with the USBR to cover DMC water wheeling costs. Of this 80%, 10% will be available to CVPIA refuges at no cost. Therefore, approximately 28% of Project water will be delivered to wetlands within GGSA and its MCDMGSA public wetlands. In 2018, GWD and DPWD secured a Proposition 1 grant from the California Natural Resources Agency (CNRA) to help cover the long-term costs of acquiring Project water for the refuges. DPWD also has the option of offering more Project water to the CVPIA refuges. In 2018, approximately 5,500 acre-feet was delivered to the refuges. Water costs for the refuges shall not exceed the cost of Project water paid by DPWD landowners, with a maximum cost of \$225 per acre-foot plus conveyance costs.

6.2.2 Measurable Objectives

The current yield of the Project is 16,500 acre-feet per year and the amount is expected to increase with construction of the Turlock segment. The total yield of recycled water delivered to

DPWD for its members and the refuges is estimated to be 59,000 acre-feet per year under future urban growth projections. Under current operations, approximately 28% (4,620 acre-feet per year) will be delivered to the refuges through long-term acquisitions agreements and exchanges with DPWD and USBR. In the future, an estimated 11,800 acre-feet per year (after adjusting for urban growth projections) of recycled water will be diverted to refuges within GGSA and its surrounding area. Project water is metered at the DMC inlet facility.

6.2.3 Circumstances for Implementation

California's drought conditions and restrictions on San Joaquin-Bay Delta pumping have resulted in reduced surface water supplies for GWD and DPWD. The Project is being implemented to develop additional surface water supplies to assist both districts in meeting their water demands within their respective Plan Areas and to improve basin sustainability. The Project will help ensure that adequate water supplies are available to meet wetland habitat requirements while providing DPWD with a vital source of surface water for its landowners.

6.2.4 Permitting and Regulatory Process

Since part of the project is already constructed and the remaining portions are under construction, no additional permits or regulatory requirements will be required for construction. Project operations are governed by the already-executed WSAs between DPWD and the Cities of Turlock and Modesto, a Water Acquisition and Exchange Agreement between DPWD and the USBR, and a Grant Agreement between DPWD and the CNRA. Stringent water quality standards will need to be met for all Project water delivered and diverted.

6.2.5 Project Schedule

The pump station at the City of Modesto's wastewater treatment plant, the 54-inch diameter pipeline from the plant to the DMC, and the DMC inlet facility are constructed and operational. The 42-inch diameter pipeline conveyance system from the City of Turlock's wastewater treatment plant to the City of Modesto's wastewater treatment plant is currently under construction with an anticipated completion date of 2019.

6.2.6 Project Benefits

California's drought conditions and restrictions on Sacramento-San Joaquin Delta pumping have resulted in reduced surface water supplies for GWD and DPWD. The NVRWP will provide a consistent and reliable surface water source to meet irrigation and refuge water demands and promote basin sustainability. The Project is already yielding up to 16,500 acre-feet per year with a minimum of 4,620 acre-feet per year for the refuges. In the long-term, the Project is expected to yield up to 59,000 acre-feet per year with an estimated 11,800 acre-feet per year for the refuges (based on urban growth projections). DPWD has the option to sell or exchange additional water to the USBR for use on the refuges.

In addition, the Project will reduce the region's reliance on other water supplies, both from south of the Delta and from the Delta itself while eliminating the discharge of treated wastewater into the San Joaquin River from the Cities of Modesto, Ceres, and Turlock.

6.2.7 Project Implementation

The Project will be a coordinated effort, implemented by the Cities of Modesto, Turlock, and Ceres; DPWD; Stanislaus County; USBR; and GWD.

6.2.8 Legal Authority

The facilities connecting the City of Modesto wastewater treatment plant to the DMC will be owned, operated, and maintained by the City of Modesto. The conveyance facilities connecting the City of Turlock's wastewater treatment plant to the City of Modesto's wastewater treatment plant will be owned, operated, and maintained by the City of Turlock. Deliveries to refuges will be managed by DPWD and governed by WSAs between DPWD and the Cities of Turlock and Modesto, a Water Acquisition and Exchange Agreement between DPWD and the USBR, and a Grant Agreement between DPWD and CNRA.

6.2.9 Project Cost Estimate/Acre-Foot of Yield

The first phase of the project, consisting of the pump station at the City of Modesto's wastewater treatment plant, the pipeline from the plant to the DMC, and the DMC inlet facilities, had a construction cost of \$44 million. The next phase, which consists of conveyance facilities from the City of Turlock's wastewater treatment plants to the City of Modesto's wastewater treatment plants, has an estimated construction cost of \$32 million. Environmental review, project design, and other planning costs are estimated at \$10 to \$12 million for a total estimated project cost of \$86 to \$88 million. Assuming operations and maintenance are included in existing annual operations for the DMC and treatment facilities, this Project would produce water for \$30 per AF over a 50-year project life expectancy.

DPWD has secured several state and federal grants for a portion of the Project costs. Water costs for the refuges will not exceed the cost of Project water paid by DPWD landowners, with the cost capped at \$225 per acre-foot plus conveyance costs. Both the USBR and the State of California have committed more than \$25 million each for the Project, which should cover the delivery of water to CVPIA wetlands through 2060.

6.2.10 Management of Groundwater Extractions and Recharge

There are no explicit groundwater extractions or recharges as part of the Project. Groundwater extractions in GWD could be reduced by meeting refuge water demands with recycled or exchanged water instead of through groundwater pumping. Surface water exchanged with DPWD could be used by its users in-lieu of groundwater pumping or for recharge purposes, improving basin sustainability.

6.3 Project 3 – Flood Water Capture

6.3.1 Project Description

The GSAs may expand and improve conjunctive use of surface water and groundwater by adopting an integrated "Flood-MAR" resource management strategy that uses flood water from local rivers and streams for managed aquifer recharge (MAR) on agricultural lands, managed wetlands, riparian corridors, and floodplains. The GSAs will continue to utilize excess surface

water flows from the San Joaquin River in accordance with procedures established by the Refuge Water Supply Program administered by USBR.

6.3.2 Measurable Objectives

The goal is to more beneficially use local flood water sources to strategically improve aquifer recharge. The measurable objective is the volume of managed aquifer recharge from floodwater applications, in acre-feet, and the measurement of any resulting groundwater extractions.

6.3.3 Circumstances for Implementation

The U.S. Bureau of Reclamation has historically delivered excess surface water flows from the San Joaquin River to the Plan Area for managed wetland use in wet years. Deliveries are measured and accounted for as Incremental Level 4 water to meet the demands of wetland habitat areas in compliance with the CVPIA. Under these circumstances, groundwater pumping is reduced in proportion to excess surface water deliveries.

6.3.4 Permitting and Regulatory Process

The GSAs receive approval from the USBR for diversion and recharge of excess flows from the San Joaquin River, under the Refuge Water Supply Program. If flood recharge projects are developed for the benefit of agricultural landowners within the Plan Area, they will be consulted. USBR in turn will apply for and receive any necessary permits from the State Water Resources Control Board, including but not limited to permit changes under Assembly Bill 658 (2019-2020).

6.3.5 Project Schedule

The project will take place in wet years on an ongoing basis, when water is available. In the meantime, the GSAs will consider adoption of a formal Flood-MAR resource management strategy, in coordination with USBR, before the 5-year GSP update for this Plan.

6.3.6 Project Benefits

When groundwater pumping is reduced in proportion to excess surface water deliveries, the upper aquifer is recharged to maintain sustainability, improve groundwater levels and groundwater quality, and benefit groundwater dependent ecosystems.

6.3.7 Project Implementation

The Project will be a coordinated effort, implemented by the GGSA, MCDMGSA, and USBR, in coordination with CDFW, USFWS, and agricultural landowners within the Plan Area.

6.3.8 Legal Authority

The USBR owns and manages water rights on the San Joaquin River.

6.3.9 Project Cost Estimate/Acre-Foot of Yield

Project implementation would be associated with the cost of water, wheeling, monitoring and analysis to recharge areas and is estimated to be less than \$100 per acre foot.

6.3.10 Management of Groundwater Extractions and Recharge

Excess surface water from flood flows and storm events would expand the wetted footprint or maintain the extent for longer duration resulting in a net increase to recharge and diminish or fully augment the need to pump groundwater during those events.

6.4 Management Actions for Future Consideration

The Grassland Plan Area is currently sustainable as managed; however, in order to more efficiently gather data, share resources, and maintain existing sustainability, it may be necessary to implement additional management programs. Listed below are some potential management actions that could be implemented as necessary in the future. This list is not intended to act as a plan for implementation, rather as a plan for consideration and future development. Should it become necessary to implement one of the management actions listed below or consider other management actions for implementation, the GGSA will further define the required criteria as set forth in **Section 354.44** of the GSP regulations.

Table 6-1: Management Actions

#	Management Action	Description	Measurable Objective
1	Require new developments (non-<i>de minimis</i> extractors) to prove sustainable water supplies	The GSAs may adopt a policy to require new developments (non- <i>de minimis</i> extractors) to prove their usage of sustainable water supplies based upon current Sustainable Management Criteria. The GSAs may review and comment on environmental review documents for proposed development projects to ensure a sustainable water balance and the adoption of corresponding mitigation measures. Requires County support.	The goal is to ensure that new developments (non- <i>de minimis</i> extractors) do not cause the Plan Area to exceed the current GSP groundwater sustainable yield and groundwater supplies are consumed or retained within the Plan Area boundary. The measurable objective is proven new development water balance with the goal of 0.0 acre-feet groundwater overdraft /year.
2	Registration of extraction facilities	The GSAs may adopt a policy to require registration of groundwater extraction facilities within the Plan Area. Requires County support.	The goal is to improve the GSAs' database of groundwater extraction locations in order to support ongoing monitoring and other management actions. The measurable objective is the number of new registered facilities.
3	Require self-reporting of groundwater extraction, water level, and water quality data	The GSAs may adopt a policy to require groundwater users in the Plan Area (excluding <i>de minimis</i> extractors) to self-report groundwater extractions, static water levels, and water quality data twice per year.	The goal is to improve the GSAs' data collection for groundwater extractions, water levels, and the water quality monitoring network and to improve future water budget and sustainable yield development.

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#	Management Action	Description	Measurable Objective
4	Groundwater quantification methods	The GSAs may adopt a policy to determine the method or methods to quantify groundwater extractions. The GGSA may consider a variety of methods including, but not limited to 1) aerial flyovers or remote sensing of irrigated areas, 2) annual crop surveys alongside aerial flyovers or remote sensing of irrigation areas including crop coefficients, 3) energy records and meter calibrations, 4) flow meter readings of pumped water, 5) remote sensing of evapotranspiration, and 6) other methods.	The goal is to accurately and efficiently quantify annual groundwater extractions. The measurable objective is the measured volume of groundwater extraction in acre-feet.
5	Recycled water use	The GSAs may explore further opportunities to utilize recycled water from nearby communities.	The goal is to maintain existing sustainability by securing affordable and reliable water supplies that are sourced locally or regionally. The measurable objective is the volume of additional recycled water delivered in acre-feet.
6	Recharge estimation methods	The GSAs may adopt a policy to better estimate recharge occurring from managed wetland uses within the Plan Area. The GSAs may consider a variety of methods, likely based on field measurements of inflows, outflows, pond levels, and groundwater elevations. The GSAs may conduct soil and percolation studies to better understand site-specific recharge.	The goal is to more accurately estimate recharge occurring from wetlands uses, which will improve both water budget estimates for the area and the representation of the area in groundwater models.
7	Increasing access to surface water	The GSAs may adopt a policy to define a method by which surface water can be conveyed to groundwater users within the Plan Area. The GSAs may consider a variety of structures that adhere to the limitations of available water supplies and allowable water uses.	The goal is to provide groundwater users in the Plan Area access to surface water to offset groundwater use. The measurable objective is the volume of surface water delivered to growers without previous access to surface water.
8	Canal or basin infrastructure incentives	The GSAs may adopt a policy to encourage groundwater extractors through incentives to develop infrastructure for surface water deliveries.	The goal is to incentivize the construction of new water conveyance and storage infrastructure to increase surface water access to growers in the Plan Area. The measurable objective is the capacity of any constructed conveyance canals or storage basins.

7 Plan Implementation

7.1 Estimate of GSP Implementation Costs

Implementation of the Plan will begin upon adoption. Funding is considered on a 5-year basis to coincide with Plan updates. The first annual report will be due April 2020. Costs for implementation include administrative costs, professional services, and monitoring and reporting. The administrative portion includes public outreach which covers time and materials for staff, consultants, and deliverables for GSA board meetings and other public events, along with insurance and other overhead costs of managing the GGSA and MCDMGSA. Professional services costs include time and materials for staff; consultants for technical, legal, and political issues that may arise during implementation; and basin-wide coordinated efforts outside of the Plan Area. Monitoring and reporting costs include management of the data management system and annual monitoring (sampling, lab analysis, data collection) and reporting (data analysis, mapping, and report development). Costs are preliminary and are not marked up for inflation. These costs also do not include project development, construction or rehabilitation of infrastructure, additional monitoring sites, supplemental Plan Area analyses, additional grant development or administration, changes due to future SGMA legislation, or added compliance requirements. Costing will be refined using actual costs as the Plan is implemented.

Table 7-1: Plan Implementation Costs

	2020-2024	2025-2029	2030-2034	2035-2039	2040
Administration Costs					
Public Outreach	40,000	40,000	40,000	40,000	8,000
Insurance	50,000	50,000	50,000	50,000	10,000
Other Overhead	25,000	25,000	25,000	25,000	5,000
Professional Services					
Agency Management	1,000,000	1,000,000	1,000,000	1,000,000	200,000
Technical Consultants	250,000	250,000	250,000	250,000	0
Legal Services	200,000	200,000	200,000	200,000	40,000
Governmental/Legislative	250,000	250,000	250,000	250,000	50,000
Coordinated Cost	250,000	250,000	250,000	250,000	50,000
Monitoring & Reporting					
DMS	50,000	50,000	50,000	50,000	10,000
Annual Monitoring	100,000	100,000	100,000	100,000	20,000
Annual Reporting	100,000	100,000	100,000	100,000	20,000
Total	2,315,000	2,315,000	2,315,000	2,315,000	413,000
Annual Average	463,000	463,000	463,000	463,000	413,000

Public Outreach - Includes \$5,000 per year during years outside of GSP updates for approximately 2 GSA board meetings per year held to direct and approve expenditures for monitoring and annual report development and \$20,000 for years in which the GSP is updated for up to 2 workshops, drafting of outreach materials, and printing, posting, and other document delivery costs.

Insurance – Includes \$5,000 per year as a portion of previous insurance requirements.

Other Overhead – Includes \$5,000 per year for other incidental costs that will likely be shared with overlapping agencies within Grassland GSA and Merced County Delta-Mendota GSA.

Agency Management – Includes salaries and benefits for day-to-day operation of GSAs and Plan implementation such as annual monitoring, Basin-wide coordination, and development of Plan updates. This includes \$160,000 per year for the four years prior to GSP updates, which covers 10% of annual workload for four professional employees to perform monitoring and annual report development. This also includes \$440,000 for GSP update years to cover 25% of annual workload for four professionals to develop GSP, coordinate with Basin-wide committees, and complete other SGMA related tasks.

Technical Consultants – Includes a one-time cost of \$250,000 every 5-years for GSP development and implementation costs.

Legal Services – Includes \$100,000 for legal consulting per year.

Government/Legislative Cost – Includes \$50,000 per year for internal and consultant costs to participate in future SGMA or related groundwater legislation development.

Coordinated Cost – Includes payment for Basin-wide annual reporting and GSP development by an outside agency. Costs include a \$20,000 annual cost for coordinated annual report development and \$150,000 for GSP update development.

DMS – Includes \$10,000 per year for routine maintenance and updating of data management system and data requests and gathering by Plan Area staff. This cost does not include the Coordinated DMS cost, which has been included in the total annual Coordinated Cost above.

Annual Monitoring – Includes \$20,000 per year for annual monitoring of groundwater conditions for representative monitoring network and wells proposed for inclusion in future Plan updates.

Annual Reporting – Includes \$20,000 per year for data analysis and materials development for annual reports.

Costs will be split between GGSA and MCDMGSA as appropriate, beginning in 2020 when GSP implementation begins. Some tasks may be performed independently by GSAs while others will require coordination and development of an appropriate cost share agreement. Considerations will be made for agency area, benefitting parties, and location of monitoring points. This estimate includes salaries and benefits for employees of GSAs working on GSP implementation and development as well as expenses for outside consulting and other incidental costs. Costs should be refined in future Plan updates to reflect annual report development and any incurred Plan implementation costs.

7.2 Identify Funding Alternatives

The annual operational costs have already begun, and recently approved rate increases for water deliveries are being used to fund GGSA operations and activities required by SGMA. These activities include retaining consulting firms and other professional services to provide GSP development oversight in order to lead the GGSA through the steps for initial GSP development and future SGMA compliance. Expenses consist of administrative support, agency

management, and annual monitoring and reporting, which are assumed to be ongoing expenses. Other expenses include the development of 5-year updates. Possible additional expenses could include the development of management actions, SGMA-specific studies, and grant writing for additional funding.

GWD has adopted Resolution 18-001, which has increased water delivery rates for the first time since 2004 and secured funds to generate sufficient revenue to fund GSP development costs, annual GSA management costs, and expenses associated with the implementation of the GSP. Assessments for refuge water service will increase by \$12 per acre (an area-based rate) between 2019 and 2022, and non-CVP agricultural water deliveries will increase by \$9 per acre-foot per year (a volume-based rate) between 2019 and 2022. GWD has developed estimated budget projections that include SGMA regulatory compliance costs through Fiscal Year 2028.

Annual operating costs for MCDMGSA will be initially funded through the County of Merced. The MCDMGSA is considering mechanisms for funding the GSA through landowner fees within the MCDMGSA management area. Any funding through fees will be conducted according to the California Water Code, the California Government Code, or any other applicable legal requirements.

Several grants have been made available to both GGSA, its member agencies GWD and GRCD, and MCDMGSA. These include grants from DWR, CDFW, and the Department of Conservation. Additional grant funding will be sought to offset the costs of Plan implementation, monitoring, and updating, including but not limited to:

- Proposition 1 and Proposition 68 Grant Funding
- Federal Grant funding opportunities
- Data Management Grant
- Well videoing/inspection Grant

7.3 Schedule for Implementation

Implementation of the Plan has already begun. Data is being gathered at representative monitoring sites, coordination between Basin members is underway in anticipation of the first annual report, and projects to reduce potential impacts are being developed and constructed. However, it should be noted that the Plan Area is currently sustainable and is not experiencing undesirable results based on existing groundwater conditions and Sustainable Management Criteria. Pumping in the Plan Area is minimal; therefore, only existing projects that are currently under construction are considered in the implementation schedule, which include the North Grassland Water Conservation and Water Quality Control Project and the North Valley Regional Recycled Water Program (see Sections 6.1 and 6.2). Both of these projects have an anticipated completion date of 2019. If the need or funding arises, the GGSA and MCDMGSA may consider implementing additional programs or projects that will assist in strengthening the sustainable management of the Plan Area. Management of the GSA, annual monitoring, and GSP implementation will be ongoing processes. The data management system, annual reporting, and 5-year Plan updates are defined in the following sections.

7.4 Data Management System

GGSA has an internal monitoring and reporting system, which has been described in detail in Chapters 2 and 5. GGSA will coordinate with MCDMGSA and other plan participants to coordinate monitoring efforts and gather necessary data as defined in **Chapter 5 – Monitoring Network**. Data will be entered into the Data Management System (DMS) by staff and consultants as measurements are recorded or received. Data necessary for coordination with the Subbasin will be submitted to the SLDMWA for entry in the Basin-wide DMS. Data relative to the GSP development can be made available for review upon request.

7.5 Annual Reporting

Legal Requirements:

§ 356.2. Annual Reports

Each Agency shall submit an annual report to the Department by April 1 of each year following the adoption of the Plan. The annual report shall include the following components for the preceding water year:

- (a) General information, including an executive summary and a location map depicting the basin covered by the report.
- (b) A detailed description and graphical representation of the following conditions of the basin managed in the Plan:
 - (1) Groundwater elevation data from monitoring wells identified in the monitoring network shall be analyzed and displayed as follows:
 - (A) Groundwater elevation contour maps for each principal aquifer in the basin illustrating, at a minimum, the seasonal high and seasonal low groundwater conditions.
 - (B) Hydrographs of groundwater elevations and water year type using historical data to the greatest extent available, including from January 1, 2015, to current reporting year.
 - (2) Groundwater extraction for the preceding water year. Data shall be collected using the best available measurement methods and shall be presented in a table that summarizes groundwater extractions by water use sector, and identifies the method of measurement (direct or estimate) and accuracy of measurements, and a map that illustrates the general location and volume of groundwater extractions.
 - (3) Surface water supply used or available for use, for groundwater recharge or in-lieu use shall be reported based on quantitative data that describes the annual volume and sources for the preceding water year.
 - (4) Total water use shall be collected using the best available measurement methods and shall be reported in a table that summarizes total water use by water use sector, water source type, and identifies the method of measurement (direct or estimate) and accuracy of measurements. Existing water use data from the most recent Urban Water Management Plans or Agricultural Water Management Plans within the basin may be used, as long as the data are reported by water year.
 - (5) Change in groundwater in storage shall include the following:
 - (A) Change in groundwater in storage maps for each principal aquifer in the basin.
 - (B) A graph depicting water year type, groundwater use, the annual change in groundwater in storage, and the cumulative change in groundwater in storage for the basin based on historical data to the greatest extent available, including from January 1, 2015, to the current reporting year.
- (c) A description of progress towards implementing the Plan, including achieving interim milestones, and implementation of projects or management actions since the previous annual report.

An annual report will be developed each year that details Plan Area operations (extraction volume, surface water use, total water use, recharged surface water), groundwater conditions (groundwater levels, groundwater storage change), and progress of GSP implementation in accordance with SGMA regulation §356.2. – Annual Reports.

7.6 Periodic Evaluations

Legal Requirements:

§ 356.4. Periodic Evaluation by Agency

Each Agency shall evaluate its Plan at least every five years and whenever the Plan is amended, and provide a written assessment to the Department. The assessment shall describe whether the Plan implementation, including implementation of projects and management actions, are meeting the sustainability goal in the basin, and shall include the following:

- (a) A description of current groundwater conditions for each applicable sustainability indicator relative to measurable objectives, interim milestones and minimum thresholds.
- (b) A description of the implementation of any projects or management actions, and the effect on groundwater conditions resulting from those projects or management actions.
- (c) Elements of the Plan, including the basin setting, management areas, or the identification of undesirable results and the setting of minimum thresholds and measurable objectives, shall be reconsidered and revisions proposed, if necessary.
- (d) An evaluation of the basin setting in light of significant new information or changes in water use, and an explanation of any significant changes. If the Agency's evaluation shows that the basin is experiencing overdraft conditions, the Agency shall include an assessment of measures to mitigate that overdraft.
- (e) A description of the monitoring network within the basin, including whether data gaps exist, or any areas within the basin are represented by data that does not satisfy the requirements of Sections 352.4 and 354.34(c). The description shall include the following:
 - (1) An assessment of monitoring network function with an analysis of data collected to date, identification of data gaps, and the actions necessary to improve the monitoring network, consistent with the requirements of Section 354.38.
 - (2) If the Agency identifies data gaps, the Plan shall describe a program for the acquisition of additional data sources, including an estimate of the timing of that acquisition, and for incorporation of newly obtained information into the Plan.
 - (3) The Plan shall prioritize the installation of new data collection facilities and analysis of new data based on the needs of the basin.
- (f) A description of significant new information that has been made available since Plan adoption or amendment, or the last five-year assessment. The description shall also include whether new information warrants changes to any aspect of the Plan, including the evaluation of the basin setting, measurable objectives, minimum thresholds, or the criteria defining undesirable results.
- (g) A description of relevant actions taken by the Agency, including a summary of regulations or ordinances related to the Plan.
- (h) Information describing any enforcement or legal actions taken by the Agency in furtherance of the sustainability goal for the basin.
- (i) A description of completed or proposed Plan amendments.
- (j) Where appropriate, a summary of coordination that occurred between multiple Agencies in a single basin, Agencies in hydrologically connected basins, and land use agencies.
- (k) Other information the Agency deems appropriate, along with any information required by the Department to conduct a periodic review as required by Water Code Section 10733.

The Plan will be evaluated at least every five years and whenever the GSP is amended. The evaluation will consider current groundwater conditions, status of projects or management actions, potential needs to update Sustainable Management Criteria or other Plan elements, changes in the monitoring network, new information or data available, existing or new data gaps or actions and monitoring implemented to close data gaps, applicable enforcement or legal actions implemented, and coordination efforts with other agencies in accordance with SGMA regulation §356.4. – Periodic Evaluation by Agency.

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Appendix A – Common Chapter

July 20, 2022

Paul Gosselin
California Department of Water Resources
715 P Street
Sacramento, CA 95814

Re: Response to 'Incomplete' Determination Letter for the Delta-Mendota Subbasin

Dear Mr. Gosselin:

The Delta-Mendota Subbasin (Subbasin) received a Consultation Initiation Letter (CIL) on January 21, 2022 from the California Department of Water Resources (DWR). The CIL identified four potential deficiencies across the six Subbasin Groundwater Sustainability Plans (GSPs) which may preclude DWR's approval of the GSPs, as well as potential corrective actions to address each potential deficiency. The CIL initiated consultation between DWR, the Basin Manager, GSP Managers, and the Subbasin's 23 Groundwater Sustainability Agencies (GSAs) on February 18, 2022 regarding the amount of time needed to address the potential deficiencies and corrective actions. Subsequent meetings with DWR were held on March 7, March 30, April 19, and May 24, 2022 to discuss the Subbasin's proposed approach to addressing the identified deficiencies.

This letter has been prepared in response to the deficiencies identified in the CIL, based on direction provided by the Delta-Mendota Subbasin Coordination Committee (Coordination Committee), the Delta-Mendota Technical Working Group (Technical Working Group), the Subbasin GSAs, and DWR. It is intended to document how the deficiencies identified in the CIL were addressed in the revised GSPs and associated Common Chapter, and where those revisions are addressed in the Common Chapter.

The four deficiencies identified in DWR's CIL are summarized as follows:

Potential Deficiency 1: The GSPs do not use the same data and methodologies.

Potential Deficiency 2: The GSPs have not established common definitions of undesirable results in the Subbasin.

Potential Deficiency 3: The GSPs in the Subbasin have not set sustainable management criteria in accordance with GSP regulations.

Potential Deficiency 4: The management areas established in the Plan have not sufficiently addressed the requirements specified in 23 CCR §354.20.

Response to Potential Deficiency 1

DWR's Deficiency 1 focused on the water budget (and associated water budget components), change in groundwater storage and sustainable yield as presented in the Common Chapter. For this deficiency, DWR stated that "...the Plan lacks detail and confirmation that the six GSPs not only consider the other

GSPs within and adjacent to the Subbasin but have addressed the regulatory aspects of Sustainable Groundwater Management Act (SGMA) in a manner that substantially complies with the GSP Regulations.” Additionally, DWR stated that “Department staff find that the Plan for the Subbasin does not utilize same data and methodologies to support the various water budget, change in storage, and sustainable yield approaches; therefore, it is unclear how the GSAs will reach, let alone track, sustainability throughout the Subbasin in a coordinated manner.” To address this deficiency, DWR recommended that “The 23 GSAs developing the six GSPs should provide supporting information that is sufficiently detailed and provide explanations that are sufficiently thorough and reasonable to explain how the various components of each GSP will together achieve the Subbasin’s common sustainability goal. The explanation should describe how the sustainable management criteria established for each GSP (including management areas if applicable) relate to each other and how they are collectively informed by the basin setting, including the water budget, change in groundwater storage, and sustainable yield, on the Subbasin-wide level.”

To address Deficiency 1, the Technical Working Group and Coordination Committee met on multiple occasions during the period from February through June of 2022 to clarify and explain how the six GSPs utilized common data and methodologies to develop the Subbasin water budget, change in groundwater storage, and sustainable yield.

Use of Common Data and Methodologies

The CIL indicates that “a statement that the GSPs are coordinated without accompanying explanation is not sufficient coordination” and goes on to state that “Department staff find that the Plan for the Subbasin does not utilize same data and methodologies to support the various water budget, change in storage, and sustainable yield approaches; therefore, it is unclear how the GSAs will reach, let alone track, sustainability throughout the Subbasin in a coordinated manner.”

The following subsections summarize how the 23 GSAs and their respective six GSPs coordinated and used the same data and methodologies to support the “sum-of-the-parts” approach to compiling water budgets at the Subbasin-level using the same data and methods, as required by the SGMA and GSP Emergency Regulations, and is intended to explain and document revisions to the Common Chapter regarding the water budgets, change in storage, and calculation of Subbasin sustainable yields.

Water Budget

Regarding coordination and use of the same data and methodologies for water budget development, the CIL states that “while the categories of inflows and outflows were agreed upon by the Coordination Committee for the land surface budget and groundwater budget, each of the GSP areas prepared separate water budgets using different modeling methods while often relying upon customized hydrogeological conceptual models which were then ‘rolled-up’ to the Subbasin level.” DWR stated that “it is uncertain whether the outflow from a particular GSP within the Subbasin is comparable to the inflow from an adjacent GSP area, as there is no coordinated explanation provided in the Plan.” Additionally, the CIL states that “some of the GSP groups used numerical models to calculate the inflows and outflows from the respective GSP areas while others used non-numerical and spreadsheet models – there was no explanation in the Common Chapter that indicated how these differing modeling approaches used the same data or methodology.” The CIL also references Technical Memoranda #1 and #3, *Common Datasets and Assumptions used in the Delta-Mendota Subbasin GSPs*

and Assumptions for the Historic, Current and Projected Water Budgets of the Delta-Mendota Subbasin, Change in Storage Cross-Check and Sustainable Yield, respectively.

The purpose of the eight Technical Memoranda appended to the Common Chapter is to document the use of common data and methodologies across the six Subbasin GSPs pursuant to Water Code Section 10727.6 and Title 23, California Code of Regulations (CCR), Section 357.4 and as described in the Subbasin Coordination Agreement. In preparing the water budgets, each GSP group coordinated use of publicly available data sets along with the best available data for their GSP region. While the same data sources were used, the terminology used to describe those data sets were not consistent across the Subbasin. The Delta-Mendota Subbasin GSAs acknowledge additional detail is needed to demonstrate that all water budget components across the six Subbasin GSPs utilize the same data sources and methodologies. As such, subsequent to receipt of the CIL, the Technical Working Group met to identify the specific data used and to develop a consistent terminology for the various water budget components. Additionally, the Technical Working Group attempted to simplify the presentation of the Subbasin water budgets.

During development of the original GSPs, the Technical Working Group met monthly to ensure modeling methods and approaches were comparable and consistent between the six Subbasin GSP water budgets, including using comparable inflows and outflows between GSP regions. (Please note that all meetings were held according to the Brown Act and meeting notes available at deltamendota.org). Technical Memorandum #1 appended to the Common Chapter states that "boundary flows were evaluated by comparing inflows and outflows assessed by each GSP Group's water budget analyses and associated data, as well as groundwater flow trends from groundwater contours and hydrogeologist input. Each set of neighboring GSP Groups had independent meetings to coordinate and compare their respective contributions to inflows and outflows, and the results were provided and discussed by the Technical Working Group and Coordination Committee." Regarding the use of numerical, analytical, and spreadsheet models by the six Delta-Mendota GSP groups, Technical Memorandum #3 appended to the Common Chapter documents meetings held in September and November 2017 with DWR representatives to discuss the use of numerical and analytical models in the Subbasin, demonstrating that the hydrologic principles and equations used for both types of modeling in the Delta-Mendota Subbasin are the same.

Following receipt of the CIL, the six Delta-Mendota GSP groups agreed to a set of common simplified definitions for water budget components, and mapped their prior water budget components to the new common definitions. Table CC-8 in the revised Common Chapter documents the data sources utilized in each of the six Subbasin GSPs' historical (Water Year [WY] 2003 to 2012) and current (WY 2013) water budgets according to the common simplified water budget component definitions, and Table CC-9 includes the same information for the projected (WY 2014-2070) water budget. No water budget data were modified during this mapping process. And, as previously noted, efforts were made to use the same data sources throughout the Subbasin where available, due to variability in data availability throughout the Subbasin, the best available data were used and characterized appropriately.

The revised water budgets contained in the redline version of the Common Chapter utilize the simplified list of coordinated water budget components that use the same data sources and methods as contained in the original water budgets, but mapped to the agreed-upon set of consistent terminology. The revised land surface budget and groundwater budget tables that align with the

revised data categories are presented respectively for the historical water budget in Tables CC-10 and CC-11, for the current water budget in Tables CC-12 and CC-13, and for the projected water budget with climate change factors and projects and management actions in Tables CC-14 and CC-15. Narrative describing the simplified set of water budget components can be found starting on page CC-131 of the revised Common Chapter.

Change in Storage

DWR's CIL states that "additional explanation of historical, current, and projected change in groundwater storage for the Subbasin is warranted, as well as a straightforward quantification of overdraft throughout the Subbasin. The compilation of water budgets and the estimation of change in groundwater storage for the Subbasin does not appear to use the same data and methodology, or the Plan lacks adequate explanation for how or why the various approaches in the GSPs can be considered as using the same data and methodologies."

Additionally, the CIL stated "The explanation related to coordinated change in storage calculations and water budgets is insufficient, especially since information presented in text, and data displayed in figures and tables, do not seem to correlate with each other and it is uncertain what the current loss of storage is throughout the Subbasin. Statements in Common Chapter Section 4.2.3, state that, 'For information on how change in storage was calculated, refer to Section 4.3.3 – *Water Budgets of this Common Chapter*.' However, Section 4.3.2 only states, 'Individual historical, current, and projected water budgets were developed by each GSP Group for their respective Plan Area. For more information on the development of those water budgets, as well as tabular and graphical representation of the results, refer to the respective sections of the individual GSPs.' This fragmented and multi-staged presentation of information is insufficient to demonstrate that the various GSPs are coordinated – Section 4.2.3 of the Common Chapter refers readers to Section 4.3.2, which then refers readers to six different GSP sections. For the Upper Aquifer, four methods [were] chosen by the respective GSP regions and summed to a subbasin total." The CIL also noted, for the Lower Aquifer, "... two methods [were] chosen by the respective GSP regions and summed to a Subbasin total."

The change in groundwater storage from the Upper Aquifer was calculated using the coordinated water budgets at the Subbasin level. Water level hydrographs and groundwater storage coefficients were used to cross-check the inputs to the water budget. All six GSPs used observed land subsidence to determine Lower Aquifer change in groundwater storage. Where data were available, water budgets for the Lower Aquifer were used as a cross-check. In response to both comments (Upper and Lower Aquifer changes in groundwater storage), please refer to Table CC-8 and Table CC-9 in the revised Common Chapter (with associated narrative found on pages CC-137 through CC-138) for information regarding the use of same data and methodologies used to calculate change in storage across the six Subbasin GSPs for the historical, current, and projected water budgets, respectively, with Subbasin-level change in storage presented in Table CC-11 for the historical water budget, Table CC-13 for the current water budget, and Table CC-15 for the projected water budget.

Finally, the CIL noted a discrepancy in compiled cumulative change in storage values presented in the Common Chapter. The text on page CC-98 of the Common Chapter has been edited to address a typographical error and provide the correct cumulative change in storage in each principal aquifer between WYs 2003 and 2013, which is -624,000 acre-feet in the Upper Aquifer and -375,000 acre-feet in the Lower Aquifer.

Sustainable Yield

The CIL states: "The Common Chapter (Section 4.3.4) and Technical Memoranda #3 address the methodology for calculating sustainable yield in the Subbasin. Of the six GSPs, three provide a sustainable yield specifically for the GSP area while the other three rely upon the estimate for the entire Subbasin." The CIL also notes that "as indicated throughout the Plan, a sustainable yield estimate is not established for each GSP area and those estimates are not correlated with undesirable results." The CIL also notes, under Deficiency 2, that common definitions for significant and unreasonable were not established at the Subbasin level and there were 17 management areas that created uncertainties as to how the SMCs were coordinated with the sustainable yield.

In response to these comments, the Subbasin has now established common definitions in response to Deficiency 2, and has removed the designation of management areas in response to Deficiency 4. Sustainable yield for each principal aquifer is discussed starting on page CC-150.

Additional Coordination Components

DWR's CIL also questions the use of same data and methodologies for groundwater elevation data, groundwater extraction data, surface water supply data, and total water use data (defined as evapotranspiration in the historical, current, and projected water budgets). All of these components are inputs into the coordinated water budget; see Tables CC-8 and CC-9 and the associated water budget narrative beginning on page CC-131 of this revised Common Chapter.

Response to Potential Deficiency 2

The CIL for potential deficiency 2 states, "The GSPs have not established common definitions of undesirable results in the Subbasin." To address this deficiency, DWR's recommended corrective action was that the GSAs "...should modify each of their respective GSPs, as well as any applicable coordination materials, to substantially comply with the GSP Regulations and define undesirable results in a manner that addresses groundwater conditions occurring throughout the Subbasin..."

The Technical Working Group and Coordination Committee met to develop, at a Subbasin level, coordinated definitions and methods for establishing sustainable management criteria (SMC) for each applicable sustainability indicator. These revised definitions, and the associated numeric SMC developed using the agreed-upon methodologies, are summarized in the revised Common Chapter (see Tables CC-16 through CC-23 and Figures CC-65 through CC-70) and in the respective Sustainable Management Criteria chapters of each Subbasin GSP. Additionally, see the Response to Potential Deficiency 3, below, for more information relative to the development of the coordinated SMC.

Response to Potential Deficiency 3

DWR's Deficiency 3 comments built on their Deficiency 2 comments, stating that the Subbasin did not comply with the Emergency GSP Regulations in establishing common definitions and methodologies for SMC. In response to these comments, the six individual GSPs have been revised to reflect the agreed-upon Subbasin-wide sustainability goal as stated on page CC-153 of the revised Common Chapter, and the Technical Working Group and Coordination Committee met to develop common definitions of significant and unreasonable impacts, common methodologies for establishing numeric MTs and MOs, and common interim milestones for each sustainability indicator. See Tables CC-16

through CC-23 for these revised SMC, and narrative describing the process starting on page CC-154 of the revised Common Chapter.

Response to Potential Deficiency 4

Deficiency 4, as detailed in DWR's CIL, pertains to the use of a total of 17 management areas in four of the six GSPs prepared for the Subbasin, stating "The Management Areas established in the Plan have not sufficiently addressed the requirements" ...defined in SGMA.

In response to the DWR comments, the Subbasin GSAs agreed to eliminate or rename the formerly identified management areas as monitoring zones throughout the six GSPs and Common Chapter, and to continue to monitor and manage groundwater use in these monitoring zones according to the metrics previously set forth. Therefore, in the six GSPs and Common Chapter, all management areas have been renamed monitoring zones.

Please feel free to contact me at (209) 826-1872 if there are any questions regarding our responses to the January 21, 2022 CIL, the work conducted by the Subbasin to prepare those responses, and revisions made to the six Subbasin GSPs and Common Chapter.

Sincerely,



John Brodie

Delta-Mendota Subbasin Plan Administrator

DELTA - MENDOTA SGMA

Common Chapter

For the Delta-Mendota Subbasin Groundwater Sustainability Plan

August 2019; revised June 2022





Delta-Mendota Groundwater Subbasin

Groundwater Sustainability Plan: Revised Common Chapter

Prepared by:



August 2019; Revised June 2022

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Appendices

Appendix A – Coordination Agreement

Appendix B – Common Technical Memoranda

Appendix C – Preparation Checklist for GSP Submittal

Appendix D – Interbasin Agreements

Appendix E – Delta-Mendota Subbasin Communications Plan

Appendix F – Summaries of Coordinated Public Workshops

Appendix G – Examples of Promotional Materials from Public Workshops

Appendix H – List of Stakeholders and Community Organizations Contacted

Acronyms

AB 3030	1992 California Assembly Bill 3030
AWMP	Agricultural Water Management Plan
BMP	Best Management Practice
CASGEM	California Statewide Groundwater Elevation Monitoring
CCC	Columbia Canal Company
CCF	Climate Change Factors
CCID	Central California Irrigation District
CDEC	California Data Exchange Center
CDFW	California Department of Fish and Wildlife
cfs	cubic feet per second
CVO	Central Valley Operations
CVP	Central Valley Project
CVRWQCB	Central Valley Regional Water Quality Control Board
DAC	Disadvantaged Community
DMC	Delta-Mendota Canal
DPWD	Del Puerto Water District
DWR	California Department of Water Resources
ET	Evapotranspiration
ET _c	Total Crop Evapotranspiration
ET _{iw}	Crop Evapotranspiration of Irrigation Water
ET _{misc}	Miscellaneous Evapotranspiration including; canal evaporation, consumptive use of phreatophytes, etc.
FCWD	Firebaugh Canal Water District
FNF	Full Natural Flow
GAMA	Groundwater Ambient Monitoring and Assessment
gpm	gallons per minute
GRCD	Grassland Resource Conservation District
GSA	Groundwater Sustainability Agency
GSP	Groundwater Sustainability Plan
GWD	Grassland Water District

Acronyms

HCM	Hydrogeologic Conceptual Model
HMRD	Henry Miller Reclamation District
IM	interim milestone
IRWM	Integrated Regional Water Management
JPA	Joint Powers Authority
KDSA	Kenneth D. Schmidt and Associates
MAF	million acre-feet
MO	measurable objective
MSL	Mean Sea Level
MT	minimum threshold
NASA JPL	National Aeronautics and Space Administration Jet Propulsions Laboratory
P&P	Provost and Pritchard Consulting Group
RCD	Resource Conservation District
RWQCB	Regional Water Quality Control Board
SB 372	2017 California Senate Bill 372
SGMA	Sustainable Groundwater Management Act
SGWP	Sustainable Groundwater Planning
SJREC	San Joaquin River Exchange Contractors
SJRECWA	San Joaquin River Exchange Contractors Water Authority
SJRIP	San Joaquin River Improvement Program
SJRRP	San Joaquin River Restoration Program
SLDMWA	San Luis & Delta-Mendota Water Authority
SMC	Sustainable Management Criteria
SWP	State Water Project
SWRCB	State Water Resources Control Board
TAF	thousand acre-feet
TDS	Total Dissolved Solids
TIWD	Turner Island Water District
TNC	The Nature Conservancy
UNAVCO	University NAVSTAR Consortium

Acronyms

USACE	U.S. Army Corps of Engineers
USBR	U.S. Bureau of Reclamation
USF&WS	U.S. Fish & Wildlife Service
USGS	United States Geological Survey
UWMP	Urban Water Management Plan
WDL	Water Data Library
WMP	Water Management Plan
WSIP	Water Storage Investment Program
WWD	Westlands Water District
WY	Water Year

DISCLAIMER

The work products presented in this Common Chapter and associated Technical Memoranda (Appendix B) are a compilation of work completed by the six (6) individual Groundwater Sustainability Plan (GSP) regions under the direction of a Professional Geologist (PG) or Professional Engineer (PE) as indicated by the stamps on the respective GSP Executive Summaries. The signature here represents work completed in compiling the Common Chapter from these individual GSPs, and the signing Professional Engineer assumes no responsibility for any errors or misleading statements presented therein. Compilation of the Common Chapter, exclusive of work conducted for the individual GSPs, and revisions to this Common Chapter have been prepared under the oversight of Leslie Dumas, P.E. and the signature below is specifically for that compilation.

1. INTRODUCTION

1.1 Purpose of Common Chapter

The 23 Groundwater Sustainability Agencies (GSAs) overlying the Delta-Mendota Subbasin (Subbasin) have prepared six Groundwater Sustainability Plans (GSPs) that, together, encompass the entire Subbasin area (**Figure CC-1**). These GSPs have been prepared in a coordinated manner under the oversight of the Delta-Mendota Subbasin Coordination Committee (Coordination Committee) and in accordance with the Delta-Mendota Subbasin Coordination Agreement (Coordination Agreement) for the Subbasin. This Common Chapter has been prepared as means of integrating key parts of the six GSPs to meet subbasin-level requirements per the Sustainable Groundwater Management Act (SGMA) and the Emergency GSP regulations (DWR, 2016).

On January 21, 2022, the Subbasin received a Consultation Initiation Letter (CIL) from the California Department of Water Resources (DWR). The CIL identified four potential deficiencies across the six Subbasin GSPs which may preclude DWR’s approval, as well as potential corrective actions to address each potential deficiency. The CIL thus initiated consultation between DWR, the Subbasin Point of Contact, Plan Managers, and the Subbasin’s GSAs. This Common Chapter has been revised to incorporate changes required to reflect the Subbasin’s response to the deficiencies identified in the CIL, based on direction provided by the Coordination Committee, the Delta-Mendota Technical Working Group (Technical Working Group), the Subbasin GSAs and DWR. This revised Common Chapter, along with the attached cover letter, are intended to document how the deficiencies identified in the CIL were addressed in the revised Subbasin GSPs and this revised Common Chapter.

This revised Common Chapter, along with the six Subbasin GSPs, Coordination Agreement (**Appendix A**) and Common Technical Memoranda (**Appendix B**), meets regulatory requirements established by DWR as shown in the completed *Preparation Checklist for GSP Submittal* (**Appendix C**). The Common Technical Memoranda summarize the common data sets, assumptions and methodologies used during preparation of the six Subbasin GSPs. The reader is referred to the individual GSP (and their associated Executive Summaries) for information, data, and GSP requirements specific to each GSP Plan Area.

1.2 Delta-Mendota Subbasin

The Delta-Mendota Subbasin (DWR Basin 5-022.07) is located in the San Joaquin Valley Groundwater Basin and adjoins nine (9) subbasins of the San Joaquin Valley Groundwater Basin. The Delta-Mendota Subbasin boundaries generally correspond to DWR’s California’s Groundwater Bulletin 118 – Update 2003 (Bulletin 118) groundwater basin boundaries. Changes made to the Subbasin boundaries as part of the SGMA planning process include the following:

- A jurisdictional internal boundary modification made in 2016 to extend the boundary of the Delta-Mendota Subbasin eastward to include all of Aliso Water District.
- A jurisdictional internal boundary modification made in 2016 to bring areas that straddle the Delta-Mendota Subbasin and adjacent subbasins fully within the Delta-Mendota Subbasin. This modification adjusted areas from the southern boundary of the Delta-Mendota Subbasin and the Westside Subbasin in coordination with Westlands Water District, and moved the eastern boundary of the Delta-Mendota Subbasin from the Madera Subbasin into the Delta-Mendota

Subbasin in coordination with Aliso Water District. The modification also moved areas from the Tracy Subbasin into the Delta-Mendota Subbasin so that Del Puerto Water District and West Stanislaus Irrigation District were fully within the Delta-Mendota Subbasin, and cleaned up boundaries between the Delta-Mendota Subbasin and the Kings Subbasin to conform with the boundaries of Tranquillity Irrigation District and the Traction Ranch property (bounded on the east by Mid-Valley Water District).

- A jurisdictional internal boundary modification made in 2018 to modify the boundary between the Delta-Mendota and the Chowchilla Subbasins to follow the western boundary of Triangle T Water District and the southern boundary of Clayton Water District. This modification moved approximately 700 acres of land from the Chowchilla Subbasin into the Delta-Mendota Subbasin.

The western San Joaquin Valley is a highly agricultural region with an economy dependent on that industry. There are no large cities or industries in the Delta-Mendota Subbasin to provide an alternative economic base; hence the availability of Central Valley Project (CVP) imported supplies and surface water supplies (primarily from the San Joaquin and Kings River) are essential elements to the economic health of the region. Other uses of CVP and surface water in the Subbasin are for municipal and industrial (M&I) purposes and wildlife refuge water supply.

Groundwater is a key component of overall water supplies in the Delta-Mendota Subbasin. Agricultural and wildlife refuge needs may be supplemented by groundwater for areas with access to CVP water. Other landowners within the Subbasin may rely wholly on groundwater for irrigation and/or potable purposes. Municipal and industrial (M&I) water use, which is a small share of total water use in the Subbasin, occurs primarily within the cities, and predominantly uses groundwater to meet those demands. The largest M&I use areas in the Delta-Mendota Subbasin, based on 2015 population estimates from the U.S. Census Bureau, are the cities of Patterson (population 21,498) and Los Banos (population 37,457) (U.S. Census Bureau, 2015).

As previously noted, most communities within the Delta-Mendota Subbasin have economies greatly dependent on agricultural production. These communities include Patterson, Grayson, Tranquillity, Mendota, Firebaugh, Dos Palos, Los Banos, Santa Nella, Newman, Gustine, Crows Landing, Westley, Volta, and Vernalis.

1.3 Disadvantaged Communities within the Delta-Mendota Subbasin

A disadvantaged community (DAC) is defined as a community with a Median Household Income (MHI) less than 80% of the California statewide MHI. The California Department of Water Resources (DWR) compiled U.S. Census Bureau's American Community Survey (ACS) data from 2012 to 2016; these data were used in GIS to identify DACs within the Delta-Mendota Subbasin. California's average statewide MHI from 2012 to 2016 is \$63,783; thus, a community with an MHI less than or equal to \$51,026 is considered a DAC. Based on these criteria, 93% of the geographic area of the Subbasin is considered disadvantaged. Furthermore, a community with an MHI of less than 60% of the California statewide MHI, meaning an MHI of less than or equal to \$38,270, is considered a severely disadvantaged community (SDAC). According to the U.S. Census ACS 2012-2016 data, there are a number of SDACs throughout the Subbasin. See **Figure CC-2** for a map of the DACs and SDACs throughout the Delta-Mendota Subbasin.

As noted above, a significant portion of the Subbasin contains DACs. Of the total population of 117,120 within the Subbasin, 80% of the population lives within a DAC, with 93% of the Subbasin's total geographic area consisting of DACs. **Table CC-1** includes the proportion of DACs in the Subbasin based on population and geographic area.

Table CC-1: DACs as a Percentage of the Delta-Mendota Subbasin

Area	Geographic Area (Square Miles)	% Based on Geographic Area	Population	% Based on Population
DAC (including SDAC)	1,109	93%	93,786	80%
Delta-Mendota Subbasin	1,194		117,120	

Table CC-2 includes Census Designated Places that are DACs in the Delta-Mendota Subbasin, with their associated MHIs and percentage of the California MHI from the ACS 5-Year 2012-2016 average. Several DACs in the Subbasin have considerably lower MHI than 80% of the California Statewide MHI and are further designated as Severely Disadvantaged Communities (SDACs). In **Table CC-2**, SDACs are indicated in bold text. Note that according to the U.S. Department of the Interior Indian Affairs, as of January 2017, there are no listed federally recognized tribes within the Region (Mosley, 2017).

Table CC-2: DAC and SDAC Census Designated Places in Delta-Mendota Subbasin

Census Designated Place (CDP)	Median Household Income (MHI)	% of CA MHI
City of Dos Palos	\$36,509	57%
City of Firebaugh	\$36,181	57%
City of Gustine	\$37,770	59%
City of Los Banos	\$45,751	72%
City of Mendota	\$26,094	41%
City of Newman	\$52,783	83%
Crows Landing	\$26,786	42%
Dos Palos Y (CDP)	\$16,656	26%
Grayson	\$29,787	47%
Madera County	\$45,490	74%
Merced County	\$43,066	70%
Fresno County	\$45,963	72%
Santa Nella	\$27,778	44%
South Dos Palos	\$41,992	66%
Tranquillity	\$30,441	48%
Volta	\$48,250	76%
Westley	\$23,375	37%
Data Sources: 1. U.S. Census ACS data from 2012 to 2016 provided by DWR Mapping Tool.		

Census Designated Place (CDP)	Median Household Income (MHI)	% of CA MHI
2. MHI data are from the 2016 Census, and percent of CA MHI is calculated based on the 2012-2016 Statewide MHI. Bold rows indicate severely disadvantaged communities (less than 60% of CA Statewide MHI).		

1.4 Economically Disadvantaged Areas within the Delta-Mendota Subbasin

An economically distressed area (EDA) is defined by the State of California as a “municipality with a population of 20,000 persons or less, a rural county, or a reasonably isolated and divisible segment of a larger municipality where the segment of the population is 10,000 persons or less, with an annual median household income that is less than 85% of the statewide median household income, and with one or more of the following conditions as determined by the (sic) Department of Water Resources:

1. Financial hardship
2. Unemployment rate at least two percent higher than the statewide average
3. Low population density (CA Assembly, 2014).”

U.S. Census GIS data provided by DWR were used to identify EDAs in the Delta-Mendota Subbasin.

Figure CC-3 shows the location of EDAs within the Delta-Mendota Subbasin

A significant portion of the Subbasin contains EDAs. Of the total population of 117,120 within the Subbasin, 87% live in areas that meet EDA Criterion 2, 20% live in areas that meet EDA Criterion 3, and 87% live in areas that meet Criteria 2 or 3. In all, 93% of the geographic area within the Subbasin consists of areas considered to meet either EDA Criteria 2 or 3. **Table CC-3** includes the proportion of EDAs in Subbasin based on population and geographic area.

Table CC-3: EDAs as a Percentage of the Delta-Mendota Subbasin

Area	Geographic Area (Square Miles)	% Based on Geographic Area	Population	% Based on Population
EDA Criterion 2	1,112	93%	102,407	87%
EDA Criterion 3	1,004	84%	23,688	20%
EDA Criteria 2 or 3	1,112	93%	102,407	87%
Delta-Mendota Subbasin	1,194		117,120	

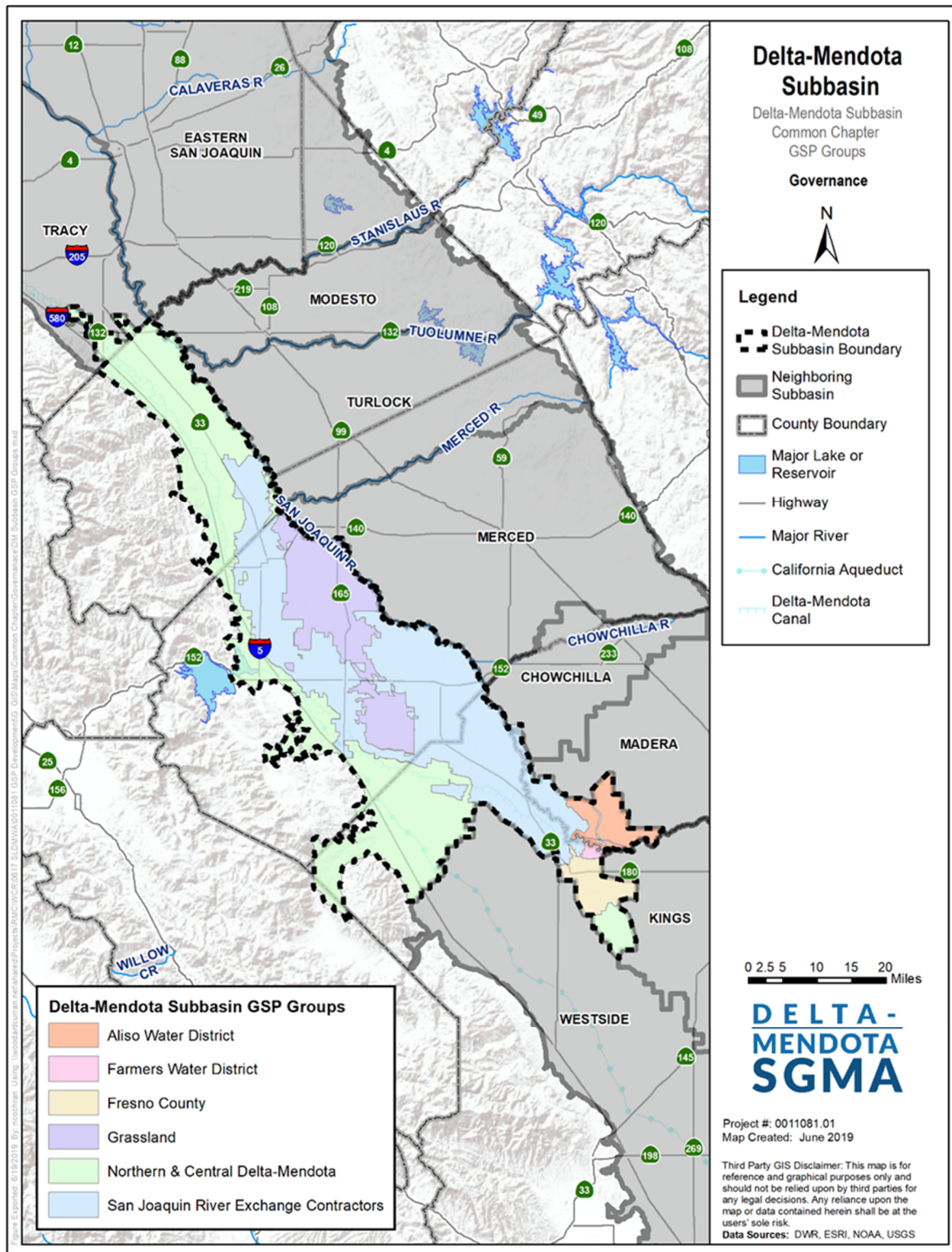


Figure CC-1: Delta-Mendota Subbasin and GSP Regions

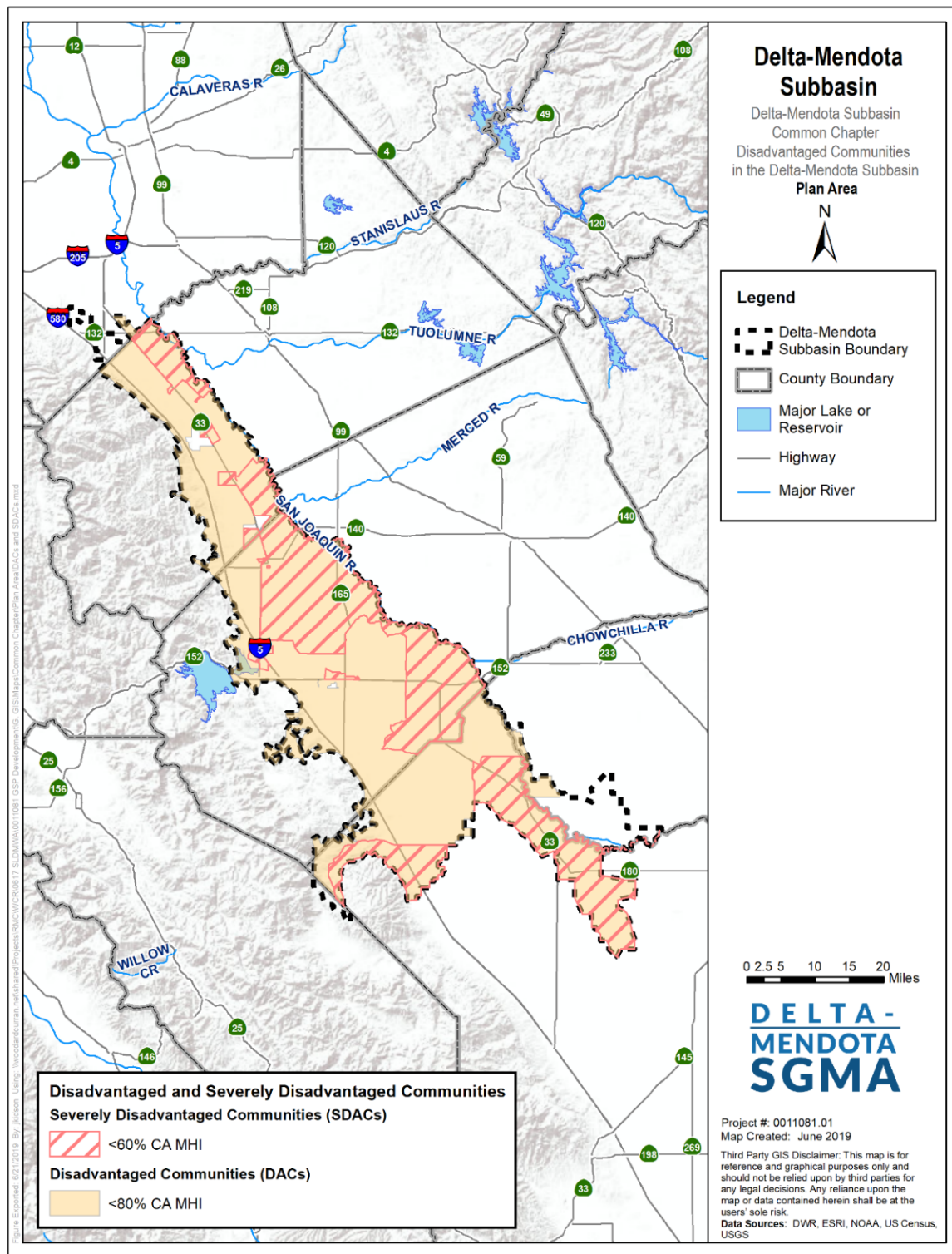


Figure CC-2: Disadvantaged and Severely Disadvantaged Communities in the Delta-Mendota Subbasin

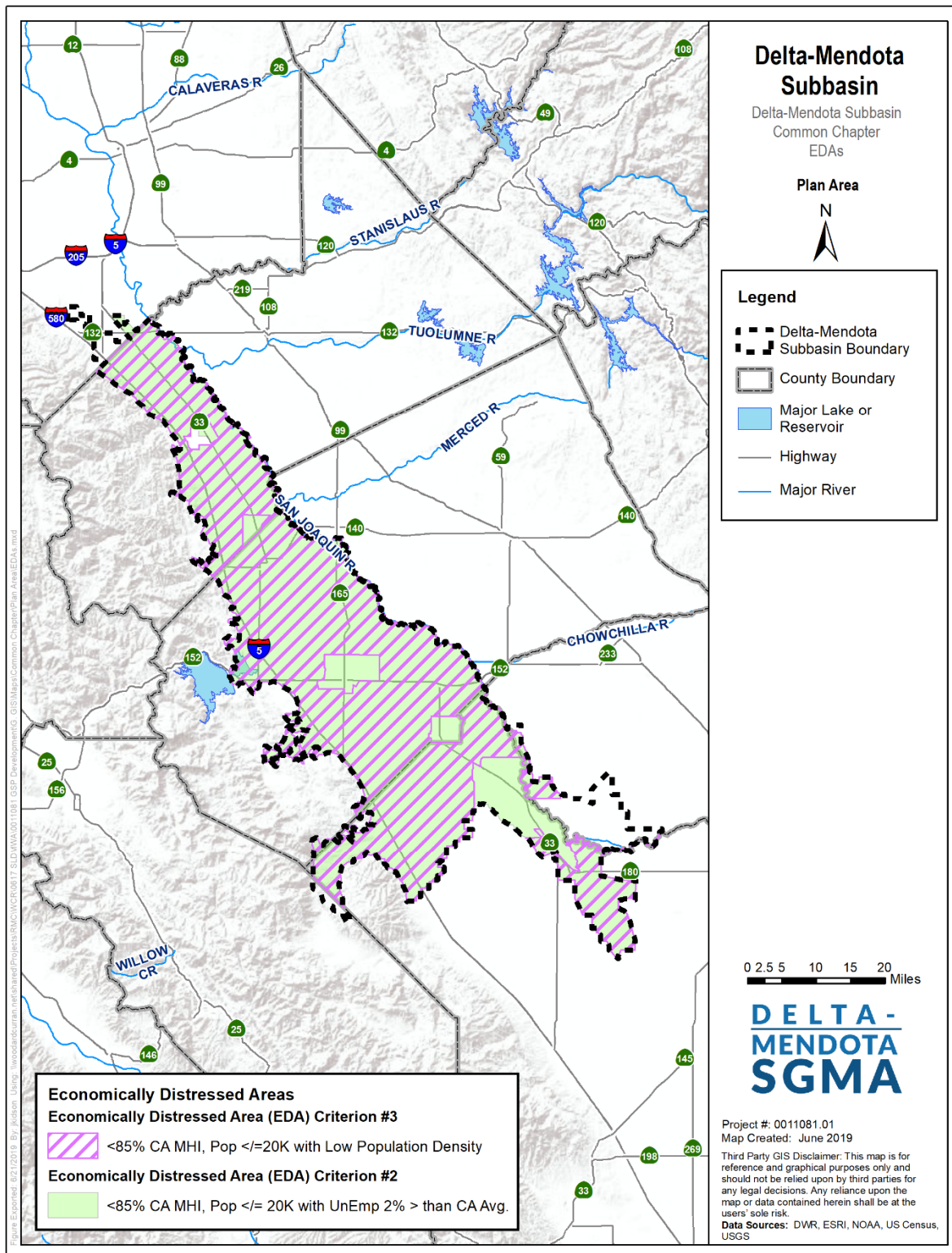


Figure CC-3: Economically Distressed Areas in the Delta-Mendota Subbasin

2. DELTA-MENDOTA SUBBASIN GOVERNANCE

This section includes information pursuant to Article 5. Plan Contents, Subarticle 1. Administrative Information, § 354.6 (Agency Information) as well as Subarticle 8. Interagency Agreements (§ 357.2 Interbasin Agreements and § 357.4 Coordination Agreements), as required by the Groundwater Sustainability Plan (GSP) Regulations. Agency Contact information for the Delta-Mendota Subbasin and the plan manager is included in this section. The organization and management structure, as well as the legal authority of each Groundwater Sustainability Agency (GSA) in the Delta-Mendota Subbasin, is detailed and accompanied by GSA boundary maps and a description of intra-basin and inter-basin coordination agreements in place for the development and implementation of the GSPs overlying the Delta-Mendota Subbasin.

Agency Contact Information

This Common Chapter to the six GSPs for the Delta-Mendota Subbasin has been prepared in a cooperative manner by the following GSAs in the Delta-Mendota Subbasin:

Northern & Central Delta-Mendota Region GSP

- Patterson Irrigation District GSA
- West Stanislaus Irrigation District GSA
- DM-II GSA
- City of Patterson GSA
- Northwestern Delta-Mendota GSA
- Central Delta-Mendota GSA
- Widren Water District GSA
- Oro Loma Water District GSA

San Joaquin River Exchange Contractors (SJREC) GSP

- San Joaquin River Exchange Contractors Water Authority GSA
- Turner Island Water District-2 GSA
- City of Mendota GSA
- City of Firebaugh GSA
- City of Los Banos GSA
- City of Dos Palos GSA
- City of Gustine GSA
- City of Newman GSA
- Madera County – 3 GSA
- Portion of Merced County – Delta-Mendota GSA
- Portion of Fresno County Management Area B GSA

Grassland GSP

- Grassland GSA
- Portion of Merced County – Delta-Mendota GSA

Aliso Water District GSP

- Aliso Water District GSA

Farmers Water District GSP

- Farmers Water District GSA

Fresno County GSP

- Fresno County Management Area A GSA
- Portion of Fresno County Management Area B GSA

The plan areas covered by each of the six Subbasin GSPs is show in **Figure CC-1. Figure CC-4** through **Figure CC-6** show the location of the GSAs comprising the six GSP regions. These GSAs are coordinating development and implementation of the six GSPs under the Coordination Agreement, as described below in Section 2.1.

The current Plan Manager for the coordinated Delta-Mendota Subbasin GSPs is John Brodie, Water Resources Program Manager for San Luis & Delta-Mendota Water Authority (SLDMWA). Mr. Brodie can be contacted as follows:

Mr. John Brodie, Plan Manager
Delta-Mendota Subbasin
842 6th Street
Los Banos, CA 93635
Phone: (209) 826-1872/ Fax (209) 833-1034
john.brodie@sldmwa.org

Contact information for each GSP plan administrator can be found in the respective GSPs. The DWR Point of Contact is shown below.

Department of Water Resources Point of Contact

The point of contact for the Delta-Mendota Subbasin is:

Christopher Olvera
Department of Water Resources
Christopher.Olvera@water.ca.gov
(559) 230-3373

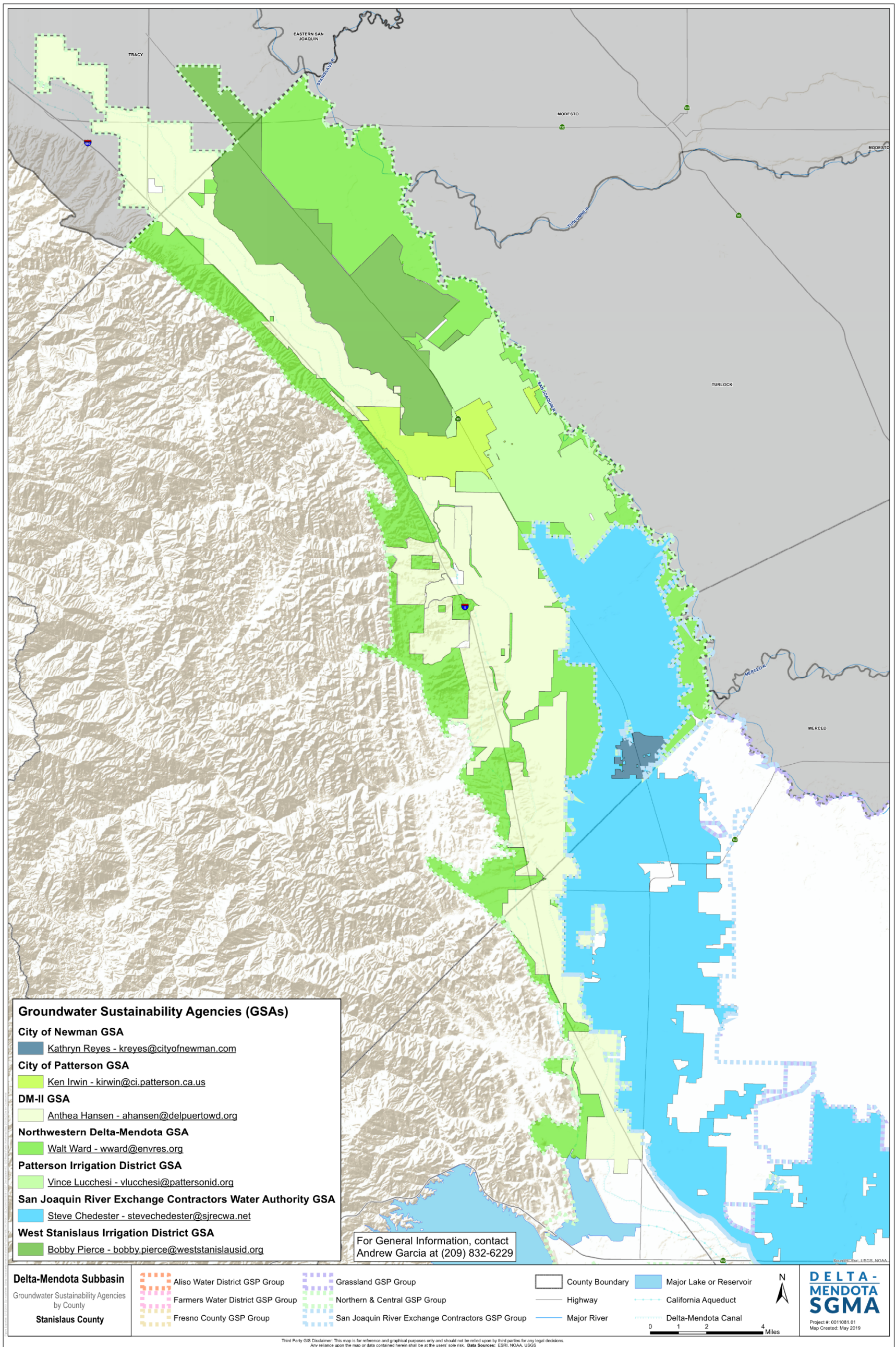


Figure CC-4: GSAs in the Delta-Mendota Subbasin – Stanislaus County

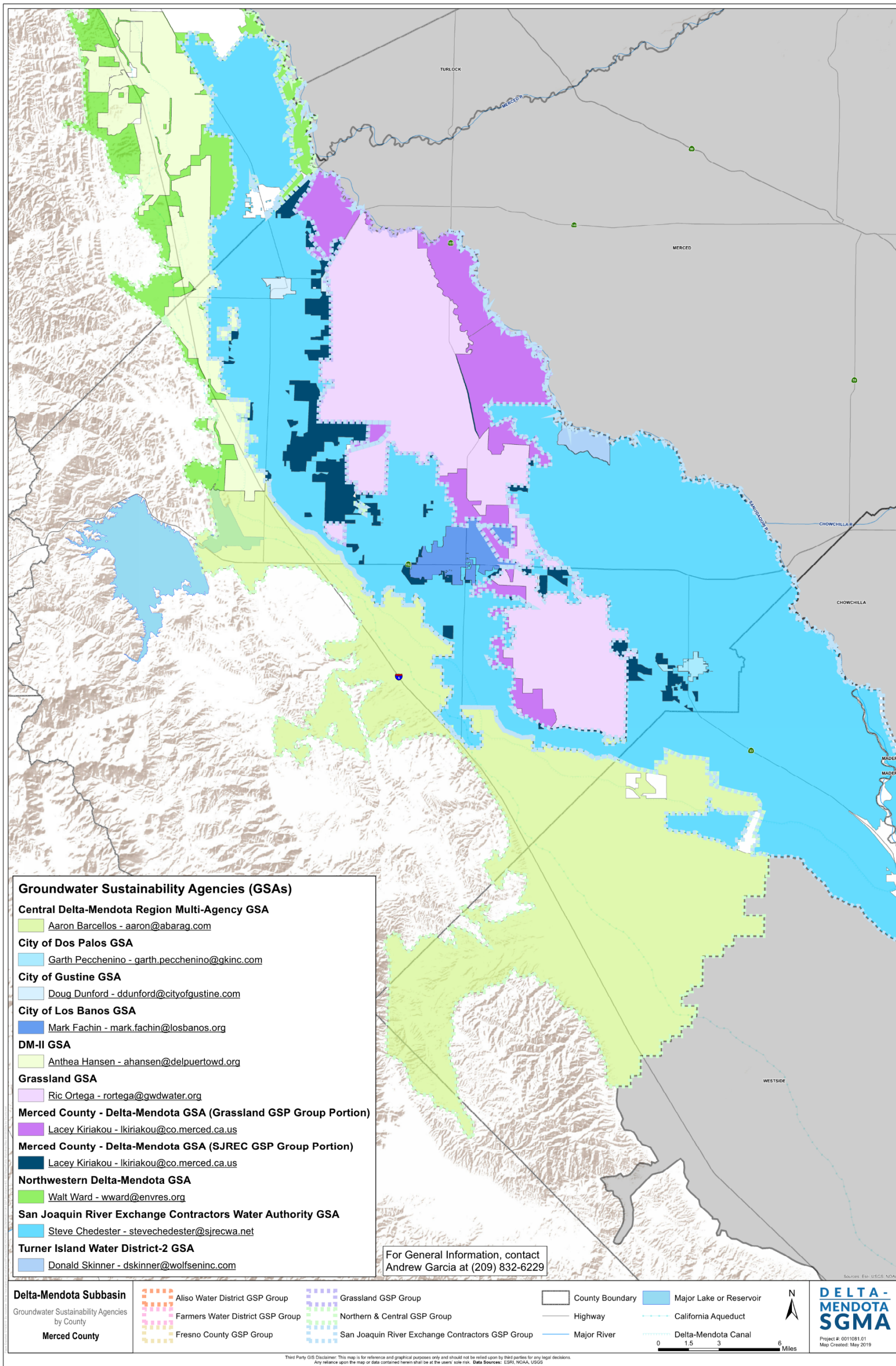


Figure CC-5: GSAs in the Delta-Mendota Subbasin – Merced County

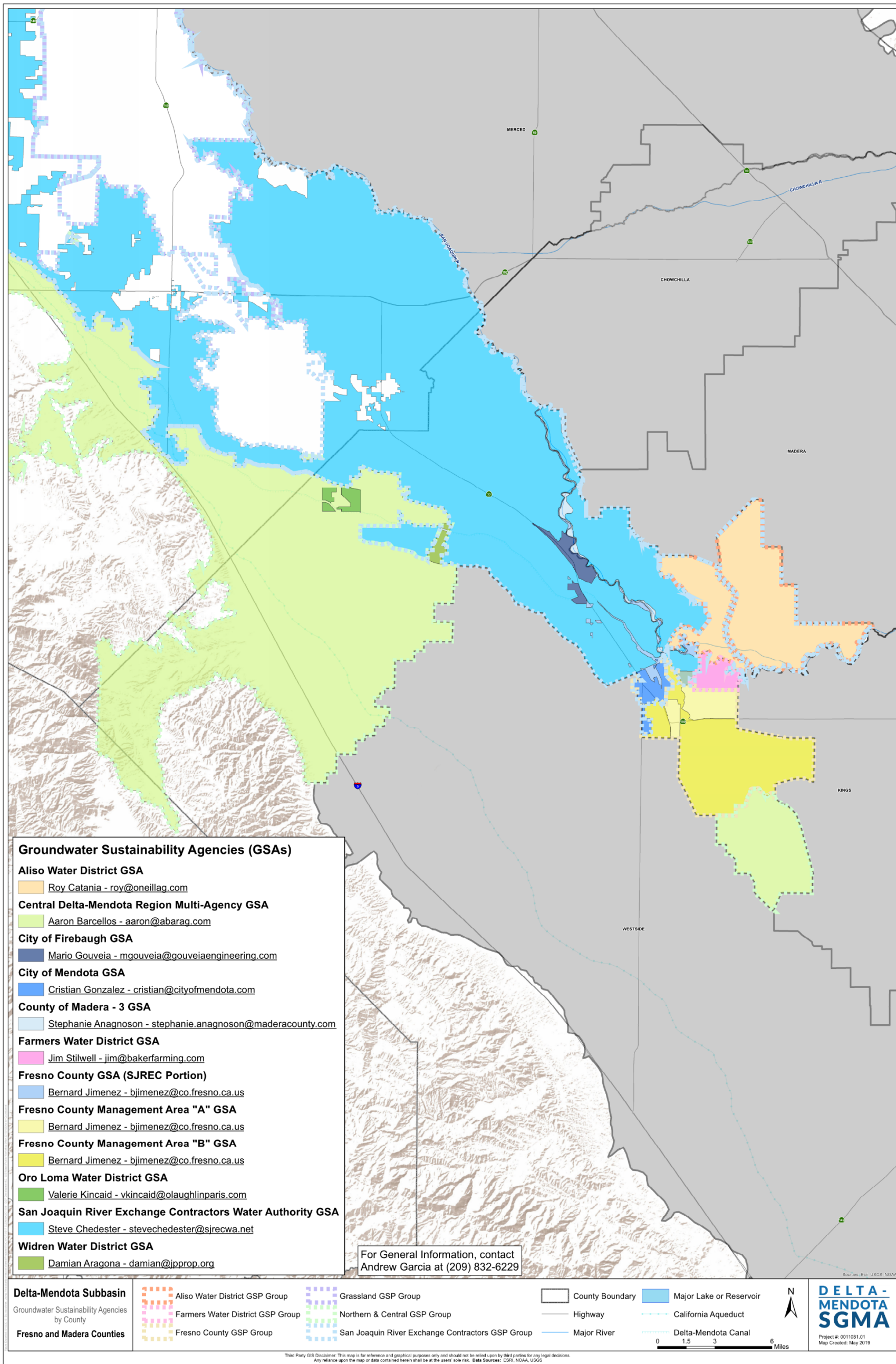


Figure CC-6: GSAs in the Delta-Mendota Subbasin – Fresno and Madera Counties

2.1 GSA and GSP Coordination and Governance

This section includes a description of intra-basin coordination agreements, which are required where there is more than one GSP prepared for a groundwater basin, and inter-basin coordination agreements, which are optional agreements between neighboring groundwater subbasins, pursuant to Article 8. Interagency Agreements, § 357.4. Coordination Agreements and § 357.2 Interbasin Agreements.

2.1.1 Delta-Mendota Subbasin SGMA Governance Structure

The GSAs within the Delta-Mendota Subbasin adopted and executed a Coordination Agreement on December 12, 2018 to comply with the SGMA requirement that multiple GSAs within a given subbasin must coordinate when developing and implementing their GSPs (see Intra-Agency Coordination subsection above for more information). Additionally, a Cost Sharing Agreement was signed and executed by the same parties on December 12, 2018. **Figure CC-5** shows the SGMA governance structure within the Delta-Mendota Subbasin. In addition to the two members appointed to represent each of the Northern & Central Delta-Mendota GSP Region and the San Joaquin River Exchange Contractors (SJREC) GSP Region on the Delta-Mendota Subbasin Coordination Committee as voting members, the Grassland GSP Region, Farmers Water District GSP Region, Fresno County Management Areas A & B GSP Region, and Aliso Water District GSP Region all have appointed one voting member each for a total of eight voting members.

Three working groups were formed under the auspices of the Delta-Mendota Subbasin Coordination Committee: the Technical Working Group, the Communications Working Group and the DMS Working Group. Representatives of each GSP region participate in each working group.

Table CC-4: Delta-Mendota Subbasin Coordination Committee Members

GSP		GSA	Agency	Coordination Committee Members	
				Primary	Alternate
Northern & Central Delta-Mendota Region GSP	Northern Delta Mendota Region Management Committee	Patterson Irrigation District GSA	Patterson Irrigation District	Vince Lucchesi	Walt Ward
			Twin Oaks Irrigation District		
		West Stanislaus Irrigation District GSA	West Stanislaus Irrigation District		
		DM-II GSA	Del Puerto Water District		
			Oak Flat Water District		
		City of Patterson GSA	City of Patterson		
	Central Delta-Mendota Region Management Committee	Central Delta-Mendota GSA	Northwestern Delta-Mendota GSA	Ben Fenters	Lacey Kiriakou
			Merced County		
			Fresno County		
			San Luis Water District		
			Panoche Water District		
			Tranquillity Irrigation District		
			Fresno Slough Water District		
			Eagle Field Water District		
			Pacheco Water District		
			Santa Nella County Water District		
			Mercy Springs Water District		
			Merced County		
			Fresno County		
		Widren Water District GSA	Widren Water District		
		Oro Loma Water District GSA	Oro Loma Water District		

GSP	GSA	Agency	Coordination Committee Members	
			Primary	Alternate
San Joaquin River Exchange Contractors GSP	San Joaquin River Exchange Contractors Water Authority GSA	Central California Irrigation District	Jarrett Martin, Alejandro Paolini	Chris White, John Wiersma
		Columbia Canal Company		
		Firebaugh Canal Water District		
		San Luis Canal Company		
	Turner Island Water District-2 GSA	Turner Island Water District		
	City of Mendota GSA	City of Mendota		
	City of Firebaugh GSA	City of Firebaugh		
	City of Los Banos GSA	City of Los Banos		
	City of Dos Palos GSA	City of Dos Palos		
	City of Gustine GSA	City of Gustine		
	City of Newman GSA	City of Newman		
	County of Madera – 3 GSA	County of Madera		
	Portion of Merced County – Delta-Mendota GSA	County of Merced		
	Portion of Fresno County Management Area B GSA	County of Fresno		
Grassland GSP	Grassland GSA	Grassland Water District	Ric Ortega	Ken Swanson
		Grassland Resource Conservation District		
	Portion of Merced County Delta-Mendota GSA	County of Merced		
Farmers Water District GSP	Farmers Water District GSA	Farmers Water District	Jim Stilwell	Don Peracchi
Fresno County GSP	Fresno County – Management Area A	County of Fresno	Buddy Mendes	Glenn Allen or Augustine Ramirez

GSP	GSA	Agency	Coordination Committee Members	
			Primary	Alternate
	Fresno County – Management Area B	County of Fresno		
Aliso Water District GSP	Aliso Water District GSA	Aliso Water District	Joe Hopkins	Board Secretary (Ross Franson)

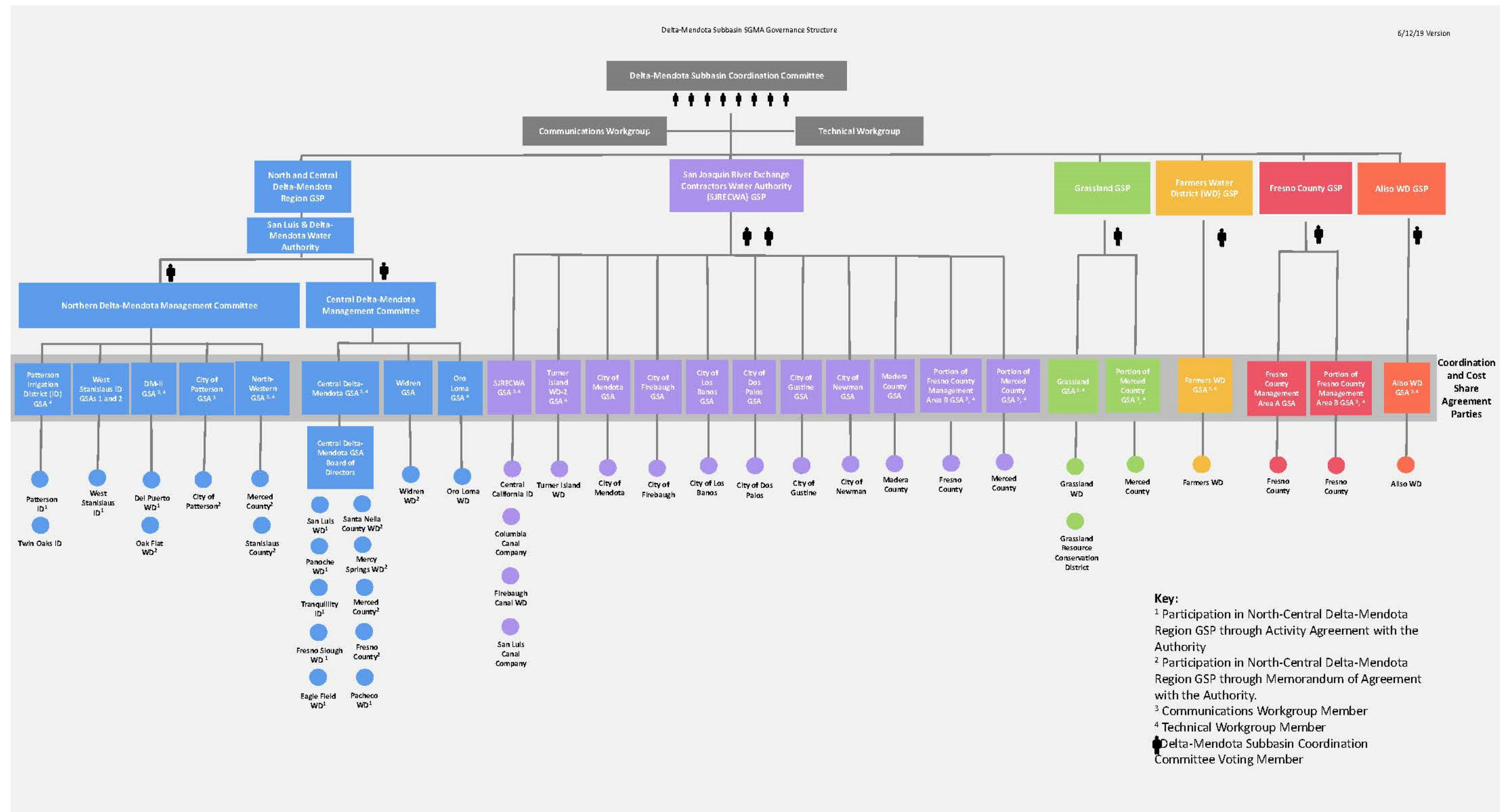


Figure CC-7: Governance Structure of the Delta-Mendota Subbasin

2.1.2 Intra-Basin Coordination

The Delta-Mendota Subbasin Coordination Agreement (Coordination Agreement), effective as of December 12, 2018, has been signed by all participating agencies in the Delta-Mendota Subbasin; a copy of this agreement is included in **Appendix A**. The purpose of the Agreement, including technical reports to be developed after the initial execution of this Agreement, is to comply with SGMA requirements and to ensure that the multiple GSPs within the Subbasin are developed and implemented utilizing the same datasets, methodologies and assumptions, that the elements of the GSPs are appropriately coordinated to support sustainable subbasin management of groundwater resources, and to ultimately set forth the information necessary to show how the multiple GSPs in the Subbasin will achieve the sustainability goal as determined for the Subbasin in compliance with SGMA and its associated regulations.

A key goal of basin-wide coordination is to ensure that the Subbasin GSPs utilize the same data and methodologies during their plan development and that elements of the Plans necessary to achieve the sustainability goal for the basin are based upon consistent interpretations of the basin setting, as required by SGMA and associated regulations. The Coordination Agreement defines how the coordinated efforts will be achieved and documented, and also sets out the process for identifying the Plan Manager. The Coordination Agreement is part of each individual GSP within the Delta-Mendota Subbasin.

The Coordination Agreement for the Delta-Mendota Subbasin covers the following topics:

1. Purpose of the Agreement, including:
 - a. Compliance with SGMA and
 - b. Description of Criteria and Function;
2. General Guidelines, including:
 - a. Responsibilities of the Parties and
 - b. Adjudicated or Alternative Plans in the Subbasin;
3. Role of San Luis & Delta-Mendota Water Authority (SLDMWA), including:
 - a. Agreement to Serve,
 - b. Reimbursement of SLDMWA, and
 - c. Termination of SLDMWA's Services;
4. Responsibilities for Key Functions, including:
 - a. Coordination Committee,
 - b. Coordination Committee Officers,
 - c. Coordination Committee Authorized Action and Limitations,
 - d. Subcommittees and Workgroups,
 - e. Coordination Committee Meetings, and
 - f. Voting by Coordination Committee;
5. Approval by Individual Parties;
6. Exchange of Data and Information, including:
 - a. Exchange of Information and
 - b. Procedure for Exchange of Information;
7. Methodologies and Assumptions, including:
 - a. SGMA Coordination Agreements,
 - b. Pre-GSP Coordination, and

- c. Technical Memoranda Required;
- 8. Monitoring Network
- 9. Coordinated Water Budget
- 10. Coordinated Data Management System
- 11. Adoption and Use of the Coordination Agreement, including:
 - a. Coordination of GSPs and
 - b. GSP and Coordination Agreement Submission;
- 12. Modification and Termination of the Coordination Agreement, including:
 - a. Modification or Amendment of Exhibit “A” (Groundwater Sustainability Plan Groups including Participation Percentages),
 - b. Modification or Amendment of Coordination Agreement, and
 - c. Amendment for Compliance with Law;
- 13. Withdrawal, Term, and Termination;
- 14. Procedures for Resolving Conflicts;
- 15. General Provisions, including:
 - a. Authority of Signers,
 - b. Governing Law,
 - c. Severability,
 - d. Counterparts, and
 - e. Good Faith; and
- 16. Signatories of all Parties

Coordination During GSP Implementation

The Coordination Agreement ensures that the multiple GSAs are working cooperatively and collaboratively to ensure GSPs within the Subbasin are developed and implemented utilizing the same methodologies and assumptions and to ultimately establish the processes necessary to show how the multiple GSPs in the Subbasin will be sustainably managed to achieve the Delta-Mendota Subbasin’s sustainability goal. The Coordination Committee intends to continue to meet and confer following the submittal of the Subbasin’s GSPs and will develop guidelines for GSP implementation between the GSP Groups and update the Coordination Agreement as the Parties to the Agreement deem necessary.

The Coordination Committee will continue meeting regularly following submittal of the Subbasin GSPs in order to develop the guidelines for coordinated implementation of GSPs. The intent of the guidelines will be to outline processes that will ensure the GSAs are progressing toward the Subbasin sustainability goal, while meeting the Annual Reporting requirements or any other requirements agreed upon for purposes of coordination.

Agency Responsibilities

In meeting the terms of the Coordination Agreement, all Parties (meaning the Delta-Mendota Subbasin GSAs) agree to work collaboratively to meet the objectives of SGMA and the Coordination Agreement. Each Party to the Agreement is a GSA and acknowledges that it is bound by the terms of the Coordination Agreement as an individual party.

The Parties have established a Coordination Committee to provide a forum to accomplish the coordination obligations of SGMA. The Coordination Committee operates in full compliance with the Brown Act and is composed of a Chairperson and Vice Chairperson, Secretary, Plan Manager, and a GSP Group Representative and Alternate Representative for each of the six GSP groups. The Chairperson and Vice Chairperson are rotated annually among GSP Groups in alphabetical order. The Secretary assumes primary responsibility for Brown Act compliance. The GSP Group Representatives, who are identified in **Table CC-4**, are selected by each respective GSP Group at the discretion of the respective GSP Group, and such appointments are effective upon providing written notice to the Secretary and to each Group Contact. The Coordination Committee recognizes each GSP Group Representative and GSP Group Alternate Representative until the Group Contact provides written notice of removal and replacement to the Secretary and to every other Group Contact. Each GSP Group is required to promptly fill any vacancy created by the removal of its Representative or Alternate Representative so that each GSP Group has the number of validly designated representatives.

Each GSP Group Representative is entitled to one vote at the Coordination Committee, where the Alternate Representative is authorized to vote in the absence of the GSP Group Representative. The unanimous vote of the GSP Representatives from all GSP Groups is required on most items upon which the Coordination Committee is authorized to act, with the exception of certain ministerial and administrative items. Voting procedures to address a lack of unanimity take place upon a majority vote of a quorum of the Coordination Committee and include straw polls, provisional voting, and delay of voting (see Section 5.6.3 – *Voting Procedures to Address Lack of Unanimity* of the Coordination Agreement). Where the law or the Coordination Agreement require separate written approval by each of the Parties, such approval is evidenced in writing by providing the resolution, Motion, or Minutes of their respective Board of Directors to the Secretary of the Coordination Committee. Minutes of the Coordinate Committee are kept and prepared by the Secretary’s appointee and maintained by the Secretary as Coordination Agreement records and are available to the Parties and the public upon request. Meeting agenda and minutes are posted on the Delta-Mendota website (www.deltamendota.org).

The Coordination Committee may appoint subcommittees, working groups, and otherwise direct staff made available by the Parties. Subcommittees or working groups may include qualified individuals possessing the knowledge and expertise to advance the goals of the Coordination Agreement on the topics being addressed by the subcommittee or working group, whether or not such individuals are GSP Group Representatives or Alternate Representatives. Tasks assigned to subcommittees, working groups, or staff made available by the Parties may include developing technical data, supporting information, and/or recommendations on specialized matters to the Coordination Committee. One GSP Group Representative or Alternate Representative is required to vote on behalf of the GSP Group at the subcommittee level. If no GSP Group Representative or Alternate Representative is present, one individual working on a subcommittee on behalf of the Parties in a GSP Group votes on behalf of the GSP Group. Subcommittees report voting results and provide information to the Coordination Committee but are not entitled to make determinations or decisions that are binding on the Parties.

The Coordination Committee is authorized to act upon the following items:

1. The Coordination Committee reviews, and consistent with the requirements of SGMA, approves the Technical Memoranda that compose the Common Chapter (see *Coordinated Data and Methodology*);
2. The Coordination Committee is responsible for ongoing review and updating of the Technical Memoranda as needed; assuring submittal of annual reports; providing five-year assessments and recommending any needed revisions to the Coordination Agreement; and providing review and assistance with coordinated projects and programs, once the GSPs have been submitted to and approved by DWR;
3. The Coordination Committee reviews and approves work plans, and in accordance with the budgetary requirements of the respective Parties, approves annual budget estimates of Coordinated Plan Expenses presented by the Secretary and any updates to such estimates provided that such estimates or updates with supporting documentation are circulated to all Parties for comment at least thirty (30) days in advance of the meeting at which the Coordination Committee will consider approval of the annual estimate;
4. The Coordination Committee is authorized to approve changes to Exhibit “A” (Groundwater Sustainability Plan Groups including Participation Percentages) to the Agreement and to recommend amendments to terms of the Agreement;
5. The Coordination Committee may assign work to subcommittees and workgroups as needed, provide guidance and feedback and ensure that subcommittees and workgroups prepare work products in a timely manner;
6. The Coordination Committee directs the Plan Manager in the performance of its duties under SGMA; and
7. The Coordination Committee provides direction to its Officers concerning other administrative and ministerial issues necessary for the fulfillment of the above-enumerated tasks.

Additional information regarding the roles, responsibilities, and duties of the Coordination Committee can be found in Section 5 – *Responsibilities for Key Functions* of the Coordination Agreement.

Exchange of Information

Timely exchange of information is a critical aspect of GSP coordination. All parties to the Coordination Agreement have agreed to exchange public and non-privileged information through collaboration and/or informal requests made at the Coordination Committee level or through subcommittees designated by the Coordination Committee. To the extent it is necessary to make a written request for information to another Party, each Party designates a representative to respond to information requests and provides the name and contact information of the designee to the Coordination Committee. Requests may be communicated in writing and transmitted in person or by mail, facsimile machine, or other electronic means to the appropriate representative as named in the Coordination Agreement. The designated representative is required to respond in a reasonably timely manner. Nothing in the Agreement shall be construed to prohibit any Party from voluntarily exchanging information with any other Party by any other mechanism separate from the Coordination Committee.

The Parties agree that each GSP Group shall provide the data required to develop the Subbasin-wide coordinated water budget but, unless required by law, will not be required to provide individual well or parcel-level information in order to preserve confidentiality of individuals to the extent authorized by law, including but not limited to Water Code Section 10730.8, subdivision (b). To the extent that a court order,

subpoena, or the California Public Records Act is applicable to a party, the Party in responding to a request made pursuant to that Act for release of information exchanged from another Party shall notify each other Party in writing of its proposed release of information in order to provide the other Parties with the opportunity to seek a court order preventing such release of information.

Dispute Resolution

Procedures for conflict resolution have been established within the Coordination Agreement. In the event that a dispute arises among Parties as it relates to the Coordination Agreement, the disputing Party or Parties are to provide written notice of the basis of the dispute to the other Parties within thirty (30) calendar days of the discovery of the events giving rise to the dispute. Within thirty (30) days after such written notice, all interested Parties are to meet and confer in good faith to informally resolve the dispute. All disputes that are not resolved informally shall be settled by arbitration. In such an event, within ten (10) days following the failed informal proceedings, each interested Party is to nominate and circulate to all other interested Parties the name of one arbitrator. Within ten (10) days following the nominations, the interested Parties are to rank their top three among all nominated arbitrators, awarding three points to the top choice, two points to the second choice, and one point to the third choice and zero points to all others. Each interested Party will then forward its tally to the Secretary, who tabulates the points and notifies the interested Parties of the arbitrator with the highest cumulative score, who shall be the selected arbitrator. The Secretary may also develop procedures for approval by the Parties for selection of an arbitrator in the case of tie votes or in order to replace the selected arbitrator in the event such arbitrator declines to act. The arbitration is to be administered in accordance with the procedures set forth in the California Code of Civil Procedure, Section 1280, *et seq.*, and of any state or local rules then in effect for arbitration pursuant to said section. Upon completion of arbitration, if the controversy has not been resolved, any Party may exercise all rights to bring legal action relating to the controversy.

Coordinated Data and Methodology

Pursuant to SGMA, the Coordination Agreement ensures that the individual GSPs utilize the same data and methodologies for developing assumptions used to determine: 1) groundwater elevation; 2) groundwater extraction data; 3) surface water supply; 4) total water use; 5) changes in groundwater storage; 6) water budgets; and 7) sustainable yield. The Parties have agreed to develop agreed-upon methodologies and assumptions for the aforementioned items prior to or concurrent with the individual development of GSPs. This development is facilitated through the Coordination Committee's delegation to a subcommittee or working group of the technical staff provided by some or all of the Parties. The basis upon which the methodologies and assumptions have been developed includes existing data/information, best management practices, and/or best modeled or projected data available and may include consultation with DWR as appropriate.

The data and methodologies for assumptions described in Water Code §10727.6 and Title 23, California Code of Regulations, Section 357.4 to prepare coordinated plans are set forth in Technical Memoranda prepared by the Coordination Committee for each of the following elements: Data and Assumptions; Hydrogeologic Conceptual Model; Coordinated Water Budgets; Sustainable Management Criteria (SMC); Coordinated Monitoring Network; Coordinated Data Management System, and Adoption and Use of the Coordination Agreement. The Technical Memoranda have been subject to the unanimous approval of the Coordination Committee and once approved, have been attached to and incorporated by reference into the Coordination Agreement without formal amendment of the Coordination Agreement being required. The Parties have agreed that they will not submit this Coordination Agreement to DWR until the Technical Memoranda described herein have been added to the Coordination Agreement. The Technical Memoranda created pursuant to the Coordination Agreement are to be utilized by the Parties during the development and implementation of their individual GSPs in order to assure coordination of

the GSPs is in compliance with SGMA. The Technical Memoranda have been included as an appendix to this GSP as a part of the Common Chapter.

Plan Implementation and Submittal

Under the Coordination Agreement, the Parties have agreed to submit their respective GSPs to DWR through the Coordination Committee and Plan Manager, in accordance with all applicable requirements. Subject to the subsequent attachment of the Technical Memoranda as appendices to the Common Chapter, the Parties intend that the described Coordination Agreement fulfill the requirements of providing an explanation of how the GSPs implemented together satisfy the requirements of SGMA for the entire Subbasin. The Coordination Agreement does not otherwise affect each Party's responsibility to implement the terms of its respective GSP in accordance with SGMA. Rather, this Coordination Agreement is the mechanism through which the Parties will coordinate their respective GSPs to the extent necessary to ensure that such GSP coordination complies with SGMA.

Each Party is responsible for ensuring that its own GSP complies with the statutory requirements of SGMA, including but not limited to the filing deadline. The Parties to this Coordination Agreement intend that their individual GSPs be coordinated together in order to satisfy the requirements of SGMA and to be in substantial compliance with the California Code of Regulations. The collective GSPs will satisfy the requirements of Water Code Sections 10727.2 and 10727.4 by providing a description of the physical setting and characteristics of the separate aquifer systems within the Subbasin, the measurable objectives for each such GSP, interim milestones (IMs), and monitoring protocols that together provide a detailed description of how the Subbasin as a whole will be sustainably managed.

The Parties agree to submit their respective GSPs to DWR through the Coordination Committee and Plan Manager, in accordance with all applicable requirements. The Coordination Committee is responsible for assuring submittal of annual reports, five-year updates, and for providing assessments recommending any needed revisions to the Coordination Agreement.

Coordinated Data Management System

The Delta-Mendota Subbasin GSAs have developed and will maintain a coordinated Data Management System that is capable of storing and reporting information relevant to the reporting requirements and/or implementation of the GSPs and monitoring network of the Subbasin.

The Parties may also develop and maintain separate Data Management Systems. Each separate Data Management System developed for each GSP will store information related to implementation of each individual GSP, monitoring network data and monitoring sites requirements, and water budget data requirements. Each system will be capable of reporting all pertinent information to the Coordination Committee. After providing the Coordination Committee with data from the individual GSPs, the Coordination Committee will ensure the data are stored and managed in a coordinated manner throughout the Subbasin and reported to DWR on an annual basis.

Adjudicated Areas and Alternative Plans

There are no adjudicated areas within the Delta-Mendota Subbasin, and no Alternative Plans have been submitted by the local agencies within the Subbasin.

Legal Bindings of the Delta-Mendota Subbasin Coordination Agreement

The Coordination Agreement, as contained herein, is reflected in the same manner and form as in the six Subbasin GSPs. All parties understand that the Delta-Mendota Subbasin Coordination Agreement is part of the GSPs for participating Subbasin GSAs and will be a primary mechanism by which the six Subbasin

GSPs will be implemented in a coordinated fashion. Further, all parties to the Coordination Agreement understand that DWR will evaluate the agreement for compliance with the procedural and technical requirements of GSP Regulations §357.4 (Coordination Agreement) to ensure that the agreement is binding on all parties and that provisions of the agreement are sufficient to address any disputes between or among parties to the agreement.

The Coordination Agreement will continue to be the framework under which the six Delta-Mendota Subbasin GSPs will be implemented and will be reviewed as part of the five-year assessment and revised as necessary, dated, and signed by all parties.

2.1.3 Inter-basin Agreements

SLDMWA, on behalf of the Northern and Central Delta-Mendota Regions, and the SJREC GSA executed inter-basin data sharing agreements with Westlands Water District (the lead entity encompassing the adjoining Westside Subbasin). The purpose of the agreement is to establish a set of common assumptions on groundwater conditions on either side of the boundary between the Westside Subbasin and the Delta-Mendota Subbasin to be used for the development of GSPs in support of implementation of SGMA. In this agreement, the parties agree to provide each other with recorded, measured, estimated, and/or simulated modeling data located within five (5) miles of the boundary between the Westside Subbasin and the Delta-Mendota Subbasin. A list of data types to be shared between the parties to the agreement can be found in **Appendix D**.

Data provided under this agreement are understood to be shared with consultants and other stakeholders in the respective basins (Delta-Mendota Subbasin and Westside Subbasin), and that the information will be made public through the development of the respective Parties' (meaning SLDMWA/SJREC and Westlands Water District) GSPs and the supporting documentation of the GSPs. Other than publishing information for those purposes, neither Party will disclose the other Party's information to any third party, except if the other Party determines, at its sole discretion, the disclosure is required by law. Each Party may review preliminary results before publishing the information.

It is recognized that many of the sustainability indicators, notably groundwater quality, inelastic land subsidence and change in storage, are regional issues that may require future inter-basin discussions and coordination. Memorandum of Intent (MOI) are being discussed with the surrounding subbasins to demonstrate/confirm the subbasins' desires to coordinate during GSP implementation. These agreements, to be discussed further following submittal of GSPs, will allow for thoughtful consideration of the intent, structure, and need for future coordination with respect to data collection, reporting, regular meetings, and updates prior to annual reporting.

3. DELTA-MENDOTA SUBBASIN PLAN AREA

This section describes the Delta-Mendota Subbasin, including major streams and creeks, institutional entities, agricultural and urban land uses, locations of state lands (including wetlands), and geographic boundaries of surface water runoff areas. The reader is referred to the individual Subbasin GSPs for descriptions of existing surface water and groundwater monitoring programs, existing water management programs, and general plans in the individual GSP Plan Areas. The information contained in this section reflects information from publicly available sources and may not reflect all information that will be used for GSP technical analysis.

This section of the GSP satisfies Section 354.8 of the SGMA regulations.

3.1 Plan Area Definition

The Plan Area for the six coordinated GSPs is the Delta-Mendota Subbasin (DWR Basin 5-022.07). As previously noted, the Delta-Mendota Subbasin is one of nine subbasins that lie completely within the San Joaquin Valley Hydrologic Region and adjoins the following subbasins (**Figure CC-8**):

- Tracy
- Eastern San Joaquin
- Modesto
- Turlock
- Merced
- Chowchilla
- Madera
- Kings
- Westside

As described in *California's Groundwater*, DWR Bulletin 1188 (2016), the Delta-Mendota Subbasin is in the San Joaquin Valley Groundwater Basin, located along the western edge of the San Joaquin Valley and includes portions of San Joaquin, Stanislaus, Merced, Fresno, San Benito, and Madera Counties. The northern boundary begins just south of Tracy in San Joaquin County, and the eastern boundary generally follows the San Joaquin River and Fresno Slough. The southern boundary is near the small town of San Joaquin, and the Subbasin is bounded on the west by the Coast Range. The Subbasin boundaries are further described in Section 4.1.5, Basin Boundaries, and is shown in relation to each of the six counties in **Figure CC-9**.

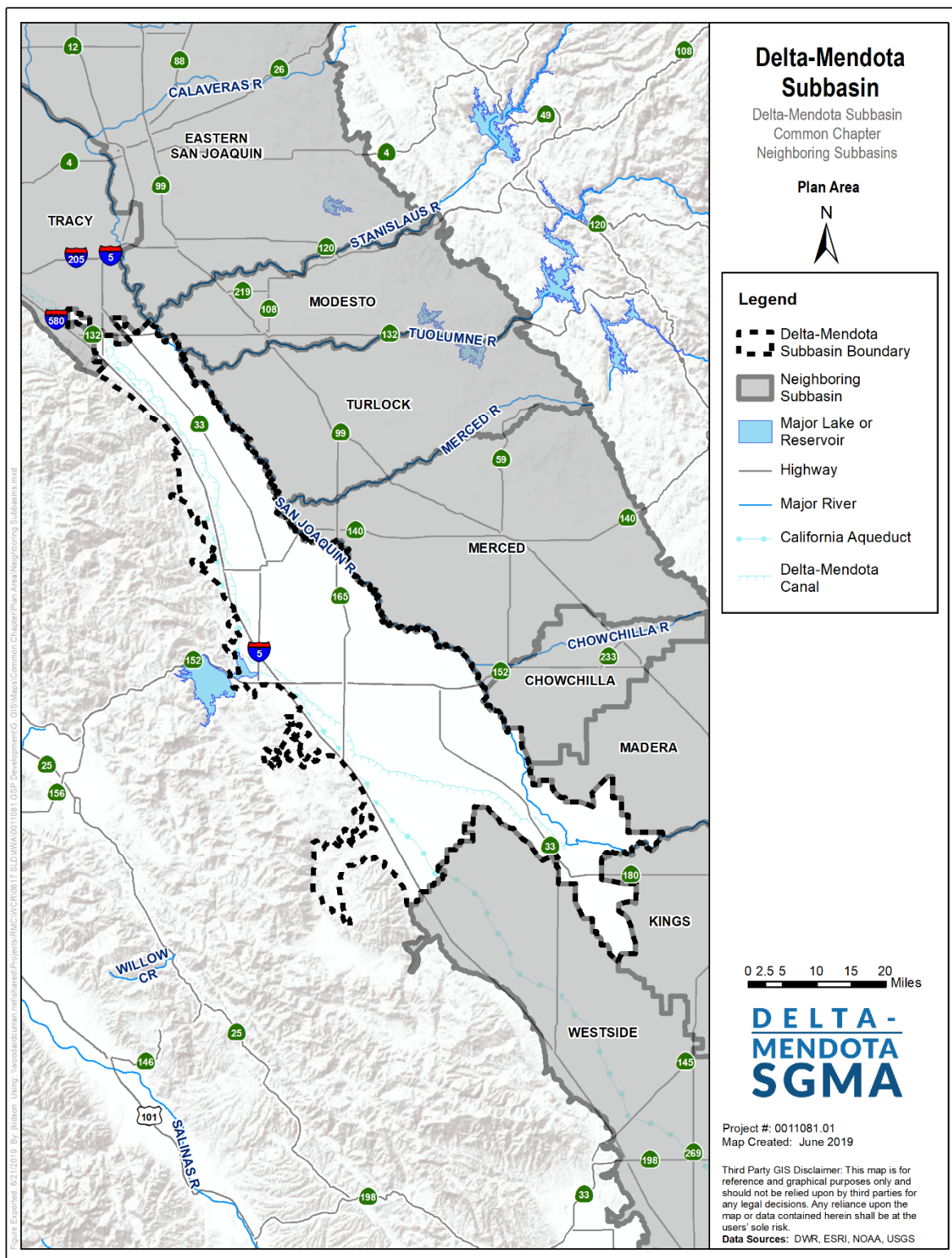


Figure CC-8: Neighboring Subbasins of the Delta-Mendota Subbasin

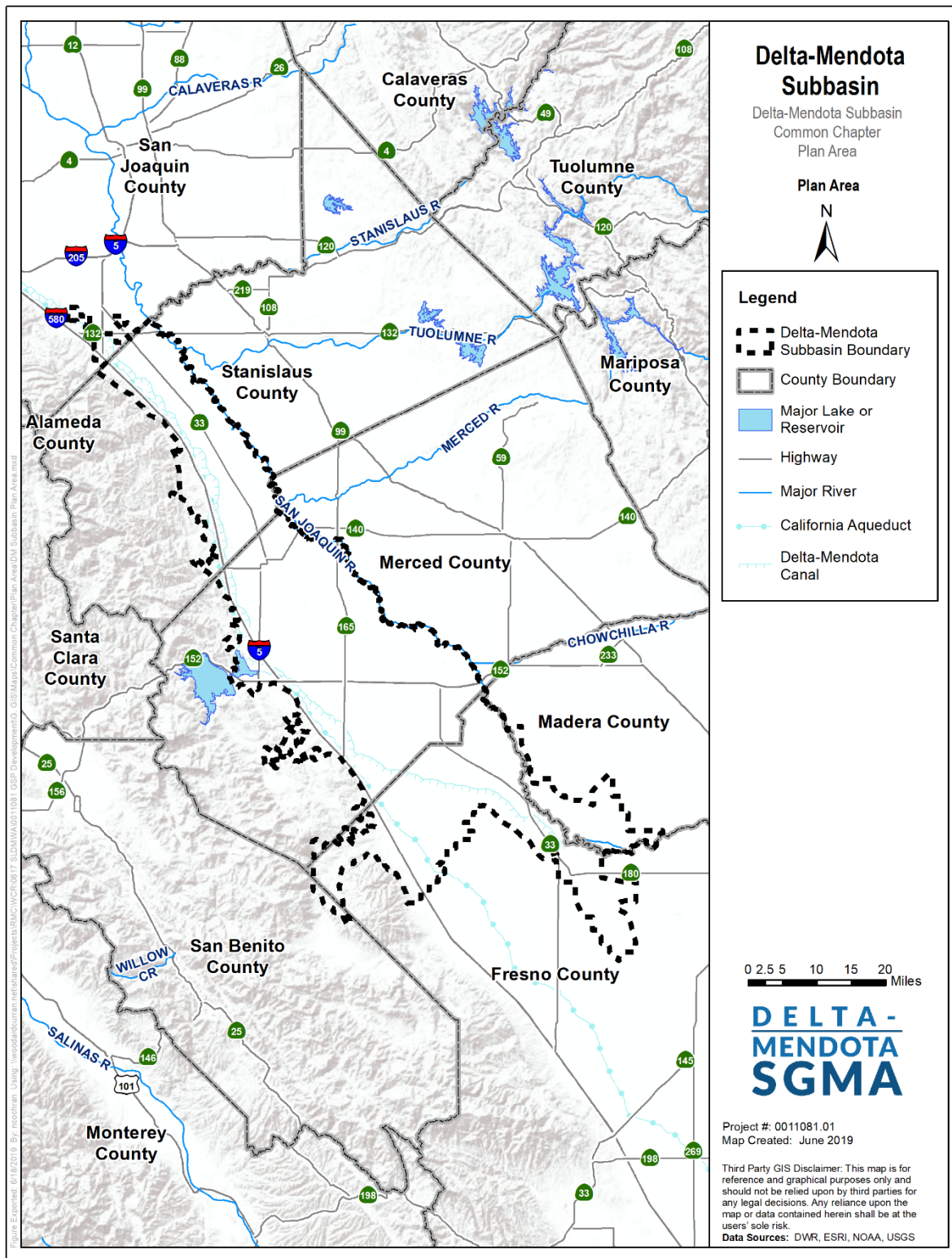


Figure CC-9: Delta-Mendota Groundwater Subbasin Plan Area

3.2 Plan Area Setting

As previously noted, the Delta-Mendota Subbasin lies along the western margin of the San Joaquin Valley. This valley is part of the large, northwest-to-southeast-trending asymmetric trough of the Central Valley, which has been filled with up to six vertical miles of sediment. This sediment includes both marine and continental deposits ranging in age from Jurassic to Holocene. The San Joaquin Valley lies between the Coast Range Mountains on the west and the Sierra Nevada on the east and extends northwestward from the San Emigdo and Tehachapi Mountains to the Sacramento-San Joaquin Delta (Delta) near the City of Stockton. The San Joaquin Valley is 250 miles long and 50 to 60 miles wide. The relatively flat alluvial floor is interrupted occasionally by low hills. Foothills adjacent on the west are composed of folded and faulted beds of mainly marine shale in the north and sandstone and shale in the south.

The San Joaquin Valley floor is divided into several geomorphic land types, including dissected uplands, low alluvial fans and plains, river floodplains and channels, and overflow lands and lake bottoms. Alluvial plains cover most of the valley floor and comprise some of the most intensely developed agricultural lands in the San Joaquin Valley. In general, alluvial sediments of the western and southern parts of the San Joaquin Valley tend to have lower permeability than east side deposits.

This section provides additional information relating to water resources in and around the Delta-Mendota Subbasin.

Watersheds

The Delta-Mendota Subbasin lies in the Middle San Joaquin-Lower Merced-Lower Stanislaus watershed and the Middle San Joaquin-Lower Chowchilla watershed (**Figure CC-10**). Historically, the San Joaquin Valley Basin was a large floodplain of the San Joaquin River that supported vast expanses of permanent and seasonal marshes, lakes, and riparian areas. Approximately 90 percent of the basin's wetlands have been lost, with approximately 58,000 flooded acres remaining on State, federal and private wildlife refuges. Approximately 100,000 acres of managed wetland, upland and riparian habitat is found within the Grassland Plan area, and together with the 12,000-acre Mendota Wildlife Area (found in the Fresno County Plan area), encompasses the vast majority of the remaining wetlands found in the basin (**Figure CC-11**).

The San Joaquin River Basin (Basin) includes the entire area drained by the San Joaquin River. The San Joaquin River Basin drains 13,513 square miles (mi²) before it flows into the Sacramento-San Joaquin Delta near the town of Vernalis. The Merced, Tuolumne and Stanislaus Rivers are the three major tributaries that join the mainstream San Joaquin River from the east before it flows into the Delta.

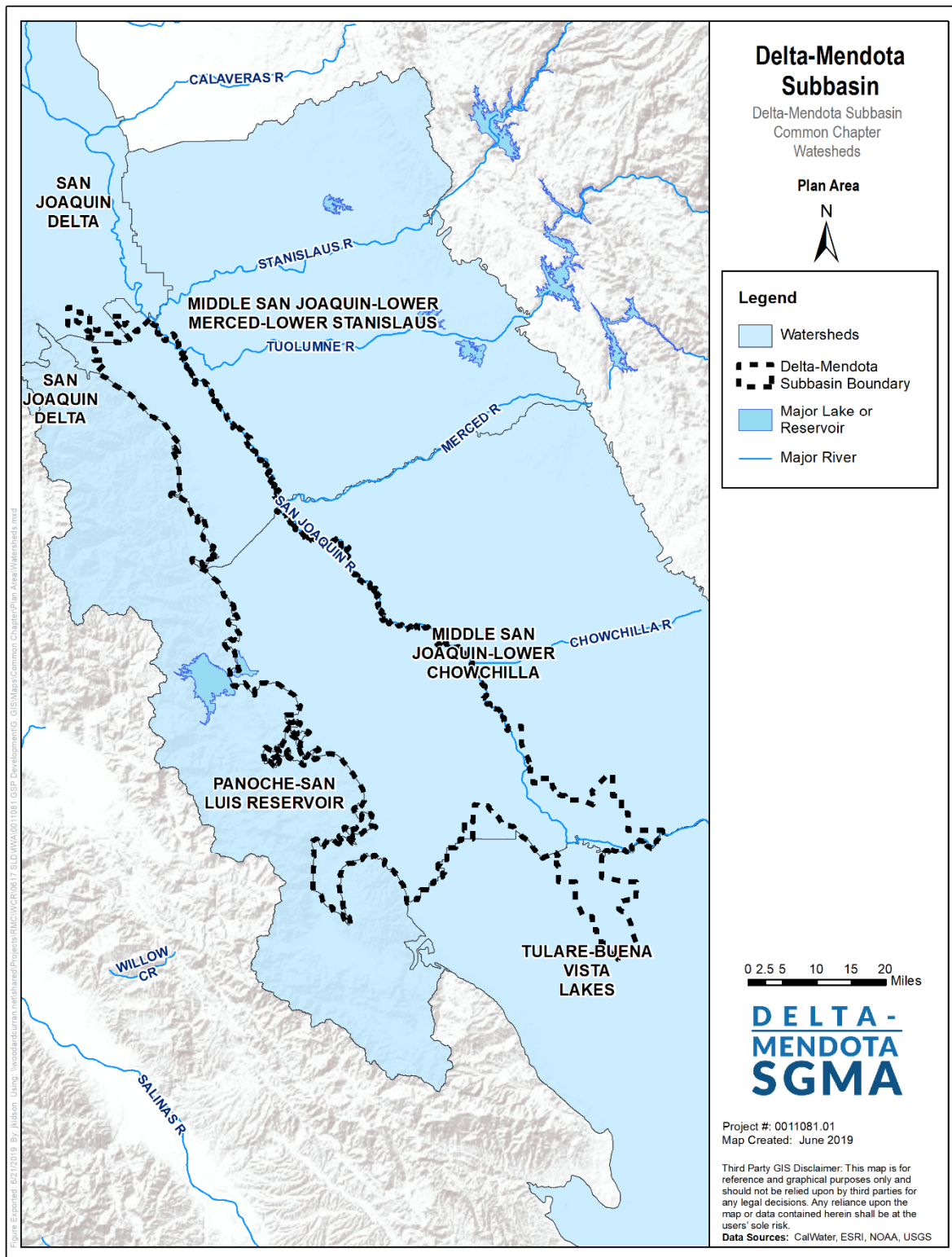


Figure CC-10: Local Watersheds

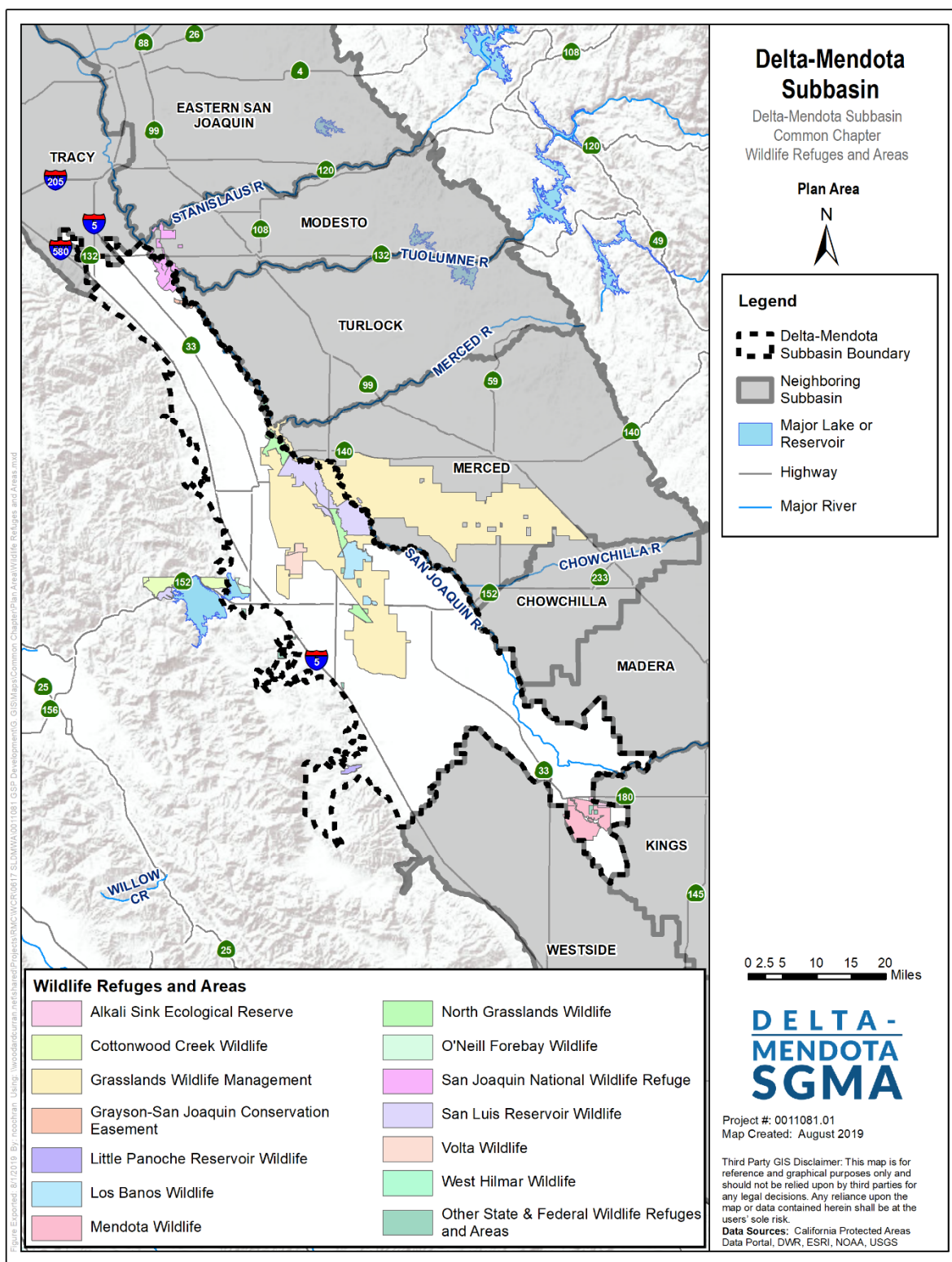


Figure CC-11: Wildlife Refuges and Wetland Habitat Areas in the Delta-Mendota Subbasin

Surface Water Use

Surface water is a primary water supply for agriculture within the Delta-Mendota Subbasin. Surface water supplies are brought into the Subbasin using an extensive series of water systems relied upon by multiple water agencies, cities, and private water users. Major water-related infrastructure in the Subbasin includes the facilities required to deliver Central Valley Project (CVP) supplies to CVP water supply contractors, in addition to key infrastructure of the State Water Project (SWP) utilized to deliver water to SWP water supply contractors and surface water diversions (e.g., intakes) to divert and distribute water from the San Joaquin and Kings Rivers.

The San Luis & Delta-Mendota Water Authority (SLDMWA) is a joint powers authority consisting of 28 member agencies that provide water to approximately 1.2 million acres of highly productive farmland, 2 million California residents, and millions of waterfowl dependent upon the nearly 200,000 acres of managed wetlands within this area of the Pacific Flyway. The SLDMWA operates and maintains portions of the CVP, including the Delta Cross Channel, the C.W. “Bill” Jones Pumping Plant, the Delta-Mendota Canal (DMC), O’Neill Pumping-Generating Plant, and the San Luis Drain, and provides emergency assistance when requested on the Delta Cross Channel and the Tracy Fish Collection Facility. The California Department of Water Resources (DWR) operates and maintains the SWP facilities, designed to deliver nearly 4.2 million acre-feet of water per year to 29 long-term SWP water supply contractors. Joint federal-state facilities include the California Aqueduct, Banks Pumping Plant, O’Neill Dam and Forebay, Sisk Dam and San Luis Reservoir, and Dos Amigos Pumping Plant. Surface water diversion facilities are owned and operated by individual water and irrigation districts and typically include some form of intake (e.g., fish screen, open water intake, flumes) plus facilities to convey the diverted surface water to a distribution system.

Groundwater Use

Groundwater is a key component of water supplies in the Delta-Mendota Subbasin. To protect the long-term sustainability of groundwater resources, pumping has significantly reduced in past years (2017-2019), allowing the groundwater levels in the Subbasin to recover to some extent. During the most recent drought period, groundwater was heavily relied upon throughout the Subbasin for irrigation as surface water deliveries were significantly severely reduced for many water users (especially those with junior surface water rights), resulting in increased groundwater pumping.

There are many communities within the Subbasin that are partially or completely reliant on groundwater for municipal and domestic water supplies, including the cities of Patterson, Newman, Gustine, Los Banos, Firebaugh, and Mendota and the communities of Grayson, Westley, Crows Landing, Santa Nella, Volta, Dos Palos Y, and Tranquillity (**Figure CC-12**). Other unincorporated areas of the Subbasin also rely on groundwater as the sole water supply source. There are several areas of *de minimis* groundwater extractors in the Subbasin, which are defined as well owners who extracts two acre-feet or less per year from a parcel for domestic purposes (SWRCB, n.d. (a)).

Figure CC-13, Figure CC-14, and Figure CC-15 show the density per square mile (PLSS Section) of domestic, production, and public wells in the Delta-Mendota Subbasin as identified by DWR’s Well Completion Report Map Application. Domestic wells are defined as individual domestic wells which supply water for the domestic needs of an individual residence or systems of four or less service connections (DWR, 1981). Within the Delta-Mendota Subbasin, the majority of PLSS Sections contain five or fewer domestic wells (**Figure CC-13**). Production well statistics include wells that are designated as irrigation, municipal, public, and industrial on well completion reports, generally indicating wells designed to obtain water from productive zones containing good-quality water (DWR, 1991). The majority of PLSS Sections in the Subbasin contain only zero, one, or two production wells (**Figure CC-**

14). The highest concentration of production wells can be found in the south of the Subbasin, near Mendota. Public wells are defined as wells that provide water for human consumption to 15 or more connections or regularly serves 25 or more people daily for at least 60 days out of the year (SWRCB, n.d. (b)). Compared to domestic and production wells, public wells are less common in the Subbasin. The status of the wells (e.g., active, abandoned, destroyed) contained in the DWR Well Completion Report Map Application has not been independently confirmed. Additionally, the reader is referred to each of the six Subbasin GSPs for more information regarding wells in the Delta-Mendota Subbasin.

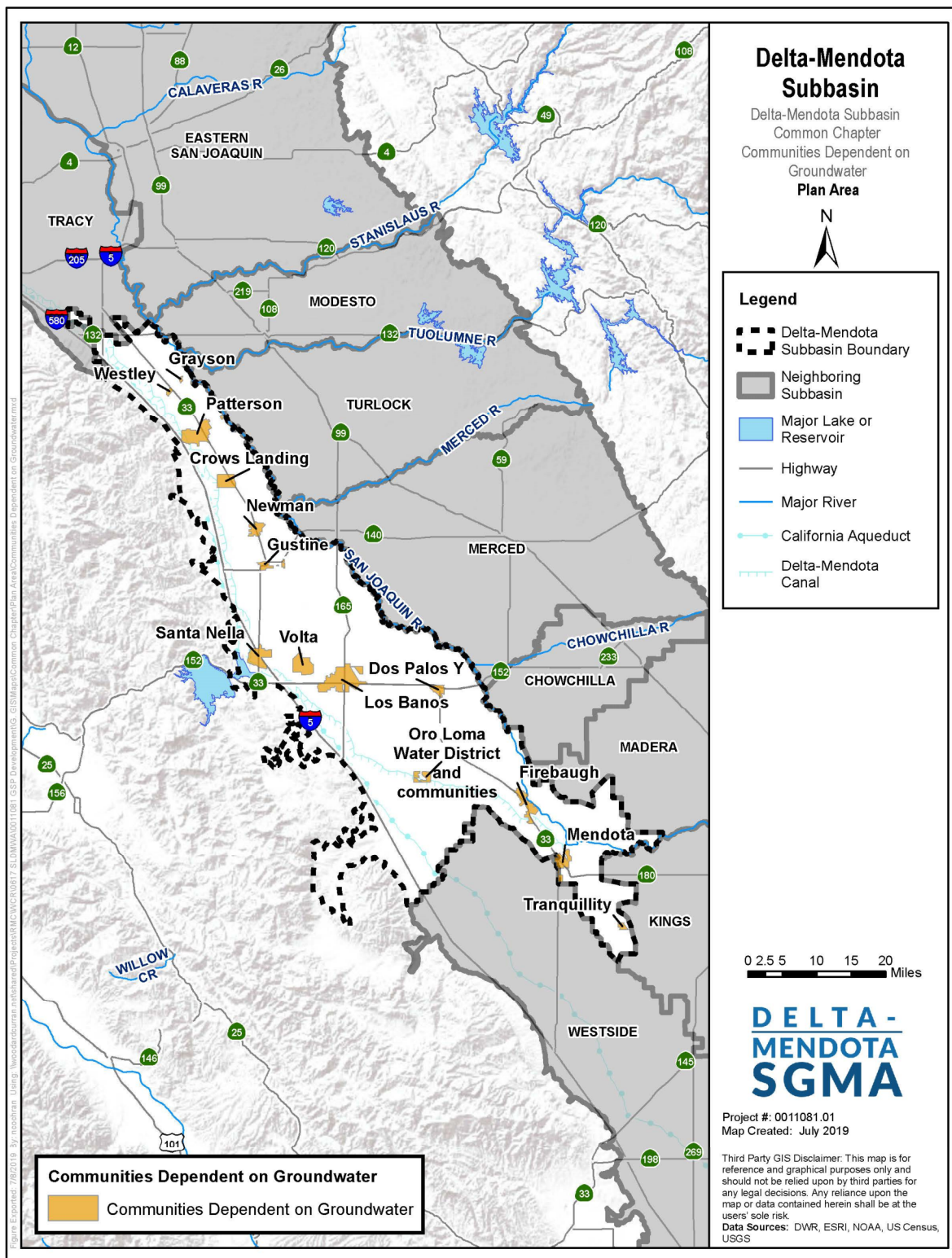


Figure CC-12: Communities Dependent on Groundwater

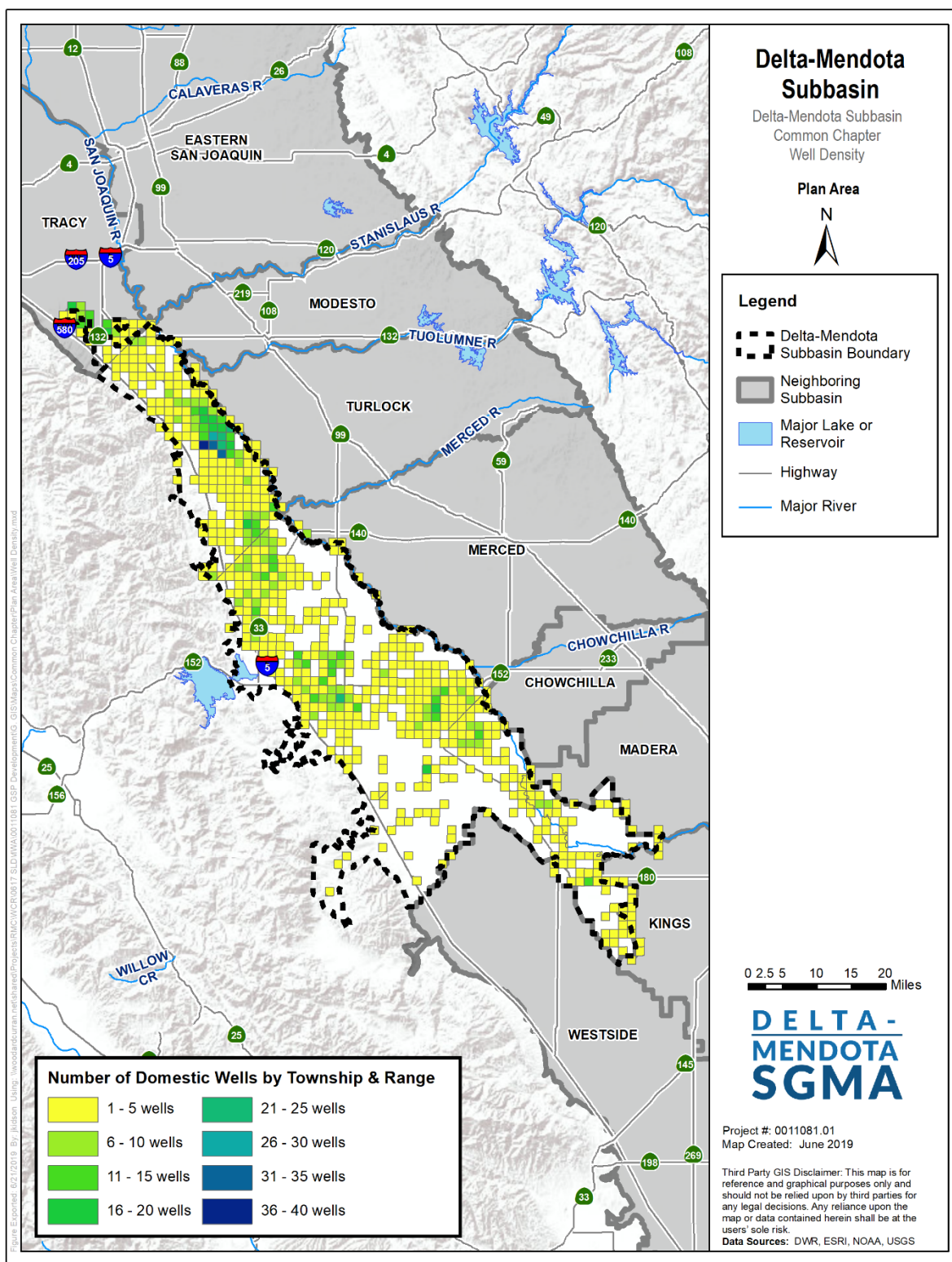


Figure CC-13: Domestic Well Density in the Delta-Mendota Subbasin

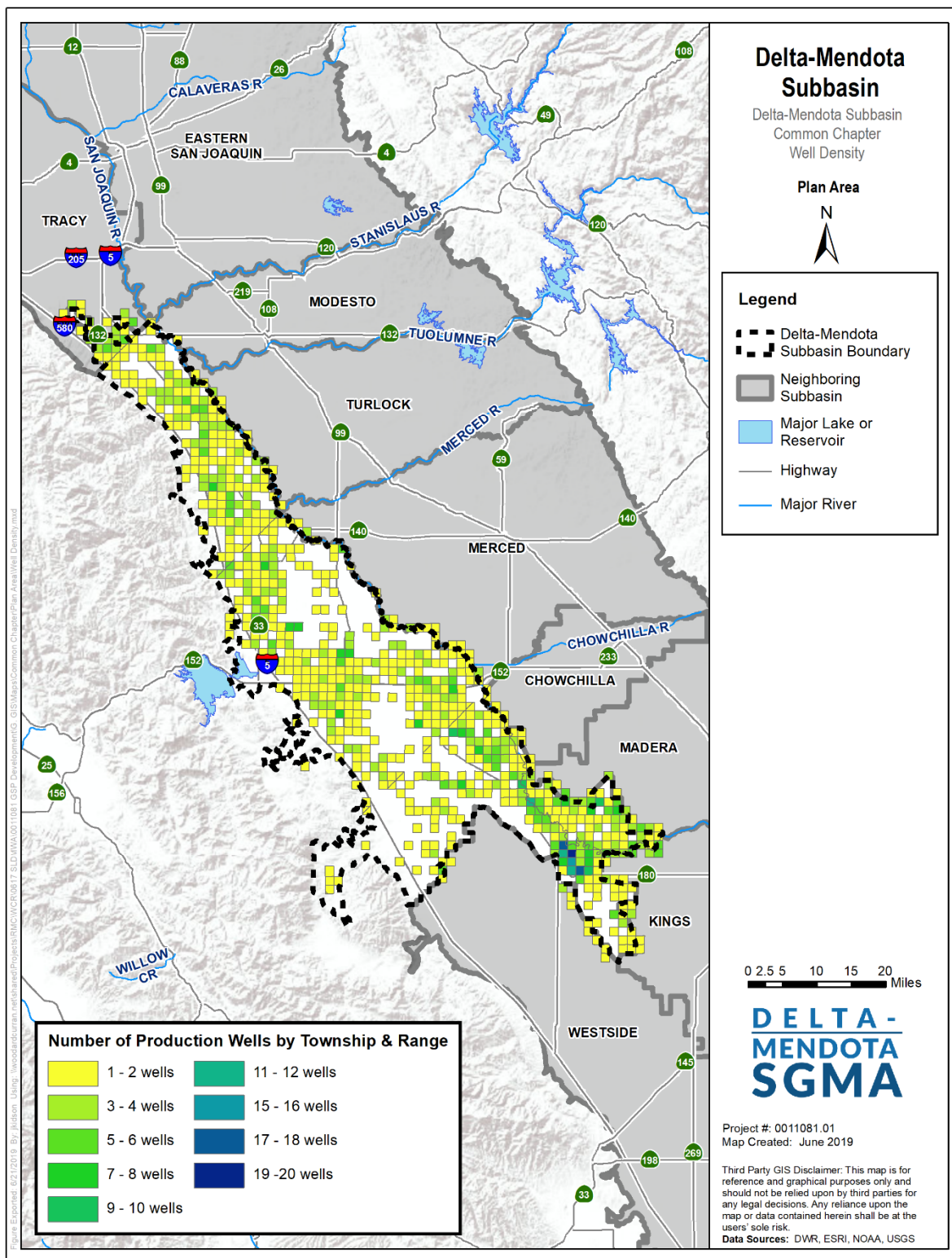


Figure CC-14: Production Well Density in the Delta-Mendota Subbasin

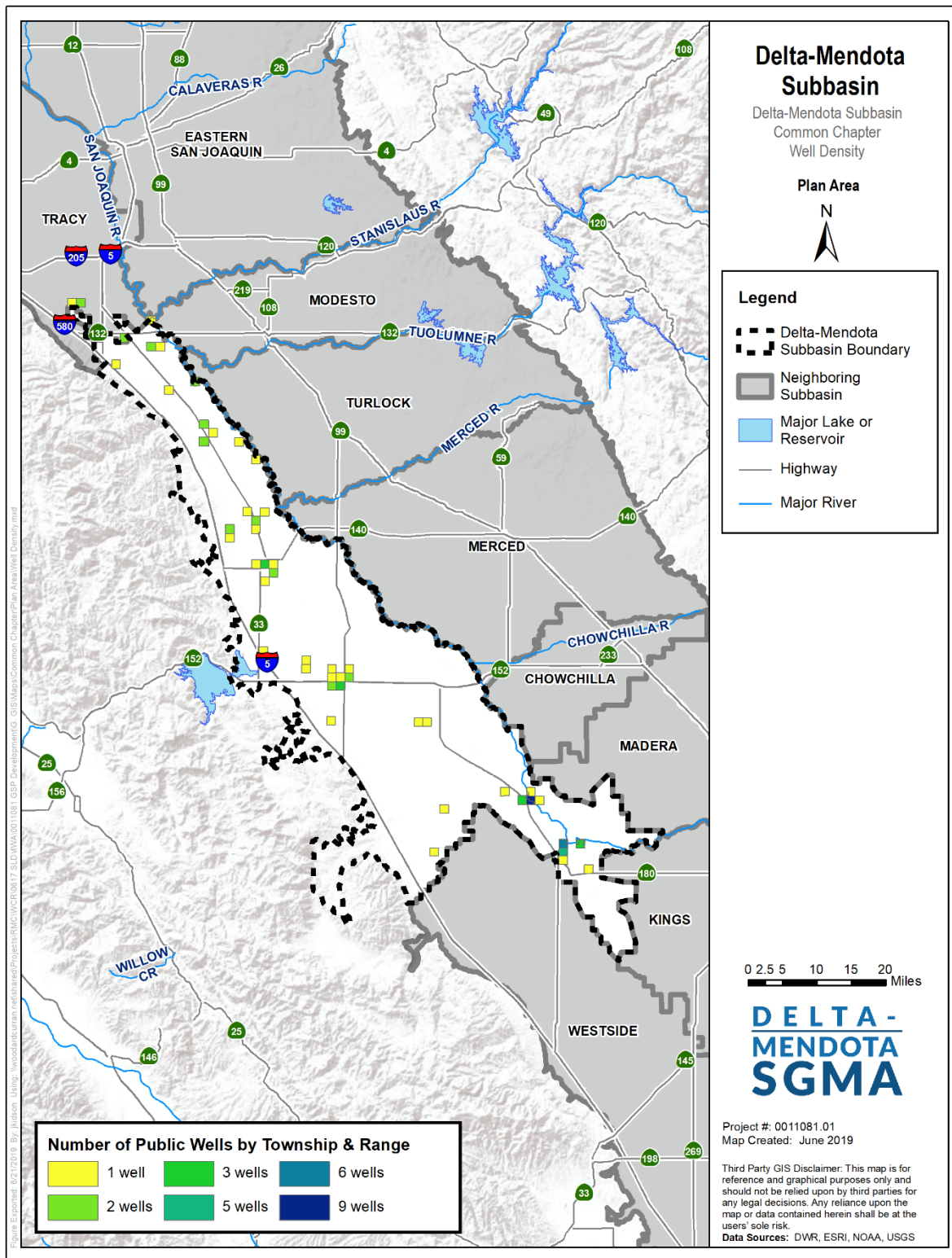


Figure CC-15: Public Well Density in the Delta-Mendota Subbasin

Flood Management

In general, the Delta-Mendota Subbasin slopes toward the San Joaquin River with steeper slopes along the western boundary (near the Coast Range), tapering off closer to the San Joaquin River. The flood management system in the San Joaquin Valley includes reservoirs to regulate snowmelt from elevations greater than 5,000 feet, bypasses at lower elevations, and levees that line major rivers.

Severe rain events in 1997/98, 2005/2006, 2011 and 2017 flooded communities, agricultural lands and refuges adjacent to the San Joaquin River in the Delta-Mendota Subbasin (specifically the communities of Firebaugh, Newman, Gustine and Mendota) and produced some localized flooding of farmland and refuges caused by runoff impoundment by elevated canal banks. Based on the recent historical events, the primary threat of flooding to urban areas will be for those along (and immediately adjacent to) the San Joaquin River. Areas within the 100-year floodplain within the Subbasin are shown in **Figure CC-16**.

Major Land Use Divisions

The Delta-Mendota Subbasin consists mostly of agricultural land use types (**Figure CC-17**). Typical land uses are described in the following sections and consist predominantly of the following:

- Pasture/Rangeland
- Agricultural Land (including rice, field crops and grains)
- Deciduous Forest
- Idle and Retired Farmland/Rangeland
- Riparian/Wetland
- Urban

The primary land use planning entities in the Delta-Mendota Subbasin include San Joaquin, Stanislaus, Merced, Fresno, and Madera Counties, as well as the cities of Patterson, Newman, Gustine, Los Banos, Dos Palos, Firebaugh, and Mendota, and Community of Santa Nella, as shown in **Figure CC-18**.

Pasture/Rangeland

Grasslands in the Central Valley were originally dominated by native perennial grasses such as needlegrass and alkali sacaton. Currently, grassland vegetation is characterized by a predominance of annual or perennial grasses in an area with few or no trees and shrubs. Annual grasses found in grassland vegetation include wild oats, soft chess, ripgut grass, medusa head, wild barley, red brome, and slender fescue. Perennial grasses found in grassland vegetation are purple needlegrass, Idaho fescue, and California oatgrass. Forbs commonly encountered in grassland vegetation include long-beaked filaree, redstem filaree, dove weed, clovers, Mariposa lilies, popcornflower, and California poppy. Vernal pools found in small depressions with an underlying impermeable layer are isolated wetlands within grassland vegetation. Pastures can consist of both irrigated and unirrigated lands dominated by perennial grasses used predominantly for grazing.

Rangeland communities are composed of similar grasses, grass-like plants, forbs, or shrubs which are grazed by livestock. Rangelands are classified into three basic types: shrub and brush rangeland, mixed rangeland, and herbaceous rangeland. The shrub and brush rangeland are dominated by woody vegetation and is typically found in arid and semiarid regions. Mixed rangelands are ecosystems where more than one-third of the land supports a mixture of herbaceous species and shrub or brush rangeland species. Herbaceous rangelands are dominated by naturally occurring grasses and forbs as well as some areas that have been modified to include grasses and forbs as their principal cover. Rangelands are, by definition, areas where a variety of commercial livestock are actively maintained.

Agricultural Land

General agricultural types occurring in the Delta-Mendota Subbasin include row crops, grains, orchards, and vineyards. Management of agricultural lands often includes intensive management, including soil preparation activities, crop rotation, grazing, and the use of chemicals.

Row Crops

Most row crops grown in the San Joaquin Valley and harvested for food are annual species and are managed with a crop rotation system. During the year, several different crops may be produced on a given parcel of land either concurrently or in succession. Typical crops grown in the Delta-Mendota Subbasin include tomatoes, melons, grain crops (such as barley, wheat, corn, and oats), rice, cotton, and beans.

Orchards and Vineyards

Orchard and vineyards consist of cultivated fruit or nut-bearing trees or grapevines. Orchards are typically open, single-species, tree-dominated habitats and are planted in a uniform pattern and intensively managed. Understory vegetation is usually sparse. Vineyards are typically managed in a similar manner for producing grapes for wine and/or direct consumption.

Deciduous Forest

Deciduous forests are composed of trees that lose their leaves in the winter. These include species such as the various California oaks, California buckeye, Fremont Cottonwoods, Goodding Willows, and California Sycamores. The interior live oak, which is not deciduous, is also found in deciduous forests. Valley oak woodlands are found in the Sacramento and San Joaquin Valleys and usually occur below elevations of 2,000 feet.

Idle or Retired Farmland/Rangeland

Lands of this category are similar to abandoned farmlands in ruderal (disturbed) areas. Plants on these parcels may consist of either native and/or non-native species.

Riparian/Wetland

Riparian and wetland communities are both natural and man-made. Managed wetlands are classified as riparian and are flooded for overwintering migratory bird habitat. In the spring the wetlands are drained to promote grasses such as swamp timothy and watergrass which are an important waterfowl food supply. Although some grazing continues on managed wetlands, historically, many of these lands were irrigated and used as rangeland throughout the summer months. Today, managed wetlands are irrigated in the spring to maximize wetland productivity and provide nesting and sensitive species habitat. Managed wetlands also contain emergent vegetation such as cattail and tule and are often adjacent to riparian corridors.

Urban

Urban land uses include cities and smaller communities, in addition to other lands used for industrial and/or commercial practices.

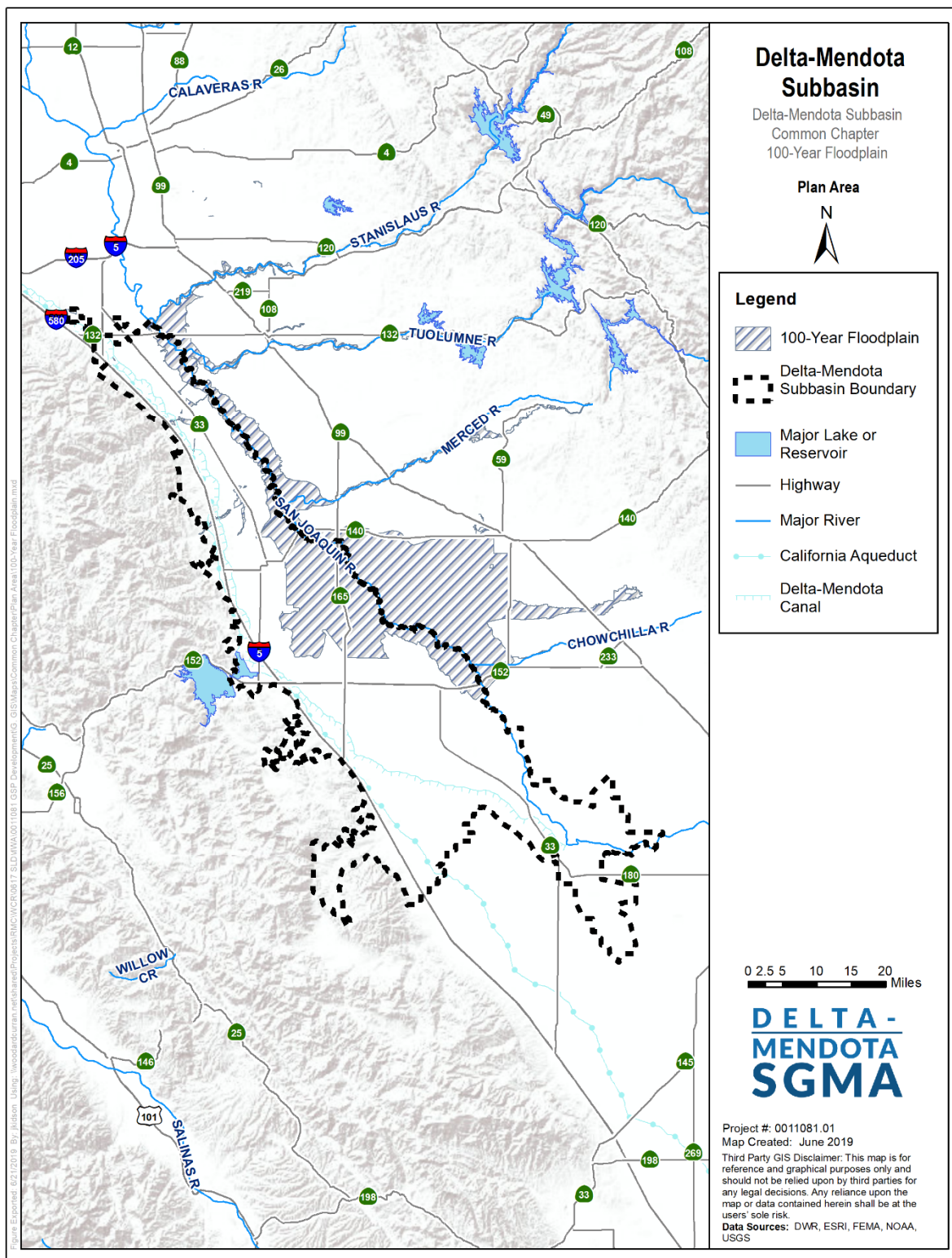


Figure CC-16: 100-Year Floodplain, Delta-Mendota Subbasin

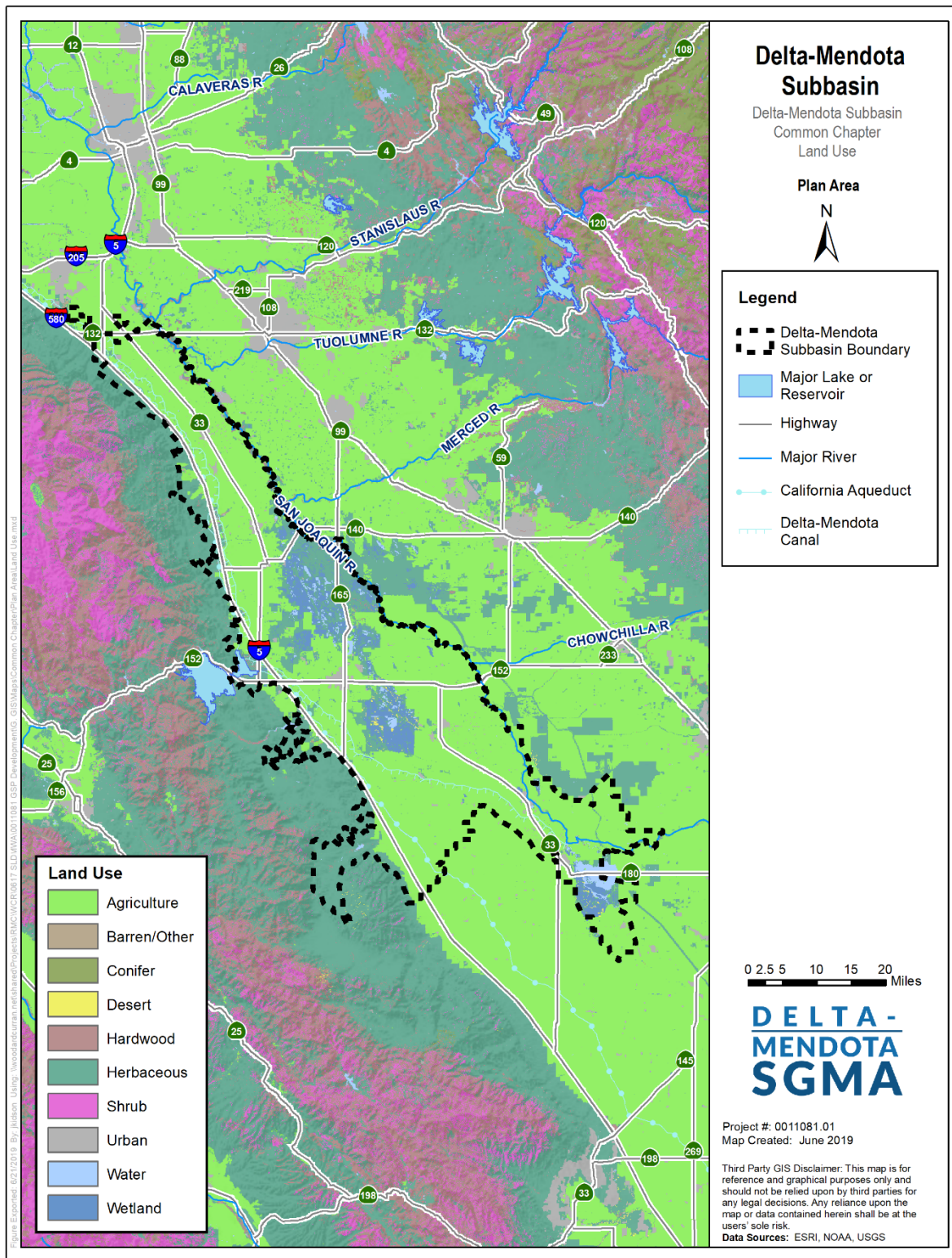


Figure CC-17: Typical Land Use

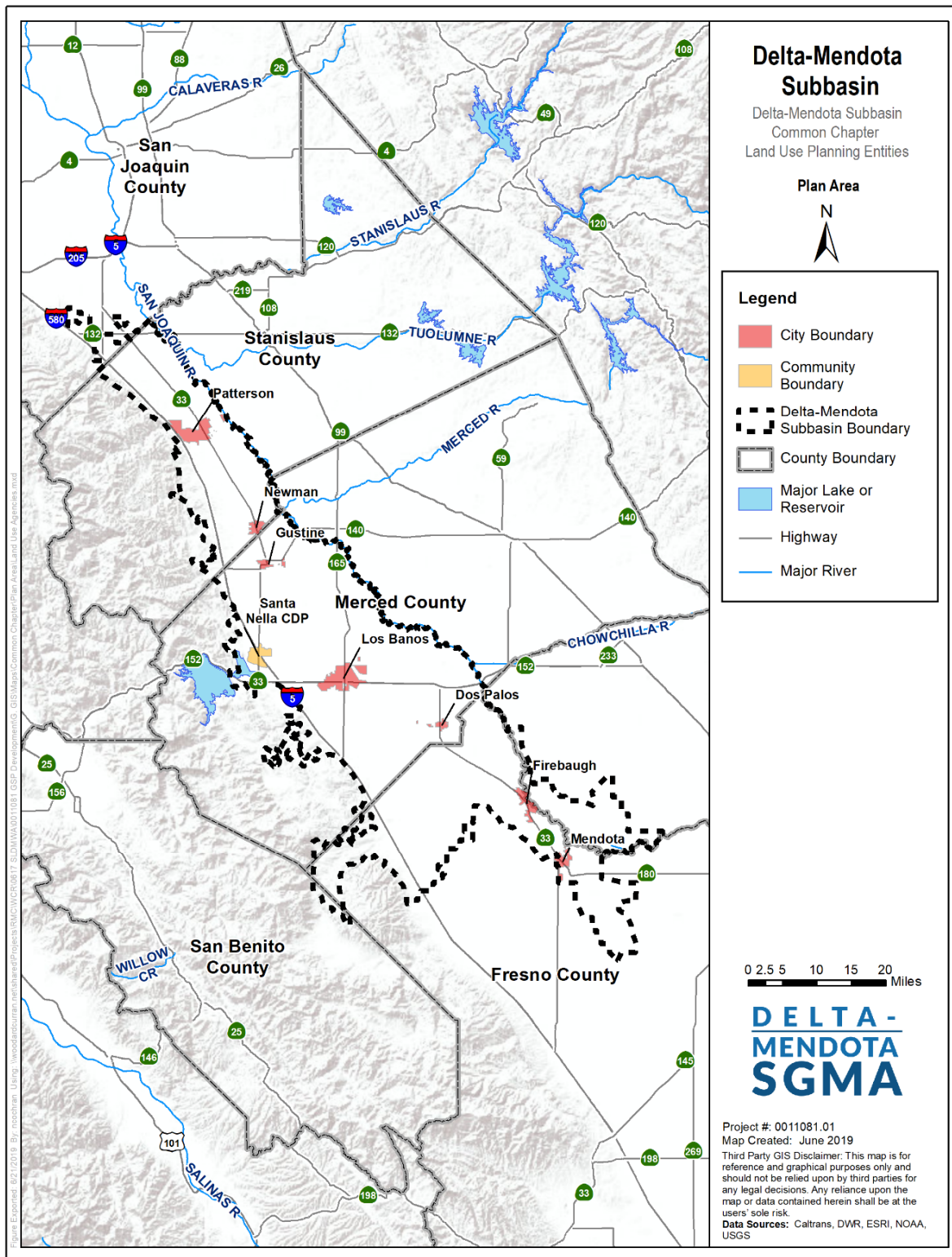


Figure CC-18: Land Use Planning Entities

Regional Economic Issues and Trends

The western San Joaquin Valley is a highly agricultural region. There are no large cities or industries in the Subbasin to provide an alternative economic base. The economy of this region is predominately driven by agricultural production and therefore, the availability of surface water supplies (predominantly in the form of CVP agricultural water and diversions from the San Joaquin and Kings Rivers) is an essential element to the economic health of the region. Other uses of surface water in the Subbasin are used for M&I purposes and wildlife refuge water supply.

Depending on water supply conditions, about 800,000 acres in the Delta-Mendota Subbasin are partially or solely irrigated with surface water. Other economic base industries include travel on the Interstate 5 (I-5) corridor, some petroleum extraction, and tourism. State, federal, and private wildlife refuges benefit local economies by attracting hunters, anglers, outdoor recreationists to the region. Managed wetland water conveyance infrastructure is maintained and improved by many contractors and local agency staff. Large scale conveyance improvements and habitat restoration projects, including mitigation banks, are also common throughout the Subbasin. M&I water use, which is a small share of total water use in the Subbasin, occurs primarily within the cities and smaller communities. The largest M&I use areas in the Delta-Mendota Subbasin, based on 2018 population estimates from the U.S. Census Bureau, are the cities of Patterson (population 22,352) and Los Banos (population 30,074) (U.S. Census Bureau, 2017).

All communities within the Delta-Mendota Subbasin have economies greatly dependent on agricultural production. These communities include Patterson, Tranquillity, Grayson, Mendota, Firebaugh, Dos Palos, Los Banos, Santa Nella, Newman, Gustine, Crows Landing, and Westley. All of these communities are strongly affected by the reliability of agricultural water supplies. Some of them are dependent upon groundwater for M&I use.

Plan Area Jurisdictional Boundaries

Jurisdictional areas within the Delta-Mendota Subbasin include counties, cities, water districts, irrigation districts, mutual water companies, and federal and state agencies. There are no federal- or state-recognized tribal communities in the Subbasin. Federal and State Lands are shown in **Figure CC-19**. More detail on specific jurisdictional areas within each GSP area can be found in the respective GSP.

In general, all municipal, water/irrigation districts and counties within the Delta-Mendota Subbasin are participating in GSP development either as a separate GSA or as members of a GSA. The California Department of Fish and Wildlife boundaries and the U.S. Fish and Wildlife Service boundaries overlay the wildlife refuges and areas and state parks within the Subbasin. DWR manages the SWP and the California Aqueduct, and the U.S. Bureau of Reclamation (USBR), through the SLDMWA, manages the CVP and the Delta-Mendota Canal. The California Department of Transportation (Caltrans) is responsible for managing the State and Interstate highways in the Subbasin, including Interstate- (I-) 5, and State Highways 132, 33, 140, 152, and 165.

Figure CC-9 depicts the Subbasin's extent relative to the boundaries of the various counties that overlie the Subbasin. Merced County has jurisdiction over the largest portion of the Subbasin (525 square miles), in the central portion of the Subbasin. Stanislaus County has jurisdiction over most of the area on the northern end of the Subbasin (covering 223 square miles). Fresno and Madera Counties have jurisdiction over the southern extent of the Delta-Mendota Subbasin (400 square miles). Finally, San Benito County covers the smallest portion of the Subbasin (5 square miles) in the southwestern portion of the Subbasin near San Luis Reservoir.

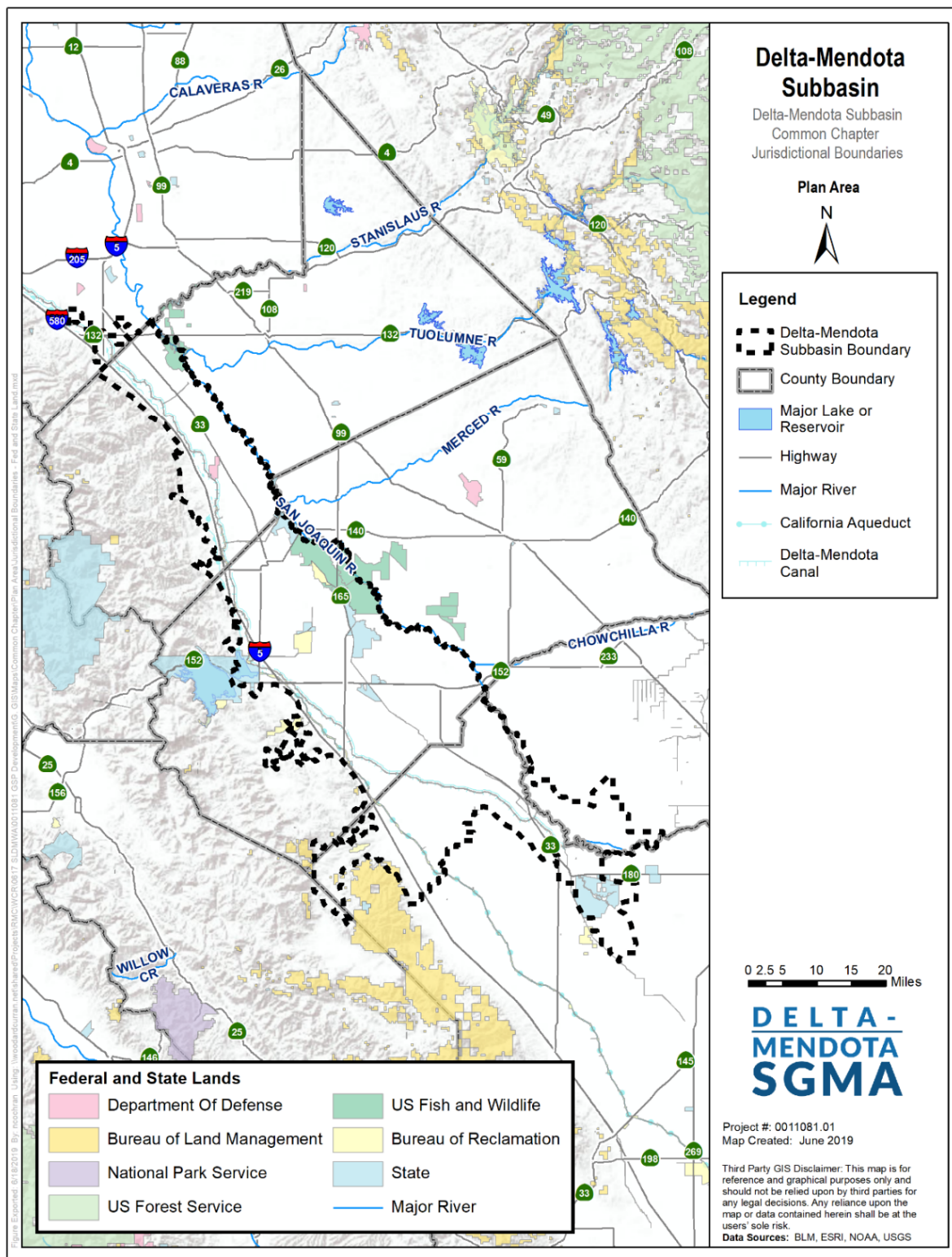


Figure CC-19: Federal and State Lands

Land Use Elements

Land use in the Delta-Mendota Subbasin is predominantly agricultural with wildlife habitat areas and areas of municipal, industrial, and commercial use. Predominant crops grown in the region include grain and hay crops, nut and fruit trees, and row crops. **Figure CC-20** shows the distribution of different land use types across the Delta-Mendota Subbasin.

Conjunctive use of surface water and groundwater is practiced throughout much of the Delta-Mendota Subbasin. Urban centers, such as the City of Patterson, and most unincorporated county areas rely solely on groundwater for their water supplies. Several water and irrigation districts hold water rights to divert from the San Joaquin River and/or the Kings Rivers. Other water purveyors receive water from the CVP and use groundwater and non-CVP-acquired surface waters to supplement demand, while some water districts rely solely on groundwater for their supplies. Refer to each GSP for detailed discussions of the water sources used by each agricultural, wetland, and urban water supplier.

Agriculture is the predominant water use sector throughout the Delta-Mendota Subbasin (**Figure CC-20**). Urban water uses are mostly concentrated within and surrounding cities (such as Patterson and Los Banos). Non-irrigated land includes any idle or native riparian land classifications, which are scattered throughout the Regions.

3.3 General Plans in Plan Area

Within each GSP, General Plans and/or Community Specific Plans overlie the area. These include County general plans for Fresno, Merced, San Benito, San Joaquin, Stanislaus, and Madera Counties, and specific plans for cities and communities. Each GSP contains a detailed list of General Plan policies and objectives relevant to water resources management in the applicable GSP area. Refer to discussions in the individual GSPs which satisfy §354.8(f) of the GSP Emergency Regulations under SGMA.

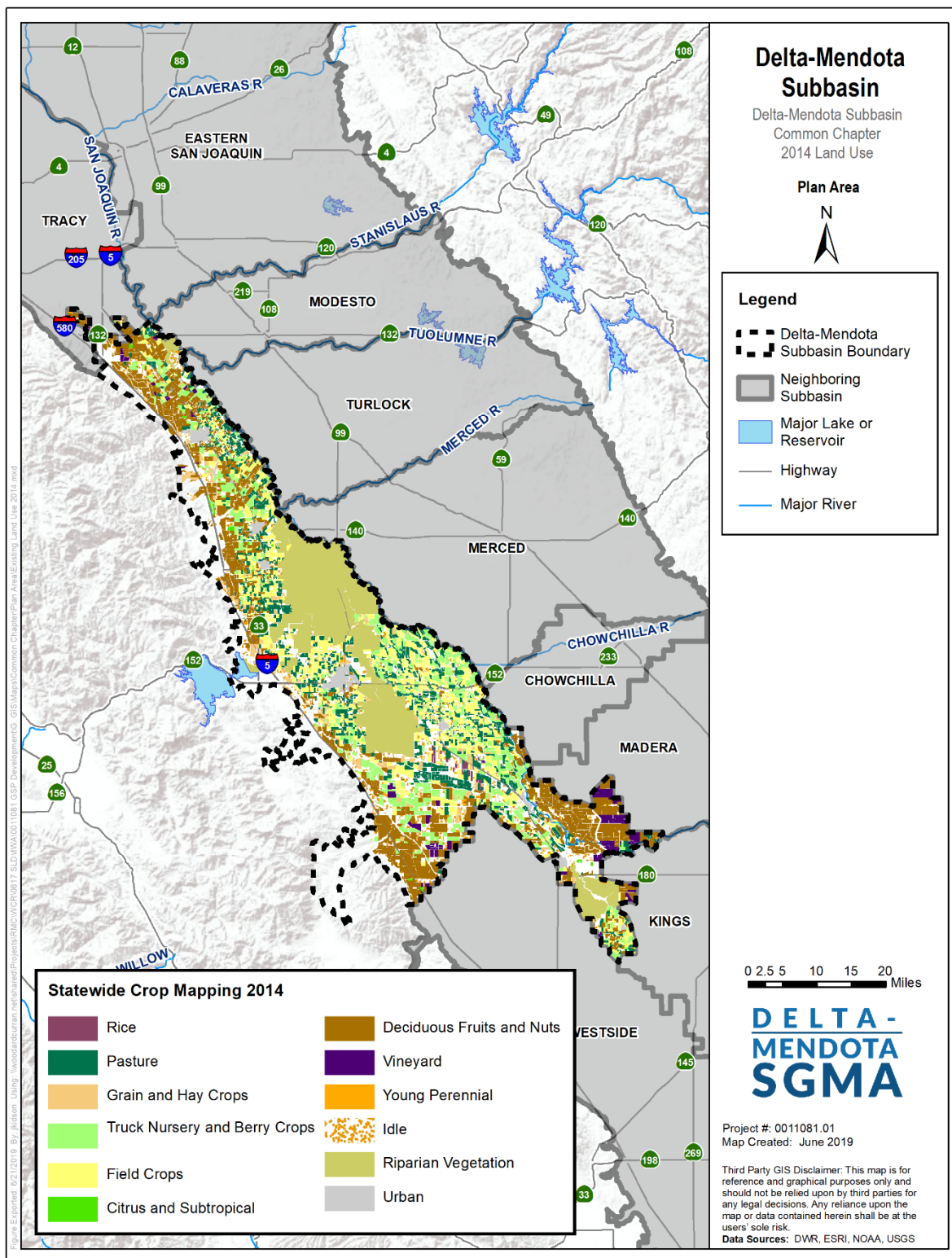


Figure CC-20: 2014 Land Use in the Delta-Mendota Subbasin

3.4 Existing Land Use Plans and Impacts to Sustainable Groundwater Management

Numerous policies in each County's and Community's General Plan compliment the GSPs' plans to conserve and sustainably manage groundwater resources. In general, the County and City General Plans guide future growth and development (and associated demands) within their respective jurisdictional areas. This additional growth may impact groundwater sustainability by placing additional demands on groundwater resources in an area where surface water resources are scarce or are otherwise unavailable. The General Plans also promote water conservation (in both the urban and agricultural sectors), which could potentially offset the additional demands associated with future urban development. In addition to conservation, some (though not all) General Plans promote groundwater recharge, the protection of recharge areas and wetlands, and the use of water transfers to further benefit groundwater sustainability.

Most General Plans within the Delta-Mendota Subbasin include goals focused on preserving agriculture, efficient use of existing and future water sources in both the urban and agricultural sectors, connecting smaller rural communities to larger water systems, and water quality protection. With respect to the protection of water quality and groundwater dependent ecosystems, the General Plans generally protect riparian and wetland habitats, encourage the protection of water quality (including through the remediation of contamination that may impact groundwater quality, requiring the use of septic systems in rural areas that are designed to be protective of groundwater quality and/or the use of community wastewater systems in urban areas), and promote flood control and management (including the associated impacts of erosion and sedimentation of surface water-courses).

The Fresno County General Plan, in particular, promotes sustainability by managing new wells in urban areas, supporting monitoring of water resources and associated habitats, and through the formation of a water resources document repository.

While the magnitude of impacts of these policies over the planning and implementation horizon are not known, such policies have been considered in this GSP, primarily through the use of the General Plans and associated zoning maps to identify future land use types and projected growth areas. These General Plans and mapping were used along with available water master plans, urban water management plans, agricultural water management plans, and other relevant planning documents to determine projected future land use and estimate future water demands by land use sector for use in the projected future water budgets.

Just as the General Plans complement the GSPs, the GSPs in the Delta-Mendota Subbasin may influence the General Plans' goals and policies. Sustainable management of groundwater resources through a GSP may change the pace, location, and type of development and/or land use that will occur in the Subbasin. GSP implementation is anticipated to be consistent with the General Plans' goals to sustainably manage land development and water resources in the Subbasin.

3.5 Existing Water Resources Monitoring and Management Programs

As required by §354.8I and (d) of the GSP Emergency Regulations, the following section describes key existing water resources-related management and monitoring programs, and a discussion of how these programs will either impact GSP implementation and/or will be incorporated into the GSPs. The information shown below is a high-level summary of key existing programs; please see the individual GSPs for additional relevant management and monitoring programs.

Irrigated Lands Regulatory Program (ILRP)

In 1999, the California Legislature passed Senate Bill 390, which eliminated a blanket waiver of water quality regulations for agricultural waste discharges. The Bill required the Regional Water Quality Control Boards to develop a program to regulate agricultural lands under the Porter-Cologne Water Quality Control Act. In 2003, the Central Valley Regional Water Quality Control Board (CV-RWQCB) issued an order that sets Waste Discharge Requirements (WDRs) for irrigated lands to protect both surface and groundwater throughout the Central Valley, primarily to address nitrates, pesticides, and sediment discharge. The resulting Irrigated Lands Regulatory Program (ILRP) regulates wastes from commercial irrigated lands that discharge into surface and groundwater. The program is administered by the CV-RWQCB working directly with a regional or crop-based coalition as well as directly with irrigators. The goal of the ILRP is to protect surface water and groundwater and to reduce impacts of irrigated agricultural discharges to waters of the State. As a result of the ILRP, monitoring reports, assessment reports, management plans, surface water quality data, and groundwater quality data are made available to the public.

Implementation of the ILRP in the Delta-Mendota Subbasin is managed primarily by the Westside San Joaquin River Watershed Coalition and the Grassland Drainage Area Coalition under the San Joaquin Valley Drainage Authority, a California Joint Powers Authority (JPA). This region specifically emphasizes nitrogen, sediment, and erosion control.

CV-SALTS

The Central Valley Salinity Alternatives for Long-Term Sustainability (CV-SALTS) is an initiative to reduce salt and nitrate impacts, restore groundwater quality, and provide safe drinking water supplies. Developed by a group of stakeholders (federal, state, and local agencies, dischargers and growers, and environmental groups) called the Central Valley Salinity Coalition, the Central Valley Salt and Nitrate Management Plan (SNMP) was released in 2017.

The Central Valley SNMP recommends revised and flexible regulations for existing Basin Plans and includes recommended interim solutions for salt and nutrient management in high priority basins in addition to long-term salt management strategies. Under the Central Valley SNMP, dischargers are provided two compliance pathways: (1) traditional permitting as an individual discharger or as a coalition (i.e., irrigated lands coalition), or (2) groundwater management zone permitting. Zone permitting allows dischargers to work as a collective in collaboration with the CV-RWQCB to provide safe drinking water with the option to extend time to achieve nitrogen balance. At this time, the Central Valley SNMP is not currently enforced.

Integrated Regional Water Management Program

Three Integrated Regional Water Management Plans (IRWMPs) overlie the Delta-Mendota Subbasin. The Westside-San Joaquin IRWMP covers most of the Subbasin, while smaller portions of the Subbasin are covered by the East Stanislaus and Madera IRWM Plans.

Integrated Regional Water Management (IRWM) is a collaborative effort to identify and implement water management solutions on a regional scale that increase regional self-reliance, reduce conflict, and manage water to concurrently achieve social, environmental, and economic objectives. Developed by Regional Water Management Groups, the IRWMPs seek to deliver higher value for investments in water resources and management by considering all interests, providing multiple benefits, and working across jurisdictional boundaries. Examples of multiple benefits include improved water quality, better flood management, restored and enhanced ecosystems, and more reliable surface and groundwater supplies.

Please see the individual GSPs for additional details regarding the IRWM program in their GSP Plan areas.

California State Groundwater Elevation Monitoring Program (CASGEM)

Since 2009, the California Statewide Groundwater Elevation Monitoring (CASGEM) Program has tracked seasonal and long-term groundwater elevation trends in groundwater basins statewide. The program's mission is to establish a permanent, locally-managed program of regular and systematic monitoring in all of California's alluvial groundwater basins. This early attempt to monitor groundwater continues to exist as a tool to help achieve the goals set out under the Sustainable Groundwater Management Act (SGMA) with mandatory annual water elevation monitoring and reporting.

San Joaquin River Restoration Program (SJRR)

The San Joaquin River Restoration Program (SJRRP) is a comprehensive, long-term effort to restore flows to the San Joaquin River from Friant Dam to the confluence of Merced River and restore a self-sustaining Chinook salmon fishery in the river while reducing or avoiding adverse water supply impacts from Restoration Flows. The program has two general goals resulting from the San Joaquin River Restoration Settlement reached in 2006:

- **Restoration:** To restore and maintain fish populations in "good condition" in the main stem of the San Joaquin River below Friant Dam to the confluence of the Merced River, including naturally reproducing and self-sustaining populations of salmon and other fish.
- **Water Management:** To reduce or avoid adverse water supply impacts to all of the Friant Division long-term contractors that may result from the Interim Flows and Restoration Flows provided for in the Settlement.

The program includes the implementation of projects, reintroduction activities and associated monitoring to assess progress towards achieving the Settlement goals.

USGS Land Subsidence Monitoring

The USGS maintains and monitors a large system of monitoring locations nationwide using interferometric synthetic aperture radar (InSAR), continuous GPS (CGPS) measurements, campaign global positioning system (GPS) surveying, and spirit-leveling surveying. Aquifer-system compaction is measured by using extensometers to aid in the understanding of the depths at which compaction is occurring. The USGS shares these results to support decision making relative to groundwater basin management with the goal of minimizing future inelastic land subsidence.

3.6 County Well Construction/Destruction Standards and Permitting

DWR has developed well standards for the state per California Water Code Sections 13700 to 13806. These standards have been adopted by the State Water Resources Control Board (SWRCB) into a statewide model well ordinance (Resolution No. 89-98) for use by the Regional Boards for enforcing well construction standards where no local well design ordinance exists that meets or exceeds the DWR standards. DWR's Well Standards are presented in Bulletin 74-81 and Bulletin 74-90.

Each GSP lists the counties within their GSP Plan areas and the respective permitting agencies and local ordinances for well construction and destruction standards. Discussion of these standards and the

respective permitting process as well as well abandonment and destruction procedures can be found in the individual GSPs.

3.7 Existing and Planned Conjunctive Use Programs

Conjunctive use programs in the Subbasin are currently implemented and planned by single agencies as well as through multi-agency partnerships. Maximizing the beneficial use of surface water, groundwater, and recycled water resources is of critical concern to water managers throughout the Delta-Mendota Subbasin with the ultimate goal of using all of these water sources more efficiently to avoid overdraft and to sustainably manage groundwater resources. Each GSP describes efforts to utilize existing water resources conjunctively and demonstrate feasibility to continue to implement conjunctive use projects in the future. These may include projects such as groundwater recharge and conveyance facilities, new wells, improved monitoring systems, improved delivery efficiency, water recycling, and water quality improvements and treatment.

Underground recharge and storage occur throughout the Delta-Mendota Subbasin through stormwater applied water and managed wetland recharge. Stormwater collects both naturally and artificially and eventually percolates through the ground and into aquifers for beneficial use for both urban and agriculture. Recharge from agricultural and wetland water conveyance and irrigation percolates into the ground and eventually into aquifers where it can be pumped again for use. This natural and unmanaged recharge creates future opportunities for conjunctive use programs; however, this recharge may decline as farmers move toward more precise and water efficient irrigation methods.

3.8 Plan Elements from California Water Code Section 10727.4

Each GSP may contain, as deemed appropriate, a detailed discussion of the additional plan elements as identified in California Water Code (CWC) Section 10727.4. These elements are:

- Control of saline water intrusion
- Wellhead protection areas and recharge areas
- Migration of contaminated groundwater
- Well abandonment and well destruction programs
- Activities implementing, opportunities for, and removing impediments to conjunctive use or underground storage
- Measures addressing groundwater contamination cleanup, groundwater recharge, in-lieu use, diversions to storage, conservation, water recycling, conveyance, and extraction projects
- Efficient Water Management Practices, as defined in Section 10902, for the delivery of water and water conservation methods to improve the efficiency of water use
- Efforts to develop relationships with state and federal regulatory agencies
- Processes to review land use plans and efforts to coordinate with land use planning agencies to assess activities that potentially create risk to groundwater quality or quantity
- Impacts on Groundwater Dependent Ecosystems

4. SUBBASIN SETTING

This Delta-Mendota Subbasin Settings section contains three main subsections as follows:

- **Hydrogeologic Conceptual Model (HCM)** – The HCM section (Section 4.1) provides the geologic information needed to understand the framework that water moves through in the Subbasin. It focuses on geologic formations, aquifers, structural features, and topography.
- **Groundwater Conditions** – The Groundwater Conditions section (Section 4.2) describes and presents groundwater trends, levels, hydrographs and level contour maps, estimates changes in groundwater storage, identifies groundwater quality issues, addresses subsidence, and addresses surface water interconnection.
- **Water Budget** – The Water Budget section (Section 4.3) describes the data used to develop the water budget. Additionally, this section discusses how the budget was calculated, provides water budget estimates for historical conditions, and current conditions and projected conditions

4.1 Hydrogeologic Conceptual Model

This section describes the hydrogeologic conceptual model (HCM) for the Delta-Mendota Subbasin based on technical studies and qualified maps that characterize the physical components and interaction of the surface water and groundwater systems, pursuant to Article 5, Plan Contents, Subarticle 2, Basin Setting, § 354.14 Hydrogeologic Conceptual Model of the GSP Emergency Regulations. The physical description of the Delta-Mendota Subbasin is based on information originally published in the *Western San Joaquin River Watershed Groundwater Quality Assessment Report* (GAR) (LSCE, 2015), *Grassland Drainage Area Groundwater Quality Assessment Report* (LSCE, 2016), and *Groundwater Overdraft in the Delta-Mendota Subbasin* (KDSA, 2015).

4.1.1 Regional Geologic and Structural Setting

The Delta-Mendota Subbasin is located in the northwestern portion of the San Joaquin Valley Groundwater Basin within the southern portion of the Central Valley (**Figure CC-21**). The San Joaquin Valley is a structural trough up to 200 miles long and 70 miles wide filled with up to 32,000 feet of marine and continental sediments deposited during periodic inundation by the Pacific Ocean and by erosion of the surrounding Sierra Nevada and Coast Range mountains, respectively (DWR, 2006). Continental deposits shed from the surrounding mountains form an alluvial wedge that thickens from the valley margins toward the axis of the structural trough. This depositional axis is slightly west of the series of rivers, lakes, sloughs, and marshes which mark the current and historic axis of surface drainage in the San Joaquin Valley.

The Delta-Mendota Subbasin (DWR Basin No. 5-22.07) is bounded on the west by the tertiary and older marine sediments of the Coast Ranges, on the north generally by the San Joaquin-Stanislous County line, on the east generally by the San Joaquin River and Fresno Slough, and on the south by the Tranquillity Irrigation District boundary near the community of San Joaquin. Surface waters converge from the Fresno, Merced, Tuolumne, and Stanislaus Rivers into the San Joaquin River, which drains to the north toward the Sacramento-San Joaquin Delta.

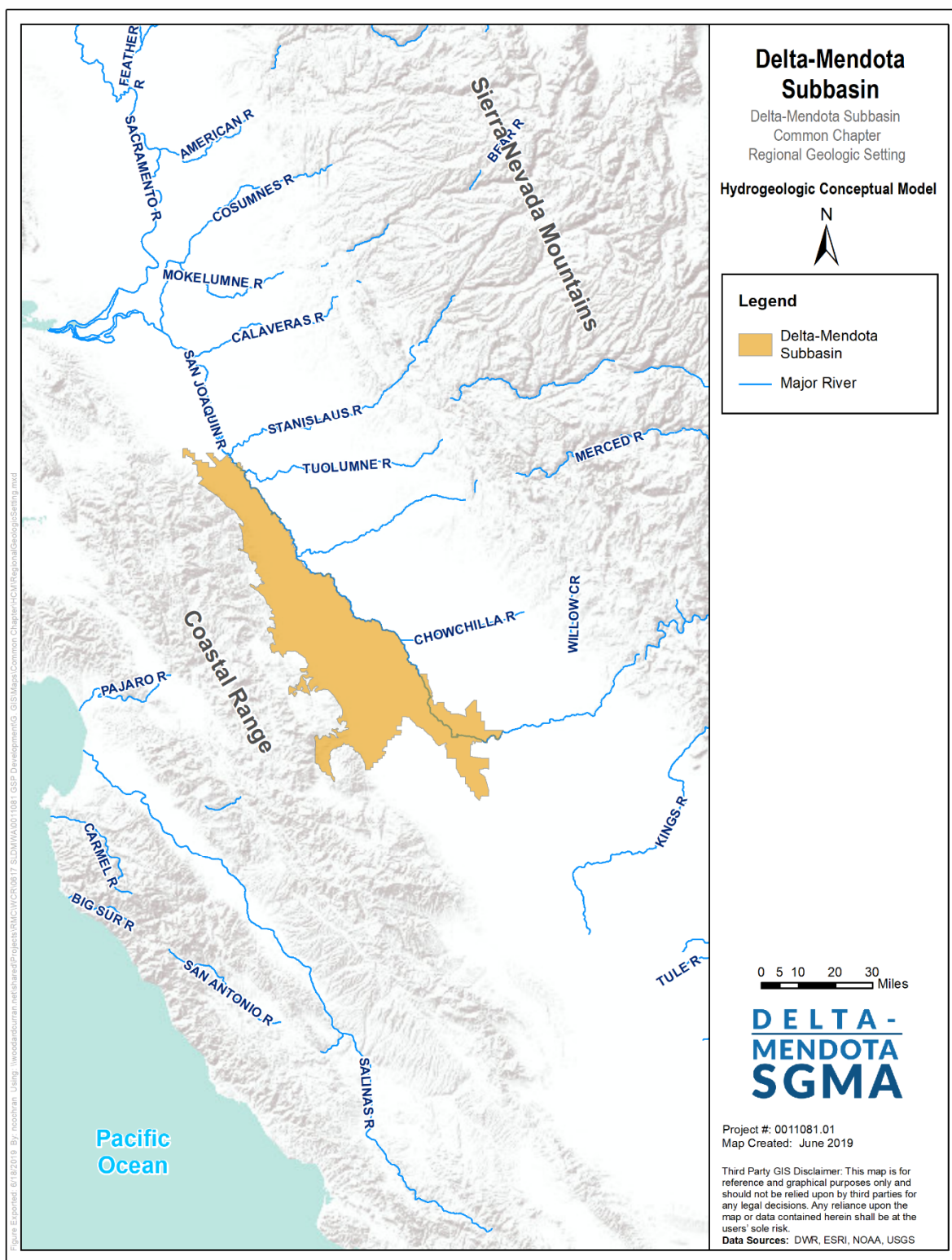


Figure CC-21: Regional Geologic Setting

4.1.2 Geologic History

Approximately three million years ago, tectonic movement of the Oceanic and Continental plates associated with the San Andreas Fault system resulted in the formation of the Coast Range which sealed off the Central Valley from the Pacific Ocean (LSCE, 2015). As this occurred, the floor of the San Joaquin Valley began to transition from a marine depositional environment to a freshwater system with ancestral rivers bringing alluvium to saltwater bodies (Mendenhall et al., 1916). The Coast Ranges on the western side of the San Joaquin Valley consist mostly of complexly folded and faulted consolidated marine and non-marine sedimentary and crystalline rocks ranging from Jurassic to Tertiary age, dipping eastward and overlying the basement complex in the region (Croft, 1972; Hotchkiss and Balding, 1971). The Central Valley Floor, in which the Delta-Mendota Subbasin lies, consists of Tertiary and Quaternary-aged alluvial and basin fill deposits (**Figure CC-22**). The fill deposits mapped throughout much of the valley extend vertically for thousands of feet, and the texture of sediments varies in the east-west direction across the valley. Coalescing alluvial fans have formed along the sides of the valley created by the continuous shifting of distributary stream channels over time. This process has led to the development of thick fans of generally coarse texture along the margins of the valley and a generally fining texture towards the axis of the valley (Faunt et al., 2009 and 2010).

Deposits of Coast Range and Sierra Nevada sources interfinger within the Delta-Mendota Subbasin. Steeper fan surfaces, with slopes as high as 80 feet per mile, exist proximal to the Coast Range, whereas more distal fan surfaces consist of more gentle slopes of 20 feet per mile (Hotchkiss and Balding, 1971). In contrast to the east side of the valley, the more irregular and ephemeral streams on the western side of the valley floor have less energy and transport smaller volumes of sediment resulting in less developed alluvial features, including alluvial fans which are less extensive, although steeper, than alluvial fan features on the east side of the valley (Bertoldi et al., 1991). Lacustrine and floodplain deposits also exist closer to the valley axis as thick silt and clay layers. Lakes present during the Pleistocene epoch in parts of the San Joaquin Valley deposited great thicknesses of clay sediments.

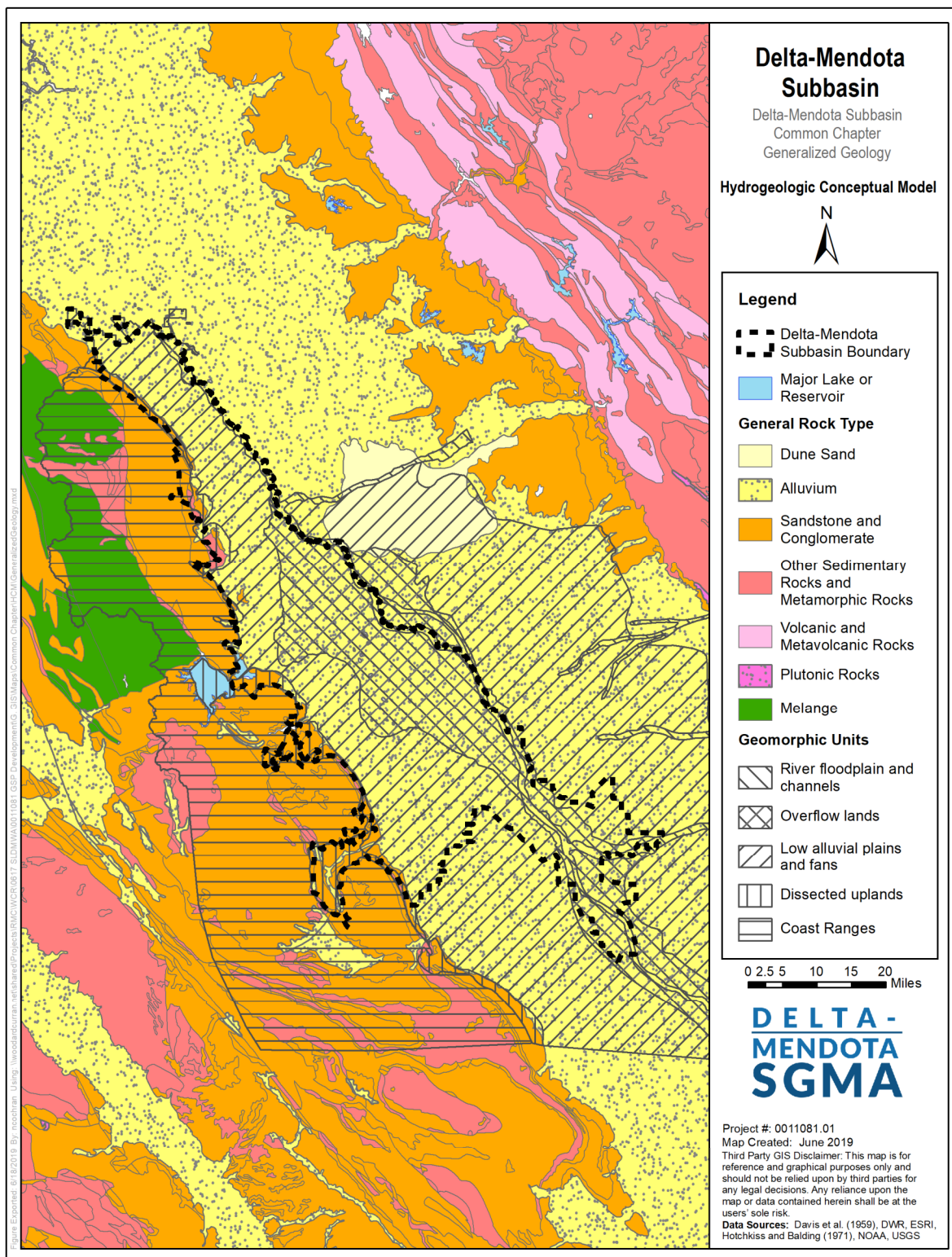


Figure CC-22: Generalized Geology

4.1.3 Geologic Formations and Stratigraphy

Distinct geomorphic units exist within the Delta-Mendota Subbasin defining areas of unique hydrogeologic environments. The geomorphic units are mapped and described by Hotchkiss and Balding (1971) and Davis et al. (1959) and are shown in **Figure CC-22**. The two primary geomorphic units within the Central Valley Floor area of the Delta-Mendota Subbasin include the overflow lands geomorphic unit and the alluvial fans and plains geomorphic unit. Overflow lands are defined as areas of relatively poorly draining soils with a shallow water table. The overflow lands geomorphic unit is located in the southeastern portion of the Subbasin and is dominated by finer-grained floodplain deposits that are the result of historical episodic flooding of this low-land area. This has formed poorly-draining soils with generally low hydraulic conductivity characteristics. In contrast, the alluvial fans and plains geomorphic unit is characterized by relatively better drainage conditions, with sediments comprised of coalescing and somewhat coarser-grained alluvial fan materials deposited by higher-energy streams flowing out of the Coast Range (Hotchkiss and Balding, 1971). The alluvial fans and plains geomorphic unit covers much of the Delta-Mendota Subbasin along the western margins of the Central Valley Floor at the base of the Coast Range.

The primary groundwater bearing units within the Delta-Mendota Subbasin consist of Tertiary and Quaternary-aged unconsolidated continental deposits and older alluvium of the Tulare Formation. Subsurface hydrogeologic materials covering the Central Valley Floor consist of lenticular and generally poorly sorted clay, silt, sand, and gravel that make up the alluvium and Tulare Formation. These deposits are thickest along the axis of the valley with thinning along the margins towards the Coast Range mountains (DWR, 2003; Hotchkiss and Balding, 1971). A zone of very shallow groundwater, generally within 25 feet of the ground surface, exists throughout large areas of the Subbasin, with considerable amounts (greater than 50 percent) of farmland in the area estimated to have very shallow depths to groundwater of less than 10 feet (Hotchkiss and Balding, 1971). Many of these areas are naturally swampy lands adjacent to the San Joaquin River.

The Tulare Formation extends to several thousand feet in depth and to the base of freshwater throughout most of the area and consists of interfingered sediments ranging in texture from clay to gravel of both Sierra Nevada and Coast Range origin. The formation is composed of beds, lenses, and tongues of clay, sand, and gravel that have been alternatively deposited in oxidizing and reducing environments (Hotchkiss and Balding, 1971).

Terrace deposits of Pleistocene age lie up to several feet higher than present streambeds and are comprised of yellow, tan, and light-to-dark brown silt, sand, and gravel with a matrix that varies from sand to clay (Hotchkiss and Balding, 1971). The water table generally lies below the bottom of the terrace deposits; however, the relatively large grain size of the terrace deposits suggests their value as possible recharge sites. Alluvium is composed of interbedded, poorly to well-sorted clay, silt, sand, and gravel and is divided based on its degree of dissection and soil formation. The flood-basin deposits are generally composed of light-to-dark brown and gray clay, silt, sand, and organic material with locally high concentrations of salt and alkali. Stream channel deposits of coarse sand and gravel are also included.

The Tulare Formation also includes the Corcoran Clay (E-Clay) member, a diatomaceous clay or silty clay of lakebed origin which is a prominent aquitard in the San Joaquin Valley, separating the upper zone from the lower zone and distinguishing the semi-confined Upper Aquifer from the confined Lower Aquifer (Hotchkiss and Balding, 1971). The depth and thickness of the Corcoran Clay are variable within the Central Valley Floor, and it is not present in peripheral areas (outside the Central Valley Floor) of the Subbasin. Within the Upper Aquifer, additional clay layers exist and also provide varying degrees of confinement, including other clay members of the Tulare Formation and layers of white clay identified by Hotchkiss and Balding (1971). These clays are variable in extent and thickness, but the white clay is

noted to be as much as 60 feet thick in areas providing very effective confinement of underlying zones (Croft, 1972; Hotchkiss and Balding, 1971). The Tulare Formation is hydrologically the most important geologic formation in the Delta-Mendota Subbasin because it contains most of the fresh water-bearing deposits. Most of the natural recharge that occurs in the Subbasin is in the alluvial fan apex areas along Coast Range stream channels (Hotchkiss and Balding, 1971).

4.1.4 Faults and Structural Features

The valley floor portion of the Delta-Mendota Subbasin contains no known major faults and is fairly geologically inactive. There are few faults along the western boundary of the Subbasin within the Coast Range mountains, but they are not known to inhibit groundwater flow or impact water conveyance infrastructure (**Figure CC-23**).

4.1.5 Basin Boundaries

The Delta-Mendota Subbasin is defined by both geological and jurisdictional boundaries. The Delta-Mendota Subbasin borders all subbasins within the San Joaquin Valley Hydrologic Region with the exception of the Cosumnes Subbasin. The following subsections describe the lateral boundaries of the Subbasin, boundaries with neighboring subbasins, and the definable bottom of the Delta-Mendota Subbasin.

Lateral Boundaries

The Delta-Mendota Subbasin is geologically and topographically bounded to the west by the Tertiary and older marine sediments of the Coast Ranges, and to the east generally by the San Joaquin River. The northern, central, and southern portion of the eastern boundary are dictated by jurisdictional boundaries of water purveyors within the Delta-Mendota Subbasin.

As described in *California's Groundwater*, DWR Bulletin 118 (2016), the Delta-Mendota Subbasin is in the San Joaquin Valley Groundwater Basin, located along the western edge of the San Joaquin Valley. The northern boundary begins just south of Tracy in San Joaquin County. The eastern boundary generally follows the San Joaquin River and Fresno Slough. The southern boundary is near the small town of San Joaquin. The subbasin is bounded on the west by the coast range. The Subbasin boundary is defined by 20 segments detailed in the descriptions below. The Delta-Mendota Subbasin extends into six (6) counties: San Joaquin, Stanislaus, Merced, Fresno, San Benito, and Madera and is shown in relation to each of the six counties in **Figure CC-9**.

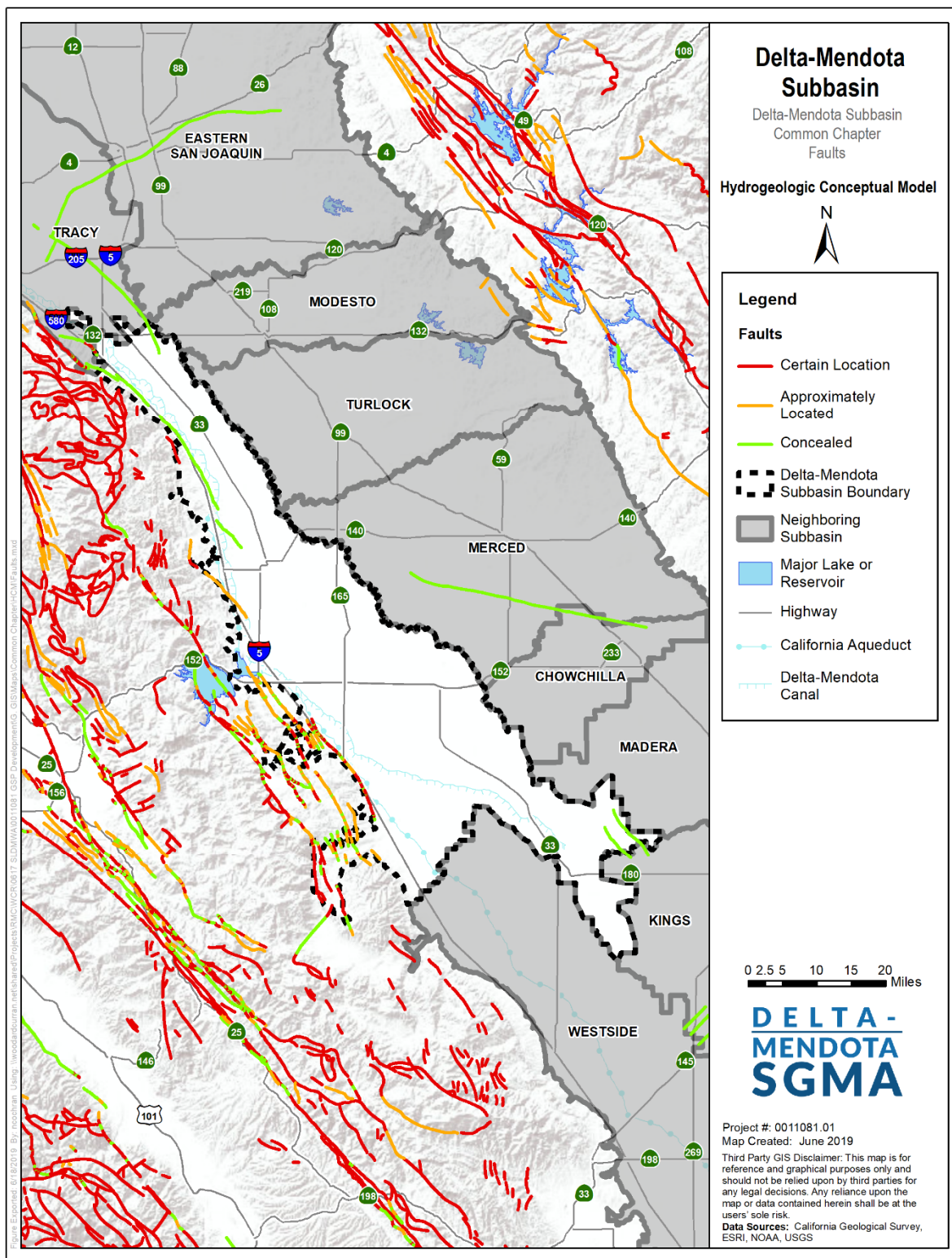


Figure CC-23: Subbasin Faults

4.1.6 Definable Bottom of Basin

In the San Joaquin Valley, the bottom of the Delta-Mendota Subbasin is defined as the interface of saline water of marine origin (base of fresh water) within the uppermost beds of the Tulare Formation. The Tulare Formation is characterized by blue and green fine-grained rocks and principally composed of fine-grained silty sands, silt, and clay (Foss and Blaisdell 1968). The Tulare Formation is predominantly marine in origin and is considered late Pliocene and possibly early Pleistocene in age. This formation is the upper shaley part of the Pliocene sequence. The top of the Tulare Formation is generally encountered around -2,000 feet mean sea level throughout the Delta-Mendota Subbasin. As agreed upon by the Delta-Mendota Subbasin GSP Groups, the base of freshwater is specifically defined by an electrical conductivity of 3,000 micromhos per centimeter at 25 °C, as presented by Page (1973). If and when significant use of water beyond the defined bottom takes place, the definition of the bottom will be revised appropriately.

4.1.7 Principal Aquifers and Aquitards

DWR's Groundwater Glossary defines an aquifer as "a body of rock or sediment that is sufficiently porous and permeable to store, transmit, and yield significant or economic quantities of groundwater to wells, and springs". There are two primary aquifers within the Delta-Mendota Subbasin: a semi-confined aquifer above the Corcoran Clay and a confined aquifer below the Corcoran Clay, with the Corcoran Clay acting as the principal aquitard within the Delta-Mendota Subbasin. **Figure CC-24** shows the locations of the representative cross-sections for the Delta-Mendota Subbasin, where **Figure CC-25** through **Figure CC-30** show the hydrostratigraphy of the representative cross-sections.

While the two-aquifer system described above is generally true across the Delta-Mendota Subbasin, there are portions of the Subbasin where the Corcoran Clay does not exist (predominantly along the western margin of the Subbasin) and hydrogeology is generally controlled by localized interfingering clays, and/or where local hydrostratigraphy results in shallow groundwater conditions that differ, to some extent, from that seen in the Subbasin as a whole. Additionally, in the southern portion of the Subbasin in the Mendota, Aliso and Tranquillity areas, there are A and C Clay layers in addition to the Corcoran Clay that inhibit vertical groundwater flow. However, while there are localized complexities throughout the Subbasin, the Corcoran Clay (or E Clay) extends through much of the Delta-Mendota Subbasin, generally creating a two-aquifer system.

Principal Aquifers

In the Delta-Mendota Subbasin, there are two primary aquifers composed of alluvial deposits separated by the Corcoran Clay (KDSA, 2015): a semi-confined Upper Aquifer (generally the ground surface to the top of the Corcoran Clay), and a confined Lower Aquifer starting at the bottom of the Corcoran Clay to the base of fresh water. However, as previously described, the localized presence of the A and C Clay layers in the southern portion of the Subbasin, the absence of the Corcoran Clay at the western margin of the Subbasin, and/or local hydrostratigraphy result in differing shallow groundwater conditions and/or perched groundwater conditions in some portions of the Subbasin. See the individual GSPs for more detailed descriptions of hydrostratigraphy in the respective Plan areas.

Upper Aquifer

The Upper Aquifer is represented by materials extending from the upper groundwater table to the top of the Corcoran Clay. The Upper Aquifer includes shallow geologic units of younger and older alluvium and upper parts of the Tulare Formation. Sediments within the upper Tulare Formation have variable sources, and subdivision of units can be distinguished between eastern and western sourced materials. Alluvial fan materials above the Corcoran Clay in the Delta-Mendota Subbasin are generally more extensive than older alluvial fan deposits within the Tulare Formation below the Corcoran Clay. As shown in Figure CC-31 by the depth to the top of the Corcoran Clay, the Upper Aquifer extends to depths ranging between approximately 150 feet and greater than 350 feet. Other notable mapped clay units also exist within the upper part of the Tulare Formation in the Delta-Mendota Subbasin, including the A and C Clay members of the Tulare Formation and a white clay mapped by Hotchkiss and Balding (1971).

Lower Aquifer

The Lower Aquifer is the portion of the Tulare Formation that is confined beneath the Corcoran Clay, extending downward to the underlying San Joaquin Formation and the interface of saline water of marine origin within its uppermost beds. The Lower Aquifer is generally characterized by groundwater that tends to be dominantly sodium-sulfate type, which is often of better quality than the Upper Aquifer (Davis et al., 1957; Hotchkiss and Balding, 1971). Exceptions to this quality do exist in the Subbasin, particularly in the southwestern portion of the Subbasin. Because of its relatively shallow depth within the Delta-Mendota Subbasin and lower salinity in areas when compared to other groundwater resources, the Lower Aquifer is heavily utilized as a source of groundwater for agricultural and drinking water uses within the Subbasin.

The base of the Lower Aquifer generally decreases from south to north, changing in depth from about 1,100 to 1,200 feet deep in the south to about 600 feet to the north. Depth to the top of the Corcoran Clay ranges from less than 100 feet on the west near Interstate 5 (I-5) to more than 500 feet in the area near Tranquillity. The Corcoran Clay pinches out or is above the water level near the California Aqueduct in the western part of the Subbasin, where the Upper and Lower Aquifers merge into interfingered layers of sand, gravel, and clay.

Corcoran Clay

The Corcoran Clay, as a regional aquitard, is a notable hydrogeologic feature throughout most of the Delta-Mendota Subbasin, impeding vertical flow between the Upper and Lower Aquifers. The Corcoran Clay is present at varying depths across most of the Central Valley floor (**Figure CC-31** and **Figure CC-33**). The depths to the top of the Corcoran Clay ranges between approximately 100 and 500 feet below the ground surface throughout most of the Subbasin, with a general spatial pattern of deepening to the south and east. In the far southeastern area of the Subbasin, in the vicinity of Mendota and Tranquillity, the top of the Corcoran Clay is at depths of greater than 350 feet (**Figure CC-31**). The thickness of the Corcoran Clay, which likely influences the degree of hydraulic separation between the Upper and Lower Aquifers, is greater than 50 feet across most of the Delta-Mendota Subbasin with thicknesses of more than 75 feet in central Subbasin areas in the vicinity of Los Banos and Dos Palos, and 140 feet in the eastern portions of the Subbasin. The Corcoran Clay appears thinner in areas north of Patterson, between Patterson and Gustine, and also in the vicinity of Tranquillity to the south (**Figure CC-33**). Along the westernmost portions of the Delta-Mendota Subbasin, the Corcoran Clay layer is generally non-existent or it exists as Corcoran-equivalent clays (clays existing at the same approximate depth but not part of the mapped aquitard).

Aquifer Properties

The following subsections include discussion of generalized aquifer properties within the Delta-Mendota Subbasin. These include hydraulic conductivity, transmissivity, specific yield and specific storage.

DWR defines hydraulic conductivity as the “measure of a rock or sediment’s ability to transmit water” and transmissivity as the “aquifer’s ability to transmit groundwater through its entire saturated thickness” (DWR, 2003). High hydraulic conductivity values correlate with areas of transmissive groundwater conditions with transmissivity generally equaling hydraulic conductivity times the saturated thickness of the formation. Storage of water within the aquifer system can be quantified in terms of the specific yield for unconfined groundwater flow and the storage coefficient for confined flow, respectively (Faunt et al., 2009). Specific yield represents gravity-driven dewatering of shallow, unconfined sediments at a declining water table, but also accommodates a rising water table. The specific yield is dimensionless and represents the volume of water released from or taken into storage per unit head change per unit area of the water table. Specific yield is a function of porosity and specific retention of the sediments in the zone of water-table fluctuation.

Where the aquifer system is confined, storage change is governed by the storage coefficient, which is the product of the thickness of the confined-flow system and its specific storage. The specific storage is the sum of two component specific storages – the fluid (water) specific storage and the matrix (skeletal) specific storage, which are governed by the compressibility of the water and skeleton, respectively (Jacob, 1940). Specific storage has units of 1 over length and represents the volume of water released from or taken into storage in a confined flow system per unit change in head per unit volume of the confined flow system (Faunt et al., 2009). Therefore, the storage coefficient of a confined flow system is dimensionless and, similar to specific yield, represents the volume of water released from or taken into storage per unit head change.

Hydraulic Conductivity

Figure CC-34 shows the saturated C-horizon hydraulic conductivity of surficial soils within the Delta-Mendota Subbasin based on the National Resource Conservation Service (NRCS) Soil Survey Geographic Database (SSURGO). Soil survey data for counties within the Subbasin were combined using the weighted harmonic mean of these representative layers to depict the saturated hydraulic conductivity of the C-horizon for each soil map unit. The soil profile represented by these data is variable but commonly extends to a depth of six or more feet.

Floodplain deposits are evident as soils with relatively low hydraulic conductivity (less than 0.5 feet per day [ft/day]) blanket much of the Central Valley Floor, although localized areas of soils with higher hydraulic conductivity are present in association with modern and ancient surface waterways and alluvial fan features (**Figure CC-34**). Coarse soils of distributary alluvial fan sediments deposited by Del Puerto Creek, Orestimba Creek, Los Banos Creek, Ortigalita Creek, and Little Panoche Creek, in addition to other ephemeral northeasterly creek flows off the Coast Ranges, are notably apparent as areas of soils of high hydraulic conductivity located along active and inactive stream channels extending eastward from the fan apex areas along the Valley Floor margins to the current alignment of the San Joaquin River in the valley axis. Additionally, soils in areas adjacent to the active channel of the San Joaquin River also exhibit high hydraulic conductivities, including values of greater than 4 ft/day which are particularly apparent in an area north of Mendota. Soils of similarly high hydraulic conductivity trending as linear features in a general northwest-southeast alignment to the north of Dos Palos and Los Banos are likely the result of historical depositional processes and paleochannels associated with the San Joaquin River (**Figure CC-34**). In areas peripheral to the Central Valley floor, soils tend to be characterized by relatively low hydraulic conductivity, although soils of somewhat higher hydraulic conductivity

associated with distinct geologic units are mapped across much of the peripheral area to the west of Patterson and Gustine and also in localized bands associated with surface water courses.

Transmissivity

Transmissivity varies greatly above the Corcoran Clay, within the Corcoran Clay, and below the Corcoran Clay within the Delta-Mendota Subbasin, with transmissivities in the confined Lower Aquifer generally being larger than those in the semi-confined Upper Aquifer. Based on testing conducted at multiple locations within both the Upper and Lower Aquifers of the Delta-Mendota Subbasin, average transmissivities in the Subbasin are approximately 109,000 gallons per day per square foot (gpd/ft²) (KDSA, 1997b).

Specific Yield

DWR defines specific yield as the “amount of water that would drain freely from rocks or sediments due to gravity and describes the proportion of groundwater that could actually be available for extraction” (DWR, 2003). Specific yield is a measurement specific to unconfined aquifers.

The estimated specific yield of the Delta-Mendota Subbasin is 0.118 (DWR, 2006). Within the southern portion of the Delta-Mendota Subbasin, specific yield ranges from 0.2 to 0.3 (Belitz et al., 1993). Specific yield estimates for the Delta-Mendota Subbasin are fairly limited in literature since the Upper Aquifer above the Corcoran Clay is semi-confined and the Lower Aquifer below the Corcoran Clay is confined. Therefore, specific yield values only characterize the shallow, unconfined groundwater within the Subbasin.

Specific Storage

Values for specific storage were extracted from the Central Valley Hydrologic Model 2 (CVHM2), which is currently under development by the United States Geological Survey (USGS) and includes refinements for the Delta-Mendota Subbasin. Specific storage varies above, within, and below the Corcoran Clay with CVMH2. Above the Corcoran Clay, specific storage ranges from 1.34×10^{-6} to $6.46 \times 10^{-2} \text{ m}^{-1}$ with average values ranging from 6.16×10^{-3} to $1.97 \times 10^{-2} \text{ m}^{-1}$. Specific storage within the Corcoran Clay is considerably smaller than above the Corcoran Clay, ranging between 1.41×10^{-6} and $2.35 \times 10^{-6} \text{ m}^{-1}$ and average values between 1.96×10^{-6} and $2.02 \times 10^{-6} \text{ m}^{-1}$. Below the Corcoran Clay, specific storage is comparable to within the Corcoran Clay with overall ranges the same as within the Corcoran Clay and average values ranging from 1.86×10^{-6} to $2.01 \times 10^{-6} \text{ m}^{-1}$. Therefore, specific storage is greatest within the semi-confined aquifer overlying the Corcoran Clay layer, with considerably smaller specific storage values within the low permeability Corcoran Clay and confined aquifer underlying the Corcoran Clay layer.

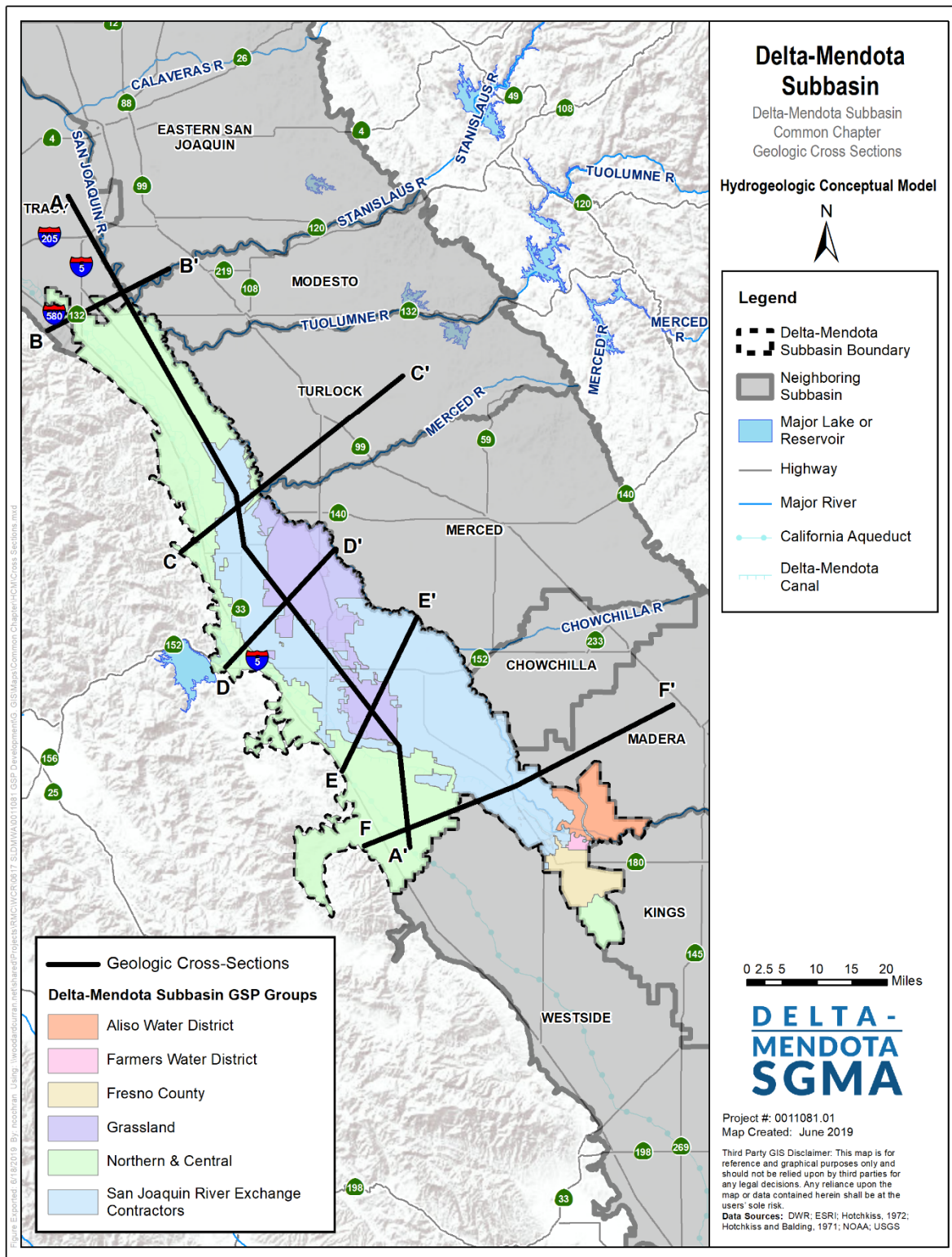


Figure CC-24: Representative Cross-Sections

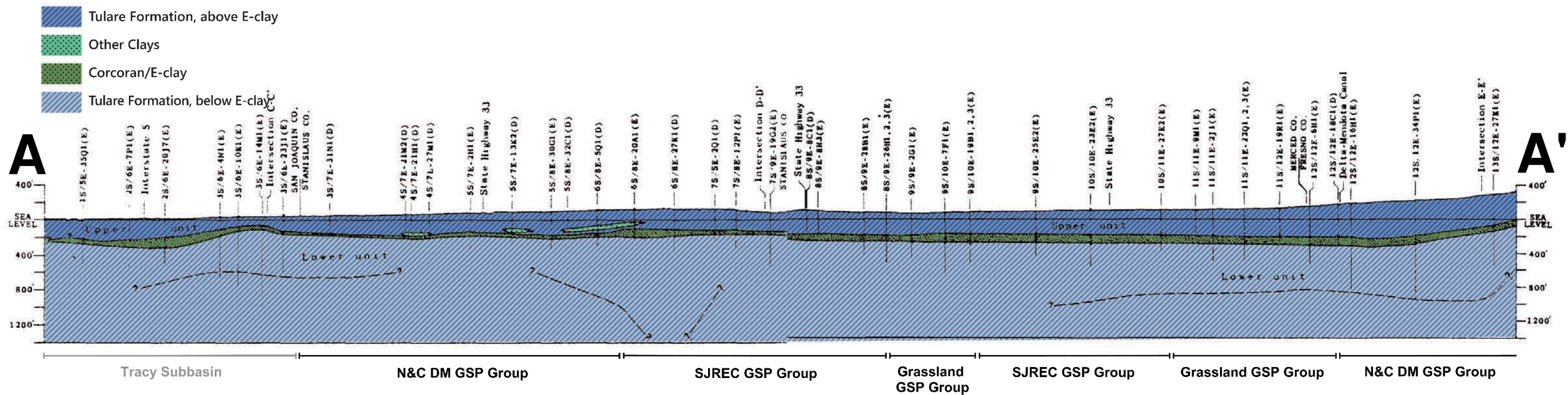


Figure CC-25: Cross-Section A-A' (Hotchkiss, 1972)

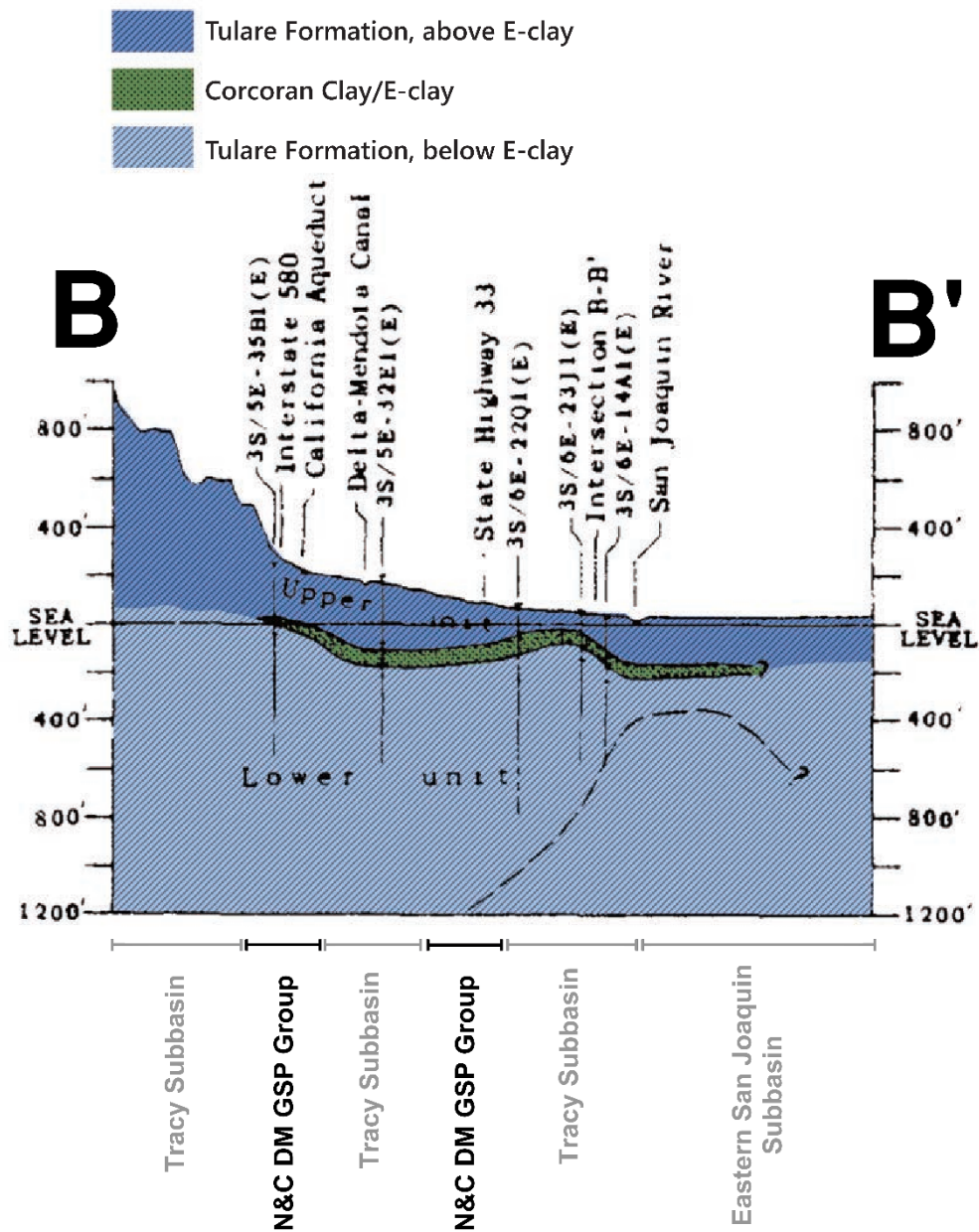


Figure CC-26: Cross-Section B-B' (Hotchkiss, 1972)

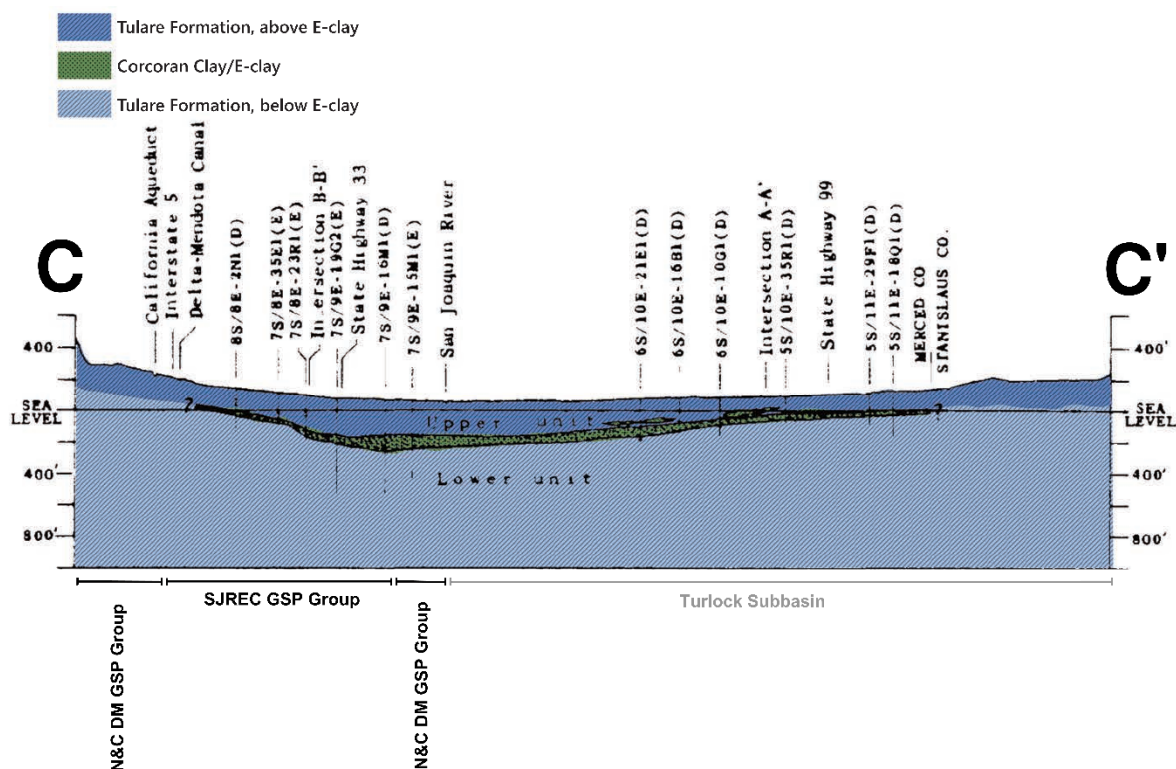


Figure CC-27: Cross-Section C-C' (Hotchkiss, 1972)

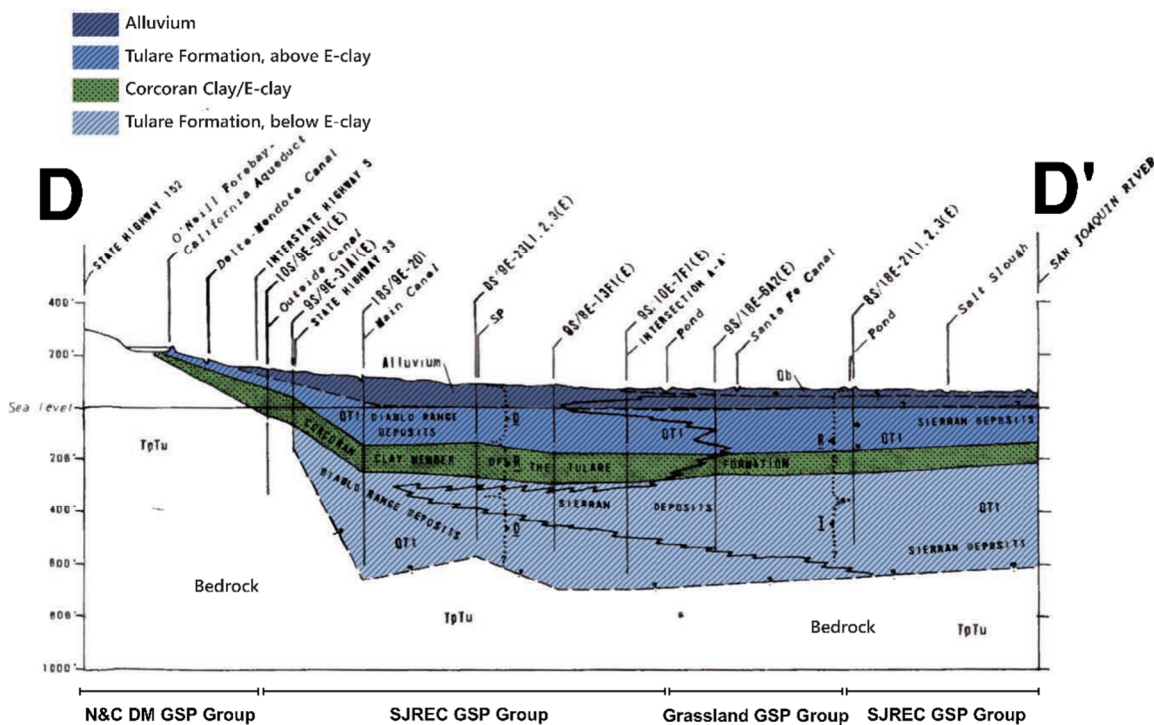


Figure CC-28: Cross-Section D-D' (Hotchkiss & Balding, 1971)

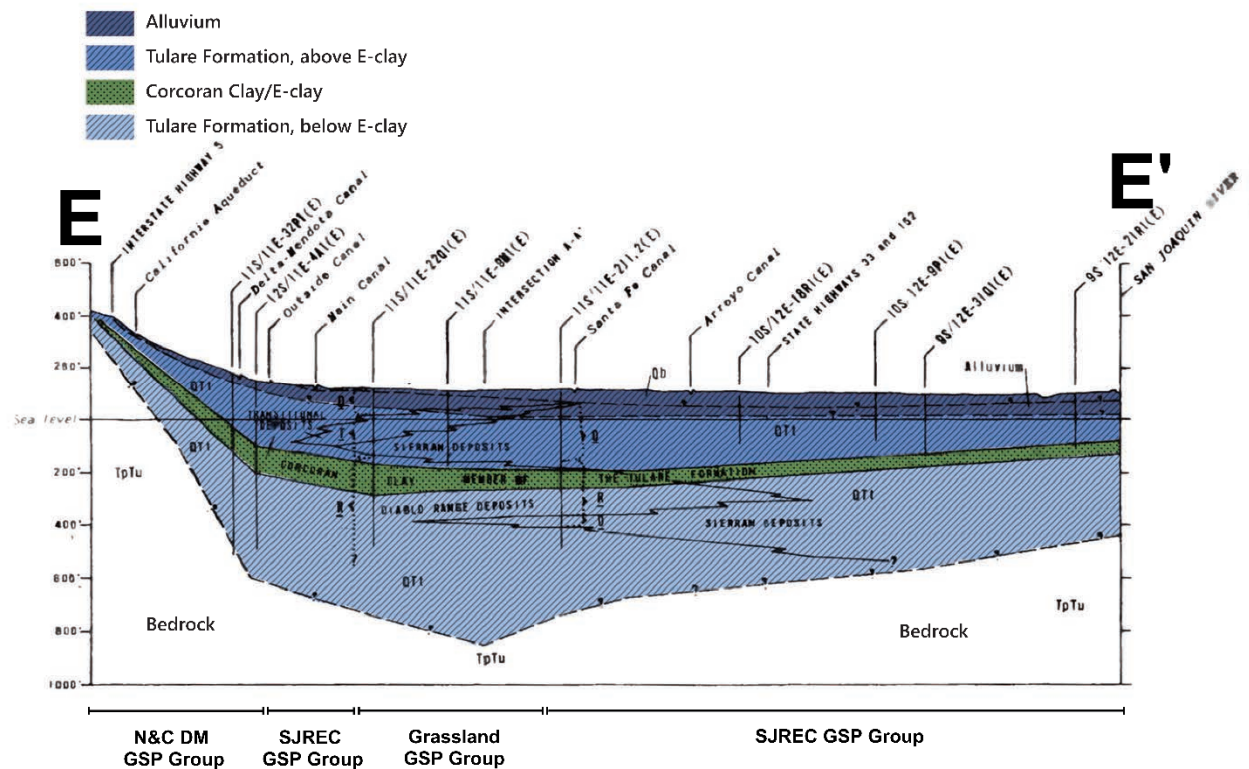


Figure CC-29: Cross-Section E-E' (Hotchkiss & Balding, 1971)

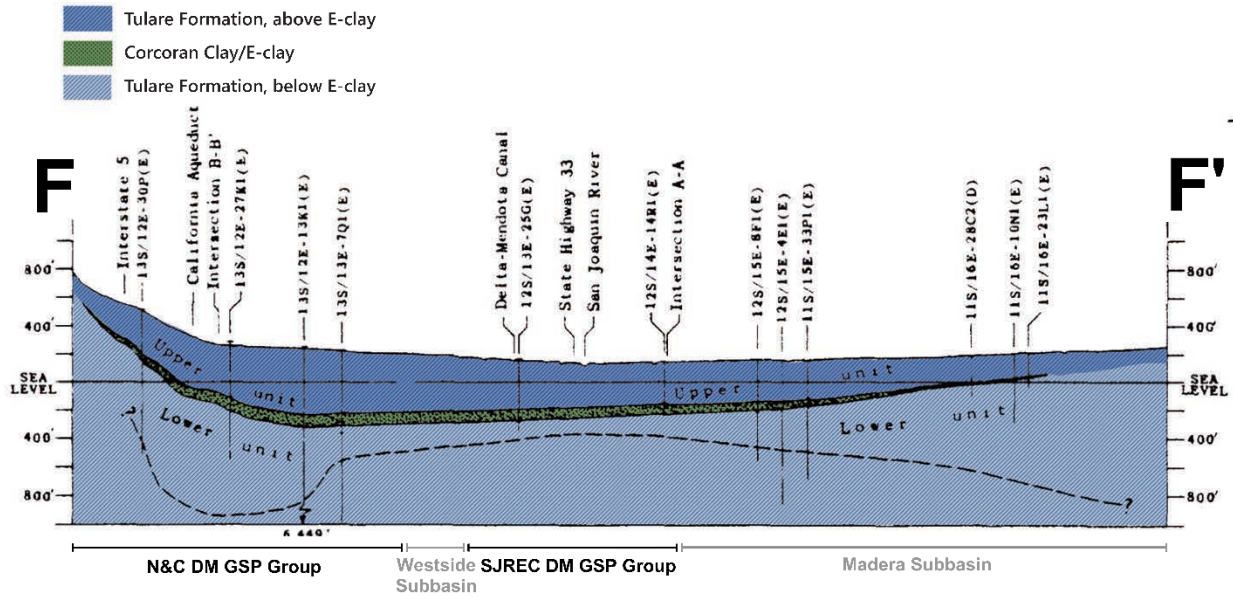


Figure CC-30: Cross-Section F-F' (Hotchkiss, 1972)

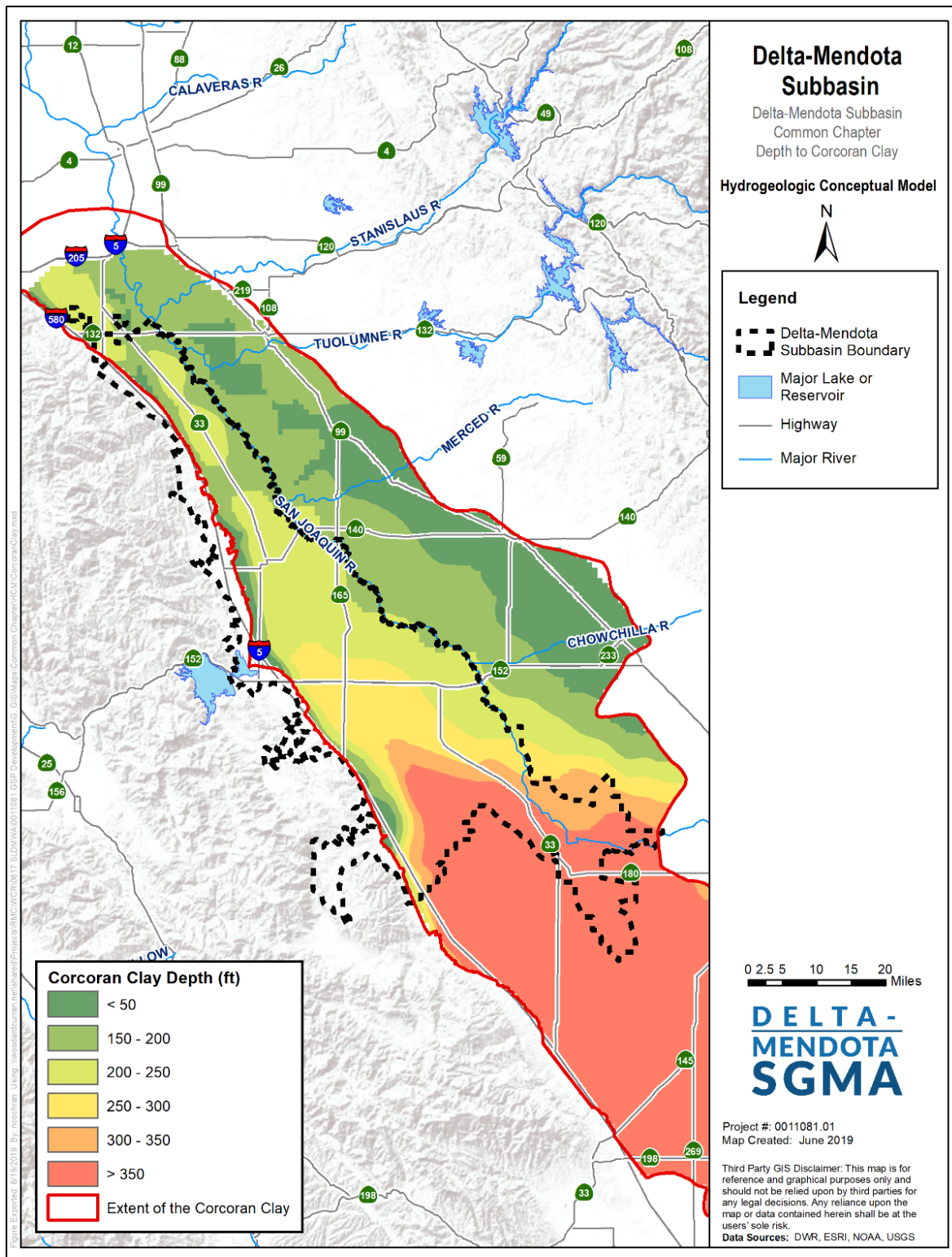


Figure CC-31: Depth to Corcoran Clay

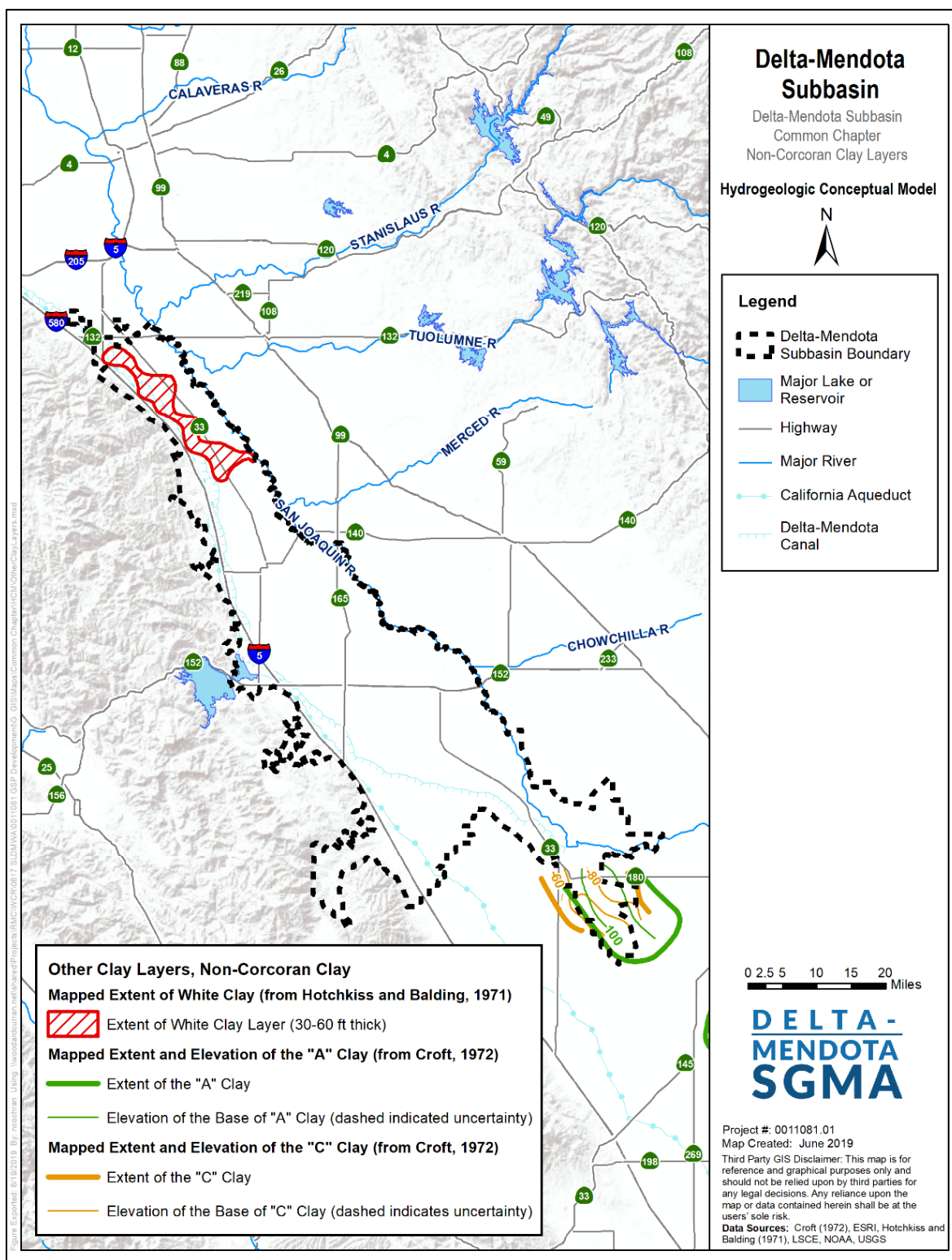


Figure CC-32: Non-Corcoran Clay Layers

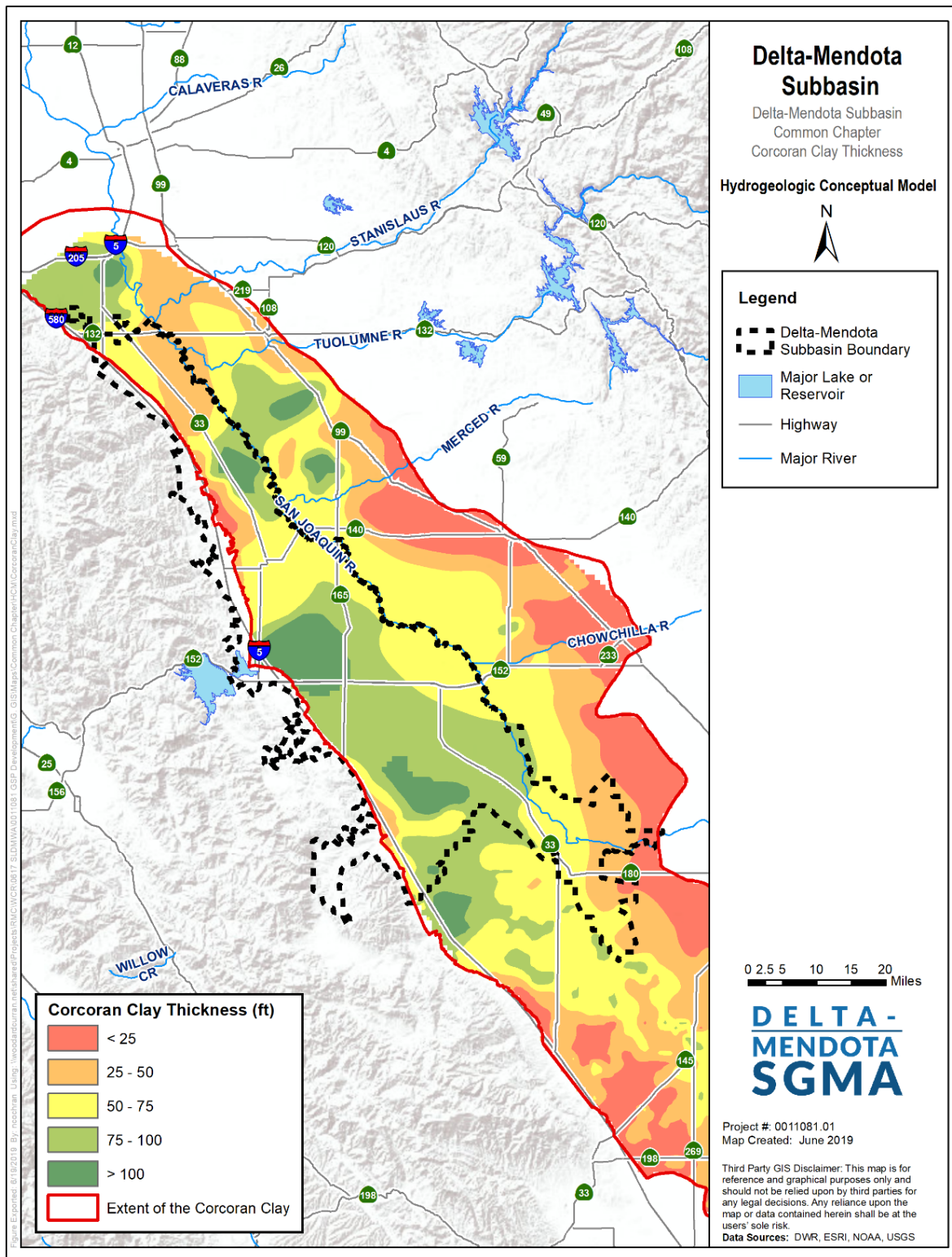


Figure CC-33: Thickness of Corcoran Clay

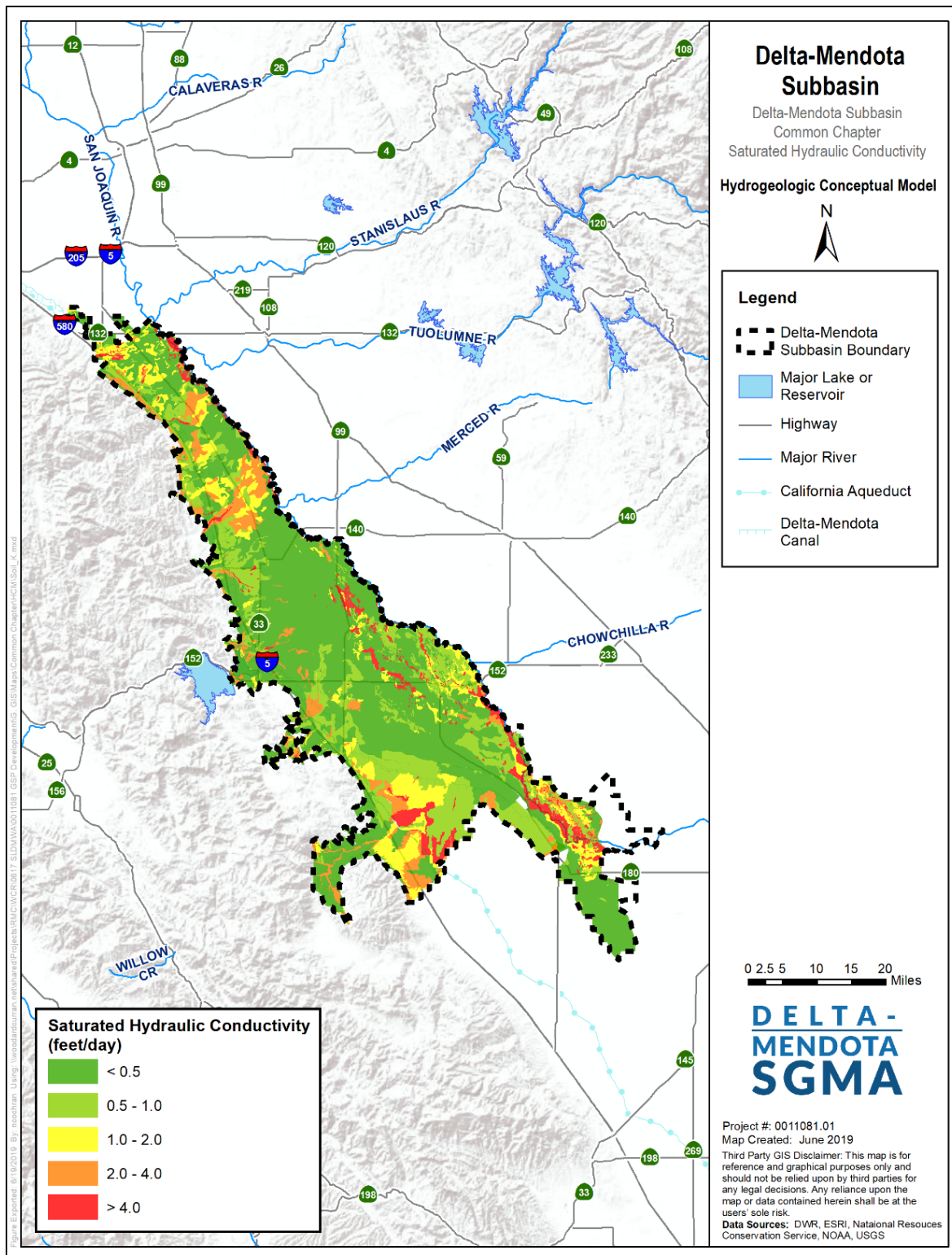


Figure CC-34: Soil Hydraulic Conductivity

4.1.8 Structural Properties and Restricted Groundwater Flow

Under natural (pre-development) conditions, the prevailing groundwater flow within the Upper and Lower Aquifer systems of the western San Joaquin Valley was predominantly in a generally northeasterly direction from the Coast Range towards and parallel to the San Joaquin River and the Sacramento-San Joaquin Delta (LSCE, 2015; Hotchkiss and Balding, 1971; KDSA, 2015). Historically, numerous flowing artesian wells within the Lower Aquifer existed throughout the Delta-Mendota Subbasin (Mendenhall et al., 1916) and the pressure gradient for groundwater flow was upward from the Lower Aquifer to the Upper Aquifer. These flowing artesian conditions have disappeared in many areas as a result of increased development of groundwater resources within the Tulare Formation (Hotchkiss and Balding, 1971). Additionally, the Delta-Mendota Subbasin has experienced periods of considerable decline in groundwater levels during which hydraulic heads in the Lower Aquifer decreased considerably in some areas due to heavy pumping (Bertoldi et al., 1991).

Despite the presence of local pumping depressions within parts of the Subbasin, the prevailing northeastward flow direction for groundwater in the Upper Aquifer within the region has remained (AECOM, 2011; DWR, 2010; Hotchkiss and Balding, 1971). Groundwater generally flows outward from the Delta-Mendota Subbasin, except along the southern and western margins where there is some recharge from local streams and canal seepage (KDSA, 2015), in addition to northward subbasin boundary flows. Within the Upper Aquifer, there are similar groundwater flow directions in most of the Subbasin with groundwater outflow to the northeast or towards the San Joaquin River in much of the Subbasin during wet and normal periods. One exception is in the Orestimba Creek area west of Newman where groundwater flows to the west during drought conditions and east during wet periods. Calculations based on aquifer transmissivity indicate the net groundwater outflow in the Upper Aquifer has been about three times greater during drought periods than during normal periods (KDSA, 1997a and 1997b).

Within the Lower Aquifer, there is a groundwater divide generally in the area between Mendota and the point near the San Joaquin River in the Turner Island area, northeast of Los Banos. Groundwater southwest of this divide generally flows southwest toward Panoche Water District and Westlands Water District. Groundwater northeast of this divide flows to the northeast into Madera and Merced Counties. Net groundwater outflow in the Lower Aquifer under drought conditions has been about two and a half times greater than for normal conditions (KDSA, 1997a and 1997b). Based on current and historical groundwater elevation maps, groundwater barriers do not appear to exist in the Delta-Mendota Subbasin (DWR, 2006).

The combined effect of pumping below the Corcoran Clay and increased leakage from the Upper Aquifer to the Lower Aquifer where the Corcoran Clay does not exist or has been perforated has developed a generally downward flow gradient in the Tulare Formation which changes with variable pumping and irrigation over time (Bertoldi et al., 1991). Periods of great groundwater level declines have also resulted in inelastic compaction of fine-grained materials in some locations, particularly between Los Banos and Mendota, potentially resulting in considerable decreases (between 1.5 and 6 times) in permeability of clay members within the Tulare Formation, including the Corcoran Clay (Bertoldi et al., 1991). However, the number of wells penetrating the Corcoran Clay may be enabling vertical hydraulic communication across the Corcoran Clay aquitard and other clay layers (Davis et al., 1959; Davis et al., 1964).

4.1.9 Water Quality

Groundwater in the Delta-Mendota Subbasin is characterized by mixed sulfate to bicarbonate water types in the northern and central portion of the Subbasin, with areas of sodium chloride and sodium sulfate waters in the central and southern portions (DWR, 2003). Total Dissolved Solids (TDS) values range from 400 to 1,600 mg/L in the northern portion, and 730 to 6,000 mg/L in the southern portion of the

Delta-Mendota Subbasin (Hotchkiss and Balding, 1971). The Department of Health Services (currently the Division of Drinking Water), which monitors Title 22 water quality standards, reports TDS values in 44 public supply wells in the Subbasin ranging in value from 210 to 1,750 mg/L, with an average value of 770 mg/L. Shallow, saline groundwater also occurs within about 10 feet of the ground surface over a large portion of the Delta-Mendota Subbasin. There are also localized areas of high iron, fluoride, nitrate, selenium, and boron in the Delta-Mendota Subbasin (Hotchkiss and Balding, 1971).

Alluvial sediments derived from west-side streams are composed of material from serpentine, shale, and sandstone parent rock, which results in soil and groundwater types entirely different from those on the east side of the San Joaquin Valley (LSCE, 2015). In contrast with the siliceous mineralogy of the alluvial sands and gravels on the eastern side of the Central Valley that are derived from the Sierra granitic rocks (which are coarser and more resistant to chemical dissolution), the sulfate and carbonate shales and sandstones of Coast Range sediments on the western side are more susceptible to dissolution processes. Some soils and sediments within the western San Joaquin Valley that are derived from marine rocks of the Coast Range have notably high concentrations of naturally-occurring nitrogen, with particularly higher nitrate concentrations in younger alluvial sediments (Strathouse and Sposito, 1980; Sullivan et al., 1979). These naturally-occurring nitrogen sources may contribute to nitrate concentrations in groundwater within the Delta-Mendota Subbasin, although it is not well known where this may occur and to what degree. Naturally high concentrations of TDS in groundwater are known to have existed historically within parts of the Subbasin due to the geochemistry of the Coast Range rocks and the marine depositional environment, the resulting naturally-high TDS of recharge derived from Coast Range streams, the dissolvable materials within the alluvial fan complexes, and the naturally-poor draining conditions which tend to concentrate salts in the system. The chemical quality of waters in the Coast Range streams can be closely correlated with the geologic units within their respective catchments. Groundwater flows discharging from these marine and non-marine rocks into streams introduce a variety of dissolved constituents resulting in variable groundwater types. The water quality and chemical makeup in westside streams can be highly saline, especially in more northern streams, including Corral Hollow, Panoche and Del Puerto Creeks, where historical baseflow TDS concentrations have typically exceeded 1,000 mg/L with measured concentrations as high as 1,790 mg/L (Hotchkiss and Balding, 1971). This is in contrast with TDS concentrations typically below 175 mg/L in streams draining from the Sierras. The contribution of water associated with these Coast Range sediments has resulted in naturally high salinity in groundwater within and around the Delta-Mendota Subbasin, which has been recognized as early as the 1900s (Mendenhall et al., 1916). Groundwater in some areas within the immediate vicinity of the San Joaquin River is influenced by lower-salinity surface water discharging from the east side of the San Joaquin Valley Groundwater Basin (Davis et al., 1957).

Areas of historical high saline groundwater documented by Mendenhall *et al.* (1916) indicate somewhat high TDS concentrations approaching or greater than 1,000 mg/L in wells sampled throughout many parts of the Delta-Mendota Subbasin. Areas of locally higher TDS concentrations (1,500-2,400 mg/L) have existed between Mendota and Los Banos; whereas the trend in deeper groundwater (average well depth of 450 feet) south of Mendota near Tranquillity indicates slightly lower historical salinity conditions, but still somewhat high with an average TDS concentration of greater than 1,000 mg/L. In the northern part of the Subbasin, north of Gustine, the average historical TDS concentration of wells was also relatively high (930 mg/L). Historically low TDS concentrations (<500 mg/L) existed in groundwater from wells with an average depth of 209 feet in the central Subbasin area between Los Banos and Gustine.

The general chemical composition of groundwater in the Subbasin is variable based on location and depth. Groundwater within the Upper Aquifer is largely characterized as transitional type with less area characterized as predominantly of chloride, bicarbonate, and sulfate water types. Transitional water types, in which no single anion represents more than 50 percent of the reactive anions, occurs in many different combinations with greatly ranging TDS concentrations. Chloride-type waters occur generally in grassland

areas east of Gustine and around Dos Palos, with sodium chloride water present in northern areas near Tracy and also extending south from Dos Palos. These waters also exhibit greatly varying salinity with typical TDS concentrations, ranging from less than 500 mg/L to greater than 10,000 mg/L and of high sodium makeup (50-75 percent of cations present) (Hotchkiss and Balding, 1971). Areas of bicarbonate groundwater within the Upper Aquifer of relatively lower TDS concentrations are directly associated with intermittent streams of the Coast Range near Del Puerto, Orestimba, San Luis, and Los Banos Creeks. Sulfate water in the central and southern Subbasin areas has TDS concentrations decreasing from west (1,200 mg/L) to east (700 mg/L) towards the San Joaquin River, similar to the bicarbonate water areas, although areas of sulfate water south of Dos Palos have much higher TDS concentrations (1,900 to 86,500 mg/L) (Hotchkiss and Balding, 1971).

Groundwater in the Lower Aquifer below the Corcoran Clay is also spatially variable, consisting of mostly transitional sulfate waters in the northern part of the Delta-Mendota Subbasin to more sodium-rich water further south in the grassland areas. In the northern part of the Delta-Mendota Subbasin, the Lower Aquifer exhibits relatively lower TDS concentrations, ranging from 400 to 1,600 mg/L, with a sulfate-chloride type makeup near the valley margin trending to sulfate-bicarbonate type near the valley axis. Farther south, TDS concentrations in the Lower Aquifer increase (Hotchkiss and Balding, 1971).

Natural conditions of groundwater salinity exist throughout the Upper and Lower Aquifers as a result of the contribution of salts from recharge off the Coast Range mountains. Surface water and groundwater flowing over and through Coast Range sediments of marine origin have dissolved naturally-occurring salts, contributing to the historical and current presence of salinity in groundwater within the Delta-Mendota Subbasin. In addition to natural salinity contributed from the Coast Range sediments, a number of other mechanisms are believed to further contribute to increased salinity in the groundwater in the region. Poorly draining soil conditions are extensive within some of the southern and eastern areas of the Subbasin, extending from the vicinity of Tranquillity to near Gustine, and these types of soil, combined with a shallow water table, contribute to a build-up of soil salinity.

4.1.10 Topography, Surface Water, Recharge, and Imported Supplies

This section describes the topography, surface water, soils, and groundwater recharge potential in the Delta-Mendota Subbasin.

Topography

As previously described, the Delta-Mendota Subbasin lies on the western side of the Central Valley and extends from the San Joaquin River on the east, along the axis of the Valley, to the Coast Range on the west side (LSCE, 2015). The Subbasin has ground surface elevations ranging from less than 100 feet above mean sea level (msl) along parts of the eastern edge to greater than 1,600 feet msl in the Coast Range mountains (**Figure CC-35**). Most of the lower elevation areas occur east of Interstate 5, in the eastern parts of the Delta-Mendota Subbasin; although some lower elevation areas also extend westward into the Coast Range, such as in Los Banos Creek Valley. Low elevation areas generally coincide with the extent of the Central Valley floor. Topography within the Delta-Mendota Subbasin consists largely of flat areas across the Central Valley floor, where slopes are generally less than 2 percent, with steepening slopes to the west. The topography outside of the Central Valley floor in the Coast Range mountains is characterized by steeper slopes, generally greater than 6 percent.

Surface Water Bodies

The San Joaquin River and its tributaries is the primary natural surface water feature within the Delta-Mendota Subbasin, flowing from south to north along the eastern edge of the Subbasin (LSCE, 2015).

During the 1960s, the San Joaquin River exhibited gaining flow conditions through much of the Subbasin (Hotchkiss and Balding, 1971). Numerous intermittent streams from the Coast Range enter the Delta-Mendota Subbasin from the west; however, none of these maintain perennial flow and only Orestimba Creek, Los Banos Creek and Del Puerto Creek have channels that extend eastward to a junction with the San Joaquin River. Most of the flow in other notable west-side creeks, including Quinto Creek, San Luis Creek, Little Panoche Creek, and Ortigalita Creek, is lost to infiltration (Hotchkiss and Balding, 1971). Flow from Los Banos and San Luis Creeks are impounded by dams on their respective systems. When flood releases are made from Los Banos Creek Reservoir, the vast majority of flows pass through Grassland Water District to the San Joaquin River as they tend to occur during times when agricultural and wetland demand is low. San Luis Reservoir on San Luis Creek, which is located along the western boundary of the Delta-Mendota Subbasin, is an artificial water storage facility for the Central Valley Project and California State Water Project and has no notable natural surface water inflows. Outflows from the reservoir go into the system of federal- and state-operated canals and aqueducts comprising the Central Valley and State Water Projects. Surface water use within the Delta-Mendota Subbasin is derived largely from water deliveries provided by these projects, including from the California Aqueduct (referred to as San Luis Canal in the joint-use area of the California Aqueduct) and Delta-Mendota Canal, and also from the San Joaquin River (**Figure CC-36**).

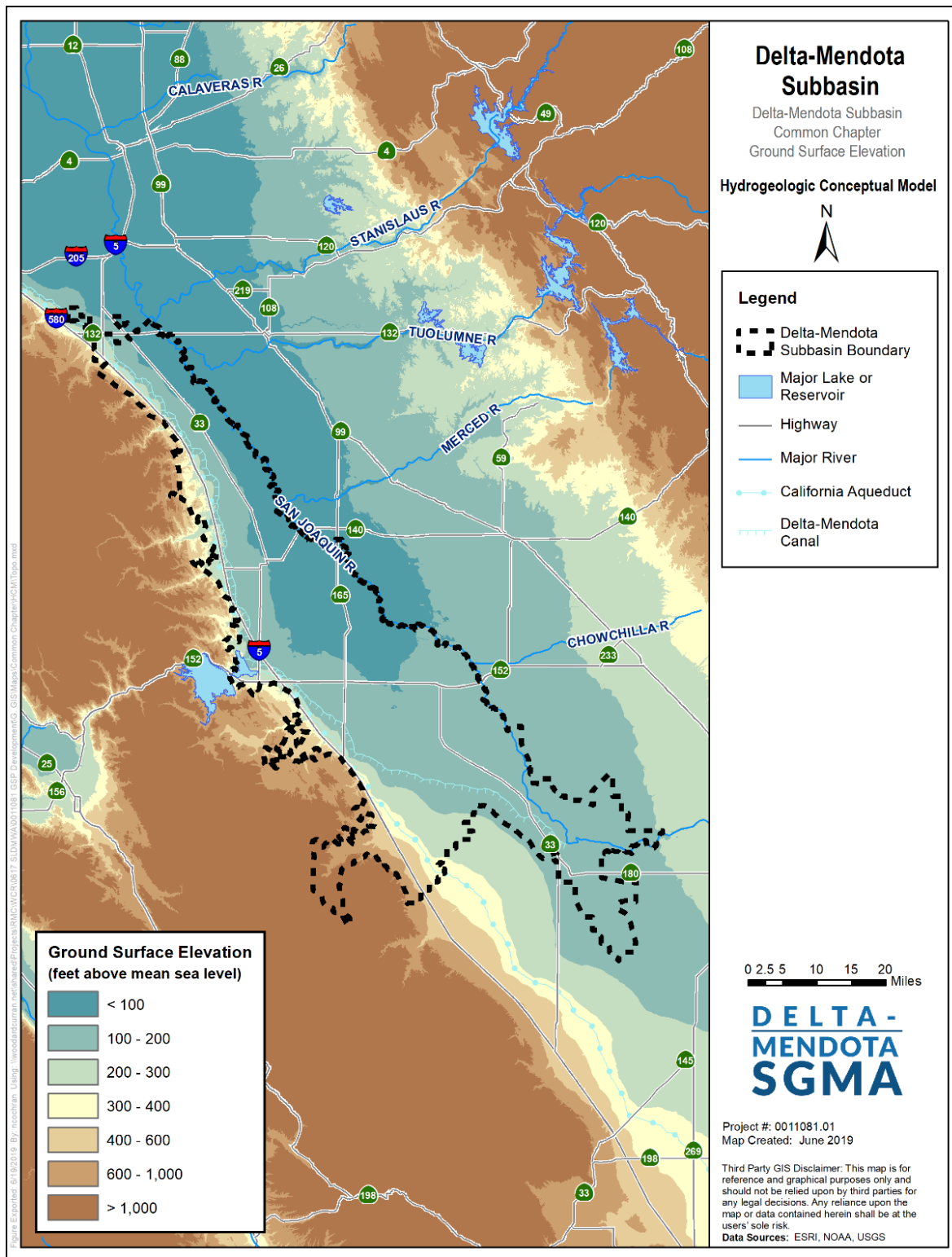


Figure CC-35: Ground Surface Elevation



Soils

The NRCS provides soil mapping in the region. One of the combining soil groupings mapped includes hydrologic groups. The predominant soil hydrologic groups within the Delta-Mendota Subbasin are soil types C and D (**Figure CC-37**). Group C soils have moderately high runoff potential when thoroughly wet (NRCS, 2009) with water transmission through the soil somewhat restricted. Group C soils typically have between 20 percent and 40 percent clay and less than 50 percent sand and have loam, silt loam, sandy clay loam, clay loam, and silty clay loam textures. Group D soils have a high runoff potential when thoroughly wet and water movement through the soil is restricted or very restricted. Group D soils typically have greater than 40 percent clay, less than 50 percent sand, and have clayey textures. In some areas, they also have high shrink-swell potential.

Soil hydraulic conductivity groups are closely related to soil drainage characteristics and hydraulic conductivity. The fine-grained floodplain deposits present across much of the southeastern area of the Subbasin are evidenced as soils with lower hydraulic conductivity in **Figure CC-37** and accordingly, these characteristics also make these areas poorly drained. Poorly draining soil conditions are extensive within the southern and eastern areas of the Subbasin, extending from the vicinity of Tranquillity to near Gustine (Fio, 1994; Hotchkiss and Balding, 1971). Soils in the northern and western parts of the Delta-Mendota Subbasin exhibit better drainage characteristics, although areas of poorly drained soils are also present in the north and west in proximity to surface water courses, including most notably directly adjacent to portions of the San Joaquin River and Los Banos Creek channels. Many of the upland soils, which are of generally coarser texture and located proximal to sediment sources derived from the Coast Range hill slopes, are characterized as moderately well drained.

In areas with low hydraulic conductivity, corresponding to areas without adequate natural drainage, tile drains are present to remove shallow groundwater from the rooting zone. Known tile drain locations are shown in **Figure CC-38**, which are primarily located along the eastern boundary of the Delta-Mendota Subbasin as well as the southern portion of the Subbasin in the Grassland Drainage Area. The Grassland Drainage Area contains a tile drainage system connected to the San Joaquin River Improvement Project, which uses tile drainage water for irrigated agriculture with a high salinity tolerance.

Areas of Recharge, Potential Recharge, and Groundwater Discharge Areas

The primary process for groundwater recharge within the Central Valley floor area is from percolation of applied irrigation water and seepage from canals and stream beds, although some groundwater recharge does occur in the Delta-Mendota Subbasin along the western boundary of the Subbasin due to mountain front recharge. In sandier areas, recharge ponds have been constructed within certain districts (CCC, Aliso Water District, CCID and Del Puerto Water District) to promote managed aquifer recharge.

Groundwater recharge potential on agricultural land based on the Soil Agricultural Groundwater Banking Index (SAGBI) is shown in **Figure CC-39**. The SAGBI is based on five major factors: deep percolation, root zone residence time, topography, chemical limitations, and soil surface conditions. Within the Delta-Mendota Subbasin, SAGBI data categorizes 160,248 acres out of 744,237 acres (21%) of agricultural and grazing land within the regions as having Excellent, Good, and Moderately Good (**Figure CC-39**) recharge properties, and 571,573 acres out of 744,237 acres (or 77%) of agricultural and grazing land as having Moderately Poor, Poor, or Very Poor recharge properties. “Modified” SAGBI data shows higher potential for recharge than unmodified SAGBI data because the modified data assumes that soils have been or will be ripped to a depth of six feet, which can break up fine grained materials at the surface to improve percolation. The modified data set was determined to more accurately represent the Delta-Mendota Subbasin due to the heavy presence of agriculture. In almost all cases, recharge from applied water on irrigated lands recharges the Upper Aquifer of the Subbasin. However, the use of percolation

ponds and other managed aquifer recharge techniques must consider existing water quality in addition to soil composition and may be limited in areas where poor water quality currently exists.

The Corcoran Clay is a known barrier restricting vertical flow between the Upper and Lower Aquifers; therefore, natural recharge of the Lower Aquifer from downward percolating water is most likely restricted where the Corcoran Clay is present, including across most of the Central Valley floor. Primary recharge areas to the Lower Aquifer are most likely in western parts of the Central Valley floor where percolating water can enter formations feeding the Lower Aquifer, particularly in the vicinity and west of Los Banos, Orestimba, and Del Puerto Creeks, along the western margin of the Subbasin.

Groundwater discharge areas are identified as springs located within the Delta-Mendota Subbasin and the San Joaquin River. **Figure CC-39** shows the location of historic springs identified by USGS. There are only six springs/seeps identified by USGS in their National Hydrograph Dataset, which are located in the southwestern corner of the Subbasin. The springs shown represent a dataset collected by USGS and are not a comprehensive map of springs in the Subbasin.

Imported Supplies

Both the California Aqueduct and Delta-Mendota Canal run the length of the Delta-Mendota Subbasin, primarily following the Interstate 5 corridor (**Figure CC-40**). The following water purveyors in the Delta-Mendota Subbasin are SLDMWA Member Agencies and thus receive water from the Central Valley Project via the Delta-Mendota Canal: California Department of Fish and Wildlife, Central California Irrigation District, Columbia Canal Company, Del Puerto Water District, Eagle Field Water District, Firebaugh Canal Water District, Fresno Slough Water District, Grassland Water District, Laguna Water District, Mercy Springs Water District, Oro Loma Water District, Pacheco Water District, Panoche Water District, Patterson Irrigation District, San Luis Canal Company, San Luis Water District, Tranquillity Irrigation District, Turner Island Water District, U.S. Fish and Wildlife Service, and West Stanislaus Irrigation District. Oak Flat Water District is the only recipient of State Water Project (SWP) water in the Delta-Mendota Subbasin; Oak Flat Water District initially bought into the SWP in 1968.

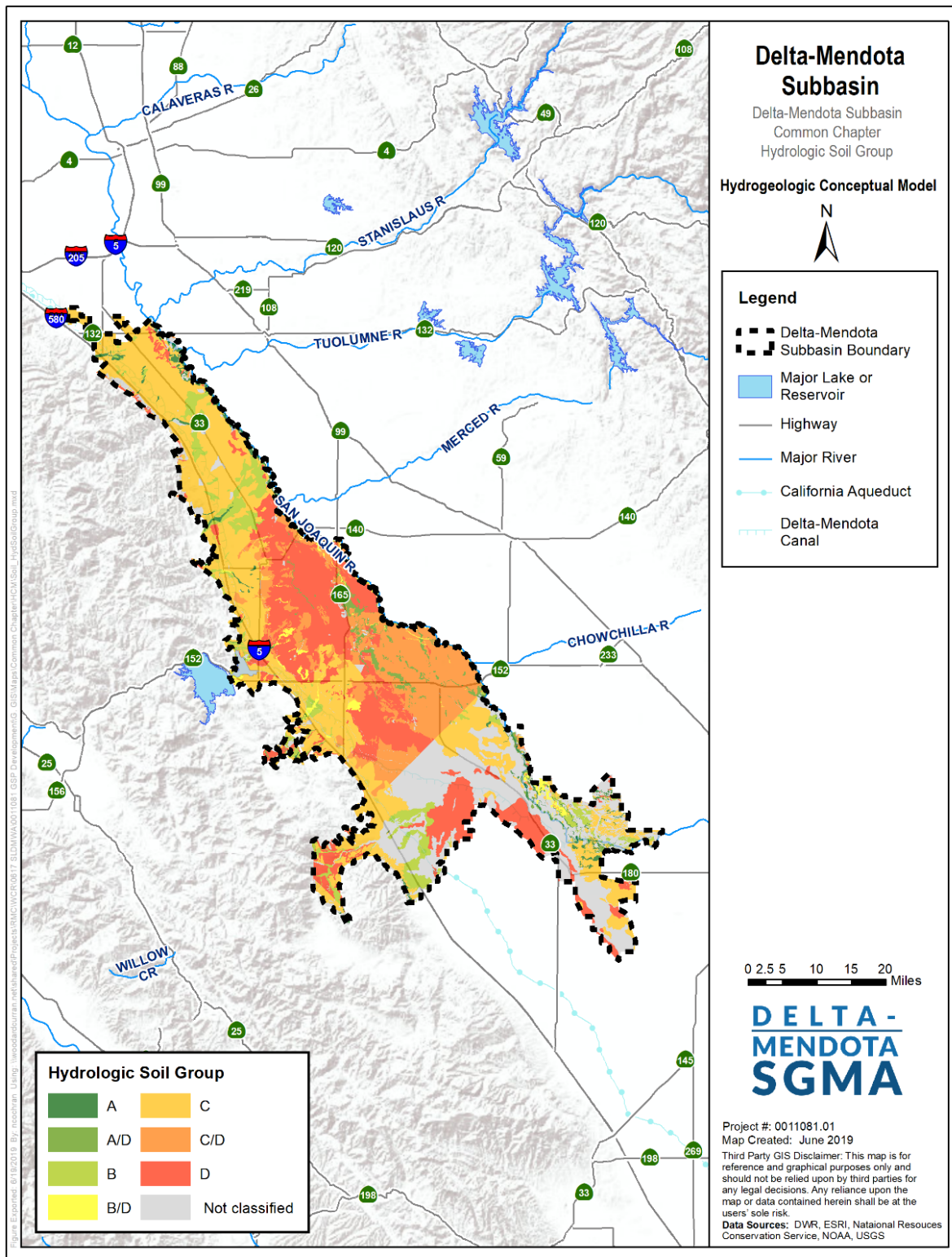


Figure CC-37: SAGBI Soils Map

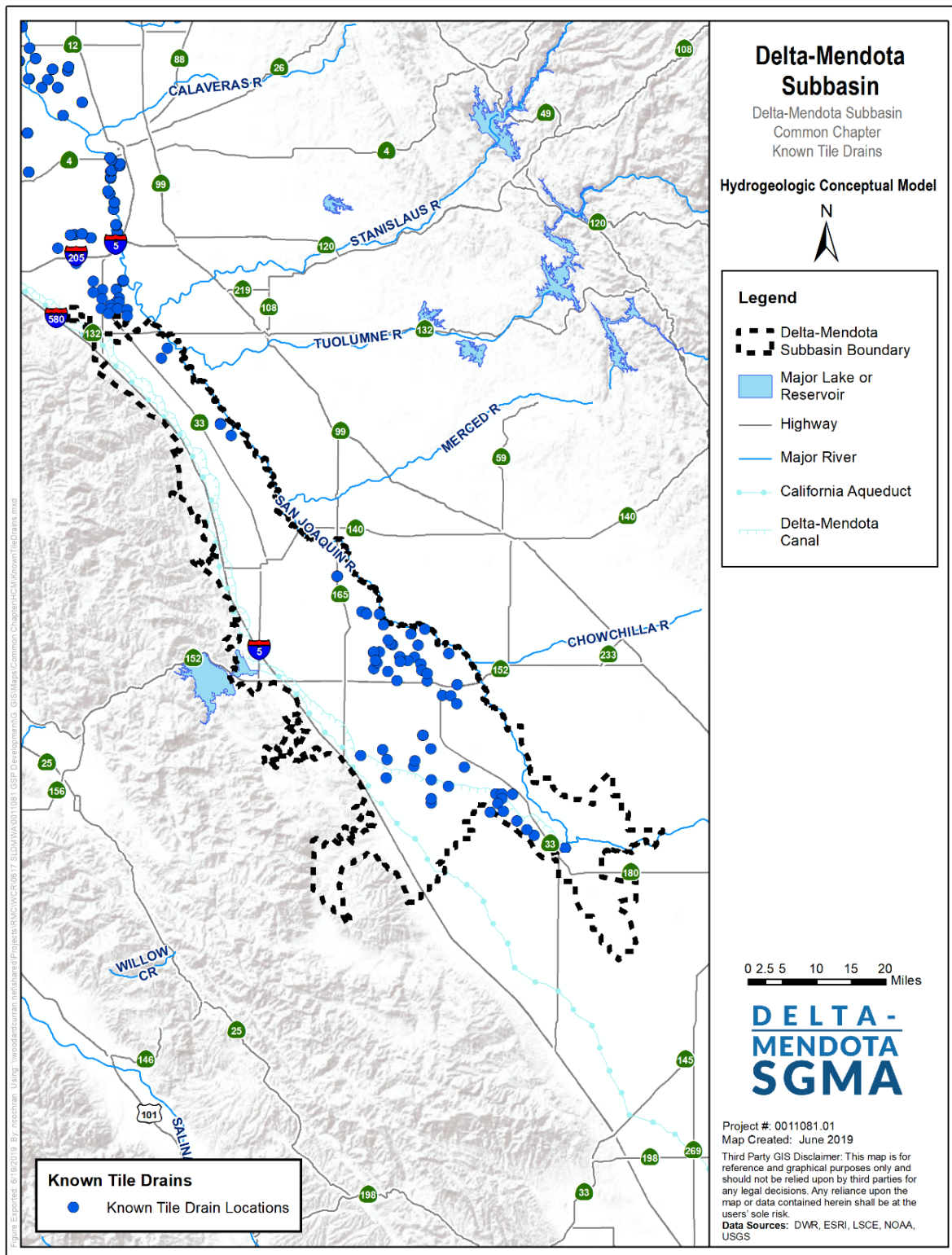


Figure CC-38: Tile Drains

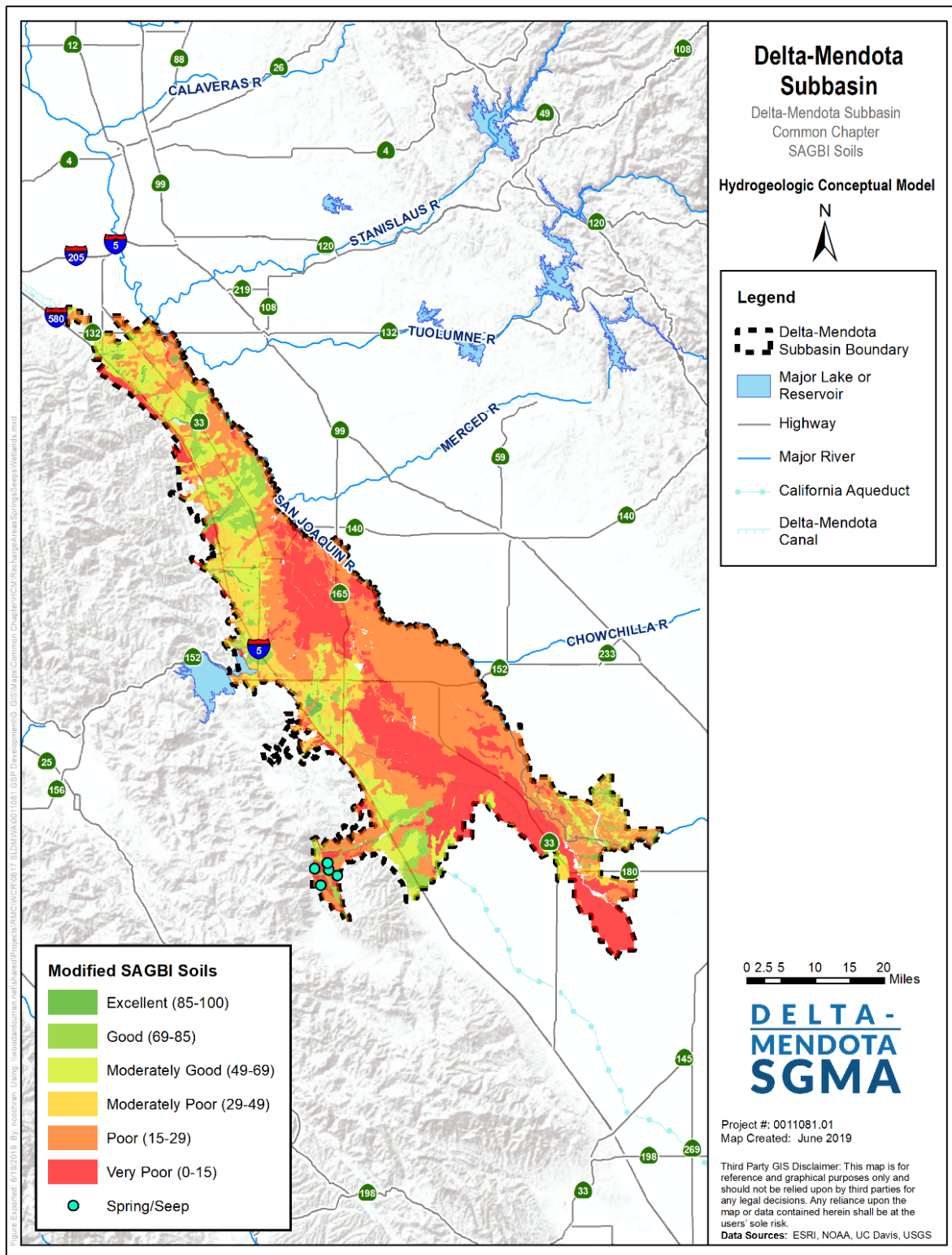
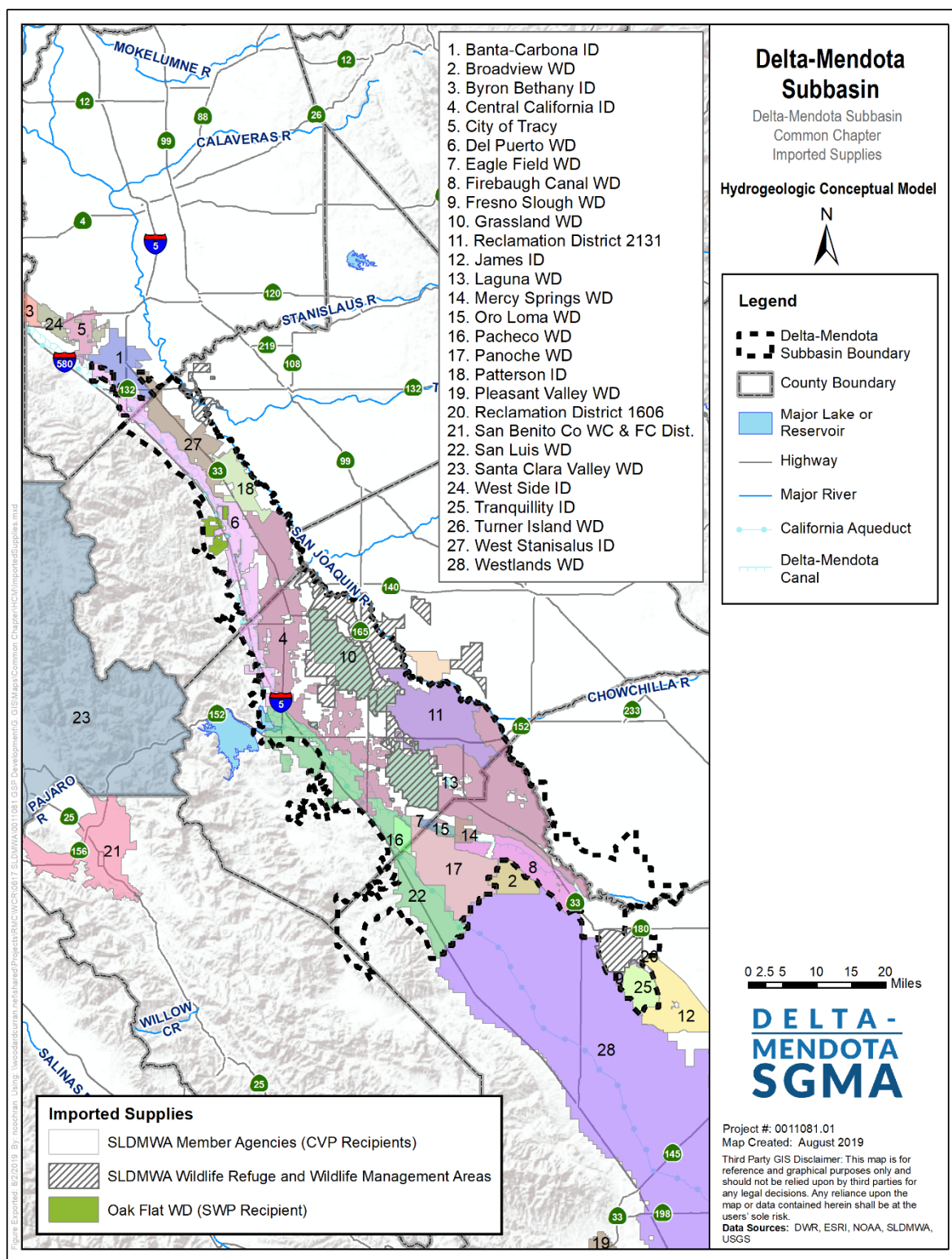


Figure CC-39: Recharge Areas, Seeps and Springs



4.2 Delta-Mendota Subbasin Groundwater Conditions

This section describes the current and historic groundwater conditions in the Delta-Mendota Subbasin, including data from January 1, 2015 to recent conditions for the following parameters: groundwater elevations, groundwater storage, groundwater quality, land subsidence, interconnected surface water systems, and groundwater dependent ecosystems (GDEs) (pursuant to Article 5 Plan Contents, Subarticle 2 Basin Setting, § 354.16 Groundwater Conditions of the GSP Emergency Regulations). Seawater intrusion is not discussed herein as the Delta-Mendota Subbasin is inland and is not impacted by seawater intrusion. For the purposes of this GSP, “current conditions” is represented by Water Year (WY) 2013 conditions, which is consistent with the year representing the Current Conditions Water Budget (see Section 4.3 for more information about Water Budgets). Data post-WY 2013 through present day are presented when available.

The purpose of describing groundwater conditions, as contained in this section and described in the individual GSPs, is to establish baseline conditions that will be used to monitor changes relative to measurable objectives (MOs) and minimum thresholds (MTs). Therefore, these established baseline conditions will help support monitoring to demonstrate measurable efforts in achieving the sustainability goal for the Delta-Mendota Subbasin.

4.2.1 Useful Terminology

This groundwater conditions section includes descriptions of the amounts, quality, and movement of groundwater, among other related components. A list of technical terms and a description of the terms are listed below. The terms and their descriptions are identified here to guide readers through the section and are not a definitive definition of each term:

- **Depth to Groundwater** – The distance from the ground surface to first-detected non-perched groundwater, typically reported at a well.
- **Upper Aquifer** – The alluvial aquifer above the Corcoran Clay (or E-clay) layer.
- **Lower Aquifer** – The alluvial aquifer below the Corcoran Clay (or E-clay) layer.
- **Horizontal gradient** – The slope of the groundwater surface from one location to another when one location is higher or lower than the other. The gradient is shown on maps with an arrow showing the direction of groundwater flow in a horizontal direction.
- **Vertical gradient** – Describes the movement of groundwater perpendicular to the ground surface. Vertical gradient is measured by comparing the elevations of groundwater in wells that are of different depths. A downward gradient is one where groundwater is moving down into the ground towards deeper aquifers and an upward gradient is one where groundwater is upwelling towards the ground surface.
- **Contour Map** – A contour map shows changes in groundwater elevations by interpolating groundwater elevations between monitoring sites. The elevations are shown on the map with the use of a contour line, which represents groundwater being at the indicated elevation along the contour line. Contour maps can be presented in two ways:
 - Elevation of groundwater above mean sea level (msl), which can be used to identify the horizontal gradients of groundwater, and
 - Depth to water (i.e., the distance from the ground surface to groundwater), which can be used to identify areas of shallow or deep groundwater.
- **Hydrograph** – A graph that shows the changes in groundwater elevation or depth to groundwater over time at a specific location. Hydrographs show how groundwater elevations change over the years and indicate whether groundwater is rising or descending over time.

- **Maximum Contaminant Level (MCL)** – MCLs are standards that are set by the State of California and the U.S. Environmental Protection Agency for drinking water quality. MCLs are legal threshold limits on the amount of an identified constituent that is allowed in public drinking water systems. At both the State and Federal levels, there are Primary MCLs, set to be protective of human health, and Secondary MCLs for constituents that do not pose a human health hazard but do pose a nuisance through either smell, odor, taste, and/or color. MCLs are different for different constituents and have not been established for all constituents potentially found in groundwater.
- **Elastic Land Subsidence** – Reversible and temporary fluctuations in the elevation of the earth’s surface in response to seasonal periods of groundwater extraction and recharge.
- **Inelastic Land Subsidence** – Irreversible and permanent decline in the elevation of the earth’s surface resulting from the collapse or compaction of the pore structure within the fine-grained portions of an aquifer system. This form of subsidence is what is required by SGMA to be monitored and reported.
- **Gaining Stream** – A stream in which groundwater flows into a streambed and contributes to a net increase in surface water flows across an identified reach.
- **Losing Stream** – A stream in which surface water is lost through the streambed to the groundwater, resulting in a net decrease in surface water flows across an identified reach.
- **Conjunctive Use** – The combined use of surface water and groundwater supplies, typically with more surface water use in wet years and more groundwater use in dry years.

4.2.2 Groundwater Elevations

This section describes groundwater elevation data utilized and elevation trends in the Delta-Mendota Subbasin. Groundwater conditions vary widely across the Subbasin. Historic groundwater conditions through present day conditions, the role of imported surface water in the Subbasin, and how conjunctive use has impacted groundwater trends temporally and spatially are discussed. Groundwater elevation contour maps associated with current seasonal high and seasonal low for each principal aquifer, as well as hydrographs depicting long-term groundwater elevations, historical highs and lows, and hydraulic gradients (both horizontal and vertical), are also described.

Available Data

Groundwater elevation data, and accompanying well construction information, within the Delta-Mendota Subbasin from the following sources and associated programs were utilized in the development of the Delta-Mendota Subbasin GSPs:

- California Department of Water Resources (DWR)
 - California Statewide Groundwater Elevation Monitoring Program (CASGEM)
 - Water Data Library (WDL)
- Water level data from local monitoring programs

Data provided by these sources included well information (such as location, well construction, owner, ground surface elevation and other related components), as well as groundwater elevation data (including information such as date measured, depth to water, groundwater surface elevation, questionable measurement code, and comments). At the time that these analyses were performed, groundwater elevation data were available for the time period from 1930 through 2018. There are many wells with monitoring data from some time in the past but no recent data, while a small number of wells have monitoring data recorded for periods of greater than 50 years.

Not all groundwater elevation data received were used in preparing the groundwater elevation contour maps for both principal aquifers (defined in this Common Chapter as the Upper and Lower Aquifers which are divided by the Corcoran Clay or E-clay layer). Some groundwater elevation data were associated with wells with unknown screened depths and/or composite well screens constructed across the Corcoran Clay. Groundwater elevation data associated with wells with composite screens and/or unknown screened depths were removed from the data set in most instances, along with any data point that appears to be an outlier when compared with surrounding data from the same period. Select wells with unknown construction were evaluated for inclusion in contour mapping efforts in areas of limited data. Duplicate well measurements were also removed prior to contouring and only one observation for a given well was used for the identified season, rather than averaging all measurements at a given well during the same season.

Figure CC-41 shows the locations of wells with known screened depths within the Delta-Mendota Subbasin as well as known spatial gaps where no well information is currently available. These wells include those monitored under CASGEM, the Delta-Mendota Canal Well Pump-in Program, and by local owners or agencies. Monitoring data available for these wells varies by local owner and agency. Well locations were provided by local agencies to the best of their knowledge at the time of writing and may include wells that have been destroyed or are no longer in service.

Historic Conditions

Historic groundwater trends changed significantly with the first deliveries of imported water deliveries to the Delta-Mendota Subbasin. Construction of the Delta-Mendota Canal and the California Aqueduct heralded the introduction of significant surface water supplies into the Subbasin and reduced dependence on groundwater as the primary water supply. These conveyance systems have resulted in significant increases in the conjunctive use of surface water and groundwater throughout the Subbasin. Various drought periods and regulations reducing delivery of supplies from the Sacramento-San Joaquin Delta also punctuate critical understandings of groundwater use patterns throughout the Subbasin, as well as what is known regarding response and recovery of groundwater levels following notable droughts.

Prior to Imported Water Deliveries (1850-1950s)

Prior to 1850, the majority of agriculture and development in the San Joaquin Valley consisted of rain-fed grain and cattle production, with irrigated development beginning sporadically during this time via river (primarily San Joaquin River) and perennial stream diversions (SWRCB, 2011). Construction of the railroad through the San Joaquin Valley from 1869 through 1875 increased demand for more extensive agriculture, making markets in larger coastal cities more accessible to valley farmers. Significant irrigation sourced from surface water and resulting production began in the western side of the San Joaquin Valley in 1872 when the San Joaquin River was diverted through the Miller and Lux canal system west of Fresno (DWR, 1965). By the 1890s and early 1900s, sizable areas of the southern San Joaquin Valley were being forced out of production by salt accumulation and shallow water tables. Much of this land lay idle until the 1920s when development of reliable electric pumps and the energy to power them accelerated the expansion of irrigated agriculture with the availability of vast groundwater

resources. The resultant groundwater pumping lowered the water table in many areas (SWRCB, 1977 and Ogden, 1988) and allowed the leaching of salts, particularly near the valley trough and western side of the valley. Groundwater pumping for irrigation from around 1920 to 1950 drew the water table down as much as 200 feet in areas along the westside of the San Joaquin River (Belitz and Heimes, 1990). Declining water tables were causing higher pumping costs and land subsidence, and farmers were finding poorer quality water as water tables continued to decline. These issues created a desire for new surface water supplies, which would be fulfilled by the Central Valley Project.

Post-Imported Water Deliveries (1950s-2012)

Surface water deliveries from the Central Valley Project via the DMC began in the early 1950s, and from the State Water Project via the California Aqueduct in the early 1970s (Sneed et al., 2013). The CVP is the primary source of imported surface water in the Delta-Mendota Subbasin, where only Oak Flat Water District receives deliveries from the SWP. Introduction of imported water supplies to the Delta-Mendota Subbasin resulted in a decrease in groundwater pumping from some parts of the Subbasin and the greater Central Valley, which was accompanied by a steady recovery of water levels. During the droughts of 1976-1977 and 1987-1992, diminished deliveries of imported surface water prompted increased pumping of groundwater to meet irrigation demands, bringing water levels to near-historic lows. Following periods of drought, recovery of pre-drought water levels has been rapid, especially in the Upper Aquifer. This trend has been observed in historic hydrographs for wells across the Subbasin.

Current Conditions

Trends similar to historic drought and subsequent recovery conditions were observed during the 2012 to 2016 drought and the 2016 to present recovery period.

Recent Drought (2012-2016)

During the most recent drought, from 2012 through 2016, similar groundwater trends were observed as during the 1976-1977 and 1987-1992 droughts. With diminished imported surface water deliveries, groundwater pumping increased throughout the Subbasin to meet irrigation needs. This resulted in historic or near-historic low groundwater levels during the height of the drought in 2014 and 2015, when CVP and SWP allocations for agricultural water service contractors were 0%, Exchange Contractors and refuge deliveries were less than 75%, and post-1914 surface water rights in the San Joaquin River watershed were curtailed. In June 2015, senior water rights holders with a priority date of 1903 or later in the San Joaquin and Sacramento watersheds and the Delta were ordered by the State Water Resources Control Board to curtail diversions (State of California, 2015). This marked the first time in recent history that pre-1914 water rights holders were curtailed.

Post-Drought (2016-present)

With wetter conditions following the 2012-2016 drought, groundwater levels began to recover. This was largely a result of increased surface water availability with CVP allocations reaching 100% and full water rights supplies available for diversion from the San Joaquin River in 2017. Additionally, inelastic land subsidence rates also drastically decreased in 2017 as imported water supplies were once again available, resulting in decreased groundwater pumping particularly from the Lower Aquifer. This pattern of increased drought-driven groundwater pumping, accompanied by declining groundwater elevations, followed by recovery is a predominant factor to be considered in the sustainable management of the Delta-Mendota Subbasin. Furthermore, subsidence mitigation projects were developed which drastically reduced the observed subsidence rate on the eastern and southern boundaries of the Subbasin.

Groundwater Trends

Groundwater levels can fluctuate greatly throughout time due to various natural and anthropogenic factors, including long-term climatic conditions, adjacent well pumping, nearby surface water flows, and seasonal groundwater recharge or depletion (LSCE, 2015). As discussed in the Hydrogeologic Conceptual Model section of this Common Chapter (Section 4.1), the Delta-Mendota Subbasin is generally a two-aquifer system consisting of an Upper and Lower Aquifer that are subdivided by the Corcoran Clay layer, a regional aquitard. The Corcoran Clay layer, or E-Clay equivalent, restricts flow between the upper semi-confined aquifer and lower confined aquifer. The presence of a tile drain network along the Grassland Drainage Area and the Subbasin's eastern boundary affects the lateral and vertical water movement in the shallow groundwater zone (LSCE, 2016).

The Delta-Mendota Subbasin has a general flow direction to the east in the Upper Aquifer, where it loses groundwater to the San Joaquin River and its neighboring subbasins. Most recharge throughout the Subbasin is attributed to applied irrigation water, where other sources of recharge include local streams, canal seepage, and infiltration along the western margin of the Subbasin from the Coast Range. The figures that follow were developed for inclusion in the Western San Joaquin River Watershed Groundwater Quality Assessment Report (LSCE, 2015) and the Grassland Drainage Area Groundwater Quality Assessment Report (LSCE, 2016) and are included herein with the intent of demonstrating general trends in groundwater elevations around the Delta-Mendota Subbasin. These figures are not to scale.

Please see the individual GSPs for more specific information relating to similar trends in those respective GSP Plan areas. Additionally, it is important to note that groundwater trends, such as these, are dependent on climatic conditions and are not necessarily representative of the historic and current water budgets for those respective GSP Plan areas.

Upper Aquifer

For the Upper Aquifer, **Figure CC-42** presents select hydrographs illustrating temporal groundwater level trends in the Upper Aquifer wells within the Subbasin. Hydrographs shown on **Figure CC-42** are displayed with different ranges of elevation values on the vertical axes. Wells in the Upper Aquifer exhibit decreasing trends to somewhat stable water levels until the mid-1980s, and increasing or stable water levels thereafter.

Similarly, **Figure CC-43** presents select hydrographs illustrating temporal groundwater level trends in the areas covered by the Central Delta-Mendota, Oro Loma Water District, and Widren Water District GSAs in the Northern & Central Delta-Mendota Region GSP Group at various depths. The three select hydrographs representing wells in the Upper Aquifer each show less than 10 years of available data with two wells showing slight declines of about 10 feet or less from about 2003 through 2013, and one well showing a more drastic elevation change, ranging from 100 feet above mean sea level (ft msl) to -20 ft msl over a 5-year period from 2010 to 2016.

Lower Aquifer

Figure CC-44 presents select hydrographs illustrating temporal groundwater level trends in Lower Aquifer wells within the Subbasin. Note, hydrographs shown on **Figure CC-44** displayed different ranges of elevation on the vertical axes. In the Lower Aquifer, piezometric head typically increased or remained relatively stable during the period from the 1980s through the early 2000s.

Again, similarly, **Figure CC-43** presents select hydrographs illustrating temporal groundwater level trends in the Central Delta-Mendota, Oro Loma Water District, and Widren Water District GSA areas of

the Northern & Central Delta-Mendota Region GSP Group at various depths. The two select hydrographs representing wells in the Lower Aquifer each show similar elevation patterns post-2010 with a total elevation change of 50 ft msl or more. USGS1000489 shows stable and increasing groundwater elevation trends from the late 1950s through the mid-1980s with a data gap from the mid-1980s through 2010, whereafter 2010 groundwater levels have a steep decline through 2016.

Vertical Gradients

Throughout most of the Delta-Mendota Subbasin, the Corcoran Clay layer acts as a regional aquitard, limiting the vertical migration of groundwater. In areas outside the Corcoran Clay layer (along the western margin of the Subbasin), localized interfingering clays minimize the downward migration of groundwater; although in areas where the clay layers are not competent or non-existent, groundwater migrates from shallower to deeper groundwater zones. Similarly, in areas where the Corcoran Clay has been compromised (due to well construction across the clay), groundwater generally flows from the Upper Aquifer to the Lower Aquifer, especially in areas where the Lower Aquifer is actively used as a water supply (lowering the potentiometric head in that zone).

Groundwater Contours

The Subbasin-wide groundwater contours reflected in **Figure CC-45** and **Figure CC-46** evaluate the seasonal high (Spring 2013) and seasonal low (Fall 2013) conditions of the current year (defined as WY2013 for the GSP analyses) for the Upper Aquifer. Spring is defined as groundwater surface elevation measurements collected between January 1 and April 8; where Fall is defined as groundwater surface elevation measurements collected between September 1 and October 31. For wells where multiple Spring 2013 or Fall 2013 measurements were available, the highest elevation for each season was used for contouring. Gaps in data and contours can be attributed to a lack of wells present, level measurements, or requirements to report level readings groundwater level data. Consistent with traditional contouring efforts, the quality of outlier water level data was investigated. In instances of poor quality data, the associated data was eliminated for the groundwater contouring effort. Furthermore, implementation of the CASGEM program in 2014 has reduced temporal and spatial gaps in groundwater level datasets, and implementation of the Delta-Mendota Subbasin GSPs' monitoring programs will add to the improved data quantity and quality.

In the Upper Aquifer, during Spring 2013, the general flow of groundwater in the Delta-Mendota Subbasin was from the Coast Range along the western boundary of the Subbasin toward the San Joaquin River along the eastern boundary. Groundwater elevations tend to increase moving south throughout the Subbasin. Within Stanislaus County, groundwater elevations are the lowest, ranging between 40 and 80 feet above msl, becoming increasingly higher in Madera County, ranging between 80 and 100 feet above msl, and in Merced and Fresno counties, ranging between 80 and 140 feet above msl (**Figure CC-45**). Similar flow directions (west to east and northeast) are observed in the Fall 2013. Within Stanislaus County, groundwater elevations are the lowest ranging between 40 and 80 feet above msl, showing little difference compared to Spring 2013; become increasingly higher in Madera County ranging between 60 and 100 feet above msl; in Merced County ranging between 60 and 140 feet above msl; and in Fresno County ranging from 60 and 120 feet above msl (**Figure CC-46**). Both maps indicate a prevailing southwest to northeast flow gradient above the Corcoran Clay. In general, little variation is apparent in groundwater elevation between seasonal high and low periods in 2013.

Due to insufficient data, groundwater elevation contour maps for the Lower Aquifer for the seasonal high and low (Spring 2013 and Fall 2013, respectively) could not be accurately prepared. **Figure CC-47** and **Figure CC-48** show the available groundwater elevation measurements for Spring 2013 and Fall 2013. Available Spring 2013 measurements range from -127 to 12 feet above msl in Stanislaus County, -65 to

124 feet above msl in Merced County, and -5 to 88 feet above msl in Fresno County (**Figure CC-47**), where no measurements are available for this time period in Madera County. Available Fall 2013 measurements range from -138 to 156 feet above msl in Stanislaus County, -94 to 19 feet above msl in Merced County, and -72 to -4 feet above msl in Fresno County (**Figure CC-48**), where no measurements are available for this time period in Madera County. The Lower Aquifer exhibits less seasonal difference in groundwater elevations than the Upper Aquifer. Throughout most of the Subbasin, the Lower Aquifer shows lower piezometric heads than the Upper Aquifer suggesting that potential exists for downward vertical gradient.

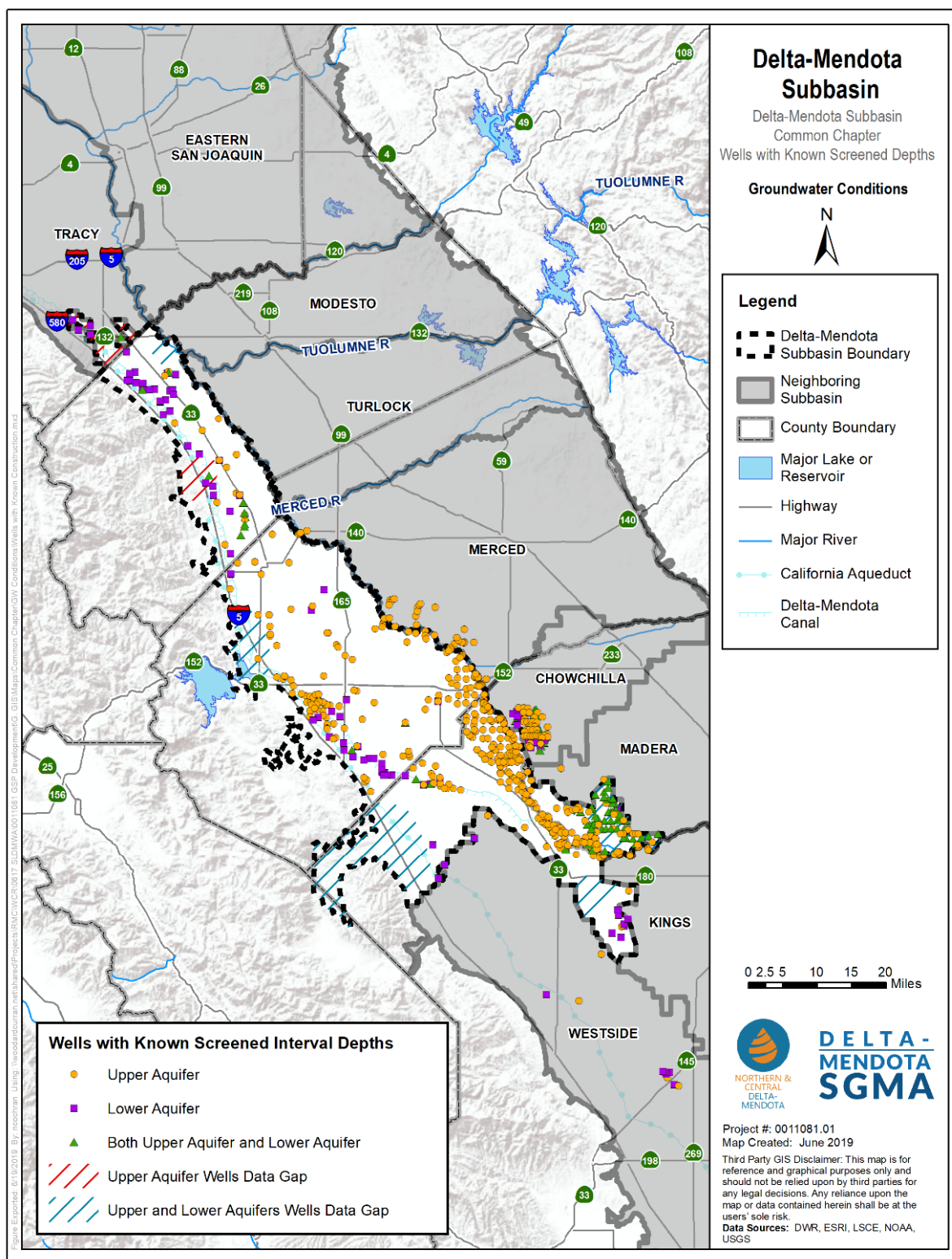


Figure CC-41: Wells with Known Screened Interval Depths

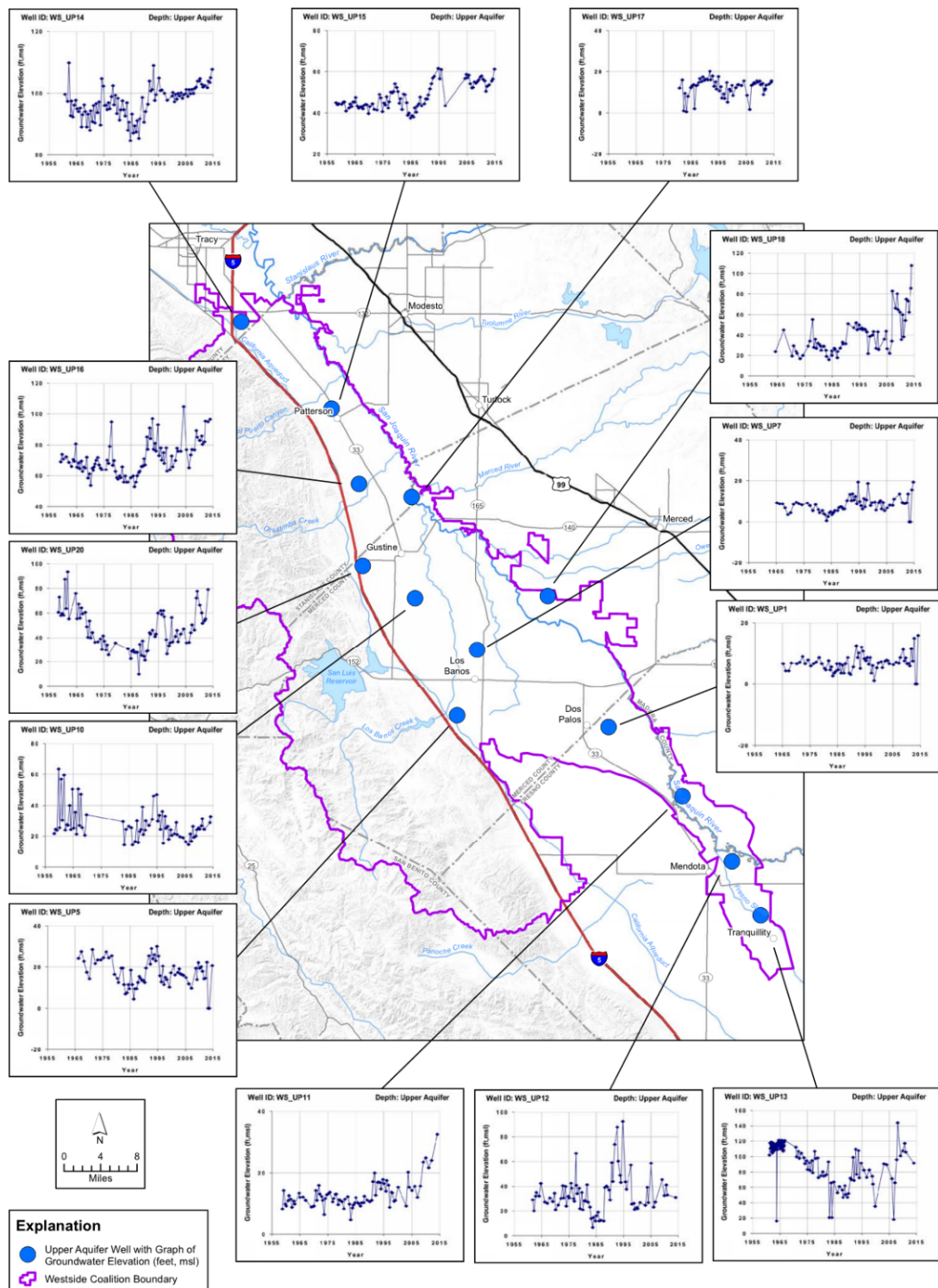
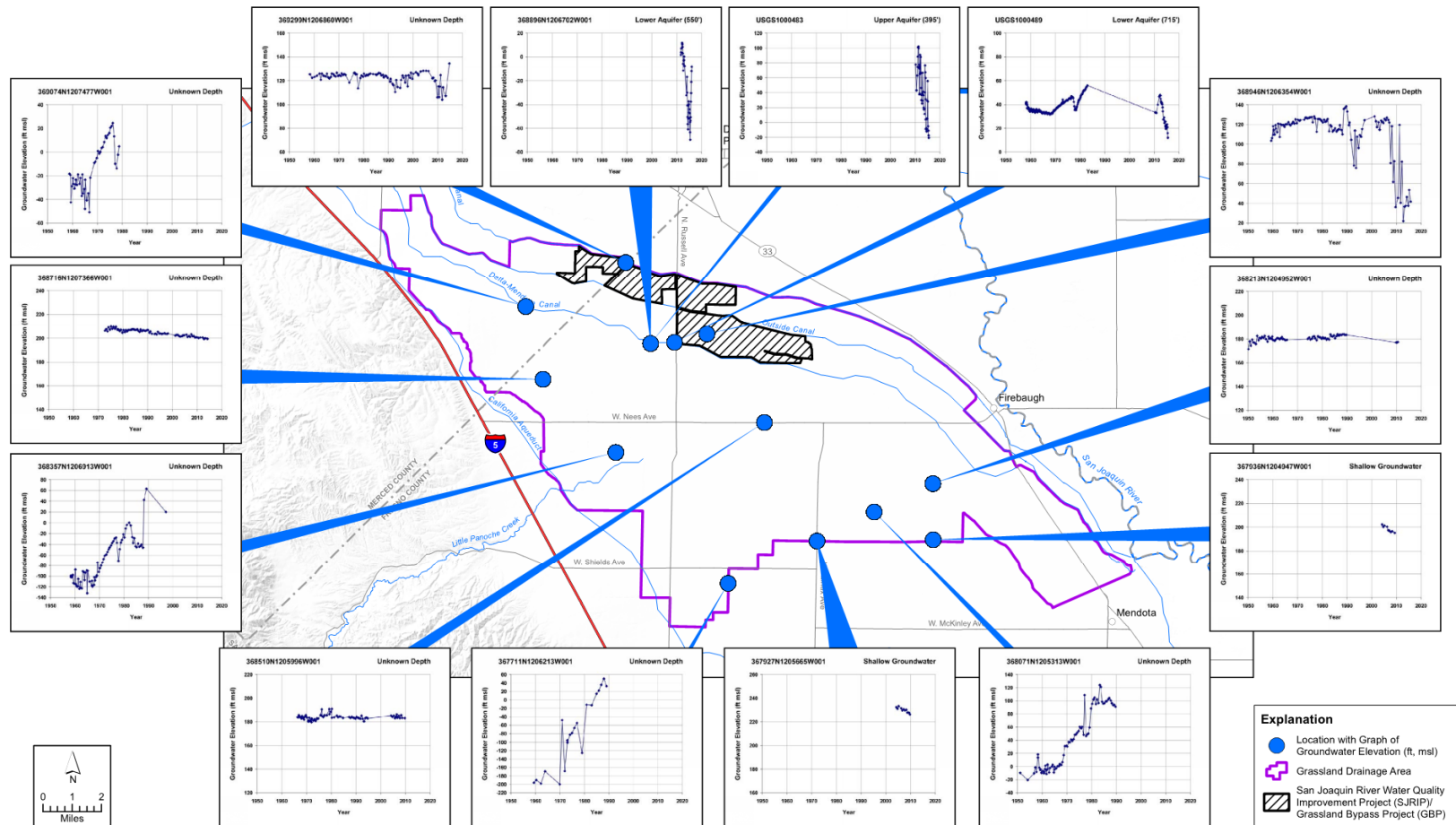


Figure CC-42: Select Graphs of Groundwater Elevations, Upper Aquifer



Note: Figure not to scale.

Source: *Western San Joaquin River Watershed Groundwater Quality Assessment Report, 2016.*

Figure CC-43: Select Graphs of Groundwater Elevations, Various Depths

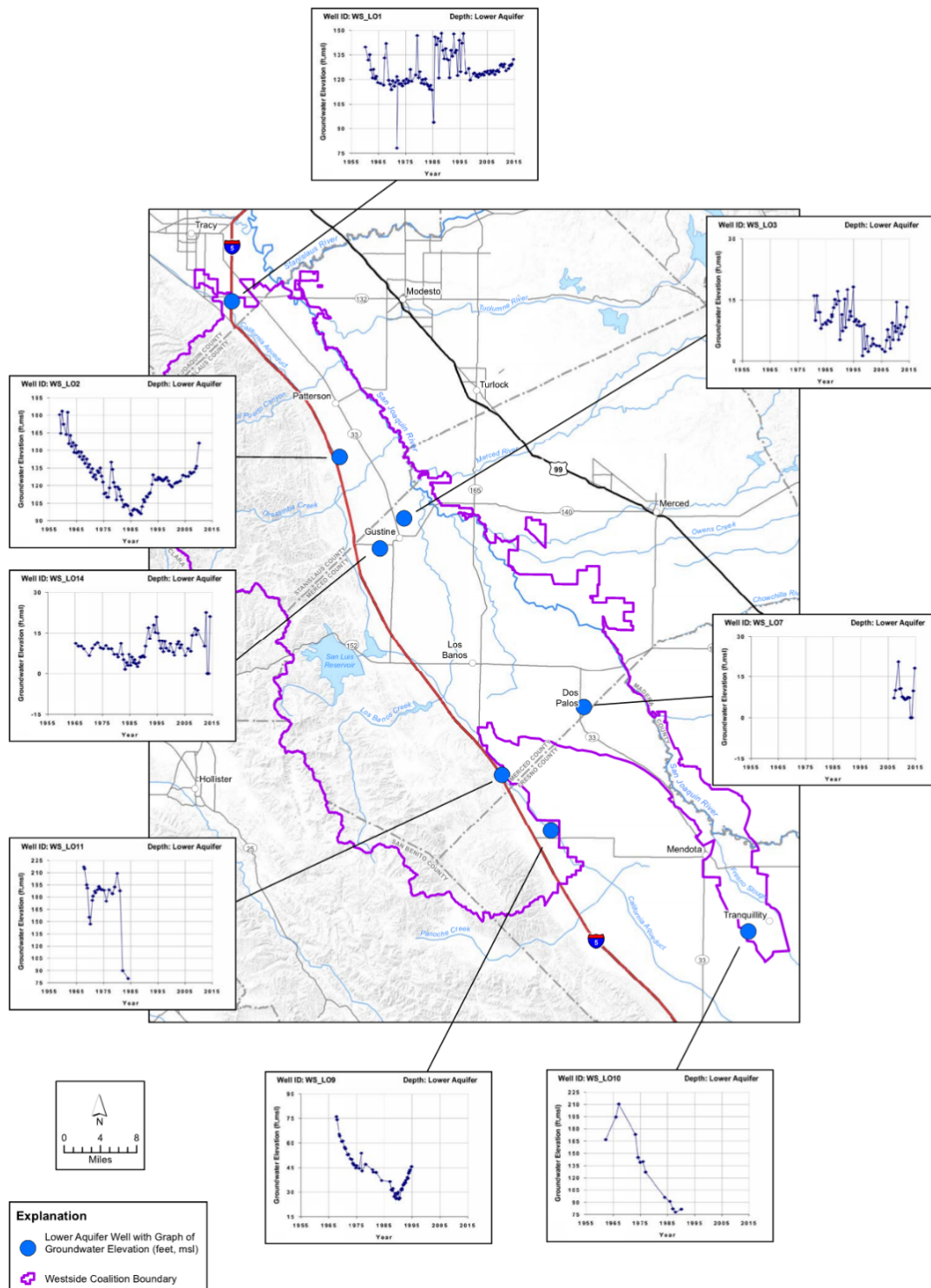


Figure CC-44: Select Graphs of Groundwater Elevations, Lower Aquifer

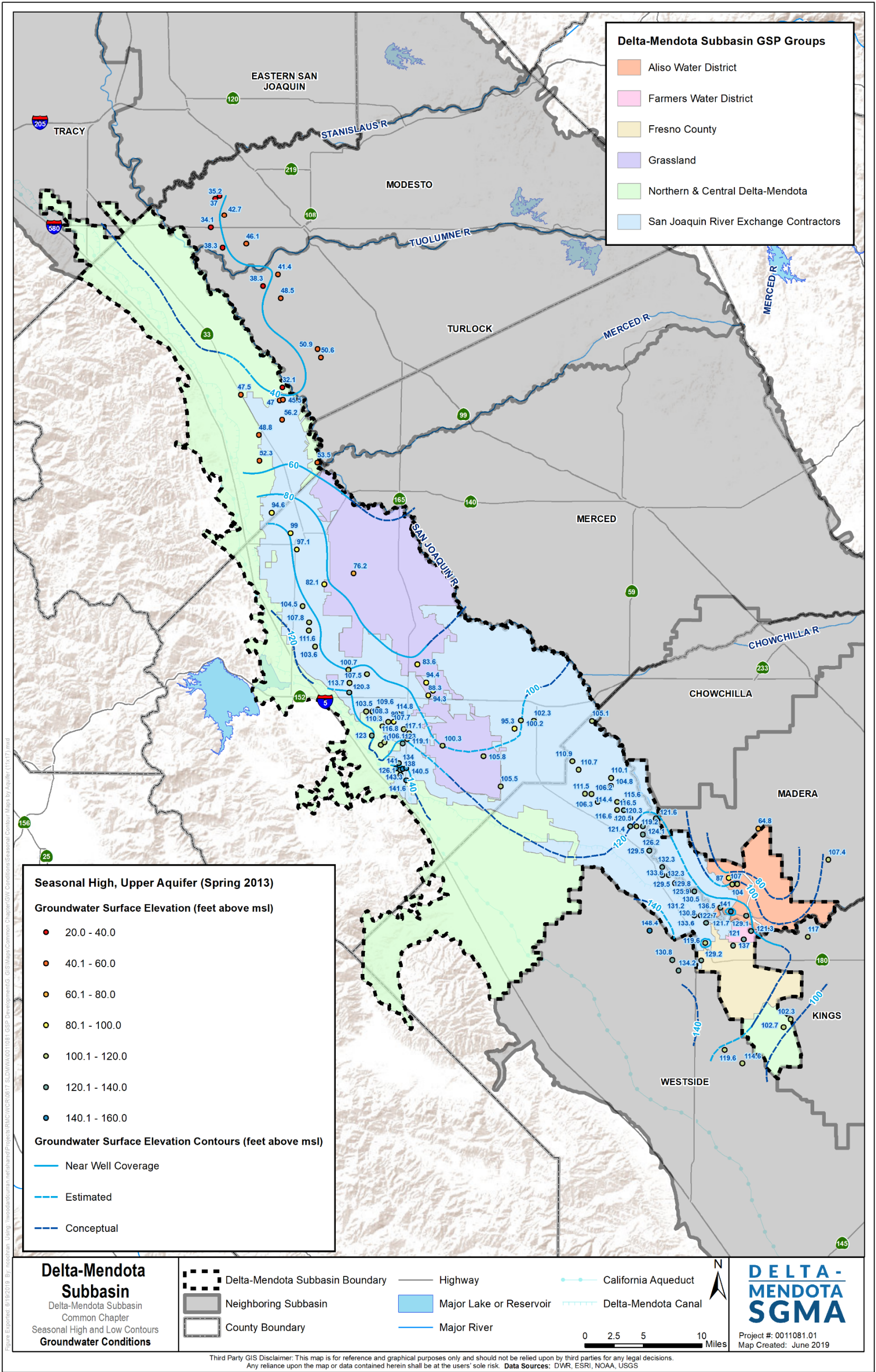


Figure CC-45: Spring 2013 Upper Aquifer Groundwater Contour Map

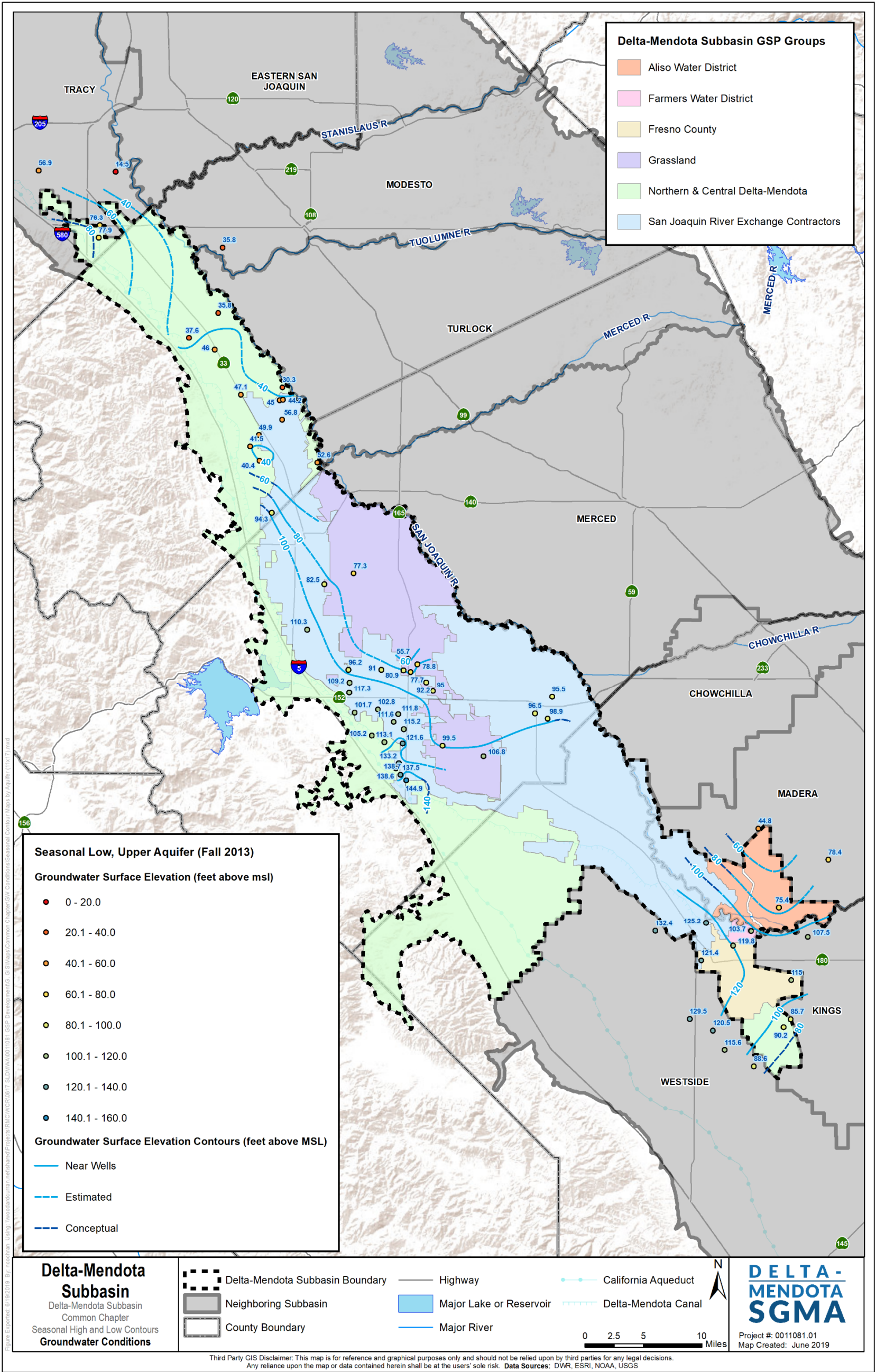


Figure CC-46: Fall 2013 Upper Aquifer Groundwater Contour Map

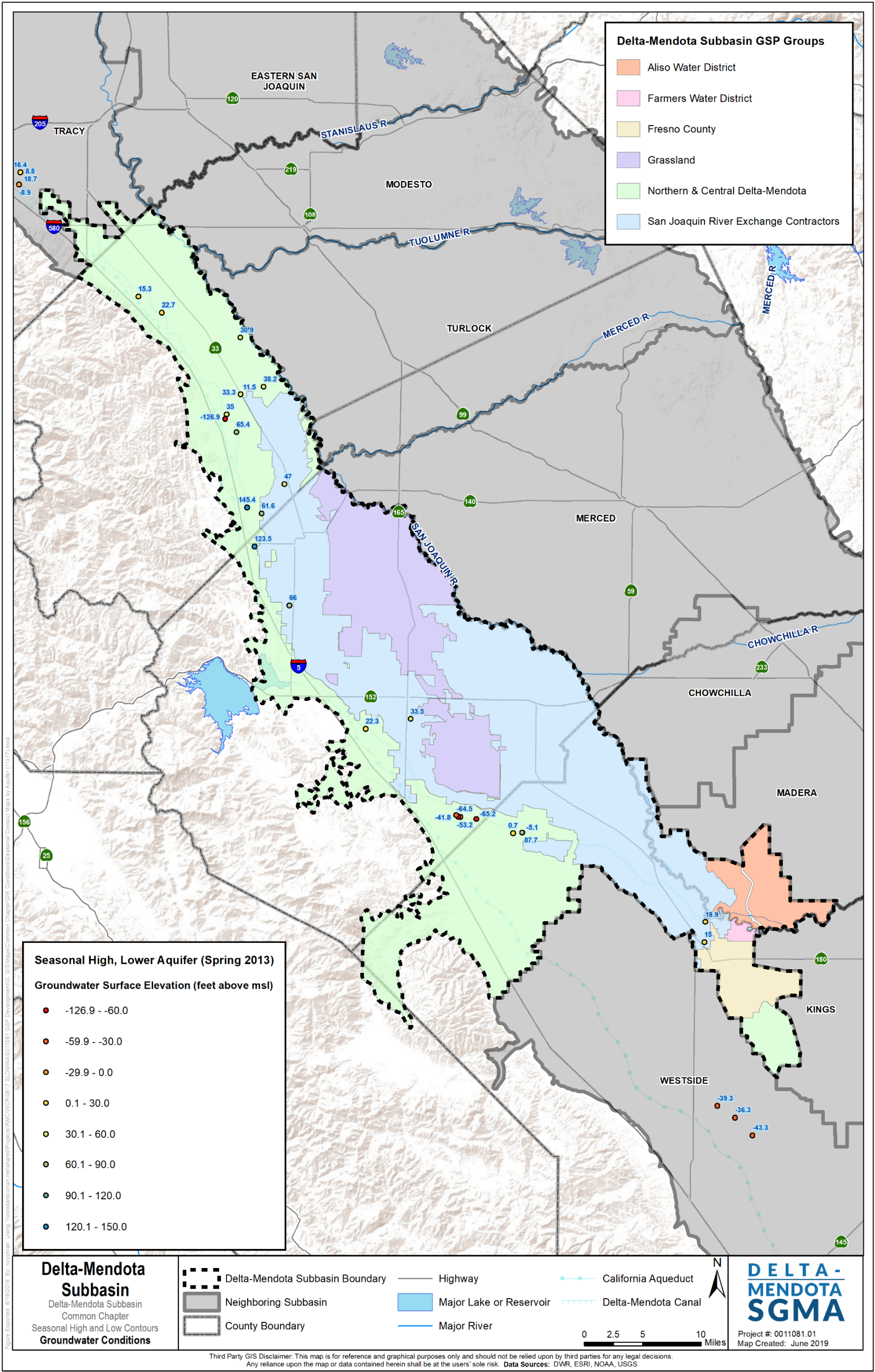


Figure CC-47: Spring 2013 Lower Aquifer Groundwater Elevation Measurements

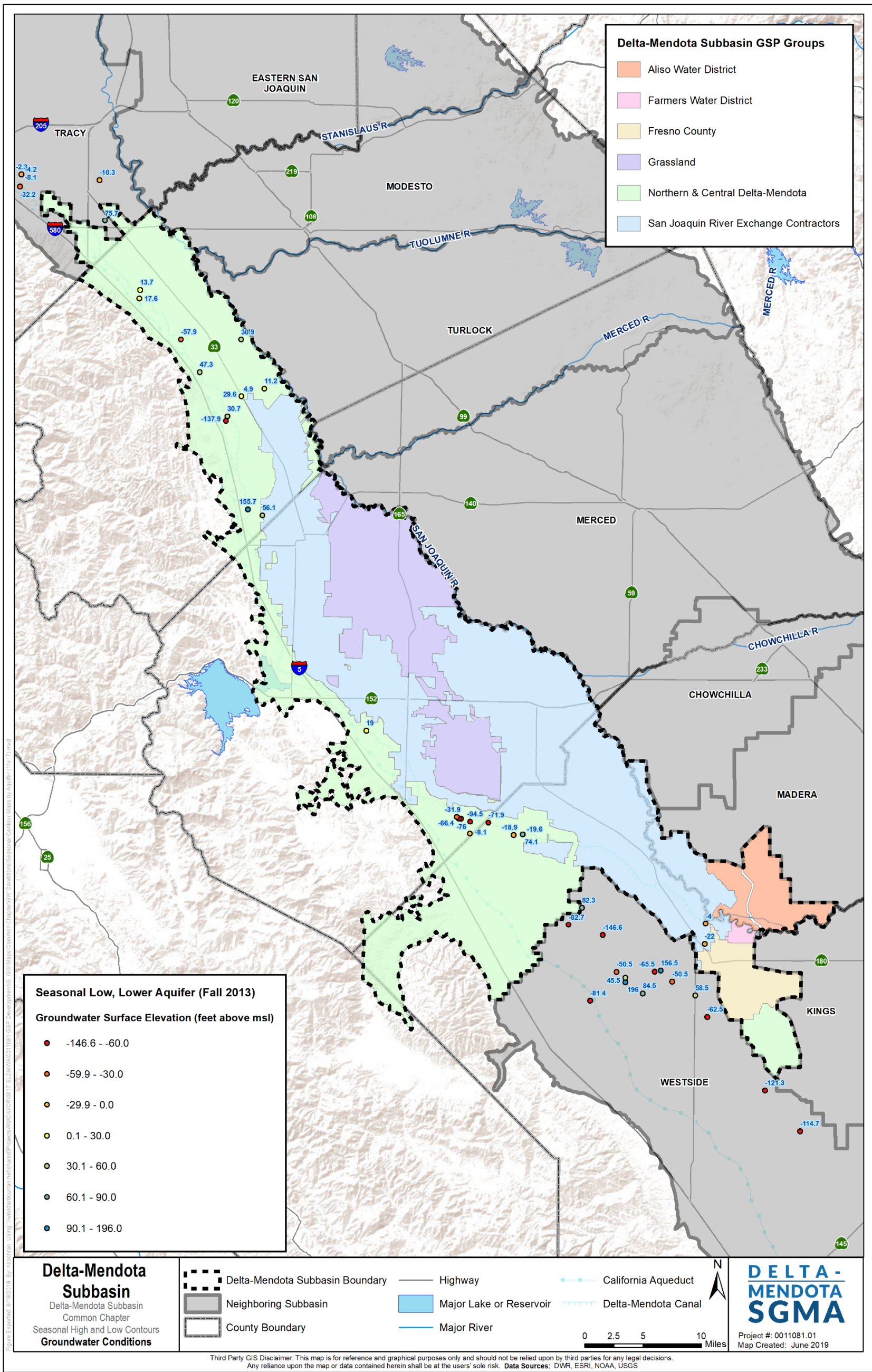


Figure CC-48: Fall 2013 Lower Aquifer Groundwater Elevation Measurements

4.2.3 Groundwater Storage

Annual changes in groundwater storage for both the Upper and Lower Aquifers in the Delta-Mendota Subbasin were estimated as part of the development of the Historic (WY2003-2012), Current (WY2013) and Projected Water Budgets (WY2014-2070). For information on how change in storage was calculated, refer to Section 4.3.2 – Water Budgets of this Common Chapter. **Figure CC-49** and **Figure CC-50** show annual change in storage, cumulative change in storage, and water year type for the Upper Aquifer and Lower Aquifer, respectively, from WY 2003 through 2013 for the Delta-Mendota Subbasin. For the purposes of the water budget four water year types were utilized, wet, average (corresponding to above and below normal water years), dry (corresponding to dry and critical water years) and Shasta critical.

Change in storage is negative for 6 out of the 11-year historic and current water budget period for the Upper Aquifer, and 9 out of 11 years for the Lower Aquifer. Despite periods of wet conditions with recharge outpacing extractions, an overall declining trend in groundwater storage can be observed in both the Upper Aquifer and Lower Aquifer. Cumulative change in storage declined more rapidly in the Upper Aquifer compared to the Lower Aquifer, declining by about 624,000 AF in the Upper Aquifer and 375,000 AF in the Lower Aquifer between WY2003 to 2013.

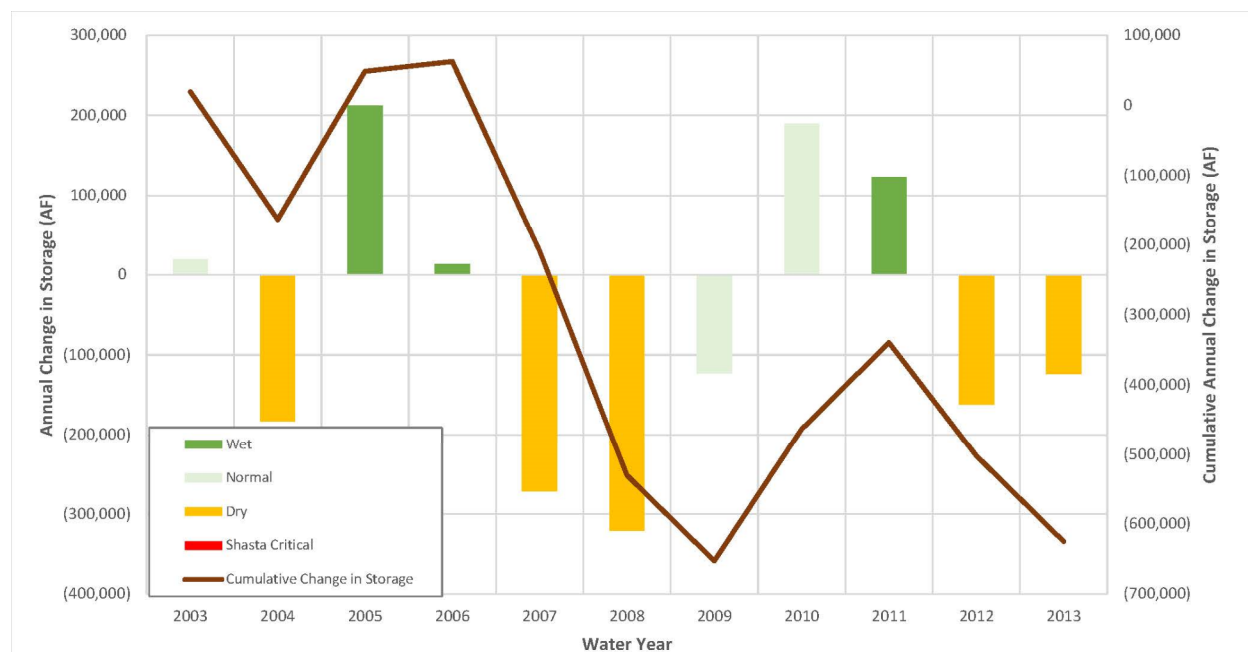


Figure CC-49: Calculated Upper Aquifer Change in Storage, Annual and Cumulative

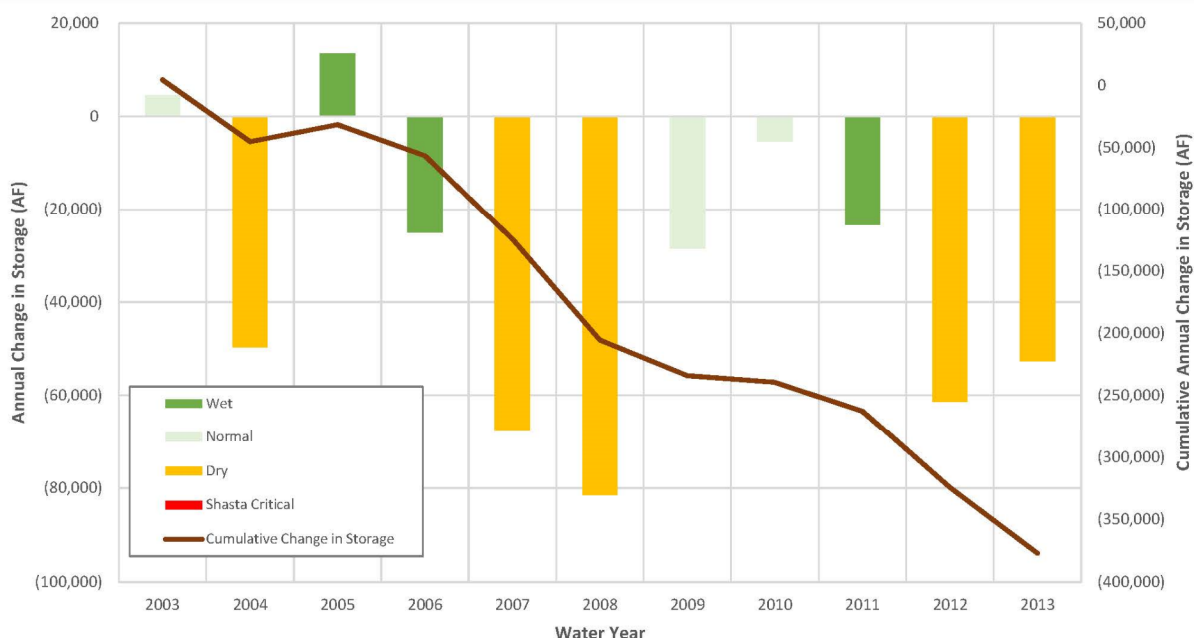


Figure CC-50: Calculated Lower Aquifer Change in Storage, Annual and Cumulative

4.2.4 Seawater Intrusion

Seawater intrusion is not an applicable sustainability indicator for the Delta-Mendota Subbasin. The Subbasin is located inland from the Pacific Ocean; thus, groundwater conditions related to seawater intrusion are not applicable to the Delta-Mendota Subbasin.

4.2.5 Groundwater Quality

Groundwater quality varies considerably from west to east and north to south throughout the Delta-Mendota Subbasin. In general, Upper Aquifer water quality has historically been impacted by overlying land uses with some areas showing increasing concentrations of nitrate and TDS. Areas of elevated salt concentrations can be found in the Subbasin, generally along the southern portion of the San Joaquin River and in the southern portion of the Subbasin. Lower Aquifer groundwater has, and remains in most cases, to be of generally good quality. For more information about historic and current conditions relative to groundwater quality in each GSP Group area, refer to the individual GSPs.

4.2.6 Land Subsidence

Long-term groundwater level declines can result in a one-time release of “water of compaction” from compacting silt and clay layers (aquitards) resulting in inelastic land subsidence (Galloway et al., 1999). There are several other types of subsidence in the San Joaquin Valley, including subsidence related to hydrocompaction of moisture-deficient deposits above the water table, subsidence related to fluid withdrawal from oil and gas fields, subsidence caused by deep-seated tectonic movements, and subsidence caused by oxidation of peat soils that is a major factor in the Sacramento-San Joaquin Delta (Sneed et al., 2013). However, aquifer-system compaction caused by groundwater pumping causes the largest magnitude and areal extent of land subsidence in the San Joaquin Valley (Poland et al., 1975; Ireland et al., 1984; Farrar and Bertoldi, 1988; Bertoldi et al., 1991; Galloway and Riley, 1999).

Land subsidence is a prevalent issue in the Delta-Mendota Subbasin as it has impacted prominent infrastructure of statewide importance, namely the DMC and the California Aqueduct, as well as local canals, causing serious operational, maintenance, and construction-design issues (Sneed et al., 2013). Reduced freeboard and flow capacity for the DMC and California Aqueduct have rippling effects on imported water availability throughout the State. Even small amounts of subsidence in critical locations, especially where canal gradients are small, can impact canal operations (Sneed and Brandt, 2015). While some subsidence is reversible (referred to as elastic subsidence), inelastic or irreversible subsidence is caused mainly by pumping groundwater from below the Corcoran Clay, thus causing compaction and reducing storage in the fine-grained materials in the lower confined aquifer as well as damaging well infrastructure. As a result, important and extensive damages and repairs have resulted in the loss of conveyance capacity in canals that deliver water or remove floodwaters, the realignment of canals as their constant gradient becomes variable, the raising of infrastructure such as canal check stations, and the releveling of furrowed fields.

Available Data

There are six UNAVCO Continuous GPS (CGPS) locations that monitor subsidence within the Delta-Mendota Subbasin (**Figure CC-51**). Changes in land surface elevation have also been measured at DMC Check Structures. **Figure CC-52** through **Figure CC-57** show the vertical change in land surface elevation from a given time point (specified on charts) for the UNAVCO CGPS stations within the Delta-Mendota Subbasin, along with annual CVP allocations. **Table CC-5** summarizes the greatest monthly land subsidence rate and corresponding year(s) of that change at each UNAVCO CGPS station. Overall, the greatest monthly subsidence rates occurring after January 1, 2015 occurred during the Spring of 2016 to the Spring of 2017. Land subsidence rates (in feet per year), as measured by USBR from December 2011 to December 2014, are shown in **Figure CC-58**. Based on these data, within the majority of the Delta-Mendota Subbasin, annual subsidence rates were between -0.15 and -0.3 feet/year during this period (or between -0.45 and -0.9 feet of total subsidence over this three-year period).

**Table CC-5: Subsidence Monitoring Trends
UNAVCO CGPS Stations**

Station ID	Greatest Monthly Land Subsidence Rate as of January 1, 2015 (feet)	Year(s) of Greatest Monthly Subsidence Rate
P255	-0.0292	Spring 2016 to 2017
P259	-0.0183	Spring 2016 to 2017
P252	-0.033	Spring 2016 to 2017
P303	-0.2190	Spring 2016 to 2017
P301	-0.0029	Spring 2016 to 2017
P304	-0.0003	Spring 2013 to 2017

Historic Conditions

Along the DMC, in the northern portion of the San Joaquin Valley, extensive groundwater extraction from unconsolidated deposits caused subsidence exceeding 8.5 meters (or about 28 feet) between 1926

and 1970 (Poland et al., 1975), reaching 9 meters (or about 30 feet) in 1980 (Ireland, 1986). Land subsidence from groundwater pumping began in the San Joaquin Valley in the mid-1920s (Poland et al., 1975; Bertoldi et al., 1991; Galloway and Riley, 1999), and by 1970, about half of the San Joaquin Valley had land subsidence of more than 0.3 meters (or about 1 foot) (Poland et al., 1975). When groundwater pumping decreased in the Delta-Mendota Subbasin following imported water deliveries from the CVP via the DMC in the early 1950s, compaction rates were reduced in certain areas and water levels recovered. Notable droughts of 1976-1977 and 1987-1992 saw renewed compaction during these periods, with increased groundwater pumping as imported supplies were reduced or unavailable. However, following these droughts, compaction virtually ceased, and groundwater levels rose to near pre-drought levels quite rapidly (Swanson, 1998; Galloway et al., 1999).

Subsidence contours for 1926-1970 (Poland et al., 1975) show the area of maximum active subsidence was southwest of the community of Mendota. Historical subsidence rates in the Mendota area exceeded 500 millimeters/year (or about 20 inches/year) during the mid-1950s and early 1960s (Ireland et al., 1984). The area southwest of Mendota has experienced some of the highest levels of subsidence in California, where from 1925 to 1977, this area sustained over 29 feet of subsidence (USGS, 2017). Historical subsidence rates along Highway 152 calculated from leveling-survey data from 1972, 1988, and 2004 show that for the two 16-year periods (1972-1988 and 1988-2004), maximum subsidence rates of about 50 millimeters/year (or about 2 inches/year) were found just south of El Nido (Sneed et al., 2013). Geodetic surveys completed along the DMC in 1935, 1953, 1957, 1984, and annually from 1996-2001 indicated that subsidence rates were greatest between 1953 and 1957 surveys, and that the maximum subsidence along the DMC (about 3 meters, or about 10 feet) was just east of DMC Check Structure Number 18.

After 1974, land subsidence was demonstrated to have slowed or largely stopped (DWR, June 2017); however, land subsidence remained poised to resume under certain conditions. Such an example includes the severe droughts that occurred between 1976 and 1977 and between 1987 and 1991. Those droughts, along with other corroborating factors, led to diminished deliveries of imported water which prompted some water agencies and farmers (especially in the western Valley) to refurbish old pumps, drill new water wells, and begin pumping groundwater to make up for cutbacks in the imported water supply. The decisions to renew groundwater pumping were encouraged by the fact that groundwater levels had recovered to near-predevelopment levels. CGPS data collected between 2007 to 2014 show seasonally variable subsidence and compaction rates, including uplift as elastic rebound occurs during the fall and winter (Sneed and Brandt, 2015). Vertical displacement at P303, near Los Banos, indicates subsidence at fairly consistent rates during and between drought periods (Sneed and Brandt, 2015). Vertical displacement at P304, near Mendota, indicates that most subsidence occurred during drought periods with very little occurring between drought periods. Finally, data from extensometers 12S/12E-16H2, located on the DMC west of Los Banos, and 14S/13E-11D6, located between the DMC and California Aqueduct west of Mendota, showed subsidence rate increases during 2014, the third year of the most recent drought (Sneed and Brandt, 2015).

Subsidence impacts to the California Aqueduct, which runs parallel and in close proximity to the Delta-Mendota Canal across the Subbasin, is of statewide importance. During the construction of the California Aqueduct, it was thought that subsidence within the San Joaquin Valley would cease with the delivery of water from the Central Valley Project, though additional freeboard was incorporated into the design and construction of the Aqueduct in an attempt to mitigate for future subsidence (DWR, June 2017). After water deliveries from the Aqueduct began, subsidence rates decreased to an average of less than 0.1 inches/year during normal to wet hydrologic years. During dry to critical hydrologic years, subsidence increased to an average of 1.1 inches per year. The 2012-2015 drought produced subsidence similar to those seen before the Aqueduct began delivering water, with some areas experiencing nearly 1.25 inches of sinking per month (based on NASA UAVSAR flight measurements). Dry and critically dry water years

since Aqueduct deliveries began have resulted in extensive groundwater withdrawals, causing some areas near the Aqueduct to subside nearly 6 feet.

Current Conditions

Based on subsidence rates observed over the last decade, it is anticipated that without mitigation, subsidence will continue to impact operations of the DMC and California Aqueduct. For example, recently, Reach 4A of the San Joaquin River near Dos Palos experienced between 0.38 and 0.42 feet/year in subsidence between 2008 and 2016. As a result of subsidence, freeboard in Reach 4A is projected to be reduced by 0.5 foot by 2026 as compared to 2016, resulting in a 50 percent reduction in designed flow capacity (DWR, May 2018). Reduced flow capacities in the California Aqueduct will impact deliveries and transfers throughout the State and result in the need to pump more groundwater, thus contributing to further subsidence.

More recent subsidence measuring indicates subsidence hot spots within the Subbasin include the area east of Los Banos and the Tranquillity Irrigation District (TRID) area. USGS began periodic measurements of the land surface in parts of the San Joaquin Valley over the last decade. Between December 2011 and December 2014, total subsidence in the area east of Los Banos, located within the Merced Subbasin (also referred to as the El Nido-Red Top area), over the three-year period ranged from 0.15 to 0.75 feet, or 1.8 to 9 inches respectively (KDSA, 2015). The Jet Propulsion Laboratory (JPL) at the California Institute of Technology has also been monitoring subsidence in California using interferometric synthetic aperture radar (or InSAR), and a recent progress report documenting data for the period from May of 2015 to September of 2016 indicates that the two previously-identified primary subsidence areas near the community of Corcoran and centered on El Nido was joined by a third area of significant subsidence near TRID. For the study period (as shown in **Figure CC-59**), maximum total subsidence of 22 inches was measured near Corcoran, while the El Nido area subsided 15 inches and the TRID area subsided around 20 inches. Analyses at two particular stations near El Nido show interesting trends. At Station P303, between 2007 and 2014, 50 mm (or nearly 2 inches) of subsidence occurred at this location. Vertical displacement at P303 (**Figure CC-55**) show subsidence at fairly consistent rates during and between drought periods, indicating that these areas continued to pump groundwater despite climatic variations (possibly due to a lack of surface water availability) (Sneed and Brandt, 2015). Residual compaction may also be a factor. Vertical displacement at Station P304 indicated that most subsidence in this particular area occurred during drought periods and very little occurred between drought periods (**Figure CC-57**). This suggests that this area received other sources of water (most likely surface water available between drought periods) and that residual compaction was not very important in this area. These two areas demonstrate a close link between the availability of surface water, groundwater pumping, and inelastic land subsidence.

Total land subsidence from April 2015 to April 2016 in the San Joaquin Valley is shown in

Figure CC-60: Vertical Displacement, April 2015 to April 2016 . Subsidence monitoring in the Delta-Mendota Subbasin, and in the San Joaquin Valley as a whole, demonstrated significant inelastic land subsidence as a result of the last drought, with effects continuing to the present time (as evidenced by continued subsidence between 2016 and 2018 through surveys of the DMC). While the impacts appeared to have slowed, the temporal and spatial impacts of continued subsidence have not yet been evaluated.

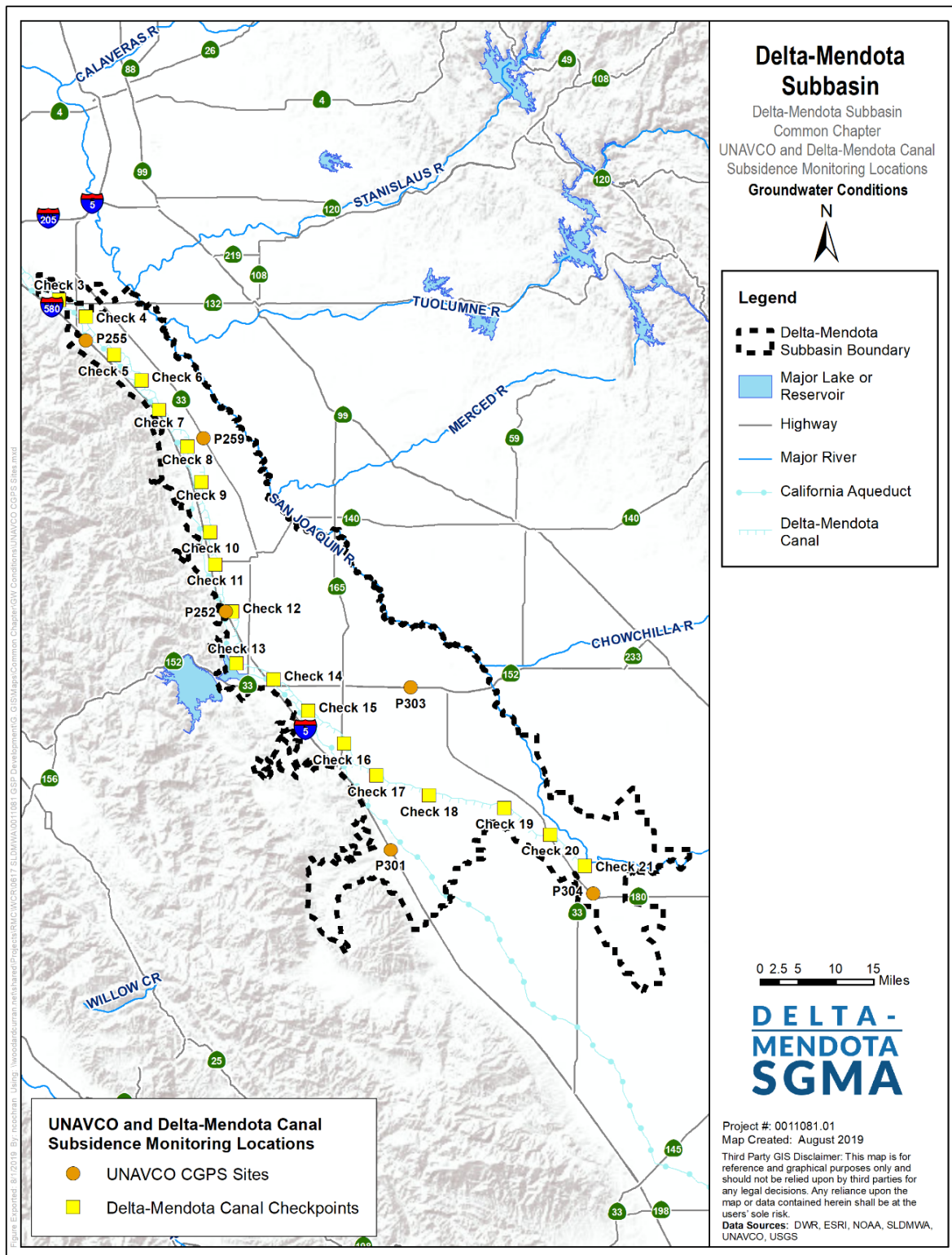


Figure CC-51: UNAVCO and Delta-Mendota Canal Subsidence Monitoring Locations

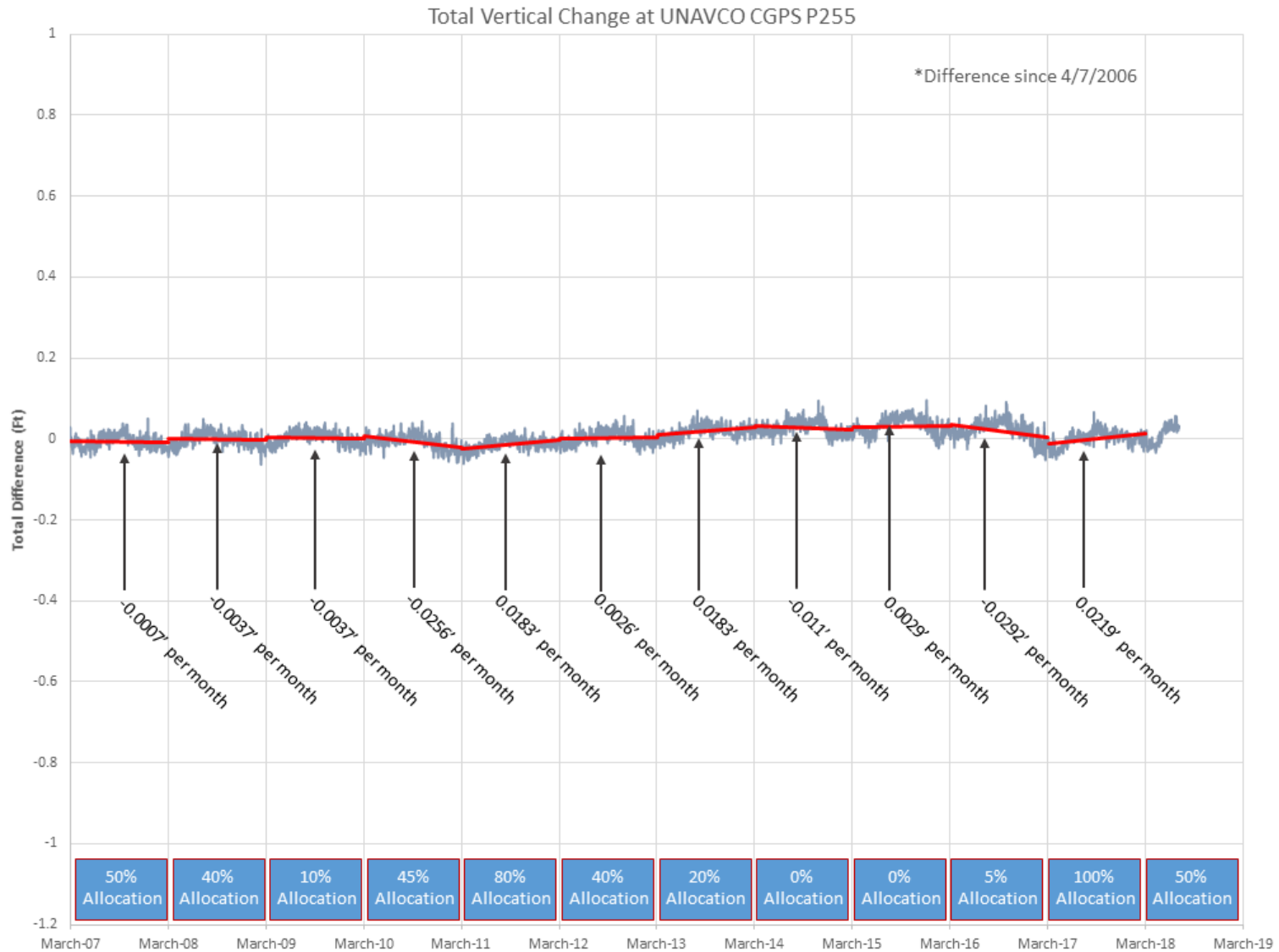


Figure CC-52: Vertical Elevation Change at UNAVCO CGPS P255, Spring 2007 to 2018

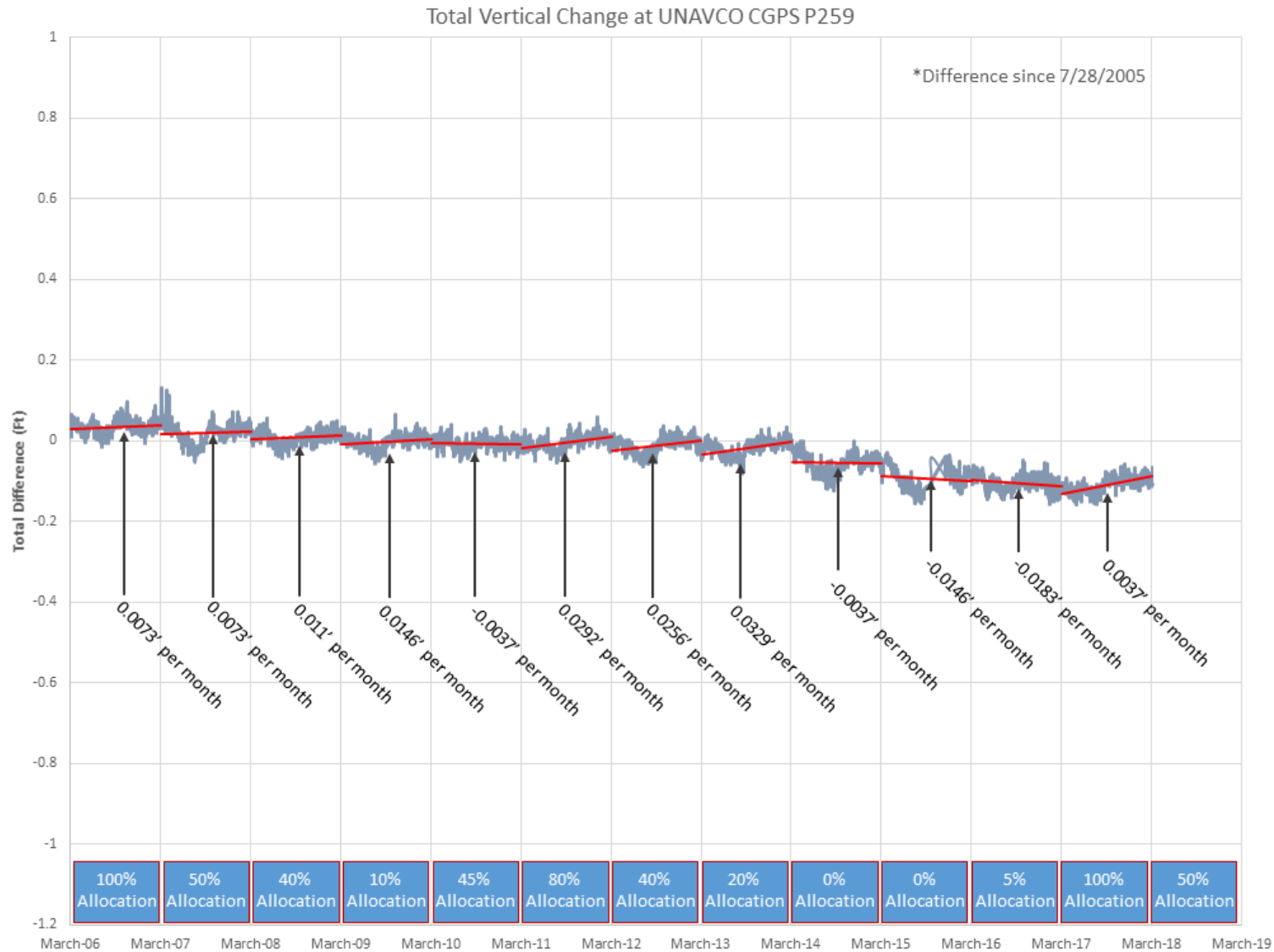


Figure CC-53: Vertical Elevation Change at UNAVCO CGPS P259, Spring 2006 to 2018

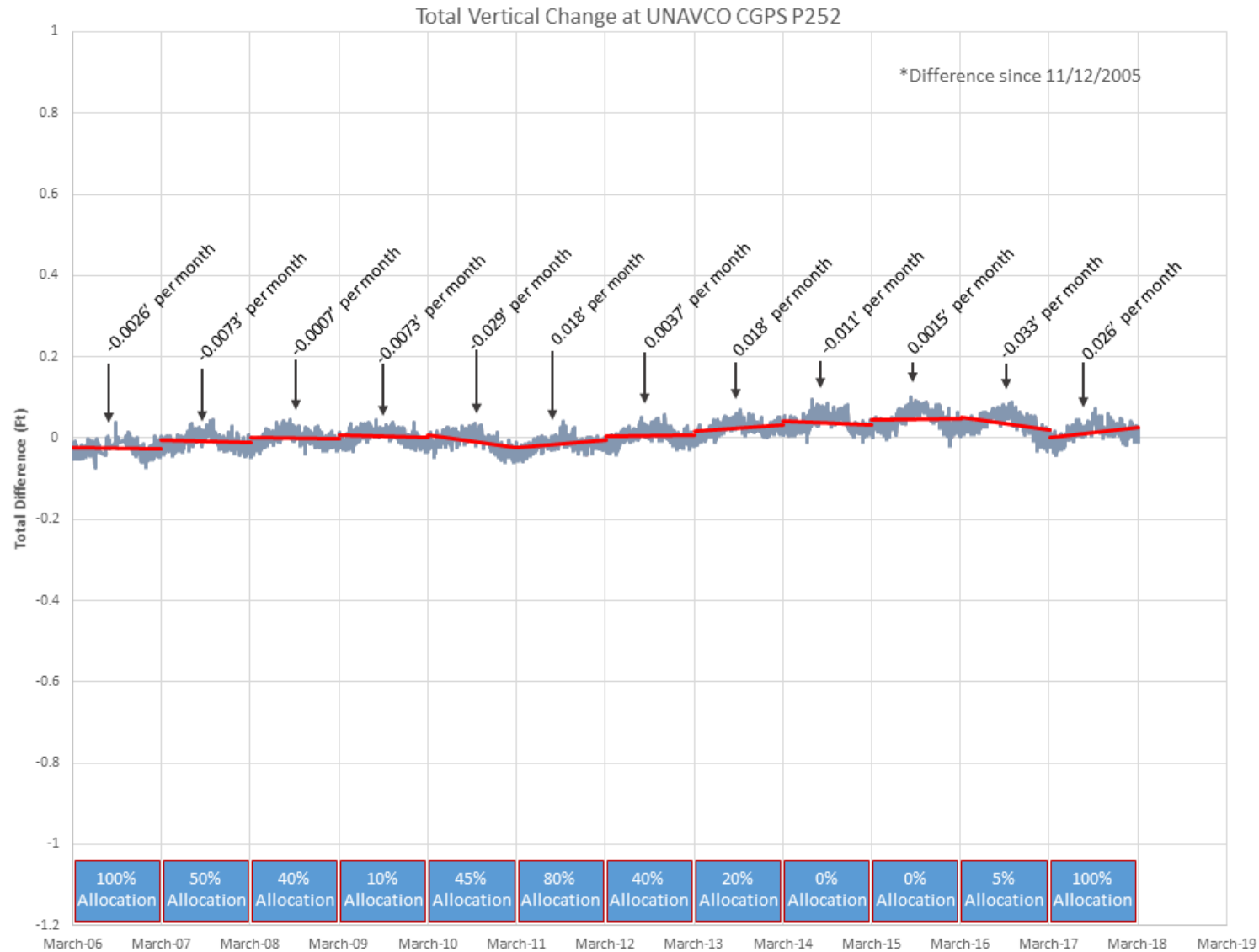


Figure CC-54: Vertical Elevation Change at UNAVCO CGPS P252, Spring 2006 to 2018

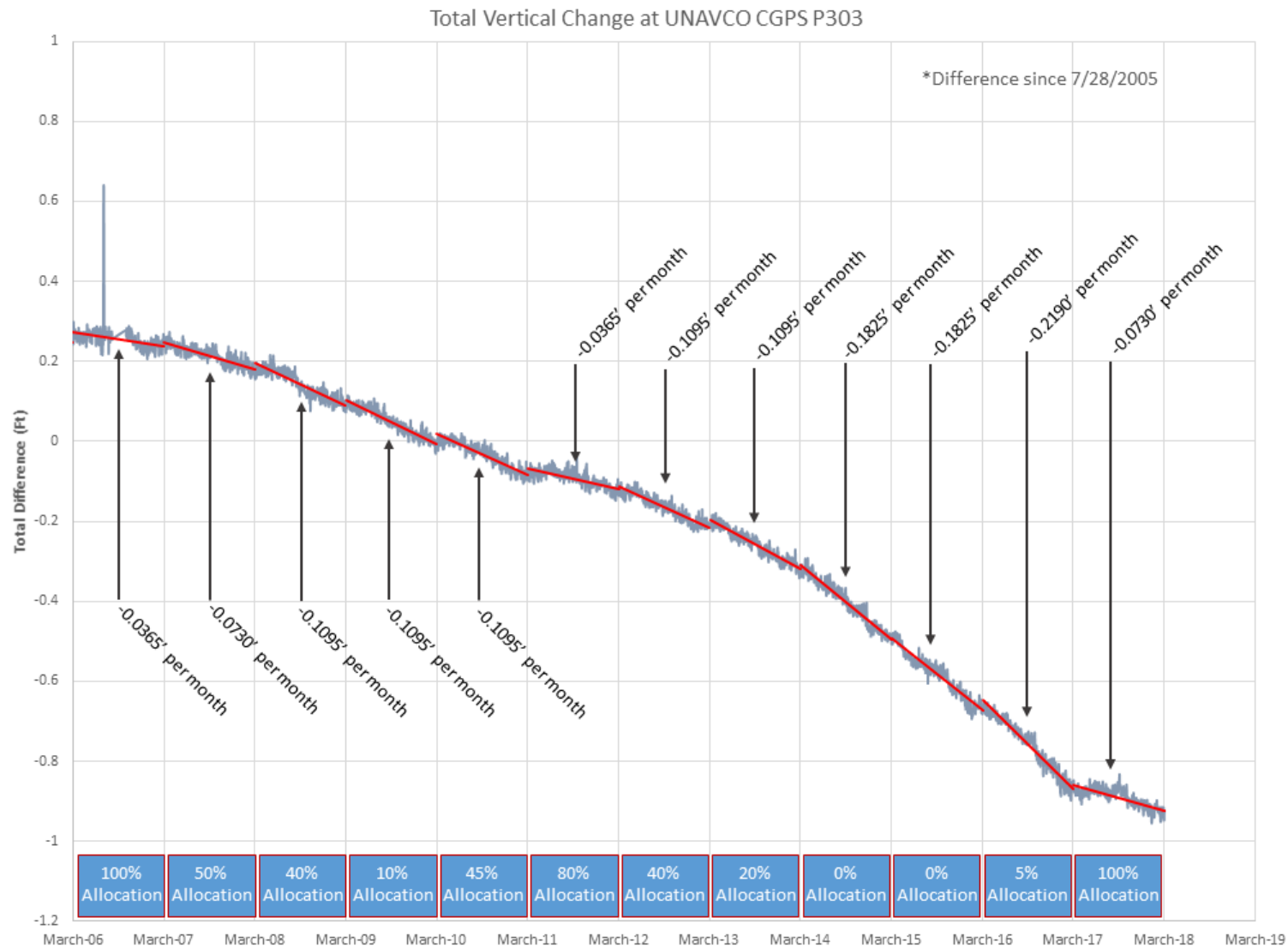


Figure CC-55: Vertical Elevation Change at UNAVCO CGPS P303, Spring 2006 to 2018

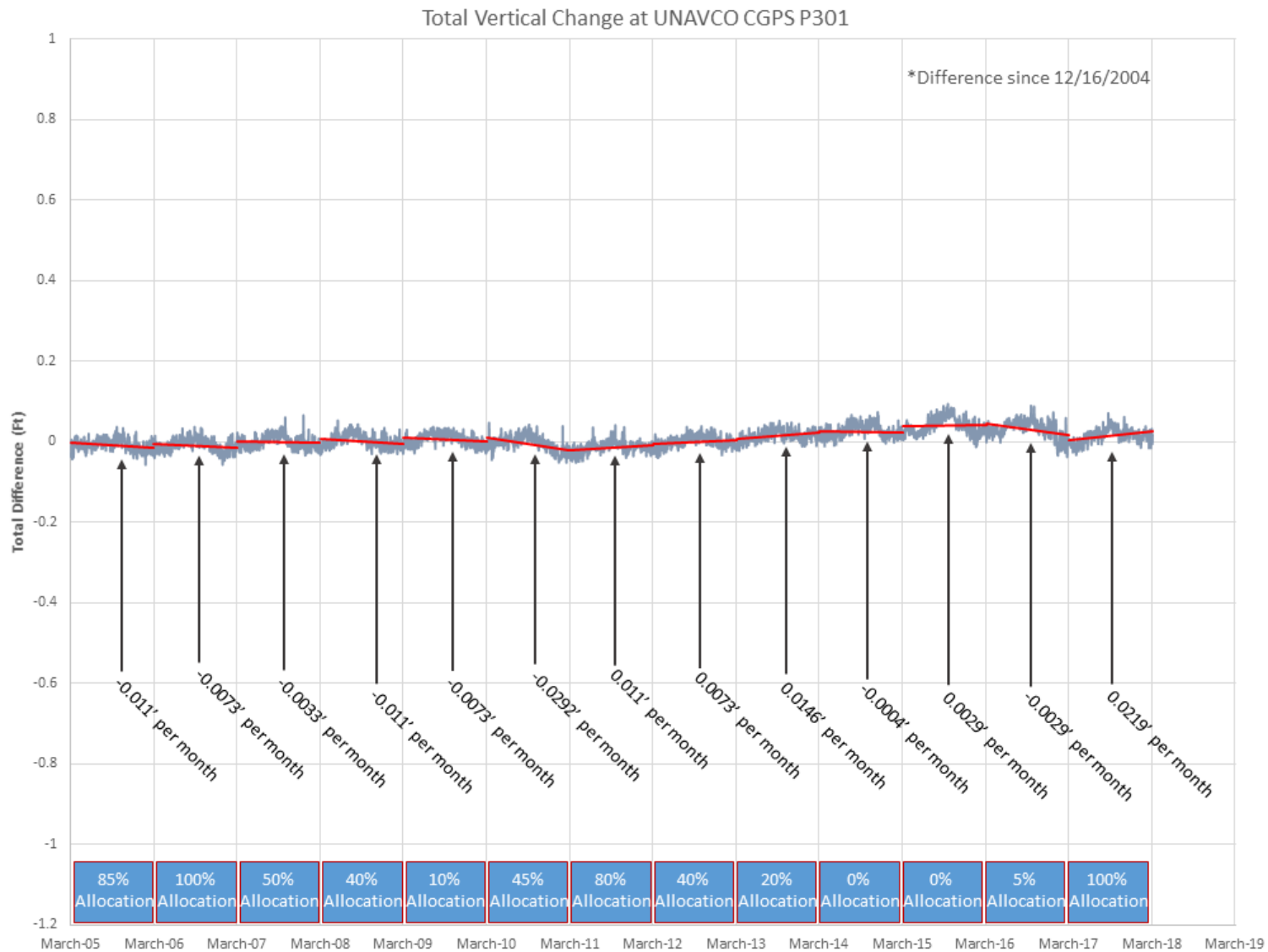


Figure CC-56: Vertical Elevation Change at UNAVCO CGPS P301, Spring 2005 to 2018

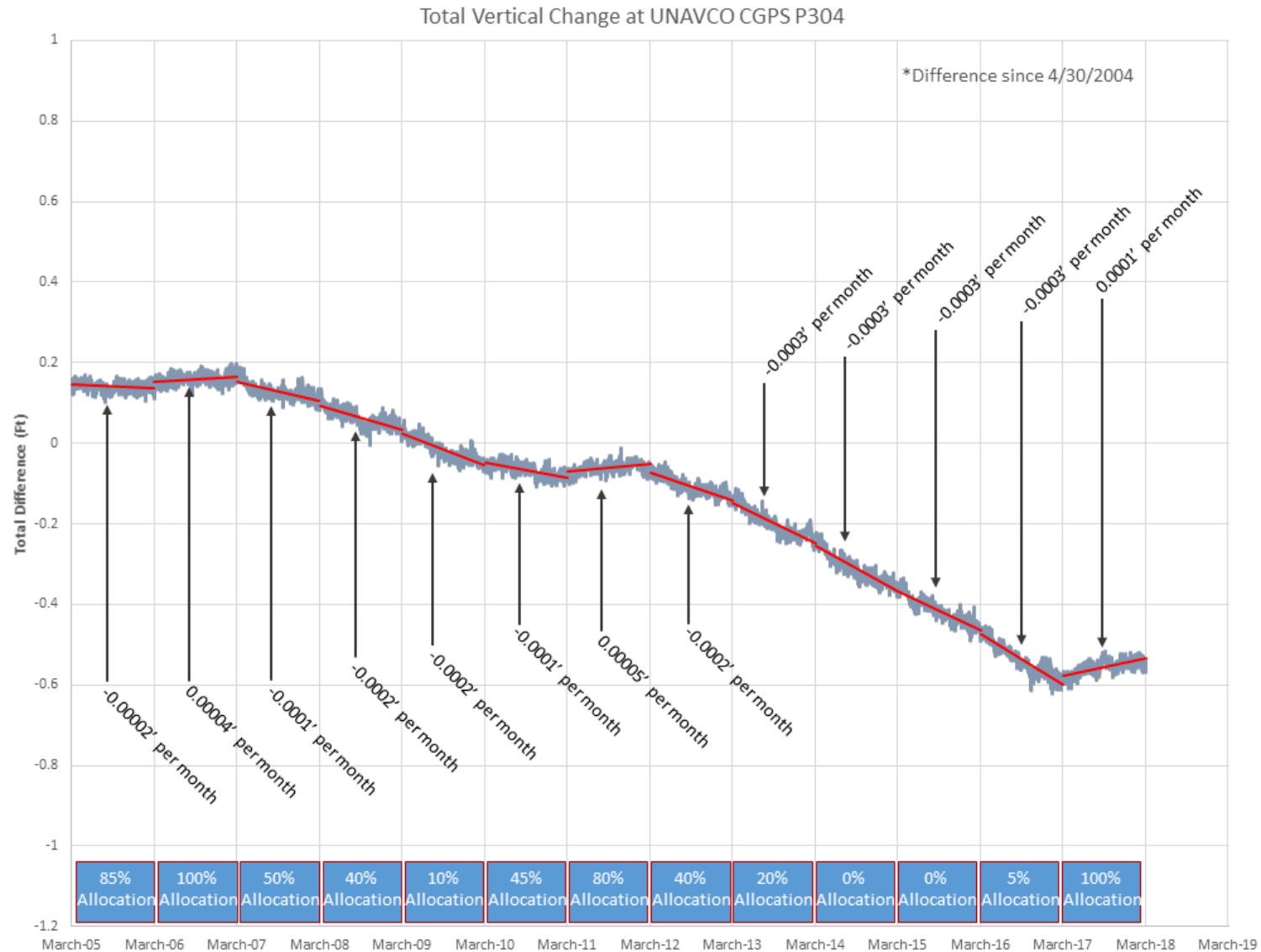


Figure CC-57: Vertical Elevation Change at UNAVCO CGPS P304, Spring 2005 to 2018

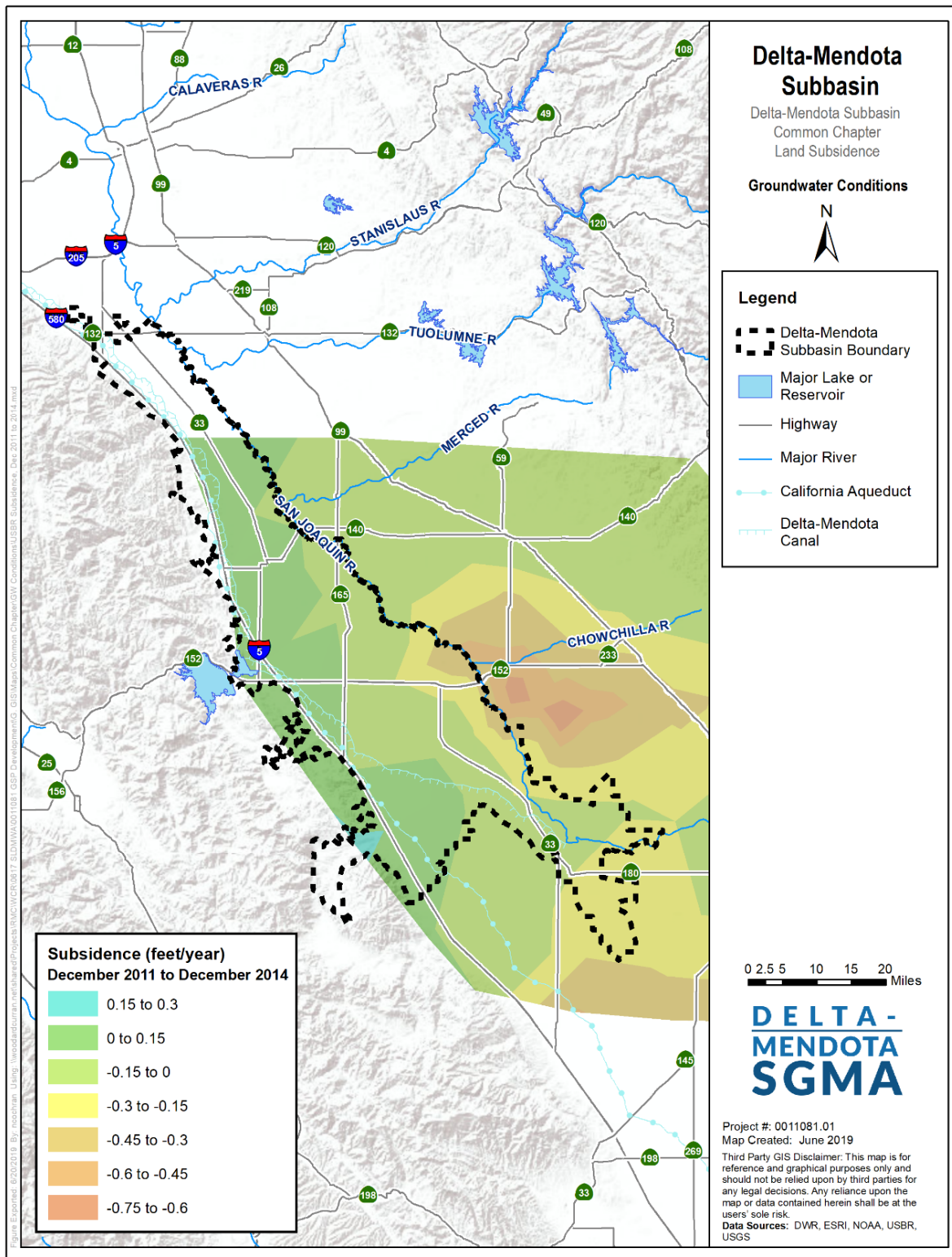


Figure CC-58: Land Subsidence, December 2011 to December 2014



Source: Progress Report: Subsidence in California, March 2015 – September 2016, Farr et. Al. JPL, 2017

Figure CC-59: Recent Land Subsidence at Key San Joaquin Valley Locations

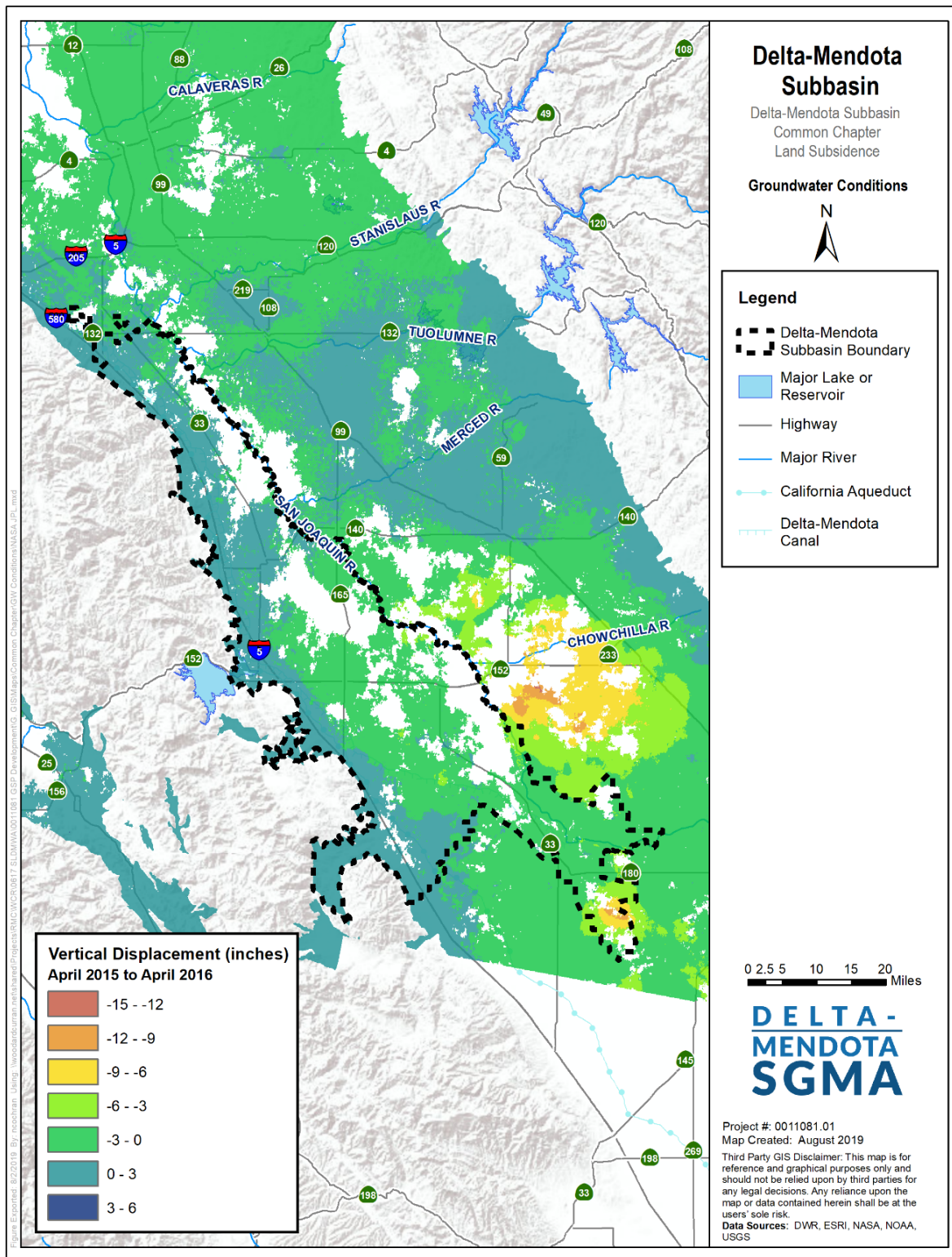


Figure CC-60: Vertical Displacement, April 2015 to April 2016

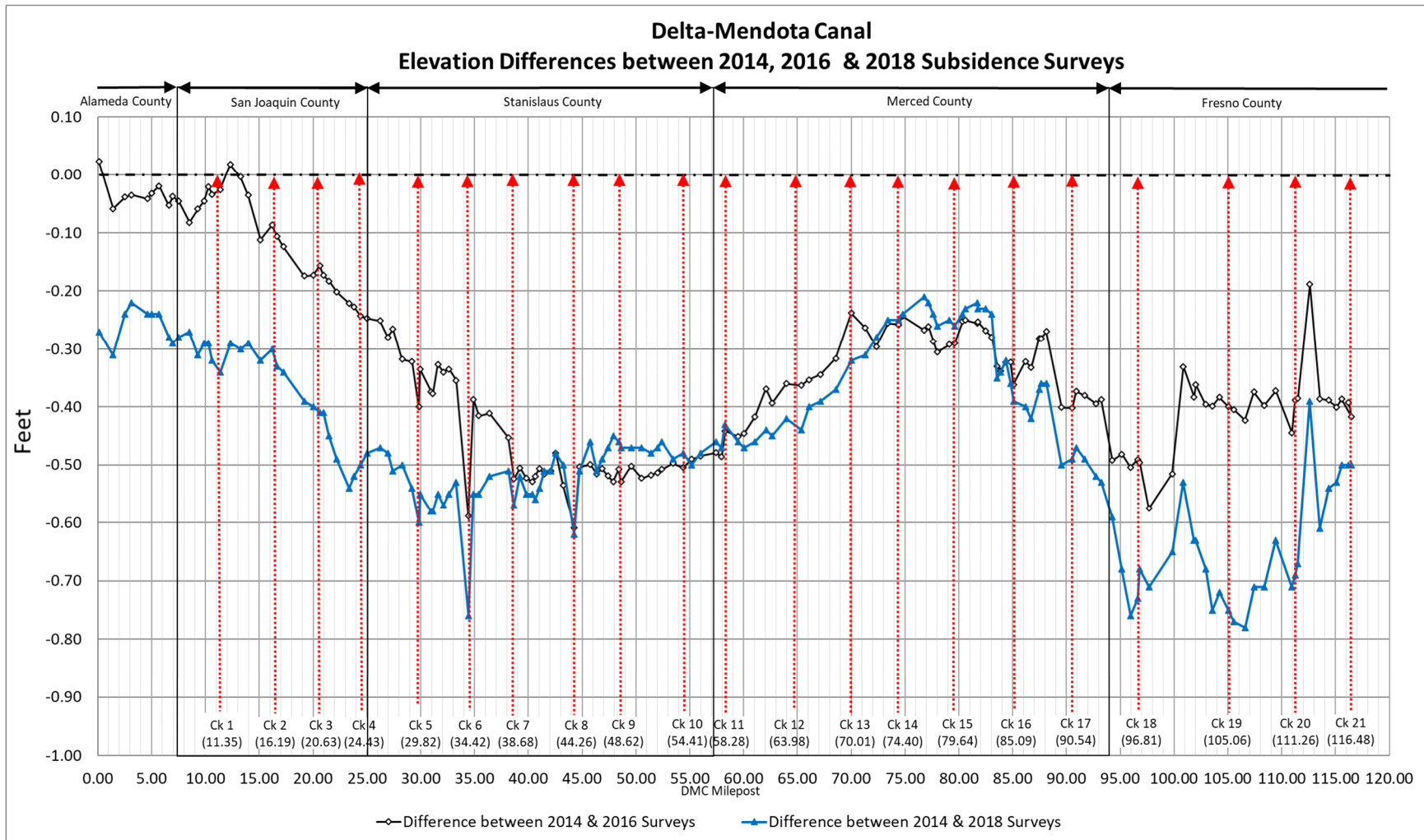


Figure CC-61: Elevation Change along the Delta-Mendota Canal, 2014 through 2018

4.2.7 Interconnected Surface Water Systems

Understanding the location, timing and magnitude of groundwater pumping impacts on interconnected surface water systems is important for the proper management of groundwater resources in order to minimize impacts on interconnected surface waters and the biological communities and permitted surface water diverters that rely on those resources. Historically, throughout the San Joaquin Valley, many interconnected stream reaches have transitioned from net-gaining to net-losing streams (TNC, 2014). Gaining streams occur when streamflows increase as a result of groundwater contribution and losing streams occur when streamflows decrease due to infiltration into the bed of the stream (McBain & Trush, Inc., 2002). Increased groundwater pumping has the ability to contribute to the depletion of interconnected waters with the nature, rate, and location of increased pumping being a function of distance to the river, as well as depth, timing, and rate of groundwater pumping.

Available Data

Two communities in the Delta-Mendota Subbasin are likely most vulnerable to the loss of interconnected surface water as a result of groundwater pumping: San Joaquin River surface water diverters and groundwater dependent ecosystems (GDEs). These communities represent the primary beneficial users of interconnected surface water and groundwater. Streams stemming from the west side of the Delta-Mendota Subbasin are ephemeral in nature, and only two of these creeks reach the San Joaquin River (Del Puerto Creek and Orestimba Creek). These creeks lose their flows to the underlying vadose zone (net-losing streams) and therefore do not represent areas of potential GDEs.

Groundwater dependent ecosystems are defined under Article 2 Definitions, § 351 Definitions of the GSP Emergency Regulations as “ecological communities or species that depend on groundwater emerging from aquifers or on groundwater occurring near the ground surface.” The Natural Communities Commonly Associated with Groundwater (NCCAG) dataset (2018) provided by DWR in conjunction with The Nature Conservancy (TNC) was initially used to identify GDEs within the Delta-Mendota Subbasin, following the associated guidance document provided by TNC (Rohde et al., 2018). Local verification efforts were conducted in the Delta-Mendota Subbasin by different GSA representatives to ground-truth GDEs based on local knowledge. Specifically, areas where natural communities have been urbanized or otherwise modified prior to 2015 were eliminated from the data set used to identify GDEs.

Identification of Interconnected Surface Water Systems

The San Joaquin River and Fresno Slough are the primary surface water bodies interconnected with Delta-Mendota Subbasin groundwater. For information about the sources used to determine the interconnected segments of the San Joaquin River and Fresno Slough within the Delta-Mendota Subbasin, refer to the individual GSPs.

Historic Conditions

The San Joaquin River and its tributaries drain approximately 13,500 mi² (measured at the USGS gaging station at Vernalis) along the western flank of the Sierra Nevada and eastern flank of the Coast Range, and flows northward into the Sacramento-San Joaquin Delta where it is joined by the Calaveras and Mokelumne Rivers before combining with the Sacramento River. Typical of Mediterranean climate catchments, river flows vary widely seasonally and from year to year. Three major tributaries join the San Joaquin from the east: the Merced, Tuolumne, and Stanislaus Rivers. Smaller tributaries include the Fresno River, Chowchilla River, Bear Creek, and Fresno Slough (from the Kings River). Precipitation is predominantly snow above about 5,500 to 6,000 feet in the Sierra Nevada, with rain in the middle and

lower elevations of the Sierra foothills and in the Coast Range. As a result, the natural hydrology historically reflected a mixed runoff regime dominated by winter-spring rainfall runoff and spring-summer snowmelt runoff. Most flow is derived from snowmelt from the Sierra Nevada, with relatively little runoff contributed from the western side of the drainage basin in the rain shadow of the Coast Range. The unimpaired average annual water yield (WY1906-2002) of the San Joaquin River, as measured immediately above Millerton Reservoir, is 1,801,000 acre-feet (USBR, 2002); the post-Friant Dam average annual water yield (WY 1950-2000) to the lower San Joaquin River is 695,500 acre-feet (USGS, 2000). As average precipitation decreases from north to south, the San Joaquin River basin (including the Stanislaus, Tuolumne, and Merced Rivers) contributes about 22% of the total runoff to the Delta (DWR, 1998).

Current Conditions

Historically, most of the San Joaquin River, which forms the great majority of the Delta-Mendota Subbasin's eastern border, was a gaining reach. Snowmelt runoff during the spring and early summer resulted in these conditions through a good portion of the year. However, significant decreases in groundwater elevations due to a myriad of factors, including pumping, tile drains, the channelizing of flood flows, and upstream diversions on the river, have reversed this condition so most reaches are now losing reaches. Some localized gaining reaches still remain on the lower river, such as between the Stanislaus and Merced Rivers; however, many reaches along these rivers (and along localized streams) may transition from gaining to losing depending on hydrology.

Estimates of Timing and Quantity of Depletions

Using available data and where feasible, each Delta-Mendota Subbasin GSP Group quantified the gains and/or losses from the groundwater at each interconnected reach of the San Joaquin River adjoining the Delta-Mendota Subbasin. **Table CC-6** summarizes these estimates. For more information about the sources or methods used to estimate the timing and quantity of depletions, refer to the individual GSPs.

Table CC-6: Estimated Quantity of Gains/Depletions for Interconnected Stream Reaches, San Joaquin River

Landmark		River Mile	GSP Group	Interconnected?	Gaining or Losing?	Quantity Gained/Loss (cfs)	Notes
REACH 1		267.5 to 229.0	Located outside the Delta-Mendota Subbasin				
A	Friant Dam	267.5					
	North Fork Road Bridge	266.8					
	Cobb Island Bridge	259.0					
	State Route 41 (Lanes Bridge)	255.2					
	Scout Island Bend	250.0					
	ATSF Railroad Bridge	245.0					
B	State Route 99	243.2					
	Southern Pacific Railroad	243.2					
	State Route 145 Bridge (Skaggs Bridge)	234.1					
	Gravelly Ford	229.0					
REACH 2		229.0 to 204.8					
A	Gravelly Ford	229.0		Yes	Losing when flowing		
	Upstream Limit of Right Bank Levee	227.0					
	Upstream Limit of Left Bank Levee	225.0					
B	Chowchilla Bypass Control Structure	216.1	Farmers Water District	Yes	Losing when flowing	-4	2003 to 2013 average. High in 2010 (-8 cfs), low in 2004 and 2009 (-1 cfs)
	Mendota Dam	204.8					
	Mendota Pool			Yes	Losing	-40	-29,000 AFY
REACH 3		204.8 to 182.0		Yes	Losing	-25	-18,000 AFY
	Mendota Dam	204.8					
	Avenue 7.5 Bridge (Firebaugh)	195.2					
	Sack Dam	182.0					
REACH 4		182.0 to 135.8				--0 - 0	Losses when wet; gaining in some areas (but unquantifiable)
A	Sack Dam	182.0		Y-s - first 2 miles -o - next 1.5 miles Y-s - remaining miles	Losing		
	State Route 152 Bridge	173.9		Yes	Gaining		
B	Sand Slough Control Structure	168.5					
	Mariposa Slough Control Structure	168.4					
	Turner Island Road Bridge	157.2					
	Mariposa Bypass confluence	147.2					

Landmark		River Mile	GSP Group	Interconnected?	Gaining or Losing?	Quantity Gained/Loss (cfs)	Notes
	Bear Creek/Eastside Bypass confluence	135.8					
REACH 5		135.8 to 118.0		Yes	Gaining	unquantifiable	Likely gaining from ag/refuge draining but unquantifiable
	Bear Creek/Eastside Bypass confluence	135.8					
	State Route 165 Bridge (Lander Avenue)	132.9					
	Salt Slough confluence	127.7					
	State Route 140 Bridge (Fremont Ford)	125.1					
	Mud Slough confluence	121.2					
	Merced River confluence (Hills Ferry Bridge)	118.0					
	Newman to Crows Landing		Northern & Central Delta-Mendota	Yes	Gaining	50	50
	Crows Landing to Patterson		Northern & Central Delta-Mendota Region	Yes	Gaining	-50 to 200	-50 to 200
	Patterson to Vernalis		Northern & Central Delta-Mendota Region	Yes	Gaining	190	6.1 cfs/mi for 30.8 miles. Based on Cooley, W. 2001. <i>Groundwater flow net analysis for lower San Joaquin River Basin</i> . Memo to CRWQCB, August 8, 2001

Groundwater Dependent Ecosystems

A groundwater dependent ecosystem (GDE) is defined under the GSP Emergency Regulations as referring “to ecological communities or species that depend on groundwater emerging from aquifers or on groundwater occurring near the ground surface” (§351(m)). Under §354.16(g) of the GSP Emergency Regulations, each Plan is required to identify GDEs within the subbasin utilizing data provided by DWR or the best available information. The following section describes the process for verifying GDEs within the Delta-Mendota Subbasin and the location of verified and potential GDEs.

The Natural Communities Commonly Associated with Groundwater (NCCAG) dataset (2018c) provided by DWR was used in conjunction with information provided by The Nature Conservancy (TNC) to identify GDEs within the Delta-Mendota Subbasin. To further screen available information regarding GDEs, each GSP Group developed individualized criteria. Additional details regarding the screening process implemented by each GSP can be found in the individual GSPs.

Based on the screening process implemented by each individual GSP Group, GDE polygons determined not to be GDEs were removed from the mapping. **Figure CC-62** and **Figure CC-63** summarize the results of the GDE analysis for the Subbasin. Results are compiled into two habitat classes: wetlands (**Figure CC-62**) and vegetation (**Figure CC-63**). Wetland features are commonly associated with surface expression of groundwater under natural, unmodified conditions. Vegetation feature types are commonly associated with the sub-surface presence of groundwater (phreatophytes – deep rooted plants). Confirmed GDEs have been grouped into larger polygons based on proximity and aquifer connection.

In general, identified Possible GDEs are primarily located along the San Joaquin River corridor, within the northern portion of the Northern & Central Delta-Mendota Region GSP, the SJREC GSP, the Grassland GSP, and the Fresno GSP Plan Areas, where some possible GDEs have been identified along ephemeral streams that originate from the Coast Range. Table CC-7 includes all freshwater species within the Delta-Mendota Subbasin as identified by TNC (2018). Per TNC data, these species (listed in Table CC-7) have either been observed or have the potential to exist within the Delta-Mendota Subbasin; however, the actual presence of these species have not been verified. As a result of the identification of Possible GDEs for the purpose of SGMA, no land use protections for GDEs are conveyed unless otherwise required. Additionally, the Delta Mendota Subbasin recognizes the opportunity to present further-refined GDE delineations in the subsequent GSP Updates.

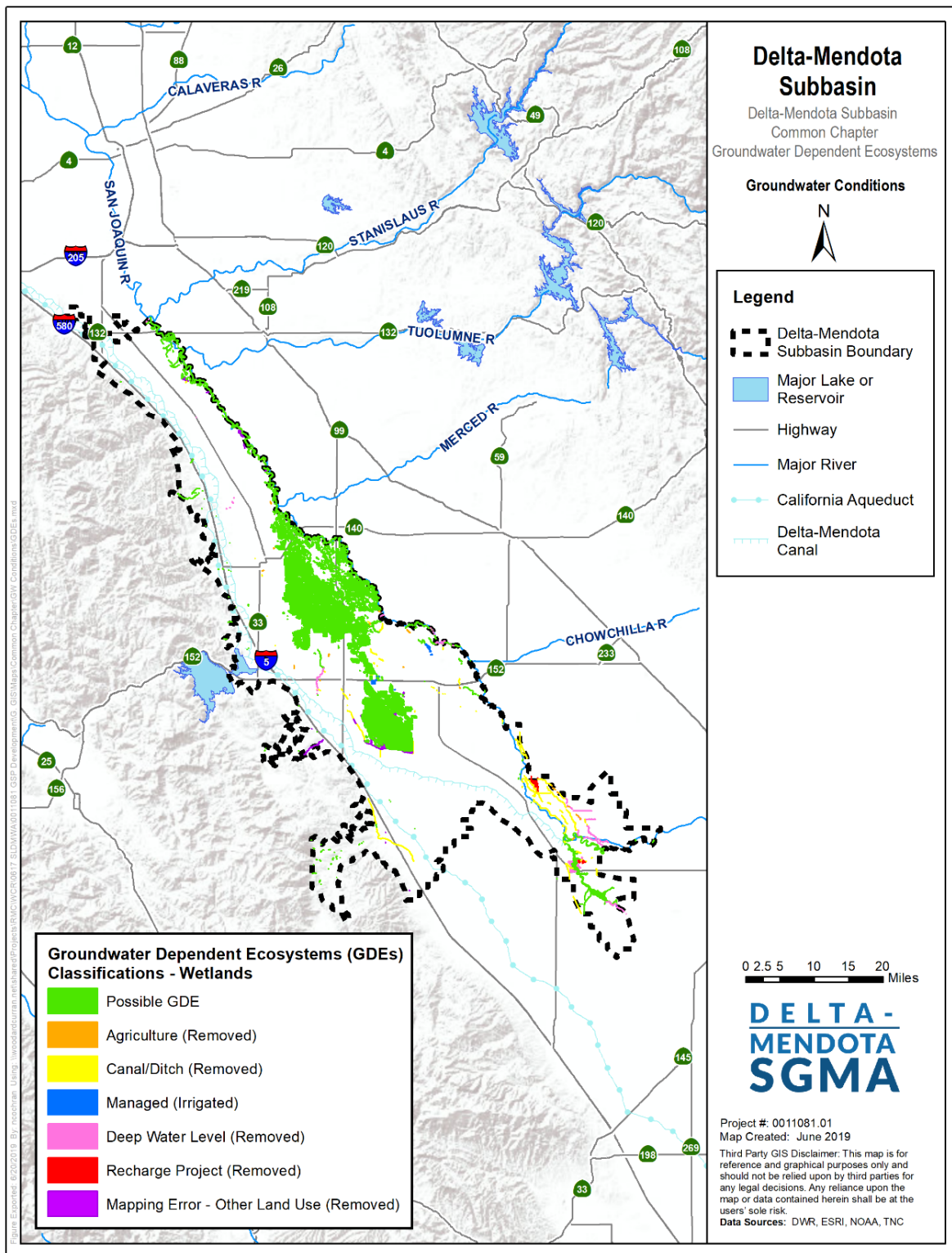


Figure CC-62: Groundwater Dependent Ecosystems, Wetlands

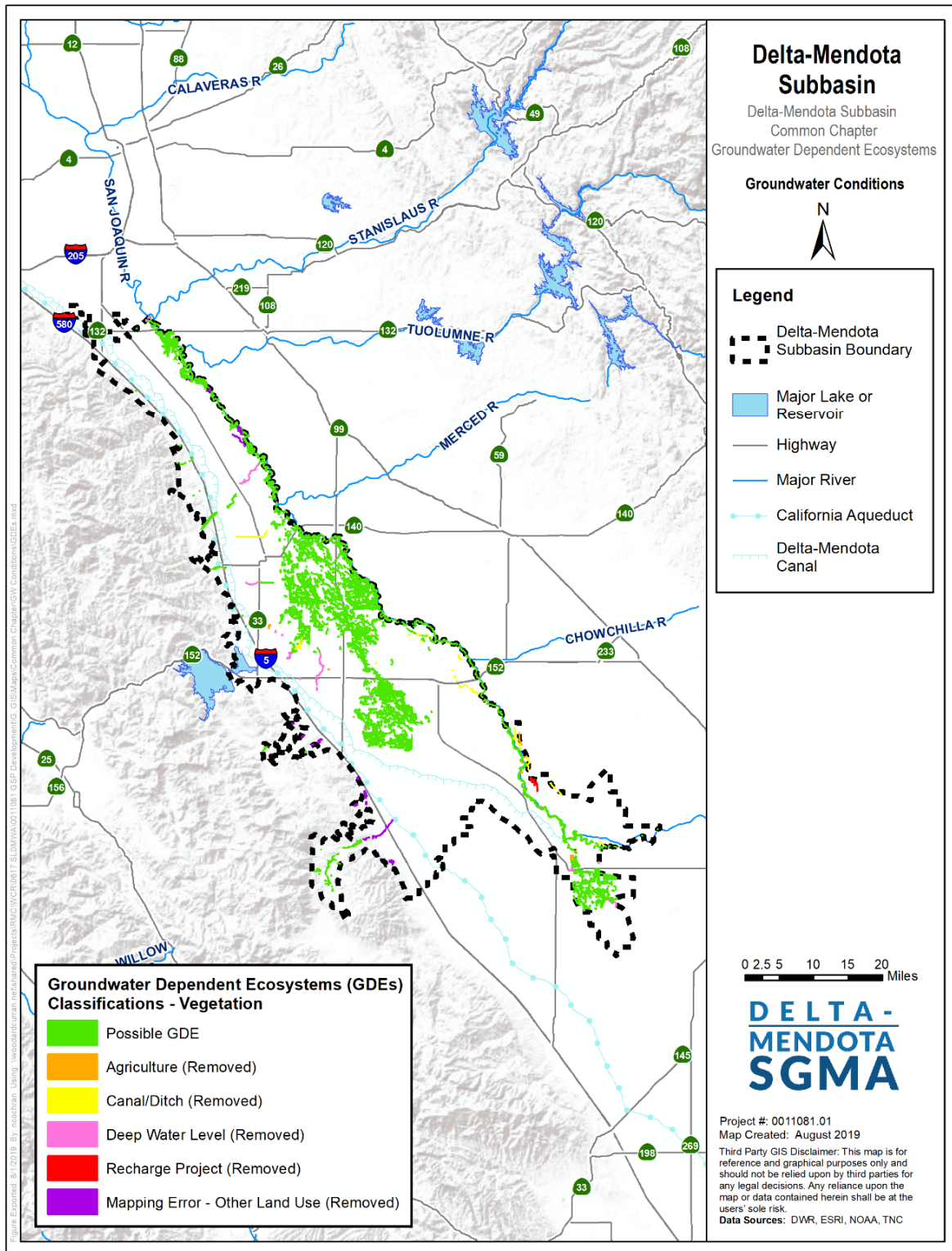


Figure CC-63: Groundwater Dependent Ecosystems, Vegetation

Table CC-7: List of Potential Freshwater Species

Scientific Name	Common Name	Group	Federal Protection Status	State Protection Status
<i>Actitis macularius</i>	Spotted Sandpiper	Birds		
<i>Aechmophorus clarkii</i>	Clark's Grebe	Birds		
<i>Aechmophorus occidentalis</i>	Western Grebe	Birds		
<i>Agelaius tricolor</i>	Tricolored Blackbird	Birds	Bird of Conservation Concern	Special Concern
<i>Aix sponsa</i>	Wood Duck	Birds		
<i>Anas acuta</i>	Northern Pintail	Birds		
<i>Anas americana</i>	American Wigeon	Birds		
<i>Anas clypeata</i>	Northern Shoveler	Birds		
<i>Anas crecca</i>	Green-winged Teal	Birds		
<i>Anas cyanoptera</i>	Cinnamon Teal	Birds		
<i>Anas discors</i>	Blue-winged Teal	Birds		
<i>Anas platyrhynchos</i>	Mallard	Birds		
<i>Ariescrifer albifrons</i>	Greater White-fronted Goose	Birds		
<i>Ardea alba</i>	Great Egret	Birds		
<i>Ardea herodias</i>	Great Blue Heron	Birds		
<i>Aythya affinis</i>	Lesser Scaup	Birds		
<i>Aythya americana</i>	Redhead	Birds		Special Concern
<i>Aythya collaris</i>	Ring-necked Duck	Birds		
<i>Aythya marila</i>	Greater Scaup	Birds		
<i>Aythya valisineria</i>	Canvasback	Birds		Special
<i>Botaurus lentiginosus</i>	American Bittern	Birds		
<i>Bucephala albeola</i>	Bufflehead	Birds		
<i>Bucephala clangula</i>	Common Goldeneye	Birds		
<i>Butorides virescens</i>	Green Heron	Birds		
<i>Calidris alpina</i>	Dunlin	Birds		
<i>Calidris mauri</i>	Western Sandpiper	Birds		
<i>Calidris minutilla</i>	Least Sandpiper	Birds		
<i>Chen caerulescens</i>	Snow Goose	Birds		

Scientific Name	Common Name	Group	Federal Protection Status	State Protection Status
<i>Chen rossii</i>	Ross's Goose	Birds		
<i>Chlidonias niger</i>	Black Tern	Birds		Special Concern
<i>Chroicocephalus philadelphia</i>	Bonaparte's Gull	Birds		
<i>Cistothorus palustris</i>	Marsh Wren	Birds		
<i>Cygnus columbianus</i>	Tundra Swan	Birds		
<i>Cypseloides niger</i>	Black Swift	Birds	Bird of Conservation Concern	Special Concern
<i>Dendrocygna bicolor</i>	Fulvous Whistling-Duck	Birds		Special Concern
<i>Egretta thula</i>	Snowy Egret	Birds		
<i>Empidonax traillii</i>	Willow Flycatcher	Birds	Bird of Conservation Concern	Endangered
<i>Fulica americana</i>	American Coot	Birds		
<i>Gallinago delicata</i>	Wilson's Snipe	Birds		
<i>Gallinula chloropus</i>	Common Moorhen	Birds		
<i>Geothlypis trichas</i>	Common Yellowthroat	Birds		
<i>Grus canadensis</i>	Sandhill Crane	Birds		
<i>Haliaeetus leucocephalus</i>	Bald Eagle	Birds	Bird of Conservation Concern	Endangered
<i>Himantopus mexicanus</i>	Black-necked Stilt	Birds		
<i>Icteria virens</i>	Yellow-breasted Chat	Birds		Special Concern
<i>Limnodromus scolopaceus</i>	Long-billed Dowitcher	Birds		
<i>Lophodytes cucullatus</i>	Hooded Merganser	Birds		
<i>Megaceryle alcyon</i>	Belted Kingfisher	Birds		
<i>Mergus merganser</i>	Common Merganser	Birds		
<i>Mergus serrator</i>	Red-breasted Merganser	Birds		
<i>Numenius americanus</i>	Long-billed Curlew	Birds		
<i>Numenius phaeopus</i>	Whimbrel	Birds		
<i>Nycticorax</i>	Black-crowned Night-Heron	Birds		
<i>Oxyura jamaicensis</i>	Ruddy Duck	Birds		
<i>Pandion haliaetus</i>	Osprey	Birds		Watch list
<i>Pelecanus erythrorhynchos</i>	American White Pelican	Birds		Special Concern

Scientific Name	Common Name	Group	Federal Protection Status	State Protection Status
<i>Phalacrocorax auritus</i>	Double-crested Cormorant	Birds		
<i>Phalaropus tricolor</i>	Wilson's Phalarope	Birds		
<i>Plegadis chihi</i>	White-faced Ibis	Birds		Watch list
<i>Pluvialis squatarola</i>	Black-bellied Plover	Birds		
<i>Podiceps nigricollis</i>	Eared Grebe	Birds		
<i>Podilymbus podiceps</i>	Pied-billed Grebe	Birds		
<i>Porzana carolina</i>	Sora	Birds		
<i>Rallus limicola</i>	Virginia Rail	Birds		
<i>Recurvirostra americana</i>	American Avocet	Birds		
<i>Riparia</i>	Bank Swallow	Birds		Threatened
<i>Setophaga petechia</i>	Yellow Warbler	Birds		
<i>Tachycineta bicolor</i>	Tree Swallow	Birds		
<i>Tringa melanoleuca</i>	Greater Yellowlegs	Birds		
<i>Tringa semipalmata</i>	Willet	Birds		
<i>Tringa solitaria</i>	Solitary Sandpiper	Birds		
<i>Vireo bellii</i>	Bell's Vireo	Birds		
<i>Vireo bellii pusillus</i>	Least Bell's Vireo	Birds	Endangered	Endangered
<i>Xanthocephalus</i>	Yellow-headed Blackbird	Birds		Special Concern
<i>Artemia franciscana</i>	San Francisco Brine Shrimp	Crustaceans		
<i>Branchinecta conservatio</i>	Conservancy Fairy Shrimp	Crustaceans	Endangered	Special
<i>Branchinecta lindahli</i>	Versatile Fairy Shrimp	Crustaceans		
<i>Branchinecta longiantenna</i>	Longhorn Fairy Shrimp	Crustaceans	Endangered	Special
<i>Branchinecta lynchi</i>	Vernal Pool Fairy Shrimp	Crustaceans	Threatened	Special
<i>Lepidurus packardii</i>	Vernal Pool Tadpole Shrimp	Crustaceans	Endangered	Special
<i>Linderiella occidentalis</i>	California Fairy Shrimp	Crustaceans		Special
<i>Oncorhynchus mykiss</i> - CV	Central Valley steelhead	Fishes	Threatened	Special
<i>Oncorhynchus mykiss irideus</i>	Coastal rainbow trout	Fishes		

Scientific Name	Common Name	Group	Federal Protection Status	State Protection Status
Pogonichthys macrolepidotus	Sacramento splittail	Fishes		Special Concern
Actinemys marmorata	Western Pond Turtle	Herps		Special Concern
Ambystoma californiense	California Tiger Salamander	Herps	Threatened	Threatened
Anaxyrus boreas	Boreal Toad	Herps		
Pseudacris regilla	Northern Pacific Chorus Frog	Herps		
Rana boylei	Foothill Yellow-legged Frog	Herps	Under Review in the Candidate or Petition Process	Special Concern
Rana draytonii	California Red-legged Frog	Herps	Threatened	Special Concern
Spea hammondi	Western Spadefoot	Herps	Under Review in the Candidate or Petition Process	Special Concern
Thamnophis atratus	Santa Cruz Gartersnake	Herps		
Thamnophis elegans	Mountain Gartersnake	Herps		
Thamnophis gigas	Giant Gartersnake	Herps	Threatened	Threatened
Thamnophis hammondi	Two-striped Gartersnake	Herps		Special Concern
Thamnophis sirtalis	Common Gartersnake	Herps		
Aeshnidae fam.	Aeshnidae fam.	Insects & other inverts		
Anax junius	Common Green Darner	Insects & other inverts		
Brillia spp.	Brillia spp.	Insects & other inverts		
Callicorixa spp.	Callicorixa spp.	Insects & other inverts		
Capnia hitchcocki	Arroyo Snowfly	Insects & other inverts		
Chironomus spp.	Chironomus spp.	Insects & other inverts		
Coenagrionidae fam.	Coenagrionidae fam.	Insects & other inverts		
Corisella spp.	Corisella spp.	Insects & other inverts		
Cricotopus spp.	Cricotopus spp.	Insects & other inverts		
Ischnura cervula	Pacific Forktail	Insects & other inverts		
Ischnura denticollis	Black-fronted Forktail	Insects & other inverts		
Mesocapnia bulbosa	Bulbous Snowfly	Insects & other inverts		

Scientific Name	Common Name	Group	Federal Protection Status	State Protection Status
<i>Paraleptophlebia associata</i>	A Mayfly	Insects & other inverts		
<i>Paratanytarsus</i> spp.	Paratanytarsus spp.	Insects & other inverts		
<i>Phaenopsectra</i> spp.	Phaenopsectra spp.	Insects & other inverts		
<i>Procladius</i> spp.	Procladius spp.	Insects & other inverts		
<i>Psectrocladius</i> spp.	Psectrocladius spp.	Insects & other inverts		
<i>Tanypus</i> spp.	Tanypus spp.	Insects & other inverts		
Tipulidae fam.	Tipulidae fam.	Insects & other inverts		
<i>Trichocorixa</i> spp.	Trichocorixa spp.	Insects & other inverts		
<i>Castor canadensis</i>	American Beaver	Mammals		
<i>Lontra canadensis</i>	North American River Otter	Mammals		
<i>Neovison vison</i>	American Mink	Mammals		
<i>Ondatra zibethicus</i>	Common Muskrat	Mammals		
<i>Anodonta californiensis</i>	California Floater	Mollusks		Special
<i>Margaritifera falcata</i>	Western Pearlshell	Mollusks		Special
<i>Pyrgulopsis diablensis</i>	Diablo Range Pyrg	Mollusks		Special
<i>Alopecurus saccatus</i>	Pacific Foxtail	Plants		
<i>Ammannia coccinea</i>	Scarlet Ammannia	Plants		
<i>Anemopsis californica</i>	Yerba Mansa	Plants		
<i>Arundo donax</i>	NA	Plants		
<i>Azolla filiculoides</i>	NA	Plants		
<i>Azolla microphylla</i>	Mexican mosquito fern	Plants		Special
<i>Baccharis salicina</i>		Plants		
<i>Bacopa eisenii</i>	Gila River Water-hyssop	Plants		
<i>Bidens laevis</i>	Smooth Bur-marigold	Plants		
<i>Bolboschoenus glaucus</i>	NA	Plants		
<i>Bolboschoenus maritimus paludosus</i>	NA	Plants		
<i>Callitriche marginata</i>	Winged Water-starwort	Plants		
<i>Ceratophyllum demersum</i>	Common Hornwort	Plants		
<i>Chloropyronmoescle hispidum</i>		Plants		Special
<i>Chloropyron palmatum</i>	NA	Plants	Endangered	Special

Scientific Name	Common Name	Group	Federal Protection Status	State Protection Status
Cotula coronopifolia	NA	Plants		
Crassula aquatica	Water Pygmyweed	Plants		
Crypsis vaginiflora	NA	Plants		
Cyperus erythrorhizos	Red-root Flatsedge	Plants		
Cyperus squarrosus	Awed Cyperus	Plants		
Downingia bella	Hoover's Downingia	Plants		
Downingia pulchella	Flat-face Downingia	Plants		
Echinodorus berteroi	Upright Burhead	Plants		
Elatine brachysperma	Shortseed Waterwort	Plants		
Elatine californica	California Waterwort	Plants		
Eleocharis acicularis	Least Spikerush	Plants		
Eleocharis atropurpurea	Purple Spikerush	Plants		
Eleocharis coloradoensis		Plants		
Eleocharis macrostachya	Creeping Spikerush	Plants		
Eleocharis montevidensis	Sand Spikerush	Plants		
Eleocharis quadrangulata	NA	Plants		
Elodea canadensis	Broad Waterweed	Plants		
Epilobium cleistogamum	Cleistogamous Spike-primrose	Plants		
Eragrostis hypnoides	Teal Lovegrass	Plants		
Eryngium castrense	Great Valley Eryngo	Plants		
Eryngium racemosum	Delta Coyote-thistle	Plants		Endangered
Eryngium spinosepalum	Spiny Sepaled Coyote-thistle	Plants		Special
Eryngium vaseyi vallicola		Plants		
Eryngium vaseyi	Vasey's Coyote-thistle	Plants		
Euthamia occidentalis	Western Fragrant Goldenrod	Plants		
Hydrocotyle verticillata	Whorled Marsh-pennywort	Plants		
Juncus acuminatus	Sharp-fruit Rush	Plants		
Juncus xiphioides	Iris-leaf Rush	Plants		

Scientific Name	Common Name	Group	Federal Protection Status	State Protection Status
<i>Lasthenia ferrisiae</i>	Ferris' Goldfields	Plants		Special
<i>Lasthenia fremontii</i>	Fremont's Goldfields	Plants		
<i>Lemna aequinoctialis</i>	Lesser Duckweed	Plants		
<i>Lemna gibba</i>	Inflated Duckweed	Plants		
<i>Lemna minor</i>	Lesser Duckweed	Plants		
<i>Lepidium jaredii</i>	Jared's Peppergrass	Plants		Special
<i>Lepidium oxycarpum</i>	Sharp-pod Peppergrass	Plants		
<i>Limnanthes douglasii</i>	Douglas' Meadowfoam	Plants		
<i>Limosella acaulis</i>	Southern Mudwort	Plants		
<i>Lipocarpa micrantha</i>	Dwarf Bulrush	Plants		
<i>Ludwigia peploides</i>	NA	Plants		
<i>Ludwigia repens</i>	Creeping Seedbox	Plants		
<i>Lythrum californicum</i>	California Loosestrife	Plants		
<i>Marsilea vestita</i>	NA	Plants		
<i>Mimulus cardinalis</i>	Scarlet Monkeyflower	Plants		
<i>Mimulus guttatus</i>	Common Large Monkeyflower	Plants		
<i>Montia fontana</i>	Fountain Miner's-lettuce	Plants		
<i>Myosurus minimus</i>	NA	Plants		
<i>Myosurus sessilis</i>	Sessile Mousetail	Plants		
<i>Myriophyllum aquaticum</i>	NA	Plants		
<i>Najas guadalupensis</i>	Southern Naiad	Plants		
<i>Navarretia heterandra</i>	Tehama Navarretia	Plants		
<i>Navarretia leucocephala</i>	White-flower Navarretia	Plants		
<i>Navarretia prostrata</i>	Prostrate Navarretia	Plants		Special
<i>Neostapfia colusana</i>	Colusa Grass	Plants	Threatened	Endangered
<i>Panicum dichotomiflorum</i>	NA	Plants		
<i>Paspalum distichum</i>	Joint Paspalum	Plants		
<i>Persicaria hydropiperoides</i>		Plants		
<i>Persicaria lapathifolia</i>		Plants		
<i>Persicaria maculosa</i>	NA	Plants		
<i>Persicaria pensylvanica</i>	NA	Plants		

Scientific Name	Common Name	Group	Federal Protection Status	State Protection Status
<i>Phacelia distans</i>	NA	Plants		
<i>Phyla lanceolata</i>	Fog-fruit	Plants		
<i>Phyla nodiflora</i>	Common Frog-fruit	Plants		
<i>Pilularia americana</i>	NA	Plants		
<i>Plagiobothrys acanthocarpus</i>	Adobe Popcorn-flower	Plants		
<i>Plagiobothrys greenei</i>	Greene's Popcorn-flower	Plants		
<i>Plagiobothrys humistratus</i>	Dwarf Popcorn-flower	Plants		
<i>Plagiobothrys leptocladus</i>	Alkali Popcorn-flower	Plants		
<i>Plantago elongata</i>	Slender Plantain	Plants		
<i>Pluchea odorata</i>	Scented Conyza	Plants		
<i>Pogogyne douglasii</i>	NA	Plants		
<i>Pogogyne zizyphoroides</i>		Plants		
<i>Potamogeton diversifolius</i>	Water-thread Pondweed	Plants		
<i>Potamogeton foliosus</i>	Leafy Pondweed	Plants		
<i>Potamogeton nodosus</i>	Longleaf Pondweed	Plants		
<i>Potamogeton pusillus</i>	Slender Pondweed	Plants		
<i>Psilocarphus brevissimus</i>	Dwarf Woolly-heads	Plants		
<i>Psilocarphus oregonus</i>	Oregon Woolly-heads	Plants		
<i>Psilocarphus tenellus</i>	NA	Plants		
<i>Puccinellia simplex</i>	Little Alkali Grass	Plants		
<i>Ranunculus sceleratus</i>	NA	Plants		
<i>Rorippa curvisiliqua</i>	Curve-pod Yellowcress	Plants		
<i>Rorippa palustris</i>	Bog Yellowcress	Plants		
<i>Rotala ramosior</i>	Toothcup	Plants		
<i>Ruppia cirrhosa</i>	Widgeon-grass	Plants		
<i>Ruppia maritima</i>	Ditch-grass	Plants		
<i>Sagittaria longiloba</i>	Longbarb Arrowhead	Plants		
<i>Sagittaria montevidensis calycina</i>		Plants		
<i>Salix exigua</i>	Narrowleaf Willow	Plants		
<i>Salix gooddingii</i>	Goodding's Willow	Plants		

Scientific Name	Common Name	Group	Federal Protection Status	State Protection Status
<i>Schoenoplectus acutus occidentalis</i>	Hardstem Bulrush	Plants		
<i>Schoenoplectus americanus</i>	Three-square Bulrush	Plants		
<i>Sinapis alba</i>	NA	Plants		
<i>Sparganium eurycarpum</i>		Plants		
<i>Stuckenia pectinata</i>		Plants		
<i>Typha domingensis</i>	Southern Cattail	Plants		
<i>Typha latifolia</i>	Broadleaf Cattail	Plants		
<i>Veronica americana</i>	American Speedwell	Plants		
<i>Wolffiella lingulata</i>	Tongue Bogmat	Plants		
<i>Zannichellia palustris</i>	Horned Pondweed	Plants		

Source: The Nature Conservancy (TNC). 2018. Identifying Environmental Surface Water Use--s - Freshwater Species List for Each Groundwater Basin dataset.
<https://groundwaterresourcehub.org/gde-tools/environmental-surface-water-beneficiaries/>

4.2.8 Data Gaps

The Delta-Mendota Subbasin is an extensive subbasin covering a large area extending along the northwestern end of the San Joaquin Valley. While there is a significant amount of data available regarding various groundwater-related aspects of the Subbasin, much is still not known in multiple locations around the Subbasin. To this end, the following data gaps have been identified and will be addressed as part of the interim period between adoption of this GSP and its first 5-year update.

- Information regarding subsidence varies in extent around the region. While there is a large amount of land elevation survey data available in association with the DMC and the San Joaquin River Restoration Program, other areas in the Delta-Mendota Subbasin require additional data collection to both further establish and monitor future land subsidence rates.
- Only three shallow groundwater wells exist proximate to the northern end of the San Joaquin River (outside of the area being addressed by the San Joaquin River Restoration Program). Additional nested or clustered monitoring wells are required adjacent to the river on the northern end of the Subbasin to evaluate horizontal and vertical groundwater gradients, and in connection with river stage monitoring, to assess the interconnection between the San Joaquin River and the northeastern end of the Delta-Mendota Subbasin.
- There are a large number of wells in the Delta-Mendota Subbasin where no well construction information exists or is readily available. Video surveys and other surveys should be conducted on selected wells that may potentially be added to the Subbasin monitoring network to (1) identify where the wells are screened, and (2) determine if the well(s) are appropriate as additions to the GSP Groups' groundwater monitoring programs.
- Mapping of GDEs in the Delta-Mendota Subbasin, as contained in this Common Chapter, is an initial assessment of their location. This mapping may be refined using most recent groundwater elevation/depth to water contour mapping.
- Monitoring networks contained herein are preliminary and were formulated based on existing well information. As additional wells are installed in the Subbasin and additional well construction information is obtained for existing wells, these networks may need to be refined to improve on the spatial (areal and vertical) distribution of monitoring points and the data collected for evaluation of conditions of the groundwater basin.
- The sustainable yield estimates and water budgets contained in this Common Chapter for both the Upper and Lower Aquifers were developed using limited data. As additional data are collected over the first five years, improved sustainable yield estimates and estimates of water in storage in both principal aquifers should be prepared utilizing the new data.

In addition to these Subbasin-level data gaps, additional data gaps have been identified for each GSP Plan Area. Please see the individual GSPs for additional identified data gaps.

4.3 Delta-Mendota Subbasin Water Budgets

This section describes the common coordinated assumptions agreed upon and utilized by each GSP Group in the Delta-Mendota Subbasin in developing the historical, current, and projected water budgets for their respective GSP Plan Areas. These coordinated historical, current, and projected water budgets were then compiled to prepare the subbasin-level water budgets required under the GSP Regulations §

357.4(b)(3)(B), presented below. The sustainable yield for the Upper Aquifer and Lower Aquifer developed at the Subbasin-level and agreed upon by all GSP Groups in the Delta-Mendota Subbasin is also presented along with a description as to how the sustainable yield for each primary aquifer was calculated.

4.3.1 Coordinated Assumptions

All common coordinated assumptions agreed upon and utilized by each GSP Group in preparing their respective historical, current, and projected water budgets are presented in Technical Memoranda 3 (*Assumptions for the Historical, Current, and Projected Water Budgets of the Delta-Mendota Subbasin*), which is included in **Appendix B** of this Common Chapter.

The data and methodologies used to develop the water budgets in the six individual GSPs (and compiled herein as the Subbasin Water Budgets) were coordinated with the express objective to “rely on the best available information and best available science to quantify the water budget for the basin” (Title 23 of the California Code of Regulations [23 CCR] § 354.18(e)). Given the complex nature of the Subbasin, different data sets and methodologies were appropriate for and/or available in different portions of the Subbasin. As such, a significant effort was made by the Subbasin GSAs to: (1) identify the different sources and accuracy of the available data; (2) consolidate these data and associated methodologies into a general hierarchy for use by the GSAs to honor the local conditions, while maintaining consistency with the intent of 23 CCR § 354.18(e); and (3) standardize the terminology for purposes of the Common Chapter presentation of the Subbasin Water Budget. These standardized water budget components and data sources are presented in **Table CC-8** and **Table CC-9** for the historic and current, and projected water budgets, respectively, and are further described below, while acknowledging that significant additional detail is presented in the six underlying GSPs. In some cases, data were not available or applicable, as acknowledged below and in the tables. Additionally, in some cases the specific terminology and/or the details of the calculations included in each underlying GSP remains unique relative to the standardized terminology and descriptions presented below; a full reconciliation of water budget nomenclature will be conducted as part of the 2025 GSP updates, as well as updates to the datasets and methodologies employed. Water use in the Subbasin is largely for agricultural purposes, with local municipal and industrial (M&I) uses. As appropriate, these M&I uses were quantified and incorporated in the individual GSP water budgets.

LAND SURFACE WATER BUDGET

The data sources/methodologies used to estimate the six major components of the Historical and Current Land Surface Water Budgets are summarized in **Table CC-8** and for the Projected Land Surface Water Budgets in **Table CC-9**. A general description of each component and the data hierarchy that was applied by the GSAs is provided below, with further detail provided in the Water Budget sections of the six underlying GSPs. For purposes of the Subbasin GSPs, the Historical and Current Water Budgets represent Water Year (WY) 2003-2013, where the historical period is WY 2003-2012 and the current year is WY 2013. The Projected Water Budgets reflect projected conditions through 2070¹ and consider the impacts

¹ The Subbasin GSAs agreed to use actual data from WYs 2014-2017 and assume a repeat of the historical hydrology for the years WY 2018-2070. The selected period for the projected water budgets meets SGMA requirements by establishing a 50-year period, where the timeframe is continuous between the historic, current, and projected water budgets. The historic hydrologic period for simulating the projected water budget hydrologic

of climate change and projects and management actions (PMAs). To the extent possible the data sources and methodology used were consistent with those identified by the California Department of Water Resources (DWR) in *Table 2 – Potential Data Sources to Support Water Budget Development* and other sections of the Best Management Practices (BMP) –4 - Water Budget.¹ As applicable and available, models and tools (e.g., the Central Valley Hydrologic Model 2 [CVHM2]) were used to support the local sources and assumptions incorporated into the development of the Subbasin Groundwater Water Budget.

- (1) **Precipitation (Inflow).** For the Historical and Current Land Surface Water Budgets, total precipitation across the Subbasin was estimated using either: (1) PRISM: the Precipitation-Elevation Regressions on Independent Slopes Model ([PRISM](#)); (2) CIMIS: area-weighted data from the California Irrigation Management Information System ([CIMIS](#)) stations located in the Subbasin; California Data Exchange Center (CDEC) and/or (3) data from the National Water Service Station located in Los Banos, CA. Total precipitation was further parsed into effective and non-effective precipitation, as applicable to each GSP area, based on assumptions regarding deep percolation percentages and other losses.

For the Projected Land Surface Water Budgets, for WY 2014-2017, actual data were provided consistent with the process described above for the Historical and Current Water Budgets. For the projected WY 2018-2070 period, the 2030 Central Tendency and 2070 Central Tendency [climate change factors and guidance provided by DWR](#) were applied to the historical precipitation record to project the impact of climate change on precipitation across the Subbasin. For example, either (1) the Gridded Statewide Precipitation and Change Factors developed for the Water Storage Investment Program (WSIP) using the Variable Infiltration Capacity (VIC) Macroscale Hydrology Model (DWR, 2018) were applied to the available precipitation data sets for the Subbasin, or (2) recommendations from the [Perspectives and Guidance for Climate Change Analysis](#) document prepared by the DWR Climate Change Technical Advisory Group (CCTAG) were incorporated (DWR CCTAG, 2015).

- (2) **Applied Water – Groundwater (Inflow).** To estimate the volume of applied groundwater for the Historical and Current Land Surface Water Budgets (including both agricultural and M&I pumping, as applicable to each GSP area), the total pumping within the Subbasin was estimated using the following hierarchy of sources, depending upon existing records: (1) Flow meters: volumetric flow meter records from pumping wells; (2) Power bills: electricity bills from pumping wells (wherein information related to the number of kilowatt-hours used was converted to a pumping volume based on assumptions related to pumping lift and efficiency); and/or (3) Consumptive use: reported crop acreages and consumptive use data based on either Irrigation Training and Research Center (ITRC)² Mapping of Evapotranspiration with Internal Calibration ([METRIC](#)) procedure or crop coefficient methodologies (e.g., those provided in the Food and Agricultural Organization of the United States (FAO) Irrigation and Drainage Paper No. 56

schema was chosen as WY 1979-2017, then wrapping around to include WY 1965-1978 hydrology. Actual data and hydrology were used for WY 2014- 2017 with the representative water years simulating WY 2018 and beyond (e.g., WY2018 is represented by the hydrology from WY1979; WY2019 is represented by the hydrology from WY1980, and so forth, with the caveat that 1979 would represent the fifth year of the projection and following sequentially the historical water year 1965 would represent the forty-fourth year of the projection).

¹ https://water.ca.gov/-/media/DWR-Website/Web-Pages/Programs/Groundwater-Management/Sustainable-Groundwater-Management/Best-Management-Practices-and-Guidance-Documents/Files/BMP-4-Water-Budget_ay_19.pdf

² California Polytechnic State University, San Luis Obispo

([FAO-56](#)) (Snyder *et. al.*, 2000, Snyder and Bali, 2008) or the ITRC Crop Coefficient data for Zone 14), corrected as applicable, for applied local and imported surface water. This volume of applied groundwater is consistent with the volume estimated under Water Budget Component (9) Extraction of the Groundwater Water Budget (see below).

For the Projected Land Surface Water Budgets, for WY 2014-2017, actual data were provided, consistent with the process described above for the Historical and Current Water Budgets. For the projected (WY 2018-2070) period, the volume of applied groundwater was estimated using various, complementary methods, including: (1) as the difference between projected demand and the assumed volumes of precipitation, surface water deliveries, and tile drainage available to meet the demand, or (2) assuming future groundwater production rates would be equivalent to historical extractions for a given year type (e.g., future dry year production rates would be equivalent to average dry year production rates over the historical record). Climate change impacts and the effects of the planned projects and management actions (PMAs) are implicitly, rather than explicitly, accounted for (i.e., to the extent that climate change and PMAs increase or decrease the amount of water otherwise available to meet applied water demands, the volume of applied groundwater will be adjusted accordingly). Total inflow to Shasta Lake dictates the amount of imported surface water available for use in the Subbasin. The WSIP model was used to analyze the impacts of climate change on the Subbasin and anticipate projected inflow to Shasta Lake, and as to whether or not the water year would be classified as Shasta Critical under the Exchange Contract, the Refuge Contract, and by municipal users.

- (3) **Surface Water Inflow (Inflow).** Surface water serves as an inflow to Subbasin water budget as both applied surface water and as seepage from streams and rivers. To estimate the volume of applied surface water for the Historical and Current Land Surface Water Budgets, the total diversions within the Subbasin over the historical and current water budget time periods were reported using the best available data for each source. Deliveries from the Central Valley Project (CVP), State Water Project (SWP), the San Joaquin River, and other local streams and rivers were compiled from records from the following sources, including, but not limited to: State Water Resources Control Board (SWRCB) diversion reports; United States Bureau of Reclamation (USBR) Central Valley Operations (CVO); Meyers Water Bank Records; CVP refuge water supply delivery data; and GSA member agency records.

To account for seepage of surface water into the Subbasin from streams and rivers for the Historical and Current Water Budgets, California Data Exchange Center (CDEC) data were used (i.e., by comparing the reductions in measured flow at successive gauging stations after accounting for other diversions) and/or from estimates of seepage losses from certain water bodies from prior water infiltration studies or modeling efforts, as described in the individual GSPs. Seepage from streams and rivers is counted either towards the Groundwater Water Budget directly or towards the Land Surface Water Budget and then, because of the lack of storage capacity in the land surface system and by way of mass balance principles, some or all of this water adds to the Groundwater Water Budget through Water Budget Component (6) Deep Percolation (see below).

For the Projected Land Surface Water Budgets, the volume of applied surface water was estimated as (1) the records of actual delivery data as available for the respective service areas for WY 2014-2017; and (2) estimates of anticipated future deliveries by WY type for WY 2018-2070, inclusive of climate change considerations to the extent they could be reasonably estimated (i.e., directly modeled based on data provided by DWR and the USBR), or using water year types as a proxy (i.e., future dry year deliveries would reflect historical average dry year deliveries over

the historical record). The impacts of planned PMAs on the availability of applied surface water volumes were also incorporated, as applicable.

For the Projected Land Surface Water Budgets, the volume of surface water seepage was adjusted, as applicable and available, based on climate change factors provided by DWR. Changes to surface water seepage were directly estimated as a result of PMAs or other program implementation (e.g., the impact on seepage resulting from the San Joaquin River Restoration Program [SJRRP] implemented by the USBR).

- (4) **Surface Water Outflow (Outflow).** As described above, total precipitation was parsed into effective and non-effective precipitation (i.e., the latter being that portion of the total precipitation that cannot be used by the plants because it either runs off or percolates beyond the root zone). Similarly, a portion of the applied water can run off or deep percolate (typically termed “irrigation inefficiency”). Other surface water outflows (losses) from the Subbasin Land Surface Water Budget include agency-measured or estimated “spills” (i.e., outflow from tile drained fields, canal spills, field runoff, and precipitation runoff) and stream gauge readings, flow meter readings, and transfer pumping data. These collective data sets, sources, and methodologies were used to estimate the historical and current outflows from this component of the Subbasin Land Surface Water Budget.

For the Projected Land Surface Water Budgets, for WY 2014-2017, the data were provided consistent with the process described above for the Historical and Current Water Budgets. For the projected (WY 2018-2070) period, the volume of surface water outflows was estimated based on estimates provided by the GSA member agencies (using water year types as a proxy), while those components that may be impacted by climate change (e.g., runoff) were adjusted to reflect changes to precipitation and reference evapotranspiration (ET_o). Changes to surface water outflows were directly estimated as a result of PMAs or other program implementation (e.g., water conservation programs to reduce spills) as information was available.

- (5) **Evapotranspiration (Outflow).** The largest outflow for the Historical and Current Land Surface Water Budget is evapotranspiration (consumptive use) by crops. As such, a combination of CIMIs ET_o data, crop acreage, and crop coefficient data and methodologies (e.g., ITRC data and methodologies) were utilized to estimate the consumptive use, including municipal uses, of water in the Subbasin. In addition, direct evaporation from surface water bodies and phreatophytes (i.e., groundwater dependent ecosystems [GDEs]) was estimated based on the surface area and time period it was wetted.

For the Projected Land Surface Water Budgets, for WY 2014-2017, the actual data were provided consistent with the process described above for the Historical and Current Water Budgets. For the projected (WY 2018-2070) period, the 2030 Central Tendency and 2070 Central Tendency [climate change factors or guidance provided by DWR](#) were applied to the historical ET_o record to project the impact of climate change on ET_o across the Subbasin. For example, either the Gridded Statewide Precipitation and Change Factors developed for the WSIP using the VIC Macroscale Hydrology Model (DWR, 2018) were applied to the available ET_o data sets for the Subbasin, or (2) recommendations from the [Perspectives and Guidance for Climate Change Analysis](#) document prepared by the DWR CCTAG (2015) were incorporated.

- (6) **Deep Percolation (Outflow).** For the Historical, Current, and Projected Land Surface Water Budgets, this water budget component is estimated as the sum of the other Outflow components (Water Budget Components 4 and 5) of the Land Surface Water Budget subtracted from the sum of the Inflow components (Water Budget Components 1 through 3) and represents the total

volume of water that seeps past the root zone and into the Subbasin aquifer(s). This includes applied water seepage, as well as stream seepage (from the San Joaquin River, Delta-Mendota Canal, and California Aqueduct, and other canals), and delivery losses. To the extent that climate change and PMA implementation affects the volumes of Water Budget Components 1 through 5, these impacts are reflected in the resultant Outflow component, Water Budget Component (6) Deep Percolation, which serves as the inflow component, and Water Budget Component (7) Deep Percolation to the Groundwater Water Budget (see below).

GROUNDWATER WATER BUDGET

The data sources/methodologies used to estimate the Historical and Current Groundwater Water Budgets are summarized in **Table CC-8** and for the Projected Groundwater Water Budgets in **Table CC-9**. A general description of each component and the data hierarchy that was applied by the GSAs is provided below, with further detail provided in the Water Budget sections of the six underlying GSPs. The time periods for the Groundwater Water Budgets are consistent with those used for the Land Surface Water Budgets, and likewise, to the extent possible, the data sources and methodology used were consistent with those identified by DWR in *Table 2 – Potential Data Sources to Support Water Budget Development* and other sections of the BMP-4 - Water Budget.¹ As identified in **Table CC-8** and **Table CC-9**, significant data gaps were identified in several of the GSPs on key aspects of the Groundwater Water Budget; additional efforts are on-going to address those data gaps and refine the water budgets as part of the 2025 GSP update. As applicable and available, models and tools (e.g., CVHM2, Westside Subbasin Groundwater Model, and a numerical flow model for the Farmers Water District and Fresno County areas) were used to validate the local sources and support assumptions used to develop the Subbasin Groundwater Water Budget.

- (7) **Deep Percolation (Inflow).** In all instances, this component of the Groundwater Water Budget is directly linked to the Water Budget Component (6) Deep Percolation of the Land Surface Water Budget. To the extent that climate change is factored into the Historical, Current, and Projected Land Surface Water Budgets, those impacts are reflected in the varying volumes of deep percolation that are assumed to recharge the aquifer system(s) via infiltration.
- (8) **Lateral Subsurface Flow (Inflow).** For the Historical and Current Groundwater Water Budgets, this component is estimated somewhat differently for the Upper and Lower Aquifer portions of the Subbasin.

8A. Upper Aquifer. For the Upper Aquifer, lateral inflows were generally estimated using Darcy's equation² and estimated aquifer characteristics, or a groundwater flow model, as available. Aquifer transmissivity values were compiled from aquifer tests, model parameters and other sources, while observed or simulated water level maps for wet, normal, and dry water year types and hydrographs were prepared to determine the elevation and direction of groundwater flow between GSP areas within the Subbasin and across Subbasin boundaries. Mountain front recharge

¹ https://water.ca.gov/-/media/DWR-Website/Web-Pages/Programs/Groundwater-Management/Sustainable-Groundwater-Management/Best-Management-Practices-and-Guidance-Documents/Files/BMP-4-Water-Budget_ay_19.pdf

² Darcy's equation in which groundwater flow velocity is identified as a function of the aquifer hydraulic conductivity and hydraulic gradient based upon measured water levels and aquifer properties. Freeze, R.A. and Cherry, J.A. 1979. Groundwater. Prentice Hall, Inc. Englewood Cliffs, NJ. p 16.

from the Coastal Range was also assumed to provide an additional source of inflow to the Upper Aquifer.

8B. Lower Aquifer. To the extent possible, lateral inflows to the Lower Aquifer were estimated, primarily using Darcy's equation and estimated aquifer characteristics, and coarse assumptions regarding contributions of other sources of inflow, or via a groundwater flow model, as available. However, this portion of the Groundwater Budget was acknowledged as a significant data gap, which the GSAs are working to address through the collection of additional data, etc.

In instances where there was significant downward flow between the Upper and Lower Aquifers, vertical flow was estimated using Darcy's equation, estimated aquifer characteristics, and groundwater gradients. Aquifer transmissivity values were compiled from aquifer tests, model parameters and other sources, while water level maps for wet, normal, and dry water year types were prepared to determine the elevation and groundwater gradient. Furthermore, flow to the Lower Aquifer from the Upper Aquifer is acknowledged as a data gap.

Projected Groundwater Water Budget. For the Projected Groundwater Water Budgets, for WY 2014-2017, the data were provided consistent with the process described above for the Historical and Current Water Budgets. For the projected (WY 2018-2070) period, this component is generally estimated using historical inflows by water year type as a proxy (i.e., the underflows used in the Historical and Current Water Budgets were averaged by WY type and used throughout the Projected Water Budget period). Impacts of climate change are implicitly incorporated, and expected increases in inflows as a result of PMAs (including projected groundwater banking activities) are directly incorporated to the extent the information was provided by the GSAs. As additional data are obtained during implementation of the GSPs, the inputs will be updated and improved to revise the Projected Groundwater Water Budget.

- (9) **Extraction (Outflow).** Consistent with the methodology used to estimate Water Budget Component (2), Applied Groundwater, of the Historical and Current Land Surface Water Budgets, the total pumping from the Subbasin aquifers was estimated using the following hierarchy of sources depending upon available records: (1) Flow meters: Volumetric flow meter records from pumping wells; (2) Power bills: Electricity bills from pumping wells (wherein information related to the number of kilowatt-hours used was converted to a pumping volume based on assumptions related to pumping lift and efficiency and duration of operation); and/or (3) Consumptive use: crop acreages and consumptive use data based on either ITRC-METRIC or crop coefficient methodologies. While the exact distribution of pumping from the Upper and Lower Aquifers is acknowledged as a data gap, total extractions were assumed to be partitioned between the aquifers, with the majority of extractions (80-90%) occurring in the Upper Aquifer. Information regarding well construction obtained and compiled from the local and Subbasin Well Census and Inventory projects completed by the GSAs in 2022 will be used to further improve the estimated allocation of groundwater extraction between the aquifers in the 2025 GSP update.

For the Projected Groundwater Water Budgets, for WY 2014-2017, the data were provided, consistent with the process described above for the Historical and Current Water Budgets. For the projected (WY 2018-2070) period, the volume of pumped groundwater was estimated using various, complimentary methods, including (1) as the difference between projected demand and the assumed volumes of precipitation, surface water deliveries, and tile drainage available to meet the demand, or (2) assuming future groundwater production would be equivalent to historical extractions for a given year type (e.g., future dry year production rates would be equivalent to average dry year production rates over the historical record, with the exception of M&I pumping which was projected based on information provided in various source documents such as Urban

Water Management Plans). Climate change impacts and the effect of the planned PMAs are implicitly, rather than explicitly, accounted for.

- (10) **Lateral Subsurface Flow (Outflow).** For the Historical and Current Groundwater Water Budgets, this component was estimated somewhat differently for the Upper and Lower Aquifer portions of the Subbasin, but similarly to Water Budget Component (8) of the Groundwater Water Budget.

10A. Upper Aquifer. Lateral outflows were generally estimated using Darcy's equation and estimated aquifer characteristics, and validated by a groundwater flow model, as available. Aquifer transmissivity values were compiled from aquifer tests, model parameters and other sources, while observed or simulated water level maps for wet, normal, and dry water year types and hydrographs were prepared to determine the elevation and direction of groundwater flow between GSP areas within the Subbasin and across Subbasin boundaries.

10B. Lower Aquifer. To the extent possible, lateral outflows from the Lower Aquifer were estimated, primarily using Darcy's equation and estimated aquifer characteristics, and validated by a groundwater flow model, as available. However, this portion of the Groundwater Water Budget was acknowledged as a significant data gap which the GSAs are working to address through the collection and evaluation of additional data, etc.

Projected Groundwater Water Budget. For the Projected Groundwater Water Budgets, for WY 2014-2017, the data were provided, consistent with the process described above for the Historical and Current Water Budgets. For the projected (WY 2018-2070) period, this component is generally estimated using historical outflows by water year type as a proxy (i.e., the underflows used in the Historical and Current Water Budgets were averaged by WY type and used throughout the Projected Water Budget period). Impacts of climate change are implicitly incorporated, and expected increases in outflows as a result of PMAs (including projected groundwater banking activities) are directly incorporated to the extent the information was provided by the GSAs.

- (11) **Change in Storage.** For the Historical and Current Groundwater Water Budgets, this component was estimated somewhat differently for the Upper and Lower Aquifer portions of the Subbasin.

11A. Upper Aquifer. A sum of the Outflow components (Water Budget Components 9 through 10) of the Groundwater Water Budget was subtracted from the Inflow components (Water Budget Components 7 and 8) to assess the change in storage. These estimates were also compared in some of the GSPs to the available hydrographs, water level contour maps, and assumed aquifer storativity values from local data sets and models to assess and confirm change in storage, and assumed consumptive use data.

11B. Lower Aquifer. Approaches varied among the GSPs given the limited available data, which the GSAs are working to address through the collection of additional data, etc. Change in storage was estimated using measured subsidence as a proxy (i.e., due to compaction caused by inelastic land subsidence), as the difference between inflows and outflows based on modeled results, or as an assumed proportion of overall groundwater change in storage. These estimates were also compared in some of the GSPs to the available hydrographs, water level contour maps, and assumed aquifer storativity values from local data sets and models to assess and confirm change in storage, and assumed consumptive use data.

Projected Groundwater Water Budgets. For the Projected Groundwater Water Budgets, for WY 2014-2017, the data were provided, consistent with the process described above for the Historical and Current Water Budgets. For the projected (WY 2018-2070) period, the change in storage volumes used in the Historical and Current Water Budgets were averaged by water year type and used throughout the projected water budget period, or were calculated as the difference between inflows and outflows.

Table CC-8: Historical and Current Water Budgets Data Sources

Water Budget	Flow Direction	Flow Budget Category	Aliso Water District	Farmers Water District	Fresno County	Grassland	Northern & Central Delta-Mendota	San Joaquin River Exchange Contractors
Land Surface	Inflow	Precipitation	Precipitation-Elevation Regressions on Independent Slopes Model (PRISM) and California Irrigation Management Information System (CIMIS)	PRISM		PRISM and CIMIS	PRISM and CIMIS	CIMIS and National Weather Service (NWS)
Land Surface	Inflow	Applied Water - Groundwater	Consumptive use	Flow meters	Flow meters, power bills, and consumptive use	Flow meters and consumptive use		Flow meters
Land Surface	Inflow	Surface Water Inflow	State Water Resources Control Board (SWRCB) diversion reports; landowner records	San Joaquin River inflows	United States Bureau of Reclamation (USBR) Central Valley Operations (CVO); Meyers Water Bank Records	Central Valley Project (CVP) refuge water supply delivery data	USBR CVO and SWRCB diversion reports	USBR CVO; California Data Exchange Center (CDEC) where available, water infiltration study used otherwise
Land Surface	Outflow	Surface Water Outflow	Non-effective precipitation	Transfer pumping and San Joaquin River outflows	Transfer pumping that exceeds applied groundwater	Non-effective precipitation and agency measured spills	Evapotranspiration and non-effective precipitation)	Non-effective precipitation and flow meter readings
Land Surface	Outflow	Evapotranspiration	Vegetation coefficients and CIMIS					
Land Surface	Outflow	Deep Percolation	Land Surface Budget Inflow - Outflow					
Groundwater	Inflow	Infiltration	Land Surface Budget Inflow - Outflow					
Groundwater	Inflow	Lateral subsurface flow - Upper Aquifer	Darcy's equation (groundwater levels and transmissivities)					
Groundwater	Inflow	Lateral subsurface flow - Lower Aquifer	Unused - Data Gap	Darcy's equation (groundwater levels and transmissivities)			Data G-p - Assumed 20% of total inflows.	Darcy's equation (groundwater levels and transmissivities)
Groundwater	Outflow	Extraction - Upper Aquifer	Consumptive use and irrigation efficiency	Flow meters	Flow meters, power bills and consumptive use	Flow meters and consumptive use		Flow meters
Groundwater	Outflow	Extraction - Lower Aquifer	Unused - Data Gap	Flow meters	Flow meters, power bills and consumptive use	Flow meters and consumptive use		Assumed 10% of total pumping
Groundwater	Outflow	Lateral subsurface flow - Upper Aquifer	Darcy's equation (groundwater levels and transmissivities)					
Groundwater	Outflow	Lateral subsurface flow - Lower Aquifer	Unused - Data Gap	Darcy's equation (groundwater levels and transmissivities)				
Groundwater	Change in Storage	Upper Aquifer	Inflow - Outflow					
Groundwater	Change in Storage	Lower Aquifer	Land subsidence as proxy	Inflow - Outflow		Land subsidence as proxy		

Table CC-9: Projected Water Budgets Data Sources

Water Budget	Flow Direction	Flow Budget Category	Aliso Water District	Farmers Water District	Fresno County	Grassland	Northern & Central Delta-Mendota	San Joaquin River Exchange Contractors
Land Surface	Inflow	Precipitation	Precipitation-Elevation Regressions on Independent Slopes Model (PRISM), applying climate change factors (CCF)			PRISM and California Irrigation Management Information System (CIMIS), applying CCF		CIMIS and National Weather Service (NWS), applying CCF
Land Surface	Inflow	Applied Water - Groundwater	Consumptive use			Flow meters and consumptive use		Flow meters
Land Surface	Inflow	Surface Water Inflow	State Water Resources Control Board (SWRCB) diversion reports, using water year (WY) types as a proxy	San Joaquin River inflows (CDEC and United States Geological Survey [USGS])	Mendota Pool inflows - USBR CVO	USBR CVO and SWRCB diversion reports, using WY types as a proxy		USBR CVO; California Data Exchange Center (CDEC) where available, using WY types as a proxy; Water infiltration study used otherwise
Land Surface	Outflow	Surface Water Outflow	Non-effective precipitation calculated with CCF and WY types as a proxy for quantity	San Joaquin River outflows (CDEC and USGS)	Mendota Pool outflows (USBR CVO)	Non-effective precipitation and agency measured spills calculated with CCF and WY types as a proxy for quantity	Non-effective precipitation calculated with CCF and WY types as a proxy for quantity	Non-effective precipitation and agency measured spills calculated with CCF and WY types as a proxy for quantity
Land Surface	Outflow	Evapotranspiration	Vegetation coefficients and CIMIS (calculated with CCFs and WY types as a proxy)					
Land Surface	Outflow	Deep Percolation	Land Surface Inflow - Outflow					
Groundwater	Inflow	Infiltration	Land Surface Budget Inflow - Outflow					
Groundwater	Inflow	Lateral subsurface flow - Upper Aquifer	Darcy's equation (groundwater levels and transmissivities) using WY types as a proxy					
Groundwater	Inflow	Lateral subsurface flow - Lower Aquifer	Unused - Data Gap	Darcy's equation (groundwater levels and transmissivities) using WY types as a proxy			Data Gap - Assumed 20% of total inflows.	Darcy's equation (groundwater levels and transmissivities) using WY types as a proxy
Groundwater	Outflow	Extraction - Upper Aquifer	Consumptive use and irrigation efficiency using WY type as a proxy with CCFs and PMAs	Adjusted historic metered data using WY type as a proxy with CCFs and PMAs		Adjusted historic metered data and consumptive use using WY type as a proxy with CCFs and PMAs		
Groundwater	Outflow	Extraction - Lower Aquifer	Unused - Data Gap	Not Applicable		Unused - Data Gap	Adjusted historic metered data and consumptive use using WY type as a proxy with CCFs and PMAs	
Groundwater	Outflow	Lateral subsurface flow - Upper Aquifer	Darcy's equation (groundwater levels and transmissivities) using WY types as a proxy with CCFs					
Groundwater	Outflow	Lateral subsurface flow - Lower Aquifer	Unused – Data Gap	Darcy's equation (groundwater levels and transmissivities) using WY types as a proxy with CCFs			Data Gap - Assumed 20% of total inflows.	Darcy's equation (groundwater levels and transmissivities) with CCFs
Groundwater	Change in Storage	Upper Aquifer	Inflow - Outflow					
Groundwater	Change in Storage	Lower Aquifer	Unused – Data Gap	Inflow - Outflow		Projected land subsidence and WY types used as a proxy with CCFs and PMAs	Inflow - Outflow	Projected land subsidence and WY types used as proxy with CCFs and PMAs

4.3.2 GSP-Level Water Budgets

Individual historical, current, and projected water budgets were developed by each GSP Group for their respective Plan Area. For more information on the development of those water budgets, as well as tabular and graphical representation of the results, refer to the respective sections of the individual GSPs.

All historical, current, and projected water budgets developed within the Delta-Mendota Subbasin are consistent with GSP Regulations §354.18 Water Budget, and DWR's *Best Management Practices for the Sustainable Management of Groundwater Water Budget BMP* (2016c) document was used when and where applicable at the discretion of each GSP Group.

4.3.3 Coordinated Water Budgets

The land surface budget, groundwater budget, and annual change in storage for the historical water budget, current water budget, and projected water budget with climate change factors (CCFs) and projects and management actions for the Delta-Mendota Subbasin were developed by compiling the water budgets prepared by each of GSP Group. The land surface budget is an accounting of water flows into and out of the land surface above an aquifer within with Delta-Mendota Subbasin, where inflows and outflows include flow between GSP Groups and neighboring subbasins, the atmosphere, and the groundwater aquifer below. The groundwater budget is an accounting of groundwater flows into and out of the two principal groundwater aquifers (Upper Aquifer and Lower Aquifer) within the Delta-Mendota Subbasin, where inflows and outflows include flow between GSP Groups and neighboring subbasins as well as the above land surface.

Subsequent to the submittal of the Delta-Mendota GSP in January 2022, and in response to the Consultation Initiation Letter (CIL) received from DWR on January 21, 2022 in which DWR stated that, while the same data may have been used in developing the water budgets, the terminology used to describe those data sets were not consistent across the basin, the Delta-Mendota Subbasin GSAs acknowledge additional detail was needed to demonstrate that all water budget components across the six Subbasin GSPs utilize the same data and methodologies. As such, subsequent to receipt of the CIL, the Technical Working Group and Coordination Committee met to identify the specific data used and to develop a consistent terminology for the various water budget components. Additionally, the Technical Working Group attempted to simplify the presentation of the Subbasin water budgets through a reduction in the number of water budget components. The mapping of the original GSP water budget components into the revised simplified coordinated water budget component terminology is discussed in the prior section (Section 4.3.1 of this revised Common Chapter).

After agreeing to the set of common simplified definitions for water budget components, the six Delta-Mendota GSP groups mapped their prior water budget components to the new common definitions. The revised land surface budget and groundwater budget are presented respectively for the historical water budget in **Table CC-10** and **Table CC-11**, for the current water budget in **Table CC-12** and **Table CC-13**, and for the projected water budget with climate change factors and projects and management actions in **Table CC-14** and **Table CC-15**. All categories presented in the land surface budget and groundwater budget tables were agreed upon by all Delta-Mendota GSP Groups, with representatives from each GSP group tasked with filling out these budget tables as appropriate to account for the unique hydrology, land use, and water use within their respective GSP regions. The tables below are simply compilations of the individual GSP water budget data as provided by their respective plan preparers, and no water budget data were modified during the mapping process.

Individual GSAs and agencies in the Delta-Mendota Subbasin understand that the historical, current, and projected water budgets were completed using best available science and data, and efforts were made to use the same data sources throughout the Subbasin where available, though due to variability in data availability throughout the Subbasin, the best available data were used and characterized appropriately. Where data gaps exist, the individual GSAs and agencies intend to conduct the work necessary to substantiate or improve the estimates and assumptions developed for determining their water budgets. Nothing in this part, or in any groundwater sustainability plan adopted pursuant to this part, determines, or alters surface water rights or groundwater rights under common law or any provision of law that determines or grants surface water rights.

Figure CC-64 shows the revised average annual and cumulative change in storage in both principal aquifers under the Subbasin projected water budget (including application of climate change factors and the addition of projects and management actions).