BASIN SETTING

6 INTRODUCTION TO BASIN SETTING

§ 354.12. Introduction to Basin Setting
This Subarticle describes the information about the physical setting and characteristics of the basin and current conditions of the basin that shall be part of each Plan, including the identification of data gaps and levels of uncertainty, which comprise the basin setting that serves as the basis for defining and assessing reasonable sustainable management criteria and projects and management actions. Information provided pursuant to this Subarticle shall be prepared by or under the direction of a professional geologist or professional engineer.

☑ **23 CCR § 354.12**

This section presents information on the Basin Setting for the Delta-Mendota Subbasin. Basin Setting information includes the Hydrogeologic Conceptual Model, Groundwater Conditions, and Water Budget.

7 HYDROGEOLOGIC CONCEPTUAL MODEL

§ 354.14. Hydrogeologic Conceptual Model
(a) Each Plan shall include a descriptive hydrogeologic conceptual model of the basin based on technical studies and qualified maps that characterizes the physical components and interaction of the surface water and groundwater systems in the basin.

☑ 23 CCR § 354.14(a)

This section presents the hydrogeologic conceptual model (HCM) for the Delta-Mendota Subbasin (Basin) Groundwater Sustainability Plan (GSP). As described in the Hydrogeological Conceptual Model Best Management Practices (BMP) document (California Department of Water Resources [DWR], 2016), an HCM provides, through descriptive and graphical means, an understanding of the physical characteristics of an area that affect the occurrence and movement of groundwater, including geology, hydrology, land use, aquifers and aquitards, and water quality. This HCM serves as a foundation for subsequent Basin Setting analysis including water budgets (**Section 9**), monitoring network development (**Section 14**), and the development of sustainable management criteria (**Sections 11** through **13**).

The HCM for the Basin is sourced from information contained in the Revised 2022 GSPs and Common Chapter which themselves were based on information originally published in various reports, including but not limited to: the *Western San Joaquin River Watershed Groundwater Quality Assessment Report* (GAR), (Luhdorff & Scalmanini Consulting Engineers [LSCE] et al., 2015), *Grassland Drainage Area Groundwater Quality Assessment Report* (LSCE, 2016), *and Groundwater Overdraft in the Delta-Mendota Subbasin* (SLDMWA, 2015), as well as various DWR and United States Geological Survey (USGS) reports.

7.1 General Description

§ 354.14. Hydrogeologic Conceptual Model
(b) The hydrogeologic conceptual model shall be summarized in a written description that includes the following:
- *(1) The regional geologic and structural setting of the basin including the immediate surrounding area, as necessary for geologic consistency.*
- *(2) Lateral basin boundaries, including major geologic features that significantly affect groundwater flow.*
- *(3) The definable bottom of the basin.*
- *(4) Principal aquifers and aquitards, including the following information:*
  - *(A) Formation names, if defined.*
  - *(B) Physical properties of aquifers and aquitards, including the vertical and lateral extent, hydraulic conductivity, and storativity, which may be based on existing technical studies or other best available information.*
  - *(C) Structural properties of the basin that restrict groundwater flow within the principal aquifers, including information regarding stratigraphic changes, truncation of units, or other features.*
  - *(D) General water quality of the principal aquifers, which may be based on information derived from existing technical studies or regulatory programs.*
  - *(E) Identification of the primary use or uses of each aquifer, such as domestic, irrigation, or municipal water supply.*
- *(5) Identification of data gaps and uncertainty within the hydrogeologic conceptual model*

☑ 23 CCR § 354.14(b)

7.1.1 Regional Geological and Structural Setting

☑ 23 CCR § 354.14(b)(1)

The Basin, designated as DWR Basin No. 5-22.07, is a long and narrow groundwater subbasin (approximately 92 miles long and between 6 and 18 miles wide) within the larger San Joaquin Valley Groundwater Basin, as illustrated in **Figure HCM-1**. The Basin's total area is 1,195 square miles. The San Joaquin Valley, which makes up the southern half of the California Central Valley (also known as the "Great Valley of California"), is a structural trough that extends up to 200 miles long from the Sacramento-San Joaquin River Delta in the north to the Tehachapi and San Emigdio Mountains in the south, and is up to 70 miles wide between the folded and faulted California Coast Range on the west and the Sierra Nevada Mountains on the east. The valley is filled with marine and non-marine (continental) sediments and volcanic detritus deposited as a result of periodic inundation by the Pacific Ocean and erosion of the surrounding mountains, respectively (DWR, 2006). Deposits within the valley extend thousands of feet below current ground surface and are up to 32,000 feet thick (DWR, 2006). Surface waters originating in the Sierra Nevada south of Lake Tahoe and north of Mono Hot Springs flow down the Fresno, Chowchilla, Merced, Tuolumne, Stanislaus, Calaveras, Mokelumne and Consumnes Rivers, along with wet year flows in the Fresno Slough (which carries a portion of flows originating in the Kings River watershed). The rivers converge into the San Joaquin River, which flows northward along the valley's topographic axis towards the Sacramento-San Joaquin River Delta. The depositional axis of the structural trough is located slightly west of the current topographic axis of the valley.

The Central Valley of California transitioned from an oceanic/marine depositional environment to a freshwater system approximately three million years ago due to tectonic movement along the San Andreas Fault System that raised the Coast Ranges, separating the valley from the Pacific Ocean (LSCE, 2015). As a result, continental deposits began to accumulate above the marine sediments already present in the valley, brought in by streams and rivers flowing from the adjacent mountains (Mendenhall et al., 1916). Continental deposits, derived from both the Coast Range and the Sierra Nevada, interfinger within the Basin. Coast Range rock types that are the source for much of the west-side deposits consist of folded and faulted consolidated marine and non-marine sedimentary and crystalline rocks of Jurassic to Tertiary age (Croft, 1972; Hotchkiss & Balding, 1971). Rock types of the Sierra Nevada, that are the source for most continental deposits on the east side of the Central Valley, include pre-Tertiary igneous and metamorphic rocks overlain in the foothills by metamorphosed Tertiary marine and non-marine sedimentary rocks. The continental deposits in the San Joaquin Valley are thicker towards the valley's depositional axis near the San Joaquin River and thinner towards the mountain ranges. Sediment textures are generally coarser towards the mountain ranges, where the energy of the depositional environment is greater, and finer towards the valley axis where deposits of silts and clays formed in low-gradient/energy environments near the San Joaquin River and thinner towards the mountain ranges. Sediment textures are generally coarser towards the mountain ranges, where the energy of the depositional environment is greater, and finer towards the valley axis where deposits of silts and clays formed in low-gradient/energy environments. During the Pleistocene epoch, periodic wet conditions led to the formation of large lakes in the Central Valley resulting in the deposition of thick layers of lake-bed clays which constitute significant regional aquitards and confining layers in the present-day groundwater system.

7.1.2 Lateral Basin Boundaries

☑ 23 CCR § 354.14(b)(2)

The lateral Basin boundaries are defined by both geological and/or natural features and jurisdictional boundaries and were last updated in 2018. To the west, the Basin is bounded by the Tertiary and older marine sediments of the Coast Ranges. The eastern boundary is generally defined by the watercourses of the San Joaquin River and Fresno Slough, though the southern section of the eastern boundary is based on the jurisdictional boundaries of water purveyors within the Basin. The Basin shares borders with all other subbasins within the San Joaquin Valley Hydrologic Region except for the Cosumnes Subbasin. The significant lateral Basin boundary features are shown on **Figure HCM-2** and summarized in **Table HCM-1**.

As shown on **Figure HCM-2**, from west to east, the northern Basin boundary starts by following the Stanislaus County/San Joaquin County line, then shifts northward to encompass the entire Del Puerto Water District before returning to the Stanislaus County/San Joaquin County line. Continuing east, it deviates north again to include all of the West Stanislaus Irrigation District before returning to the Stanislaus County/San Joaquin County line. The boundary extends eastward along this line until it intersects with the San Joaquin River.

The eastern Basin boundary, starting from the northern end at the Stanislaus County/San Joaquin County line, follows the course of the San Joaquin River until it reaches Township 11S (in Madera County), where it shifts eastward along the northern perimeter of the Columbia Canal Company. Continuing along this path, it intersects with the northern boundary of the Aliso Water District. The boundary then turns eastward, tracing the northern and eastern boundaries of the Aliso Water District until it intersects with the Madera County/Fresno County line. It then heads westward along the Madera County/Fresno County line to the eastern boundary of the Farmers Water District. Proceeding south, it follows the eastern boundary of the Farmers Water District before moving southerly along a section line until it meets the Southern Pacific railway lines. It then extends eastward along the railway lines until it intersects with the western boundary of the Mid-Valley Water District. The boundary continues southward along the western boundary of the Mid-Valley Water District until it intersects with the northern boundary of Reclamation District 1606. From this point, it moves westward and then southward, following the boundary of Reclamation District 1606 and James Irrigation District until it meets the boundary of the Westlands Water District.

The southern Basin boundary, from east to west, aligns with the northern boundaries of the Westlands Water District as last revised in 2006. It then extends westward along the southernmost limit of the San Luis Water District until it intersects with the western extent of the Basin.

The western Basin boundary is defined based on the surficial geologic contact between the Plio-Pleistocene continental deposits and the Tertiary and older rocks of the Coast Range mountains.

The valley floor portion of the Basin contains no major faults and is fairly seismically inactive. There are a few faults along the western boundary of the Basin, within the Coast Range mountains, but they are not known to inhibit groundwater flow or impact water conveyance infrastructure. **Figure HCM-3** shows the locations of the O'Neill fault system, Ortigalita fault zone, Panoche Hills fault, and the San Joaquin fault, all of which run parallel to and intersect portions of the western Basin margin.

Table HCM-1. Basin Boundary Description and Type

Boundary	Type	Description
Western	Geologic	Contact between Plio-Pleistocene continental deposits and older Tertiary marine deposits
Northern	Jurisdictional	Stanislaus County/San Joaquin County line, deviating northward to encompass entire Del Puerto Water District and entire West Stanislaus Irrigation District
Northeastern	Watercourse	San Joaquin River
Southeastern	Jurisdictional	Northeastern boundary of Columbia Canal Company; eastern and southern boundaries of Aliso Water District; eastern boundary of Farmers Water District; western boundary of San Luis Water District; western boundary of Reclamation District No. 1606; northern boundary of James Water District
Southern	Jurisdictional	Boundary of Westlands Water District

7.1.3 <u>Bottom of the Basin</u>

☑ **23 CCR § 354.14(b)(3)**

The bottom of the Basin is considered to be the interface between saline ("connate") water of marine origin and fresh groundwater within the uppermost beds of the Tulare Formation. In other words, the definable bottom of the Basin is the base of fresh groundwater, and uses the definition of "Fresh Ground Water" as published by R. W. Page (1973) (Delta-Mendota Groundwater Sustainability Agencies [GSAs], 2022a). Page (1973) defines fresh groundwater as having a maximum specific conductance of 3,000 micromhos per centimeter (µmhos/cm) at 25°C, and while specific conductance and total dissolved solids (TDS) concentrations are not directly related, the 3,000 µmhos/cm specific conductance level is commonly associated with a TDS concentration of approximately 2,000 milligrams per liter (mg/L). The adoption of this definition of the definable bottom of the basin was the result of an agreement reached by the Basin's Technical Working Group and subsequently endorsed by the Delta-Mendota Coordination Committee during a deliberative process spanning from December 2017 to April 2019. It is important to note that if there is substantial utilization of water resources extending beyond/below the defined bottom of the Basin, adjustments to the definition of the bottom of the Basin will be made as necessary.

As shown in **Figure HCM-4**, adapted from Page (1973), the elevation of the base of fresh groundwater in the Basin ranges from approximately -400 to -1,600 feet above mean sea level (ft msl) based on available data. Base of fresh groundwater elevation contours indicate a general pattern of higher elevations to the east, near the course of the San Joaquin River, and lower elevations to the west. In the southeastern portion of the Basin near Tranquillity, the base of fresh groundwater base elevation is as deep as -1,200 ft msl with elevations decreasing to the southwest outside of the Basin towards a local low in the vicinity of Cantua Creek in the Westside Basin. In the vicinity of the City of Firebaugh, the base of fresh groundwater elevation is approximately -400 ft msl. The central and northern portions of the Basin have extensive data gaps with localized exceptions. In the Los Banos area, the base of fresh groundwater ranges in elevation from approximately -400 to 1,000 ft msl, lower towards the west. Near the City of Newman, the base of fresh groundwater occurs at an elevation of approximately -800 ft msl. In the far northern portion of the

Basin, the base of fresh groundwater elevation ranges from approximately -600 ft msl near the San Joaquin River to -1,600 ft msl west of Vernalis.

7.1.4 Principal Aquifers and Aquitards

☑ 23 CCR § 354.14(b)(4)

This section presents information on the principal aquifers and aquitards in the Basin, including formation names, lateral and vertical extents, and hydraulic properties. Principal aquifer characteristics are summarized in **Table HCM-2**. In this discussion, the vertical position of various features (e.g., aquifer or formation contacts) is given at times in elevation (in ft msl) and at other times as depth (in feet below ground surface [ft bgs]), reflecting the various ways that the information is presented in the cited source documents.

According to DWR's Groundwater Glossary (DWR, 2018b), an aquifer is defined as a geological formation composed of rock or sediment that possesses sufficient porosity and permeability to store, transmit, and yield significant or economically viable quantities of groundwater to wells and springs. Within the Basin, two principal aquifers have been defined for purposes of this HCM: “Upper” semi-confined aquifer located above the Corcoran Clay, and a “Lower” confined aquifer situated below the Corcoran Clay.[27] The Corcoran Clay (also known as “E” Clay) is a prominent, regionally extensive aquitard in the San Joaquin Valley and serves as the principal aquitard, or low-permeability layer, within the Basin separating the Upper Aquifer from the Lower Aquifer (Hotchkiss & Balding, 1971). The semi-confined Upper Aquifer typically extends from the ground surface to the upper boundary (or top) of the Corcoran Clay, and the confined Lower Aquifer begins at the lower boundary (or bottom) of the Corcoran Clay and extends to the base of the fresh water. The depth to the top of the Corcoran Clay and the thickness of the Corcoran Clay are shown, respectively, on **Figure HCM-5** and **Figure HCM-6**, and are discussed further below.

While the two-aquifer system described above applies to most of the Basin, there are specific areas within the Basin, mainly along its western margins, where the Corcoran Clay is absent. In these areas, hydrogeological conditions are influenced by localized interfingering clays. Additionally, in the southern part of the Basin, within the Mendota, Aliso, and Tranquillity areas, there are other locally important clay layers (i.e., the “A” and “C” Clay layers) in addition to the Corcoran Clay which may impede vertical groundwater flow (Croft, 1972). The locations and extents of the “A” and “C” Clay layers in the Basin are illustrated in **Figure HCM-7**. The localized presence of the “A” and “C” Clay layers in the southern portion of the Basin, the absence of the Corcoran Clay at the western margin of the Basin, and/or variable local hydrostratigraphy result in differing shallow groundwater conditions and/or perched groundwater conditions in some portions of the Basin. Despite these local complexities, the presence of the Corcoran Clay through a significant portion of the Basin generally establishes a two-aquifer system.

[27] The Upper and Lower aquifers may occasionally be referred to as the “Shallow” and “Deep” aquifers, respectively.

7.1.4.1 Formation Names

☑ 23 CCR § 354.14(b)(4)(A)

The groundwater system in the Basin comprises various geologic units, including the Tulare Formation, terrace deposits, alluvium, and flood-basin deposits.

The Tulare Formation is the most important geologic formation in terms of Basin hydrogeology because it contains the majority of the fresh groundwater. This formation is characterized by alternating layers, lenses, and tongues of clay, sand, and gravel, formed through alternating oxidizing and reducing processes and originating from both the Sierra Nevada and Coast Range sources (Hotchkiss & Balding, 1971). The Tulare Formation is characterized by its blue and green fine-grained rocks, primarily consisting of fine-grained silty sands, silt, and clay (Foss & Blaisdell, 1968). This geological formation is largely attributed to marine origins dating to the late Pliocene and possibly early Pleistocene periods and constitutes the upper shaley segment of the Pliocene sequence.

Within the Tulare Formation, the Corcoran Clay unit acts as a confining layer (Croft, 1972). The Corcoran Clay is a diatomaceous clay or silty clay of lakebed origin with a distinctive grey/blue color due to the reduced conditions under which it was deposited.

Terrace deposits of Pleistocene age are present in some locations, slightly elevated above present streambeds. They consist of silt, sand, and gravel in various shades of yellow, tan, and brown, with a matrix ranging from sand to clay (Hotchkiss & Balding, 1971). Typically, the saturated zone (water table) lies below these terrace deposits, although their relatively coarse texture indicates their potential suitability as sites for augmented recharge.

Alluvium is characterized by poorly to well-sorted mixtures of clay, silt, sand, and gravel, and it is classified based on the extent of dissection and soil formation.

Flood-basin deposits, on the other hand, primarily consist of clay, silt, sand, and organic materials in shades of brown and gray, often containing high salt and alkali concentrations. Additionally, stream channel deposits of coarse sand and gravel are included within this geological composition.

7.1.4.2 Lateral and Vertical Extents of Principal Aquifers

Upper Aquifer

The Upper Aquifer extends from the upper groundwater table to the top of the Corcoran Clay. This aquifer includes both younger and older shallow alluvial deposits, as well as the upper portions of the Tulare Formation. The sediments of the upper Tulare Formation can be divided between units sourced from the eastern and western regions. In the Basin, the alluvial fan deposits situated above the Corcoran Clay are generally more extensive in comparison to the older alluvial fan deposits within the Tulare Formation that lie beneath the Corcoran Clay. **Figure HCM-5** illustrates the depth of the top of the Corcoran Clay in feet below ground surface, showing that the Upper Aquifer reaches depths ranging from approximately 150 feet to over 550 ft bgs.

Additionally, within the upper part of the Tulare Formation in the Basin, other notable clay units include the “A” and “C” Clay members in the southeastern Basin and a white clay unit in the northern Basin

(Hotchkiss & Balding, 1971). The A-clay is situated at elevations ranging from approximately 100 to 160 ft msl. In contrast, the deeper "C" Clay is found at lower elevations, generally ranging from 20 to 100 ft msl, as illustrated in **Figure HCM-7**. A continuous clay layer known as the "White Clay" exists from the northern jurisdictional boundary of the Basin to approximately 10 miles south of Patterson, stretching farther west than the Corcoran Clay layer in this area (Hotchkiss & Balding, 1971). The White Clay varies in thickness from 30 to 60 feet at depths ranging between 100 and 200 ft bgs and serves as a locally effective confining layer.

Lower Aquifer

The Lower Aquifer extends vertically from the part of the Tulare Formation that is confined beneath the Corcoran Clay to the underlying San Joaquin Formation and the boundary where saline water of marine origin is first encountered. Due to its relatively shallow depth within the Basin and the higher groundwater quality, the Lower Aquifer is utilized as a source of groundwater for agricultural and drinking water purposes within the Basin (Delta-Mendota GSAs, 2022a). The lower extent of the Lower Aquifer (i.e., the definable bottom of the Basin; see **Section 7.1.3**) ranges in depth from approximately 1,100 to 1,200 ft bgs in the southern portion of the Basin to around 600 ft bgs in the northern portion (USGS, 1973).

Corcoran Clay

The Corcoran Clay is a regional aquitard throughout most of the Basin and plays a significant role in the Basin's groundwater hydraulics by impeding vertical groundwater flow between the Upper and Lower Aquifers. Across the Central Valley, the Corcoran Clay is encountered at various depths, as illustrated in **Figure HCM-5** (Hotchkiss & Balding, 1971). There is a general trend of the Corcoran Clay deepening towards the south and east. The depth to the upper Corcoran Clay ranges from less than 100 ft bgs near Interstate 5 (I-5) on the western side of the Basin to more than 500 ft bgs in the far southern portion of the Basin near Tranquillity. In the western part of the Basin, particularly near the California Aqueduct, the Corcoran Clay thins out or is located above the water table. In this area, the Upper and Lower Aquifers converge into interbedded layers consisting of sand, gravel, and clay.

The thickness of the Corcoran Clay, a factor that influences the level of hydraulic separation between the Upper and Lower Aquifers, exceeds 50 feet across most of the Basin. In central Basin areas around Los Banos and Dos Palos, it reaches thicknesses of over 75 feet, while in the eastern portions of the Basin it reaches up to 140 feet in thickness. The Corcoran Clay is thinner in the northern half of the Basin between Patterson and Gustine and in the vicinity of Tranquillity to the south, as shown in **Figure HCM-6**. In the westernmost sections of the Basin, the Corcoran Clay layer is either absent or exists as Corcoran-equivalent clays, which are clay layers found at approximately the same depth but are not considered part of the formally mapped aquitard.

Table HCM-2. Principal Aquifers

Characteristic	Upper Aquifer	Lower Aquifer
Geologic Formation(s)	Recent Alluvial Deposits Recent Basin Deposits Tulare Formation	Tulare Formation San Joaquin Formation
Vertical Extent	From the top of the saturated zone to the top of the Corcoran Clay (ranging from approximately 150 to 350 ft bgs)	From the base of the Corcoran Clay to the base of fresh groundwater;
Lateral Extent	Entire Delta-Mendota Subbasin	Entire Delta-Mendota Subbasin
Properties that Restrict Groundwater Flow	Corcoran Clay (below)	Corcoran Clay (above)
General Water Quality	Variable; primarily transitional, some areas with chloride, bicarbonate, and sulfate water types; some areas with high or very high TDS	Variable; predominantly transitional/sulfate type in north, sodium type in south, sulfate-chloride and sulfate-bicarbonate types near valley axis
Primary Use(s)	Irrigated agriculture; municipal supply; domestic supply	Irrigated agriculture; municipal supply; domestic supply

Abbreviations:
TDS = total dissolved solids ft bgs = feet below ground surface

7.1.4.3 Physical Properties of Aquifers and Aquitards

☑ **23 CCR § 354.14(b)(4)(B)**

The following subsections provide information on the general physical properties of aquifers found in the Basin including properties related to their ability to transmit water (hydraulic conductivity and transmissivity) and store water (specific yield and specific storage). Information on hydraulic properties is typically obtained through aquifer pumping tests conducted in wells but can also be derived indirectly from well logs based on empirical relationships between aquifer properties and sediment texture and by the calibration of groundwater flow models. Values for hydraulic conductivity, transmissivity, and storage properties were compiled from available historical documentation and studies conducted for previous GSPs within the Basin, as well as from the Central Valley Hydrologic Model 2 (CVHM2), a numerical groundwater flow model developed by the USGS that includes refinements specific to the Basin.

The CVHM2-based hydraulic property estimates are derived from model parameters for the approximately 1,400 model grid cells covering the entire Basin, and thus provide an indication of Basin-wide values and variability. **Table HCM-3** provides hydraulic property summary statistics of the principal aquifers based on CVHM2 estimates, including median values and ranges based on the 25th and 75th

percentile values; values are rounded to two significant digits. Conversely, previous technical studies from which hydraulic property values were compiled typically focus on specific subareas within the Basin rather than providing full Basin coverage. The sections below discuss both the Basin-wide summary statistics for the values derived from CVHM2, as well as location-specific values from technical studies. Because the available technical studies do not cover all parts of the Basin, the level of discussion of hydraulic property information from technical studies is not consistent throughout the Basin.

Table HCM-3. Hydraulic Properties for Principal Aquifers and the Corcoran Clay

Hydraulic Property	Upper Aquifer	Corcoran Clay	Lower Aquifer
Hydraulic Conductivity	Median: 190 ft/d Range: 110 to 370 ft/d	Median: 0.76 ft/d Range: 0.37 to 2.5 ft/d	Median: 140 ft/d Range: 57 to 370 ft/d
Transmissivity	Median: 46,000 ft^2/d Range: 28,000 to 93,000 ft^2/d	Median: 56 ft^2/d Range: 32 to 130 ft^2/d	Median: 210,000 ft^2/d Range: 85,000 to 550,000 ft^2/d
Specific Storage	Median: 4.9×10^{-4} ft^{-1} Range: 2.4×10^{-4} to 8.9 10^{-4} ft^{-1}	Median: 6.5×10^{-7} ft^{-1} Range: 5.9×10^{-7} to 6.8×10^{-7} ft^{-1}	Median: 5.8×10^{-7} ft^{-1} Range: 5.6×10^{-7} to 6.0×10^{-7} ft^{-1}
Storativity	Median: 0.13 Range: 0.07 to 0.21	Median: 4.23×10^{-5} Range: 3.0×10^{-5} to 5.6×10^{-5}	Median: 8.7×10^{-4} Range: 8.4×10^{-4} to 9×10^{-4}

Abbreviations:
CVHM2 = Central Valley Hydrologic Model version 2
ft = feet
ft/d = feet per day
ft^2/d = feet squared per day

Notes:
1. Aquifer property values shown are derived from the CVHM2 model parameters.
2. Range is based on the 25th to 75th percentile values.

Water Transmission Properties

Groundwater flow through the subsurface occurs within the interconnected pore spaces of the porous medium and is driven by spatial gradients in hydraulic head at rates controlled by the permeability of the medium.

Hydraulic Conductivity

Hydraulic conductivity is a measure of the capacity of rock or sediment to transmit water under a unit hydraulic gradient and is typically correlated to the texture of the unit, with coarser textures leading to greater hydraulic conductivity and finer textures leading to lower hydraulic conductivity.

Hydraulic conductivity estimates derived from CVHM2 indicate that median hydraulic conductivity across the Basin is greater in the Upper Aquifer than in the Lower Aquifer. In the Upper Aquifer, the median value of hydraulic conductivity is 187 feet per day (ft/d) and the range, based on the 25th and 75th percentiles, is between 110 and 365 ft/d. The Lower Aquifer has a median hydraulic conductivity of 140 ft/d and a range between 57 and 367 ft/d. Hydraulic conductivity in the Corcoran Clay layer between these two aquifers is much lower due to the fine, compacted texture of the unit. Median CVHM2 hydraulic conductivity in the Corcoran Clay layer of the Basin is 0.76 ft/d and ranges between 0.37 and 2.47 ft/d based on the 25th and 75th percentiles.

Technical studies providing hydraulic conductivity data from pumping tests are relatively limited in spatial extent and are mostly focused on the southern portion of the Basin. In the area south of Mendota, hydraulic conductivity values determined from multiple pumping tests in the shallow Upper Aquifer zone (above the regional A-clay) range between 50 to 500 feet per day (ft/d), with an average of 230 ft/d. To the northwest of the Fresno County Management Area (FCMA)[28], values in the shallow Upper Aquifer range between 400 to 600 ft/d. Technical studies in this area, as detailed in LSCE (2018), have reported a range of values for the shallow zone (above the A-clay) between 10 to 230 ft/d, with the highest values occurring along the San Joaquin River (150 to 230 ft/d), and the lowest values west of the Fresno Slough and San Joaquin River (10 to 50 ft/d). For the deeper portions of the Upper Aquifer in the northwest portion of the FCMA, the Fresno County Groundwater Sustainability Plan (2022) cites hydraulic conductivity values ranging from 20 to 170 ft/d, with an average of 70 ft/d. Hydraulic conductivity values for the deeper portion of the Upper Aquifer values to the west, near the City of Mendota, range from 50 to 250 ft/d, and values in the northern FCMA range from 30 to 260 ft/d. Technical studies in the FCMA area have reported a range of hydraulic conductivity values between 50 to 330 ft/d with higher values generally occurring in the lower portion of the Upper Aquifer between the "C" Clay and Corcoran Clay (Westlands Water District *et al*., 2018). These studies also indicate that hydraulic conductivity values of the Lower Aquifer generally range from 10 to 100 ft/d, with values near the FCMA in the southern Basin ranging slightly lower between 10 to 50 ft/d.

Transmissivity

Transmissivity relates to an aquifer's ability to convey groundwater throughout its entire saturated thickness and is equal to the product of hydraulic conductivity and the saturated thickness of the aquifer. Transmissivity exhibits significant variation throughout the Basin. Generally, transmissivity of the confined Lower Aquifer is greater due to its greater saturated thickness than that of the semi-confined Upper Aquifer. Transmissivity in the Corcoran Clay layer is affected by both the unit's lower average hydraulic conductivity and the relatively small layer thickness (as compared to the aquifer thicknesses).

With a median saturated thickness of 279 feet in the CVHM2 model, median transmissivity in the Upper Aquifer is approximately 46,000 feet squared per day (ft^2/d), with a range based on the 25th and 75th percentiles of approximately 28,000 to 93,000 ft^2/d. With a median saturated thickness of 1,490 feet in the CVHM2 model, median transmissivity in the Lower Aquifer is approximately 210,000 ft^2/d and with a range of approximately 85,000 to 550,000 ft^2/d. It should be noted that spatial coverage of Lower Aquifer thickness data used by CVHM2 is relatively sparse and the aquifer thickness may be overestimated in some areas, possibly due to inclusion of aquifer materials that are deeper than the base of fresh water; therefore, the transmissivity values for the Lower Aquifer derived from the CVHM2 model thus have a relatively high degree of uncertainty and should be considered alongside other physical parameters. The

[28] The use of the term "management area" in "Fresno County Management Area (FCMA)" reflects the name of the GSA. It does not indicate the use of separate management areas for purposes of groundwater management per 23 CCR § 354.20.

median CVHM2 transmissivity value in the Corcoran Clay layer of the Basin is 56 ft^2/d with a range of 32 to 127 ft^2/d.

Based on hydraulic testing conducted at multiple locations within both the Upper and Lower Aquifers, the average transmissivity in the Subbasin is approximately 109,000 gallons per day per foot (gpd/ft), or 14,600 ft^2/d (San Joaquin River Exchange Contractors [SJREC], 1997), although transmissivity varies significantly. Results from specific technical studies in certain subareas of the Basin are discussed below.

Most of the available technical studies with transmissivity data are for the Upper Aquifer. Transmissivities of the Upper Aquifer from aquifer pumping tests are highly variable across the Basin due to factors including differences in sedimentary depositional environments (e.g., alluvial fans at the mouths of creeks on the west side of the Basin, and Sierran sands found on the eastern portion of the Basin), well construction (i.e., gravel pack versus open-hole wells), and testing conditions (Grassland Water District, 2018). In the southern Basin area near Mendota, transmissivities of Upper Aquifer strata above the A-clay averaged 28,100 ft^2/d (LSCE, 1993)**.** The transmissivity of strata within the Upper Aquifer below the A-clay near Mendota averaged 16,000 ft^2/d. North of Mendota, in the San Joaquin River Exchange Contractors Water Authority (SJRECWA) service area spanning large areas of the central and eastern Basin, transmissivities ranged widely from 4,300 to 67,000 ft^2/d (CCID, 1997). High transmissivities (53,500 to 66,900 ft^2/d) in the SJRECWA area were mainly located in the Crows Landing-Newman area, whereas lower transmissivities (5,000 to 7,900 ft^2/d) were recorded from wells north of Mendota in the Firebaugh area. Transmissivities for various portions of the Upper Aquifer in the SJRECWA area ranged from about 13,400 to 25,400 ft^2/d (Grassland Water District, 2018).

Lower Aquifer pumping tests drawdown measurements performed southwest of Dos Palos, approximately two miles northwest of the Fresno County-Merced County line, resulted in a Lower Aquifer transmissivity estimate of 21,400 ft^2/d (CCID, 1997). In a larger study of the SJRECWA service area, covering the larger central and eastern Basin area, transmissivities of the Lower Aquifer ranged from about 8,000 to 21,400 ft^2/d (Grassland Water District, 2018).

Storage Properties

The volume of water stored within an aquifer system, and how that volume changes in response to an observed change in hydraulic head (i.e., groundwater level) is governed by the aquifer system's storage properties. The three storage properties of interest are the specific yield, which applies to unconfined aquifers (i.e., the Upper Aquifer) where changes in head result in dewatering of the aquifer materials, and specific storage and storativity, which apply to confined aquifers (i.e., the Lower Aquifer) and saturated portions of aquifers where changes in head do not result in dewatering of the aquifer materials.

Specific Yield

Storage properties and behavior for unconfined aquifers are characterized by the aquifer's specific yield (Faunt, 2009). Specific yield is a dimensionless number representing the volume of water released from or taken into storage per unit change in hydraulic head 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. DWR describes the specific yield as the quantity of water that could freely drain from rocks or sediments under the influence of gravity, representing the portion of groundwater potentially available for extraction (DWR, 2006).

Recognizing that there are spatial variations in this storage property, a representative value for specific yield for the Basin as a whole is approximately 0.118 (DWR, 2006). The USGS report by Davis *et al.* (1959) additionally provides specific yield estimates for combined depth intervals between 10 to 200 ft bgs for the Upper Aquifer. Average Upper Aquifer specific yields were estimated as 0.14 for the northern Basin around the Tracy-Patterson area, 0.11 to 0.12 for the area around Los Banos in the central Basin, and 0.09 in the southern Basin around the Mendota-Huron area. More recent estimates of Upper Aquifer specific yield east of Mendota, based on an examination of geologic materials and model calibration for the Farmers Water District historical water budget, range between 0.18 and 0.24 (County of Fresno GSA, 2022; Farmers Water District, 2022). A general specific yield value of 0.12 for the Upper Aquifer was deemed representative by the Grassland GSAs for their area through analysis of USGS data and subsurface geological cross-sections (Grassland GSA and Merced County, 2022).

Specific Storage

Specific storage includes two distinct components: the fluid (water) specific storage and the matrix (skeletal) specific storage, which are governed by the compressibility of the water and of the porous medium skeleton, respectively. Specific storage is expressed in units of inverse length [L^{-1}] and signifies the volume of water that is either released from or taken into storage within a confined flow system per unit change in head per unit volume of the confined flow system (Faunt, 2009).

Based on CVHM2 data, specific storage values are highest in the aquifer materials comprising the Upper Aquifer. Above the Corcoran Clay, specific storage ranges, based on the 25th and 75th percentiles, between 2.44×10^{-4} and 8.92×10^{-4} feet^{-1} (ft^{-1}), with a median value of 4.87×10^{-4} ft^{-1}. In contrast, lower specific storage values are associated with the low-permeability Corcoran Clay and the confined Lower Aquifer located beneath it. The Corcoran Clay specific storage values (derived from CVHM2) are within the range of 5.86×10^{-7} to 6.80×10^{-7} ft^{-1}, with a median value of 6.53×10^{-7} ft^{-1}. Specific storage values below the Corcoran Clay (i.e., in the Lower Aquifer) have a median value of 5.80×10^{-7} ft^{-1} and ranges from 5.61×10^{-7} to 6.04×10^{-7} ft^{-1}.

Storativity

Storage change behavior in confined aquifer systems is determined by storativity, which is the storage coefficient for a confined flow system. Storativity is the product of specific storage [L^{-1}] and aquifer thickness (units of length [L]), is dimensionless, and represents the volume of water released from or taken into storage per unit head change, similar to specific yield.

Using the assumed thicknesses of the aquifers and Corcoran Clay layer from CVHM2, as detailed in the *Transmissivity* section above, median storativity in the Upper Aquifer is estimated at 0.13 with a 25th and 75th percentile range between 0.07 and 0.21. Significantly lower storativity values are reported for the Lower Aquifer in accordance with the relatively small model values for specific storage. Median storativity in the Lower Aquifer is 8.68×10^{-4} and the range is from 8.37×10^{-4} to 9×10^{-4}. Storativity values in the Corcoran Clay layer are of a similar order to the Lower Aquifer values. The median CVHM2 storativity value in the Corcoran Clay layer of the Basin is 4.23×10^{-5} and the range is from 2.97×10^{-5} to 5.57×10^{-5}.

Storativity is measurable by aquifer pumping tests that utilize observation wells, and several technical studies within certain parts of the Basin provide storativity values. Two leaky aquifer tests performed near Mendota determined a storativity range of 7×10^{-4} to 1×10^{-3} of the Upper Aquifer strata below the A-clay in this region (Luhdorff & Scalmanini Consulting Engineers, 1993). Lower Aquifer drawdown measurements performed southwest of Dos Palos, approximately two miles northwest of the Fresno County-Merced County line, determined a Lower Aquifer storativity of 0.001 (CCID, 1997). The Farmers Water District based Lower Aquifer storativity calculations on model calibration to historical conditions in the southern portion of the Delta-Mendota Subbasin and estimated a larger representative value of $4.1x10^{-3}$ (Farmers Water District, 2022). Values ranging from 0.001 to 0.0001 were determined reasonable storativity estimates for the Lower Aquifer by the Aliso Water District GSA (Aliso Water District GSA, 2022).

7.1.4.4 Structural Properties of the Basin that Restrict Groundwater Flow

☑ **23 CCR § 354.14(b)(4)(C)**

Based on **Figure HCM-3** and current and historical groundwater elevation maps, there do not appear to be restrictive structures or features affecting lateral groundwater flow within the Basin (DWR, 2006). Groundwater gradients and flow directions are discussed further in **Section 8.2**.

7.1.4.5 General Water Quality of the Principal Aquifer(s)

☑ **23 CCR § 354.14(b)(4)(D)**

The chemical composition of groundwater in the Basin varies based on location and depth. The general distribution of water types in the Basin aquifer systems, after Bertoldi (1991), are shown in **Figure HCM-8**. This section provides an overview of general water quality within the principal aquifers based on sources including the 2006 update of *California's Groundwater Bulletin 118* for the Basin (DWR, 2006) and historical water quality information documented in Hotchkiss & Balding (1971) and Davis & Poland (1957). A more detailed discussion of the occurrence of specific water quality constituents is provided in **Section 8.5**.

As shown in **Figure HCM-8**, in the northern and central parts of the Basin, groundwater is characterized by mixed sulfate to bicarbonate water types, while the central and southern portions feature areas with sodium chloride and sodium sulfate waters; it should be noted that no specific aquifer (Upper or Lower) is indicated in this characterization (DWR, 2006). Shallow, saline groundwater is found within approximately 10 feet of the ground surface over a substantial portion of the Basin (DWR, 2006). Multiple areas within the Basin exhibit high concentrations of iron, fluoride, nitrate, selenium, or boron (Hotchkiss & Balding, 1971).

Groundwater in the Upper Aquifer is primarily characterized as transitional, meaning no single anion represents greater than 50 percent of the reactive anions and TDS concentrations are variable (Hotchkiss & Balding, 1971). A smaller total area of the Upper Aquifer comprises chloride, bicarbonate, and sulfate water types. Chloride-type waters are found in grassland areas east of Gustine and around Dos Palos, with sodium chloride water present in northern areas near Tracy, extending south to Dos Palos. The salinity of these waters varies greatly, with typical TDS concentrations ranging from less than 500 mg/L to over 10,000 mg/L. Bicarbonate groundwater in the Upper Aquifer is associated with intermittent streams of the Coast Range near Del Puerto, Orestimba, San Luis, and Los Banos Creeks, and generally exhibits lower TDS concentrations. Sulfate water is present in the central and southern Basin areas, with TDS concentrations decreasing from 1,200 mg/L in the west to 700 mg/L in the east toward the San Joaquin River. Areas south of Dos Palos have notably higher TDS concentrations, ranging from 1,900 to 86,500 mg/L (Hotchkiss & Balding, 1971).

Groundwater in the Lower Aquifer below the Corcoran Clay has variable chemical composition, with predominantly transitional sulfate waters in the northern Basin and more sodium-rich water in grassland areas to the south (Hotchkiss & Balding, 1971). The valley margin in the north is primarily sulfate-chloride type and trends toward sulfate-bicarbonate type near the valley axis. TDS concentrations in the Lower Aquifer generally increase moving southward. Groundwater in the Lower Aquifer is often of better quality than that found in the Upper Aquifer, though some exceptions to this water quality can be observed in certain areas of the Basin, particularly in the southwestern region (Davis & Poland, 1957; Hotchkiss & Balding, 1971).

Historically, groundwater in certain parts of the Basin has exhibited naturally high TDS concentrations due to several factors, including the geochemistry of the Coast Range rocks and marine depositional environment, naturally high TDS levels in recharge water from Coast Range streams, dissolvable materials within alluvial fan complexes, and poor drainage conditions that concentrate salts in the system. The chemical composition of waters in the Coast Range streams is closely related to the geological units within their respective catchment areas. Groundwater flowing from these marine and non-marine rocks into streams introduces various dissolved constituents, resulting in diverse groundwater types. The water in westside streams can be highly saline, particularly in the more northern streams like Corral Hollow, Panoche, and Del Puerto Creeks, which contrasts with the typically lower TDS concentrations in streams that drain from the Sierras (Hotchkiss & Balding, 1971). The inflows of water associated with Coast Range sediments has led to naturally high salinity in groundwater within and around the Basin, a phenomenon recognized in the early 1900s (Mendenhall et al., 1916). Properties of the high-TDS water originating from the Coast Range sediments, also known as the Western Saline Front, are further discussed in **Section 8.5**. Soil salinity build-up also occurs due to poorly draining soil conditions and a shallow water table in some southern and eastern areas of the Basin between Tranquillity and Gustine. In some areas near the San Joaquin River, groundwater is influenced by lower-salinity surface water from the east side of the San Joaquin Valley Groundwater Basin (Davis & Poland, 1957).

7.1.4.6 Primary Uses of Each Aquifer

☑ **23 CCR § 354.14(b)(4)(E)**

The primary uses for groundwater extracted from both the Upper and Lower Aquifers are for irrigated agriculture and municipal water supply. Additional groundwater users in the Basin include industry, rural domestic supply, and Groundwater Dependent Ecosystems (GDE). There are an estimated 1,200 domestic, 841 production, and 58 public supply wells within the Basin according to DWR Well Completion Report records with screening assumptions detailed in **Section 5.1.5**. Domestic wells supply water for individual residences or systems of four or less service connections (DWR, 1981). Production wells are designated for irrigation, municipal, public, and industrial purposes and are generally designed to obtain water from productive zones containing good-quality water (DWR, 1991). Public supply wells are those that provide water for human consumption to 15 or more connections or regularly serve 25 or more people daily for at least 60 days out of the year (State Water Resources Control Board [SWRCB], 2023). The density of wells per PLSS section and by type, based on DWR's Well Completion Report database, is shown in **Figure PA-7**.

The distribution of wells by aquifer based on field-verified data compiled by the GSAs is shown on **Figure PA-8** (Upper Aquifer and Lower Aquifer) and **Figure PA-9** (composite [both aquifers], and unknown aquifer). As shown on these figures, the distribution of wells by type and by aquifer varies spatially throughout the Basin. Most of the private domestic supply wells in the Basin are screened in the Upper Aquifer, while most municipal production wells are screened in the Lower Aquifer. Production wells for irrigated agriculture have been constructed with screens in the Upper Aquifer, the Lower Aquifer, and with composite screens. The highest density of production wells for irrigated agriculture in the Upper Aquifer is in the southeast portion of the Basin near the communities of Mendota and Firebaugh. Agricultural production wells in the Upper Aquifer are also found in the northern portion of the Basin near the City of Patterson, along the northwestern margin north and south of Gustine, and in the Los Banos Area. The highest density of production wells for irrigated agriculture in the Lower Aquifer is in the northern portion of the Basin including the entire area north of Crows Landing, with additional Lower Aquifer wells in the southern portion of the Basin south of Oro Loma and in the far southeast near Tranquillity. A high density of composite wells for irrigated agriculture is located in the far southeast near the boundary with the Madera Subbasin. High densities of unknown aquifer wells are found in that same southeast area as well as in the northern portion of the Basin north of Patterson. Most groundwater pumping in the Basin is from the Upper Aquifer; further details on groundwater pumping rates are provided in the Water Budget discussion in **Section 9**.

7.1.5 Data Gaps and Uncertainty

☑ **23 CCR § 354.14(b)(5)**

The hydrogeology and hydrostratigraphy underpinning the Basin's HCM are generally well understood based on the numerous studies that have been conducted in the area. There is relatively greater uncertainty in the characterization of the Lower Aquifer, compared to the Upper Aquifer, in terms of its thickness, hydraulic properties, and definable bottom. This uncertainty is a natural consequence of the fact that fewer wells have been drilled to the deepest depth zones and therefore spatial data density is necessarily lower. This relatively greater uncertainty in the HCM at deeper depth is not considered a data gap in and of itself, as the available information is sufficient to characterize hydrogeologic conditions for purposes of groundwater management in the depth zones where most of the Basin pumping occurs. To the extent that new wells are drilled in the Lower Aquifer of the Basin in the future, the HCM can be refined to incorporate information collected from those wells, including aquifer properties, significant stratigraphic horizons, and general water quality. Data gaps related to groundwater conditions (i.e., groundwater levels, quality, storage, subsidence, and interconnected surface water) are discussed in **Section 8.9** of this GSP.

7.2 Cross-Sections

§ 354.14. Hydrogeologic Conceptual Model
(c) The hydrogeologic conceptual model shall be represented graphically by at least two scaled cross-sections that display the information required by this section and are sufficient to depict major stratigraphic and structural features in the basin.

☑ **23 CCR § 354.14(c)**

Six representative geologic cross-sections depicting the major stratigraphic and structural features of the Basin were developed for this GSP. The locations of the cross-sections are shown on **Figure HCM-9** along with the point data used to inform their development (discussed below). The cross-sections themselves are depicted on **Figure HCM-10** through **Figure HCM-15**. This section includes a description of the methods and data used to develop the cross-sections and interpretations for each cross-section.

7.2.1 Cross-Section Development

The cross-sections were developed by geospatial analysis of geologic information from well logs and Airborne Electromagnetic (AEM) data throughout the Basin. The two primary data sources used for this analysis, both available through the California Natural Resources Agency Open Data website, are:

1. The set of borehole lithology logs which were compiled by the DWR as supporting data for its Statewide AEM Survey program. Approximately half of the lithologic data are from logs having a verified location accuracy of less than 50 meters and an average lithology description interval length of less than 30 meters. In creating this dataset, each log was digitized and tabulated by DWR with the original lithologic descriptions translated into standardized texture descriptions based on the Unified Soil Classification System (USCS).
2. The DWR AEM Interpreted Survey Data. DWR developed hydrostratigraphic interpretations based on a cluster model analysis of resistivity and coarse fraction data from its AEM surveys. Comparing cluster model rankings (1-5) of AEM Survey Data intervals to nearby boreholes, it was found that clusters 1 and 2 were representative of fines/aquitard, and clusters 3 through 5 were more representative of aquifer materials.

The borehole lithology data (data source 1) and the Interpreted Survey data (data source 2), along with a supplementary set of lithology data in the same format as data source 1 from the Patterson Irrigation District and West Stanislaus Irrigation District area, were imported based on each data point's coordinates into LeapFrog Works (Seequent), a three-dimensional (3-D) geologic modeling platform designed to facilitate development and visualization of 3-D spatial representations of the subsurface, including the distribution of coarse- and fine-grained units. Additional datasets imported in the LeapFrog Works included the Basin boundary, the surface topography from the USGS, and the depth and thickness of the Corcoran Clay after Page (1986).

Once these data were imported into LeapFrog Works, two geologic models were developed using geospatial interpolation techniques. These two models were used together to provide a combination of full spatial coverage and greater detail where possible.

The first geologic model (Model 1) was based on the individual USCS-based texture classifications from the borehole lithology log data (data source 1)[29], consolidated into broad aquifer and aquitard hydrostratigraphic groups as follows:

- Classified as Aquifer: gravel, gravel with fines, sand, and sand with fines.
- Classified as Aquitard: silt & organics and clay.[26]

The second geologic model (Model 2) was based on the AEM Interpreted Survey Data (and the clay layer from the borehole lithology log data[26]) with cluster model values assigned as follows:

[29] The clay USCS-based texture classification in the high-quality lithology log data had varying spatial dependencies on positions and volumes of other layers in Model 1 and was found to align better with borehole data when modeled as part of Model 2.

- Classified as Aquifer: cluster model values 3 through 5.
- Classified as Aquitard: cluster model values 1 and 2.

In Model 1, geologic layers were modeled conservatively (i.e., limited in space) with no background "filler" soil type established and therefore blank areas existed in the model at greater distances from the borehole data. In Model 2, a larger interpolation distance was allowed, and so no blank areas existed. A combination of the two models, with Model 1 superimposed on Model 2, allowed for complete coverage of the broad aquifer/aquitard groups, with greater detail (i.e., USCS-based texture classifications, represented by hatching patterns in the cross-sections) in the vicinity of lithology borehole data.

Six cross-section locations were selected to represent geologic conditions throughout the Basin, as shown in **Figure HCM-9**. These included four cross-sections in a roughly west-southwest/east-northeast (WSW/ENE) orientation (sections A-A', B-B', C-C', and D-D') and two cross-sections in a roughly north-northwest/south-southeast (NNW/SSE) orientation (sections E-E' and F-F'). The four WSW/ENE cross-sections are roughly parallel to the slope of the land surface and extend from the Coast Range foothills on the western Basin margin to the San Joaquin River on the eastern Basin margin, with the exception of section D-D' which begins along the Basin boundary with the Westside Subbasin, approximately 20 miles east of the Coast Range foothills. The two NNW/SSE cross-sections are roughly parallel to the long axis of the Basin, the Coast Range foothills, and the San Joaquin River.

The length of each cross-section varies, with the WSW/ENE sections being generally shorter (as they cut across the narrower dimension of the Basin) and the NNW/SSE sections being longer (as they cut across the longer dimension of the Basin). The cross-sections extend vertically from the land surface elevation to a bottom elevation of -1,000 ft msl. The vertical exaggeration for the WSW/ENE cross-sections is 10x whereas the vertical exaggeration for the longer NNW/SSE sections is 20x.

To aid in visual interpretation, the geologic models use colors to depict the two primary hydrostratigraphic groups – blue for aquifer materials and grey for aquitard materials. Individual textures, where available based on Model 1, are distinguished by fill patterns within each of the two broader groups. The cross-sections show borehole/well log information for locations within a certain distance from each section line (4,000 feet for the four WSW/ENE cross-sections, 500 ft for section E-E' and 1,000 ft for section F-F'), although it should be noted that the interpolation process used considers the entire dataset, not just those logs closest to the section lines. Areas of relatively greater uncertainty in the textures based on the absence of well logs within three miles of the section line are indicated by faded colors on the cross-section; these areas of greater uncertainty are typically along the western edge of the Basin and in the deeper portions of the sections, although in some cases they extend as shallow as approximately 300 ft bgs (i.e., where no deeper borehole logs exist within three miles of the section line). Lastly, the top and bottom depth of the Corcoran Clay unit along each cross-section line were extracted from Page (1986) and are shown by white dashed overlays on the sections.

7.2.2 Cross-Section Descriptions

Cross-Section A-A' (**Figure HCM-10**): Cross-section A-A' is approximately 6.5 miles long and cuts in a WSW/ENE direction through the northern portion of the Basin north of the City of Patterson. The land surface along this section line slopes from west to east, mostly steeply on the western edge of the Basin. In the more gently sloping portion of the section, which comprises the valley floor portion with land surface elevations between 200 ft msl on the west to 50 ft msl on the east, aquifer materials comprising the Upper Aquifer extend from the land surface to elevations of about 50 ft msl in the west and -150 ft msl in the east end, except in the eastern approximately two-miles where clay textures are found from the land surface to depths of approximately 25 to 50 ft bgs. The Corcoran Clay aquitard occurs at a depth of approximately 150 ft bgs throughout the section and is not present over the western approximately one mile of the section. Beneath the Corcoran Clay, aquifer materials comprising the Lower Aquifer are found down to elevations of approximately -800 ft msl, slightly shallower to the east. In the eastern third of the section, clay materials are present for several hundred feet below the defined Corcoran Clay unit. Areas of uncertainty are shallower in the eastern portion due to fewer deep borehole data.

Cross-Section B-B' (**Figure HCM-11**): Cross-section B-B' is approximately 15 miles long and cuts in a WSW/ENE direction through the central portion of the Basin south of Gustine. The land surface along this section line slopes gently from west to east, with the eastern half of the section being essentially flat with land surface elevation of approximately 80 ft msl. At the western end of the section, land surface elevation is approximately 250 ft msl. Aquifer materials comprising the Upper Aquifer extend from the land surface to elevations of about -150 ft msl in the eastern two thirds of the section. In the western third of the section, the upper 100 to 200 ft of the subsurface consists of predominantly fine-grained materials. This fine-grained texture in the west may be due to the fact that the section line does not pass through any alluvial fans from surface water streams. The Corcoran Clay aquitard occurs at depths ranging from approximately 100 to 150 ft bgs in the western portion of the section, deepening to approximately 250 ft bgs in the central portion of the section, and then shallowing to the east to occur at depths of approximately 180 ft bgs. Beneath the Corcoran Clay, aquifer materials comprising the Lower Aquifer are found to elevations of approximately -700 ft msl, slightly shallower to the east, and with greater uncertainty with depth to the west.

Cross-Section C-C' (**Figure HCM-12**): Cross-section C-C' is approximately 18 miles long and cuts in a WSW/ENE direction through the south-central portion of the Basin, passing through Dos Palos on its eastern end. The land surface along this section line slopes west to east, with steeper slopes in the west, and an essentially flat land surface elevation of approximately 110 ft msl in the east. Aquifer materials comprising the Upper Aquifer extend from the land surface to elevations of about -150 ft msl in the eastern half of the section. In the western half of the section, the upper several hundred feet of the subsurface has more fine-grained materials than aquifer materials. Like section B-B', section C-C' is not aligned with the present-day course of any surface water stream, nor does it pass through an alluvial fan, and is thus fine in texture near the western Basin boundary. The top of the Corcoran Clay aquitard occurs at depths of approximately 250 to 300 ft bgs in the western portion of the section where the aquitard is deepest, thickest (i.e., 100 or more feet thick), and at its lowest elevation in the section (i.e., extending down to elevations as low as approximately -280 ft msl). The Corcoran Clay is then encountered at shallower depths of approximately 180 to 230 ft bgs in the eastern portion of the section. Beneath the Corcoran Clay, the subsurface materials consist of fine-grained units in the eastern one third of the section and relatively coarser materials in the western half of the section. A number of Lower Aquifer wells exist in the western portion of the section, likely constructed to these greater depths because of the finer texture and thus lower productivity in the Upper Aquifer in the western portion. To the east, where coarser Upper Aquifer sediments exist, the wells tend to be shallower and therefore relatively greater uncertainty exists with depth to the east due to few deep borehole data.

Cross-section D-D’ (**Figure HCM-13**): Cross-section D-D’ is approximately 10 miles long and cuts in a SW/NE direction through the far southern portion of the Basin, passing Mendota and Tranquillity. As this section does not extend westward to the Coast Range foothills (unlike cross-sections A-A’, B-B’, and C-C’), it does not have a perceptible land surface slope, but rather has a generally flat land surface elevation of approximately 170 ft msl. Within the top 300 to 400 ft bgs, coarse-grained materials are predominant, with some interbedded fine materials present except in the vicinity of the present course of the San Joaquin River beneath which the Upper Aquifer is all coarse-grained. The Corcoran Clay is encountered at depths of approximately 450 ft bgs at the western end of the section (corresponding to approximately -300 ft msl) to approximately 350 ft bgs in the eastern end of the section (approximately -200 ft msl). The Corcoran Clay is approximately 50 ft thick along the line of this section. Below the Corcoran Clay, sediments comprising the Lower Aquifer are coarser in the eastern portion of the section and finer to the west, although a lack of deep borehole data results in greater uncertainty throughout most of the section below the Corcoran Clay.

Cross-Section E-E’ (**Figure HCM-14**): Cross-section E-E’ is approximately 72 miles long and extends along the Basin’s long dimension from the northern Basin boundary near Vernalis to the southern Basin boundary with the Westside Subbasin. The land surface elevation along this section ranges from approximately 75 ft msl at the northern end of the section to over 300 ft msl at the southern end. Relatively high land surface elevations occur where the section line passes closer to the Coast Range foothills about 13 miles from its northern end and where the section line encounters the alluvial fan of Little Panoche Creek near the southern end of the section. The geologic materials in the upper 200 to 300 ft bgs of the section vary horizontally along the section line, with some areas dominated by coarse-grained materials, others by fine-grained materials, and others a mixture of both coarse and fine. This variation appears to be correlated with the depositional environments along the section line, with coarser textures found where the section line crosses the alluvial fans of Del Puerto Creek, Orestimba Creek, Los Banos Creek and Little Panoche Creek. The elevation of the top of the Corcoran Clay aquitard is slightly higher in the northern third of the section (i.e., approximately -50 to -120 ft msl) than in the middle third of the section (i.e., approximately -150 ft msl), but is highest near the southern end of the section (0 to -50 ft msl). Below the Corcoran Clay aquitard unit the geologic materials comprising the Lower Aquifer are also variable along the section line, including both coarse- and fine-grained textures. Relatively greater certainty in the geologic model is found at depth in the far southern end of the section line compared to the central and northern portions, due to a larger amount of deep borehole lithology data in the south.

Cross-Section F-F (**Figure HCM-15**): Cross-section F-F’ is approximately 41 miles long and extends in a northwest/southeast (NW/SE) direction parallel to the Basin’s long dimension along its eastern edge, from the San Joaquin River south of Merced National Wildlife Refuge to the far southern Basin boundary south of Tranquillity. The land surface elevation slopes gradually upwards along the section line, from approximately 100 ft msl at the San Joaquin River to approximately 160 ft msl at the southern end. Aquifer materials comprising the Upper Aquifer tend to be coarse-grained throughout the section, with only limited areas of fine-grained textures. The Corcoran Clay unit decreases in elevation and increases in depth from north to south along the section line, with the top of the unit occurring at approximately -50 to -100 ft msl (approximately 130 to 180 ft bgs) at the northern end of the section to approximately -400 ft msl (approximately 600 ft bgs) at the southern end of the section. Below the Corcoran Clay, the Lower Aquifer along this section line tends to consist of fine-grained materials, with coarse grained materials found only in an approximately 8- to 12-mile-long area near and north of Firebaugh. However, greater uncertainty exists below the Corcoran Clay, especially in the northern portion of the section.

7.3 Physical Characteristics

§ 354.14. Hydrogeologic Conceptual Model
(d) Physical characteristics of the basin shall be represented on one or more maps that depict the following:
(1) Topographic information derived from the U.S. Geological Survey or another reliable source.
(2) Surficial geology derived from a qualified map including the locations of cross- sections required by this Section.
(3) Soil characteristics as described by the appropriate Natural Resources Conservation Service soil survey or other applicable studies.
(4) Delineation of existing recharge areas that substantially contribute to the replenishment of the basin, potential recharge areas, and discharge areas, including significant active springs, seeps, and wetlands within or adjacent to the basin.
(5) Surface water bodies that are significant to the management of the basin.
(6) The source and point of delivery for imported water supplies.

☑ **23 CCR § 354.14(d)**

The following sections present information about the physical characteristics of the Basin, including topography, surficial geology, soil characteristics, recharge and discharge areas, surface water bodies, and the source and point of delivery of imported water supplies.

7.3.1 Topographic Information

☑ **23 CCR § 354.14(d)(1)**

Figure HCM-16 shows the topography within the Basin, in which ground surface elevations range from approximately 30 ft msl to greater than 1,600 ft msl. The lowest elevations are in the northeastern portion of the Basin along the San Joaquin River, and topography in most of the Basin is characterized by near-level terrain across the Central Valley floor, with surface slopes to the east/northeast of generally less than two percent. Elevations increase along the western margin of the Basin along the foothills of the Coast Range mountains, where slopes often exceed six percent. The highest elevations in the Basin are in the upper portions of Little Panoche Creek in the far southwest.

7.3.2 Surficial Geology

☑ **23 CCR § 354.14(d)(2)**

Figure HCM-17 shows the surficial geology within the Basin based on the *Geologic Map of California, San Jose sheet* and *Santa Cruz sheet* (CDMG, 1958) and associated map explanations. The predominant surficial geologic unit covering most of the Basin are Recent deposits of the Great Valley, including predominantly basin deposits (“Qb”) in the northern and eastern portions of the Basin and alluvial fan deposits (“Qf”) in the southern portion and along the western edge where streams originating in the Coast Range mountains flow into the Basin. Directly adjacent to the San Joaquin River are areas of Recent stream channel deposits (“Qsc”). Areas of older (Pleistocene and Plio-Pleistocene) non-marine deposits exist along and adjacent to some of the more significant Coast Range streams and along the mountain front. **Sections 7.1.1** and **7.1.4.1**, respectively, discuss the regional geologic setting and local geology formations.

With respect to surface geomorphology, the Basin exhibits several distinct geomorphic units reflecting unique hydrogeological environments. Within the main valley floor area of the Basin, the two primary geomorphic units are the overflow lands geomorphic unit and the alluvial fans and plains geomorphic unit (SJREC GSA, 2022). The overflow lands geomorphic unit, found in the southeastern part of the Basin, consists of finer-grained floodplain deposits with substantial silt and clay layers formed by episodic flooding in this low-lying area, and is characterized by poorly draining soils and a shallow water table. Conversely, the alluvial fans and plains geomorphic unit which covers much of the Basin's western portion, formed through erosion of continental sediments from adjacent mountain ranges and deposition of coarser textured materials in coalescing alluvial fan structures along the valley's margins. This geomorphic unit is characterized by relatively better drainage conditions. Thick fans of predominantly coarse textures are present along the valley's margins, while the sediment texture generally becomes finer towards the valley's center (Faunt, 2009; Northern and Central Delta-Mendota GSAs, 2022). Due to the smaller streams and watersheds in the Coast Range as compared to the Sierra Nevada, the alluvial features (including alluvial fans) on the west side of the San Joaquin Valley are less developed than those on the east side (Bertoldi et al., 1991).

7.3.3 Soil Characteristics

☑ **23 CCR § 354.14(d)(3)**

Soil map units in the Basin have been mapped by the United States Department of Agriculture (USDA) Natural Resources Conservation Service (NRCS). From the standpoint of water management, the pertinent characteristics of soils include the soils' hydraulic conductivity and their runoff characteristics, as represented by an attribute known as the Hydrologic Soils Group, each of which is discussed below.

7.3.3.1 Soil Hydraulic Conductivity

Soil hydraulic conductivity is intrinsically linked to soil drainage characteristics and hydraulic conductivity (Delta-Mendota GSAs, 2022a). To depict the saturated hydraulic conductivity for each soil map unit within the Basin, soil survey data from the NRCS Soil Survey Geographic Database (SSURGO) were combined using a weighted harmonic mean of these representative layers, as shown in **Figure HCM-18**. The soil profile data presented here typically extend to a depth of six feet or more.

Figure HCM-18 shows how the soils with lower hydraulic conductivity across the southeastern Basin floor from Tranquillity to near Gustine evidence fine-grained floodplain deposits with poor drainage conditions (Fio, 1994; Hotchkiss & Balding, 1971). Tile drains are often implemented in these areas with low hydraulic conductivity soils to remove shallow groundwater from the rooting zone. **Figure HCM-19** shows that the known tile drain locations are found concentrated in the eastern Basin and Grassland Drainage Area to the south. Soils with better drainage are found in the northern and western areas of the Basin except near surface water courses, notably adjacent sections of the San Joaquin River and Los Banos Creek channels. Upland soils, distinguished by coarser textures and their proximity to sediment sources originating from the Coast Range, are predominantly classified as moderately well drained.

Across much of the Central Valley, soils associated with floodplain deposits exhibit relatively low hydraulic conductivity, typically measuring less than 0.5 ft/d. There are localized areas where soils with higher hydraulic conductivity are found, often in proximity to modern and ancient surface waterways and alluvial fan features. Soils formed from the deposition of coarse distributary alluvial fan sediments by Del Puerto

Creek, Orestimba Creek, Los Banos Creek, Ortigalita Creek, Little Panoche Creek, and other ephemeral northeastern creek flows originating from the Coast Ranges exhibit high hydraulic conductivity. These areas are especially prominent along active and inactive stream channels that extend eastward from the fan apex regions along the margins of the Valley Floor, aligning with the current course of the San Joaquin River in the valley axis.

Soils located near the active channel of the San Joaquin River also have relatively greater hydraulic conductivity, with some values exceeding 4.0 ft/d in the area north of Mendota. Linear features of soils with similarly high hydraulic conductivity, aligned in a general northwest-southeast orientation to the north of Dos Palos and Los Banos, are likely attributable to historical depositional processes and paleochannels associated with the floor of the San Joaquin River Valley. In contrast, soils in other areas are generally characterized by relatively lower hydraulic conductivity, although there are exceptions where soils with somewhat higher hydraulic conductivity are identified. These higher conductivity soils are typically mapped across much of the peripheral region to the west of Patterson and Gustine, as well as in localized bands associated with surface watercourses.

7.3.3.2 Hydrologic Soil Groups

The NRCS classifies soils into Hydrologic Soil Groups (USDA-NCRS, 2009), ranging from Hydrologic Soil Group A, which have the lowest runoff and highest infiltration potentials, to Hydrologic Soil Group D which have the highest runoff and lowest infiltration potentials. As shown in **Figure HCM-20**, the prevalent hydrologic soil groups in the Basin primarily comprise soil types C and D. Group C soils typically consist of 20 to 40 percent clay, less than 50 percent sand, and exhibit a range of loamy textures. Group D soils have higher runoff potentials than Group C and consist of more than 40 percent clay, less than 50 percent sand, and feature clayey textures.

7.3.4 Recharge and Discharge Areas

☑ 23 CCR § 354.14(d)(4)

Groundwater recharge and discharge represent additions and subtractions of water to the groundwater system, respectively, as a result of interactions between the Principal Aquifers and surface water, land surface/root zone, and groundwater systems. Recharge includes leakage from surface water in creeks, rivers and reservoirs; deep percolation of precipitation, applied irrigation water (both surface- and groundwater), and return flow from septic systems out of the land surface/root zone; and the exchange of water between groundwater systems as subsurface inflow across the Basin boundaries (interbasin flow). Discharge includes seepage of groundwater into the surface water systems; well extractions for urban, rural farmstead, agriculture, and aquaculture land uses; and subsurface interbasin outflow.

Recharge

Groundwater recharge within the Central Valley predominantly results from the percolation of applied irrigation water and seepage from canals and stream beds, though mountain front recharge along the western boundary contributes some groundwater recharge (Northern and Central Delta-Mendota GSAs, 2022). In some areas with more permeable sandy soil types, including areas within Columbia Canal Company, Aliso Water District, Central California Irrigation District, Del Puerto Water District, and Fresno

County Management Area B near the Mendota Pool, recharge ponds are used to augment aquifer recharge (Delta-Mendota GSAs, 2022a).

In most instances, applied irrigation water and canal and streambed seepage contribute to the recharge of the Upper Aquifer within the Basin. Recharge to the Lower Aquifer via downward percolation is constrained across most of the Basin floor where the Corcoran Clay layer is prevalent, although hydraulic connection between the Upper and Lower Aquifer likely occurs, allowing recharge to the Lower Aquifer where the Corcoran Clay is thin or penetrated by composite wells. The primary areas of recharge to the Lower Aquifer are likely situated in the western margins of the Basin, where percolating water can enter formations that feed the Lower Aquifer. This is particularly evident in the vicinity and west of Los Banos, Orestimba, and Del Puerto Creeks along the western margin of the Basin. The Lower Aquifer also likely receives recharge via the same mechanism on the eastern side of the Central Valley in the Sierra Nevada foothills.

The potential for groundwater recharge on agricultural land is determined by the Soil Agricultural Groundwater Banking Index (SAGBI), which incorporates the five major factors of deep percolation, root zone residence time, topography, chemical constraints, and soil surface conditions. SAGBI data classifies 21 percent (160,248 acres) of the total 744,237 acres of agricultural and grazing land in the Basin as having Excellent, Good, and Moderately Good recharge properties, while 77 percent (571,573 acres) exhibit Moderately Poor, Poor, or Very Poor recharge properties. Because of the extensive agricultural activity in the Basin, it was found that "Modified" SAGBI data better represents groundwater recharge potential of the area. The Modified SAGBI data show relatively greater recharge potentials as it is calculated under the assumption that soils have been or will be tilled to a depth of six feet, which enhances percolation by breaking up fine-grained surface materials. Modified SAGBI data for the Basin is shown in **Figure HCM-21**, displaying large areas of Poor recharge potential in the central-eastern basin, Very Poor recharge potential in the central-southern Basin, and a varied mix of recharge potential properties in the western and northern Basin.

Discharge

Well extractions represent the primary discharges from both the Upper and Lower Aquifers; the locations and uses of wells in the Basin are shown on **Figure PA-8** and **Figure PA-9**. Areas of natural groundwater discharge located within the Basin and the San Joaquin River are characterized by the presence of springs (Northern and Central Delta-Mendota GSAs, 2022). The locations of these historic springs, as identified by the USGS, are depicted in **Figure HCM-22**. The USGS has documented six springs/seeps in their National Hydrograph Dataset, all of which are concentrated in the southwestern corner of the Basin. It is important to note that the springs depicted in this dataset and thus in **Figure HCM-22** do not offer a comprehensive representation of all springs within the Basin.

7.3.5 Surface Water Bodies

☑ **23 CCR § 354.14(d)(5)**

Figure HCM-23 shows the significant surface water features in the Basin. The principal natural surface water feature in the Basin is the San Joaquin River and its tributaries. The San Joaquin River flows northward along the eastern edge of the Basin and defines the northern portion of the eastern Basin boundary. The Mendota Pool is located near the City of Mendota at the confluence of the San Joaquin

River and Fresno Slough (Kings River). On the western side of the Basin, numerous intermittent streams originating in the Coast Range flow east/northeast into the Basin. Most of these intermittent streams do not have channels extending all the way east to the San Joaquin River, exceptions being those channels of Orestimba Creek, Los Banos Creek, and Del Puerto Creek. Most of the flow from other prominent western creeks, such as Quinto Creek, San Luis Creek, Little Panoche Creek, and Ortigalita Creek, experience significant water loss due to infiltration (Hotchkiss & Balding, 1971).

Los Banos Creek, Little Panoche Creek, and San Luis Creek have dams within their respective systems that affect their flows (Delta-Mendota GSAs, 2022a). Los Banos Dam and Reservoir on Los Banos Creek is part of the Central Valley Project (CVP) – San Luis Unit. When flood releases are made from the Los Banos Reservoir, most of the water traverses the Grassland Water District to reach the San Joaquin River, as these flows occur during the wet season that generally coincides with periods of low agricultural and wetland water demand. Little Panoche Dam and Reservoir on Little Panoche Creek is a joint-use facility owned by the USBR and operated and maintained by the DWR which acts as a sediment trap and prevents flooding of the San Luis Canal downstream.

San Luis Reservoir, situated on San Luis Creek along the western boundary of the Basin, is a major reservoir of statewide importance. It serves as an artificial water storage facility for the CVP and California State Water Project. Outflows from the reservoir are directed into the network of federal- and state-operated canals and aqueducts that constitute the Central Valley and State Water Projects.

Surface water use within the Basin primarily relies on water deliveries provided by the CVP and SWP, including from the California Aqueduct (referred to as San Luis Canal in the joint-use area of the California Aqueduct) and the Delta-Mendota Canal, in addition to the San Joaquin River. Both the California Aqueduct and Delta-Mendota Canal run the length of the Basin, transporting water in a southward direction. These two canals generally follow the I-5 corridor in the northern portion of the Basin. South of Los Banos, the Delta-Mendota Canal turns eastward towards Firebaugh and Mendota, whereas the California Aqueduct continues southwards along the western edge of the San Joaquin Valley.

7.3.6 Source and Point of Delivery for Imported Water Supplies

☑ **23 CCR § 354.14(d)(6)**

Imported surface water is, and has been, delivered to the Basin by the CVP and SWP. **Figure HCM-24** shows the sources and points of delivery of imported surface water supplies coming into the Basin. The figure shows the locations of the California Aqueduct and Delta-Mendota Canal, which run along the western boundary of the Basin before the Delta-Mendota Canal diverges eastward and terminates in the southern Basin near Mendota, as well as the jurisdictional areas of the 28 recipient agencies of CVP in the Basin. The following water purveyors in the Basin are San Luis & Delta-Mendota Water Authority Member Agencies and thus receive water from the CVP 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, which bought into the SWP in 1968, is the only recipient of SWP water in the Basin (Delta-Mendota GSAs, 2022a).

Descriptions of the major facilities of the CVP are provided below.

C. W. "Bill" Jones Pumping Plant (Jones Pumping Plant): The Jones Pumping Plant lifts water from the Sacramento-San Joaquin Delta into the Delta-Mendota Canal. Most of the water supplied to the Jones Pumping Plant comes from CVP reservoirs located in northern California. Water is released from these reservoirs and routed across the Sacramento-San Joaquin Delta, predominantly via the Sacramento and San Joaquin Rivers, to the intakes of the pumps. The Plant has six pumps that lift the water about 200 feet from the intake to the headworks of the Delta-Mendota Canal at a maximum flow rate of 5,200 cubic feet per second (cfs).

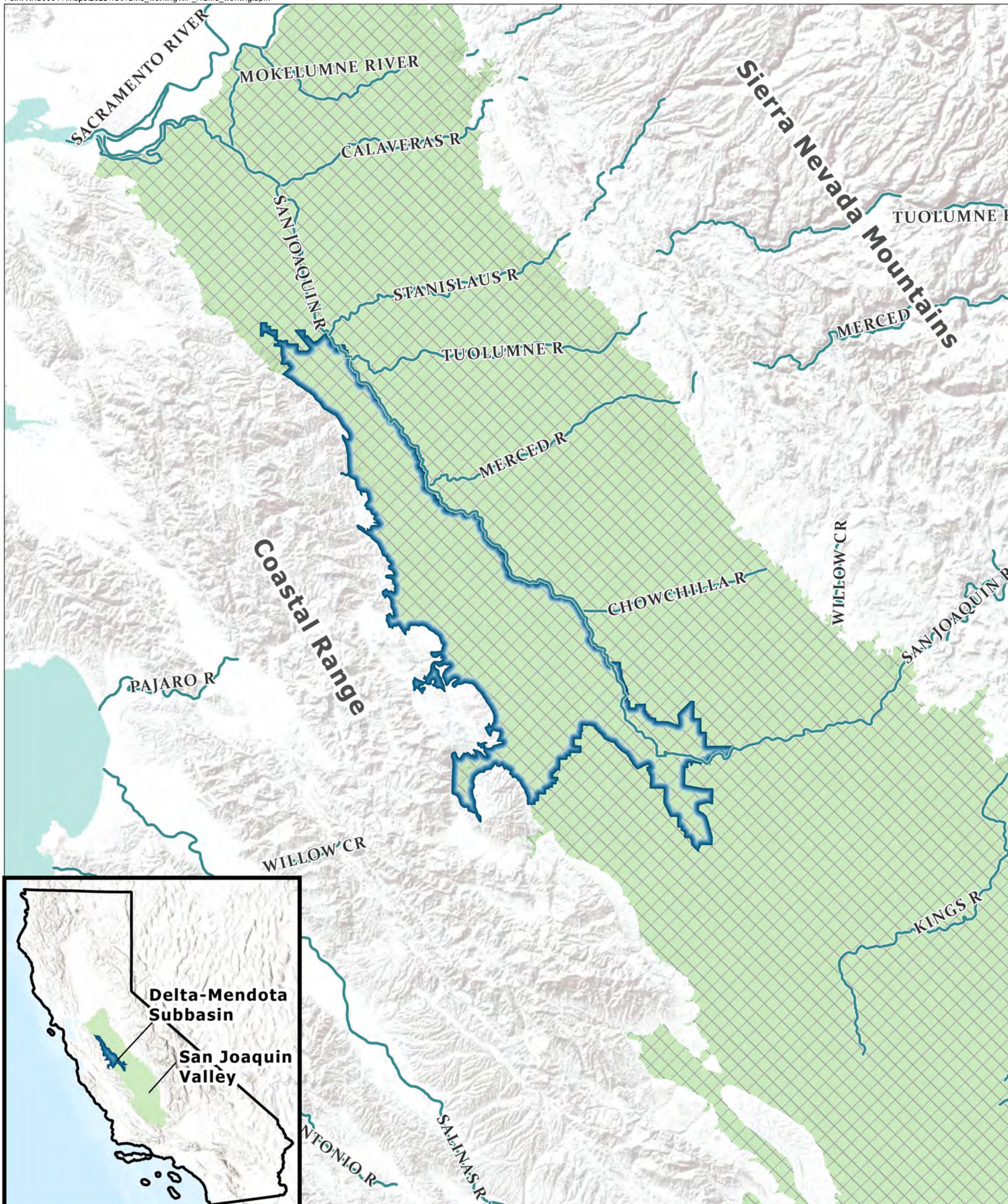
Delta-Mendota Canal (DMC): The headworks of the DMC are at the Jones Pumping Plant. The DMC carries water from Jones Pumping Plant south and terminates at the Mendota Pool. The DMC was completed in 1951 with a capacity of 4,600 cfs at the head that gradually decreases to 3,200 cfs after the 116-mile journey to the Mendota Pool.

*O'Neill Pumping-Generating Plant***:** Located about twelve miles west of the City of Los Banos on the DMC, the O'Neill Pumping Plant connects the DMC to the O'Neill Forebay and ultimately the San Luis Reservoir. This plant was completed in 1968 and is capable of pumping about 3,900 cfs into the O'Neill Forebay and ultimately into the San Luis Reservoir. The O'Neill Plant is also capable of generating power when water is released from the San Luis Reservoir into the O'Neill Forebay and then into the DMC. This facility was constructed along with the State Water Project to allow for storage of water south of the Delta.

San Luis Reservoir and O'Neill Forebay: The SWP received authorization of the Legislature in 1951 to begin construction of a water storage and supply system. One of the projects was a joint venture between the USBR and DWR to construct the California Aqueduct (San Luis Canal), O'Neill Forebay and the San Luis Reservoir to provide additional surface water to agriculture and urban areas south of the Delta. The San Luis Reservoir can store over 2.0 million acre-feet (MAF) shared between the SWP contractors and the CVP contractors.

Mendota Pool: The Mendota Pool is located near the City of Mendota at the confluence of the San Joaquin River and Fresno Slough (Kings River). The Mendota Pool is used for storage and distribution of CVP water, and is also the terminus of the DMC.

Sack Dam: Sack Dam is located on the San Joaquin River downstream of the Mendota Pool and is the headworks where San Luis Canal Company takes delivery of surface water from the San Joaquin River.



Legend

- Delta-Mendota Subbasin (DWR Basin No. 5-022.07)
- San Joaquin Valley
- Major River

Abbreviations

DWR = California Department of Water Resources
R = River
CR = Creek

Notes

1. All locations are approximate.
2. If accommodation or alternative format is needed for this figure, please contact the Plan Manager for assistance.

Sources

1. Basemap is ESRI's ArcGIS Online world topographic map, obtained 8 September 2023
2. DWR Groundwater basins are based on the boundaries defined in California's Groundwater Bulletin 118 - Final Prioritization, dated February 2019.
3. Major water drainage networks from the United States Geological Survey National Hydrography Dataset, obtained 8 September 2023.

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Regional Geologic Setting

Delta-Mendota Subbasin
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Figure HCM-1

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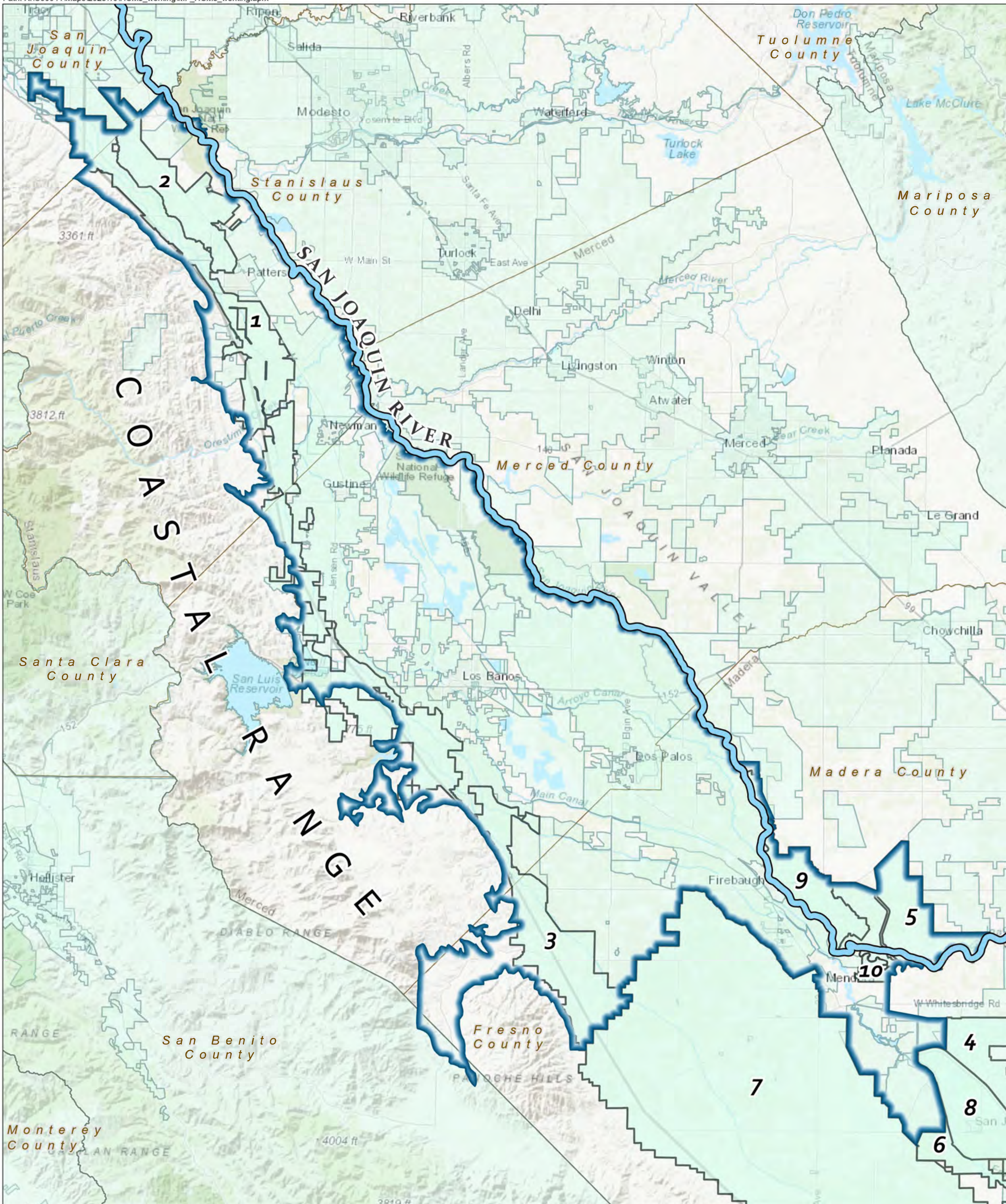

Legend

- San Joaquin River
- Delta-Mendota Subbasin (DWR Basin No. 5-022.07)
- County Boundary
- Water Districts

Boundary-defining Districts

1. Del Puerto Water District
2. West Stanislaus Irrigation District
3. San Luis Water District
4. Mid-Valley Water District
5. Aliso Water District
6. James Irrigation District
7. Westlands Water District
8. Reclamation District No. 1606
9. Columbia Canal Company
10. Farmers Water District

Abbreviations

DWR = California Department of Water Resources

Notes

1. All locations are approximate.
2. If accommodation or alternative format is needed for this figure, please contact the Plan Manager for assistance.

Sources

1. Basemap is ESRI's ArcGIS Online world topographic map, obtained 8 September 2023
2. DWR Groundwater basins are based on the boundaries defined in California's Groundwater Bulletin 118 - Final Prioritization, dated February 2019.
3. Water District boundaries obtained from the California Department of Water Resources, dated February 16, 2022.

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Lateral Basin Boundaries

Delta-Mendota Subbasin
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Figure HCM-2

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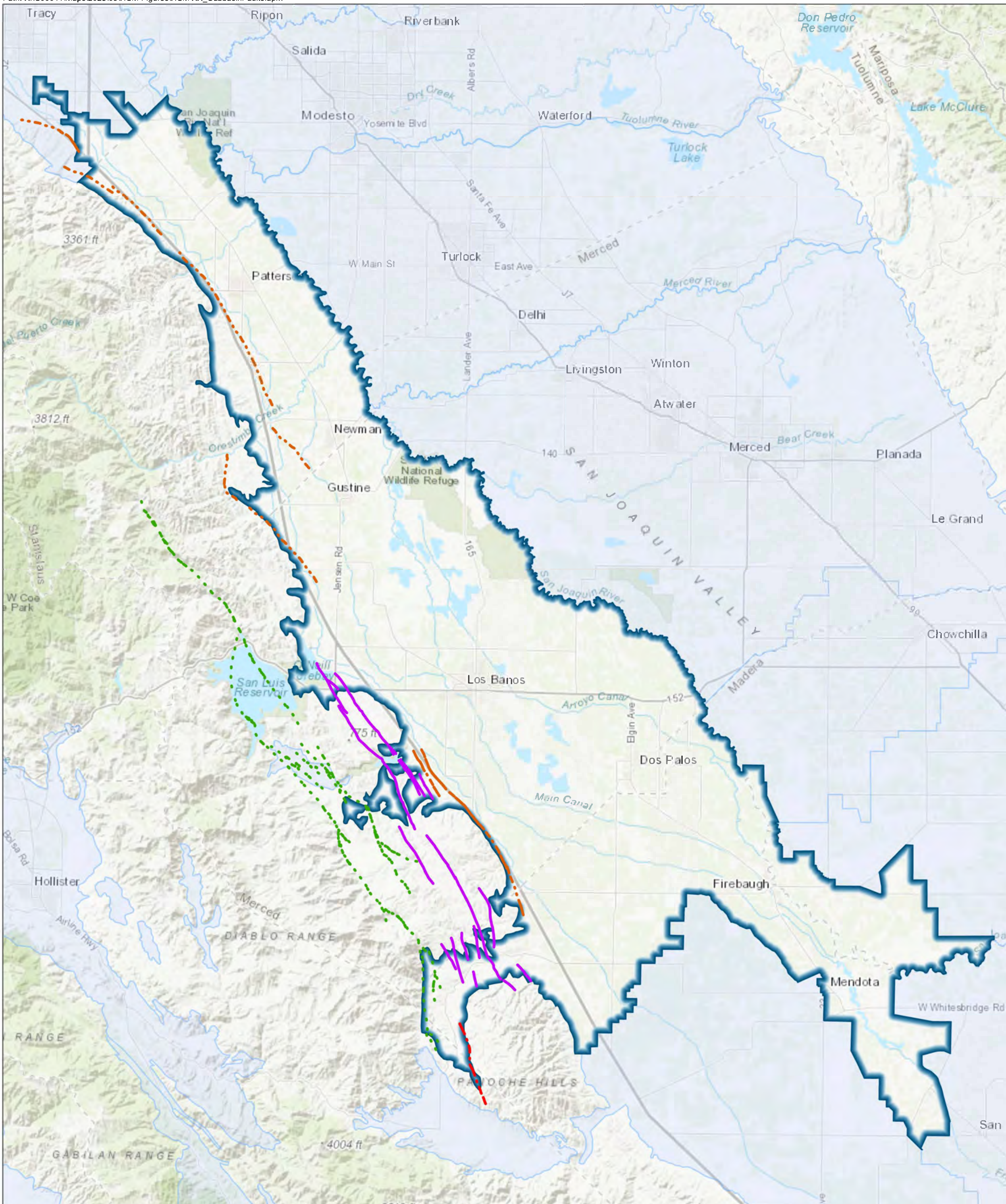

Legend

Delta-Mendota Subbasin (DWR Basin No. 5-022.07)

California Groundwater Basin

Fault

O'Neill fault system

Ortigalita fault zone

Panoche Hills fault

San Joaquin fault

Abbreviations

DWR = California Department of Water Resources

Notes

1. All locations are approximate.
2. If accommodation or alternative format is needed for this figure, please contact the Plan Manager for assistance.

Sources

1. Basemap is ESRI's ArcGIS Online world topographic map, obtained 8 September 2023
2. DWR Groundwater basins are based on the boundaries defined in California's Groundwater Bulletin 118 -Final Prioritization, dated February 2019.
3. Faults layer obtained from the California Department of Conservation, California Geologic Survey, various dates: https://maps.conservation.ca.gov/cgs/#datalist

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Subbasin Faults

Delta-Mendota Subbasin
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Figure HCM-3

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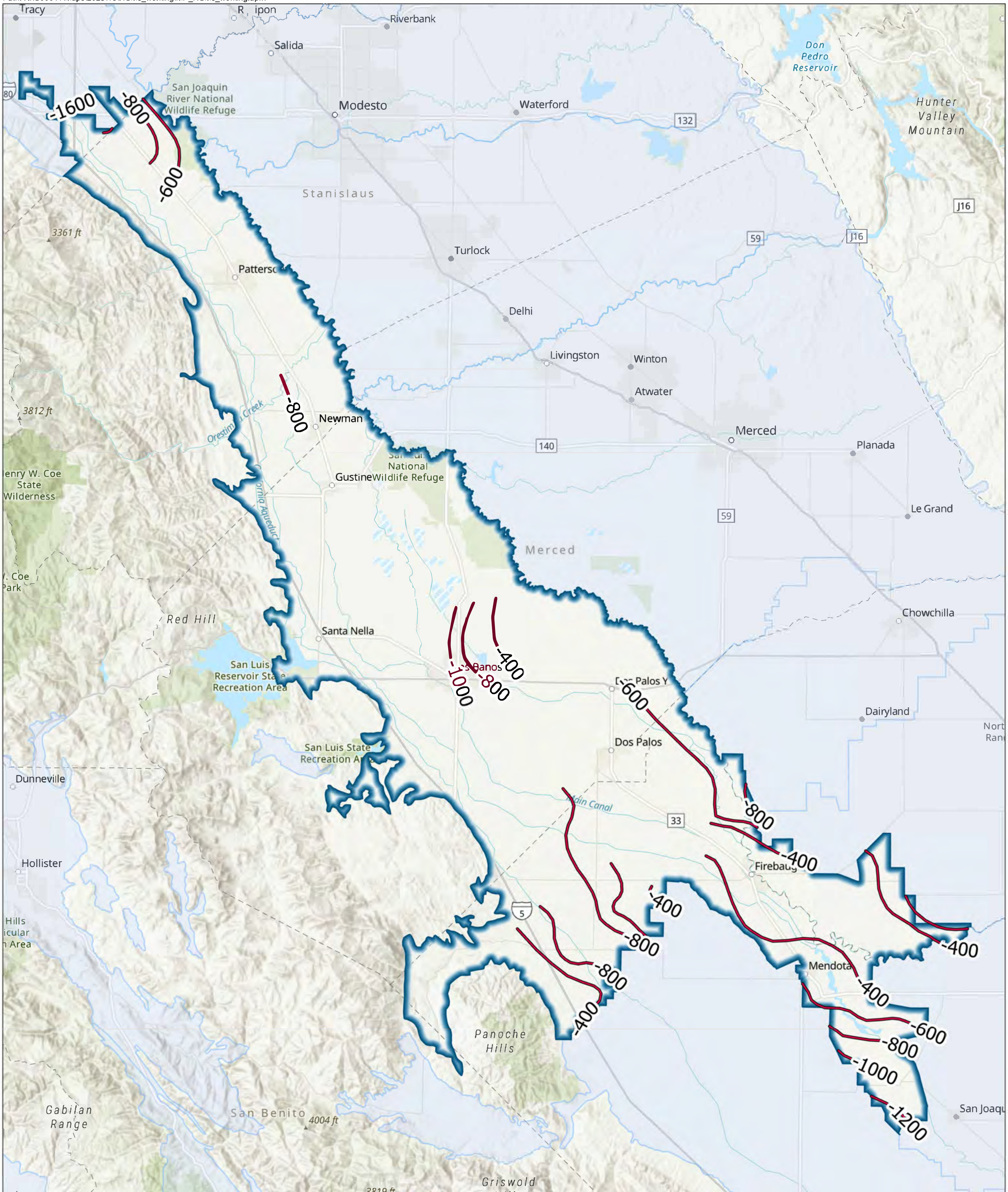

Legend

Delta-Mendota Subbasin (DWR Basin No. 5-022.07)

California Groundwater Basin

Base of Fresh Groundwater Elevation (ft MSL)

Abbreviations

DWR = California Department of Water Resources
ft MSL = feet above Mean Sea Level

Notes

1. All locations are approximate.
2. If accommodation or alternative format is needed for this figure, please contact the Plan Manager for assistance.

Sources

1. Basemap is ESRI's ArcGIS Online world topographic map, obtained 8 September 2023
2. DWR Groundwater basins are based on the boundaries defined in California's Groundwater Bulletin 118 - Final Prioritization, dated February 2019.
2. Base of freshwater contours from: Page, 1973. Base of Fresh Ground Water- Approximately 3,000 micromhos-in the Sacramento Valley and Sacramento-San Joaquin Delta, California.

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Base of Fresh Groundwater

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Delta-Mendota Subbasin
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Figure HCM-4

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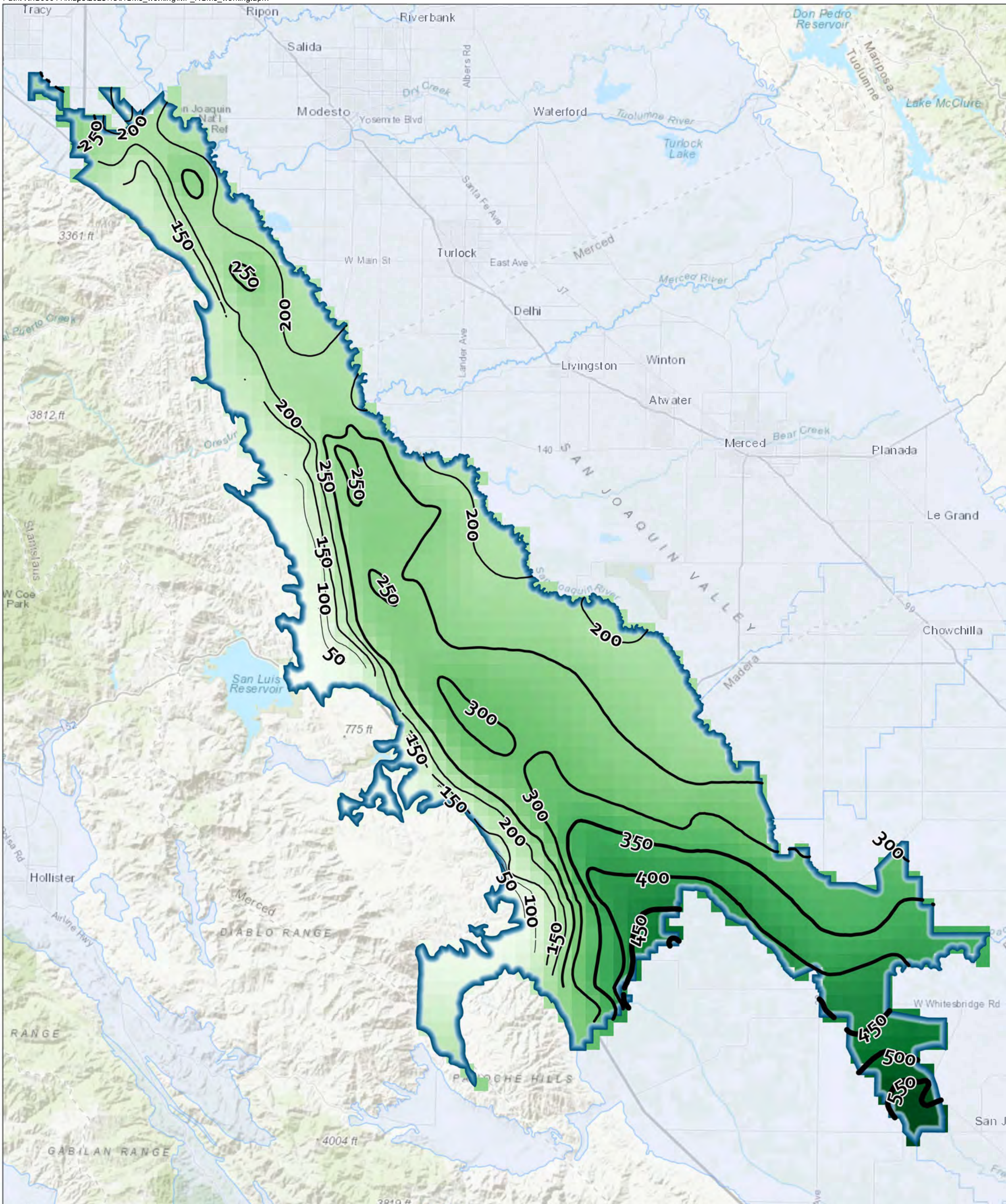

Legend

Delta-Mendota Subbasin (DWR Basin No. 5-022.07)

California Groundwater Basin

Corcoran Clay Depth Below Ground Surface (feet)

600

10

Abbreviations

DWR = California Department of Water Resources

Notes

1. All locations are approximate.
2. If accommodation or alternative format is needed for this figure, please contact the Plan Manager for assistance.

Sources

1. Basemap is ESRI's ArcGIS Online world topographic map, obtained 8 September 2023
2. DWR Groundwater basins are based on the boundaries defined in California's Groundwater Bulletin 118 - Final Prioritization, dated February 2019.
3. Depth to Top of Corcoran Clay layer obtained from DWR San Joaquin District 1:253,440 scale map, 1981.

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Depth to Top of Corcoran Clay

Delta-Mendota Subbasin
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Figure HCM-5

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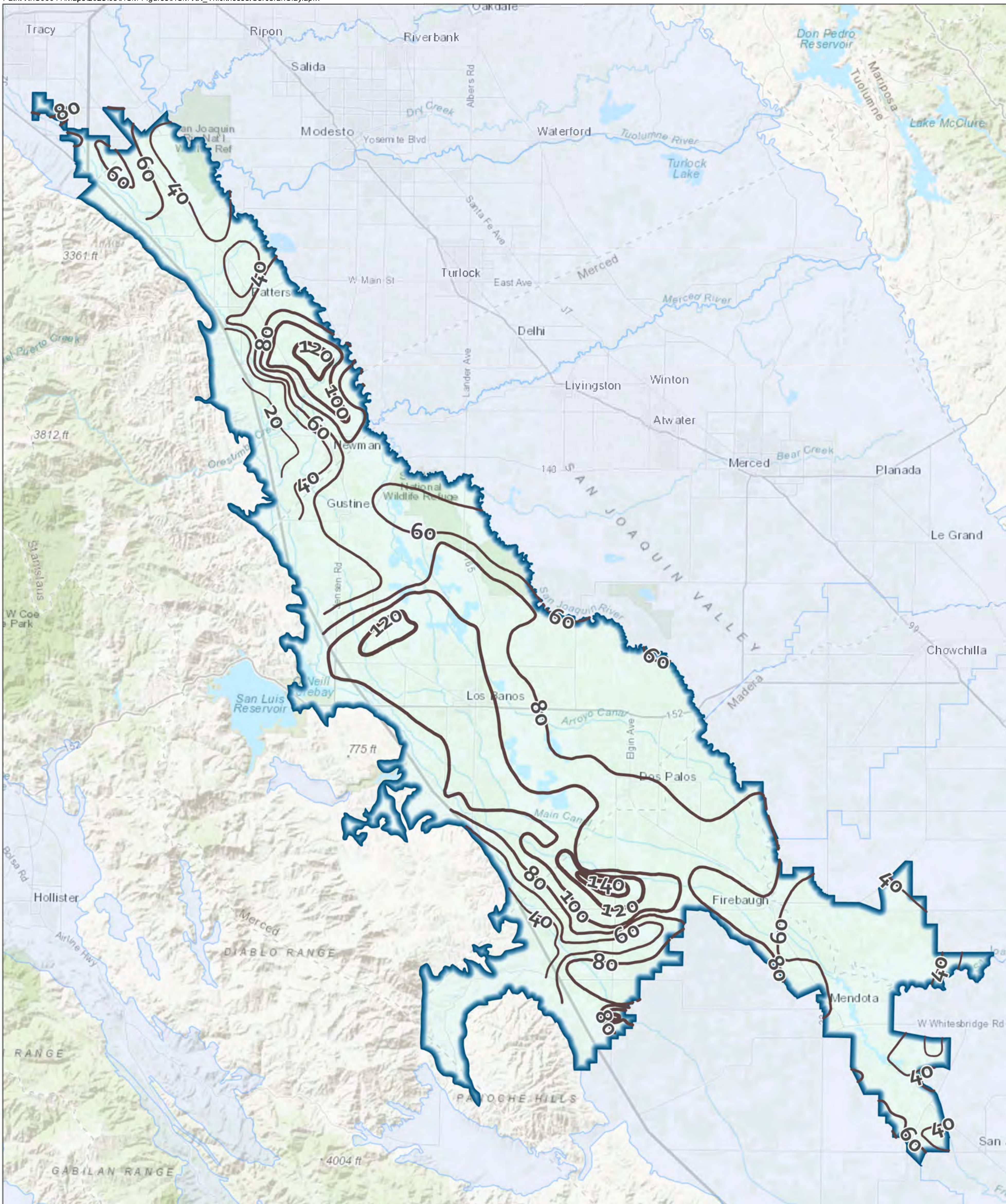

Legend
- Delta-Mendota Subbasin (DWR Basin No. 5-022.07)
- California Groundwater Basin

Corcoran Clay Thickness (feet)
- 20
- 21 - 40
- 41 - 60
- 61 - 80
- 81 - 100
- 101 - 140

Abbreviations
DWR = California Department of Water Resources

Notes
1. All locations are approximate.
2. If accommodation or alternative format is needed for this figure, please contact the Plan Manager for assistance.

Sources
1. Basemap is ESRI's ArcGIS Online world topographic map, obtained 8 September 2023
2. DWR Groundwater basins are based on the boundaries defined in California's Groundwater Bulletin 118 -Final Prioritization, dated February 2019.
3. Corcoran Clay Thickness Layer obtained from United States Geological Survey Central Valley Spatial Database, 2012: https://ca.water.usgs.gov/projects/centralvalley/central-valley-spatial-database.html

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Thickness of Corcoran Clay

Delta-Mendota Subbasin
July 2024
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Figure HCM-6

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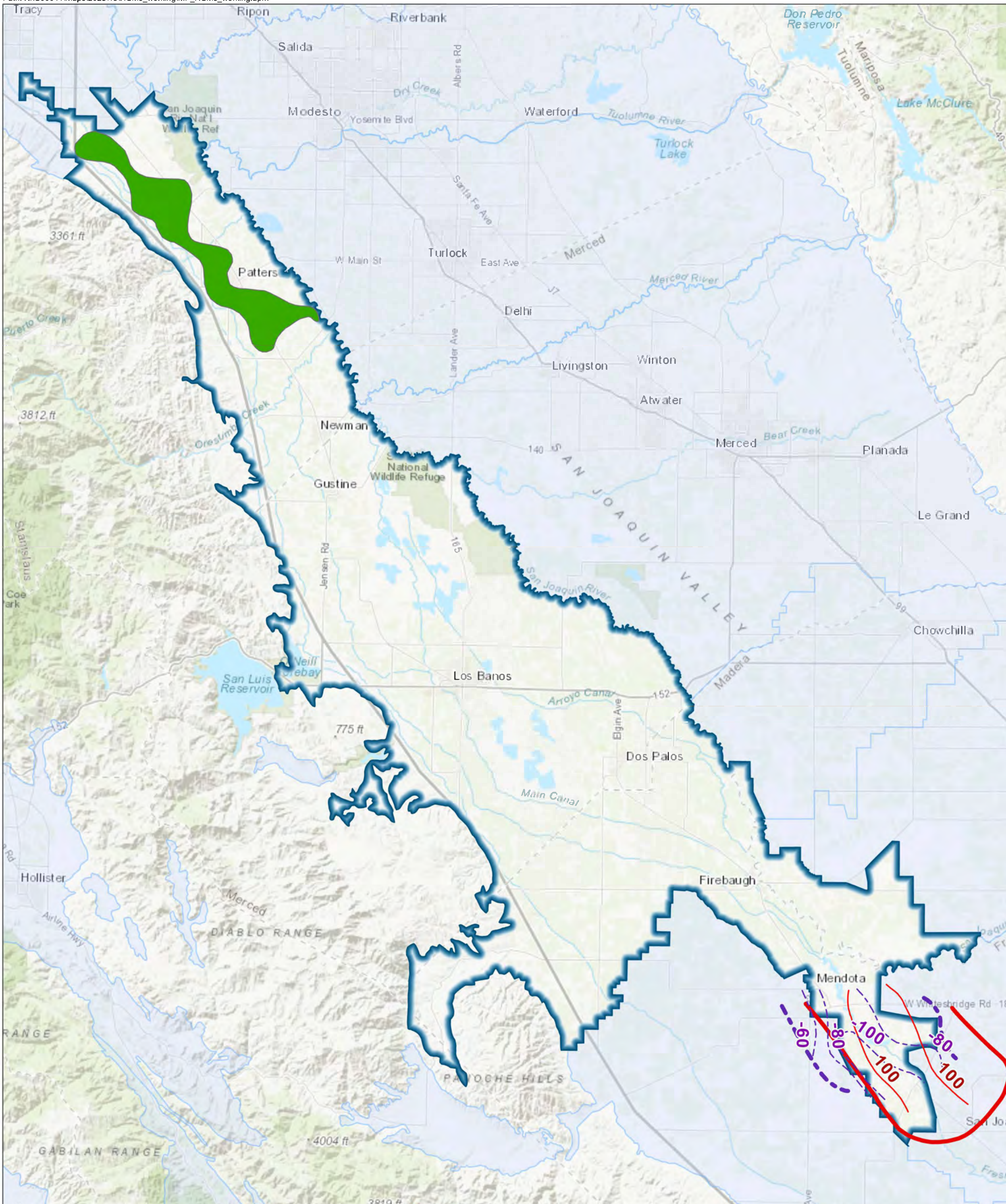

Legend

Delta-Mendota Subbasin (DWR Basin No. 5-022.07)

California Groundwater Basin

Mapped Extent and Elevation of the "C" Clay (from Croft, 1972)

Extent of the "C" Clay

Elevation of the base of "C" Clay

Mapped Extent and Elevation of the "A" Clay (from Croft, 1972)

Extent of the "A" Clay

Elevation of the base of "A" Clay

Mapped Extent of White Clay (from Hotchkiss and Balding, 1971)

Extent of White Clay Layer (30-60 ft thick)

Abbreviations

DWR = California Department of Water Resources

Notes

1. All locations are approximate.
2. If accommodation or alternative format is needed for this figure, please contact the Plan Manager for assistance.

Sources

1. Basemap is ESRI's ArcGIS Online world topographic map, obtained 8 September 2023
2. DWR Groundwater basins are based on the boundaries defined in California's Groundwater Bulletin 118 - Final Prioritization, dated February 2019.
3. White Clay extent from Hotchkiss & Balding, 1971. Geology, hydrology, and water quality of the Tracy-Dos Palo area, San Joaquin Valley, California.
4. A and C Clay data from Croft, 1972. Subsurface geology of the Late Tertiary and Quaternary water-bearing deposits of the southern part of the San Joaquin Valley, California.

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Non-Corcoran Clay Layers

Delta-Mendota Subbasin
July 2024
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Figure HCM-7

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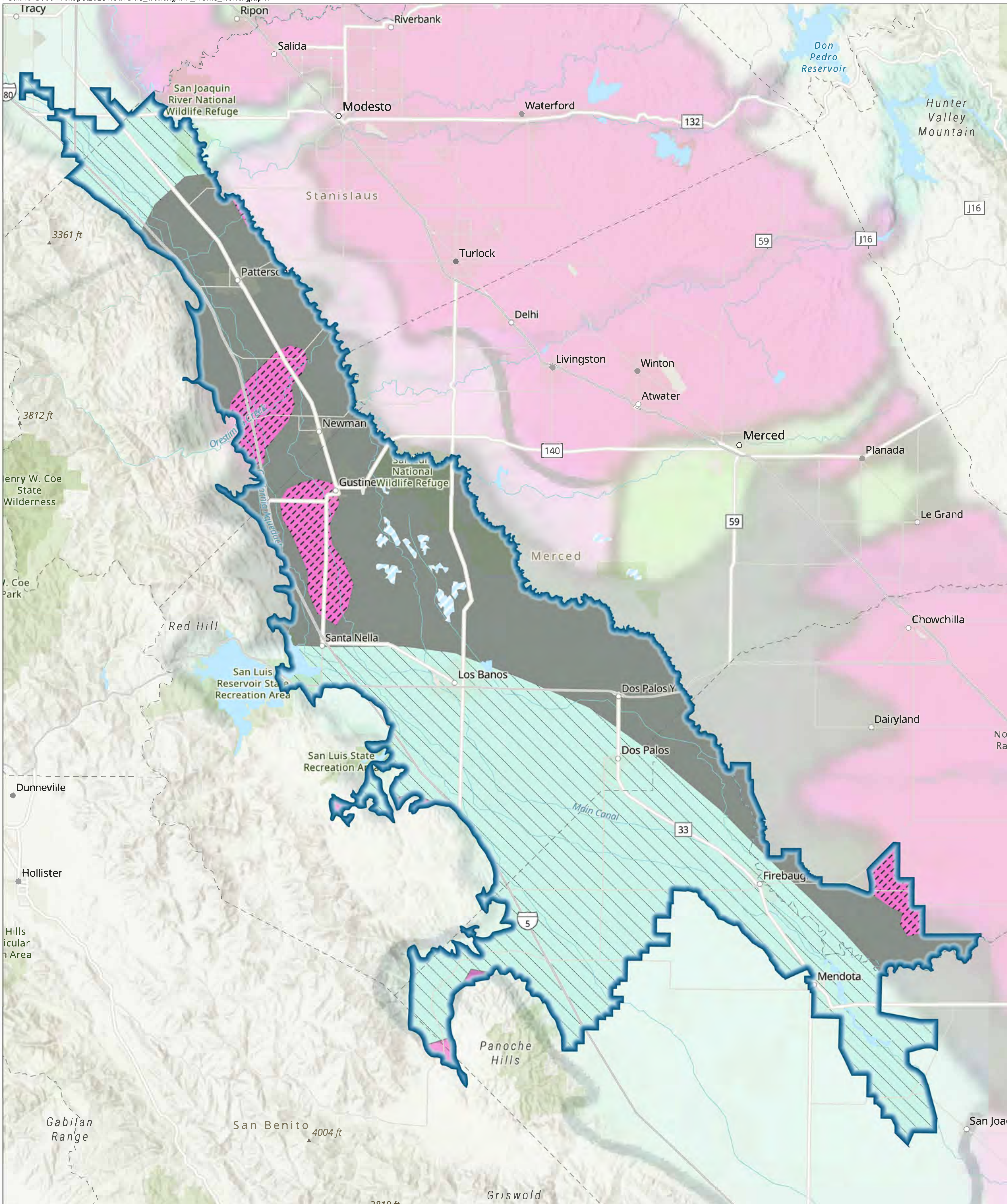

Legend

- Delta-Mendota Subbasin (DWR Basin No. 5-022.07)
- Sodium calcium bicarbonate or calcium sodium bicarbonate
- Sodium or calcium, chloride or sulfate are most common in various combinations
- Transitional: Calcium, magnesium, sodium, chloride, sulfate, and bicarbonate may occur in any combination

Abbreviations
DWR = California Department of Water Resources

Notes
1. All locations are approximate.
2. If accommodation or alternative format is needed for this figure, please contact the Plan Manager for assistance.

Sources
1. Basemap is ESRI's ArcGIS Online world topographic map, obtained 8 September 2023
2. DWR Groundwater basins are based on the boundaries defined in California's Groundwater Bulletin 118 - Final Prioritization, dated February 2019.
3. General Groundwater Quality data from Bertoldi et al. (1991) "Ground Water in the Central Valley, California-- A Summary Report", U.S. Geological Survey Professional Paper 1401-A.

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General Groundwater Quality

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Delta-Mendota Subbasin
July 2024
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Figure HCM-8

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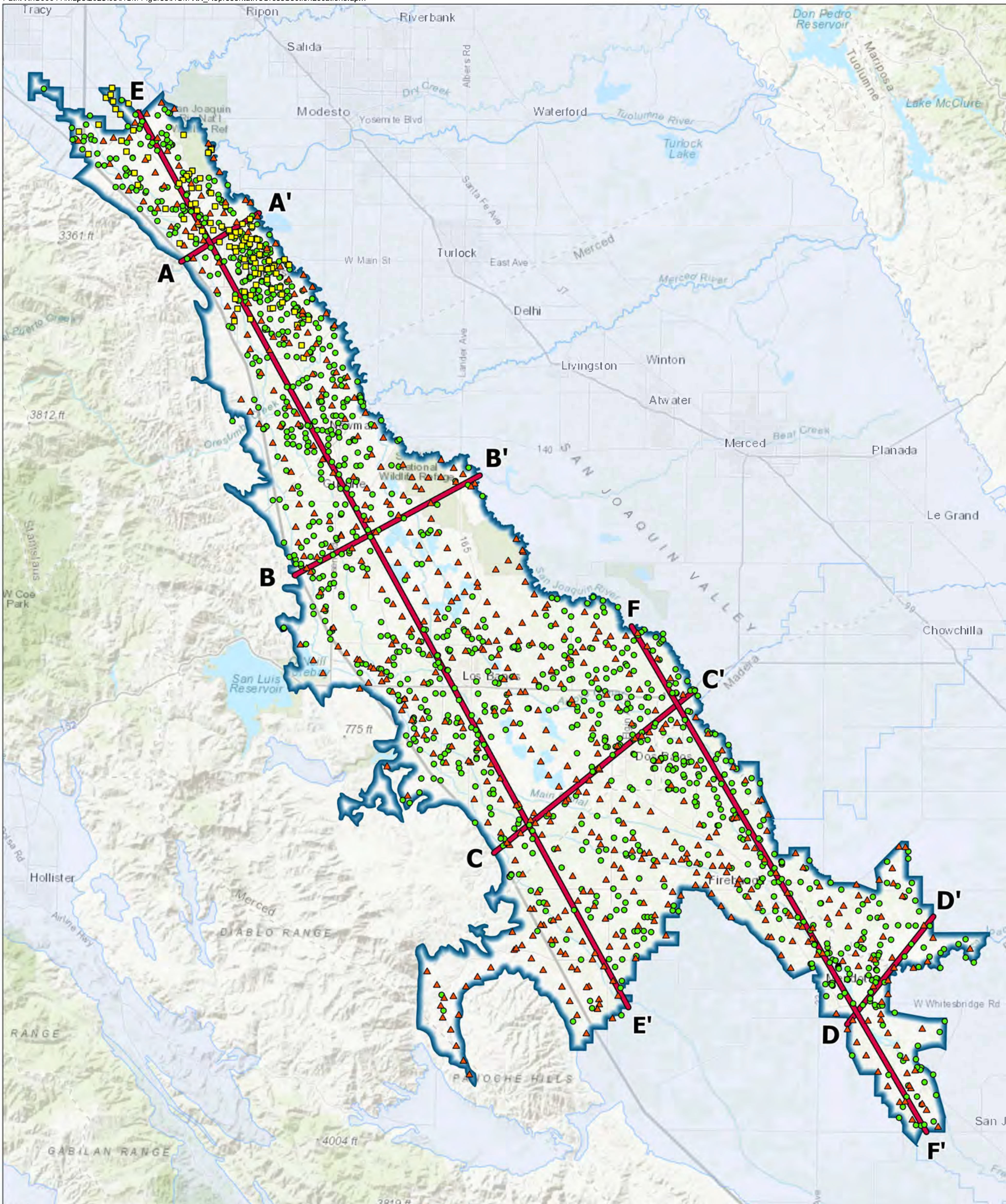

Legend

- Delta-Mendota Subbasin (DWR Basin No. 5-022.07)
- California Groundwater Basin
- Cross-Section Locations
- Data from DWR AEM Survey Interpreted Data (567 points)
- Data provided by PID and WSID (104 points)
- Data from DWR AEM Supporting Data Borehole Lithology (1,213 points)

Abbreviations

AEM = Airborne Electromagnetic
DWR = California Department of Water Resources
PID = Patterson Irrigation District
WSID = West Stanislaus Irrigation District

Notes

1. All locations are approximate.
2. If accommodation or alternative format is needed for this figure, please contact the Plan Manager for assistance.

Sources

1. Basemap is ESRI's ArcGIS Online world topographic map, obtained 8 September 2023
2. DWR Groundwater basins are based on the boundaries defined in California's Groundwater Bulletin 118 -Final Prioritization, dated February 2019.

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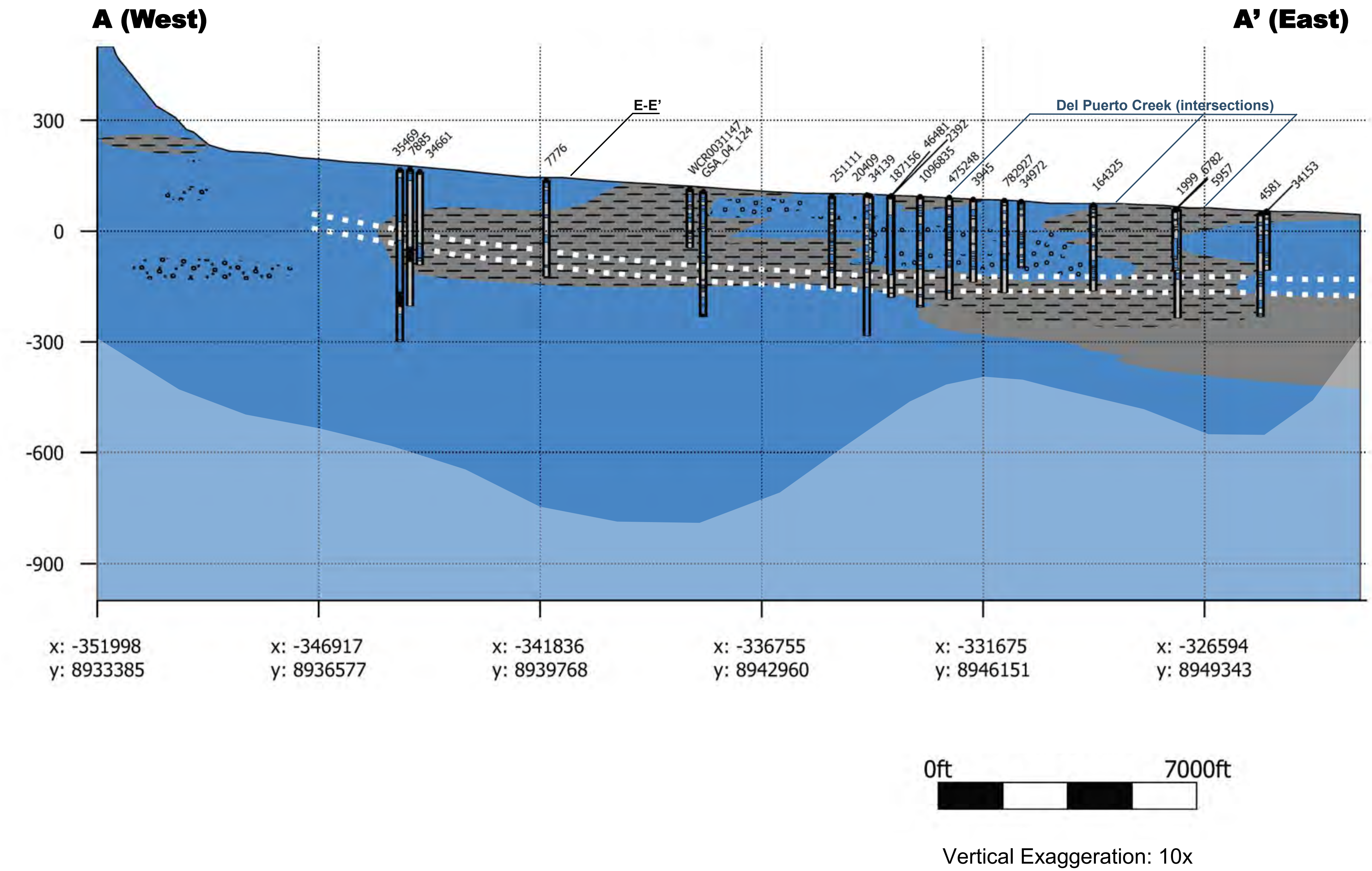
Cross-Section Locations with Data Locations

Delta-Mendota Subbasin
July 2024
C00041.09

eki environment & water

Figure HCM-9

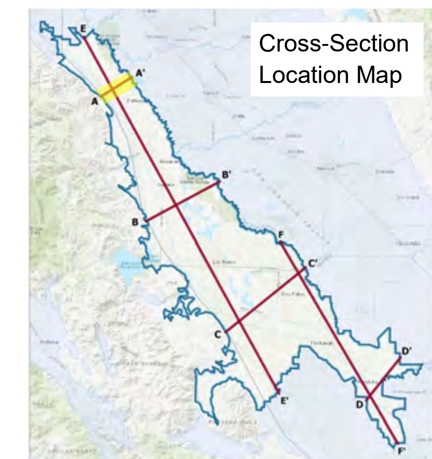


Legend

- Aquifer
- Aquitard

Geology	Hydrostratigraphy
Gravel	Aquifer
Gravel with fines	Aquifer
Sand	Aquifer
Sand with fines	Aquifer
Silt & organics	Aquitard
Clay	Aquitard

- Corcoran Clay from Page (1986)



Abbreviations

DWR = Department of Water Resources
ft = feet
NAD83 = North American Datum 83

Sources

1. DWR Airborne Electromagnetic Survey Interpreted data.
2. DWR digitized lithology logs.
3. Page (1986) Geology of the fresh ground-water basin of the Central Valley, California, with texture maps and sections.

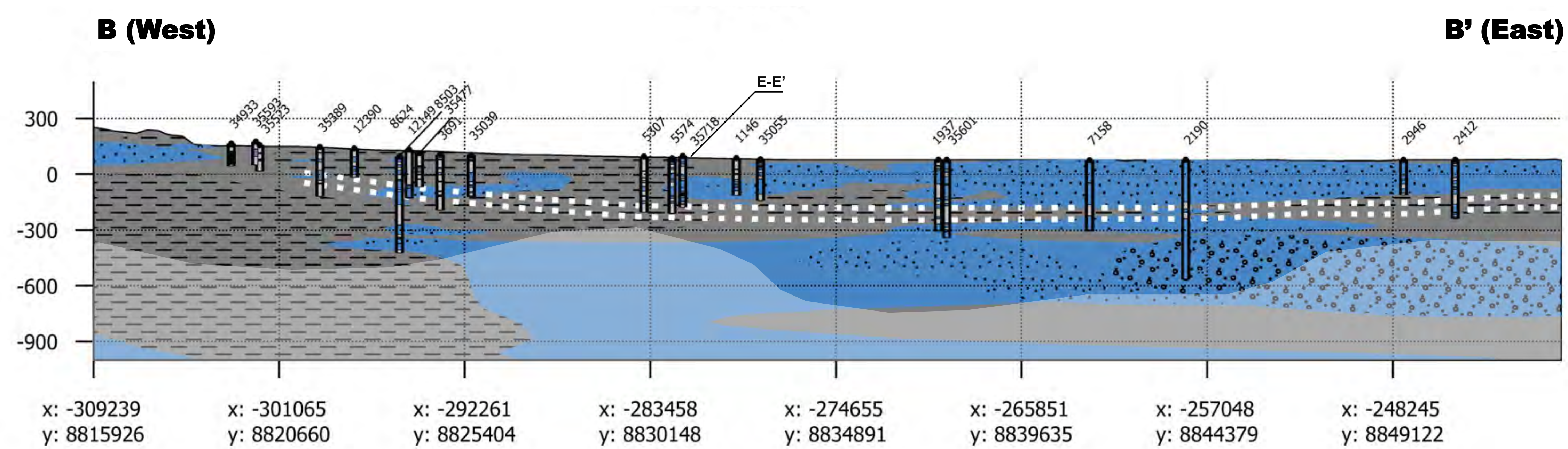
Notes

1. Cross-sections developed using LeapFrog software based on texture data from Source 1 and borehole lithology data from Source 2.
2. Faded colors denote areas of greater data uncertainty.
3. x / y coordinates shown are ft easting / northing in NAD83 California (Teale) Albers (U.S. ft).
4. If accommodation or alternative format is needed for this figure, please contact the Plan Manager for assistance.

Cross-Section A-A'

eki environment & water

Delta-Mendota Subbasin
July 2024
C00041.09
Figure HCM-10



0ft 20000ft

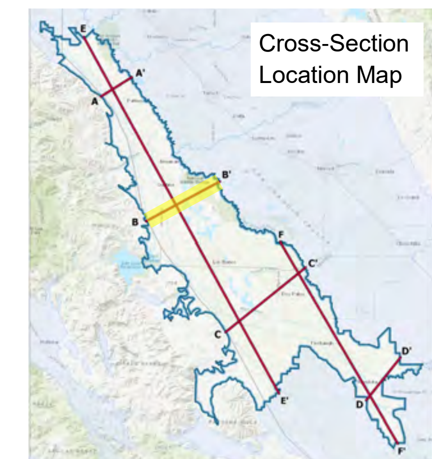
Vertical Exaggeration: 10x

Legend

- Aquifer
- Aquitard

Geology	Hydrostratigraphy
Gravel	Aquifer
Gravel with fines	Aquifer
Sand	Aquifer
Sand with fines	Aquifer
Silt & organics	Aquitard
Clay	Aquitard

- Corcoran Clay from Page (1986)



Abbreviations

DWR = Department of Water Resources
ft = feet
NAD83 = North American Datum 83

Sources

1. DWR Airborne Electromagnetic Survey Interpreted data.
2. DWR digitized lithology logs.
3. Page (1986) Geology of the fresh ground-water basin of the Central Valley, California, with texture maps and sections.

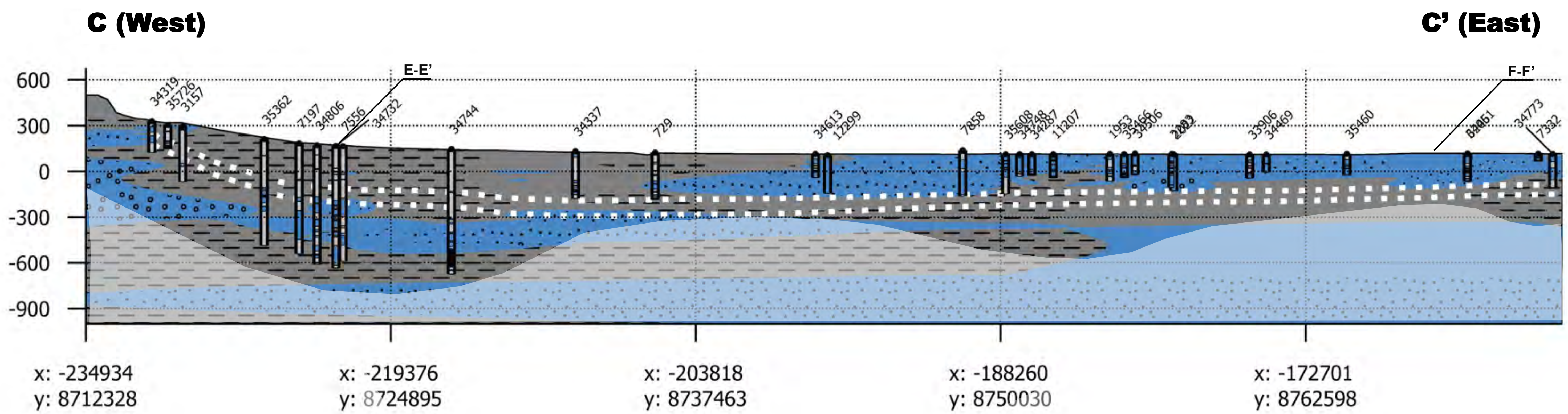
Notes

1. Cross-sections developed using LeapFrog software based on texture data from Source 1 and borehole lithology data from Source 2.
2. Faded colors denote areas of greater data uncertainty.
3. x / y coordinates shown are ft easting / northing in NAD83 California (Teale) Albers (U.S. ft).
4. If accommodation or alternative format is needed for this figure, please contact the Plan Manager for assistance.

Cross-Section B-B’

eki environment & water

Delta-Mendota Subbasin
July 2024
C00041.09
Figure HCM-11



0ft 20000ft

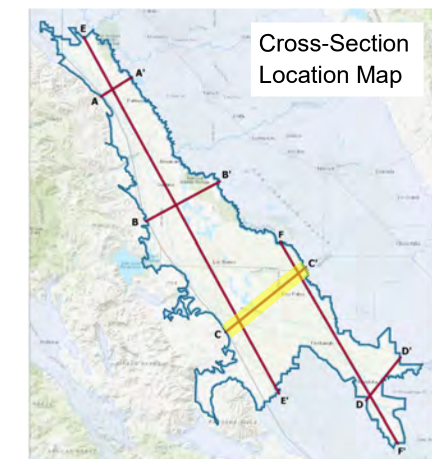
Vertical Exaggeration: 10x

Legend

- Aquifer
- Aquitard

Geology	Hydrostratigraphy
Gravel	Aquifer
Gravel with fines	Aquifer
Sand	Aquifer
Sand with fines	Aquifer
Silt & organics	Aquitard
Clay	Aquitard

- Corcoran Clay from Page (1986)



Abbreviations

DWR = Department of Water Resources
ft = feet
NAD83 = North American Datum 83

Sources

1. DWR Airborne Electromagnetic Survey Interpreted data.
2. DWR digitized lithology logs.
3. Page (1986) Geology of the fresh ground-water basin of the Central Valley, California, with texture maps and sections.

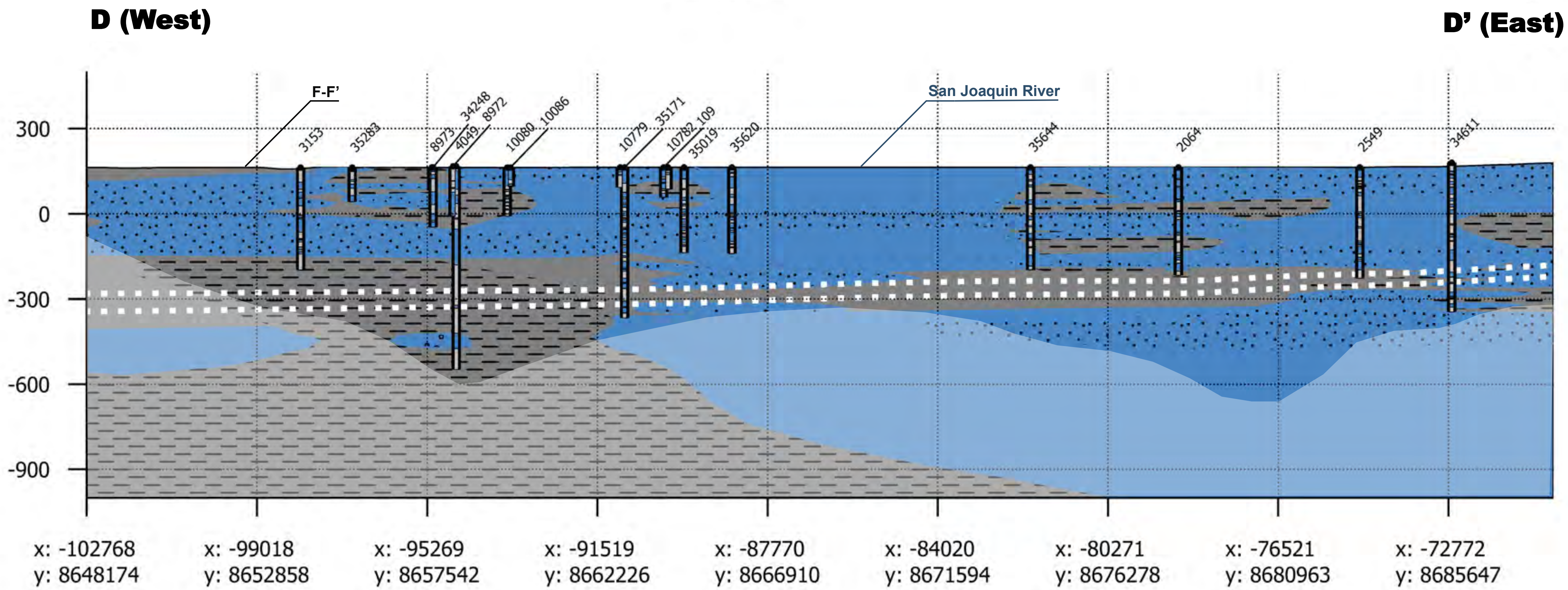
Notes

1. Cross-sections developed using LeapFrog software based on texture data from Source 1 and borehole lithology data from Source 2.
2. Faded colors denote areas of greater data uncertainty.
3. x / y coordinates shown are ft easting / northing in NAD83 California (Teale) Albers (U.S. ft).
4. If accommodation or alternative format is needed for this figure, please contact the Plan Manager for assistance.

Cross-Section C-C'

eki environment & water

Delta-Mendota Subbasin
July 2024
C00041.09
Figure HCM-12



0ft 7000ft

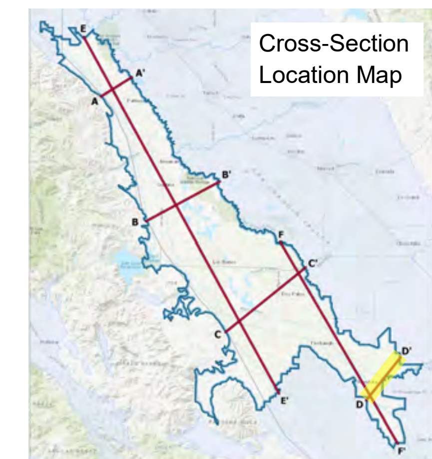
Vertical Exaggeration: 10x

Legend

- Aquifer
- Aquitard

Geology	Hydrostratigraphy
Gravel	Aquifer
Gravel with fines	Aquifer
Sand	Aquifer
Sand with fines	Aquifer
Silt & organics	Aquitard
Clay	Aquitard

Corcoran Clay from Page (1986)



Abbreviations

DWR = Department of Water Resources
ft = feet
NAD83 = North American Datum 83

Sources

1. DWR Airborne Electromagnetic Survey Interpreted data.
2. DWR digitized lithology logs.
3. Page (1986) Geology of the fresh ground-water basin of the Central Valley, California, with texture maps and sections.

Notes

1. Cross-sections developed using LeapFrog software based on texture data from Source 1 and borehole lithology data from Source 2.
2. Faded colors denote areas of greater data uncertainty.
3. x / y coordinates shown are ft easting / northing in NAD83 California (Teale) Albers (U.S. ft).
4. If accommodation or alternative format is needed for this figure, please contact the Plan Manager for assistance.

Cross-Section D-D'

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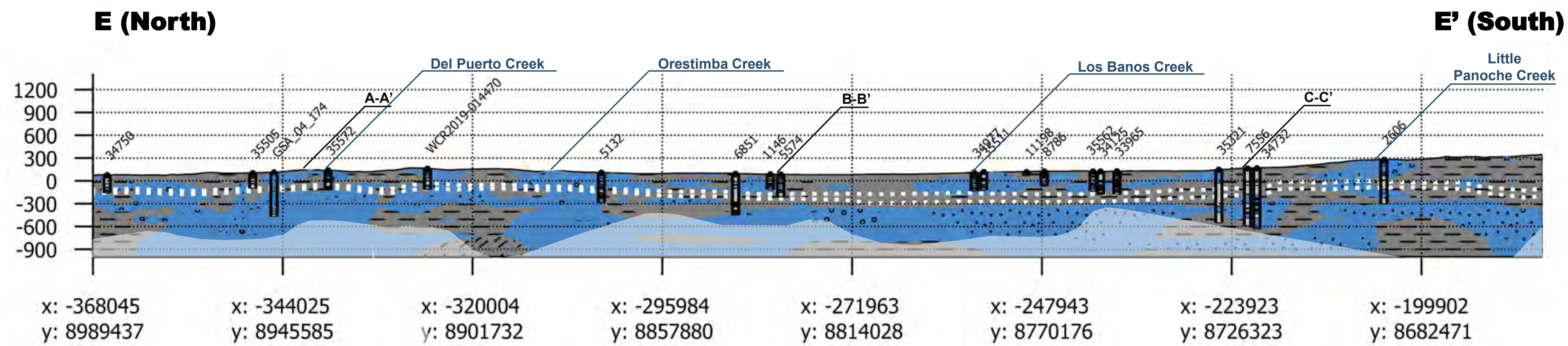
Delta-Mendota Subbasin
July 2024
C00041.09
Figure HCM-13



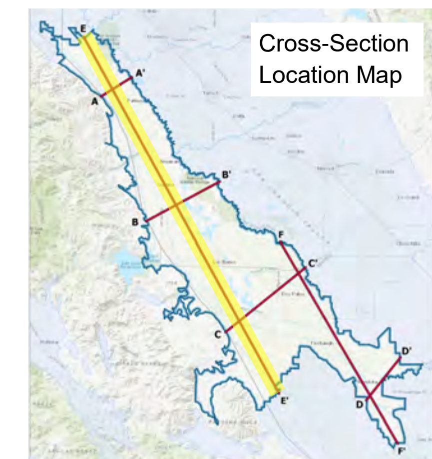
Vertical Exaggeration: 20x

Legend

- Aquifer
- Aquitard

Geology	Hydrostratigraphy
Gravel	Aquifer
Gravel with fines	Aquifer
Sand	Aquifer
Sand with fines	Aquifer
Silt & organics	Aquitard
Clay	Aquitard

- Corcoran Clay from Page (1986)



Abbreviations

DWR = Department of Water Resources
ft = feet
NAD83 = North American Datum 83

Sources

1. DWR Airborne Electromagnetic Survey Interpreted data.
2. DWR digitized lithology logs.
3. Page (1986) Geology of the fresh ground-water basin of the Central Valley, California, with texture maps and sections.

Notes

1. Cross-sections developed using LeapFrog software based on texture data from Source 1 and borehole lithology data from Source 2.
2. Faded colors denote areas of greater data uncertainty.
3. x / y coordinates shown are ft easting / northing in NAD83 California (Teale) Albers (U.S. ft).
4. If accommodation or alternative format is needed for this figure, please contact the Plan Manager for assistance.

Cross-Section E-E'

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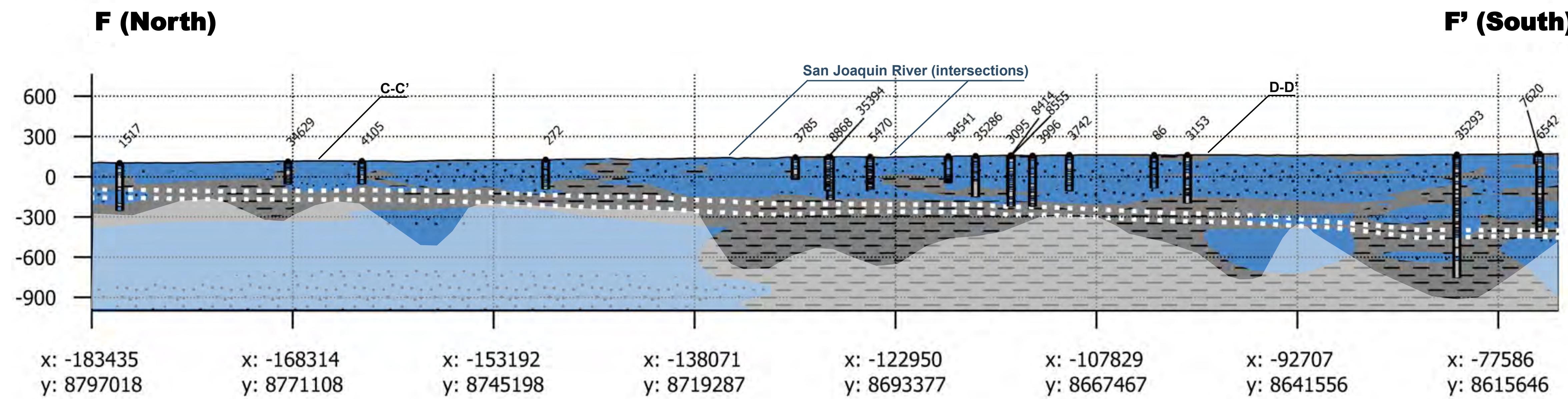
Delta-Mendota Subbasin
July 2024
C00041.09
Figure HCM-14



0ft 60000ft

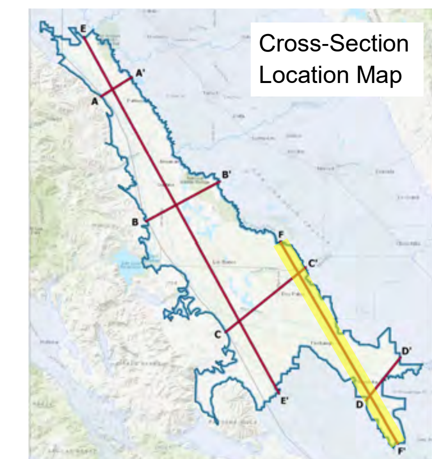
Vertical Exaggeration: 20x

Legend

- Aquifer
- Aquitard

Geology	Hydrostratigraphy
Gravel	Aquifer
Gravel with fines	Aquifer
Sand	Aquifer
Sand with fines	Aquifer
Silt & organics	Aquitard
Clay	Aquitard

- Corcoran Clay from Page (1986)



Abbreviations

DWR = Department of Water Resources
ft = feet
NAD83 = North American Datum 83

Sources

1. DWR Airborne Electromagnetic Survey Interpreted data.
2. DWR digitized lithology logs.
3. Page (1986) Geology of the fresh ground-water basin of the Central Valley, California, with texture maps and sections.

Notes

1. Cross-sections developed using LeapFrog software based on texture data from Source 1 and borehole lithology data from Source 2.
2. Faded colors denote areas of greater data uncertainty.
3. x / y coordinates shown are ft easting / northing in NAD83 California (Teale) Albers (U.S. ft).
4. If accommodation or alternative format is needed for this figure, please contact the Plan Manager for assistance.

Cross-Section F-F'

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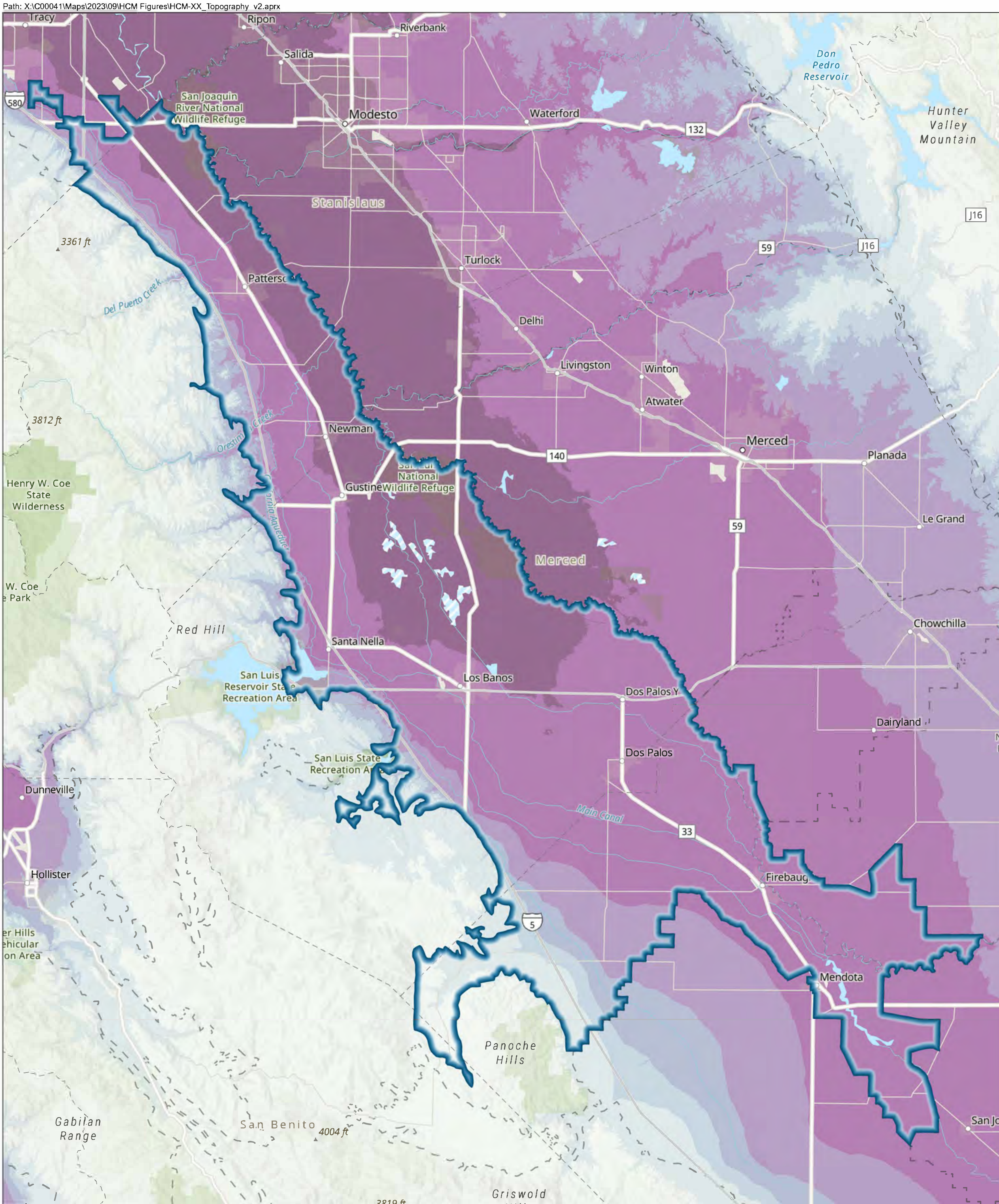
Delta-Mendota Subbasin
July 2024
C00041.09
Figure HCM-15

Path: X:\C00041\Maps\2023\09\HCM Figures\HCM-XX_Topography_v2.aprx



Legend

Delta-Mendota Subbasin (DWR Basin No. 5-022.07)

California Groundwater Basin

Ground Surface Elevation (feet above MSL)

- <= 100
- 100 - 200
- 200 - 300
- 300 - 400
- 400 - 500
- 500 - 1,000
- >= 1,000

Abbreviations

DWR = California Department of Water Resources
MSL = mean sea level

Notes

1. All locations are approximate.
2. If accommodation or alternative format is needed for this figure, please contact the Plan Manager for assistance.

Sources

1. Basemap is ESRI's ArcGIS Online world topographic map, obtained 8 September 2023
2. DWR Groundwater basins are based on the boundaries defined in California's Groundwater Bulletin 118 -Final Prioritization, dated February 2019.
3. Ground surface elevation data obtained from United States Geological Survey National Elevation Dataset, 2018.

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Topography

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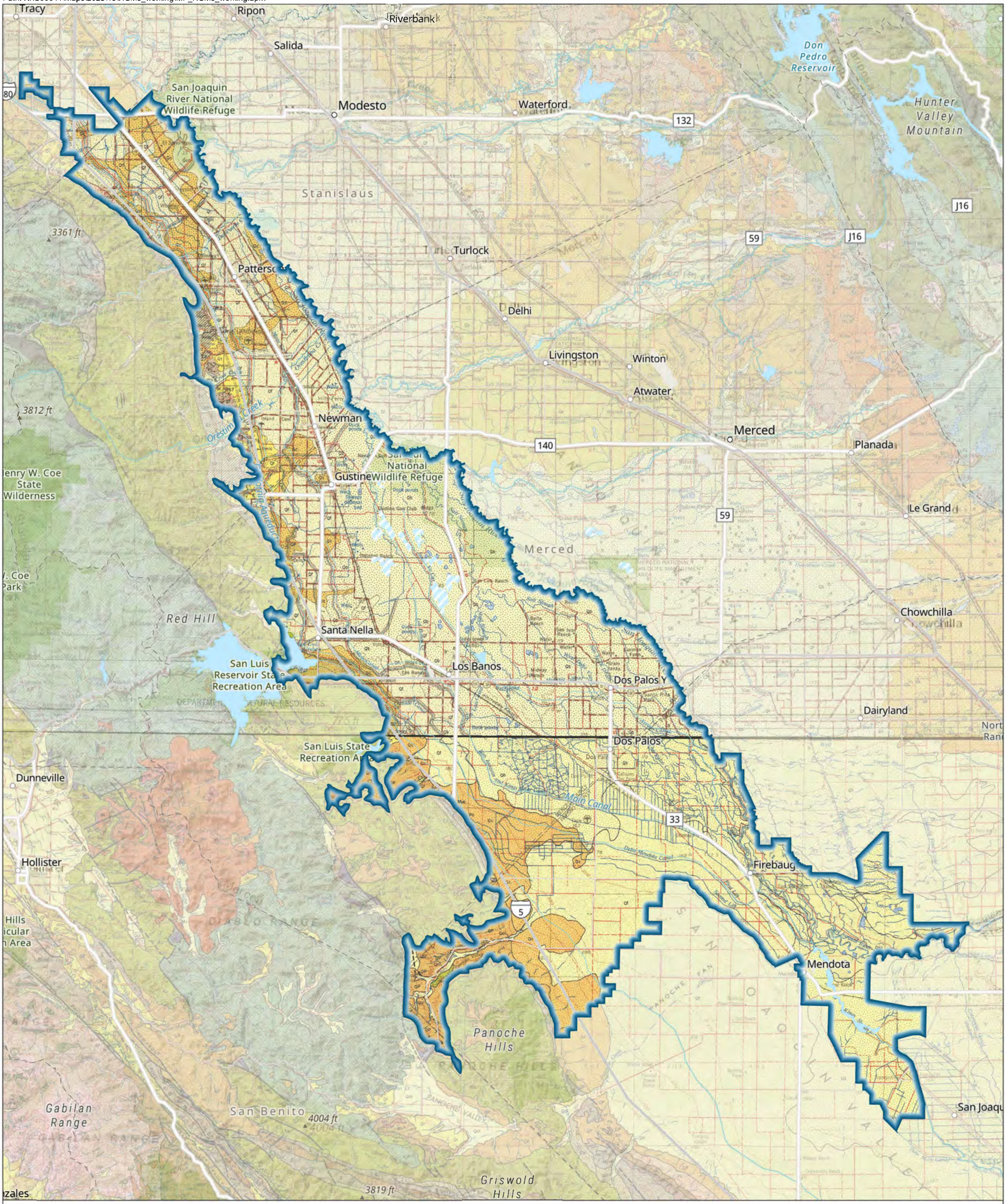
Delta-Mendota Subbasin
July 2024
C00041.09

Figure HCM-16

Path: X:\C00041\Maps\2023\10\HCMs_working\MF_HCMs_working.aprx



Legend

- Delta-Mendota Subbasin (DWR Basin No. 5-022.07)
- Qs — Dune sand
- Qal — Alluvium
- Great Valley:
  - Qsc — Stream channel deposits
  - Qf — Fan deposits
  - Qb — Basin deposits
- Qt — Quaternary nonmarine terrace deposits
- Qm — Pleistocene marine and marine terrace deposits
- Qc — Pleistocene nonmarine
- QP — Plio-Pleistocene nonmarine
- Pc — Undivided Pliocene nonmarine
- Pmlc — Middle and/or lower Pliocene nonmarine
- E — Eocene marine
- Ep — Paleocene marine
- Ku — Upper Cretaceous marine

Abbreviations

DWR = California Department of Water Resources

Notes

1. All locations are approximate.
2. If accommodation or alternative format is needed for this figure, please contact the Plan Manager for assistance.

Sources

1. Basemap is ESRI's ArcGIS Online world topographic map, obtained 8 September 2023.
2. DWR Groundwater basins are based on the boundaries defined in California's Groundwater Bulletin 118 - Final Prioritization, dated February 2019.
3. Surficial Geology layer obtained from State of California Division of Mines & Geology: Geologic Map of California, San Jose sheet (1966) and Santa Cruz sheet (1958).

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Surficial Geology

Delta-Mendota Subbasin
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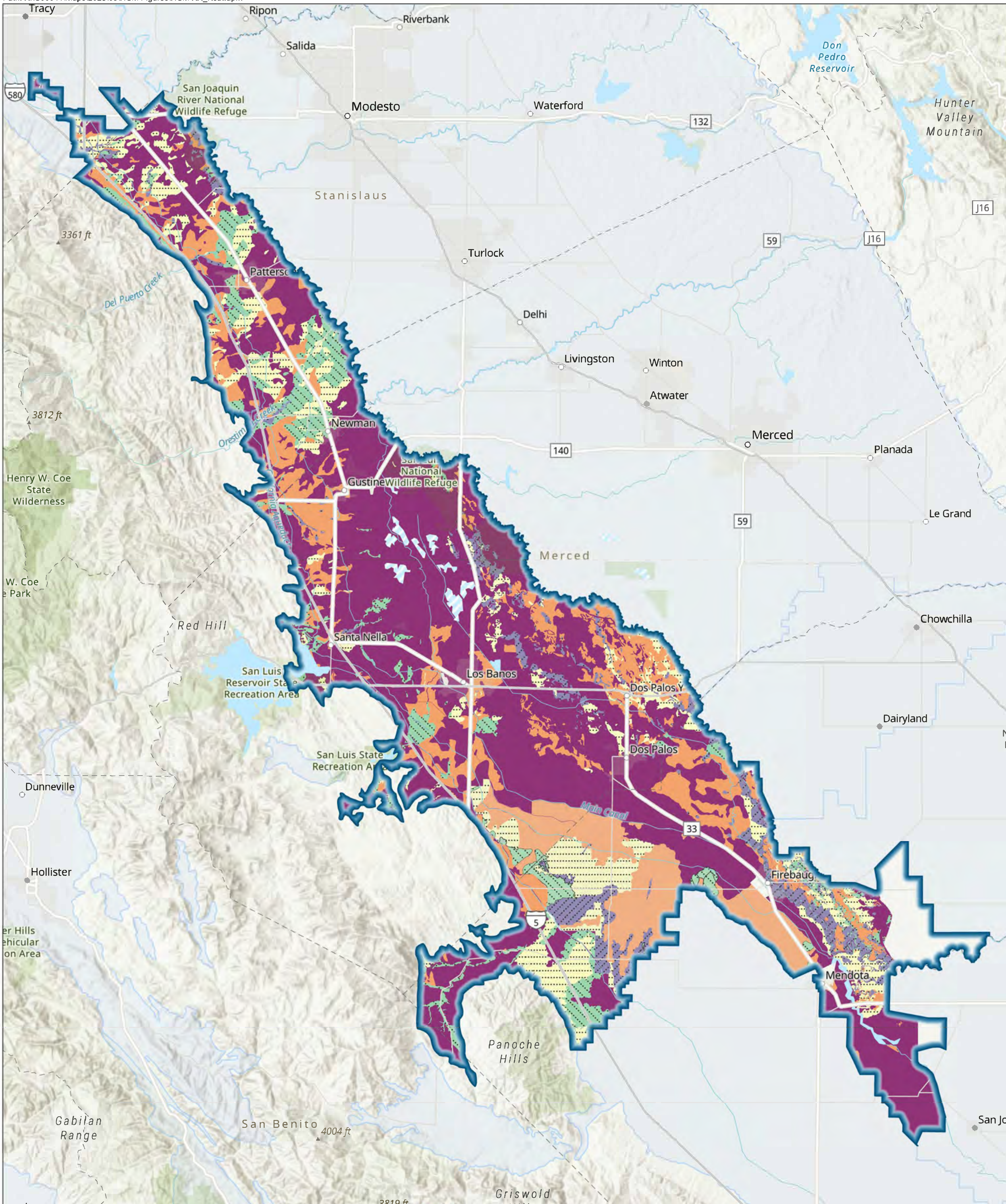
Figure HCM-17

Path: X:\C00041\Maps\2023\09\HCM Figures\HCM-XX_Ksat.aprx



Legend

Delta-Mendota Subbasin (DWR Basin No. 5-022.07)

California Groundwater Basin

Saturated Hydraulic Conductivity (feet/day)

- <0.5
- 0.5 - 1.0
- 1.0 - 2.0
- 2.0 - 4.0
- > 4.0

Abbreviations

DWR = California Department of Water Resources

Notes

1. All locations are approximate.
2. If accommodation or alternative format is needed for this figure, please contact the Plan Manager for assistance.

Sources

1. Basemap is ESRI's ArcGIS Online world topographic map, obtained 8 September 2023
2. DWR Groundwater basins are based on the boundaries defined in California's Groundwater Bulletin 118 -Final Prioritization, dated February 2019.
3. Saturated Hydraulic Conductivity data from National Resource Conservation Service (NRCS) Soil Survey Geographic Database (SSURGO), 2023.

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Soil Characteristics - Saturated Hydraulic Conductivity

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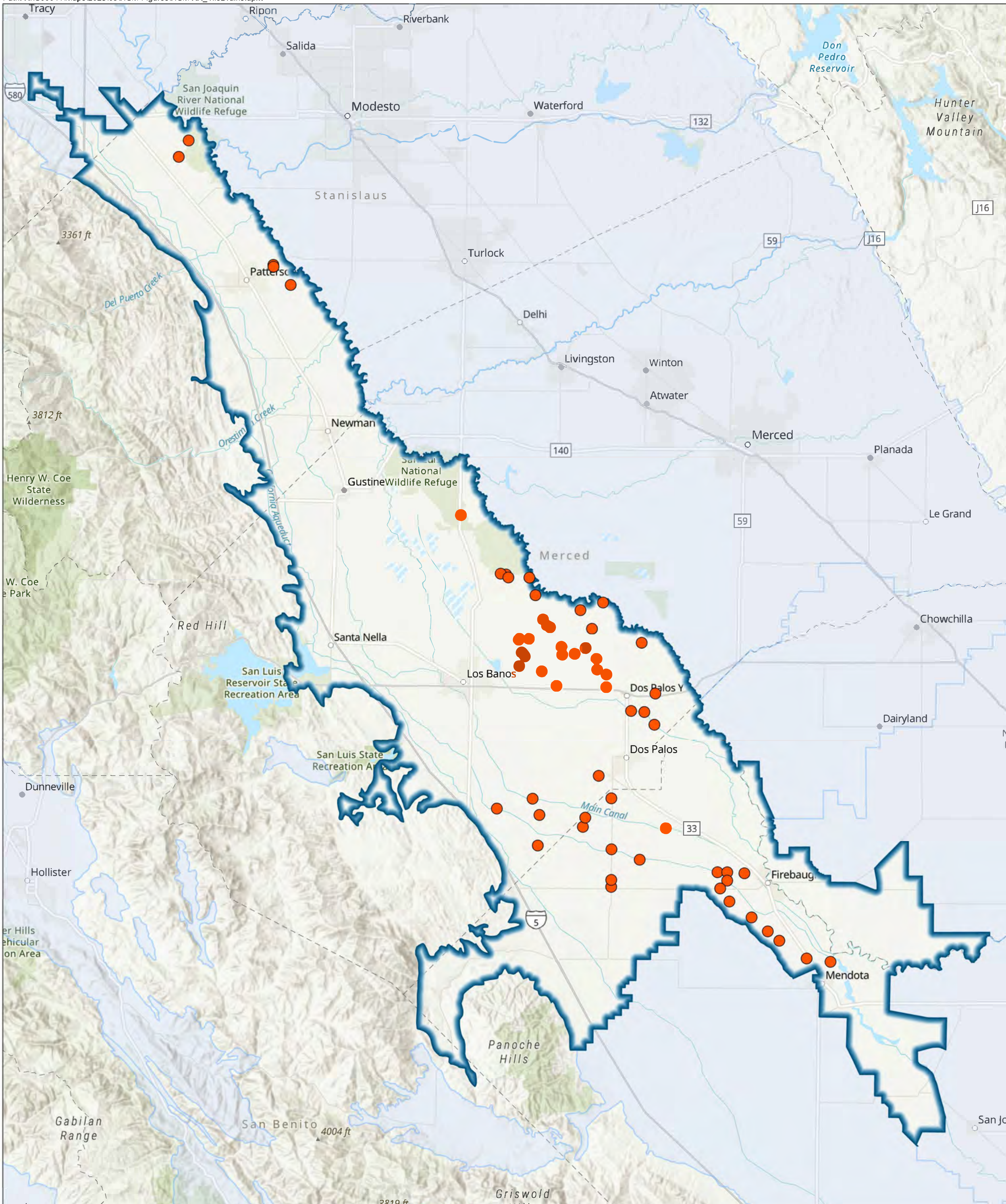
Delta-Mendota Subbasin
July 2024
C00041.09

Figure HCM-18

Path: X:\C00041\Maps\2023\09\HCM Figures\HCM-XX_TileDrains.aprx



Legend

- Delta-Mendota Subbasin (DWR Basin No. 5-022.07)
- California Groundwater Basin
- Known Tile Drain Location

Abbreviations

DWR = California Department of Water Resources

Notes

1. All locations are approximate.
2. If accommodation or alternative format is needed for this figure, please contact the Plan Manager for assistance.

Sources

.1. Basemap is ESRI's ArcGIS Online world topographic map, obtained 8 September 2023
2. DWR Groundwater basins are based on the boundaries defined in California's Groundwater Bulletin 118 -Final Prioritization, dated February 2019.
3.Tile Drain Locations layer obtained from Woodard and Curran on 29th August 2023.

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Known Tile Drain Locations

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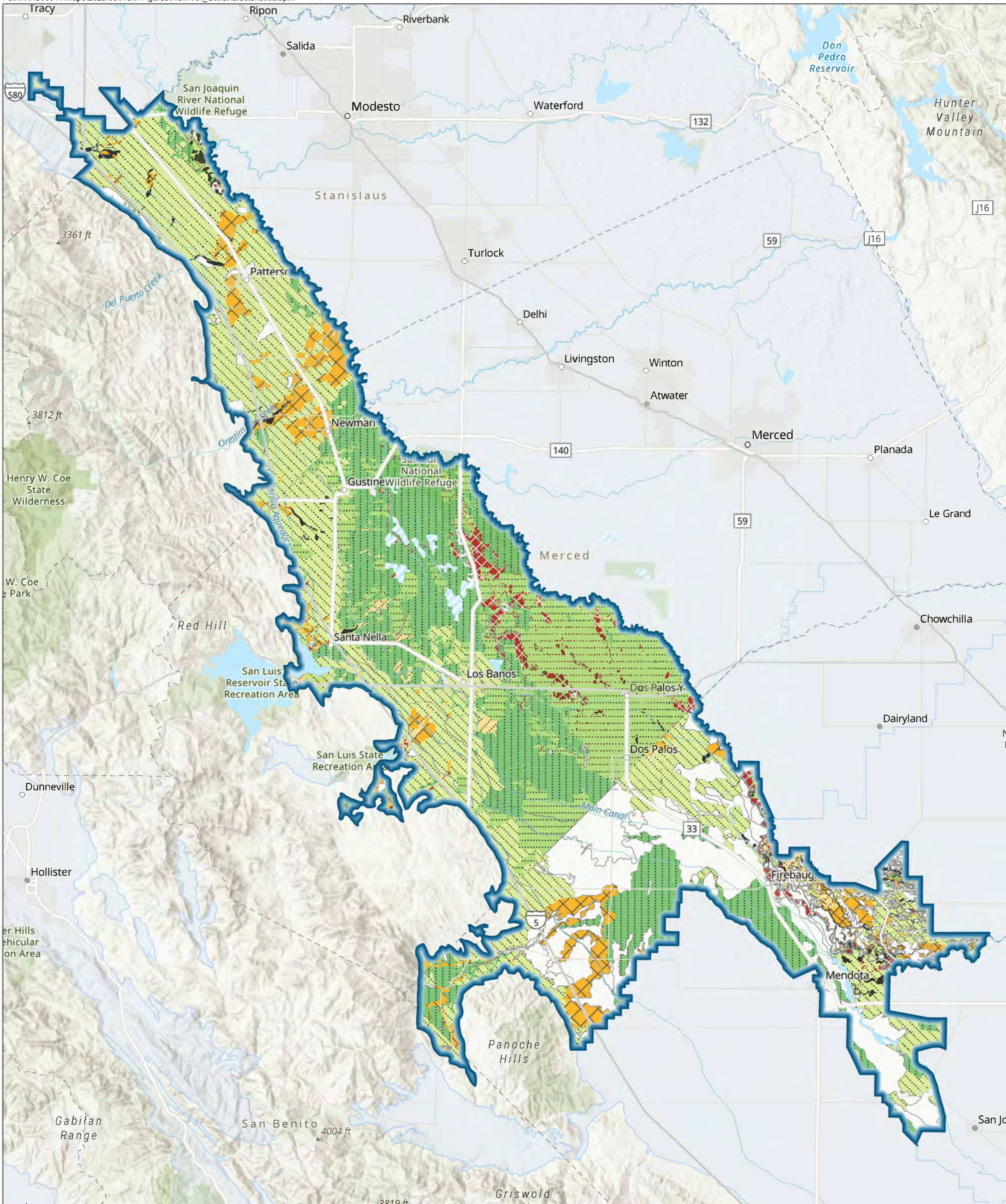
Delta-Mendota Subbasin
July 2024
C00041.09

Figure HCM-19

Path: X:\C00041\Maps\2023\09\HCM Figures\HCM-XX_SoilCharacteristics.aprx



Legend

- Delta-Mendota Subbasin (DWR Basin No. 5-022.07)
- California Groundwater Basin

Hydrologic Soil Groups

- Not Classified
- A
- A/D
- B
- B/D
- C
- C/D
- D

Abbreviations

DWR = California Department of Water Resources

Notes

1. All locations are approximate.
2. If accommodation or alternative format is needed for this figure, please contact the Plan Manager for assistance.

Sources

1. Basemap is ESRI's ArcGIS Online world topographic map, obtained 8 September 2023
2. DWR Groundwater basins are based on the boundaries defined in California's Groundwater Bulletin 118 -Final Prioritization, dated February 2019.
3. Hydrologic Soil Groups data from National Resources Conservation Service (NRCS) Part 630 Hydrology National Engineering Handbook, Chapter 7, 2009.

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Soil Characteristics - Hydrologic Soil Groups

Delta-Mendota Subbasin
July 2024
C00041.09

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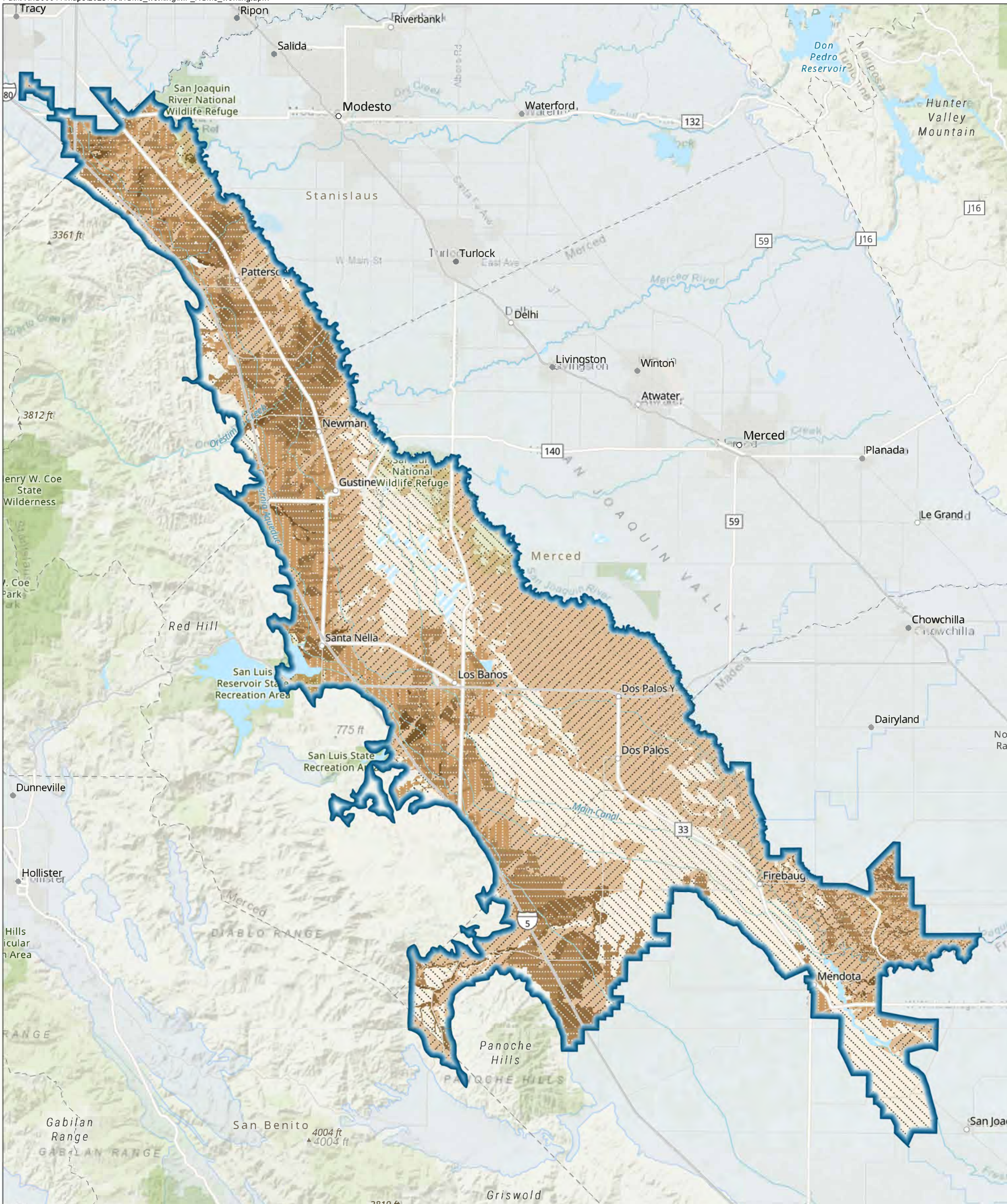
Figure HCM-20

Path: X:\C00041\Maps\2023\10\HCMs_working\MF_HCMs_working.aprx



Legend

- Delta-Mendota Subbasin (DWR Basin No. 5-022.07)
- California Groundwater Basin

Modified SAGBI

- Excellent (85-100)
- Good (69-85)
- Moderately Good (49-69)
- Moderately Poor (29-49)
- Poor (15-29)
- Very Poor (0-15)

Abbreviations

DWR = California Department of Water Resources
SAGBI = Soil Agricultural Groundwater Banking Index

Notes

1. All locations are approximate.
2. If accommodation or alternative format is needed for this figure, please contact the Plan Manager for assistance.

Sources

1. Basemap is ESRI's ArcGIS Online world topographic map, obtained 8 September 2023
2. DWR Groundwater basins are based on the boundaries defined in California's Groundwater Bulletin 118 - Final Prioritization, dated February 2019.
3. Modified SAGBI layer obtained from University of California, Davis (UCD) Department of Agriculture and Natural Resources, Soil Resource Lab: https://casoilresource.lawr.ucdavis.edu/sagbi/

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Modified Soil Agricultural Groundwater Banking Index (SAGBI)

Delta-Mendota Subbasin
July 2024
C00041.09

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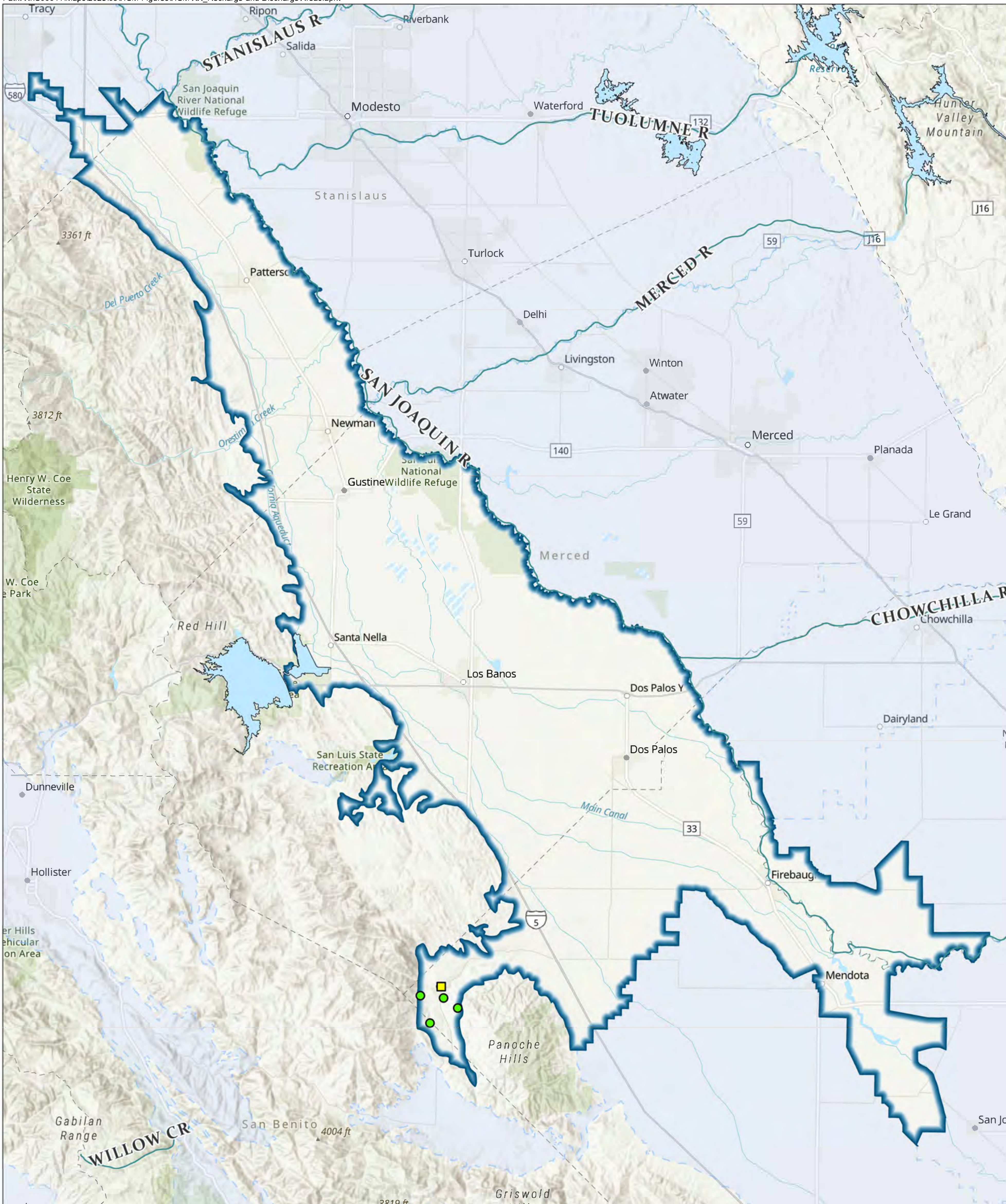
Figure HCM-21

Path: X:\C00041\Maps\2023\09\HCM Figures\HCM-XX_Recharge and Discharge Areas.aprx



Legend

- 1 Spring/Seep
- 2 Springs/Seeps
- Delta-Mendota Subbasin (DWR Basin No. 5-022.07)
- California Groundwater Basin
- Major River
- Lakes and Reservoirs

Abbreviations

DWR = California Department of Water Resources
MSL = mean sea level
R = River
CR = Creek
USGS = United States Geological Survey

Notes

1. All locations are approximate.
2. Only the six shown springs/seeps have been identified by USGS in the Subbasin and do not represent a comprehensive set of springs/seeps in the Subbasin.
3. If accommodation or alternative format is needed for this figure, please contact the Plan Manager for assistance.

Sources

1. Basemap is ESRI's ArcGIS Online world topographic map, obtained 8 September 2023
2. DWR Groundwater basins are based on the boundaries defined in California's Groundwater Bulletin 118 -Final Prioritization, dated February 2019.
3. Major water drainage networks and spring/seep location data from the USGS National Hydrography Dataset, obtained 8 September 2023.

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Springs and Seeps

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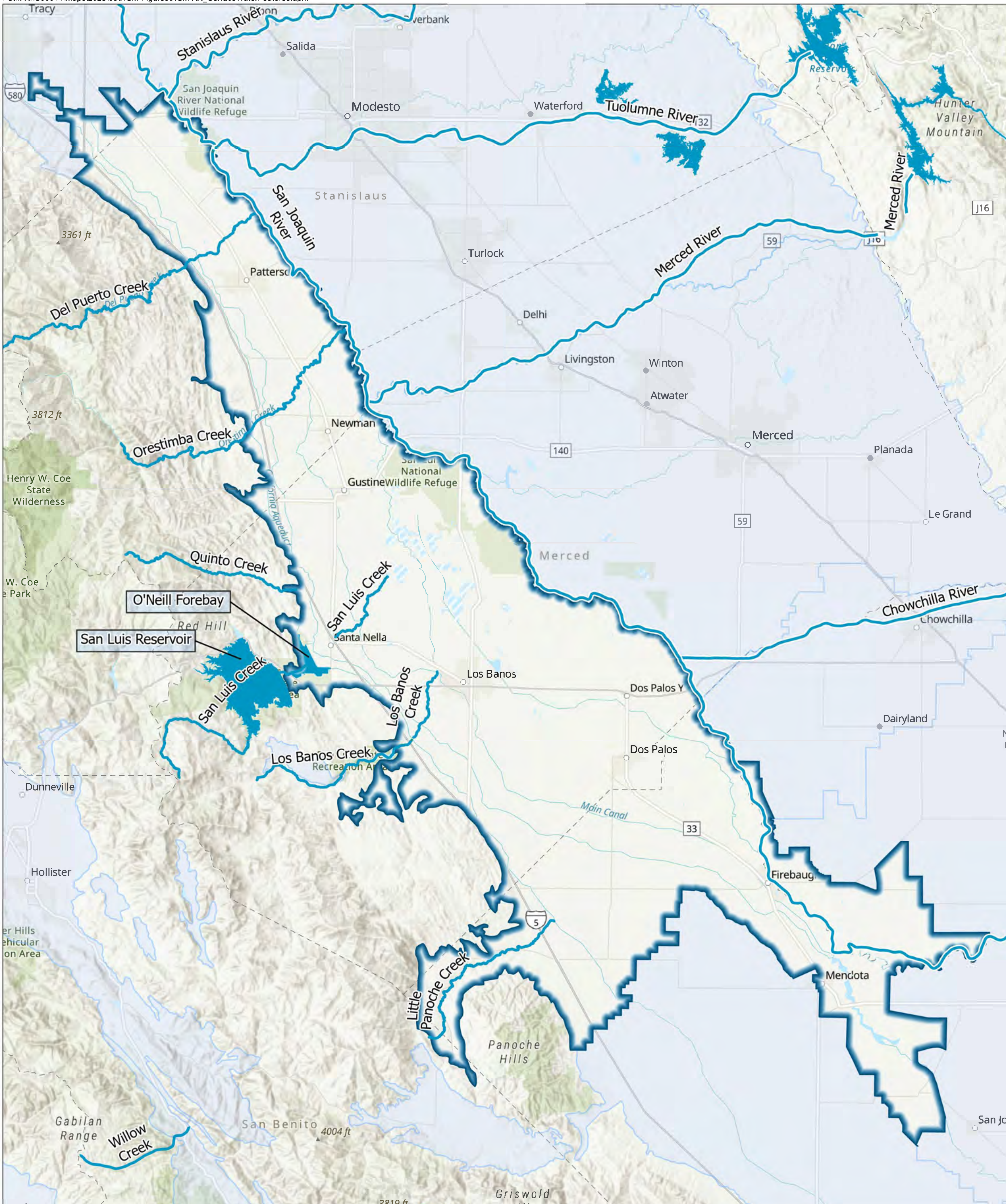
Delta-Mendota Subbasin
July 2024
C00041.09

Figure HCM-22

Path: X:\C00041\Maps\2023\09\HCM Figures\HCM-XX_SurfaceWaterFeatures.aprx



Legend

- Delta-Mendota Subbasin (DWR Basin No. 5-022.07)
- California Groundwater Basin
- Rivers & Streams
- Lakes and Reservoirs

Abbreviations

DWR = California Department of Water Resources

Notes

1. All locations are approximate.
2. San Luis Creek downstream of San Luis Reservoir is no longer an active channel.
3. If accommodation or alternative format is needed for this figure, please contact the Plan Manager for assistance.

Sources

1. Basemap is ESRI's ArcGIS Online world topographic map, obtained 8 September 2023
2. DWR Groundwater basins are based on the boundaries defined in California's Groundwater Bulletin 118 -Final Prioritization, dated February 2019.
3. Major water drainage networks from the United States Geological Survey National Hydrography Dataset, obtained 8 September 2023.

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Surface Water Features

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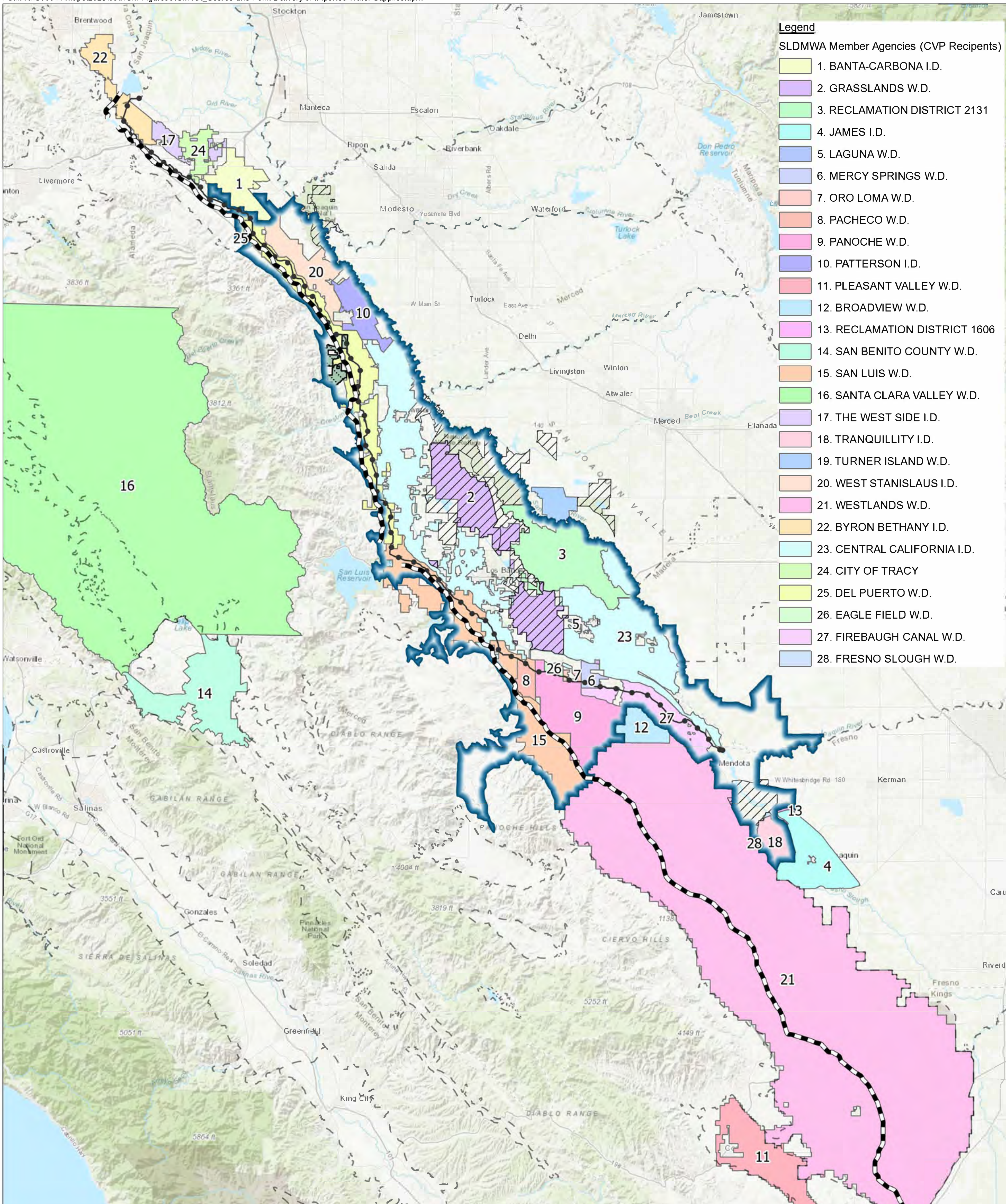
Delta-Mendota Subbasin
July 2024
C00041.09

Figure HCM-23

Path: X:\C00041\Maps\2023\09\HCM Figures\HCM-XX_Source and Point Delivery of Imported Water Supplies.aprx



Legend

- Delta-Mendota Subbasin (DWR Basin No. 5-022.07)
- California Groundwater Basin
- Oak Flat WD (SWP Recipent)
- SLDMWA Wildlife Refuge and Wildlife Management Area
- California Aqueduct
- Delta-Mendota Canal

Abbreviations

DWR = California Department of Water Resources
WD = Water District
SWP = State Water Project
SLDMWA = San Luis & Delta-Mendota Water Authority
CVP = Central Valley Project
ID = Irrigation District

Notes

1. All locations are approximate.
2. If accommodation or alternative format is needed for this figure, please contact the Plan Manager for assistance.

Sources

1. Basemap is ESRI's ArcGIS Online world topographic map, obtained 8 September 2023
2. DWR Groundwater basins are based on the boundaries defined in California's Groundwater Bulletin 118 -Final Prioritization, dated February 2019.
3. Agencies & wildlife areas shapefiles obtained from San Luis & Delta-Mendota Water Authority, 2022.
4. Canals and aqueducts shapefile from California State Geoportal, obtained 8 September 2023.

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Source & Point of Delivery of Imported Water Supplies

Delta-Mendota Subbasin
July 2024
C00041.09

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Figure HCM-24