Groundwater Sustainability Plan

for the

Santa Monica Groundwater Subbasin

January 2022

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Groundwater Sustainability Plan for the Santa Monica Groundwater Subbasin

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This Groundwater Sustainability Plan for the Santa Monica Groundwater Subbasin has been prepared under the direction of a professional geologist licensed in the State of California as required by the California Code of Regulations, Title 23 Section 354.12, consistent with professional standards of practice.

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Acronyms and Abbreviations

Acronym/Abbreviation	Definition
AF	Acre-feet
AFY	Acre-feet per year
AWPF	Advanced Water Purification Facility
Basin Plan	Water Quality Control Plan for the Los Angeles Basin
BMP	Best Management Practice
BTEX	Benzene, toluene, ethylbenzene, and xylenes
CASGEM	California Statewide Groundwater Elevation Monitoring
CAWC	California American Water Company
CDFW	California Department of Fish and Wildlife
CEQA	California Environmental Quality Act
CIMIS	California Irrigation Management Information System
CRA	Colorado River Aqueduct
CWC	California Water Code
DAC	Disadvantaged Community
DDW	Division of Drinking Water
DPH	Los Angeles County Department of Public Health
DWR	California Department of Water Resources
ETo	Reference Evapotranspiration
GAMA	Groundwater Ambient Monitoring and Assessment
GDE	Groundwater-Dependent Ecosystem
gpm	Gallons Per Minute
GPS	Global Positioning System
GSA	Groundwater Sustainability Agency
GSP	Groundwater Sustainability Plan
GSWC	Golden State Water Company
GSWC-CC	Golden State Water Company – Culver City
HA	Hydrologic Area
HU	Hydrologic Unit
InSAR	Interferometric synthetic aperture radar
LACPGM	Los Angeles Coastal Plain Groundwater Model
LACDPW	Los Angeles County Department of Public Works
LADWP	Los Angeles Department of Water and Power
LAX	Los Angeles International Airport
LCP	Local Coastal Programs
MCL	Maximum Contaminant Level
mg/L	Milligrams Per Liter
msl	Mean Sea Level
MTBE	Methyl-tert-butyl ether
MWD	Metropolitan Water District of Southern California
NCCAG	Natural Communities Commonly Associated with Groundwater
NPDES	National Pollutant Discharge Elimination System
NOAA	National Oceanographic and Atmospheric Administration
PCE	Tetrachloroethene

Acronym/Abbreviation	Definition
Plan Area	Non-adjudicated portion of the Santa Monica Groundwater Subbasin
RWQCB	Regional Water Quality Control Board
SB	Senate Bill
SCAG	Southern California Association of Governments
SDWA	Safe Drinking Water Act
SMBGSA	Santa Monica Basin Groundwater Sustainability Agency
SMURRF	Santa Monica Urban Runoff Recycling Facility
SNMP	Salt and Nutrient Management Plan
Subbasin	Santa Monica Subbasin
SWP	State Water Project
SWRCB	State Water Resources Control Board
TCE	Trichloroethene
TDS	Total Dissolved Solids
SGMA	Sustainable Water Management Act
SMARTS	Stormwater Multiple Application and Report Tracking System
UCLA	University of California Los Angeles
USGS	U.S. Geological Survey
UWMP	Urban Water Management Plan
VOC	Volatile Organic Compound
WBMWD	West Basin Municipal Water District
WDR	Waste Discharge Requirement
WSA	Water Supply Analysis

Executive Summary

The Santa Monica Basin Groundwater Sustainability Agency (GSA), which comprises the City of Santa Monica, the City of Los Angeles via its Department of Water and Power (LADWP), the City of Culver City, the City of Beverly Hills, and the County of Los Angeles, has prepared this Groundwater Sustainability Plan (GSP) for the non-adjudicated portion of the Santa Monica Subbasin (Subbasin) of the Los Angeles Plain Groundwater Basin (DWR Basin 4-011.01). This GSP was prepared in compliance with the 2014 Sustainable Groundwater Management Act (SGMA), which is codified in California Water Code (CWC), Part 2.75 (Sustainable Groundwater Management), §10720 et seq.[1] This GSP has been developed in accordance with the Department of Water Resources (DWR) GSP Regulations[2] to apply to the entirety of the Subbasin that is not adjudicated[3] (Plan Area; Figure ES-1).

The purpose of this GSP is to define the groundwater conditions that will be used to ensure the long-term sustainability of groundwater resources for current and future stakeholders through ongoing, proactive stewardship. Long-term sustainability includes:

- Maintaining sufficient groundwater in storage to allow for continued groundwater production that meets the operational demands and regulatory commitments of the City of Santa Monica as well as other groundwater producers and stakeholders.
- Ensuring groundwater conditions in the Subbasin support sufficient seaward flow of fresh water to prevent significant and unreasonable seawater intrusion in the Silverado aquifer.
- Continuing groundwater production at rates and in aquifers that do not impact the ability of groundwater dependent ecosystems to access groundwater.

ES-1.0 Introduction

The Subbasin is an approximately 50-square mile groundwater basin in Los Angeles County (Figure ES-1). DWR has designated the Subbasin, which underlies the municipalities of Santa Monica, Los Angeles, Culver City, Beverly Hills, and the County of Los Angeles a medium-priority groundwater basin. As a result of this designation, the Subbasin is subject to SGMA. The cities of Santa Monica, Los Angeles, Culver City, and Beverly Hills, and the County of Los Angeles formed the Santa Monica Basin GSA under a memorandum of understanding (MOU) and notified DWR of their intent to become the GSA for the Subbasin in 2017. The SMBGSA assumes the responsibility for ensuring ongoing sustainable management of the groundwater resources of the Subbasin under the sustainable management criteria described in this GSP.

This GSP covers the entire extent of the Subbasin. However, as a result of mapping discrepancies between the southern boundary of the Subbasin and the northern boundary of the West Coast Basin adjudicated area, approximately 143 acres (less than 0.5%) of the Subbasin overlaps the West Coast Basin adjudicated area (Adjudication ID No. A05). Because production and distribution of groundwater in the adjudicated area is overseen by a watermaster, in accordance with a court judgement, the portion of the West Coast Basin adjudicated area that overlaps with the Subbasin is not

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1 Specific Sections of the CWC are cited in this GSP as "CWC § […]."

2 GSP Regulations refers to the emergency regulations adopted by DWR as California Code of Regulations (CCR), Title 23 (Waters), Division 2 (Department of Water Resources), Chapter 1.5 (Groundwater Management), Section 350 et seq. Specific Sections of the CCR are cited in the GSP as "23 CCR §[…]"

3 CWC Section 10720.8 states that SGMA does not apply to adjudicated basins. Slivers of both the West Coast and Central Basin adjudications overlap with the boundaries of the Santa Monica Subbasin, likely resulting from mapping inconsistencies through time. This GSP consists of a "single plan covering the entire basin developed and implemented by one groundwater sustainability agency," per CWC Section 10727(b)(1), with the Santa Monica GSA acting as the multi-agency GSA for the Subbasin.

subject to SGMA. Because this area is so small relative to the size of the entire Subbasin, and there are no groundwater production wells within the area of overlap, the descriptions of the Subbasin, water balance, and sustainable yield in this GSP incorporate the entire Subbasin, including the area of overlap.

The GSP was developed as part of a collaborative effort between the member agencies of the GSA and Subbasin stakeholders who participated in public meetings and provided feedback at different stages of GSP development. Stakeholder input has improved every section of this GSP, and the GSA remains committed to ongoing stakeholder engagement throughout the GSP implementation process.

ES-2.0 Basin Setting

The Subbasin, which is adjacent to the Pacific Ocean in western Los Angeles County, south of the Santa Monica Mountains, west of the Newport-Inglewood Fault Zone, and north of the Ballona Escarpment, is highly urbanized. Land use is predominantly residential (64%), with commercial, industrial, and public facilities accounting for an additional 23.5% of the land use. Open space occupies 11.5 % of the area in the Subbasin. There are no agricultural users of groundwater in the Subbasin.

Approximately 510,000 people live within the Subbasin boundaries. These residents are provided drinking water by one of six retail water utilities in the Subbasin: the City of Santa Monica, LADWP, the City of Beverly Hills, Los Angeles County Waterworks District 29, Golden State Water Company, and California American Water Company. Of these water utilities, the City of Santa Monica is the only one that produces groundwater from the Subbasin. There are no private domestic well users in the Subbasin.

ES-2.1 Surface Water and Precipitation

The Subbasin lies within the approximately 673-square mile Santa Monica Bay Hydrologic Unit (Figure ES-2). The primary drainages in the Subbasin are Ballona Creek, in the southern part of the Subbasin, and Santa Monica Canyon Channel and Rustic Canyon Channel in the northern part of the Subbasin. Ballona Creek, which is approximately 9 miles long, has been maintained as a lined and grouted flood-control channel since the 1950s (ACOE 1982). Santa Monica Canyon and Rustic Canyon Channels are also lined and drain directly into the Pacific Ocean (Figure ES-2). Flows in Ballona Creek within the Subbasin are measured, while those in Rustic Canyon and Santa Monica Canyon are not. Ballona Creek flows reflect the dry Southern California setting in which the Subbasin is located, with the majority of the flow occurring between November and March.

There are eight active precipitation stations in the Subbasin. Of these, the UCLA station operated by the National Oceanographic and Atmospheric Administration has the longest and most complete record. The average water-year[4] precipitation measured at the UCLA station is 17.3 inches from water years 1933 to 2019 (Figure ES-3). This gauge has the highest average precipitation in the Subbasin with precipitation measured at other gauges in the Subbasin ranging from 11.6 to 13.3 inches over the time period during which those gauges operated.

4 A water-year begins on October 1 and ends on September 30 of the following year. For example, water year 2015 began October 1, 2014 and ended September 30, 2015.

ES-2.2 Hydrogeologic Conceptual Model

Land surface elevations in the Subbasin range from approximately 2 feet above mean sea level (msl), adjacent to the Pacific Ocean on the western boundary of the Subbasin, to approximately 700 feet msl in the foothills of the Santa Monica Mountains (Figure ES-4). The Santa Monica Mountains form the northern boundary of the Subbasin, and the Pacific Ocean forms the western boundary of the Subbasin. To the east, the Subbasin is separated from the Hollywood and Central Subbasins by the Newport-Inglewood Fault Zone. To the south, the Subbasin is separated from the West Coast Subbasin by the Ballona Escarpment. The bottom of the Subbasin is defined by a change in sediment age and state of consolidation that occurs several hundred feet below land surface (Section 2.3.1).

Early Pleistocene marine sediments of the San Pedro Formation through late Holocene alluvial deposits of the Ballona aquifer compose the primary groundwater bearing sediments in the Subbasin. The two primary aquifers in the Subbasin are the Ballona aquifer, and the Silverado aquifer, the latter of which occurs within the San Pedro Formation. The Sunnyside aquifer, which also occurs within the San Pedro Formation, may be present beneath the Silverado aquifer in portions of the Subbasin, but is not currently used for groundwater production. The base of the San Pedro Formation, which occurs at depths ranging from 600 feet below mean sea level to 300 feet above mean sea level, is considered to be the base of the freshwater aquifers.

The variable thickness and depth of the San Pedro and overlying formations reflects the complex tectonic and depositional environment in the Subbasin. Movement along the Santa Monica Fault Zone, Anacapa-Dume fault, Brentwood Knoll, Overland Avenue Fault, and Newport-Inglewood Fault Zone have offset the base of the San Pedro Formation in several areas of the Subbasin and faulting impacts groundwater flow within the Subbasin.

The location of production areas within the Subbasin, the relative contribution of inflow and outflow sources, and the subsurface geology are shown in Figure ES-5, which summarizes the hydrogeologic conceptual model of the Subbasin. Historically, the primary inflows have been mountain front recharge and areal recharge (Figure ES-5). The primary outflow is groundwater production (Figure ES-5).

ES-2.3 Current and Historical Groundwater Conditions

Groundwater Elevations

Groundwater elevations in the Subbasin are influenced by the rates of groundwater production and groundwater recharge. Consistent groundwater elevation measurements are sparse before the late 1980s in the Silverado aquifer and the late 1990s in the Ballona aquifer. Groundwater elevations were measured more consistently in the Silverado aquifer at an earlier time because this is the primary groundwater production aquifer for the City of Santa Monica. However, consistent groundwater elevation measurements began in the late 1990s in the Ballona aquifer as part of various groundwater contamination investigations in the Subbasin.

Between 1999 and 2010, groundwater elevations rose in the Ballona aquifer in response to a period of above-average precipitation and reduced groundwater production from the City of Santa Monica's wells, which were shut down in 1996 after the discovery of methyl tert-butyl ether (MTBE)[5] in the groundwater. The City of Santa Monica resumed groundwater production from its Charnock wellfield in 2010, and groundwater elevations in the Ballona aquifer declined. Adjacent to the Charnock wellfield, groundwater elevation declined by approximately 30 feet

5 MTBE is a common fuel additive that helps gasoline burn more completely and reduces automobile emissions.

between 2010 and 2020, and several Ballona aquifer monitoring wells went dry. Approximately 3 miles south of the Charnock wellfield, at the southern boundary of the Subbasin, groundwater elevations declined by approximately 7 feet between 2010 and 2020. However, indicative of the complex faulting and depositional history of the Subbasin, groundwater elevations in southern Subbasin wells screened in the Ballona aquifer at a similar distance from the Charnock wellfield, but farther west declined by less than 3 feet between 2010 and 2020. The water level declines in these Ballona aquifer wells likely reflect the drier-than-average climate conditions over this time period, rather than the influence of groundwater production from the Charnock wellfield.

Within the Silverado aquifer groundwater elevation trends vary by location within the Subbasin. To the north of the Santa Monica Fault Zone, groundwater elevation trends reflect long term trends of recharge from the Santa Monica Mountains. In the central part of the Subbasin, groundwater elevations are driven by production at the Charnock and Olympic wellfields. Groundwater elevations rose between 1995 and 2010, when the Charnock wellfield was shut down, and declined between 2010 and 2020 with the resumption of groundwater production and the lower-than-average rainfall conditions. In the southern part of the Subbasin, groundwater elevations have been rising since the 1980s in some wells, while in others the groundwater elevations recover and decline in association with the shut-down and resumption of pumping at the Charnock wellfield.

Groundwater elevations in the Subbasin measured in the second half of 2018 ranged from approximately 0 feet above mean sea level (MSL) to 5 feet MSL in the Ballona aquifer, and from 53 feet below MSL to 230 feet above MSL in the Silverado aquifer. The highest groundwater elevations were measured in the northern part of the Subbasin, at the base of the Santa Monica Mountains, and the lowest groundwater elevations were measured adjacent to the Charnock wellfield. Groundwater flow directions in the Subbasin are complex and depend on both local groundwater production operations, and subsurface hydrogeology. In general, however, groundwater within the Subbasin tends to flow from the recharge areas in the north toward the south, except in areas of the City of Santa Monica production wellfields.

Groundwater in Storage

Change in groundwater in storage was calculated using the Los Angeles Coastal Plan Groundwater Model (LACPGM), developed by the United States Geological Survey (USGS). When the City of Santa Monica is not producing groundwater from the Charnock and Olympic wellfields, the LACPGM suggests that the Subbasin gains groundwater in storage in water years when the precipitation is greater than 105% of average. When the Charnock and Olympic wellfields are producing groundwater, however, the Subbasin gains groundwater storage in water years when the precipitation is greater than 135% of average. Between water years 1985 and 2012, the LACPGM estimates that groundwater in storage decreased by an average rate of approximately 580 AFY, for a cumulative decrease of approximately 15,700 AF (Figure ES-6). The primary influences on the groundwater in storage were groundwater production and groundwater recharge.

In this GSP, the current condition water budget was calculated from the LACPGM using the average groundwater supply, demand, and changes in storage between water years 2013 and 2015. During this time period, there was 3,300 AFY of average annual recharge to the Subbasin, and an average annual groundwater discharge of 11,800 AFY. This resulted in an average annual decrease in groundwater in storage of approximately 8,500 AFY between 2013 and 2015, for a cumulative decrease of approximately 25,500 AF. It should be noted that some of the recharge during this period came from the western boundary of the LACPGM, which may indicate the potential for seawater intrusion during periods of high groundwater production and low groundwater recharge.

Seawater Intrusion

The Subbasin is adjacent to the Pacific Ocean and has experienced historical episodes of seawater intrusion in the Ballona aquifer. Currently, however, there is no evidence of seawater intrusion in either the Ballona or Silverado aquifers in the Subbasin. Chloride concentrations measured between 2015 and 2019 in groundwater samples collected from wells screened in the Ballona aquifer ranged from 88 mg/L to 330 mg/L, with the highest concentration occurring at the farthest inland well and lower concentrations occurring closer to the coast. All of the samples were collected from wells near Playa Vista, in the southern Subbasin.

Chloride concentrations measured between 2015 and 2019 in groundwater samples collected from wells screened in the Silverado aquifer ranged from 51 mg/L to 530 mg/L (Figure ES-7). The highest concentrations of chloride in the Silverado aquifer were measured in the eastern Playa Vista area. There is, however, an area of the Silverado aquifer between Marina del Rey and the Charnock wellfield that currently lacks monitoring wells and chloride data. This GSP recommends installing two nested monitoring wells in this area to fill in this data gap.

Groundwater Quality

Groundwater quality data has been collected from wells within the Subbasin since the early 1900s. However, regular sampling and recording of groundwater quality data in the Subbasin did not begin until the 1980s. Samples from the City of Santa Monica municipal supply wells provide the most complete record of groundwater quality data in the Silverado aquifer. Additional groundwater quality data are available from monitoring wells associated with environmental cleanup sites, of which there are over 40 open sites and 535 total sites in the Subbasin.

Groundwater quality has been negatively impacted by industrial activity in the Subbasin. In 1996, after detecting MTBE, a fuel additive, in routine samples collected from its production wells in the Charnock wellfield, the City of Santa Monica ceased groundwater production from five of its most productive wells. In 2006, the City of Santa Monica reached a settlement with the responsible parties who have funded efforts to restore the Charnock wellfield to operational status. Industrial contamination has also impacted the Olympic wellfield. Treatment of the raw groundwater from both wellfields is required in order to meet drinking water standards. The City of Santa Monica complies with the requirements of the State Water Resources Control Board (SWRCB) Division of Drinking Water (DDW), which, in addition to requiring that treated water supplies be sampled to demonstrate compliance with drinking water quality standards, requires the City of Santa Monica and other water purveyors in the Plan Area to collect and analyze raw water samples from their drinking water systems (including groundwater wells).

Given the long history of urban development in the Subbasin, it is difficult to separate anthropogenic impacts to groundwater quality from natural groundwater quality conditions. Concentrations of inorganic constituents (sodium, calcium, magnesium, chloride, sulfate, and bicarbonate) in groundwater samples from across the Subbasin are, however, consistent with groundwater sourced from natural recharge. The *Water Quality Control Plan for the Los Angeles Region* (Basin Plan) defined groundwater quality objectives that provide for the “reasonable protection of beneficial uses of groundwater” for six constituents in the Subbasin: total dissolved solids (TDS), sulfate, chloride, boron, nitrate, and total coliform bacteria (Table ES-1).

Table ES-1. Santa Monica Subbasin Basin Plan Water Quality Objectives

Constituent	Basin Plan Objective (mg/L)[a]	MCL (mg/L)
TDS	1,000	1,000[b]
Sulfate	250	500[b]
Chloride	200	500[b]
Boron	0.5	1[c]
Nitrogen (nitrate plus nitrite)	10	10
Total Coliform Bacteria[d]	**1.1[d]**	**0.99[d]**

Notes:
a Source: RWQCB 2019
b Secondary Maximum Contaminant Level (SMCL)
c California notification level (NL)
d Total coliform objectives are measured in units of bacteria count per 100 mL

TDS concentrations measured between 2015 and 2019 exceeded the Basin Plan Objective in both the Ballona and Silverado aquifers in some, but not all, wells in the Subbasin. The highest concentrations of TDS were measured in the eastern Playa Vista area, where oilfield brines and other industrial activities have impacted the groundwater quality. Sulfate concentration in the eastern Playa Vista area also exceeded the Basin Plan Objective. Concentrations of TDS in the vicinity of the Olympic and Charnock wellfields ranged from 832 mg/L to 1,328 mg/L. Concentrations of sulfate in the Olympic and Charnock wellfields ranged from 230 mg/L to 460 mg/L.

Between 2015 and 2019, nitrate as nitrogen concentrations in the Ballona aquifer ranged from less than the detection limit (0.1 mg/L) to 0.07 mg/L. Nitrate as nitrogen concentrations in the Silverado aquifer ranged from less than the detection limit (0.1 mg/L) to 7.1 mg/L. In the Playa Vista area, groundwater in both the Ballona and Silverado aquifers has nitrate-reducing conditions, which is why nitrate concentrations in this area are below the detection limit.

Boron concentrations and total coliform bacteria were not measured in samples collected from the Ballona aquifer. Total coliform bacteria was also not measured in samples collected from the Silverado aquifer. Boron concentrations in the Silverado aquifer were below the Basin Plan Objective in all samples collected.

Subsidence

Subsidence related to groundwater withdrawal has not been documented historically and is not currently occurring in the Subbasin. Between 1996 and 2020, the land surface elevation at a surface deformation measurement station on the UCLA campus rose by 1 to 2 centimeters (0.4 to 0.8 inches). Interferometric synthetic aperture radar (InSAR) measurements indicate that the land surface elevation in the central part of the Subbasin may have declined by 0.3 to 0.5 centimeters (0.1 to 0.2 inches) since 2015. These declines are not linked to groundwater withdrawals as groundwater elevations during the period of measurement were generally above historical low groundwater levels. Instead, the change in land surface elevation is likely related to tectonic activity in the Subbasin.

Groundwater/Surface Water Connections and Groundwater Dependent Ecosystems

Surface water in the Plan Area is principally drained by storm drains constructed of reinforced concrete, brick, cast iron, clay and other impermeable materials. The primary drainages are Ballona Creek and Centinela Creek in the southern part of the Subbasin and Rustic Canyon Channel and Santa Monica Canyon Channel in the northern part of the Subbasin. The entire extent of the Rustic and Santa Monica Canyon channels is lined with concrete within the Subbasin and is therefore disconnected from the underlying groundwater aquifers. The eastern, upstream, portion of Ballona Creek is lined with concrete, while west of Centinela Avenue, Ballona Creek has paved or boulder-lined banks with an unpaved bottom.

At this transition from lined to unlined channel bottom, Ballona Creek is located within the sediments of the Bellflower aquitard and has an approximate elevation of 6 feet above mean sea level. Infiltration of surface water into the Bellflower aquitard downstream of Centinela Avenue contributes to the Ballona Wetlands Ecological Reserve (BWER), located approximately half a mile downstream. These wetlands constitute the primary area of groundwater-surface water interaction in the Subbasin.

Within the BWER there are approximately 40 acres of vegetation communities that rely on groundwater. The dominant species are mule fat (*Baccharis salicifolia),* quailbush (*Atriplex lentiformis)*, arroyo willow (*Salix lasiolepis)*, spreading alkalai weed (*Cressa truxillensis)*, and desert saltgrass *(Distichlis spicata)*. This vegetation, as well as other non-groundwater dependent vegetation, provides habitat for 17 special status species that were confirmed present within the boundaries of the BWER.

The overall health of the ecosystems in the BWER has been impacted by the channelization of Ballona Creek, construction of nearby roads, and modifications to the land surface during construction of Marina del Rey when the site was used as a receiving area for dredge spoils and fill materials. Degradation of the wetland habitat through time has resulted in a loss of vital ecosystem function. The California Department of Fish and Wildlife and the U.S. Army Corps of Engineers have proposed a restoration project for the BWER to restore wetland and other ecological functions, while also maintaining flood management.

There is no direct link between the shallow surface water in the Bellflower aquitard at BWER and the Silverado aquifer in the vicinity of the primary production wellfields. Therefore, groundwater production from existing wells will not impact groundwater elevations or the identified GDEs within the BWER.

ES-2.4 Water Budget

The water budget for the Subbasin was developed using the LACPGM. Groundwater conditions between 1985 and 2012 are characterized as the historical groundwater conditions in this GSP, and the historical water budget was calculated using the LACPGM results over this time period. Current conditions were calculated for the 2013 to 2015 time period. Future conditions were simulated using an updated version of the LACPGM. The updates included incorporating future projects, projected groundwater extractions, and recent and future projected climate conditions. The future water budget was calculated based on LACPGM results for 2016 through 2076. A summary of the historical, current, and projected water budgets for the Subbasin are presented in Table ES-2.

Table ES-2. Historical Current, and Projected Average Annual Water Budget Inflows and Outflows

	Inflows (AFY)	Outflows (AFY)	Average Annual Change in Storage (AFY)[1]
Plan Area			
Historical Period Average (1985-2012)	8,700	9,200	-600
Current Period Average (2013-2018)	3,300	11,800	-8,500

Table ES-2. Historical Current, and Projected Average Annual Water Budget Inflows and Outflows

	Inflows (AFY)	Outflows (AFY)	Average Annual Change in Storage (AFY)[1]
Future Projected Average (2019-2070)	10,600	10,700	100

Note:
1 Note that errors in rounding compound in the inflows and outflows so that the average annual change in storage, which was calculated separately and rounded independently, does not exactly match the difference between the inflows and outflows. Negative values are a loss of storage from the Subbasin.

Throughout the historical period, annual groundwater outflows from the Subbasin averaged approximately 9,200 AFY. Over the same period of time, groundwater in storage in the Plan Area decreased by approximately 15,700 AF, or approximately 600 AFY (Table ES-2; Figure ES-8). The change in groundwater storage in the historical period includes inflows averaging approximately 300 AFY across the western boundary of the Subbasin. Thus, the model is suggesting that a portion of the recharge to the Subbasin is coming from the ocean and may, over time, replace fresh groundwater in storage with seawater.

During the current period, which comprised 3 water years with an average annual precipitation of 8.6 inches, or approximately half of the average annual precipitation, groundwater inflows to the Subbasin were less than half of the historical inflows, and groundwater outflows increased by approximately 2,600 AFY over the historical average outflows. Thus, the Subbasin experienced a net decline in storage of approximately 25,500 AF between 2013 and 2015 (Figure ES-8). The change in groundwater storage in the current period includes inflows averaging approximately 1,300 AFY across the western boundary of the Subbasin.

Under projected conditions, groundwater outflows in the Subbasin are estimated to reach 10,700 AFY with ongoing groundwater production from the City of Santa Monica's Charnock wellfield. At a constant groundwater production rate of approximately 9,200 AFY, groundwater in storage is anticipated to increase on average by approximately 1,000 AF over the course of the 60-year projected hydrologic conditions (Figure ES-9). Given the uncertainty inherent in the model projection of future conditions, an increase of 1,000 AFY over the 61-year modeling period is equivalent to no net loss or gain of storage in the future projection. However, the change in groundwater storage in the projected conditions includes inflows averaging approximately 2,100 AFY across the western boundary of the Subbasin. If approximately 2,100 AFY of the 10,700 AFY of total recharge, or approximately 20% of the total recharge, to the Subbasin is coming from the ocean, seawater intrusion may cause undesirable results in the Subbasin in the future. This GSP recommends additional monitoring for seawater intrusion in the area between Marina del Rey and the Charnock wellfield to monitor for and avoid undesirable results from seawater intrusion.

Potential impacts to the projected water budget were also evaluated using two projected climate scenarios, provided by DWR. These two scenarios, which are taken from global climate models and scaled to 6 square kilometer grids across California, project changes to future precipitation and evapotranspiration rates in 2030 and 2070. Using projected precipitation and evapotranspiration conditions for 2030, the cumulative increase in storage in the Subbasin was projected to be approximately 2,000 AF. In the 2070 climate scenario, the cumulative increase in storage was projected to be approximately 2,400 AF. Flow across the western boundary of the model is projected to be 2,100 AFY in the 2030 climate scenario, and 2,000 AFY in the 2070 climate scenario. The storage change and flows across the western boundary in the 2030 and 2070 climate scenarios are similar to that in the future baseline scenario without climate change.

Sustainable Yield

Historical estimates for the sustainable yield of the Subbasin range from 10,800 AFY to 19,700. These estimates, which are typically broken down by production area[6] within the Subbasin, refer to a groundwater budget extraction amount that produced no long-term net loss of groundwater storage relative to the water balance recharge. As defined by SMGA, "sustainable yield" means the maximum quantity of groundwater, calculated over a base period representative of long-term conditions in the Subbasin and including any temporary surplus, that can be withdrawn annually from a groundwater supply without causing an undesirable result relative to any of the six groundwater sustainability indicators. Because undesirable results related to groundwater extraction have not been observed historically in the Silverado aquifer, which is the primary source of groundwater, and estimated flow across the western boundary of the Subbasin in the future model scenarios may fall within the uncertainty of the model estimates at this time, this GSP adopts the historical range of estimates for the sustainable yield for the Subbasin of 10,800 AFY to 19,700 AFY.

ES-3.0 Sustainable Management Criteria

The sustainability goal for the Subbasin is to ensure the long-term health and availability of groundwater resources for current and future stakeholders through ongoing, proactive stewardship. Long-term health and availability include:

- Maintaining sufficient groundwater in storage to allow for continued groundwater production that meets the operational demands and regulatory commitments of the City of Santa Monica as well as other groundwater producers and stakeholders.
- Ensuring groundwater conditions in the Subbasin support sufficient seaward flow of fresh water to prevent significant and unreasonable seawater intrusion in the Silverado aquifer.
- Continuing groundwater production at rates and in aquifers that do not impact the ability of groundwater dependent ecosystems to access groundwater.

The sustainability goal for the Subbasin was developed based on the current understanding of the hydrogeologic conceptual model, which incorporates historical groundwater elevation, groundwater in storage, and groundwater quality data. Over the past 30 years, groundwater in storage has fluctuated, increasing between 1995 and 2010 and declining between 2010 and 2015, with the resumption of production from the City of Santa Monica's Charnock wellfield and the onset of drought marked by several below-average precipitation years in a row (Figure ES-6). Undesirable results related to groundwater production have not been observed in the Subbasin since the 1950s, indicating long-term sustainable management of the Subbasin by the GSA member agencies and stakeholders.

ES-3.1 Undesirable Results

Under SGMA, undesirable results occur when the effects caused by groundwater conditions occurring throughout the Subbasin cause significant and unreasonable impacts to any of six sustainability indicators. The undesirable results are:

- Chronic Lowering of Groundwater Levels

6 This GSP adopts the term "production area" to refer to the historical subbasins to avoid confusion with references to the Santa Monica Subbasin itself.

- Significant and Unreasonable Reduction of Groundwater in Storage
- Significant and Unreasonable Degradation of Water Quality
- Significant and Unreasonable Land Subsidence
- Significant and Unreasonable Depletion of Interconnected Surface Water
- Significant and Unreasonable Seawater Intrusion

The definition of significant and unreasonable for each of the six indicators was determined by the GSA using the processes and criteria described in this GSP.

Chronic Lowering of Groundwater Levels

Significant and unreasonable chronic lowering of groundwater levels indicating a depletion of supply is an undesirable result applicable to the Subbasin. The primary cause of groundwater conditions that would lead to a significant and unreasonable chronic lowering of groundwater levels is groundwater production in excess of natural and artificial recharge over a period that contains both wet and dry water years. Chronic lowering of groundwater levels in the Subbasin would cause undesirable results if groundwater levels drop to elevations below which:

- The effectiveness of existing and future projects to mitigate groundwater quality degradation in the Subbasin is impaired
- The volume of groundwater available in the aquifer is insufficient for beneficial uses; and
- Land subsidence that is induced by groundwater withdrawals substantially interferes with land use

The GSA used well construction information, production history, and historical water levels to define that chronic lowering of groundwater levels indicating a depletion of supply may occur in the Subbasin if pumping groundwater elevations at the Charnock and Olympic wellfields fall below 50% of the combined thickness of the Silverado and Sunnyside aquifers. Therefore, the criteria used to define undesirable results associated with chronic groundwater level declines are static groundwater elevations in monitoring wells that correspond to pumping groundwater levels at the mid-point of the Silverado and Sunnyside aquifers in the Subbasin.

Significant and Unreasonable Reduction of Groundwater in Storage

Significant and unreasonable reduction of groundwater in storage is an undesirable result applicable to the Subbasin. Reduction of groundwater in storage is related to chronic lowering of groundwater levels. The primary cause of a reduction of groundwater in storage is groundwater production in excess of natural and artificial recharge during a period containing both wet and dry water years. The GSA used well construction information, production history, and historical groundwater levels to define that significant and unreasonable reduction of groundwater in storage could occur in the Subbasin if pumping groundwater elevations at the fall below the mid-point of the Silverado and Sunnyside aquifers. Therefore, the criteria used to define undesirable results associated with reduction of groundwater in storage are static groundwater elevations in monitoring wells that correspond to pumping groundwater levels at the mid-point of the Silverado and Sunnyside aquifers in the Subbasin.

Groundwater elevations that correspond to the mid-point of the Silverado and Sunnyside aquifers are lower than historical low water levels. However, reduction of groundwater storage beyond that previously experienced in the Subbasin may be required to maintain operational flexibility for water quality management projects, protect potable groundwater supplies, and ensure ongoing beneficial use of groundwater for municipal and industrial purposes.

Significant and Unreasonable Seawater Intrusion

Significant and unreasonable seawater intrusion is an undesirable result that could occur in the Subbasin. Seawater intrusion is related to chronic lowering of groundwater levels, and the primary cause of seawater intrusion is groundwater production in excess of natural and artificial recharge during a period containing both wet and dry water years. The GSA used historical groundwater quality data to define that significant and unreasonable seawater intrusion could occur in the Subbasin if chloride concentrations at the primary production wellfields reach 500 mg/L.

Significant and Unreasonable Degradation of Water Quality

The Subbasin has not experienced significant and unreasonable degradation of groundwater quality related to groundwater production. However, significant and unreasonable degradation of groundwater quality resulting from historical industrial and manufacturing activities, as well as leaking underground storage tanks at multiple gas stations, is an undesirable result that occurred in the Subbasin prior to 2015. The City of Santa Monica's groundwater production wells are currently being used to help remediate the groundwater in the Subbasin. Because there is no historical evidence of groundwater production causing significant and unreasonable degradation of groundwater quality in the Subbasin, industrial contamination of the Subbasin occurred prior to 2015, and the City of Santa Monica is actively remediating this contamination under the regulatory oversight of the SWRCB, DDW, and RWQCB, this GSP does not define additional undesirable results for groundwater degradation within the Subbasin.

Significant and Unreasonable Land Subsidence Resulting from Groundwater Withdrawals

Land subsidence resulting from groundwater withdrawal is a sustainability indicator that is applicable to the Subbasin, but significant and unreasonable land subsidence resulting from groundwater withdrawal is not currently occurring within the Subbasin. Groundwater levels that are below historical conditions may cause subsidence because groundwater acts to reduce the effective stress needed to maintain pore-structures in the aquifer. As groundwater levels decline, pressure on the aquifer matrix increases, which may cause the pore-structure to collapse, causing the land surface to subside. The undesirable result for land subsidence in the Subbasin is defined as land subsidence resulting from groundwater withdrawals that substantially interferes with surface land uses. Groundwater levels will be used as a proxy for direct measurement of land subsidence.

Significant and Unreasonable Depletion of Interconnected Surface Water and Groundwater

Significant and unreasonable reduction of interconnected surface water and groundwater is an undesirable result that is not occurring within the Subbasin and is unlikely to occur in the Subbasin. The Subbasin is characterized by channels that have historically been lined with concrete to facilitate flood protection. Therefore, the primary surface drainages are disconnected from the underlying groundwater throughout much of the Subbasin.

Potential wetlands, shallow groundwater (less than 30 feet[7]), and groundwater dependent ecosystems (GDEs) have been identified within the Subbasin. However, depletion of groundwater supporting these areas is not currently occurring and will not occur as a result of groundwater production because the groundwater that supports the GDE habitats occurs within the Bellflower aquitard, a shallow surface aquifer that is not used for groundwater production.

7 30-foot depth is identified by the Nature Conservancy as representative of groundwater conditions that may sustain common phreatophytes and wetland ecosystems (Rohde et al. 2018).

Because the identified GDE habitat in the Subbasin is not supported by groundwater in the Ballona or Silverado aquifers, where the majority of the groundwater in the Subbasin is produced, and no groundwater production is planned for the Bellflower aquitard within one mile of the existing habitat, specific undesirable results related to interconnected surface water and groundwater are not defined in this GSP. However, in the event that future groundwater production is planned within a mile of the BWER, additional investigations should be performed to assess whether the planned production may cause significant and unreasonable depletion of interconnected surface water and groundwater that negatively impacts GDEs

Defining Undesirable Results

Undesirable results are defined using representative monitoring points (RMPs) selected from the broader groundwater monitoring well network in the Subbasin. Eighteen total RMPs were selected; eight are used to monitor undesirable results related to groundwater levels and ten are used to monitor undesirable results related to seawater intrusion (Figure ES-10; Table ES-3).

Table ES-3. Representative Monitoring Points in the Subbasin

RMP Casing Name	Groundwater Monitoring Program [a]	Screen Interval (s) (ft bgs)	Sustainability Indicator(s)[b] Monitored
RMW-3	CASGEM; Charnock R	179.5–199.5	Levels, Storage, Subsidence
RMW-8	CASGEM; Charnock R	240–269.5	Levels, Storage, Subsidence
RMW-9	CASGEM; Charnock R; Charnock E	164–184	Levels, Storage, Subsidence
RMW-28	CASGEM; Charnock R	157–172	Levels, Storage, Subsidence
OB-7	CASGEM; Olympic	215–246	Levels, Storage, Subsidence
OB-9B	CASGEM; Olympic	202.15–222.15	Levels, Storage, Subsidence
OB-9C	CASGEM; Olympic	305.33–335.33	Levels, Storage, Subsidence
OB-17C	CASGEM; Olympic	295.6–325.6	Seawater Intrusion
Arcadia No. 4	DDW	85–218	Seawater Intrusion
Arcadia No. 5	DDW	122–222	Seawater Intrusion
Santa Monica No. 1	DDW	151–250	Seawater Intrusion
Santa Monica No. 3	DDW	210–270; 300–380; 410–430; 490–530	Seawater Intrusion
Santa Monica No. 4	DDW	200–410; 470–540	Seawater Intrusion
Charnock No. 16	DDW	230–390	Seawater Intrusion
Charnock No. 18	DDW	240–455	Seawater Intrusion
Charnock No. 19	DDW	200–450	Seawater Intrusion

Table ES-3. Representative Monitoring Points in the Subbasin

RMP Casing Name	Groundwater Monitoring Program [a]	Screen Interval (s) (ft bgs)	Sustainability Indicator(s)[b] Monitored
Charnock No. 20	DDW	242–295; 315–385	Seawater Intrusion
City Hall Well	—	60–90; 120–160	Seawater Intrusion

Notes:

[a] The majority of the RMPs are associated with existing groundwater monitoring programs discussed further in Section 2.1.2 Water Resources Monitoring and Management Programs. CASGEM = California Statewide Groundwater Elevation Monitoring; Charnock R = Charnock Groundwater Management Program; Charnock E = Charnock Early Warning Groundwater Quality Monitoring; DDW = Division of Drinking Water; Olympic = Olympic Wellfield Groundwater Monitoring Program

[b] Levels = Chronic Decline in Groundwater Levels, Subsidence = Land Subsidence resulting from groundwater withdrawals, Storage = Reduction of Groundwater Storage

The eight wells used to monitor undesirable results related to chronic declines in groundwater elevation, significant and unreasonable loss of groundwater in storage, and significant and unreasonable land subsidence resulting from groundwater withdrawal were chosen based on their proximity to areas of active groundwater production, well construction, and records of measurement, and inclusion in historical groundwater monitoring programs. Historical groundwater elevations at these wells are representative of groundwater conditions in the vicinity of the primary production wellfields. Undesirable results for chronic lowering of groundwater levels, significant and unreasonable reduction of groundwater in storage, and land subsidence resulting from groundwater withdrawals are defined as groundwater elevations that are below the minimum threshold at five out of the eight-water level representative monitoring points.

The ten wells used to monitor undesirable results related to groundwater quality were chosen because they have the longest record of chloride concentrations in the Subbasin and are the wells that would be impacted if chloride concentrations increase in the Subbasin. The Subbasin would be found to be experiencing undesirable results related to significant and unreasonable seawater intrusion if the concentration of chloride exceeds 500 mg/L at six of the ten seawater intrusion representative monitoring points.

New monitoring wells are recommended to be installed to add to the understanding of seawater intrusion in the Subbasin over the next 5 years. The data from these wells will be included in the monitoring network for the GSP.

ES-3.2 Minimum Thresholds

Minimum threshold groundwater elevations established at the eight RMPs used to monitor undesirable results related to chronic declines in groundwater elevation, significant and unreasonable loss of groundwater in storage, and significant and unreasonable land subsidence resulting from groundwater withdrawals, coincide with pumping water levels at the mid-point of the Silverado and Sunnyside aquifers (Table ES-4). The water level minimum thresholds provide operational flexibility for projects in the Subbasin that aim to mitigate groundwater quality degradation while ensuring ongoing beneficial use of groundwater by maintaining the volume of groundwater available for municipal and industrial supplies.

Table ES-4. Minimum Thresholds and Measurable Objectives

RMP	Chronic Decline in Groundwater Levels		Reduction of Groundwater Storage		Land Subsidence		Seawater Intrusion	
	Groundwater Elevation (ft MSL)						*Concentration of TDS (mg/L)*	
	MT[1]	*MO*[2]	*MT*	*MO*	*MT*	*MO*	*MT*	*MO*
RMW-3	-175	-115	-175	-115	-175	-115	NA	NA
RMW-8	-165	-110	-165	-110	-165	-110	NA	NA
RMW-9	-165	-110	-165	-110	-165	-110	NA	NA
RMW-28	-160	-105	-160	-105	-160	-105	NA	NA
OB-7	5	30	5	30	5	30	NA	NA
OB-9B	20	45	20	45	20	45	NA	NA
OB-9C	-95	-40	-95	-40	-95	-40	NA	NA
OB-17C	-85	-30	-85	-30	-85	-30	NA	NA
Arcadia No. 4	NA	NA	NA	NA	NA	NA	500	200
Arcadia No. 5	NA	NA	NA	NA	NA	NA	500	200
Santa Monica No. 1	NA	NA	NA	NA	NA	NA	500	200
Santa Monica No. 3	NA	NA	NA	NA	NA	NA	500	200
Santa Monica No. 4	NA	NA	NA	NA	NA	NA	500	200
Charnock No. 16	NA	NA	NA	NA	NA	NA	500	200
Charnock No. 18	NA	NA	NA	NA	NA	NA	500	200
Charnock No. 19	NA	NA	NA	NA	NA	NA	500	200
Charnock No. 20	NA	NA	NA	NA	NA	NA	500	200
City Hall Well	NA	NA	NA	NA	NA	NA	500	200

Notes:
Interconnected surface water-groundwater and degradation of water quality related to groundwater production MTs are not established because they are not undesirable results applicable to the Subbasin. (NA) -Not Applicable
1 MT – Minimum Threshold
2 MO – Measurable Objective

Although seawater intrusion is related to groundwater elevation, the two cannot be correlated in the Subbasin at the present time because seawater intrusion is not currently occurring within the Subbasin and the LACPGM parameters that are most sensitive to seawater intrusion have a small influence on the model predicted groundwater elevations. Therefore, groundwater level thresholds cannot be used as a proxy for seawater intrusion. The minimum threshold for significant and unreasonable seawater intrusion is a chloride concentration of 500 mg/L in groundwater at the ten-seawater intrusion RMPs (Table ES-4). A concentration of chloride in the groundwater equal to 500 mg/L corresponds to the lower limit of brackish groundwater.

ES-3.3 Measurable Objectives

Measurable objectives are "quantifiable goals for the maintenance and improvement of specified groundwater conditions that have been included in an adopted Plan [GSP] to achieve the sustainability goal for the basin" (23 CCR §351. Definitions). The groundwater level measurable objectives are between 25 feet and 60 feet higher than the groundwater level minimum thresholds in the Subbasin (Table ES-4). These measurable objectives provide a reasonable margin of operational flexibility under adverse conditions, by allowing for changes to groundwater production to occur before the groundwater levels reach an elevation at which undesirable results would occur. The groundwater level measurable objectives are approximately equal to historical low groundwater levels at the RMPs in the Subbasin.

Groundwater quality measurable objectives were established using the Basin Plan Objective of 200 mg/L chloride (Table ES-4). The Basin Plan Objective is based on the historical water quality and the concentration of chloride at the RMPs is currently below the Basin Plan Objective.

ES-3.4 Monitoring Network

The objective of the monitoring network in the Subbasin is to track and monitor parameters that demonstrate groundwater conditions, and associated factors that influence groundwater conditions. In order to accomplish this objective, the monitoring network must be capable of:

- Monitoring changes in groundwater conditions
- Monitoring groundwater conditions relative to the sustainable management criteria
- Quantifying annual changes in water budget components.

The Subbasin has an existing network of wells that are used to monitor groundwater conditions. This network includes both dedicated monitoring wells and production wells. The current network is capable of representing groundwater conditions in the Subbasin. The network will continue to be used to monitor groundwater conditions to assess long and short-term trends in groundwater elevation and groundwater quality. New monitoring wells are recommended to be installed to add to the understanding of seawater intrusion in the Subbasin over the next 5 years. The data from these wells will be included in the monitoring network for the GSP.

Additionally, this GSP recommends installing meters on all groundwater wells producing more than 2 AFY from the Subbasin. Currently, groundwater extraction volumes are only available from the City of Santa Monica groundwater production wells. Metering all wells that produce more than 2 AFY will provide data that can be incorporated into numerical groundwater model updates to provide a more comprehensive understanding of the sustainable yield of the Subbasin.

ES-4.0 Projects and Management Actions

The projects and management actions outlined in this GSP document the potential actions that the GSA could undertake in the event that the current understanding of the hydrogeologic conceptual model of the Subbasin, and the numerical groundwater modeling based on that conceptual model, have not sufficiently represented the long-term groundwater conditions in the Subbasin. At this time, projects and management actions are not necessary to achieve sustainability in the Subbasin, which has been managed sustainably over the past 30 years. However, projects and management actions may be necessary to respond to changing conditions in the Subbasin in the future.

ES-4.1 Management Action #1 - Adjust Groundwater Production As-Needed to Meet Water Level and/or Water Quality Objectives

The City of Santa Monica is committed to environmental stewardship. This includes becoming carbon neutral by 2050 and reducing the volume of imported water to the greatest extent possible. While the City of Santa Monica is implementing projects to reduce reliance on imported water, the City will maintain the two MWD turnouts that deliver water to the Subbasin to provide added water security in case groundwater production causes undesirable results in the Subbasin, or in case of a natural disaster or other emergency. Under this management action the City of Santa Monica could adjust the volume of groundwater produced in different geographic areas while maintaining the overall flow needed to meet anticipated consumer demand. Additionally, if undesirable results occur within the Subbasin, the City of Santa Monica could reduce its overall groundwater production while still meeting customer demand by using additional imported water until the undesirable results are stopped.

ES-4.2 Management Action #2 – Impose Recharge or Imported Water Purchase/Pumping Offset Fee

The City of Santa Monica is currently both the largest producer of groundwater and the sole producer of drinking water within the Subbasin. Since at least 1985, the combined groundwater extractions from the City of Santa Monica wells and private wells have not exceeded the sustainable yield of the Subbasin and projected future extractions are not anticipated to cause undesirable results in the Subbasin. Projected groundwater extractions are, however, anticipated to approximately equal the sustainable yield of the Subbasin. Therefore, new projects that rely on groundwater or increase groundwater production rates from existing wells would exceed the production rates modeled and may cause undesirable results. In the event that groundwater conditions within the Subbasin warrant additional management by the GSA, the GSA may impose a replenishment fee, or a water purchase / pumping offset fee for groundwater users in the Subbasin. These fees would be used to develop and support projects that increase recharge or purchase imported water to offset groundwater production in the Subbasin.

ES-4.3 Management Action #3 – Develop a Salt Nutrient Management Plan for the Subbasin

The Santa Monica Subbasin does not currently have a salt and nutrient management plan (SNMP) to address the use of recycled water in the Subbasin, and its potential impacts on groundwater quality. Recycled water may play an integral role in maintaining the sustainability of groundwater conditions in the Subbasin, as it could be used to replenish groundwater pumped in production areas, as a seawater injection barrier, or for other municipal and industrial uses. The SNMP for the Subbasin would be prepared by the relevant GSA member agencies, not by the GSA itself, and the relevant member agencies would work in collaboration with Subbasin stakeholders and other interested parties, as well as LADPW, the Sanitation Districts of Los Angeles County, and any other relevant wastewater entities. The SNMP process was designated by the SWRCB as the appropriate way to address salt and nutrient issues and ensure attainment of water quality objectives and protection of beneficial uses.

ES-4.4 Management Action #4 – Develop a Groundwater Allocation

In the event that new projects relying on groundwater production for non-municipal purposes or increasing groundwater production rates from existing wells cause undesirable results in the Subbasin, the SMBGSA may enact a means of limiting over-pumping by developing a groundwater allocation for pumpers in the Subbasin. Any groundwater allocation would be developed in conjunction with Subbasin stakeholders and would be anticipated to incorporate historical groundwater production from existing stakeholders and the City of Santa Monica. After development of the groundwater allocation, the SMBGSA would work to develop a fee structure for groundwater production in excess of the allocations assigned to each groundwater producer. If conditions require, this management action would be developed with stakeholder input after the GSP is adopted.

ES-4.5 Management Action #5 – Increase Water Conservation

The City of Santa Monica has successfully implemented water conservation measures that have reduced the average per capita water use to 110 gallons per capita per day (City of Santa Monica 2018). The City intends to further reduce the aggregate water use to 90 gallons per capita per day by 2025 through continuation of existing water saving programs and implementation of new incentives and programs. The existing and new incentives and programs will together save an estimated 677 AFY by 2025 and 732 AFY by 2030, thereby reducing groundwater demand in the Subbasin.

ES-4.6 Project #1 – Increase Recycled Water for Non-Potable Reuse

The City of Santa Monica intends to reduce reliance on imported water and reduce demand for local groundwater by increasing production of recycled water. This project, which is anticipated to be completed in 2022 will provide approximately 500 AFY additional supply for the City of Santa Monica's non-potable system, as well as for groundwater recharge.

ES-4.7 Project #2 – Recharge Local Groundwater Aquifers

City of Santa Monica plans to construct a new advanced water purification facility which, after proper permitting, will provide purified water to recharge groundwater aquifers adjacent to the Olympic Wellfield and offset imported water purchases by approximately 1,100 AFY. This project was included in the future groundwater model simulations used to assess the future water budget in the Subbasin. Prior to implementation, this project will require permitting from DDW.

ES-4.8 Project #3 – Production Efficiency Enhancement at Arcadia Water Treatment Plant

The City of Santa Monica Arcadia Water Treatment Plant currently has an efficiency rate of 82%. Improving the efficiency of the treatment process will yield additional treated water from the equivalent volume of raw water, which will help reduce groundwater demand. The City of Santa Monica is in the process of upgrading the efficiency of the treatment process at the Arcadia WTP to approximately 90%, which is anticipated to yield approximately 1,000 AFY of treated water and reduce demand on groundwater production.

ES-4.9 Project #4 – Install Additional Monitoring Wells

While the exiting groundwater monitoring network is adequate to document conditions in the Subbasin, it could be improved by the addition of two wells in the area between Marina Del Rey and the Charnock wellfield. These wells could be used to help refine the understanding of the hydrostratigraphy and aquifer properties and would be incorporated into the groundwater level and seawater intrusion monitoring networks for the Subbasin.

ES-4.10 Project #5 – Conduct Additional Investigations and/or Technical Studies

Projected groundwater elevations in the Subbasin are not expected to approach either the measurable objectives, or the minimum thresholds at any of the groundwater level RMPs during the 50-year planning and implementation horizon under the future baseline scenario. However, measured future groundwater conditions may differ from the projected conditions. If the projects and management actions listed above fail to control groundwater level declines or increases in chloride concentration at the RMPs, the City of Santa Monica will conduct additional investigations and/or technical studies to fill in data gaps and improve the understanding of the primary controls on groundwater conditions in the Subbasin.

ES-4.11 Adaptive Management

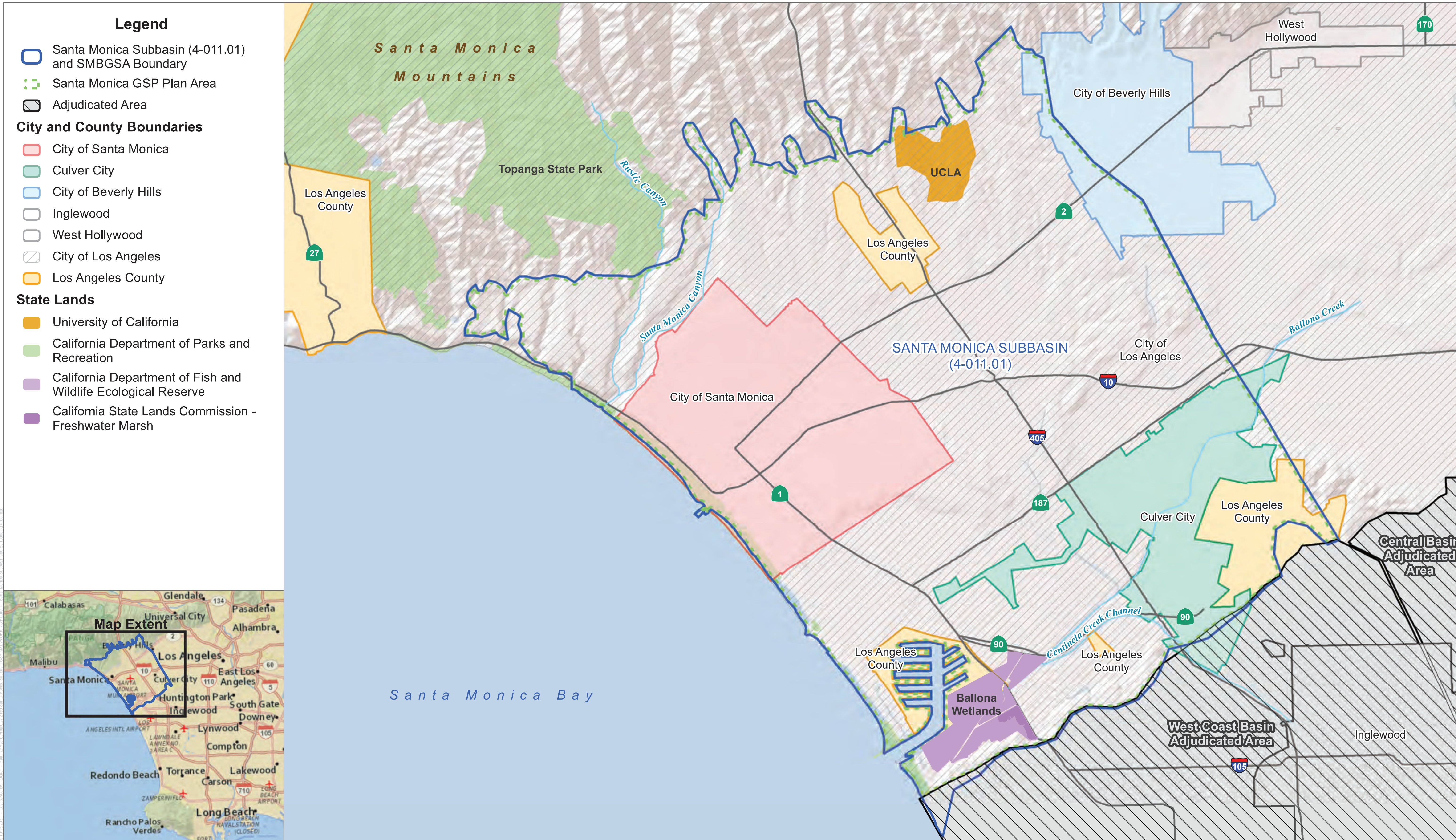
The projects and management actions included in this GSP are part of a broad portfolio of management strategies that the City of Santa Monica has successfully employed to sustainably manage groundwater conditions in the Subbasin to date. The City of Santa Monica and the SMBGSA have adopted an adaptive management strategy for the Subbasin. Because projects have been implemented to improve groundwater quality in the Subbasin, the decision to pursue or implement the projects and management actions in this GSP will be based on an evaluation of potential impacts to future groundwater conditions, including groundwater quality, in the Subbasin. This allows for additional data to be collected, which will help reduce uncertainty and inform future decision-making.

Consistent with SGMA, the projects and management actions suggested in this GSP will be evaluated every five years, at a minimum. New projects or management actions may be proposed, and the current projects and management actions may be modified or eliminated during the 5-year evaluation process.

ES-5.0 GSP Implementation

Implementation of this GSP will require the SMBGSA to prepare and submit annual reports and 5-year GSP evaluations to DWR. The City of Santa Monica, as the primary point of contact for the GSP, will be the member agency responsible for submitting these reports. The City of Santa Monica has prepared reports for numerous groundwater monitoring and remediation activities in the Subbasin and will submit an annual report for the Subbasin to DWR by April 1 of each year. The annual report will include the required components for each preceding water year.

The SMBGSA will evaluate the GSP every five years as required by SGMA. This 5-year evaluation will be provided as a written assessment to DWR that will describe whether the GSP implementation, including implementation of projects and management actions, are suitable to maintain sustainable groundwater use in the Subbasin.



SOURCE: ESRI; DWR; USGS; Los Angeles County

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FIGURE ES-1

Santa Monica Subbasin and Surrounding Area

Groundwater Sustainability Plan for the Santa Monica Subbasin

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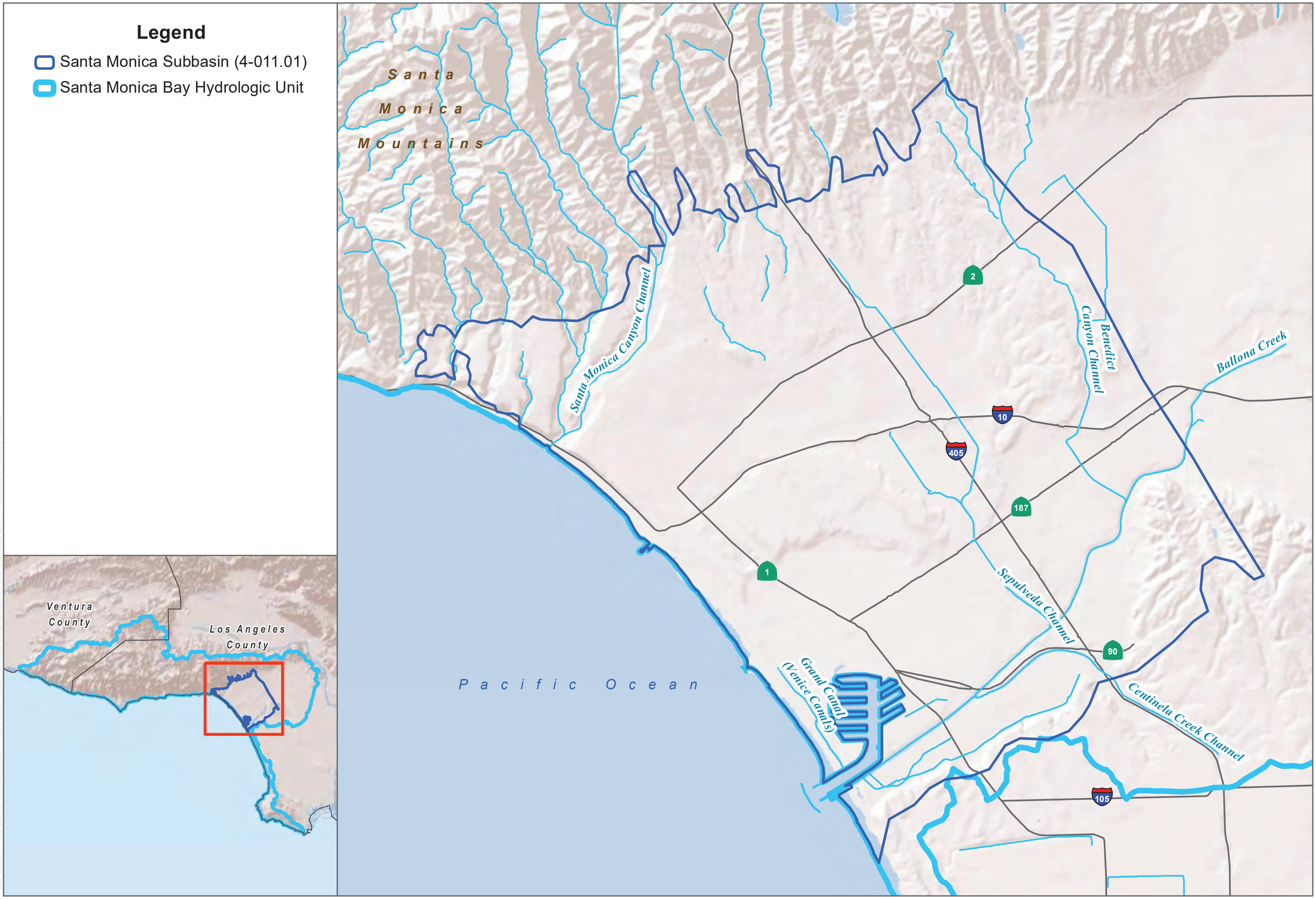

SOURCE: ESRI; DWR; USGS

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FIGURE ES-2

Watershed and Drainage Map

Groundwater Sustainability Plan for the Santa Monica Subbasin

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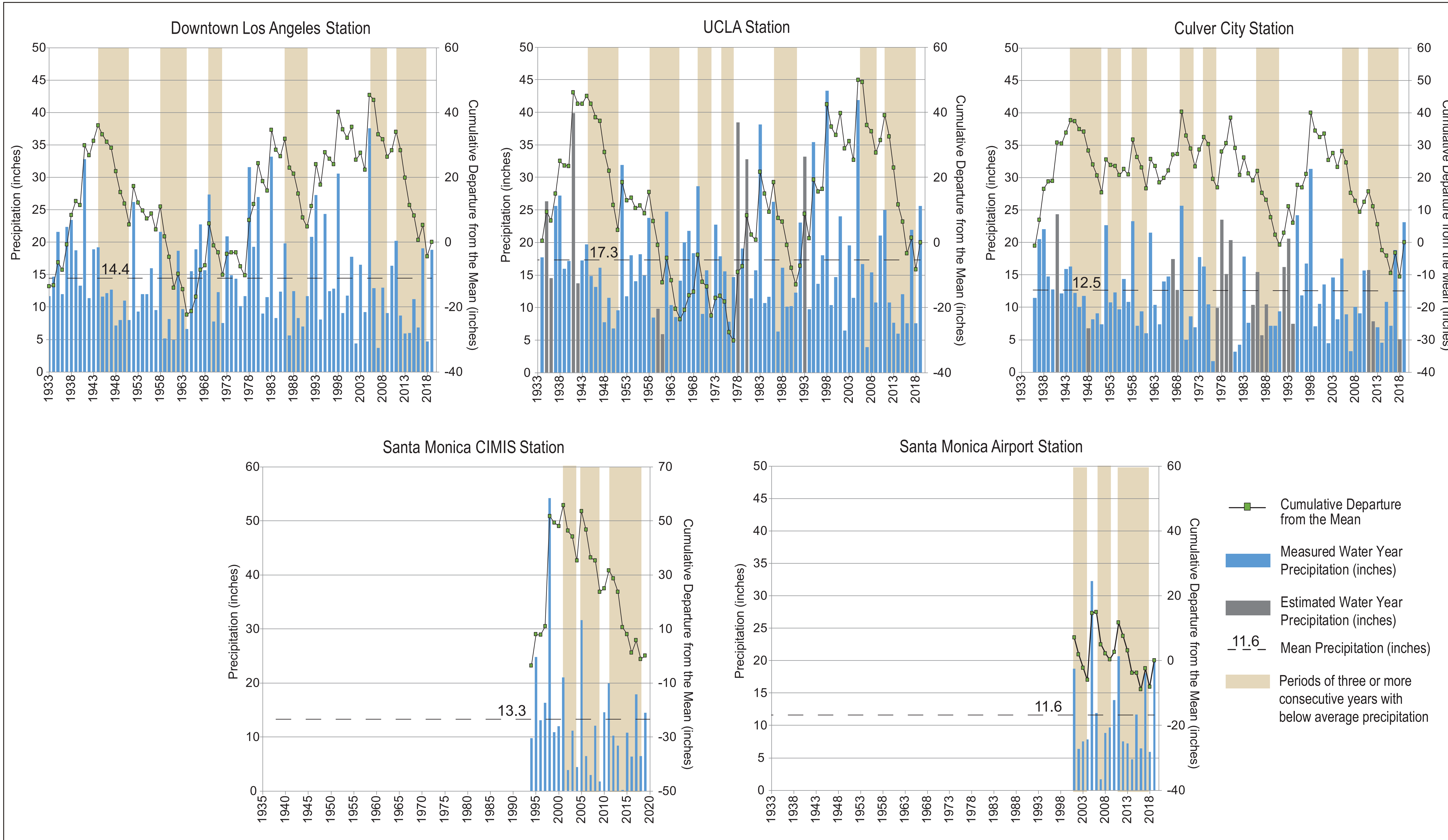

SOURCE: NOAA; CIMIS
NOTE: 1) Water Year is October 1 through September 30; 2) Estimated Water Year Precipitation Reconstructed from Correlation with Downtown LA Station

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FIGURE ES-3

Water Year Precipitation

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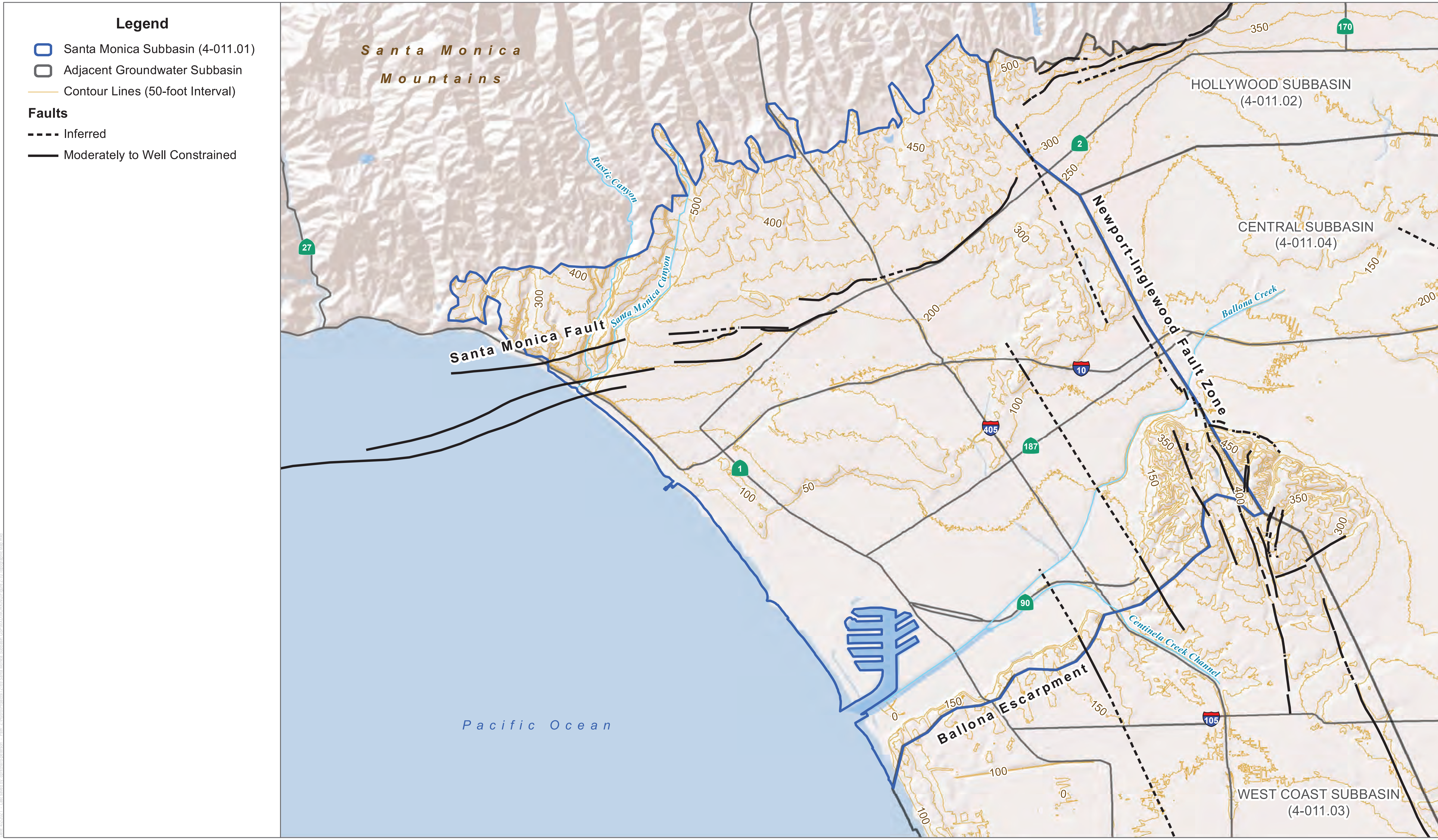

SOURCE: ESRI; DWR; USGS; LARIAC

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FIGURE ES-4

Topographic Map

Groundwater Sustainability Plan for the Santa Monica Subbasin

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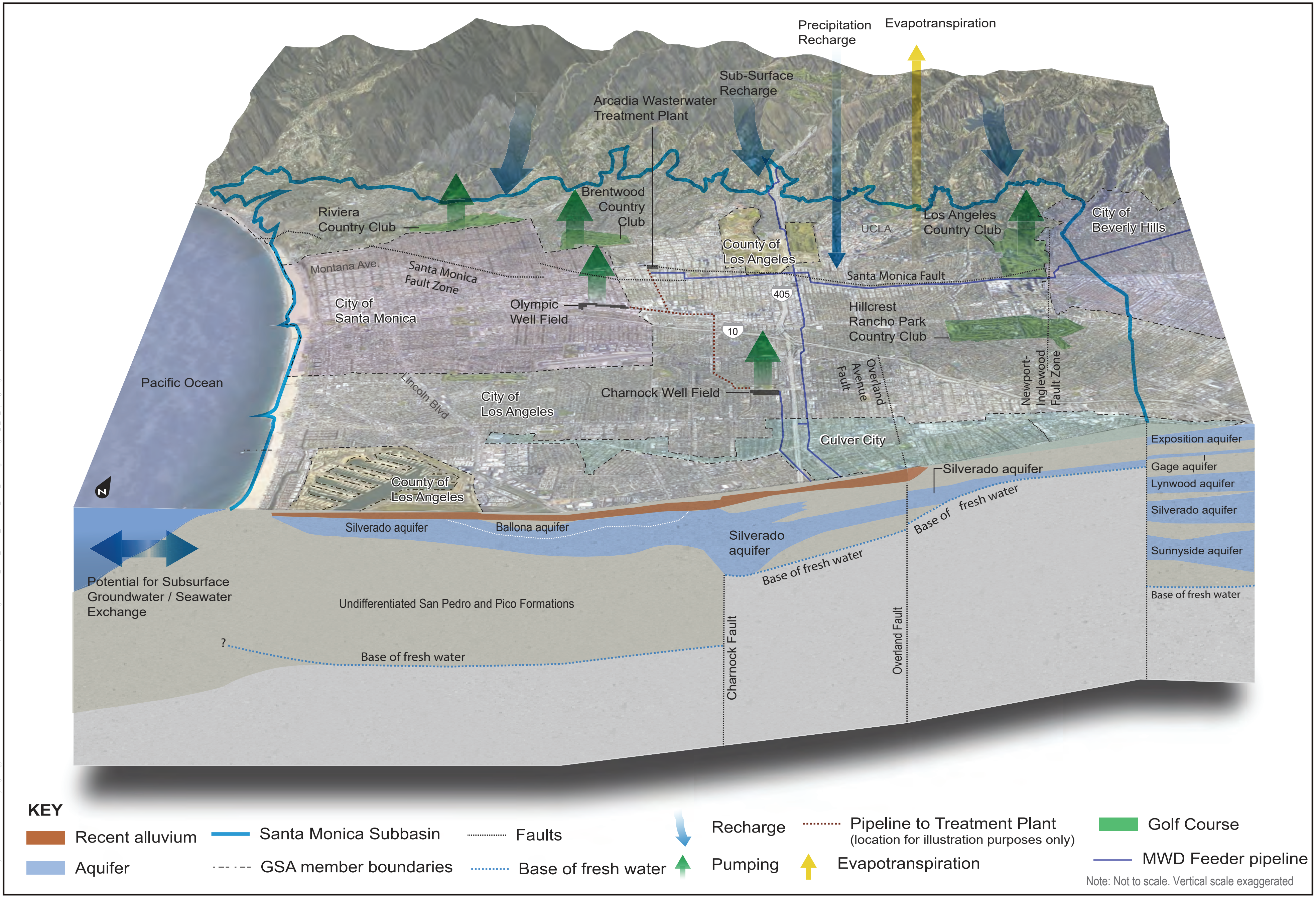

SOURCE: Google Earth, USGS 1959

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FIGURE ES-5

Hydrogeologic Conceptual Model

Groundwater Sustainability Plan for the Santa Monica Subbasin

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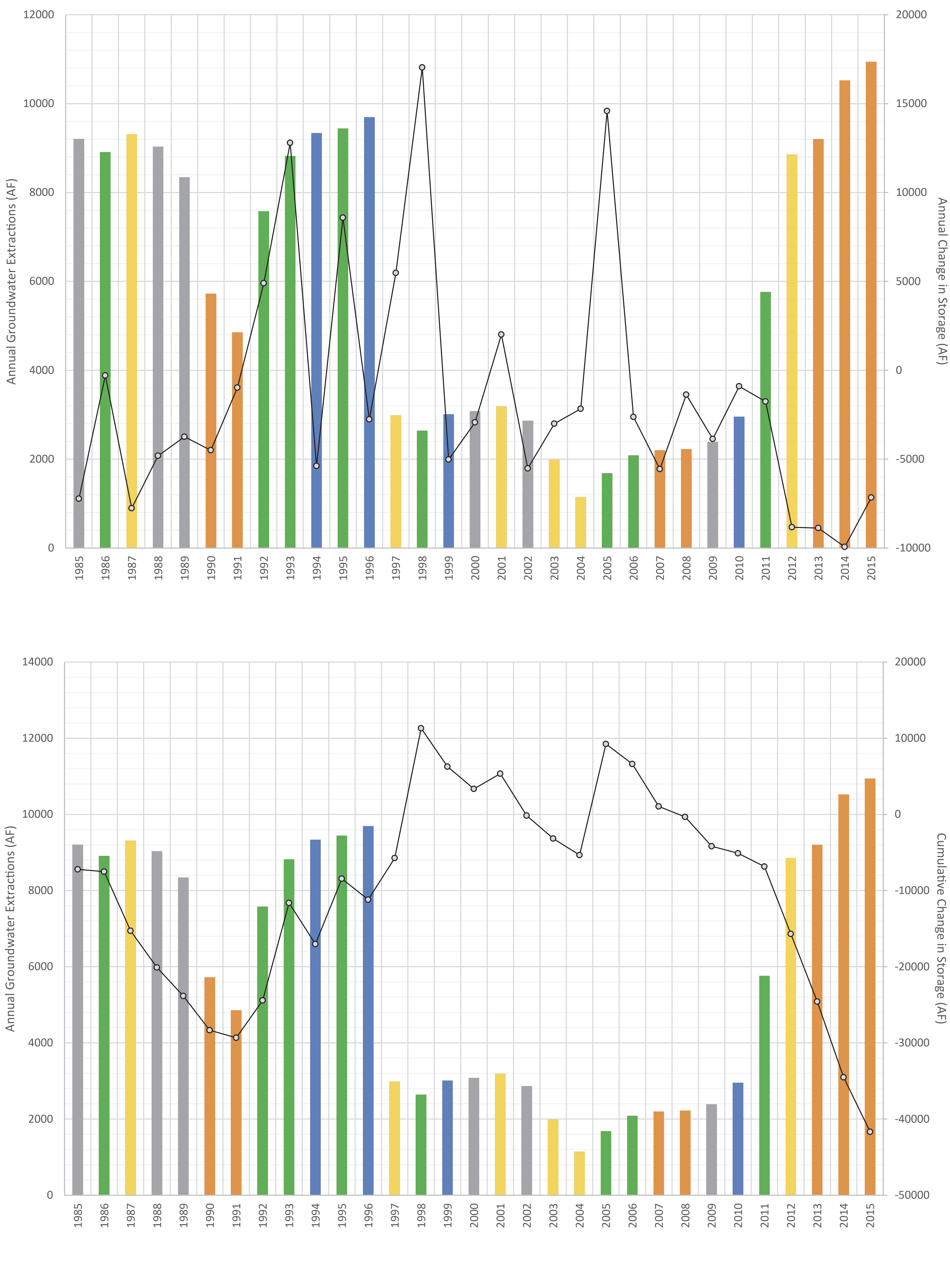

<u>Notes:</u>
(1) Water Year is October 1 to September 30
(e.g. water year 1977 is Oct. 1, 1976 to Sept. 30, 2012)
(2) Water Year Type is based on DWR water year type

Cumulative Change in Storage
Groundwater Production - color indicates water year type
Critical
Dry
Below Normal
Above Normal
Wet

SOURCE: DWR

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FIGURE ES-6
Change in Storage
Groundwater Sustainability Plan for the Santa Monica Subbasin

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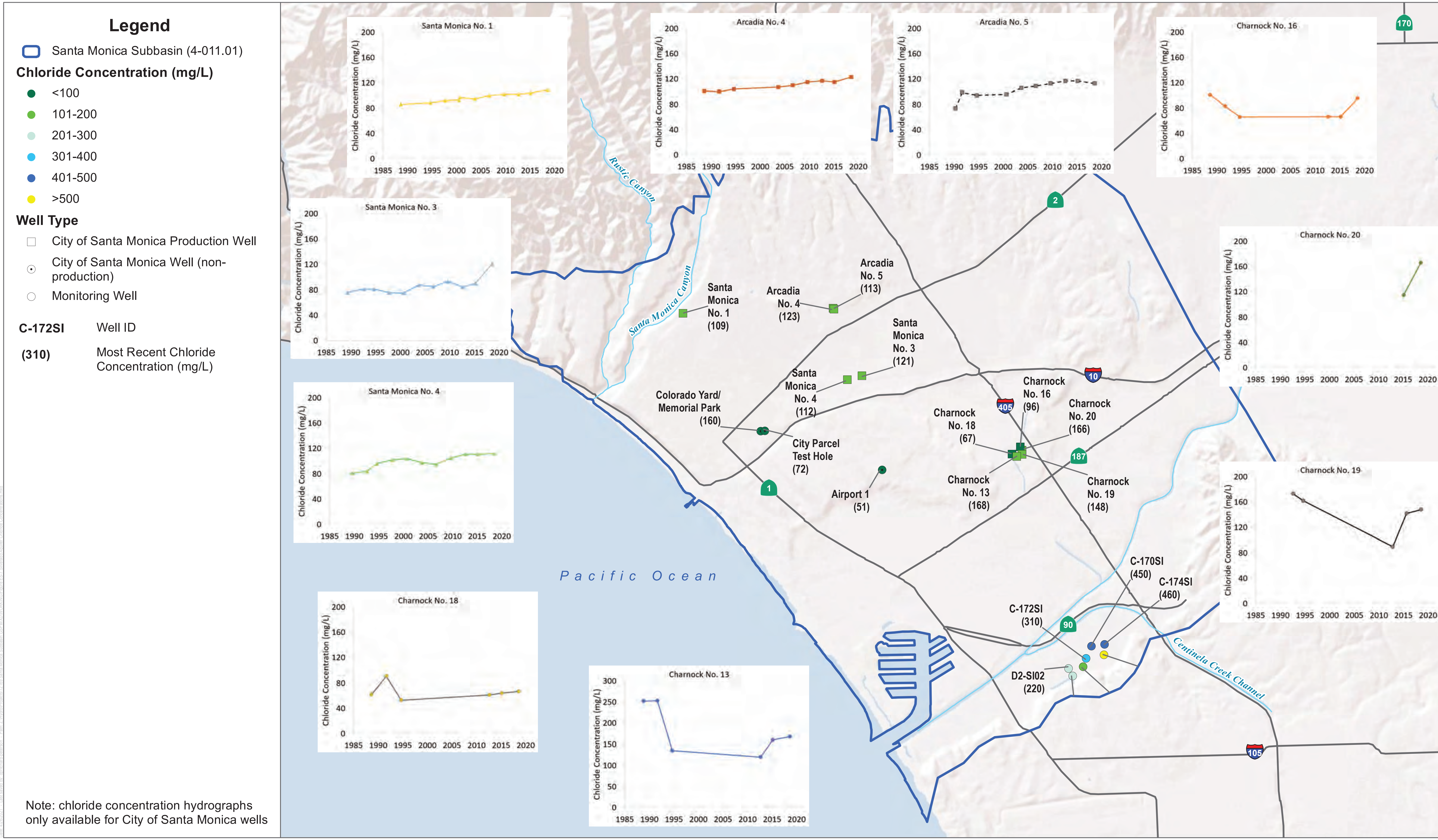

SOURCE: SWRCB; City of Santa Monica

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FIGURE ES-7

Silverado Aquifer Chloride Concentrations

Groundwater Sustainability Plan for the Santa Monica Subbasin

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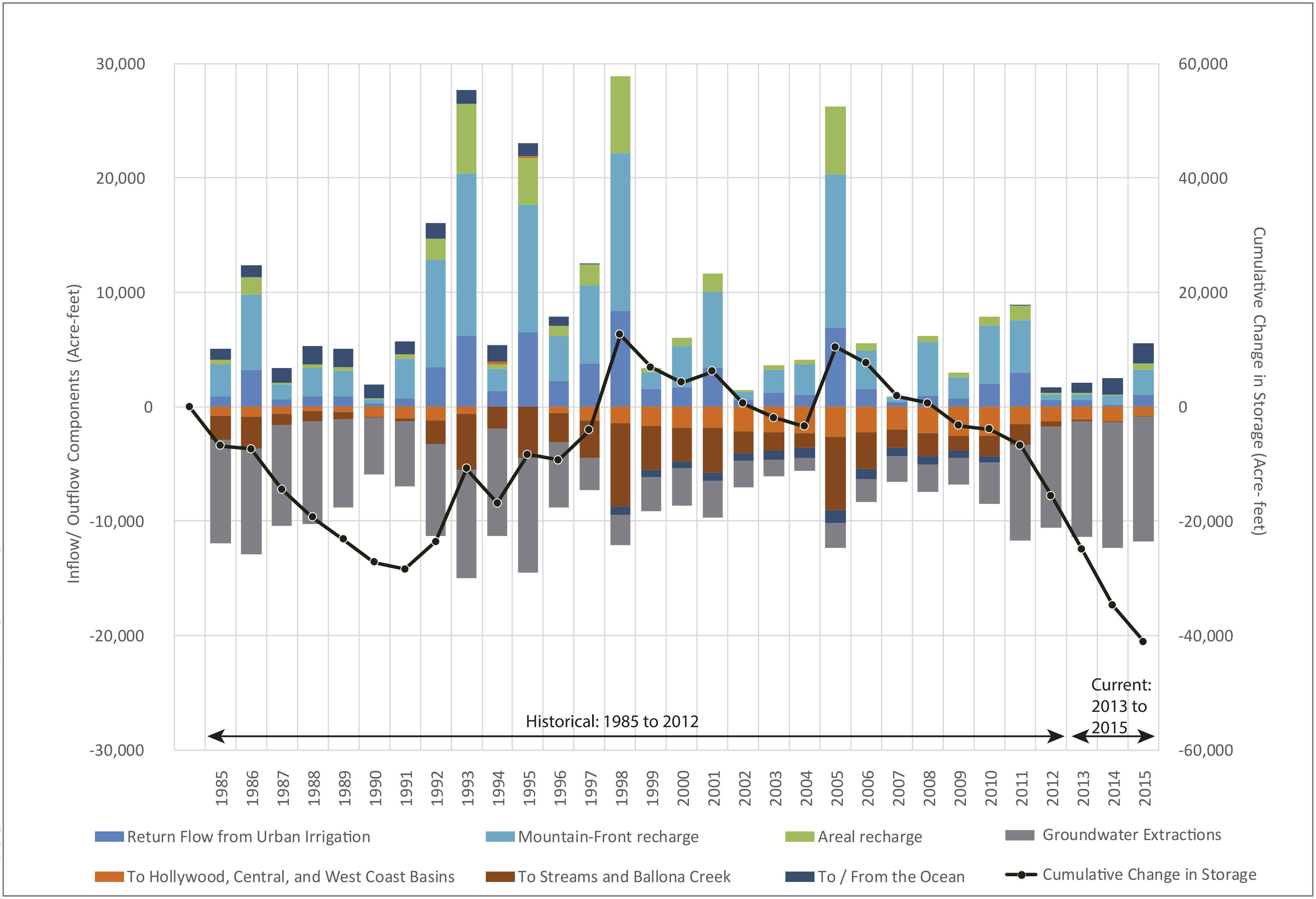

FIGURE ES-8

Historical and Current Water Budget

Groundwater Sustainability Plan for the Santa Monica Subbasin

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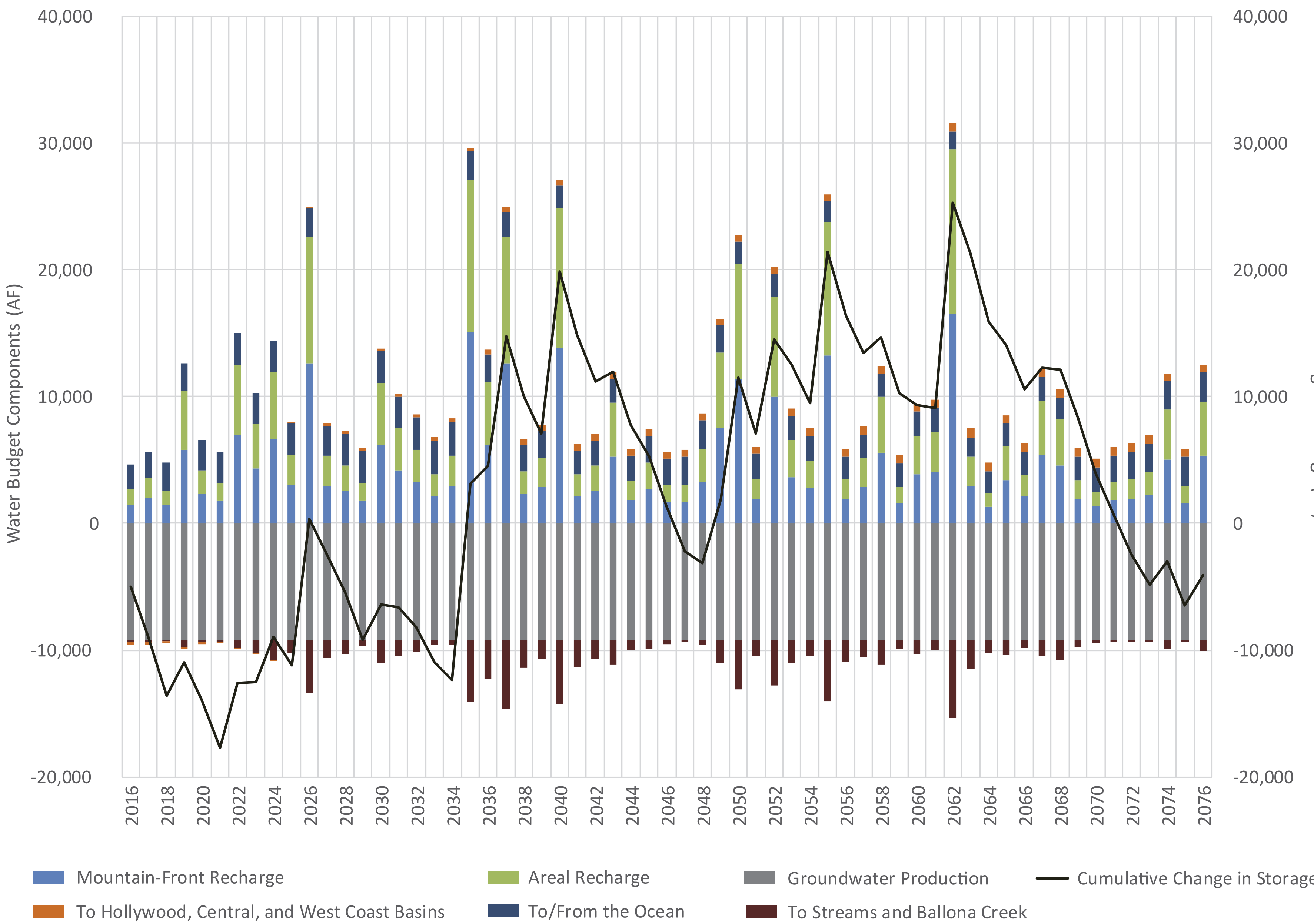

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FIGURE ES-9

Projected Water Budget

Groundwater Sustainability Plan for the Santa Monica Subbasin

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Legend

Santa Monica Subbasin (4-011.01)

Representative Monitoring Points

Sustainability Indicator

- Levels, Storage, Subsidence
- Seawater Intrusion

RMP Casing Name	Chronic Decline in Groundwater Levels (ft MSL)	
	Minimum Threshold	Measurable Objective
RMW-3	-175	-115
RMW-8	-165	-110
RMW-9	-165	-110
RMW-28	-160	-105
OB-7	5	30
OB-9B	20	45
OB-9C	-95	-40
OB-17C	-85	-30

RMP Casing Name	Seawater Intrusion (Chloride – mg/L)	
	Minimum Threshold	Measurable Objective
Arcadia No. 4	500	200
Arcadia No. 5	500	200
Santa Monica No. 1	500	200
Santa Monica No. 3	500	200
Santa Monica No. 4	500	200
Charnock No. 16	500	200
Charnock No. 18	500	200
Charnock No. 19	500	200
Charnock No. 20	500	200
City Hall Well	500	200

SOURCE:Geotracker GAMA; City of Santa Monica

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0 1 2 Miles

FIGURE ES-10

Representative Monitoring Points

Groundwater Sustainability Plan for the Santa Monica Subbasin

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1 Introduction

1.1 Purpose of the Groundwater Sustainability Plan

The Santa Monica Basin Groundwater Sustainability Agency (GSA), which comprises the City of Santa Monica, the City of Los Angeles via its Department of Water and Power, the City of Culver City, the City of Beverly Hills, and the County of Los Angeles, has prepared this Groundwater Sustainability Plan (GSP) for the non-adjudicated portion of the Santa Monica Subbasin (Subbasin) of the Los Angeles Plain Groundwater Basin (DWR Basin 4-011.01). This GSP was prepared in compliance with the 2014 Sustainable Groundwater Management Act (SGMA), which is codified in California Water Code (CWC), Part 2.75 (Sustainable Groundwater Management), §10720 et seq.[1] This GSP has been developed in accordance with the Department of Water Resources (DWR) GSP Regulations[2] to apply to the entirety of the Subbasin that is not adjudicated[3] (Plan Area; Figure 1-1).

SGMA defines sustainable groundwater management as the management and use of groundwater in a manner that can be maintained over a 50-year planning and implementation horizon without causing undesirable results. Under SGMA, undesirable results occur when significant and unreasonable effects for any of six sustainability indicators are caused by groundwater conditions occurring throughout the Subbasin.[4] The definition of significant and unreasonable effects is left to each GSA to define. The six sustainability indicators defined in SGMA are:

- Chronic lowering of groundwater levels
- Groundwater storage
- Seawater intrusion
- Degraded water quality
- Land subsidence
- Depletions of interconnected surface water

As described in Chapter 2, Basin Setting, of this GSP, the Subbasin has experienced historical degradation of groundwater quality as a result of industrial development and activities dating back to the mid-1900s as well as from leaking underground storage tanks at gas stations located adjacent to and upgradient from the primary groundwater production wells in the Subbasin. The City of Santa Monica is engaged in multiple programs to remediate the degraded groundwater in the Subbasin (see Chapter 2). These programs are overseen by the Division of Drinking Water (DDW), the Regional Water Quality Control Board (RWQCB), and the State Water Resources Control Board (SWRCB). Degradation of water quality that occurred before 2015, the year in which SGMA became effective, is not required to be addressed in this GSP (SWRCB 2019). Water quality in the Subbasin was degraded prior to 2015, the extent of degradation is well characterized, the City of Santa Monica is actively treating the groundwater under programs overseen by DDW, the RWQCB, and the SWRCB, and the degradation

1 Specific sections of the CWC are cited in this GSP as "CWC § […]."
2 GSP Regulations refers to the emergency regulations adopted by DWR as California Code of Regulations (CCR), Title 23 (Waters), Division 2 (Department of Water Resources), Chapter 1.5 (Groundwater Management), Section 350 et seq. Specific sections of the CCR are cited in the GSP as "23 CCR §[…]"
3 CWC Section 10720.8 states that SGMA does not apply to adjudicated basins. Slivers of both the West Coast and Central Basin adjudications overlap with the boundaries of the Santa Monica Subbasin, likely resulting from mapping inconsistencies through time. This GSP consists of a "single plan covering the entire basin developed and implemented by one groundwater sustainability agency," per CWC Section 10727(b)(1), with the Santa Monica GSA acting as the multi-agency GSA for the Subbasin.
4 As defined in SGMA (CWC Section 10721), "basin" means a groundwater basin or subbasin identified and defined in Bulletin 118, or as modified pursuant to basin boundary modification approved by DWR

was not caused by groundwater production. Therefore, this GSP does not address undesirable results relating to water quality degradation. Undesirable results within the Subbasin are not currently occurring with respect to any of the other sustainability indicators.

Historically, groundwater level declines and concurrent reduction of storage have not been documented in the Subbasin (DWR 2019). Portions of the Subbasin have experienced seawater intrusion in the past but shifting groundwater production away from the coast and to deeper aquifers have prevented further seawater intrusion (DWR 2019). Land subsidence due to groundwater withdrawal from the principal aquifers and aquitards that compose the Subbasin has not been documented (Bawden 2003; DWR 2014). Depletions of interconnected surface water have not occurred historically in the Subbasin because Ballona Creek, the primary surface water drainage, has been maintained as a lined and grouted flood-control channel since the 1950's (ACOE 1982; DWR 2019). Details of the historical groundwater conditions for each sustainability indicator are discussed in Chapter 2.

The purpose of this GSP is to define the conditions under which the groundwater resources of the Plan Area, which support municipal, industrial, and environmental uses, will continue to be managed sustainably over the next 50 years. The publication of this GSP represents the commitment of the Santa Monica Basin GSA to maintaining long-term, sustainable use of groundwater resources within the Subbasin, as required by SGMA. Over the next 20 years, data will continue to be gathered and used to refine the estimated sustainable yield discussed in the following chapters. As the understanding of the Subbasin improves, the findings of this GSP will be evaluated and updated as necessary. This GSP documents a viable approach, determined by the GSA in collaboration with stakeholders and informed by the best available information, to maintaining the long-term sustainability of the groundwater resources within the Subbasin.

Appendix A includes the *Preparation Checklist for GSP Submittal*, which identifies where in this GSP each of the statutory requirements under SGMA are addressed.

1.2 Sustainability Goal

The sustainability goal for the Subbasin is to ensure the long-term health and availability of groundwater resources for current and future stakeholders through ongoing, proactive stewardship. Long-term health and availability include:

- Maintaining sufficient groundwater in storage to allow for continued groundwater production that meets the operational demands and regulatory commitments of the City of Santa Monica, as well as other groundwater producers and stakeholders.
- Ensuring groundwater conditions in the Subbasin support sufficient seaward flow of fresh water to prevent significant and unreasonable seawater intrusion in the Silverado aquifer[5].
- Continuing groundwater production at rates and in aquifers that do not impact the ability of groundwater dependent ecosystems to access groundwater.

[5] The Silverado aquifer is the primary production aquifer in the Subbasin and is the aquifer from which the majority of the groundwater production occurs (see Section 2.3.2). In addition to the Silverado aquifer, the Subbasin also contains the Ballona aquifer, Sunnyside aquifer, and Bellflower aquitard.

1.3 Agency Information

Appendix B contains documentation, in reverse chronological order, of the formation of the GSA and initiation of the GSP in compliance with SGMA. Appendix B includes the Notice of the GSA formation published in multiple local newspapers by each member agency of the GSA, documentation of the public hearing on GSA formation, which was conducted on April 12, 2017, and notification of GSA formation provided to DWR, dated June 13, 2017. The SMBGSA website (https://www.santamonica.gov/gsp) contains updated information regarding the SMBGSA, development of this GSP, and SGMA compliance. The information includes public meeting agendas and minutes, and recordings of meeting conducted via webinar as a result of COVID-19 health protection measures.

The contact information for the GSA is:

Santa Monica Basin Groundwater Sustainability Agency
Attn: Dr. Lisette Gold
1212 5th Street, 3rd Floor
Santa Monica, California 90401

Lisette.Gold@santamonica.gov

1.3.1 Organization and Management Structure of the Groundwater Sustainability Agency

The five member agencies of the SMBGSA signed a Memorandum of Understanding for the formation of the SMBGSA in May 2017 and signed the first amendment to the Memorandum of Understanding in 2019 (Appendix B). The amendment outlined the cost-sharing agreement between the member agencies for preparation of this GSP.

The City of Santa Monica is the coordinating agency for the SMBGSA and is the point of contact for DWR. All actions undertaken by the SMBGSA must receive unanimous consent from the member agencies.

1.3.2 Legal Authority of the Groundwater Sustainability Agency

The SMBGSA notified DWR of its intent to become a GSA for the Santa Monica Subbasin in 2017, following public outreach to ensure that the interests of all beneficial uses and users of groundwater would be considered in the process of forming the GSA, and in the development and implementation of this GSP. The agencies that compose the SMBGSA have water supply, water management, or land use responsibilities within the Subbasin. The City of Santa Monica is the only local agency that currently produces groundwater from the Subbasin. The City has been producing groundwater from the Subbasin since the 1930's and has been actively managing groundwater in the Charnock, Olympic, and Arcadia well fields since the 1950s. More recently, this management has included coordination with the SWRCB, the DDW, and the RWQCB to remove industrial pollutants that have contaminated the groundwater in the Subbasin.

The SMBGSA assumes responsibility for ensuring ongoing sustainable management of the groundwater resources of the Subbasin under the sustainable management criteria described in Chapter 3 of this GSP. In order to manage groundwater conditions, the SMBGSA may require metering of all groundwater extractions, excluding those from *de* *minimis* extractors. In this GSP *de minimis* extractors are defined as a person or persons who extract(s), for domestic purposes, two acre-feet or less per year (CWC 10721 [e]).

Although the analyses conducted as part of this GSP suggest that the current and planned future groundwater production are within the estimated sustainable yield of the Subbasin, future demands not anticipated in the GSP may necessitate the adoption of measures to restrict groundwater production. These measures may include, but are not limited to, regulating, limiting, or suspending groundwater extraction from individual wells or wells in-aggregate, imposing extraction fees on groundwater producers in the GSA area, and developing a groundwater allocation (Chapter 4, Projects and Management Actions).

1.4 Groundwater Sustainability Plan Organization

This GSP is organized according to the DWR guidance document for preparation of a GSP annotated outline (DWR 2016A – annotated outline). Chapter 1 provides information on the purpose of the GSP, the sustainability goal for the Plan Area, and information on the SMBGSA. Chapter 2 provides information on the SMBGSA setting, the hydrogeologic conceptual model for the Subbasin, and the water budget for the Subbasin. Chapter 3 provides information on the sustainable management criteria and monitoring network in the Subbasin. Chapter 4 provides information on the projects and management actions to ensure continued sustainable management of the Subbasin as defined by the sustainability goal. Chapter 5 provides information on the GSP implementation.

The Preparation Checklist for GSP Submittal can be found in Appendix A (DWR 2016B – preparation checklist).

1.5 References Cited

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DWR (California Department of Water Resources). 2016A. *Guidance Document for the Sustainable Management of Groundwater: Groundwater Sustainability Plan Annotated Outline*. December 2016.

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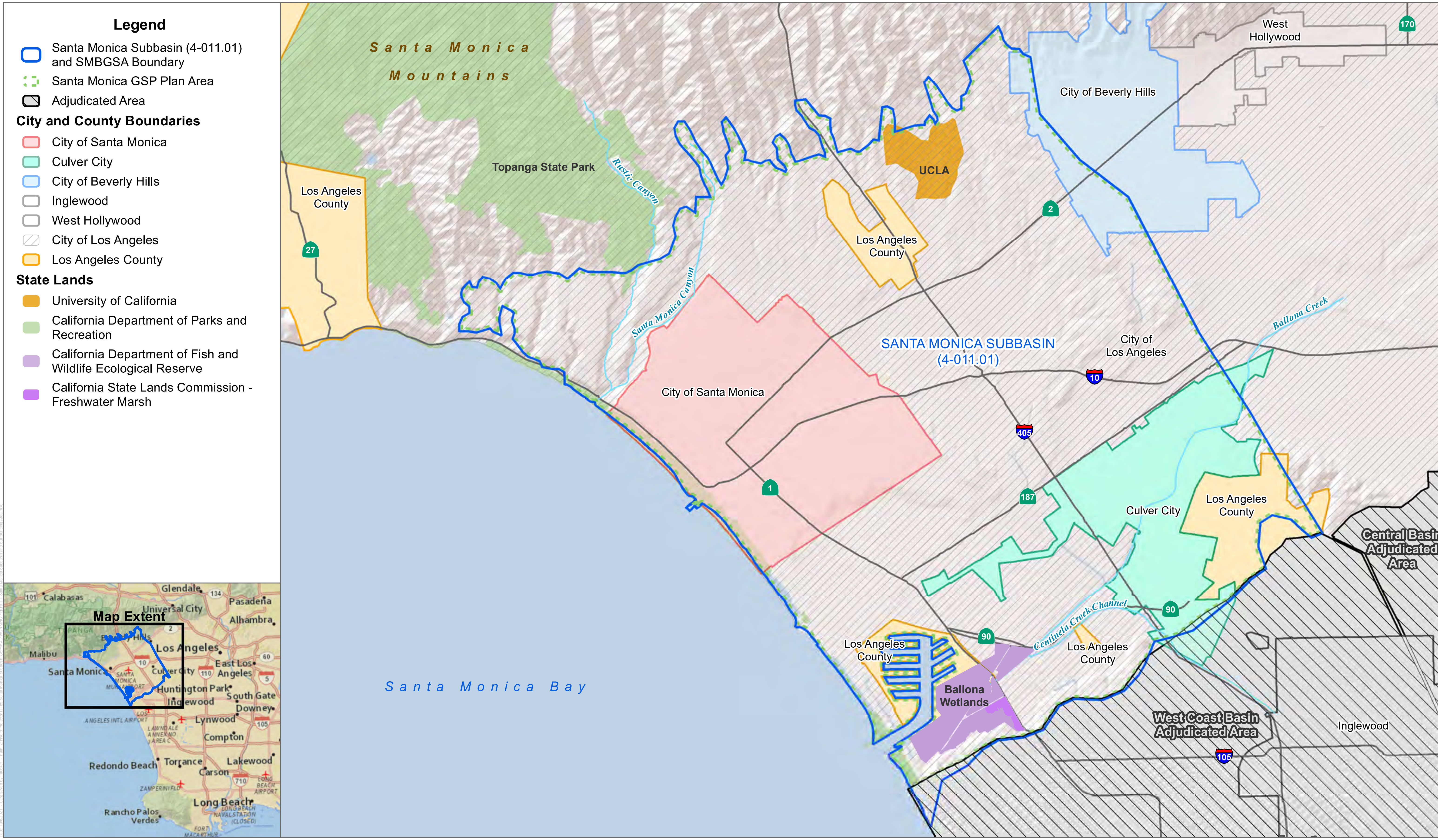

SOURCE: ESRI; DWR; USGS; Los Angeles County

0 1 2 Miles

FIGURE 1-1

Santa Monica Subbasin and Surrounding Area

Groundwater Sustainability Plan for the Santa Monica Subbasin

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2 Plan Area and Basin Setting

This chapter is organized in two major parts. The first covers administrative, statutory, and policy considerations, as well as aspects of the built environment related to water supply and demand (See Section 2.1); whereas the second covers the physical setting and data used to develop the hydrogeologic framework for the Subbasin (See Sections 2.2 through 2.5). Specifically, Section 2.1 describes administrative boundaries, land use, and population characteristics, identifies existing water resources monitoring and management plans and programs, and describes the stakeholder process. Sections 2.2 through 2.5 describe the physical and geographic setting of the Subbasin, the hydrogeologic conceptual model, current, historical, and projected groundwater conditions, and the groundwater budget.

2.1 Description of Plan Area

The Santa Monica Subbasin is designated by DWR under CWC §12924 as one of California's 515 alluvial groundwater basins. The Subbasin (DWR Basin No. 4-011.01) has a surface area of 31,779 acres, or 49.7 square miles, and underlies the northwestern part of the Coastal Plain of Los Angeles Groundwater Basin (Figure 2-1; DWR 2019). The Subbasin is bounded to the east by the Hollywood and Central Subbasins (DWR Basin Nos. 4-011.02 and 4-011.04), to the south by the West Coast Subbasin (DWR Basin No. 4-011.03), to the north by the Santa Monica Mountains, and to the west by the Pacific Ocean (Figure 2-1; DWR 2004). The base of the Subbasin is defined by the transition from fresh groundwater to brackish groundwater and occurs at variable depths within the geographic boundaries of the Subbasin (DWR 1961).

Although the majority of the Central Subbasin was adjudicated in 1965, the Santa Monica Subbasin shares a boundary with the unadjudicated portion of the Central Subbasin. Approximately 142.8 acres (less than 0.5%) of the Subbasin overlaps the West Coast Basin adjudicated area (Adjudication ID No. A05)[1] in several slivers along its southeastern edge (Figure 2-2). This imperfect overlap primarily results from differences in mapping precision and does not impact management of groundwater resources in either the Santa Monica Subbasin or the West Coast Basin adjudicated area. The area of overlap, along with the remainder of the West Coast Basin adjudicated area is managed by a watermaster that oversees the production and distribution of groundwater in accordance with a court judgement. There are no groundwater production wells in the area of overlap. The portion of the West Coast Basin adjudicated area that overlaps with the Santa Monica Subbasin is not subject to SGMA. However, because this area is so small, the descriptions of the Subbasin, water balance, and sustainable yield in this GSP incorporate the entire Subbasin, including the area of overlap.

This GSP consists of a "single plan covering the entire basin developed and implemented by one groundwater sustainability agency," per CWC Section 10727(b)(1) and applies to the 31,637 acres within the Subbasin that are not adjudicated (Plan Area). The SMBGSA has developed and will implement this GSP.

1 DWR refers to the West Coast Subbasin as a subbasin of the Coastal Plain of Los Angeles Groundwater Basin. The areas of the West Coast Subbasin that is adjudicated is referred to as the West Coast Basin adjudicated area.

2.1.1 Summary of Jurisdictional Areas and Other Features

2.1.1.1 Land Use Jurisdictions within the Plan Area

The Plan Area is subject to State and local jurisdictions (Table 2-1; Figure 2-2). Although there are federally owned lands in the Plan Area, these areas fall under the land use jurisdiction of Los Angeles County. The State of California, the County of Los Angeles and the municipalities of Santa Monica, Los Angeles, Culver City, and Beverly Hills have land use jurisdiction that covers the entire Plan Area.

2.1.1.1.1 County / Municipal

The entirety of the Plan Area lies within Los Angeles County, and the County has land use jurisdiction over 1,913 acres, or approximately 6%, of the Plan Area (Figure 2-2; Table 2-1). County land use jurisdiction within the Plan Area is discontinuous and comprises the Inglewood Oil Field in the southeastern corner of the Plan Area, an area near Wilshire and I-405 that includes the Veteran's Administration Hospital, Veteran's Park and the Los Angeles National Cemetery, a portion of Playa Vista adjacent to Ballona Creek, and Marina Del Rey (Figure 2-2). Unincorporated parts of the Plan Area consist of open space, public facilities, industrial, commercial and residential uses.

Table 2-1. Land Use Jurisdictional Authorities within the Plan Area

Jurisdictional Authority	Area Within Plan Area (acres)	Percent of Plan Area
Plan Area		
City of Los Angeles (Department of Water and Power)	19,539	62%
City of Santa Monica	5,165	16%
City of Culver City	2,981	9%
City of Beverly Hills	596	2%
County of Los Angeles	1,913	6%
State of California Lands (various agencies)	1,443	5%
Total	**31,637**	**100%**

The Ballona Creek watershed, which covers approximately 130 square miles located primarily in the City of Los Angeles, drains into Santa Monica Bay through the Ballona Wetlands, adjacent to Marina Del Rey (Figure 2-3). Between 1935 and 1939 Ballona Creek was straightened and cemented by the U.S Army Corps of Engineers to allow for faster conveyance of stormwater through the Ballona Creek watershed and to the Pacific Ocean (USACE 1982). The Los Angeles County Department of Public Works (LACDPW) – Flood Control District and the Army Corps of Engineers have jurisdiction over the Ballona Creek channel and levee system. Dredge material from the straightening of the channel and from the later development of Marina del Rey in the 1960s was deposited in the Ballona Wetlands, raising its elevation (CDFW 2019).

The majority of the Plan Area consists of private land under the jurisdictions of the City of Los Angeles (62%) and the cities of Santa Monica (16%), Culver City (9%), and Beverly Hills (2%) (Table 2-1; Figure 2-2). Land use designation within municipal jurisdictions in the Plan Area includes urban and open space. Land use in the County and municipal areas of the Plan Area are guided by general, specific and master plans and governed under local municipal codes and ordinances (Section 2.1.3).

2.1.1.1.2 State

State of California lands falling under the jurisdictions of the California Department of Fish and Wildlife (CDFW), the California State Lands Commission, the University of California Board of Regents, and the California Department of Parks and Recreation compose a total of 1,443 acres within the Plan Area. CDFW manages the Ballona Wetlands Ecological Reserve (BWER), the University of California Board of Regents manages the University of California Los Angeles campus, and the California Department of Parks and Recreation manages all beaches within the Plan Area, as well as the Will Rodgers State Historic Park, of which 11 acres extend into the northwestern portion of the Plan Area (Figure 2-2).

The Ballona Wetlands consist of approximately 575 acres of tidal and non-tidal marshes, grassland, coastal scrub, invasive vegetation, and developed land, located south of Marina del Rey, north of the Ballona escarpment, and west of the Marina Freeway (SR-90) (Figure 2-2). CDFW manages and maintains primary ownership of the BWER with a smaller interest owned by the California State Lands Commission (CDFW 2019). Los Angeles Department of Water and Power (LADWP) and LACDPW – Waterworks Division maintain water mains located along the perimeter of the Ballona Wetlands; however, the Culver Marina Little League baseball field and restrooms are the only areas within the Ballona Wetlands that receive water from LADWP (CDFW 2019).

The University of California, Los Angeles (UCLA) covers 414.5 acres, 410 of which are located in the northern part of the Plan Area. Water is provided to UCLA, which has an estimated daily weekday population of 74,132, by LADWP (UCLA 2016). As part of the University of California system, UCLA is governed by the Regents of the University of California. Any new or amended Long Range Development Plan for the campus must first be adopted by the Board of Regents.

The Plan Area contains 439 acres of State beaches, 196 acres of which are located in the City of Santa Monica and 243 acres of which are located in the City of Los Angeles. The beaches include, from north to south: Will Rodgers State Beach, Santa Monica State Beach, Venice Beach and the northern portion of Dockweiler State Beach (Figure 2-2). While Santa Monica State Beach is managed by the City of Santa Monica in cooperation with California State Parks, the other beaches in the Plan Area are operated by the Los Angeles County Department of Beaches and Harbors. Santa Monica State Beach receives water from the City of Santa Monica, and LADWP provides water to the remaining beaches in the Plan Area.

The Will Rodgers State Historic Park consists of a 186-acre ranch, 11 acres of which extend into the Plan Area and the rest of which are located in the Santa Monica Mountains to the east of the Plan Area. The 11 acres of the historic park within the Plan Area are generally undeveloped green spaces that are designated for low intensity use. This land is managed by the California Department of Parks and Recreation under land use policies established in a 1992 General Plan (CSP 1992). LADWP provides water to the Park.

2.1.1.1.3 Federal

Federal lands in the Plan Area include the U.S. Department of Veterans Affairs West Los Angeles Healthcare Campus and the U.S. Department of Veterans Affairs National Cemetery Administration for management of the Los Angeles National Cemetery. Originally founded in 1887 on donated lands, these two areas are located adjacent to one another on parcels that are bisected by the San Diego Freeway (I-405) (Figure 2-2). The West Los Angeles Healthcare Campus (approximately 388 acres) and the Los Angeles National Cemetery (approximately 190 acres) occupy a total of 578 acres (1.8%) of the Plan Area.

Although this land is owned by the Federal government, it is considered an unincorporated part of Los Angeles County for regulatory purposes. Therefore, any proposed groundwater production on U.S. Veteran's Administration property would be regulated by the Los Angeles County Department of Public Health, Environmental Health division, Drinking Water Program. Currently, LADWP provides water to these facilities through three service connections at the West Los Angeles Healthcare Campus and one connection at the Los Angeles National Cemetery (VA 2016).

2.1.1.2 Water Agencies Relevant to the Plan Area

Retail water suppliers within the Plan Area include Los Angeles County Waterworks District 29, the Cities of Santa Monica and Beverly Hills, LADWP, Golden State Water Company (GSWC), and California American Water Company (CAWC). Los Angeles County Waterworks District 29 provides water for 395 acres including and surrounding Marina del Rey (Table 2-2; Figure 2-4). GSWC provides service for 2,906 acres within the Plan Area, 2,776 acres of which are located in Culver City, and the remainder are located in adjacent areas in Los Angeles. In the southeastern corner of the Plan Area, CAWC provides service for 101 acres of Baldwin Hills (Table 2-2; Figure 2-4). The Cities of Beverly Hills and Santa Monica provide water service within their respective jurisdictional boundaries in the Plan Area[2]. The remainder of the Plan Area is served by LADWP (Figure 2-4).

The Metropolitan Water District of Southern California (MWD) is a regional wholesaler that provides water for 26 public member agencies, either directly to member cities within its service area or to member water agencies within its service area. Within the Plan Area, the City of Santa Monica, City of Beverly Hills, and the City of Los Angeles are member cities of MWD. West Basin Municipal Water District (WBMWD) is the only MWD member water agency within the Plan Area. WBMWD provides wholesale distribution of MWD water to local retail water providers including GSWC and CAWC. Additionally, WBMWD provides imported surface water to Los Angeles County Waterworks District 29.

The City of Santa Monica is the only water agency that produces groundwater from within the Plan Area.

Table 2-2. Water Agencies within the Plan Area

Water Agency	Water Agency Type	Service Connections / Retail Population	Total Size of Service Area (Acres)	Service Area Within GSP Plan Area (Acres)	Water Sources
Metropolitan Water District (MWD)	Wholesale	+400 / ~19,000,000[1]	3,367,956	31,637	Colorado River Aqueduct (CRA), State Water Project (SWP)
West Basin Municipal Water District (WBMWD)	Wholesale	+400 / ~813,000[2]	105,031	6,666	CRA, SWP, recycled water, desalinated brackish groundwater from the West Coast Basin
Los Angeles Department of Water and Power (LADWP)	Retail	721,935 / ~4,040,000[3]	305,656	21,558[9]	Los Angeles Aqueduct, Purchased surface water from MWD, local groundwater from the San Fernando, Sylmar and Central Basins, recycled water

2 The City of Santa Monica also provides water to Santa Monica State Beach.

Table 2-2. Water Agencies within the Plan Area

Water Agency	Water Agency Type	Service Connections / Retail Population	Total Size of Service Area (Acres)	Service Area Within GSP Plan Area (Acres)	Water Sources
City of Santa Monica	Retail	17,600 / 92,357[4]	5,291	5,291[10]	Purchased surface water from MWD, groundwater from the Santa Monica Subbasin, recycled water
GSWC – Culver City	Retail	9,839 / 36,321[5]	3,210	2,906	Purchased surface water from WBMWD
CAWC – Baldwin Hills	Retail	6,243 / 17,695[6]	2,056	101	Purchased surface water from WBMWD, local groundwater from the Central Basin.
City of Beverly Hills	Retail	10,752 / 43,371[7]	4,046	594	Purchased surface water from MWD, local groundwater from Hollywood Subbasin
Los Angeles County Waterworks District 29	Retail	7,488 / 30,808[8]	30,197	395	Purchased surface water from WBMWD

Notes:
1 Metropolitan Water District, UWMP, 2020 (MWD 2021).
2 West Basin Municipal Water District, UWMP, 2015 (WBMWD 2016).
3 LADWP, UWMP, 2020 (LADWP 2021).
4 City of Santa Monica, UWMP, 2020 (City of Santa Monica 20121).
5 GSWC – Culver City, UWMP, 2015 (City of Culver City 2016).
6 CAWC, Southern Division – Los Angeles County District, UWMP, 2020 (California American Water 2021).
7 City of Beverly Hills, UWMP, 2020 (City of Beverly Hills 2021).
8 Los Angeles County Waterworks District 29 – Malibu and the Marina del Rey Water System, UWMP, 2015 (LACDPW 2017)
9 LADWP provides water to the City of LA as well as portions of Culver City and a small portion of Marina del Rey
10 The City of Santa Monica provides water to the area within its boundaries as well as to Santa Monica State Beach.

2.1.1.2.1 Metropolitan Water District of Southern California

MWD's 2020 Urban Water Management Plan (UWMP) provides the following description of its service area (MWD 2021):

> "Metropolitan's service area covers the Southern California coastal plain. It extends about 200 miles along the Pacific Ocean from the city of Oxnard on the north to the international boundary with Mexico on the south, and it reaches as far as 70 miles inland from the coast. The total area served is approximately 5,200 square miles, and it includes portions of Los Angeles, Orange, Riverside, San Bernardino, San Diego, and Ventura counties. Although only 14 percent of the land area of the six Southern California counties is within Metropolitan's service area, nearly 85 percent of the populations of those counties reside within Metropolitan's boundaries."

The population in MWD's service area grew from approximately 15 million people in 1990 to an estimated 18.7 million in 2015, with the current population size estimated to be approximately 19 million people (MWD 2021). Between 1983 and 2020, retail water demands varied between 2.9 million acre-feet (AF) and 4.2 million AF (MWD 2021). Water demand is influenced by multiple factors including, drought, conservation efforts, mandatory water use restrictions, and economic recessions. Each of these factors contributed to lower water demands in the early 1990s and between 2008 and 2012. The onset of historic drought conditions in 2012 led to a large-scale conservation campaign that included State and local water use restrictions, many of which have continued to be employed and are reflected in lower (MWD 2021). Municipal and industrial water demand constitutes 97% of the total water demand in MWD's service area, and agricultural demand constitutes the remaining 3% of water demand. Due to urbanization and the increasing price of water, the share of agricultural demand has decreased over the past 50 years (MWD 2021). There are no agricultural users of water in the Plan Area.

The principal sources of MWD water are the State Water Project (SWP), which supplies imported surface water from Northern California, and the Colorado River Aqueduct (CRA). Through these resources, MWD provides water to meet approximately 50% of its member agencies' demand. The remainder of the demand is met by local groundwater, recycled water, imported water via the Los Angeles Aqueduct, locally stored runoff, transfers from the Imperial Irrigation District and water conserved by lining the Coachella and All-American Canal (MWD 2021).

MWD does not currently operate any groundwater extraction and recovery projects within its service area. These projects are operated by MWD member agencies, with many of the newer groundwater extraction and recovery projects supported financially through MWD's Local Resources Program (MWD 2021).

2.1.1.2.2 West Basin Municipal Water District (WBMWD)

As a member agency of MWD, WBMWD provides wholesale potable water from the SWP and CRA to 17 cities through investor-owned utilities, municipal water districts, and Los Angeles County Waterworks District 29. WBMWD's 185 square mile service area includes approximately 800,000 residents in communities of southern and southwestern Los Angeles County. Approximately 10.4 square miles of WBMWD's service area is within the Plan Area. Communities in the Plan Area that receive wholesale water from WBMWD through their local water supplier include Marina del Rey, Centinela, Culver City, Ladera Heights/Baldwin Hills, the West Los Angeles Veterans Administration Campus, and the Los Angeles National Cemetery (WBMWD 2016). Prior to the founding of WBMWD in 1947, these communities relied almost entirely on groundwater.

In 2015 78% of the water supplied by WBMWD was imported, 21.5% was recycled water, and 0.5% was desalted brackish groundwater. Although its customers use groundwater to meet approximately 20% of their demand, WBMWD does not directly supply groundwater for retail use within the Plan Area and does not extract groundwater from the Subbasin (WBMWD 2016).

Since the 1990s WBMWD has increased development of local supplies in response to declining reliability of imported supply. These local supplies include desalted brackish groundwater and recycled water from the City of Los Angeles' Hyperion Water Reclamation Plant. Future WBMWD supply may include 21,500 AFY of ocean water desalination (WBMWD 2016).

2.1.1.2.3 Los Angeles Department of Water and Power (LADWP)

LADWP is the largest municipal utility in the United States, providing water service to over 675,000 connections and over 4 million customers. LADWP's service area is slightly larger than the boundaries of the City of Los Angeles because it includes portions of West Hollywood, Culver City, Universal City, and Los Angeles County. LADWP provides water service to 68% of the Plan Area, including the communities of Brentwood/Pacific Palisades, Bel Air/Beverly Crest, Westwood, West Los Angeles, Palms/Mar Vista/Del Rey, Venice, Westchester/Playa del Rey, and West Adams/Baldwin Hills/Leimert, and Culver City (LADWP 2016).

Since its chartering in 1925, LADWP has provided water to its customers from a variety of sources. Currently, the primary water sources for LADWP are the Los Angeles Aqueduct (delivering water from Mono Lake and the eastern Sierra Nevada), local groundwater (from the San Fernando, Sylmar and Central Basins), and imported water from the SWP and CRA (supplied by MWD). While these currently make up 98% of LADWP's supply, recycled water is becoming an increasingly important part of the water portfolio.

Between 2012 and 2020 groundwater made up approximately 8% of LADWP supply (LADWP 2021). Groundwater rights from the adjudicated San Fernando, Sylmar, Eagle Rock, Central and West Coast Basins equal approximately 109,809 AFY, with the majority of these rights located in the San Fernando basin. From 2015 to 2020, LADWP extracted 95% of its groundwater supply from the San Fernando Basin. LADWP does not extract groundwater in the Plan Area.

2.1.1.2.4 City of Santa Monica

The Santa Monica Public Works Department supplies a combination of imported water, groundwater, and recycled urban runoff to approximately 93,283 residential, commercial and landscape customers in its 5,291-acre (17% of the Plan Area) service area. The City of Santa Monica produces groundwater from its Charnock, Olympic, and Arcadia groundwater wells, purchases imported water from MWD to supplement local groundwater resources and produces recycled water at its Santa Monica Urban Runoff Recycling Facility (SMURRF). Between 2005 and 2009, imported water composed 86%, on average, of the Santa Monica water supply (City of Santa Monica 2016). The City of Santa Monica's current Tier 1 allocation of imported water from MWD is 7,406 AFY, and water purchases from MWD averaged 8,223 AFY between 2005 and 2018 (City of Santa Monica 2018a). Between 2010 and 2015, however, the share of imported water purchases in Santa Monica's water supply portfolio fell to 45%, on average, while the share of groundwater supplied rose from 13% to 54%. This translated to reduction in average imported water use of approximately 4,000 AFY between 2013 and 2017 (City of Santa Monica 2018a). The increase in groundwater use was due, in part, to the reactivation of five wells in the Charnock Wellfield that had been taken offline because of methyl tert-butyl ether (MTBE)[3] contamination in the groundwater (See Sections 2.1.2.3.5 and 2.4.4). Following the completion of the Charnock Water Treatment Unit and upgrades to the Arcadia Water Treatment Plant in 2010, these wells were once again capable of delivering water that met State and Federal water quality standards.

In total, the City of Santa Monica maintains 11 active groundwater wells: 5 in the Charnock wellfield (Charnock 13, 15, 16, 18, and 19), 3 in the Arcadia wellfield (Santa Monica 1, Arcadia 4 and 5), and 3 in the Olympic Wellfield (Santa Monica 3/9, 4, and 8). While the total pumping capacity of these wells is 10,180 gallons per minute (gpm), the wells are not all run simultaneously.

The resident population of Santa Monica is projected to grow approximately 19% over the next 20 years (City of Santa Monica 2021). In addition to permanent residents, Santa Monica is a commercial and cultural center that attracts people during daytime hours. Daytime population in the City of Santa Monica is estimated to be 200,000. During peak summer months, this daytime population has been observed to be as large as 500,000 (City of Santa Monica 2016).

The City of Santa Monica continues to increase the reliability of its water supply through innovative projects, conservation measures, and restoring local groundwater supplies (City of Santa Monica 2016). Water conservation measures, including efficiency standards and financial incentives, have resulted in decreased water demand in the City of Santa Monica in recent years. Between 2010 and 2015, which were drought years, the average potable demand decreased to 13,473 AFY, which is 1,061 AFY less than the average water demand between 2005 and 2010. In 2015, the average water use rate was 113 gallons per capita per day and in 2020, the average water use rate is 103 gallons per capita per day. With the projected population growth, and ongoing conservation measures, the water demand projection for the year 2040 is approximately 20% higher than the 2020 water demand (City of

3 MTBE is a common fuel additive that helps gasoline burn more completely and reduces automobile emissions.

Santa Monica 2021). However, if additional conservation measures are implemented, the projected water demand for 2040 is only 4% higher than the 2020 water demand (City of Santa Monica 2021).

2.1.1.2.5 City of Beverly Hills

The Beverly Hills Utilities Corporation has provided water utility service to the City of Beverly Hills since 1906. The Beverly Hills Utility Corporation service area encompasses an area of 4,046 acres, 594 acres of which are in the Plan Area. In 2020, the resident population of the Beverly Hills Utility Corporation service area was estimated to be 43,371 with a daytime population of up to 250,000 (City of Beverly Hills 2016; City of Beverly Hills 2021). The residential population is projected to reach 46,279 by 2045 (City of Beverly Hills 2021).

Total water demand in the Beverly Hills Utilities Corporation service area was estimated to be 9,583 AFY in 2020. By 2045 the average water demand is projected to increase to 12,768 AFY, which is approximately 300 AFY less than the 2005 to 2010 average (City of Beverly Hills 2021).

The City of Beverly Hills water utility purchases the majority of its supply from MWD. In addition to imported water, the City of Beverly Hills has pumped groundwater from the Hollywood Subbasin using a set of four wells (Nos. 2, 4, 5 and 6). This water is treated at the City's Foothill Water Treatment Plant (City of Beverly Hills 2021). The City of Beverly Hills does not extract groundwater from the Subbasin.

2.1.1.2.6 Los Angeles County Waterworks District 29

The LACDPW maintains five waterworks districts that, in total, serve as the water utility for approximately 240,000 customers. Los Angeles County Waterworks District 29's service area encompasses 30,197 acres, 395 of which are in the Plan Area, and includes the City of Malibu and portions of unincorporated Los Angeles County. Within the Plan Area, Los Angeles Waterworks District 29 operates and maintains the Marina del Rey Water System on behalf of the Los Angeles County Department of Beaches and Harbors. Of the 7,480 water connections in District 29, 300 are located in Marina del Rey, serving a population of 8,474 in 2015 (LACDPW 2017). The population of Marina del Rey is expected to grow by approximately 31% between 2015 and 2035, with the population in 2035 projected to reach 11,106. (LACDPW 2017).

Water demand in Marina del Rey is projected to increase from approximately 1,625 AFY in 2015 to 2,130 AFY by 2035, based on population growth estimates and current per capita water use (LACDPW 2017). District 29 receives the majority of its water supply through a purchase agreement with WBMWD. District 29 uses some recycled water to meet demand in Malibu, but the Marina del Rey Water System does not use recycled water to meet demand. Groundwater is not produced by District 29 (LACDPW 2017).

2.1.1.2.7 Golden State Water Company – Culver City

The GSWC is an investor-owned public utility company that owns and operates 39 water systems throughout California, including the Culver City system (Figure 2-4). The Culver City system provides water utility service to an area of approximately 3,210 acres, 2,906 acres of which are located within the Plan Area and serves most of Culver City as well as neighboring portions of the City of Los Angeles.

The population of the GSWC-Culver City (GSWC-CC) service area was estimated to be 36,321 in 2015. By 2040, the population of the GSWC-CC service area is projected to grow by approximately 2.8%. Water demand is projected to increase by 27% to 6,258 AFY by 2040, assuming no increase in water use efficiency, a linear increase in the number of service connections, and constant water use factors (City of Culver City 2016). Due to the simplified assumptions used to project water demand, these projections most likely overestimate future demand.

Currently, 100% of GSWC-CC water supply is purchased from WBMWD. In 2015, this equated to 4,951 AF of water (City of Culver City 2016). The GSWC-CC system has not used groundwater as a source of supply since 1998 and GSWC sold their groundwater pumping rights in the Charnock wellfield to the City of Santa Monica in 2004 (City of Culver City 2016).

2.1.1.2.8 California American Water Company – Baldwin Hills

CAWC is a subsidiary of American Water Works Company, an investor-owned water and wastewater utility company. CAWC is operated by three division offices: the Northern, Central and Southern Divisions. The Southern Division includes the Ventura County District, Los Angeles County District and San Diego County District. The Los Angeles County District provides water utility service to three separate service areas: Baldwin Hills, Duarte and San Marino. Only the Baldwin Hills service area is located in the Plan Area.

The Baldwin Hills service area of CAWC encompasses approximately 2,056 acres, 101 acres of which are located in the Ladera Heights neighborhood, located in the southeast corner of the Plan Area (Figure 2-4). In 2020, CAWC provided water utility service to approximately 17,695 people in Baldwin Hills (CAWC 2021). The majority of the people served in 2020 worked within the Plan Area but did not reside within the Plan Area. The service area population is projected to grow to 18,574 by the year 2045. Geographic expansion of CAWC's service area within the Plan Area is limited by the Inglewood Oil Field (CAWC 2021).

In 2020, CAWC provided 2,945 AF of potable water to the Baldwin Hills service area, a volume that is projected to increase to 3,891 by 2045 (CAWC 2021). This demand is met principally through groundwater extraction from the Central Basin, and secondly through imported surface water purchased from WBMWD (CAWC 2021). CAWC does not extract groundwater from the Subbasin.

2.1.2 Water Resources Monitoring and Management Programs

Multiple water resources monitoring and management programs have historically been, and are currently being, implemented throughout the Plan Area by GSA member agencies and stakeholders seeking to maintain and/or enhance water resources in the region, and to comply with state and federal laws applicable to water supply, water quality, watershed health and/or wildlife habitat. This section describes the monitoring and management programs that are most relevant to groundwater sustainability.

Existing monitoring programs for precipitation, streamflow, groundwater elevation, water quality, and water supply within the Plan Area are described in Sections 2.1.2.1 through 2.1.2.4. Data from some of the monitoring programs described herein, including the California Irrigation Management Information System (CIMIS) and the California Statewide Groundwater Elevation Monitoring (CASGEM) Program, will be incorporated into the monitoring of groundwater conditions and parameters that influence groundwater conditions that will be conducted under the umbrella of SGMA compliance. A description of how these existing monitoring networks will be incorporated into monitoring associated with the GSP is provided in Chapter 3 (Section 3.5 Monitoring Network). Section 2.1.2.5 describes how the understanding of the conditions gained through these programs enhances future opportunities for operational flexibility in the Plan Area.

2.1.2.1 Precipitation and Streamflow

Several entities monitor climate and streamflow in the Subbasin, including the National Oceanic and Atmospheric Administration (NOAA)[4], the LACDPW - Stormwater Engineering Division[5], the U.S. Geological Survey (USGS)[6], and DWR (Table 2-3). NOAA and LACDPW each maintain three active weather stations in the Plan Area and DWR maintains one CIMIS[7] weather station in the Plan Area. Additionally, NOAA has operated weather stations that are no longer active within the Subbasin, and both NOAA and LACDPW maintain active weather stations adjacent to the Plan Area. These weather stations provide information on long-term climate and local climatic variability (Table 2-3; Figure 2-5; See Section 2.2.3).

Table 2-3. Weather Stations and Stream Gauges in the Vicinity of the Plan Area

Station Name (Agency No./ID)	Latitude	Longitude	Elevation (feet msl)	Status	Period of Record	Located Within the Plan Area?
Weather Stations						
NOAA						
Culver City, CA US (USC00042214)	34.005	-118.4139	92	Active	1935–present	Yes
Santa Monica Municipal Airport, CA US (USW00093197)	34.01583	-118.45139	174	Active	1998–present	Yes
UCLA, CA US (USC00049152)	34.0697	-118.4427	430	Active	1933–present	Yes
Santa Monica Pier, CA US (USC00047953)	34.0075	-118.49972	14	Inactive	1937–2010	Yes
Santa Monica, CA US (USC00047950)	34.01667	-118.48333	59	Inactive	1900–1979	Yes
Los Angeles Downtown USC, CA US (USW00093134)	34.0236	-118.2911	179	Active	1906–present	No
Los Angeles International Airport, CA US (USW00023174)	33.938	-118.3888	97	Active	1944–present	No
Getty Center, CA US (USC00043392)	34.0869	-118.4794	340.5	Inactive	2000–2016	No
Bel Air FC 10A, CA US (USC00040619)	34.08333	-118.45	541	Inactive	1948–1980	No
LACDPW						
Hillcrest Country Club (462B)	34.05139	-118.40472	185	Active	2004–present	Yes
Ballona Creek @ Sawtelle Blvd (AL370)	33.99833	-118.40222	9	Active	2001–present	Yes

4 https://www.ncdc.noaa.gov/cdo-web/
5 https://www.ladpw.org/wrd/hydro.cfm
6 https://maps.waterdata.usgs.gov/mapper/index.html
7 https://cimis.water.ca.gov/

Table 2-3. Weather Stations and Stream Gauges in the Vicinity of the Plan Area

Station Name (Agency No./ID)	Latitude	Longitude	Elevation (feet msl)	Status	Period of Record	Located Within the Plan Area?
Electric Avenue Pumping Plant (AL461)	33.99306	-118.47306	10[a]	Active	2008–present	Yes
Bel Air Hotel (10A)	34.08611	-118.44639	490	Active	1997–present	No
DWR/CIMIS						
Santa Monica (Station #99)	34.044311	-118.47689	—	Active	1993–present	Yes
Stream Gauges						
USGS						
Ballona Creek (11103500)	33.998333	118.401389	—	Inactive	1928–1978	Yes
Ballona Creek (F38-R, F38B-R, F38C-R)	33.998393	118.402324	39 top 16 bottom	Active	1928-present	Yes

Source: NOAA; DWR/CIMIS; USGS; LACDPW.
Notes: Dash (–) indicates data are not available; msl = above mean sea level.
a LACDPW lists the station elevation as 397 ft msl.

LACDPW maintains one stream gauge (Station Number F38C-R) on Ballona Creek, located between Sepulveda and Sawtelle Boulevards in the southeastern part of the Plan Area (Table 2-3; Figure 2-5). There have been multiple stream gauges at this location through time, with LACDPW Station F38-R operating from February 27, 1928, until April 27, 1936, LACDPW Station F38B-R operating from May 14, 1936, until August 10, 1967, and LACDPW Station F38C-R operating from August 10, 1967, to present. Stage height, in feet above channel bottom, is recorded hourly. Stage height is converted to flow in cubic feet per second based on the channel geometry.

Historical daily discharge data from this station are provided by the USGS (USGS Station Number 11103500) which operated the station from 1928 to 1978. The data from these weather stations and stream gauges are used to inform development of the groundwater basin setting, hydrogeological conceptual model, and groundwater budget (Sections 2.2, 2.3, 2.4, and 2.5).

2.1.2.2 Groundwater Elevations

California Statewide Groundwater Elevation Monitoring Program

In response to Senate Bill (SB) X7-6, passed by the legislature in 2009, DWR developed the CASGEM Program to collect statewide groundwater elevations for the purpose of tracking seasonal and long-term groundwater elevation trends in groundwater basins statewide. DWR works cooperatively with local agencies, referred to as CASGEM "Monitoring Entities," to collect and maintain groundwater elevation data in a manner that is readily available to the public through the CASGEM online reporting system[8].

8 CASGEM data are available to the public through DWR's "SGMA Data Viewer" map application: https://sgma.water.ca.gov/webgis/?appid=SGMADataViewer#gwlevels.

In August 2014, the City of Santa Monica became the designated CASGEM monitoring entity for tracking groundwater elevation trends within the Subbasin. As the monitoring entity, the City of Santa Monica collects water levels twice per year from 21 designated CASGEM monitoring wells. Water levels are collected in late April/early May and late November/early December of each year to capture the seasonal high and low water levels (Table 2-4). In addition to the 21 designated CASGEM monitoring wells, the City of Santa Monica also collects data from seven voluntary wells. Groundwater elevations at voluntary wells are typically collected on the same dates and with the same frequency as the CASGEM wells and are also submitted to the CASGEM database (Table 2-4). The City of Santa Monica has been submitting groundwater elevation data to the CASGEM online reporting system since 2011.

Table 2-4. CASGEM Groundwater Monitoring Network

Common Well Name	State Well Identification (SWID)	Latitude	Longitude	CASGEM/ Voluntary	Well Depth	Top Screen	Bottom Screen
Arcadia Subunit							
Santa Monica No. 5	01S15W30P001S	34.049807	-118.494066	CASGEM	255	145	235
Charnock Subunit							
RMW-8	—	34.014607	-118.422688	CASGEM	272	240	269.5
RMW-9	—	34.014547	-118.422701	CASGEM	184	164	184
RMW-10	—	34.014593	-118.422622	CASGEM	138	116.5	136
RMW-57	—	34.012269	-118.421470	CASGEM	145	130	145
RMW-56	—	34.012252	-118.421515	CASGEM	169	153	168
RMW-12	—	34.013917	-118.419497	CASGEM	148	114.5	144.5
RMW-11	—	34.013938	-118.419527	CASGEM	182	166.5	180.5
RMW-4A	—	34.018353	-118.424577	CASGEM	149	108	148
RMW-3	—	34.018266	-118.424782	CASGEM	202	179.5	199.5
RMW-29	—	34.016029	-118.421267	CASGEM	152	136	151
RMW-28	—	34.016056	-118.421202	CASGEM	174	157	172
RMW-22	—	34.026641	-118.421377	Voluntary	157	141	156
RMW-48	—	34.01448	-118.420808	Voluntary	158	141	156
RPZ-7	—	34.026641	-118.421377	Voluntary	176	159.5	175.5
Olympic Subunit							
OB-5	—	34.031798	-118.473111	CASGEM	176	145.9	175.9
OB-4	—	34.030364	-118.471022	CASGEM	192	161.3	191.3
OB-7	—	34.031440	-118.468014	CASGEM	246	215	246
OB-9B	—	34.030468	-118.463530	CASGEM	223	202.15	222.15
MW-11	—	34.028829	-118.467383	CASGEM	141	120	140
OB-9C	—	34.030468	-118.463530	CASGEM	336	305.33	335.33
OB-6C	—	34.028051	-118.473689	CASGEM	176	145.9	175.9
GW-19-5	—	34.029141	-118.469727	CASGEM	206	190.15	190.45
GW-20-6	—	34.029887	-118.466023	CASGEM	264	262.95	263.25
OB-15B	—	34.029034	-118.470042	Voluntary	130	121.1	131.1
OB-15C	—	34.029034	-118.470042	Voluntary	215	185	215

Table 2-4. CASGEM Groundwater Monitoring Network

Common Well Name	State Well Identification (SWID)	Latitude	Longitude	CASGEM/ Voluntary	Well Depth	Top Screen	Bottom Screen
OB-17B	—	34.030314	-118.465254	Voluntary	205	194.9	204.9
OB-17C	—	34.030314	-118.465254	Voluntary	325	295.6	325.6

Source: City of Santa Monica 2014.

Data collected as part of the CASGEM program have been used to develop the Basin Setting (Section 2.2), current and historical groundwater conditions (Section 2.3), and have been integrated into the monitoring and reporting program developed as part of this GSP (Section 3.5).

2.1.2.3 Water Quality

2.1.2.3.1 Clean Water Act and Porter Cologne Water Quality Control Act Permitting

As the primary water quality control laws for California, the Clean Water Act and the Porter–Cologne Water Quality Control Act (codified in the California Water Code, Section 13000 et seq.) prompt most of the water quality plans and programs in the Plan Area. The Clean Water Act applies to all waters of the United States, whereas the Porter–Cologne Act applies to waters of the state, which includes isolated wetlands and groundwater in addition to federal waters. The Porter-Cologne Water Quality Control Act is implemented by the SWRCB and the nine RWQCBs. In addition to other regulatory responsibilities, the RWQCBs have the authority to conduct, order, and oversee investigation and cleanup where discharges or threatened discharges of waste to waters of the state[9] could cause pollution or nuisance, including impacts to public health and the environment.

Surface water and groundwater quality data are generated through permitting and compliance activities in the Plan Area required under the Clean Water Act and the Porter Cologne Water Quality Control Act. Remediation of groundwater impacted by releases from underground storage tanks, manufacturing, and light industrial operations has been critical to restoring beneficial uses of the groundwater in the Plan Area, which has been degraded by several contaminants of concern, including petroleum-based fuel products, tetrachloroethene (PCE), and trichloroethene (TCE).

Water Quality Control Plan for the Los Angeles Region

The *Water Quality Control Plan for the Los Angeles Region* (Basin Plan) designates beneficial uses, establishes water quality objectives, and contains implementation programs and policies to achieve those objectives for all waters addressed through the plan which include the coastal watersheds of Los Angeles and Ventura Counties (CWC §13240 through 13247). The Basin Plan must conform to the policies set forth in the Porter–Cologne Act as established by the SWRCB in its state water policy. The Porter–Cologne Act also provides the RWQCBs with authority to include within their respective basin plans water discharge prohibitions applicable to particular conditions, areas, or types of waste. The Basin Plan is continually being updated to include amendments related to implementation of Total Maximum Daily Loads, revisions of programs and policies within the Los Angeles RWQCB region, and changes to beneficial use designations and associated water quality objectives.

9 "Waters of the state" are defined in the Porter–Cologne Act as "any surface water or groundwater, including saline waters, within the boundaries of the state" (California Water Code, Section 13050(e)).

Surface water is divided into 6 hydrologic units (HUs) within the Basin Plan, generally following the boundaries of the USGS 8-digit hydrologic unit code defined “subbasins”. The Plan Area is located within the Santa Monica Bay HU. The Santa Monica Bay HU is divided into hydrologic areas (HAs) and hydrologic sub-areas. The Plan Area lies within the Ballona Creek HA, the Santa Monica Canyon and Santa Monica Beach hydrologic sub-areas of the Garapito Creek HA, and the Manhattan Beach hydrologic sub-area of the Frontal Santa Monica Bay – San Pedro Bay HA. The small portion of the Plan Area that is located within the San Gabriel HU falls within the Upper Dominguez Channel hydrologic sub-area of the Dominguez Channel HA (Figure 2-3). The Plan Area is crossed by Reach 2 of Ballona Creek, and includes the Ballona Wetlands, Ballona Lagoon / Venice Canals, the Del Rey Lagoon and the Ballona Creek Estuary as the creek empties into Santa Monica Bay. Centinela Creek and the Sepulveda Channel are tributaries to Ballona Creek in the southern portion of the Plan Area (Figure 2-3).

The Basin Plan designates beneficial uses for both surface waters and groundwater within the coastal watersheds of Los Angeles and Ventura Counties (Table 2-5). The actual and potential beneficial uses of Ballona Creek and its associated water bodies as indicated in the Basin Plan consist of MUN[10], NAV[11], COMM[12], EST[13], MAR[14], WILD[15], RARE[16], MIGR[17], SPWN[18], SHELL[19], WET[20], WARM[21], REC1[22], L-REC1[23] and REC2[24](Table 2-5). Beneficial uses for Centinela Creek and the Sepulveda Channel are not defined in the Basin Plan.

10 Municipal and Domestic Supply (MUN): Uses of water for community, military, or individual water supply including, but not limited to, drinking water supply.

11 Navigation (NAV): Uses of water for shipping, travel, or other transportation by private, military, or commercial vessels.

12 Commercial and Sport Fishing (COMM): Uses of water for commercial or recreational collection of fish, shellfish, or other organisms including, but not limited to, uses involving organisms intended for human consumption or bait purposes.

13 Estuarine Habitat (EST): Uses of water that support estuarine ecosystems including, but not limited to, preservation or enhancement of estuarine habitats, vegetation, fish, shellfish, or wildlife (e.g., estuarine mammals, waterfowl, shorebirds).

14 Marine Habitat (MAR): Uses of water that support marine ecosystems including, but not limited to, preservation or enhancement of marine habitats, vegetation such as kelp, fish, shellfish, or wildlife (e.g., marine mammals, shorebirds).

15 Wildlife Habitat (WILD): Uses of water that support terrestrial ecosystems including, but not limited to, preservation and enhancement of terrestrial habitats, vegetation, wildlife (e.g., mammals, birds, reptiles, amphibians, invertebrates), or wildlife water and food sources.

16 Rare, Threatened or Endangered Species (RARE): Uses of water that support the habitats necessary, at least in part, for the survival and successful maintenance of plant or animal species established under state or federal law as rare, threatened or endangered.

17 Migration of Aquatic Organisms (MIGR): Uses of water that support habitats necessary for migration, acclimatization between fresh and salt water, or other temporary activities by aquatic organisms, such as anadromous fish.

18 Spawning, Reproduction, and/or Early Development (SPWN): Uses of water that support high quality aquatic habitats suitable for reproduction and early development of fish.

19 Shellfish Harvesting (SHELL): Uses of water that support habitats suitable for the collection of filter-feeding shellfish (e.g., clams, oysters, and mussels) for human consumption, commercial, or sports purposes.

20 Wetland Habitat (WET): Uses of water that support ecosystems, including, but not limited to, preservation or enhancement of wetland habitats, vegetation, fish, shellfish, or wildlife, and other unique wetland functions which enhance water quality, such as providing flood and erosion control, stream bank stabilization, and filtration and purification of naturally occurring contaminants.

21 Warm Freshwater Habitat (WARM): Uses of water that support warm water ecosystems including, but not limited to, preservation or enhancement of aquatic habitats, vegetation, fish, or wildlife, including invertebrates.

22 Water Contact Recreation (REC1): Uses of water for recreational activities involving body contact with water where ingestion of water is reasonably possible. These uses include, but are not limited to, swimming, wading, water-skiing, skin and scuba diving, surfing, whitewater activities, fishing and use of natural hot springs.

23 Limited Water Contact Recreation (L-REC1): Uses of water for recreation activities involving body contact with water, where full REC1 use is limited by physical conditions such as very shallow water depth and restricted access and, as a result, ingestion of water is incidental and infrequent.

24 Non-contact Water Recreation (REC2): Uses of water for recreational activities involving proximity to water, but not normally involving body contact with water, where ingestion of water is reasonably possible. These uses include, but are not limited to, picnicking, sunbathing, hiking, beachcombing, camping, boating, tidepool and marine life study, hunting, sightseeing and aesthetic enjoyment in conjunction with the above activities.

Table 2-5. Basin Plan Beneficial Uses, Select Water Quality Objectives, and Water Quality Impairments for Receiving Waters within the Santa Monica Subbasin

Receiving Waters	Designated Beneficial Uses	Water Quality Objectives for Total Dissolved Solids (TDS)/Nitrate + Nitrogen (mg/L)/Sulfate (mg/L)/Boron (mg/L)/ Chloride (mg/L)	Water Quality Impairments (303(d) Listed)
Groundwater			
Santa Monica Subbasin	MUN, IND, PROC, AGR	Total Dissolved Solids: 1,000 Nitrate (as Nitrogen) + Nitrite (as Nitrogen): 10 Sulfate: 350 Boron: 0.5 Chloride: 200	NA
Surface Water			
Ballona Creek Estuary (ends at Centinela Creek)	NAV, COMM, EST, MAR, WILD, RARE, MIGR, SPWN, SHELL, REC1, REC2	No waterbody specific objectives	Cadmium, Chlordane, Copper, DDT, Indicator Bacteria, Lead, PAHs, Silver, Toxicity, Zinc
Ballona Lagoon/ Venice Canals	NAV, COMM, EST, MAR, WILD, RARE, MIGR, SPWN, SHELL, WET, REC1, REC2	No waterbody specific objectives	Considered part of Ballona Wetlands for 303(d) list.
Ballona Wetlands	EST, WILD, RARE, MIGR, SPWN, WET, REC1, REC2	No waterbody specific objectives	Exotic Vegetation, Habitat Alterations, Reduced Tidal Flushing, Trash
Del Rey Lagoon	NAV, COMM, EST, WILD, RARE, MIGR, SPWN, WET, REC1, REC2	No waterbody specific objectives	Not assessed
Ballona Creek Reach 2 (Estuary to National Blvd.)	MUN*, WARM*, WILD*, REC1*, LREC-1, REC2	Total Dissolved Solids: 500 Nitrate (as Nitrogen): 10	Copper, Cyanide, Indicator Bacteria, Lead, Selenium, Toxicity, Trash, Enteric Viruses, Zinc
Sepulveda Canyon	Not considered in Basin Plan	No waterbody specific objectives	Copper, Indicator Bacteria, Lead, Selenium, Zinc
Santa Monica Canyon	MUN*, WARM*, WILD*	Total Dissolved Solids: 500 Nitrate (as Nitrogen): 10	Indicator Bacteria, Lead
Rustic Canyon	MUN*, WARM**, WILD	Total Dissolved Solids: 500 Nitrate (as Nitrogen): 10	No listed impairments
Sullivan Canyon	MUN*, WARM**, WILD	Total Dissolved Solids: 500 Nitrate (as Nitrogen): 10	No listed impairments
Mandeville Canyon	MUN*, WARM**, WILD	Total Dissolved Solids: 500 Nitrate (as Nitrogen): 10	No listed impairments
Will Rogers State Beach	NAV, COMM, MAR, WILD, SPWN*, SHELL, REC1, REC2	No objectives for TDS or Nitrate	Indicator Bacteria
Santa Monica Beach	NAV, COMM, MAR, WILD, MIGR, SPWN, SHELL, REC1, REC2	No objectives for TDS or Nitrate	Indicator Bacteria

Table 2-5. Basin Plan Beneficial Uses, Select Water Quality Objectives, and Water Quality Impairments for Receiving Waters within the Santa Monica Subbasin

Receiving Waters	Designated Beneficial Uses	Water Quality Objectives for Total Dissolved Solids (TDS)/Nitrate + Nitrogen (mg/L)/Sulfate (mg/L)/Boron (mg/L)/ Chloride (mg/L)	Water Quality Impairments (303(d) Listed)
Venice Beach	NAV, COMM, MAR, WILD, RARE, MIGR, SPWN, SHELL, REC1, REC2	No objectives for TDS or Nitrate	Indicator Bacteria
Marina del Rey Harbor	NAV, COMM, MAR, WILD, SHELL, REC1, REC2	No waterbody specific objectives	Chlordane, Copper, DDT, Dieldrin, Indicator Bacteria, Lead, Dissolved Oxygen, polychlorinated biphenyls, Toxicity, Zinc
Marina del Rey Public Beach Area	NAV, COMM, MAR, WILD, RARE, REC1, REC2	No waterbody specific objectives	Indicator Bacteria
Marina del Rey Entrance Channel	NAV, COMM, MAR, WILD, RARE, SHELL, REC1, REC2	No waterbody specific objectives	Considered part of Marina del Rey Harbor for 303(d) list.
Marina del Rey (All other areas)	NAV, COMM, MAR, WILD, RARE, SHELL, REC1*, REC2	No waterbody specific objectives	Considered part of Marina del Rey Harbor for 303(d) list.
Dockweiler Beach	IND, NAV, COMM, MAR, WILD, SPWN*, REC1, REC2	Total Dissolved Solids: 520 Nitrate (as Nitrogen): 1.0	Indicator Bacteria
Santa Monica Bay	IND, NAV, COMM, MAR, WILD, BIOL, RARE, MGR, SPWN, SHELL	No objectives for TDS or Nitrate	Arsenic, DDT, Mercury, polychlorinated biphenyls, Trash

Notes: NA – not applicable. Water quality impairments apply to surface water, not groundwater.

* Potential beneficial use for one or more of the following reasons: implementation of the State Board's policy entitled "Sources of Drinking Water Policy" (State Board Resolution No. 88-63); plans to put the water to such future use; potential to put the water to such future use; designation of a use by the Regional Board as a regional water quality goal, or; public desire to put the water to such future use.

** Intermittent beneficial use due to intermittent stream flow.

In the northwestern portion of the Plan Area, Temescal Canyon, La Pulga Canyon, and Santa Monica Canyon, with its tributaries of Rustic Canyon, Sullivan Canyon and Mandeville Canyon, are surface water bodies identified by the Basin Plan that discharge into Santa Monica Bay. Santa Monica Canyon and its associated tributaries are identified as having the following existing, intermittent or potential beneficial uses: MUN, WARM and WILD. Neither Temescal Canyon nor La Pulga Canyon are identified as having beneficial uses in the Basin Plan.

The Basin Plan identifies beneficial uses and groundwater quality objectives for the Santa Monica Subbasin (Table 2-5). The existing beneficial uses for groundwater are: MUN, IND[25], PROC[26] and AGR[27]. Coastal features within the

[25] Industrial Service Supply (IND): Uses of water for industrial activities that do not depend primarily on water quality including, but not limited to, mining, cooling water supply, hydraulic conveyance, gravel washing, fire protection, or oil well re-pressurization.

[26] Industrial Process Supply (PROC): Uses of water for industrial activities that depend primarily on water quality.

[27] Agricultural Supply (AGR): Uses of water for farming, horticulture, or ranching including, but not limited to, irrigation, stock watering, or support of vegetation for range grazing.

Plan Area with beneficial uses identified by the Basin Plan include Will Rogers State Beach, Santa Monica Beach, Venice Beach, Marina del Rey (harbor, public beach area, entrance channel and all other areas), the Ballona Creek Estuary, the Ballona Lagoon/Venice Canals, the Ballona Wetlands, Del Rey Lagoon, Dockweiler Beach and the Santa Monica Bay (Table 2-5). The beneficial uses of these coastal features include: IND, NAV, COMM, EST, MAR, WILD, BIOL[28], RARE, MIGR, SPWN, SHELL, WET, REC1 and REC2.

Basin Plan Triennial Review

Both State and federal laws require the periodic review of basin plans and their water quality standards (CWC §13240 and Clean Water Act §303(c)(1)). In accordance, every three years, the Basin Plan is subjected to a triennial review. As part of this review the RWQCB can adjust water quality objectives and programs as new data and information become available or as new problems arise. No adjustments were made to the Basin Plan objectives for groundwater in the Santa Monica Subbasin during the most recent Basin Plan triennial review, which covers 2017 through 2019.

Waste Discharge Requirements and Stormwater Programs

Due to the broad scope of state and federal water quality regulations, the SWRCB and RWQCB have developed general waste discharge requirements (WDRs) specific to activities that involve similar types of discharges and thus also require similar types of pollution control. This is the focus of the construction, industrial, and municipal stormwater programs administered by the RWQCB. Additionally, the RWQCB has the authority to implement general permits to multiple permittees, and to provide waivers of WDRs. The permits applicable to the Plan Area are summarized in Table 2-6, along with a description of the data reporting the general permit prompts. Most reporting of data occurs through one of two SWRCB databases: 1) the Stormwater Multiple Application and Report Tracking System (SMARTS) for compliance with stormwater permits, and 2) the Geotracker online database for compliance activities related to WDRs (point source discharges).

Table 2-6. SWRCB and Los Angeles RWQCB General Permits Applicable to the Plan Area

Program/Activity	Order Number/ NPDES Number	Permit Name	Affected Area/ Applicable Activity	Water Resources Data Reporting
General Permits				
Construction Stormwater Program	2009-0009-DWQ/ CAS000002, as amended	NPDES General Permit for Storm Water Discharges Associated with Construction and Land Disturbance Activities (Construction General Permit)	Statewide/ Construction-related land disturbance of > 1 acre.	Annual report submittals to SMARTS database, including sampling and analysis results.
Municipal Stormwater Program	Los Angeles RWQCB Order No. R4-2012-0175/ CAS004001	Waste Discharge Requirements for Municipal Separate Storm Sewer System (MS4) Discharges within the Coastal Watersheds	Los Angeles Region with the exception of Long Beach, Avalon, Lancaster, Palmdale and unincorporated	Annual report submittals to SMARTS database, including sampling and

28 Preservation of Biological Habitats (BIOL): Uses of water that support designated areas or habitats, such as Areas of Special Biological Significance (ASBS), established refuges, parks, sanctuaries, ecological reserves, or other areas where the preservation or enhancement of natural resources requires special protection.

Table 2-6. SWRCB and Los Angeles RWQCB General Permits Applicable to the Plan Area

Program/Activity	Order Number/ NPDES Number	Permit Name	Affected Area/ Applicable Activity	Water Resources Data Reporting
General Permits				
		of Los Angeles County, Except Those Discharges Originating from the City of Long Beach MS4	portions of Los Angeles County	analysis results.
Non-Stormwater Discharge to Land	SWRCB Order No. 2003-0003-DWQ	Statewide General Waste Discharge Requirements for Discharges to Land with a Low Threat to Water Quality (WDR for Discharge to Land)	Statewide/Non-stormwater discharges to land only	Notice of Intent and, if applicable, discharge monitoring. Water Quality BMPs for discharge are required as condition of General WDR.
Discharge of Treated Groundwater from Groundwater Investigation and/or Cleanup to Surface Water	Los Angeles RWQCB Order No. R4-2018-0087/ CAG914001)	Waste Discharge Requirements for Discharges of Treated Groundwater from Investigation and/or Cleanup of Volatile Organic Compounds-Contaminated Sites to Surface Waters in Coastal Watershed of Los Angeles and Ventura Counties	Los Angeles Region/Non-stormwater discharges to surface water	Notice of Intent and, if applicable, discharge monitoring. Water Quality BMPs for discharge are required as condition of General WDR.
Construction Dewatering Discharge to Surface Water	Los Angeles RWQCB Order No. R4-2018-0125/ CAG994004)	Waste Discharge Requirements for Discharges of Groundwater from Construction and Project Dewatering to Surface Waters in Coastal Watershed of Los Angeles and Ventura Counties	Los Angeles Region/Non-stormwater discharges to surface water	Notice of Intent and, if applicable, discharge monitoring. Water Quality BMPs for discharge are required as condition of General WDR.

Note: BMP – Best management practice

<u>Construction Stormwater Program (SWRCB Order 2009-0009-DWQ)</u>

For stormwater discharges associated with construction activity in the State of California, the SWRCB has adopted the General Permit for Storm Water Discharges Associated with Construction and Land Disturbance Activities (“Construction General Permit”) to avoid and minimize water quality impacts attributable to such activities. The construction general permit is required for all projects where construction activities will disturb one acre or more of soil. Construction activity subject to this permit includes clearing, grading, and disturbances to the ground, such as stockpiling and excavation. The construction general permit requires the development and implementation of a stormwater pollution prevention plan, which would include and specify water quality best management practices (BMPs) designed to prevent pollutants from contacting stormwater and keep all products of erosion from moving off-site into receiving waters. Routine inspection of all BMPs is required under the provisions of the construction general permit, and the stormwater pollution prevention plan must be prepared and implemented by “qualified individuals” as defined by the SWRCB.

Municipal Stormwater Program (Los Angeles RWQCB Order R4-2012-0175-A01)

The *Waste Discharge Requirements for the Municipal Separate Storm Sewer System (MS4) Discharges from the Coastal Watersheds of Los Angeles County, except those discharges originating from the City of Long Beach MS4* (MS4 Permit) covers 84 cities and most of the unincorporated areas of Los Angeles County. Under the MS4 Permit, the LACFCD is designated as the "Principal Permittee." The "Permittees" are the 84 Los Angeles County cities, including the Cities of Santa Monica, Beverly Hills, Culver City, and Los Angeles, with the exception of Avalon, Long Beach, Palmdale and Lancaster, and Los Angeles County. Collectively, these Permittees are the “Co-Permittees.”

The MS4 Permit requires Co-Permittees to implement a development planning program to address stormwater pollution. These programs require project applicants for certain types of projects to implement a Standard Urban Stormwater Mitigation Plan throughout the operational life of the project. The purpose of a Standard Urban Stormwater Mitigation Plan is to reduce the discharge of pollutants in stormwater and to eliminate increases in pre-existing runoff rates and volumes by outlining BMPs that must be incorporated into the design plans of new development and redevelopment.

Non-Stormwater Discharge to Land (SWRCB Order 2003-0003-DWQ)

This Order establishes minimum standards for discharges to land determined to pose a low threat to water quality. Such discharges include well development water, monitoring well purge water, water main/storage tank/hydrant flushing, pipeline/tank hydrostatic testing discharge, swimming pool discharge, and small dewatering projects, among others. Dischargers seeking coverage under these general WDRs must file with the Regional Board a notice of intent, an annual fee, a project map, evidence of California Environmental Quality Act (CEQA) compliance and a monitoring plan. If there is a conflict determined between these WDRs and the Basin Plan, the more stringent provision will prevail. Discharges covered by this Order are considered low threat to water quality and consist of a low volume of water with minimal pollutant concentrations. Each discharge category is monitored according to the requirements established for that category.

Treated Groundwater from Investigation and/or Cleanup Discharge to Surface Water (Los Angeles RWQCB Order R4-2018-0087)

This general order *(Waste Discharge Requirements for the Discharge of Treated Groundwater from Investigation and/or Cleanup of Volatile Organic Compounds-Contaminated Sites to Surface Waters in the Coastal Watersheds of Los Angeles and Ventura Counties)* is intended to authorize discharges of treated groundwater generated from remediation of groundwater contaminated by volatile organic compounds (VOCs). Discharges from facilities to waters of the United States that have undergone remediation to lower the VOC concentrations in the discharge to below specified maximum daily effluent concentration limits are authorized discharges in accordance with the conditions set forth in this order. To demonstrate coverage under the order, dischargers must submit documentation to show that the discharge would not cause or contribute to a violation of any applicable water quality objective/criteria for the receiving waters, or any other discharge prohibition listed in the order. In addition, dischargers must perform reasonable potential analysis using a representative sample of untreated groundwater to be treated and discharged under the order. The discharger is required to treat the groundwater to acceptable standards prior to discharging it to the surface water.

Construction Dewatering Discharge to Surface Water (Los Angeles RWQCB Order R4-2018-0125)

This general order *(Waste Discharge Requirements for the Discharge of Groundwater from Construction and Project Dewatering to Surface Waters in the Coastal Watersheds of Los Angeles and Ventura Counties)* is intended to authorize discharges of treated or untreated groundwater generated from permanent or temporary dewatering operations or other applicable wastewater discharges not specifically covered in other general or individual National Pollutant Discharge Elimination System (NPDES) permits. Discharges from facilities to waters of the United States that do not cause, have the reasonable potential to cause, or contribute to an in-stream excursion above any applicable state or federal water quality objectives/criteria or cause acute or chronic toxicity in the receiving water are authorized discharges in accordance with the conditions set forth in this order. To demonstrate coverage under the order, dischargers must submit documentation to show that the discharge would not cause or contribute to a violation of any applicable water quality objective/criteria for the receiving waters, or any other discharge prohibition listed in the order. In addition, dischargers must perform reasonable potential analysis using a representative sample of groundwater or wastewater to be discharged. The sample is analyzed, and the data compared to the water quality screening criteria for the constituents listed in the order. If results show exceedance of water quality screening criteria, the discharger is required to treat the wastewater to acceptable standards prior to discharge.

2.1.2.3.2 SWRCB Division of Drinking Water Required Monitoring

SWRCB DDW is responsible for regulating and enforcing potable water quality standards. SWRCB receives the majority of its statutory authority related to public health and potable water from the California Safe Drinking Water Act, as defined in the California Health and Safety Code and CCR Titles 17 and 22. In addition, SWRCB DDW has the primary enforcement authority (primacy) to enforce the federal Safe Drinking Water Act (SDWA), and is responsible for the regulatory oversight of approximately 8,000 public water systems throughout the state including the City of Santa Monica, the City of Beverly Hills, LADWP, CAWC, GSWC and Los Angeles County Waterworks District 29 within the Plan Area.

SWRCB DDW requires public water systems to report raw water quality as well as finished treated water quality to ensure it meets drinking water standards prior to delivery to customers. The data generated by this program is publicly available through consumer confidence reports and other online web services (e.g., California Drinking Water Watch and the Groundwater Ambient Monitoring and Assessment Program). For example, the Santa Monica water system reports up to 90 different water quality parameters for 70 different sampling points including 2 active MWD connections for treated SWP water and 10 active groundwater wells[29].

2.1.2.3.3 Groundwater Ambient Monitoring and Assessment and Surface Water Ambient Monitoring Program

The Groundwater Ambient Monitoring and Assessment (GAMA) Program conducts comprehensive monitoring of California's groundwater quality, compiles and standardizes groundwater quality data across several different sources and regulatory programs and makes that data readily accessible to the public. In addition, the GAMA Program conducts groundwater studies related to groundwater vulnerability, groundwater quality in domestic wells, and groundwater impacts associated with non-point sources of contamination. GAMA regional scientific

29 https://www.waterboards.ca.gov/drinking_water/certlic/drinkingwater/Monitoring.html

assessment reports, which document the results of groundwater quality investigations, can be accessed through the GAMA Groundwater Projects and Publications Webmap[30].

Additionally, the Surface Water Ambient Monitoring Program and the California Environmental Data Exchange Network contain water quality data collected by state and regional monitoring programs; GeoTracker includes information on cleanup sites with the potential to impair water quality. A review of historical water quality data for the Plan Area is included in Section 2.4.4 (Groundwater Quality).

2.1.2.3.4 Olympic Wellfield Groundwater Monitoring Program

The Olympic Wellfield Groundwater Management Plan was developed in response to groundwater contamination detected in the vicinity of the City of Santa Monica's Olympic Wellfield (Figure 2-6; City of Santa Monica 2011). The Olympic Wellfield is located in a formerly industrial corridor that includes a City of Santa Monica vehicle fueling, maintenance and storage facility for solid waste handling, and industrial facilities operated by Douglas Aircraft, Mor-Flo Industries, American Appliance Manufacturing Corporation, and Gillette/Paper Mate. Activities at the City of Santa Monica maintenance yard and the Gillette/Paper Mate facility have contributed to degradation of the groundwater that has impacted the City of Santa Monica's groundwater supply wells (SM-3 and SM-4). Treatment of the raw groundwater pumped from the Olympic Wellfield is required in order for the groundwater to meet DDW drinking water standards. The City of Santa Monica modified its Arcadia Water Treatment Plant in the early 1990s to treat solvent-impacted groundwater and ensure the safety of the public drinking water (City of Santa Monica 2011).

Prior to 2011, groundwater monitoring activities at the sites surrounding the Olympic Wellfield were conducted under separate RWQCB administrative orders (RWQCB Case Nos. 904040434 and 0130E2). Under a settlement and release agreement between the City of Santa Monica and Gillette/Paper Mate the City of Santa Monica assumed legal responsibility for control and remediation of all contamination originating from the Gillette site that was present in the drinking water aquifers. This settlement agreement resulted in the merging of quarterly monitoring and reporting at the City of Santa Monica vehicle maintenance yard and the Gillette site under the single Olympic Wellfield Groundwater Monitoring Program (City of Santa Monica 2011; Geotracker Global ID T0603799303).

The Olympic Wellfield Groundwater Monitoring Program was designed to "demonstrate that pumping of the City [of Santa Monica's] groundwater production wells in the Olympic Wellfield provides adequate hydraulic control" of the dissolved phase volatile organic compound (VOC) plume (City of Santa Monica 2011). A program of quarterly groundwater monitoring was established to demonstrate hydraulic control. This program currently includes recording groundwater elevations at 21 monitoring wells and collecting groundwater quality samples from 25 monitoring wells. Groundwater quality samples are analyzed for VOCs, including benzene, toluene, ethylbenzene, and xylenes (BTEX), fuel oxygenate additives, 1,4-Dioxane, and 1,2,3-trichloropropane (City of Santa Monica 2020a). The quarterly groundwater monitoring results for the Olympic Wellfield Groundwater Monitoring program are submitted to the RWQCB.

2.1.2.3.5 Charnock Wellfield Groundwater Quality Monitoring

In 1996, after detecting MTBE, a fuel additive, in routine samples collected from its production wells in the Charnock wellfield, the City of Santa Monica ceased groundwater production from five of its most productive wells (Figure 2-6; City of Santa Monica 2016). The U.S. EPA and RWQCB identified 32 potential source sites within a one and one

30 https://waterboards.maps.arcgis.com/apps/webappviewer/index.html?id=1ea24606744847f3b7f1222289264e53

quarter mile radius of the wellfield. These source sites were required to conduct a preliminary investigation into the potential extent of soil and groundwater contamination (RWQCB 2002). In 2006, Shell, Chevron, and Exxon Mobil (collectively referred to as the Charnock Technical Advisory Group) reached a settlement with the City of Santa Monica, whereby the companies would fund the City of Santa Monica's efforts to restore the Charnock wellfield to operational status (City of Santa Monica 2007). As part of the restoration, the City of Santa Monica re-designed the Charnock Treatment Unit , added a granular activated carbon treatment unit at the Charnock wellfield, and upgraded the Arcadia Water Treatment Plant to provide a multi-barrier treatment system to restore the Charnock wellfield. This allowed Santa Monica to produce groundwater from the Charnock wellfield again beginning in December 2010.

The City of Santa Monica continues to conduct two groundwater quality monitoring programs associated with the contamination at the Charnock Field. The first program, referred to as the Charnock Groundwater Management Program, consists of a voluntary regional groundwater monitoring program that augments the monitoring and remediation activities at individual potential source sites (City of Santa Monica 2018b). The second, referred to as the Charnock Wellfield Early Warning Groundwater Quality Monitoring Program, is conducted to provide the City with an early warning of additional contaminant migration toward the Charnock wellfield (City of Santa Monica 2019). Each of these monitoring programs is described in more detail below.

Charnock Groundwater Management Program

Under the Charnock Groundwater Management Program, the City of Santa Monica collects semi-annual groundwater elevation data from 52 regional groundwater wells, 41 of which are sampled for groundwater quality either annually, semi-annually, or every three years. Semi-annual groundwater quality samples are collected from 12 wells, annual samples are collected from an additional six wells, and samples every three years are collected from an additional 23 wells (City of Santa Monica 2020b). Semi-annual samples are analyzed for fuel constituents, oxygenates, and volatile fuel hydrocarbons. Annual samples are analyzed for VOCs including fuel parameters, and volatile fuel hydrocarbons.

The wells in the Charnock Groundwater Management Program are screened in the shallow, upper Silverado, and lower Silverado aquifers, which together compose the primary aquifer system from which the City of Santa Monica production wells extract groundwater. Groundwater quality and groundwater elevation sampling has been conducted in these wells for over 15 years, and the data collected from the wells has provided a comprehensive understanding of groundwater elevation and groundwater quality in the vicinity of the Charnock Wellfield. Ongoing annual groundwater monitoring reports documenting the groundwater conditions in January are due to the RWQCB by July 15 of each year and semiannual sampling reports, documenting the groundwater conditions in July, are due to the RWQCB by January 15 of the following year. Modifications to the monitoring program require approval from the RWQCB.

Early Warning Groundwater Quality Monitoring

In addition to the Charnock Groundwater Management Program, the City of Santa Monica collects groundwater quality data from 12 sentry wells within the capture zone of the Charnock wellfield as part of the drinking water permitting process for the Charnock Treatment Unit and associated facilities under DDW (formerly Department of Public Health) Policy Memorandum 97-005 ("Policy Guidance for Direct Domestic Use of Extremely Impaired Sources"). This monitoring constitutes the City's Early Warning Groundwater Quality Monitoring program for the Charnock wellfield, and data collected under this program is submitted to the DDW. Six of the 12 wells in the Early Warning Groundwater Quality Monitoring program are used to track MTBE plume migration toward the wellfield, and six of the wells are used to monitor ambient groundwater quality (City of Santa Monica 2019). Two of the plume tracking wells are sampled annually, while the other four are sampled every two years. The ambient groundwater quality wells are sampled every three years (City of Santa Monica 2019). All groundwater samples collected are analyzed for the list of chemicals under 22 CCR, including tentatively identified compounds, non-target VOCs, non-target semi-volatile organic compounds, inorganics, VOCs, non-volatile synthetic organic chemicals, radionuclides, secondary drinking water standards and unregulated chemicals (City of Santa Monica 2019). Through the Early Warning Groundwater Quality Monitoring program, the City of Santa Monica helps ensure that all groundwater pumped, treated, and distributed to City residents meets all Federal, State, and local drinking water regulations.

2.1.2.4 Water Supply

Water conservation, water supply planning, and consideration of water availability have long been at the forefront of efforts by the GSA member agencies in the Plan Area. In addition to local efforts, the State has codified water supply planning in CWC Sections 10608 through 10609.42, which establish water use and demand reduction targets, Sections 10610 through 10657, which address UWMPs, Sections 10910 through10914, which address Water Supply Assessments (WSAs), and California Government Code Section 66473.7 (part of the Subdivision Map Act), which contains requirements related to written verifications (i.e., “will-serve” letters). Collectively, these laws, along with CEQA, prompt cities, counties, special districts, and water suppliers to evaluate growth in a broader geographic and temporal context, by coordinating land use planning with water availability and sustainability.

Urban Water Management Plans

Water supply availability is evaluated at various geographic scales, each of which are addressed in different sections of the CWC. Urban water suppliers in the Plan Area[31] (MWD, WBMWD, LADWP, City of Santa Monica, GSWC – CC, CAWC – Baldwin Hills, City of Beverly Hills, Los Angeles County Waterworks District 29) are required to prepare UWMPs that describe existing and planned water supply sources, identifies human and/or environmental threats to water reliability, outlines how they will meet State-mandated water conservation targets[32], establishes water shortage contingency plans, and assesses whether their existing and future water supplies will be sufficient over a 20-year planning horizon, incorporating projections of growth and land use in the service area along with drought scenarios. UWMPs provide valuable data on regional water demand and supply, provide a means to measure how effective water conservation and water use efficiency efforts have been, and set the framework for evaluating and prioritizing future capital improvements. UWMPs are required to be updated every 5-years.

UWMPs for the suppliers in the Plan Area were updated in 2020. The City of Santa Monica is the only urban water supplier in the Subbasin that produces groundwater. The City of Santa Monica was actively involved with preparation of the GSP and ensured that the water supply assumptions of the updated UWMP were consistent with the GSP. Similarly, implementation of the GSP in this highly urbanized Subbasin that is already subject to multiple regulatory programs overseeing water supply is not anticipated to change water demands or affect achievement of sustainability.

Water Efficiency Standards

SWRCB in coordination with DWR, are in the process of determining and adopting long-term standards for the efficient use of water and performance measures for commercial, industrial, and institutional water use. This effort was undertaken as part of Assembly Bill (AB)1688 and SB 606, passed in May 2018, which together establish a

31 Per CWC Section 10617, an urban water supplier means a supplier, either publicly or privately owned, providing water for municipal purposes either directly or indirectly to more than 3,000 customers or supplying more than 3,000 acre-feet of water annually.

32 Water Conservation Act of 2009 (i.e., Senate Bill X7-7) requires that the state reduce urban water consumption by 20% by the year 2020, as measured in gallons per capita per day.

standard for indoor water use of 55 gallons per capita daily to be reached by 2025, 52.5 gallons per capita daily beginning in 2025, and 50 gallons per capita daily beginning in 2030. DWR will also adopt long-term standards for outdoor residential water use and outdoor irrigation in connection with commercial, industrial, and institutional water use. Together with the 20% by 2020 conservation goal pursued in the Water Conservation Act of 2009 (SB X7-7), these bills extend UWMP requirements. Compliance will be measured with uniform standards based on the aggregate volume of water that would have been delivered the previous year by an urban retail water supplier if all that water had been used efficiently, rather than relative to a water district's baseline. Assembly Bill 1668 continues the requirements for urban water suppliers to submit UWMPs every 5 years and makes water suppliers ineligible for *any* water grant or loan if it does not submit an UWMP. The bills also add requirements for Agricultural Water Management Plans to be organized by groundwater basin or subbasin. There are no entities considered to be agricultural water suppliers[33] in the Subbasin and thus there are no Agricultural Water Management Plans relevant to the Plan Area.

Water Supply Assessments

WSAs, which apply to specific categories of projects subject to CEQA, include a discussion of the availability of an identified water supply over a 20-year projection. The supply is assessed under normal-year, single-dry-year, and multiple-dry-year conditions and accounts for the projected water demand of the project in addition to other existing and planned future uses of the identified water supply. WSAs are similar to UWMPs but analyze the water supply for an individual project or subdivision rather than for a broader service area. If groundwater is used wholly or in part to supply a project or subdivision, additional analytical steps are required that could expand the necessary scope of WSA, CEQA document, and/or written verification, as applicable. Future WSAs may incorporate relevant information from GSPs to assess water supply availability and reliability.

2.1.2.5 Operational Flexibility and Conjunctive Use Programs

Operational flexibility is a key consideration in integrated water resource management because it helps water purveyors adapt to known legal, operational, and environmental constraints, and plan for an uncertain future, especially related to drought resiliency and the effects of climate change. Operational flexibility is maximized when a water purveyor has a large variety of sources in a water supply portfolio, when it has local control over such sources, and when such sources are connected to each other (e.g., conjunctively managed). On a general statewide scale, water purveyors are increasingly looking to minimize reliance on imported water supplies by promoting stormwater recharge, maximizing wastewater recycling, and sustainably developing local sources of water.

For the Plan Area, the GSA member agencies and associated retail water providers collectively draw from a combination of sources—including surface water imports from the SWP and the Colorado River, recycled water, and groundwater—which differ in terms of the volume available, area served, timing of peak availability, and reliability. There are no conjunctive use programs in the Plan Area, because local surface water is not a significant source of supply for the area. The City of Santa Monica is the only GSA member agency or water provider in the Plan Area that currently produces groundwater as a component of its water supply portfolio. The City has a long history of sustainable management of the groundwater resources in the Plan Area. Once this GSP is adopted, future groundwater extraction will be evaluated against the minimum thresholds and measurable objectives established for each relevant sustainability indicator in order to ensure ongoing sustainable management of the groundwater resources (Chapter 3).

[33] Per CWC Section 10608.12(a), an agricultural water supplier means a water supplier, either publicly or privately owned, providing water to 10,000 or more irrigated acres, excluding recycled water.

The minimum thresholds and measurable objectives established in this GSP are designed to complement and enhance existing projects and programs currently in place to maximize beneficial use of water resources and increase operational flexibility within the Plan Area. Both the City of Santa Monica and LADWP have projects in the building or planning stages that have the potential to increase operation flexibility in the Plan Area. These projects were conceived and developed in conjunction with review of regional and local data collected as part of the water resources monitoring and management programs described above. Additional detail on the projects is provided below and in Chapter 4 of this GSP.

City of Santa Monica

The City of Santa Monica is implementing several water supply projects to diversify its water supply portfolio as outlined in the City of Santa Monica's 2018 Sustainable Water Master Plan Update (City of Santa Monica 2018a). Key water supply projects outlined in the 2018 Sustainable Water Master Plan Update include:

- Sustainable Water Infrastructure Project (SWIP)

  <u>SWIP Element 1 -</u> Upgrade to the existing SMURRF, which currently treats approximately 98 AFY of dry weather urban runoff, to increase recycled water production for non-potable uses in the City. The upgraded facility will include a new brackish/saline reverse osmosis unit that will be used to treat stormwater, brackish groundwater, and dry weather urban runoff (City of Santa Monica 2018a). Stormwater flows will be captured in a 1.6 million gallon tank and routed to SMURRF for treatment and use (City of Santa Monica 2018a). To increase the reliability of dry weather flows, which have decreased with time as the City has implemented water conservation measures, horizontal subdrains will be installed to collect and route shallow brackish groundwater to SMURRF. The subdrains will be located beneath an existing stormwater harvest tank whose structural integrity may be threatened by high groundwater levels and will improve beach water quality at the stormwater outfall beneath the Santa Monica Pier. SMURRF upgrades are expected to increase the average production rate from 98 AFY to 560 AFY.

  <u>SWIP Element 2 -</u> Constructing a below-ground Advanced Water Purification Facility (AWPF) beneath the current Civic Center parking lot on Main Street (City of Santa Monica 2018a). This treatment facility would provide purified water that meets or exceeds drinking water requirements to recharge groundwater aquifers near the Olympic Wellfield (City of Santa Monica 2018a). This facility will advance treat approximately 1,100 AFY of municipal wastewater for non-potable and potable reuse (City of Santa Monica 2018a). An Antidegradation Study prepared by the City of Santa Monica and submitted to the SWRCB demonstrated that injecting advance treated wastewater at the Olympic Wellfield is consistent with the SWRCB Recycled Water Policy and will be protective of beneficial uses of the groundwater (City of Santa Monica 2020c).

  <u>SWIP Element 3 –</u> A new 1.5 million gallon stormwater harvesting tank located below ground adjacent to the SWIP AWTF. The new tank would capture both dry-weather and stormwater, up to an 85^{th} percentile rain event. Captured runoff/stormwater would be blended with municipal wastewater for treatment at the SWIP AWTF.

- Olympic Wellfield Restoration Project. The Olympic sub-basin will be restored to full pumping capacity with a new well head treatment system to remove the contaminants (e.g., 1,2,3-TCP, 1,4 Dioxane, TCE, and PCE) that is limiting current production. The Olympic Wellfield Restoration consists of: 1) Equipping two new groundwater wells, 2) construction of a new pipeline to convey the groundwater to the well head treatment facility, and 3) construction of a new Olympic AWTF to remove contaminants from the Olympic Wellfield before it is sent to the City's Arcadia WTP (City of Santa Monica 2018a).
- Arcadia Water Treatment Plant Expansion and Production Efficiency Enhancement. The proposed project will upgrade the existing reverse osmosis process at the Arcadia Water Treatment Plant with a high-recovery

system to increase the treatment efficiency from 80 percent to 90 percent or greater and reduce concentrate discharge to the sewer system. This upgrade is expected to allow the Arcadia Water Treatment Plant to supply approximately 1,200 AFY of additional water to meet the City's water demands (City of Santa Monica 2018a). The treatment capacity of the Arcadia Water Treatment Plant will also be expanded to accommodate the production efficiency enhancement as well as groundwater from the Olympic Wellfield Restoration Project.

LADWP's Operation NEXT and Hyperion 2035

Hyperion 2035 and Operation NEXT are future Programs planned by LADWP and Los Angeles Sanitation and Environment to increase the production of treated wastewater for beneficial use. The Hyperion 2035 project proposes to retrofit the Hyperion Water Reclamation Plant (Hyperion) with advanced treatment facilities to produce up to 217 million gallons per day (approximately 243,000 AFY) of purified recycled water (LADWP 2021). Operation NEXT is the LADWP's Program to convey the purified recycled from Hyperion to nearby groundwater basins to recharge local aquifers. Commissioning of the project is planned for 2035 (LADWP 2021). LADWP has also been working with MWD to potentially convey purified recycled water to MWD's Regional Recycled Water Program Backbone System (LADWP 2021). Hyperion 2035 and Operation NEXT would decrease LADWP's reliance on imported water sources. If water from Operation NEXT is available for use in the Santa Monica Plan Area it could be used to offset groundwater production or to create a seawater intrusion barrier, which would allow groundwater production to continue without negative impacts to the aquifer, thereby increasing operational flexibility throughout the Plan Area.

2.1.3 Land Use Elements of Topic Categories of Applicable General Plans

2.1.3.1 Land Use

The Plan Area is highly urbanized with parks and open space occupying 11.5% of the area in the Plan Area (Table 2-7; Figure 2-7). The remaining 87.5% of the Plan Area is occupied by public facilities, residential, commercial, and industrial land uses. Of these, residential land use accounts for 64% of the land use in the Plan Area with commercial, industrial, and public facilities each accounting for 7 to 8% of the land use (Figure 2-7 Table 2-7).

Table 2-7. Land Use in the Plan Area

Land Use Type	Coverage (Acres)	Percentage of Plan Area
Multi-Family Residential	4,059	16.9%
Single Family Residential	10,052	41.8%
Mixed Use Residential	1,283	5.3%
Commercial	1,827	7.6%
Industrial	1,706	7.1%
Parks and Open Space	2,755	11.5%
Public Facilities	2,026	8.4%

Sources: SCAG 2016

2.1.3.2 Population

The member agencies of the Santa Monica GSA estimate population within their respective jurisdictions every 5 years in conjunction with preparing each agency's UWMP. Of the 5 member agencies, only the City of Santa Monica lies completely within the Plan Area. Other member agencies have jurisdictions that overlap the Plan Area but do not lie completely within the Plan Area boundaries. Therefore, the population listed in the UWMP for each of the remaining member agencies is larger than the population of that agency within the Plan Area.

The population estimates used in this GSP are based on:

- Decennial census block data for 1990, 2000, and 2010 (Manson, et al. 2020, SCAG 2018) and census estimates for 2019 (SCAG 2020).
- Regional growth forecast by the Southern California Association of Governments (SCAG 2020).

The decennial census block are the smallest areas reported by the U.S. Bureau of the Census, the boarders of which are formed by streets and other physical and cultural features in the Plan Area. These data were collected in 1990, 2000, and 2010 and were of a sufficient scale to be used to derive a direct estimate of population within the Plan Area. For years without census block data, the population in the Plan Area was estimated based on the percentage of land area for each city in the Plan Area, and regional growth forecasts by SCAG.

SCAG projects population growth for each city the Plan Area between 2016 and 2045. The annual SCAG projected growth rate within the Plan Area is 0.45%. The estimated 2019 population for the Plan Area is 510,537 with an expected growth to approximately 587,617 by 2045 (Table 2-8).

Table 2-8. Past, Current, and Projected Population for the Plan Area

Population	1990	2000	2010	2016	2019	2045 SCAG Projection
Incorporated Cities						
Santa Monica	86,905[1]	84,084[1]	89,736[1]	93,600[3]	90,401 [2]	114,700[3]
Culver City	38,793[1]	38,816[1]	38,895[1]	40,100[3]	39,185 [2]	41,600[3]
Beverly Hills	31,971[1]	33,784[1]	34,109[1]	34,700[3]	33,792 [2]	35,800[3]
Los Angeles	3,485,398[1]	3,694,820[1]	3,792,621	3,933,800[3]	3,979,576 [2]	4,771,300[3]
				GSP Plan Area Estimate	**510,537**	**587,617**
Countywide Counts						
Los Angeles County (all)	8,863,164[1]	9,519,338[1]	9,818,605[1]	10,039,107	10,110,000	11,674,000
Los Angeles County (unincorporated)	—	—	—	1,095,276	1,044,500	1,258,000

Sources:
1 U.S. Census Bureau Decennial Census Data
2 U.S. Census Bureau Estimate
3 SCAG 2020 (for Los Angeles County 1990–2045)
Note: — = not available or unknown.

There are no Disadvantaged Communities (DAC)[34] Places in the Plan Area. There are, however, several Census block groups within the Plan Area that have been identified as geographies that have less than 80% of the statewide annual median household income ($51,026 for 2018). DAC block groups are located in portions of the City of Santa Monica, the City of Los Angeles including the UCLA campus and Venice Beach, and the unincorporated area around

34 Map-based DAC information developed by the DWR can be reviewed at https://gis.water.ca.gov/app/dacs/.

the West Los Angeles Veteran's Affair campus (Figure 2-8). All residents in the identified DAC block group areas are served by their respective water purveyor: the City of Santa Monica, LADWP, or GSWC (Figure 2-4). There are no known currently active domestic wells located in the Subbasin. Therefore, the only DACs that receive groundwater produced within the Subbasin are those located within the City of Santa Monica.

Residents in the DAC block group areas that rely on groundwater within the Subbasin do so via connection to the City of Santa Monica's distribution system, which distributes safe, clean drinking water to all communities throughout the City of Santa Monica. All groundwater, with the exception of one groundwater well (SM-1), in the distribution system is treated the City's Arcadia Water Treatment Plant, which is the single treatment plant for the entire City. After treatment, this water is distributed to every connection within the City. City residents receive an annual water quality report documenting the sources of water supplied to City residents, the history of groundwater contamination that has impacted the City's groundwater production wells, the treatment processes that occur prior to distribution, and the water quality testing results for water served by the City of Santa Monica. This water quality report also encourages sustainability and stakeholder participation, providing information on how to attend City Council meetings, participate in conservation events, and receive newsletters and alerts.

2.1.3.3 Applicable General Plans

The following section presents a review of the various land use plans in the Plan Area and their applicability to groundwater resource management. State law requires that all cities and counties adopt a comprehensive, long-term general plan that outlines physical development of the county or city, in accordance with Section 65300 of the California Government Code. The general plan must cover a local jurisdiction's entire planning area so that it can adequately address the broad range of issues associated with urban and/or community development. Ultimately, the general plan expresses the community's development goals and embodies public policy relative to the distribution of future public and private land uses. The general plan may be adopted as a single document or as a group of documents relating to subjects or geographic segments of the planning area.

Land use within the Plan Area is guided by the City of Santa Monica General Plan, the City of Los Angeles General Plan, the City of Beverly Hills General Plan, the Culver City General Plan, and the Los Angeles County General Plan (City of Santa Monica 2017, City of Beverly Hills 2010, City of Culver City 2000, LACDRP 2015). The County of Los Angeles divides its general plan into 11 different "area plans" for the purpose of land use planning, as each has unique physiography, demographics, development pressures, and priorities. Similarly, the City of Los Angeles divides its general plan into 35 community plan areas. The entirety of the GSP Plan Area lies within the County of Los Angeles Westside Planning Area and the GSP Plan Area intersects eight community plan areas in the City of Los Angeles General Plan: (1) Brentwood – Pacific Palisades, (2) Bel Air – Beverly Crest, (3) Westwood, (4) West Los Angeles, (5) West Adams – Baldwin Hills – Leimert, (6) Palms – Mar Vista – Del Rey, (7) Venice, and (8) Westchester – Playa del Rey.

Each of the planning documents applicable to GSP plan area is a living document made up of multiple elements that are periodically updated by the respective municipal planning departments. General plans are generally structured around broad visions and goals that then get refined into specific land use policies and various community plans, where the local setting, policy issues and community concerns are taken into account through a public participation process. All elements of a general plan, whether mandatory or optional – including community plan principles, goals, objectives, policies, and plan proposals – must be internally consistent with each other as all elements have equal legal status (i.e., no element is legally subordinate to another).

The development and implementation of the GSP is relevant to several General Plan and community plan elements, and vice versa, because both contain policies and implementation actions that are intended to be protective of water resources. General Plans, because they outline a community's vision for the future – which usually includes the accommodation of population growth and provision of additional housing (including affordable housing provisions) – have significant implications for the sustainability of water resources. Population growth and economic development can often result in increases in water demand and if not planned for and/or managed properly, can lead to depletion of available water supplies over time. All applicable land use plans acknowledge and broadly encourage water conservation, and prohibit new development and redevelopment, such as tentative map and subdivision approvals, unless the owner/applicant can demonstrate that adequate water resources are available.

Relevant General and Specific Plans governing areas within the Plan Area were reviewed for policies relevant to groundwater resources, which are provided in Table 2-9 below.

Table 2-9. Summary of General Plan and Community Plan Land Use Policies Relevant to Groundwater Sustainability in the Plan Area

Plan	Element	Policy	Description
City of Santa Monica General Plan			
City of Santa Monica General Plan	Land Use & Circulation Element	**Goal S5:** Improve the environmental performance of buildings.	
		S 5.1	Continue to maintain a building code and prescriptive compliance options that meet or exceed state requirements for energy, water and other sustainability standards. Specifically, pursue California Energy Commission goals to achieve "zero net" energy buildings by 2020 for low-rise residential buildings and 2030 for commercial buildings and achieve a LEED-equivalent local building code by 2020.
		S 5.6	Encourage cool roofs or green roofs on new buildings.
		Goal S6: Promote water conservation and increase the use of reclaimed and recycled water.	
		S 6.1	Ensure sufficient water supplies for new development.
		S 6.2	Implement the recommendations of the 2005 Santa Monica Urban Water Management Plan, including increasing water supply and conservation measures such as the City's no waste ordinance, landscape ordinance, wastewater control ordinance, and low-flow ordinance, and complete an assessment of the viability of additional urban runoff recycling.
		S 6.3	Implement landscape water conservation requirements for new construction projects.
		S 6.4	Continue to remediate the City's own contaminated groundwater supply.
		S 6.5	Continue the City's water-using appliances retrofit upon resale ordinance to encourage water conservation.
		S 6.6	Continue to explore and expand additional potential water conservation measures for the community, such as expanding reclaimed water access and availability.
		S 6.7	Increase the use of groundwater consistent with the safe yield of the Santa Monica Groundwater Basin and reduce reliance on imported surface water supplies from the Metropolitan Water District. As necessary, implement conservation measures as

Table 2-9. Summary of General Plan and Community Plan Land Use Policies Relevant to Groundwater Sustainability in the Plan Area

Plan	Element	Policy	Description
			identified in the City's Water Shortage Response Plan to ensure that adequate water supplies are available to the City.
		S 6.8	Prepare a citywide Groundwater Management Plan, and as part of that effort, conduct groundwater studies to confirm or adjust as necessary the safe yields of the Arcadia and Olympic Subbasins.
		Goal S7: Reduce the carbon footprint of the City's municipal operations.	
		S 7.5	Seek to complete the energy and water retrofits on all existing municipal buildings by 2020
		Goal S10: Create a sustainable local economy that focuses on green jobs.	
		S 10.1	Support the expansion of a green economy that focuses on the following: energy technologies; water conservation; green building construction, design and architecture practices; water management; policy development related to sustainability; and other similar green businesses.
	Housing Element	**Goal 1.0:** Construction of new housing that is high quality, sustainable, compatible with the surrounding neighborhood and offers opportunities for active living.	
City of Santa Monica General Plan	Housing Element	1.d	Maintain Energy and Water Conservation/ Production Programs - Continue to monitor energy and water usage citywide and investigate other appropriate programs to conserve these scarce natural resources. Strive to reduce city-wide water and energy use in accordance with the goals and targets set out in the Sustainable City Plan, Climate Action Plan and the Sustainable Water Master Plan.
		Goal 7.0: Promote quality housing and neighborhoods.	
		7.b	Maintain energy and water conservation programs - Continue to monitor energy and water usage in the City and investigate other appropriate programs to conserve these scarce natural resources. Continue to reduce city-wide water and energy use in accordance with the goals and targets set out in the Sustainable City Plan.
	Conservation Element	**Goal 1:** Preservation of the ecological balance and natural resource of the city and conservation of the energies and materials without serious interference with community needs.	
		1.4	Consider environmental impacts as a decision-making factor in planning.
		1.7	Ensure that those resources necessary for the maintenance and enhancement of the health and well-being of the city be conserved and protected.
		Policy Statements	
		1	The City shall increase the source of its water supply in accordance with the population.
		2	The City shall protect and expand (when feasible and desirable) its underground water rights.
		3	The City Water Division shall be charged with the responsibility of determining and maintaining the safe level of local well water extraction to obtain the highest possible production while avoiding the hazards of saltwater intrusion

Table 2-9. Summary of General Plan and Community Plan Land Use Policies Relevant to Groundwater Sustainability in the Plan Area

Plan	Element	Policy	Description
		4	The City shall actively participate in the protection of watershed areas affecting Santa Monica water supplies.
		5	The City shall cooperate with adjoining water jurisdictions to investigate the feasibility of artificially recharging, spreading or other means of replenishing ground water basins, when the appropriate technology becomes available, and such action appears to be economically beneficial.
		6	The City shall protect the city aquifers from contamination by controlling all forms of access or contact such as private wells, industrial dumping or any other type of intrusion into the aquifers which may affect the water quality.
		7	The City shall continue to strive for higher quality water standards even though they may exceed those of recognized domestic and international agencies and organizations which develop such standards.
		8	The Public Works Department shall identify and mitigate all potential sources of industrial or commercial pollution, which may adversely affect water supplies stored in city reservoirs or water being pumped into the city.
		9	The City shall cooperate with adjoining communities for the purpose of reclaiming wastewater and improving the sewage treatment processes to include secondary and tertiary treatment.
City of Santa Monica General Plan	Conservation Element	Programs for Implementation	
		1	The water division shall supervise the exploration and construction of new potable well water sites and renovation of existing equipment when it is determined to be in the best interests of Santa Monica.
		2	In order to ensure water rights at those well sites outside the city boundaries the City should optimize production at those sites and increase the production whenever possible, while remaining within safe limits to avoid saltwater intrusion.
		3	Monitoring programs shall be maintained to ensure constant adherence to prevailing standards of water quality.
		4	New methods for the monitoring of water quality should be investigated to ensure all aspects of quality testing are considered.
		5	The water division shall protect the potable water system from accidental or malicious introduction of contaminants.
		6	The city should ensure the identification and regulation of any construction or activity which is likely to make direct contact with the city's underground aquifers or which may otherwise pose a potential hazard to the quality of water in those aquifers.
		7	An industry that has produced pollutants in excess of city standards shall pay or remove that portion of its pollutants from whatever water supply is affected.
	Open Space Element	***Objective 2:*** Expand the open space system through use of public properties.	
		2.5	Transform surface parking lots.
		Objective 6: Reinforce the underlying physiographic structure of the City.	

Table 2-9. Summary of General Plan and Community Plan Land Use Policies Relevant to Groundwater Sustainability in the Plan Area

Plan	Element	Policy	Description
		6.1	Restore stream corridors, wherever feasible.
		Objective 8: Heighten the sense of nature in the City.	
		8.1	Maintain and expand the community forest.
		8.4	Develop new community gardens.
		8.5	Introduce water in City open spaces.
City of Los Angeles General Plan			
City of Los Angeles General Plan	Mobility Element	***Objective:*** Reduce the pollutant load of stormwater runoff to meet Total Maximum Daily Load standards.	
		Not Numbered	Maximize opportunities to capture and infiltrate stormwater within the City's public rights-of-way.
	Housing Element	**Goal 2:** Safe, livable, and sustainable neighborhoods.	
		Objective 2.3	Promote sustainable buildings, which minimize adverse effects on the environment and minimize the use of non-renewable resources.
		Policy 2.3.2	Promote and facilitate reduction of water consumption in new and existing housing.
	Open Space Element	**Goal 1:** To ensure the preservation and conservation of sufficient open space to serve the recreational, environmental, health and safety needs of the City.	
		Goal 4: To conserve and/or preserve those open space areas containing the City's environmental resources including air and water.	
City of Los Angeles General Plan	Open Space Element	*Policy 1*	Ecologically important areas are generally considered as open space and shall be so designated. The following shall apply: a. To the extent feasible, ecologically important areas should be kept in a natural state
		Policy 2	Flood endangered areas should be set aside for appropriate open space uses.
	Land Use Element West Adams, Baldwin Hills, Leimert Community Plan	**Goal CF16:** A comprehensive strategy to ensure that high quality and reliable sources of clean water are provided for the community.	
		CF16-2	Alternative Water Supplies - Support the development of reliable and cost-effective sources of alternative water supplies, including opportunities for groundwater recharge, water reclamation and exchanges and transfers.
		CF16-3	Urban "Greening" - Promote urban "greening" as a method of ensuring healthy watersheds that generate reliable water supplies that provide clean water.
		CF16-4	Groundwater Supplies - Encourage the protection of existing water supplies from contamination, and clean-up groundwater supplies so such resources can be more fully utilized.
		CF16-5	Water Conservation - Continue to require water conservation measures, as recommended by LADWP.
		Goal CF19: A storm drainage infrastructure that minimizes flood hazards and protects water quality by employing watershed-based approaches that balance environmental, economic and engineering considerations.	
		CF19-3	Watershed Management - Promote watershed management policies that integrate flood protection with water conservation, improvement in the quality of stormwater runoff and groundwater, and reduce the pollution of water resources while preserving and creating recreation and habitat areas.

Table 2-9. Summary of General Plan and Community Plan Land Use Policies Relevant to Groundwater Sustainability in the Plan Area

Plan	Element	Policy	Description
		Goal LU75: A community where oil extraction activities are performed with the greatest regard for public and environmental health and welfare.	
		LU75-3	Community Health - Recommend that any extraction technology, including fracking, acidizing, or other technologies that involve potentially hazardous materials, has no negative impacts on public or environmental health. Support comprehensive plans, which strive to stop the release of chemicals from extraction sites into the groundwater or surrounding environment.
		Goal M2: A circulation system that supports successful neighborhood commercial areas by providing multi-modal access that accommodates public open space and gathering places, and streets that enhance sustainable watershed management.	
		M2-3	Watershed Management - Support watershed management in the design of streets by incorporating swales, water retention and other such features in new development, streetscape programs and other street improvement programs.
City of Culver City General Plan			
City of Culver City General Plan	Land Use Element	**Goal:** Ample and efficient City services and infrastructure.	
		Objective 19: Adequate Services	
		Policy 19.C: Investigate the possibility of using reclaimed water for irrigation.	
City of Beverly Hills General Plan			
City of Beverly Hills General Plan	Land Use Element	**Goal LU 2:** Community Character and Quality - A built environment that is distinguished by its high level of site planning, architecture, landscape design, and sensitivity to its natural setting and history.	
		LU 2.2	Public Streetscapes and Landscapes - Maintain and enhance the quality and health of the "green infrastructure" that contributes to the City's identity and quality of life, including its street trees, landscaped medians and parkways, parks and open spaces, while seeking to conserve water resources.
		Goal LU 14: Environmental Sustainability and Carbon Footprint - Land uses and built urban form that are environmentally sustainable by minimizing consumption of scarce resources, pollution, greenhouse gas emissions, wastes, and exposure of residents and visitors to toxics and hazards.	
		LU 14.2	Site Development - Require that sites and buildings be planned and designed to meet applicable environmental sustainability objectives by: …(d) enabling capture and re-use of stormwater and graywater on-site while reducing discharge into the stormwater system…
		LU 14.4	New Construction of Private Buildings - Require that new and sustainably renovated buildings be designed and constructed in accordance with the City's sustainability programs such as the City's Green Building Ordinance or comparable criteria to reduce energy, water, and natural resource consumption…
		LU 14.7	Public Streetscapes - Design and improve public streetscapes to enhance their attractiveness for walking as an alternative to automobile use and as a demonstration of the City's commitment to environmental sustainability by using techniques such as … (b) selecting tree and plant species and irrigation systems that

Table 2-9. Summary of General Plan and Community Plan Land Use Policies Relevant to Groundwater Sustainability in the Plan Area

Plan	Element	Policy	Description
			minimize water consumption; (c) exploring the use of recycled water for irrigation…
		LU 14.8	Private Development Landscaping Material and Irrigation - Require the use of landscaping materials and irrigation systems that minimize water use and runoff onto public streets and drainage systems.
	Open Space Element	**Goal OS4:** Recharge Groundwater Resources.	
		OS 4.1	Permeable surfaces - Develop guideline that limit the percentage of impermeable surface, such as asphalt, for large new or renovated public, institutional, residential, and commercial projects. Where feasible, require the use of landscaping and permeable surface treatments as alternatives. Develop aesthetic and functional criteria for repaving alleys and identify sources of materials available that meet these criteria.
		OS 4.2	Shallow Groundwater - Further enhance the City's efforts to minimize shallow groundwater being discharged into the storm water system and encourage alternative means such as groundwater recharging when dewatering subterranean structures.
		OS 4.3	Recycled Stormwater - Explore methods of retaining and using storm water that would otherwise go into storm drains as runoff.
		Goal OS5: Water Quality Protection - Protection of local watersheds and groundwater resources.	
City of Beverly Hills General Plan	Open Space Element	OS 5.1	Stormwater Quality - Control sources of pollutants and improve and maintain urban runoff water quality through stormwater protection measures consistent with the City's NPDES permit.
		OS 5.5	Stormwater Capture and Re-Charge - Consider the use of city parks for stormwater capture and recharge using grading, channelings and subterranean and other feasible capture methods.
		OS 5.6	Extensive Landscaping - Require extensive landscaping of open space areas on a property to provide the maximum permeable surface area to increase infiltration, reduce site runoff, control the overland migration of silt, and reduce the amount of surface paving. Provide guidance to property owners on recommended water-efficient plant materials.
		OS 5.7	Continue Watershed Education - Implement watershed awareness, water quality educational programs, and continued education in stormwater pollution and abatement for City staff, community groups, the public, and other appropriate groups.
		OS 5.9	Regional Planning - Continue to work with local, State, and federal agencies and private watershed organizations to improve water quality.
		Goal OS9: Park and Recreation Preservation - The improvement, maintenance, and preservation of existing parks and recreation facilities, and the expansion of indoor recreational facilities.	
		OS 9.5	Use sustainable concepts and practices in the design, materials, and operation of parks in the City, and require such concepts with respect to open space required in new developments in the City.

Table 2-9. Summary of General Plan and Community Plan Land Use Policies Relevant to Groundwater Sustainability in the Plan Area

Plan	Element	Policy	Description
			Such practices may include, but are not limited to, use of drought tolerant plant palettes in landscaping and strategic use of plants for fire protection near areas of wildland fire hazard, external shading of building and parking lots, and landscape design that allows irrigation and stormwater to recharge groundwater systems and filter out pollutants.
	Housing Element	**Goal H2:** Housing Supply and Diversity - Provide a variety of housing types and adequate affordable housing supply to meet the existing and future needs of the community.	
		H 2.7	Promote conservation of water and energy, use of sustainable building materials and drought-resistant landscaping to reduce the operating costs and carbon emissions associated with housing.
	Conservation Element	**Goal CON1:** Water Supply System - High-quality reliable water supply, treatment, distribution, pumping and storage systems that provide water as affordable as possible and meet current and future daily and peak water demands of the City, considering the sustainability goals and policies in this general plan.	
		CON 1.1	Rights to Groundwater - The City should continue to retain rights to groundwater.
		CON 1.4	Water Storage - Maximize the City's access to water supplies, including possible acquisition of wells outside the City, and designate and acquire land, if necessary, for siting future water supply, storage, and distribution facilities.
		CON 1.7	Development Requirements, Groundwater - Require engineering design and construction practices to ensure that existing and new development does not degrade the City's groundwater supplies.
City of Beverly Hills General Plan	Conservation Element	**Goal CON2:** Water Conservation through System Improvements - Provision of a system that minimizes water consumption through conservation methods and other techniques.	
		CON 2.1	Water Conservation Goals - Continue to establish, review and update water conservation goals and benchmarks on a continuous basis.
		CON 2.2	Public Outreach on Need to Conserve Water - Maintain and enhance the City's comprehensive program to educate and publicize the need to conserve water.
		CON 2.3	Water Conservation Measures for Public Facilities - Continue to require water conservation measures and devices that limit water usage for all new municipal projects and major alterations to existing municipal facilities.
		CON 2.4	Water Conservation Measures for Private Projects - Continue providing incentives, and where practical, require the installation of water conservation measures, devices and practices for new private construction projects and major alterations to existing private buildings, including requirements for using reclaimed water for construction watering and for pumping subterranean water back into the ground rather than into the storm drain system.
		CON 2.5	Water Efficient Landscaping - Where feasible, encourage installation of drought tolerant landscaping or water-efficient

Table 2-9. Summary of General Plan and Community Plan Land Use Policies Relevant to Groundwater Sustainability in the Plan Area

Plan	Element	Policy	Description
			irrigation systems for all private and city landscaping and parkways. Identify and implement minimum design and installation efficiency criteria for landscape irrigation systems.
		CON 2.6	New Conservation Technology - Explore ways to strengthen local building codes for new construction and to implement ordinances that require existing buildings to generate a higher level of water efficiency as a requirement for renovations or additions, and upon sale of the property.
		CON 2.7	Funding - Explore methods to provide financial support for water conservation efforts.
		Goal CON3: Water Conservation through Reduced Consumption - Conservation programs that limit water consumption through site design, the use of water conservation systems and other techniques.	
		CON 3.1	Water Conservation Ordinance - Review the City's water conservation ordinance and efficient landscaping ordinance regularly and modify them as appropriate to achieve best management practices.
		CON 3.2	Green Building Program - Review the City's green building program to ensure that the program achieves water conservation, energy efficiency of buildings, encourages resource conservation, reduces waste generated by construction projects, and promotes the health and productivity of residents, workers, and visitors to the City.
		CON 3.3	Rebate Programs - Continue cooperating with the MWD to offer rebate incentives for the replacement of inefficient plumbing fixtures with water saving fixtures for all residential, commercial, industrial, and institutional uses.
		CON 3.4	Public Education - Continue to provide public education to residents, businesses, and students regarding the importance and value of water conservation. Establish a comprehensive program to educate and publicize the need to conserve water, the incentives available, and regulations applicable to conserve water.
City of Beverly Hills General Plan	Conservation Element	CON 3.5	Restrict Water Runoff - Restrict wasteful watering methods and control runoff.
		CON 3.6	Water Auditing - Establish auditing programs to evaluate the extent of success in meeting water conservation goals and the effectiveness of programs and technology.
		CON 3.7	Water Conservation Measures for Public Facilities - Require water conservation measures/devices that limit water usage for all new municipal projects and major alterations to existing municipal facilities. These measures should include the use of water-efficient landscaping and irrigation, storm water capture, efficient appliances, and use of "gray water" for irrigation. Explore partnerships with other public agencies such as the Beverly Hills Unified School District to reduce water consumption.
		CON 3.8	Water Conservation Measures for Private Projects - Require the installation of water conserving measures, devices and practices

Table 2-9. Summary of General Plan and Community Plan Land Use Policies Relevant to Groundwater Sustainability in the Plan Area

Plan	Element	Policy	Description
			that meet "green building" standards for new private construction projects and major alterations to existing private buildings.
		CON 3.9	Water-Efficient Landscaping - Encourage and promote drought-tolerant landscaping or water efficient irrigation systems for all private and city landscaping and parkways.
		CON 3.10	Optimum Timing for Water Irrigation - Require that all public and private irrigation systems irrigate at optimum times of the day, such as early mornings, or late afternoon and use weather sensors to facilitate optimum irrigation. Develop an enforcement mechanism and regulations to prohibit wasteful irrigation and water use practices, such as watering for street cleaning, and utilize technology to permit monitoring and control.
		CON 3.11	New Conservation Technology - Ensure all new private and City facility projects utilize conservation technologies.
		CON 3.12	Monitoring System - Adopt state-of-the-art water monitoring systems to remotely monitor the City's water usage, leaks, and ruptures.
		CON 3.13	Infrastructure Upgrades - Continue to upgrade the City's water infrastructure to minimize water leakage, ensure adequate supply for residents and businesses, and incorporate earthquake hardening techniques.
		CON 3.14	Funding - Explore methods to provide financial support for water conservation efforts.
		CON 3.15	Retrofit of Existing Multi-family Housing - Require that water fixtures such as shower heads, faucets and toilets be replaced with low-flow fixtures and other conservation features at the change of tenancy in multi-family residential units.
		Goal CON5: Alternative Water Resources - Expanded use of alternative water sources to provide adequate water supplies for present uses and future growth.	
		CON 5.1	Cooperative Ventures for Alternative Water Sources - Continue to explore new sources of water to serve the community, including cooperative ventures with other jurisdictions for reclaimed water or desalinization.
City of Beverly Hills General Plan	Conservation Element	CON 5.2	Recycled Water Master Plan - Prepare and implement a Recycled Water Master Plan to serve irrigation and firefighting needs. Explore all possible reclaimed water opportunities, including the Los Angeles Department of Water and Power's and Los Angeles Bureau of Sanitation and Integrated Resource Plan, and any rights to Hyperion treated water. Explore feasibility of developing a city reclamation plant for reclaimed water, including potential sites.
		CON 5.3	Funding Sources - Apply for federal, state, and private grants to assist the City in developing a recycled water infrastructure. Explore feasibility of issuing bonds for this purpose. Explore opportunities to partner with other agencies.
		Goal CON6: Groundwater Recharge - A System that recharges the groundwater resources.	

Table 2-9. Summary of General Plan and Community Plan Land Use Policies Relevant to Groundwater Sustainability in the Plan Area

Plan	Element	Policy	Description
		CON 6.1	Alleys -Develop aesthetic and functional criteria for repaving of alleys and explore whether materials are available that could increase the amount of permeable surfaces.
		CON 6.2	Stormwater - Require that grading plans be designed and implemented to reduce storm water runoff by capturing rainwater onsite and stored on a temporary, short-term basis to facilitate groundwater recharge rather than relying solely on community drainage facilities.
		CON 6.3	Shallow Groundwater - Further enhance the City's efforts to minimize shallow groundwater being discharged to the stormwater system and encourage beneficial use instead of dewatering subterranean structures.
County of Los Angeles General Plan			
County of Los Angeles General Plan	Land Use	**Goal LU 11:** Development that utilize sustainable design techniques.	
		LU 11.4	Encourage subdivisions to utilize sustainable design practices, such as maximizing energy efficiency through lot configuration; preventing habitat fragmentation; promoting stormwater retention; promoting the localized production of energy; promoting water conservation and reuse; maximizing interconnectivity; and utilizing public transit.
	Conservation and Natural Resources Element	**Goal C/NR 6:** Protected and usable local groundwater resources.	
		C/NR 6.1	Support the LID philosophy, which incorporates distributed, post-construction parcel-level stormwater infiltration as part of new development.
		C/NR 6.2	Protect natural groundwater recharge areas and regional spreading grounds.
		C/NR 6.3	Actively engage in stakeholder efforts to disperse rainwater and stormwater infiltration BMPs at regional, neighborhood, infrastructure, and parcel-level scales.
		C/NR 6.4	Manage the placement and use of septic systems in order to protect high groundwater.
		C/NR 6.5	Prevent stormwater infiltration where inappropriate and unsafe, such as in areas with high seasonal groundwater, on hazardous slopes, within 100 feet of drinking water wells, and in contaminated soils.
	Open Space & Conservation Element	**Goal P/R 6:** A sustainable parks and recreation system.	
		P/R 6.1	Support the use of recycled water for landscape irrigation in County parks.
		P/R 6.4	Ensure that new buildings on County park properties are environmentally sustainable by reducing carbon footprints, and conserving water and energy.
County of Los Angeles General Plan	Public Services and Facilities Element	**Goal PS/F 2:** Increased water conservation efforts.	
		PS/F 2.1	Support water conservation measures.
		PS/F 2.2	Support educational outreach efforts that discourage wasteful water consumption.
		Goal PS/F 3: Increased local water supplies through the use of new technologies.	

Table 2-9. Summary of General Plan and Community Plan Land Use Policies Relevant to Groundwater Sustainability in the Plan Area

Plan	Element	Policy	Description
		PS/F 3.1	Increase the supply of water through the development of new sources, such as recycled water, gray water, and rainwater harvesting.
		PS/F 3.2	Support the increased production, distribution and use of recycled water, gray water, and rainwater harvesting to provide for groundwater recharge, seawater intrusion barrier injection, irrigation, industrial processes and other beneficial uses.

2.1.3.4 Other Planning/Land Use Considerations

2.1.3.4.1 California Environmental Quality Act

All discretionary projects proposed within the Plan Area under municipal, County and/or state jurisdiction are required to comply with CEQA. In 2019, the Governor's Office of Planning and Research released an update to the CEQA Guidelines that included a new requirement to analyze projects for their compliance with adopted GSPs. Specifically, the new applicable significance criteria include the following:

- Would the program or project substantially decrease groundwater supplies or interfere substantially with groundwater recharge such that the project may impede sustainable groundwater management of the basin?
- Would the program or project conflict with or obstruct implementation of a water quality control plan or sustainable groundwater management plan?

In additional to the general statewide CEQA Guidelines, each public agency is encouraged to develop and publish thresholds of significance that the agency uses in the determination of the significance of environmental effects. Agencies within the Plan Area that have adopted their own CEQA thresholds include Los Angeles County and the City of Los Angeles (County of Los Angeles 1987; City of Los Angeles 2006).

The Los Angeles County thresholds include defining projects that "will normally have a significant effect on the environment" if it will:

- Substantially degrade water quality;
- Contaminate a public water supply;
- Substantially degrade or deplete ground water resources;
- Interfere substantially with ground water recharge (County of Los Angeles 1987).

The City of Los Angeles includes CEQA thresholds for both groundwater levels and groundwater quality. Under these thresholds, a project would normally have a significant impact on groundwater level if it would:

- Change potable water levels sufficiently to
  - o Reduce the ability of a water utility to use the groundwater basin for public water supplies, conjunctive use purposes, storage of imported water, summer/winter peaking, or to respond to emergencies and drought;

  - o Reduce yields of adjacent wells or Wellfields (public or private); or
  - o Adversely change the rate or direction of flow of groundwater; or
- Result in demonstrable and sustained reduction of groundwater recharge capacity (City of Los Angeles 2006).

The screening criteria for groundwater quality are:

- Would the project include the installation or operation of water wells, or any groundwater extraction or recharge system, that is in the vicinity (usually within one mile) of the coast, an area of known groundwater contamination or seawater intrusion, a municipal supply well or spreading ground facility?
- Would the project include surface or subsurface application or introduction of potential contaminants or waste materials during construction or operation? Examples of such projects include: on-site disposal systems (septic systems), holding/equalization tanks, evaporation ponds, underground or above-ground storage tanks, percolation ponds and leach fields, landfills and other land surface waste disposal facilities, land treatment units (bioremediation), oil field brine disposal, and agricultural activities.
- Could the project result in releases or spills of contaminants that could reach a groundwater recharge area or spreading ground or otherwise reach groundwater through percolation?
- Would the project involve drilling to or through a clean or contaminated aquifer (City of Los Angeles 2006)?

Therefore, to the extent the general plans allow growth that could have an impact on groundwater supply, such projects would be evaluated for their consistency with this GSP and for whether they adversely impact the groundwater resources of the Plan Area. Under CEQA, potentially significant impacts identified must be avoided or substantially minimized unless significant impacts are unavoidable, in which case the lead agency must adopt a statement of overriding considerations.

2.1.3.4.2 Well Permitting (Construction, Repair, Reconstruction, Destruction)

The Los Angeles County Department of Public Health (DPH), Environmental Health Division is responsible for permitting the design, construction, modification, and destruction of water wells throughout Los Angeles County including within the entirety of the Plan Area. Statewide standards for the construction, repair, reconstruction, or destruction of wells are found in DWR Bulletin 74-81 and 74-90 (i.e., California Well Standards) (DWR 1981, 1990). California's Water Well Standards include requirements to avoid sources of contamination or cross-contamination, proper sealing of the upper annular space (i.e., first 50 feet), disinfection of the well following construction work, use of appropriate casing material, and other requirements. The DPH has developed its own requirements and adopted the State standards by reference. DPH also regulates Small Water Systems, those serving fewer than 200 connections, under Section 116330 of the California Health and Safety Code (DPH 2020). Municipal Water Companies within Los Angeles County are those that serve more than 200 connections. These are regulated by the SWRCB DDW (formerly the California Department of Public Health) under the provisions of the SDWA. Requirements for private residential and commercial well construction within the Los Angeles County include demonstration of well water availability, adherence to construction criteria, payment of fees, site visits by a DPH inspector, and performance of groundwater well yield and water quality testing (DPH 2020).

The Coastal Zone within the plan area extends to a maximum of approximately 2 miles inland from the shoreline within the Plan Area and encompasses the lower reach of Ballona Creek (Figure 2-9). Groundwater wells drilled within the Coastal Zone qualify as "development" pursuant to Coastal Act Section 30106, and may require a Coastal Development Permit, either from Los Angeles County or the California Coastal Commission (See Section 2.1.3.4.3). In areas with adopted LCPs, a Coastal Development Permit from the County must be obtained for groundwater wells located within the certified LCP jurisdiction, and a Coastal Development Permit from the Commission must be obtained for wells located within their retained jurisdiction. Since the policies of the Coastal Act are incorporated into the County LCP, the development standards applied to new wells are similar regardless of which agency is issuing the Coastal Development Permit.

Individual Cities may adopt groundwater well related ordinances in addition to those requirements of the DPH. In 2018 the City of Santa Monica adopted the *Sustainable Groundwater Management Ordinance* which prohibits the installation of groundwater wells (except for City wells) or the expansion of existing wells until specifically authorized by the adopted GSP (Article 7, Chapter 7.18, Santa Monica Municipal Code).

2.1.3.4.3 Local Coastal Programs

LCPs are planning tools used by local governments to guide development in the coastal zone, in partnership with the Coastal Commission. In California, the coastal zone includes the land and water area extending seaward to the state's outer limit of jurisdiction and extending inland generally 1,000 yards from the mean high tide line of the Pacific Ocean. In significant coastal estuarine, habitat, and recreational areas it extends inland to the first major ridgeline paralleling the sea or five miles from the mean high tide line of the sea. LCPs contain the ground rules for future development and protection of coastal resources, similar to General Plans, specifying appropriate location, type, and scale of new or changed uses of land and water. Each LCP includes a land use plan and measures to implement the plan which governs decisions that determine the short- and long-term conservation and use of coastal resources.

LCPs segments located within the Plan Area include Pacific Palisades, the City of Santa Monica, Venice, Marina del Rey/Del Rey Lagoon, and Playa Vista (Figure 2-9). Of these, only the City of Santa Monica, Venice, the Del Rey Lagoon and Marina del Rey have LCP documents approved by the Coastal Commission as of February 2020. These documents contain policies requiring low impact development principals such as the use of water conservation technology in development and groundwater recharge of storm water runoff.

2.1.3.4.4 Urban Water Management Plans

UWMPs plans support urban water suppliers long-term resource planning to ensure that adequate water supplies are available to meet existing and future water needs by assessing the reliability of water resources over a 20-year planning period, describing demand management measures and water shortage contingency plans, reporting progress toward meeting a targeted 20% reduction in per-capita consumption, and discussing the use and planned use of recycled water. Draft Guidelines for preparation of 2020 UWMPs include requirements for coordination of UWMPs with GSPs (DWR 2020). In the Plan Area, LADWP, the City of Santa Monica, GSWC-CC, the City of Beverly Hills, and the Los Angeles County Waterworks District 29 which serves the Marina del Rey water system must submit UWMPs. Policies and ordinances related to groundwater and water consumption in the UWMPs relevant to the Plan Area are listed in Table 2-10.

Table 2-10. Summary of Urban Water Management Plan Policies and Ordinances Relevant to Groundwater Sustainability in the Plan Area

Policy	Description
City of Santa Monica UWMP	
Sustainable City Plan	System level indicators: Reduce demand by 1.3 Mgal, reduce per capita consumption to 123 gpd, increase source up to 100% local water, upward trend in non-potable use.

Table 2-10. Summary of Urban Water Management Plan Policies and Ordinances Relevant to Groundwater Sustainability in the Plan Area

Policy	Description
Sustainable Water Master Plan	• Water Use Allowances (WUAs) - WUAs represent the amount of water that can be used by a water customer without risk of receiving an exceedance citation. • WUA Exceedance Citations - Administrative citation and fine for exceeding the WUA for any given billing periods. • Water School - A customer can have the first WUA exceedance citation waived by completing the Water School educational course on Santa Monica water and conservation. Also, can include an audit of water fixtures and irrigation system. • Water Use Consultations - Free audits by WCU staff of indoor and outdoor water use and water meter checks. • Enhanced Landscape Rebate Program - "Cash for Grass", yard and parkway conversion, rain gardens and rock gardens, unlimited commercial conversions • Landscape Consultants - $50 for 2-hour consultation on sustainable landscaping • Sustainable Landscape Training - One-on-one sustainable landscape trainings for residents. • Enhanced Water Waste Patrols - Enforcement of the "No Water Waste" (SMMC 7.16.020); power to issue Notices of Violation • Enhanced MWD Water Conservation Rebate Incentive Program - rebates through MWD for high efficiency toilets, urinals, clothes washers, restaurant appliances, irrigation devices and other devices. Free Water Saving Items - free distribution of low-flow faucet aerators, low-flow showerheads, automatic shut-off hose nozzles, toilet leak-detection dye tabs, shower buckets, flow-rate bags, and reusable canvas bags.
Bay Saver Fee Ordinance	Assesses a fee on water bills until fixtures are replaced with water conserving fixtures. Free water saving assessment offered by City staff.
Good Housekeeping Ordinance	Includes anti-runoff provisions for irrigation and a prohibition of washing down paved areas with potable water.
Water Conservation Ordinance	Prohibits irrigation between 10:00am and 4:00pm, the watering down of paved or hard-surfaced areas, irrigation runoff, the filling of decorative fountains, washing of vehicles with a running hose and the draining and refilling of pools. Water leaks required to be repaired immediately. Mandates that restaurants serve water only upon request.
Green Building Ordinance	Requires the most water-efficient plumbing fixtures, irrigation, and landscaping for new construction, major remodels and new or remodeled landscapes.
LADWP UWMP	
Mayor's Executive Directive No. 5	Sets goals using a FY 2013/14 baseline to 1. reduce per capita potable water use by 20% by 2017 (22.5% by 2025 and 25% by 2035), reduce LADWP purchase of imported potable water by 50% by 2024 and creates an integrated water strategy to increase local water supplies and improve water security in the context of climate change and seismic vulnerability
Sustainable City Plan	Establishes strategies to meet targets related to goals: 1. Create an integrated water strategy for Los Angeles, 2. Ensure safe, secure, and reliable drinking water supply and system, 3. Reduce per capita potable water use and increase recycled water, 4. Increase stormwater capture and protect marine life
Plumbing Retrofit Ordinance (1988)	Mandated installation of conservation devices in all existing residential and commercial properties and installation of water-efficient landscaping in all new construction. 1998 Amendment requires ultra low-flush toilets and water-saving showerheads prior to close of escrow (Retrofit on Resale Ordinance).

Table 2-10. Summary of Urban Water Management Plan Policies and Ordinances Relevant to Groundwater Sustainability in the Plan Area

Policy	Description
Water Efficiency Requirements Ordinance (2009)	Establishes water efficiency requirements for new developments and renovations of existing buildings by requiring installation of high efficiency plumbing fixtures in all residential and commercial buildings.
Landscape Ordinance (1996, amd. 2009)	Goals of improving outdoor water use efficiency.
Emergency Water Conservation Plan Ordinance	Establishes six phases of water conservation with prohibitions and water conservation measures steadily increasing by phase.
LADWP Ordinance No. 182047	Allows customers to use recycled water when service is available.
GSWC-CC UWMP	
104	The City shall protect and, where feasible, restore the quality of coastal waters to implement Coastal Act policies. Coastal waters include the ocean, rivers, streams, wetlands, estuaries, lakes, and groundwater.
113	Development and construction activities shall protect and, where feasible, restore the water quality of groundwater.
118	The City shall promote onsite and offsite rain harvesting BMP solutions for non-potable water uses, such as infiltration for shallow flora uptake or groundwater recharge, or storage for irrigation and indoor flushing
Beverly Hills UWMP	
Emergency Water Conservation Ordinance	Establishes five stages of water shortage severity and increasing levels of water demand restrictions related to each stage.
Efficient Landscape Ordinance	Provides for the efficient use of water in landscaping by requiring that landscape plans be certified by a Landscape Architect or Irrigation Auditor and must address the criteria of plant materials grouped according to water needs, erosion and runoff control addressed, and efficient irrigation system design.
Water Survey Programs for Single and Multi-Family Residential Customers	City water surveys aimed at developing residential customer water use efficiency for both landscape and indoor water use.
Residential Plumbing Retrofit	Provides customers with water efficient plumbing devices such as low-flow showerheads.
System Water Audits, Leak Detection and Repair	Conducted by water operations/maintenance staff, these programs aim at reducing water losses through the water agency's mains.
High-Efficiency Washing Machine Rebate Program	City's customers can receive a rebate towards the purchase of a high-efficiency washing machine.
Conservation Pricing	Program that provides economic incentives for water use efficiency.
Residential Ultra Low-Flush Toilet Replacement Program	City assists customers in replacing their existing toilets with water efficient models.

Table 2-10. Summary of Urban Water Management Plan Policies and Ordinances Relevant to Groundwater Sustainability in the Plan Area

Policy	Description
LA County Waterworks District 29 UWMP	
Model Water Efficient Landscape Ordinance	Statewide ordinance that reduces residential outdoor landscape demands for new construction by up to 20% and commercial landscape for new construction demands by up to 35%
California Energy Commission Title 20	Statewide ordinance that sets appliances efficiency standards for toilets, urinals, faucets and showerheads
CALGreen Building Standards Code	Statewide code that requires residential and non-residential water efficiency and conservation measures for new buildings and structures.
Water Waste Ordinance	Los Angeles County ordinance that outlines prohibitions on hose water, irrigation, car wash facilities, public eateries and decorative fountains.

2.1.3.4.5 University of California – Los Angeles, Long Range Development Plan

In 2002, UCLA completed its Long-Range Development Plan with the purpose of planning academic, physical and operational needs to support a forecast student body increase of 4,000 full-time-equivalent students (UCLA 2003). Water is currently supplied to the campus by LADWP, which does not presently extract groundwater from the Subbasin. Goals related to water conservation and use in the Long-Range Development Plan include:

- Creating buildings and systems that are environmentally friendly and help provide for a sustainable environment.
- Incorporating design features, technological adaptation and principles that encourage the concept of environmental sustainability and stewardship.
- Promoting efficient use of water with natural drainage patterns, drought tolerant landscaping, and recycling and reuse.

The campus maintains extensive water conservation and recycling programs that have substantially reduced campus water demand in spite of an increasing campus population.

2.1.4 Additional GSP Components

Each GSP is required to include a description of additional elements in CWC 10727.4 that the GSA determines to be appropriate (23 CCR 354.8 (g)). These additional elements are listed below:

- Control of saline water intrusion – There are no existing saline water intrusion programs in the Plan Area. For further information see Sections 2.4.3, 3.2.3, 3.3.3, and 3.4.3.
- Wellhead protection – Section 2.1.3.3 (Well Permitting).
- Migration of contaminated groundwater – Section 2.1.2.3 (Water Quality).
- Well abandonment and well destruction program – Section 2.1.3.3 (Well Permitting).
- Replenishment of groundwater extractions – Section 2.5.
- Conjunctive use and underground storage –Section 2.1.2.5.
- Well construction policies – Section 2.1.3.3.

- Groundwater contamination cleanup, recharge, diversions to storage, conservation, water recycling, conveyance, and extraction projects – Section 2.1.2.3.
- Efficient water management practices – Sections 2.1.2.5 and 2.1.3.
- Relationships with state and federal regulatory agencies – Sections 2.1.1.1 and 2.1.2.
- Land use plans and efforts to coordinate with land use planning agencies to assess activities that potentially create risks to groundwater quality or quantity – Section 2.1.3.
- Impacts on groundwater dependent ecosystems – Sections 2.4.6 and 2.4.7.

2.1.5 Notice and Communication

Notification and communication regarding the development of this GSP has taken place in the following phases:

1. GSA Formation
2. Initial Notification
3. GSP Development
4. Draft GSP Review and Comment

SMBGSA notified DWR of its intent to become the groundwater sustainability agency for the Subbasin on June 13, 2017.

Following the notification of intent to form a GSA, SMBGSA submitted a Notice of Intent to develop a GSP for the Santa Monica Groundwater Subbasin to DWR on November 15, 2019. The GSP Development phase included extensive outreach and engagement with the stakeholders, including beneficial users, as described in more detail in Section 2.1.5.2, Public Meetings Summary, and Section 2.1.5.5, Communication.

The Draft GSP Review and Comment phase included a formal public comment period for the Draft GSP and response to comments, as discussed in Section 2.1.5.3, Summary of Comments and Responses.

The last notification and communication phase for the preparation of this GSP will begin once the SMBGSA submits the final GSP to DWR. This phase will include engagement with the public and beneficial users regarding the progress of monitoring and reporting updates on the GSP to DWR, establishment of fees, should they become necessary, and the development and implementation of management strategies, including projects, as needed.

2.1.5.1 Summary of Beneficial Uses and Users

The primary beneficial use of groundwater in the Plan Area is municipal water supply. Beneficial users of groundwater and property interests potentially affected by the use of groundwater include municipal well operators, private water users, local land use planning agencies, environmental users, and disadvantaged communities. There are no federally recognized tribal lands within the Plan Area.

Beneficial users of groundwater and property interests potentially affected by the use of groundwater within the Plan Area include municipal well operators, public and private water purveyors, local land use planning agencies, environmental users, and disadvantaged communities (Table 2-11). The beneficial users of groundwater within the Plan Area are described in more detail in the following paragraphs.

Municipal Well Operators and Public and Private Water Purveyors. The City of Santa Monica is the only public water agency that operates groundwater wells in the Plan Area (See Section 2.1.1.2). The City of Santa Monica is a member agency of the GSA and participated in discussions regarding the development of this GSP.

Local Land Use Planning Agencies. The City of Santa Monica, City of Beverly Hills, City of Culver City, City of Los Angeles, and the County of Los Angeles all have land use planning authority over the portions of the Plan Area within their jurisdictional boundaries. Each of these agencies is a member agency of the GSA and staff from each agency participated in discussions regarding the development of this GSP.

Environmental Users. There are limited environmental users of groundwater in the Plan Area (See Section 2.4.7). The SMBGSA has taken steps to incorporate the interests of environmental users in the development of the GSP through a review and documentation of the potential interconnectedness of surface and groundwater in the Subbasin and avoiding groundwater production in areas adjacent to surface water bodies. Additionally, environmental stakeholders were invited to participate in and present at quarterly stakeholder meetings. These stakeholders were also invited to meet individually with GSA member agency staff to discuss concerns regarding the BWER and comments from environmental stakeholders received on the public draft of the GSP were incorporated into the final GSP.

Disadvantaged Communities. SMBGSA invites involvement and comments from DAC community members at quarterly public meetings and DAC community members have been invited, along with other stakeholders, to meet with Dr. Lisette Gold from the City of Santa Monica at any time to discuss the GSP development. DACs within the City of Santa Monica are the only DACs in the Subbasin that receive local groundwater produced within the Subbasin. DACs within the Subbasin that are outside the jurisdiction of the City of Santa Monica's Department of Public Works (i.e., within the City of Los Angeles and County of Los Angeles) receive imported water, not local groundwater, through their respective water supplier.

The City of Santa Monica conducts regular engagement with DACs that rely on the City's water supply. These engagement activities began prior to the passage of SGMA in 2015 with the 1991 formation of the Task Force on the Environment, renamed in 2021 to the Commission on Sustainability, Environmental Justice, and the Environment. The Commission on Sustainability, Environmental Justice, and the Environment provides advice to City staff and decision makers on environmental policy. Members of the Commission on Sustainability, Environmental Justice, and the Environment have expertise in energy, water, transportation, waste reduction and public health, land use and sustainable development, and public education and community outreach. Commission meetings, when allowed to be held in-person, are held monthly in the Pico neighborhood at Virginia Avenue Park, within a DAC to encourage DAC participation in the decision-making process.

As discussed in Section 2.1.3.2, all City of Santa Monica residents receive an annual water quality report documenting the sources of water supplied to City residents, the history of groundwater contamination that has impacted the City's groundwater production wells, the treatment processes that occur prior to distribution, and the water quality testing results for water served by the City of Santa Monica. This water quality report also encourages sustainability and stakeholder participation, providing information on how to attend City Council meetings, participate in conservation events, and receive newsletters and alerts. All community members are invited to provide feedback, and the water quality report lists the phone numbers and websites of the City's Division of Water Resources Offices, the City's Office of Sustainability and the Environment, MWD, and the SWRCB DDW. Additionally, the water quality report provides the timing of and website for the City of Santa Monica City Council Meetings, which are open to the public and where public feedback in the decision-making process is actively encouraged.

In conjunction with other City of Santa Monica initiatives to encourage sustainable use of groundwater, the City of Santa Monica conducts community meetings and open houses discussing water rates, progress of the City's Sustainable Water Master Plan implementation, and overall water supply outlook at neighborhood groups (total of 7 neighborhood organizations in the City of Santa Monica) and also at various locations throughout the City to encourage participation from local residents and DACs. Depletion of local water resources can impact DACs if these depletions result in increased water rates.

In addition to the active outreach efforts maintained by the City of Santa Monica and the SMBGSA, all public meeting materials related to the preparation of this GSP are posted to the SMBGSA SGMA webpage for public review and comments.

Table 2-11. Stakeholder Categories in the Plan Area

Category of Interest	Examples of Stakeholder Groups	Engagement Purpose
General Public	General Public	Inform to improve public awareness of sustainable groundwater management
Land Use	City of Santa Monica City of Los Angeles City of Culver City City of Beverly Hills County of Los Angeles	Consult and involve to ensure land use policies are supporting GSP and vice-versa
Urban Users/ Golf Courses	City of Santa Monica Brentwood County Club – golf course Riviera Country Club – golf course Los Angele Country Club – golf course Holy Cross Cemetery	Collaborate to ensure sustainable management of groundwater
Environmental and Ecosystem	Ballona Creek Renaissance Friends of Ballona Wetlands Heal the Bay Grassroots Coalition Sierra Club – Airport Marina Group Ballona Ecosystem Education Group	Inform, involve, and collaborate to sustain vital ecosystems
Economic Development	—	Inform and involve to support a stable economy
Human right to water	Disadvantaged and Severely Disadvantaged Communities	Inform, involve, and collaborate to provide safe and secure groundwater supplies to DACs
Integrated Water Management	Regional water management groups (IRWM regions)	Inform, involve, and collaborate to improve regional sustainability

2.1.5.2 Public Meetings Summary

SMBGSA has been discussing the development of a GSP since 2016. Public meetings in which the participants discussed SGMA, the SMBGSA, or took action on the GSP are listed below:

- May 2, 2017 – LADWP Board Meeting
- May 9, 2017 – City of Santa Monica Council Meeting
- May 23, 2017 – County of Los Angeles Board of Supervisors Meeting
- May 30, 2017 – City of Culver City Council Meeting
- June 13, 2017 – City of Beverly Hills Council Meeting
- July 23, 2019 – City of Santa Monica Council Meeting
- December 19, 2019 – SMBGSA Public Workshop

- June 25, 2020 – SMBGSA Public Workshop
- September 17, 2020 – SMBGSA Public Workshop
- December 17, 2020 – SMBGSA Public Workshop
- March 18, 2021 – SMBGSA Public Workshop
- June 7, 2021 – Northeast Neighbors Meeting
- June 17, 2021 – SMBGSA Public Workshop
- July 19, 2021 – Commission on Sustainability, Environmental Justice, and the Environment
- August 16, 2021 – Commission on Sustainability, Environmental Justice, and the Environment
- August 19, 2021 – SMBGSA Public Workshop
- September 16, 2021 – SMBGSA Member Agency Meeting
- October 7, 2021 – North of Montana Association
- October 18, 2021 – Commission on Sustainability, Environmental Justice, and the Environment
- December 16, 2021 – SMBGSA Board Meeting
- January 13, 2022 – SMBGSA Board Meeting

2.1.5.3 Summary of Comments and Responses

The SMBGSA released a public draft of the GSP on July 15, 2021. A public workshop was held on August 19, 2021, to present the Public Draft GSP, answer questions, and solicit comments. The comment period was open between July 15 and September 28, 2021. Formal comments were accepted in writing only. Comments could be submitted electronically via email to Lisette.Gold@smgov.net or through a comment page linked directly to the SMBGSA website. A total of 5 comment letters were received. Before completing this Final GSP, the public comments received on the Draft GSP were reviewed and, where appropriate, incorporated into this Final GSP. Additionally, SMBGSA staff met with representatives from The Nature Conservancy, Audubon California, Local Government Commission, Union of Concerned Scientists, and Clean Water Action/Clean Water Fund, to discuss the comments received by this group and better understand how to inform the general public about the way this GSP fits into the broader environmental planning, social justice, and climate change mitigation efforts already underway in the Santa Monica Subbasin. Public comments on the Draft GSP are included in Appendix C.

2.1.5.4 Summary of Initial Information on Relationships between State and Federal Regulatory Agencies

SMBGSA has not entered into any formal agreements with the federal government regarding preparation or administration of this GSP or groundwater management pursuant to SGMA, Section 10720.3(c). There are no federally recognized Indian Tribes within the Plan Area.

SMBGSA recognizes the need for both formal and informal consultation with state and federal regulatory agencies throughout the implementation of the GSP. SMBGSA includes the following state and federal regulatory agencies on its list of interested parties:

- Santa Ana Regional Water Quality Control Board
- California Department of Water Resources

2.1.5.5 Communication

A Public Outreach and Engagement Plan was developed for this GSP (Appendix D). The purpose of the Public Outreach and Engagement Plan was to create a common understanding and transparency throughout the groundwater sustainability planning process, including fulfilling the requirements of SGMA as described in 23 CCR §354.10.d. The Public Outreach and Engagement Plan discusses the SMBGSA decision-making process; identifies opportunities for public engagement and provides a discussion of how public input and response will be used; describes how SMBGSA encourages the active involvement of diverse social, cultural, and economic elements of the population within the Subbasin; and describes the method SMBGSA shall follow to inform the public about progress implementing the public outreach and engagement plan, including the status of projects and management actions.

SMBGSA has provided ongoing opportunities for stakeholders to engage in the GSP development process. Meeting agendas and presentations were made available on the SMBGSA website. Additional technical information about the GSP development was made available on the SMBGSA website. The Public Draft GSP was available online for more than 100 days, including an official 75-day public comment period. SMBGSA encouraged active participation from stakeholders through the GSP development process.

2.2 Basin Setting

2.2.1 Geography

The Santa Monica Subbasin, which underlies the City of Santa Monica, as well as portions of the cities of Los Angeles, Culver City, and Beverly Hills, is located in western Los Angeles County (Figures 2-1 and 2-2). Land surface elevations range from approximately 2 feet above mean sea level (msl), adjacent to the Pacific Ocean on the western boundary of the Subbasin, to approximately 700 feet msl in the foothills of the Santa Monica Mountains (Figure 2-10). The Santa Monica Mountains rise to a height of approximately 1,900 feet msl to the north of the Subbasin. To the east, the Subbasin is separated from the Hollywood and Central Subbasins by the Newport-Inglewood Fault. To the south, the Subbasin is separated from the West Coast Subbasin by the Ballona Escarpment, an approximately 100 feet high escarpment that was created over time by erosional activity of Ballona Creek. The bottom of the Subbasin is defined by a change in sediment age and state of consolidation that occurs several hundred feet below land surface (Section 2.3.1).

2.2.2 Surface Water and Drainage Features

The Subbasin lies within the Santa Monica Bay Hydrologic Unit, an approximately 673 square mile watershed that extends from the Ventura County line in the north to the Palos Verdes peninsula in the south (Figure 2-3). The Santa Monica Bay Hydrologic Unit is sub-divided into five hydrologic areas of which two, the Ballona Creek and Garapito Creek – Frontal Santa Monica Bay hydrologic areas, intersect the boundaries of the Subbasin. The Ballona Creek watershed is approximately 130 square miles and drains the eastern and southern parts of the Subbasin, while the Garapito Creek – Frontal Santa Monica Bay watershed is approximately 80 square miles and drains the northwestern part of the Subbasin (Figure 2-3). Ballona Creek, which is approximately 9 miles long, has been maintained as a lined and grouted flood-control channel since the 1950's (ACOE 1982). The primary channels contributing flow to Ballona Creek are Centinela Creek and Sepulveda Canyon Channel on the south side of the Subbasin, and Benedict Canyon Channel on the north side of the Subbasin. Numerous storm drains throughout the Subbasin also contribute flow to Ballona Creek. In the northwestern part of the Subbasin, the Santa Monica Canyon and Rustic Canyon Channels drain directly into the Pacific Ocean, and do not contribute flow to Ballona Creek (Figure 2-3).

The only historical record of streamflow in the Subbasin is on Ballona Creek. This record consists of measurements at USGS gauge 11103500, which was active between 1928 and 1978, and DWP gauge F38C-R from 1978 through 2019. Between 1928 and 1978, the average streamflow ranged from 9.1 cubic feet per second (cfs) in June, to 108.1 cfs in February (Table 2-12). The months with this highest streamflow correspond to the months with the highest rainfall (Table 2-12; See Section 2.2.3). Additionally, rainy-season streamflow rates vary between years, with a difference between the maximum and minimum flows recorded in February of 658 cfs (Table 2-12; Figure 2-11). Dry season flows reflect urban runoff rates, and the maximum and minimum flows during the dry season are much closer than they are in the rainy season (Table 2-12; Figure 2-11).

Table 2-12. Ballona Creek Stream Flow

Month	Streamflow (cfs)		
	Maximum	*Minimum*	*Average*
January	591.6	5.6	114.6
February	662.3	4.1	134.7
March	436.7	1.1	82.7
April	193.7	0.7	38.8
May	107.9	0.2	18.2
June	68.6	0.1	13.5
July	50.4	0.0	12.5
August	62.3	0.0	13.7
September	134.2	0.0	18.4
October	179.0	0.4	22.8
November	350.1	0.6	49.6
December	406.0	1.7	79.2

Source: USGS; LACDPW

2.2.3 Historical, Current, Projected Climate

The climate of the Subbasin is typical of coastal southern California with seasonal temperatures moderated by the Pacific Ocean and the majority of the water-year precipitation falling between October and March (Figures 2-12 and 2-13). Coastal marine fog is common, especially during the summer months. Precipitation and temperature measurements in downtown Los Angeles have been recorded since the early 1900’s and within the Subbasin since the 1930’s.

There are eight currently active weather stations in the Subbasin (Table 2-3; See Section 2.1.2.1). Four of these stations, operated by LACDPW, are strictly precipitation gauges, and do not include coincident temperature measurements. The remaining four active stations record both daily temperature and precipitation. Of these, the NOAA UCLA and Culver City stations have the longest records in the Subbasin (See Section 2.1.2.1).

The climate record from the NOAA UCLA station begins in water year[35] 1933 and the climate record from the NOAA Culver City station begins in water year 1935. During their respective periods of record, each station has years in which more than 18 days (5% of the possible reporting days in the record) of data are missing. The NOAA Los Angeles Downtown station, located approximated 5 miles east of the Subbasin, has a complete 98-year record beginning in water year 1922. A linear regression was used to assess the correlation between the precipitation record at the NOAA Los Angeles Downtown station and the NOAA UCLA and Culver City stations for years in which a complete dataset was recorded. The R^2 correlation coefficient between the NOAA Los Angeles Downtown and UCLA stations was 0.95, while the R^2 correlation coefficient between the NOAA Los Angeles Downtown and Culver City stations was 0.65. Because the relationship between the NOAA Los Angeles Downtown station and NOAA UCLA station had a higher R^2, this relationship was used to estimate precipitation at the NOAA UCLA station for the years with missing data, and the NOAA UCLA reconstructed record is used to represent long-term climate conditions in the Subbasin. More recent data from the other weather stations in the Subbasin are used to assess local variability in climate parameters.

The historical and current climate are discussed in Section 2.2.3.1. The projected climate is discussed in Section 2.2.3.2.

2.2.3.1 Historical and Current Climate

Temperature

Temperatures within the Subbasin range from an average low of 49.9 °F in January, to an average high of 78.4 °F in August at the NOAA UCLA station and are similar at the other weather stations in the Subbasin (Table 2-13; Figure 2-12). Average high temperatures in July, August, and September are generally 10 to 15 degrees Fahrenheit (°F) higher than the average high temperatures in December, January and February (Figure 2-12). The difference between the average monthly high temperature and low temperature varies with location in the Subbasin (Table 2-13). At the NOAA Santa Monica Airport station, the difference between the average monthly high and average monthly low temperatures ranges from 6.2 °F in June to 11.6 °F in November (Table 2-13). The variation in average monthly high and low temperature differences is smaller at the UCLA station where the average monthly high temperature in June is 14.8 °F higher than the average monthly low temperature, and the average monthly high temperature in September, October, and November is 17.2 °F higher than the average monthly low temperature (Table 2-13). Temperature differences are highest at the NOAA Culver City station, ranging from 15.8 °F in June to 21.1 °F in November (Table 2-13).

Table 2-13. Average Monthly High and Low Temperatures

Month	Weather Station							
	UCLA		*Culver City*		*Santa Monica Airport*		*CIMIS*	
	Average Temperature (degrees Fahrenheit)							
	Min	*Max*	*Min*	*Max*	*Min*	*Max*	*Min*	*Max*
January	49.9	66.2	45.8	66.7	57.2	67.0	49.5	66.5
February	50.0	66.5	46.9	67.2	56.3	65.6	48.5	65.0
March	50.4	66.9	48.7	68.0	58.7	67.0	50.2	66.3
April	52.5	68.8	51.5	70.3	59.1	68.0	51.5	67.6

35 A water year begins October 1 and ends September 30 of the following year. For example: water year 2019 began October 1, 2018 and ended September 30, 2019.

Table 2-13. Average Monthly High and Low Temperatures

Month	Weather Station							
	UCLA		*Culver City*		*Santa Monica Airport*		*CIMIS*	
	Average Temperature (degrees Fahrenheit)							
	Min	*Max*	*Min*	*Max*	*Min*	*Max*	*Min*	*Max*
May	55.0	69.9	54.9	71.6	62.4	69.4	54.6	67.9
June	57.8	72.6	58.3	74.2	65.4	71.5	57.9	70.7
July	61.0	77.2	61.6	78.0	68.3	75.2	61.1	74.4
August	61.8	78.4	62.2	79.0	68.4	76.1	61.3	76.1
September	61.2	78.3	60.8	78.7	68.3	76.4	60.6	76.3
October	58.3	75.5	56.6	76.2	63.9	74.2	57.1	74.3
November	54.3	71.6	50.6	71.7	59.1	70.7	52.4	70.3
December	50.7	66.9	46.4	67.4	56.5	65.8	48.9	66.0

Sources: NOAA; CIMIS.

Precipitation

Over the entire historical record, average water year precipitation in the Subbasin ranges from 17.3 inches at the UCLA station to 12.5 inches at the Culver City station (Figure 2-13). Between 1985 and 2019[36] the average water year precipitation was 16.4 inches at the NOAA UCLA station and 12.1 inches at the Culver City Station (Table 2-14). The UCLA station is located at the base of the Santa Monica Mountains, and receives more precipitation than areas farther south in the Subbasin (Figure 2-5). More recent historical averages are lower at all the stations in the Subbasin and reflect the drying trend observed in the precipitation record since 2005 (Table 2-14; Figure 2-13).

Table 2-14. Measured Water Year Precipitation from 1985 to 2019

Water Year	Weather Station				
	Downtown LA	*UCLA*	*Culver City*	*Santa Monica Airport[a]*	*CIMIS[b]*
	Mean Precipitation (Inches)				
1985	12.38	11.69	—	—	—
1986	19.82	26.28	—	—	—
1987	5.61	6.3	—	—	—
1988	12.47	16.15	—	—	—
1989	8.34	10.17	7.13	—	—
1990	7.02	10.19	7.17	—	—
1991	11.67	12.27	9.37	—	—
1992	20.86	23.09	—	—	—
1993	27.28	—	—	—	—
1994	8.11	9.73	—	—	9.74
1995	24.37	35.39	24.19	—	24.84
1996	12.44	13.61	11.82	—	13.14
1997	12.85	18.03	16.72	—	16.35

36 The period from 1985 to 2019 was selected to correspond to the time-period of the historical water budget discussion in Section 2.5.

Table 2-14. Measured Water Year Precipitation from 1985 to 2019

Water Year	Weather Station				
	Downtown LA	*UCLA*	*Culver City*	*Santa Monica Airport*[a]	*CIMIS*[b]
	Mean Precipitation (Inches)				
1998	30.57	43.35	31.32	–	54.19
1999	9.08	10.38	7.06	–	10.89
2000	11.79	14.69	10.52	–	11.99
2001	17.72	24.04	13.54	18.75	20.99
2002	4.42	6.49	4.45	6.42	3.85
2003	16.49	19.54	14.61	7.53	11.2
2004	9.24	11.46	8.15	7.83	4.4
2005	37.54	41.88	17.54	32.30	31.62
2006	12.90	16.7	8.90	11.93	6.49
2007	3.73	3.91	3.20	1.71	2.98
2008	13.01	15.39	10.07	8.87	12.12
2009	9.08	10.8	9.08	9.71	1.75
2010	16.36	21.1	15.67	13.92	14.59
2011	20.20	25	–	20.65	19.92
2012	8.70	10.78	–	7.51	10.27
2013	5.93	7.64	6.95	7.24	8.38
2014	6.04	6.03	4.53	4.76	0.22
2015	11.24	12.04	10.84	11.66	10.77
2016	6.88	7.55	7.14	6.43	6.41
2017	19.07	21.97	18.80	18.10	17.85
2018	4.72	7.62	–	5.93	6.42
2019	18.85	25.58	23.15	19.80	14.48
1985 – 2019 Average	**13.62**	**16.38**	**12.08**	–	**13.30**
2000 – 2019 Average	**12.70**	**15.51**	**11.01**	**11.63**	**10.84**
2010 – 2019 Average	**11.80**	**14.53**	**12.44**	**11.60**	**10.93**

Sources: NOAA; CIMIS.
Note: Dash (–) indicates data are not available.
[a] Water year precipitation data are not available for the Santa Monica Airport station for the year 2000.
[b] Water year precipitation data are not available for the Culver City station for the years 2011, 2012, and 2018.

Although the volume of precipitation recorded across the Subbasin differs with geographic location and elevation, the overall trends in precipitation measured at each gauge are similar (Figure 2-13). The majority of precipitation falls between October and April, with February being the wettest month on average (Figure 2-14). Occasionally, during the dry season, moist air from the Gulf of California travels northward producing isolated showers over the region. However, cumulative precipitation between May and September is generally less than 5% of the total rainfall received during the water year.

Between 1933 and 2019 the Subbasin experienced seven periods during which there were three or more consecutive years of below-average precipitation (Figure 2-13). The length of these periods ranges from 3 to 8 years, with an average duration of 6 years. Two of these periods, from 2006 through 2009 and from 2012 through 2018, have occurred in the last 14 years of the record, and were separated by only two consecutive years of above-average precipitation (Figure 2-13).

Evapotranspiration

Reference evapotranspiration (ETo) in the Subbasin is calculated from the data collected at the Santa Monica CIMIS station (station no. 99) on a daily basis between 1993 and 2019 (Figure 2-5). The average ETo is 47.78 inches (Table 2-15). The average ETo reflects the amount of water that could be transpired by grass or alfalfa if supplied by irrigation. It does not represent the actual transpiration from any specific crop or native vegetation. Furthermore, there are no agricultural operations within the Subbasin. Therefore, the ETo is provided for reference in this GSP, but is not used to calculate water budget components or impacts to groundwater demand from future climate change.

Table 2-15. Monthly and Yearly ETo Totals for CIMIS Station No. 99

Year	Monthly ETo (inches)												Annual Total (inches)
	Jan	*Feb*	*Mar*	*Apr*	*May*	*Jun*	*Jul*	*Aug*	*Sep*	*Oct*	*Nov*	*Dec*	
1994	2.71	2.6	3.6	4.01	4.19	5.52	4.98	5.81	4.31	3.11	2.99	2.44	46.27
1995	1.33	2.13	3.68	5.08	4.4	4.75	6.05	6.05	4.58	3.52	2.69	2.02	46.28
1996	2.55	1.65	2.56	4.03	4.01	3.92	3.66	3.93	2.9	3.39	2.35	2.07	37.02
1997	1.41	2.47	2.98	4.94	5.59	5.55	5.57	5.8	4.74	2.51	2.13	1.52	45.21
1998	1.87	2.04	3.73	4.55	5.11	5.18	5.56	5.92	3.9	4.08	2.23	2.71	46.88
1999	2.33	2.59	3.43	4.24	4.83	5.37	6.08	5.81	3.75	3.92	2.47	2.53	47.35
2000	2.12	2.02	3.81	5.35	5.89	6.54	6.86	6.33	5	4.5	2.57	3.02	54.01
2001	2.39	2.09	3.56	4.7	5.01	6.19	6	5.82	4.37	3.06	2.96	2.36	48.51
2002	2.49	3.19	4.42	4.41	5.62	5.82	6.03	5.43	4.64	3.05	2.03	2.11	49.24
2003	2.74	2.55	4.49	4.76	4.94	3.94	5.47	6.05	3.69	2.84	2.79	2.07	46.33
2004	2.48	2.59	3.71	4.55	5.76	4.81	5.99	5.29	4.77	3.1	2.49	2.04	47.58
2005	1.95	2.18	3.41	4.89	5.32	5.34	5.56	5.28	4.29	2.8	2.48	2.1	45.6
2006	2.73	2.85	3.21	3.67	4.18	4.98	5.62	5.39	4.12	3	2.63	1.85	44.23
2007	2.76	2.59	4.01	4.25	4.9	5.41	5.97	5.58	4.78	3.2	2.4	2.41	48.26
2008	2.21	2.66	4.42	5.3	4.9	5.71	5.69	5.46	4.21	4.02	2.09	2.46	49.13
2009	2.95	2.43	3.92	4.97	5.14	4.75	6.3	5.66	4.65	4.43	2.75	1.9	49.85
2010	2.12	2.29	4.07	4.26	5.10	4.81	5.07	5.87	4.31	2.71	2.02	1.48	44.11
2011	2.49	2.52	3.41	4.90	5.57	4.67	5.57	5.20	3.57	3.30	2.29	2.38	45.87
2012	2.76	2.58	3.48	4.44	5.36	5.09	5.27	5.86	4.73	3.61	2.08	1.63	46.89
2013	2.75	2.88	3.52	4.70	5.72	4.86	5.12	5.60	4.80	3.72	2.57	2.67	48.91
2014	2.72	2.60	4.08	5.36	5.95	5.80	5.82	5.76	4.95	3.96	3.11	1.85	51.96
2015	2.59	2.89	4.70	5.31	4.93	5.15	5.59	5.93	4.96	4.14	3.25	2.55	51.99
2016	2.02	3.71	4.08	5.22	5.04	5.07	6.07	5.85	4.87	3.79	3.23	2.17	51.12
2017	2.03	1.92	4.55	5.83	5.18	5.51	6.31	5.70	4.80	4.18	2.71	2.94	51.66
2018	2.62	3.26	3.68	5.08	4.80	5.62	6.39	6.19	4.41	3.88	3.00	2.33	51.26
2019	2.11	2.22	4.13	4.63	4.56	4.44	5.95	5.93	4.8	4.57	2.67	1.98	47.99
Average	**2.42**	**2.69**	**3.97**	**4.97**	**5.22**	**5.10**	**5.72**	**5.79**	**4.62**	**3.79**	**2.69**	**2.20**	**47.78**

Source: CIMIS.

2.2.3.2 Projected Climate

Future climate conditions in the Subbasin are projected to be warmer and drier than they have been historically (Cayan et al. 2010; Allen and Anderson 2018). In order to better quantify the potential effects of climate change within each groundwater basin in California, DWR provided climate change datasets at an approximately 6 km grid-scale that were originally developed for the Water Storage Investment Program (DWR 2018). These datasets were derived from a collection of 20 global climate projections. The central tendency of each of the 20 projections was used to establish 2030 and 2070 projected climate conditions.

Within the Subbasin, the central tendency 2030 and 2070 datasets consist of monthly change factors for precipitation, and evapotranspiration that, when multiplied by the historical precipitation, or evapotranspiration provide an estimate of future climate conditions. Additionally, DWR provided de-trended historical temperature and 2030 and 2070 predicted temperatures in the Subbasin. These data sets were used to calculate temperature change factors and were applied to the historical temperature record. Using the DWR climate change factors, temperatures in the Subbasin are expected to increase by approximately 2 degrees Fahrenheit by 2030 and approximately 4.5 degrees Fahrenheit by 2070 (Figure 2-12).

Precipitation in the Subbasin is projected to remain relatively constant in both the 2030 and 2070 scenarios. At the UCLA precipitation gauge, precipitation is projected to be 16.51 inches, slightly higher than the long-term historical average, under the 2030 scenario, and 16.33 inches, approximately equal to the long-term historical average, under the 2070 scenario. The timing of the precipitation is, however, projected to change with more precipitation received in January and February, and less precipitation received in October, November, and December (Figure 2-14).

Overall, evapotranspiration is projected to increase by approximately 4% relative to historical rates in the 2030 scenario and by approximately 9% relative to historical rates in the 2070 scenario. Higher evapotranspiration rates reflect projected increases in temperature for the Subbasin in each of these scenarios.

In addition to the central tendency climate change scenarios, DWR developed monthly precipitation and ET change factors that represent wetter mild warming (WMW) and drier extreme warming (DEW) future conditions. These change factors were developed using simulation results from a single global climate model that employed the IPCC RCP 4.5 (intermediate emissions) and RCP 8.5 (high emissions) scenarios. The most extreme warming conditions in the Subbasin are captured using the DEW scenario change factors.

Under the DEW conditions, precipitation is expected to decrease by approximately 11% relative to historical rates. At the UCLA precipitation gauge, this translates to a reduction in the mean annual precipitation of approximately 2.3 inches per year. These projected extreme warming conditions would also result in a 16% increase in ET across the Subbasin. Groundwater conditions were not directly assessed using numerical model results. Rather, the central tendency climate change factors provided by DWR were incorporated into numerical groundwater simulations of future conditions in the Subbasin in order to assess the impacts of potential future climate scenarios on groundwater conditions (See Section 2.5.5.3 Projected Water Budget).

2.2.3.3 Precipitation Year Types

GSP regulations require that the historical water budget evaluate the water budget relative to water year type (23 CCR §354.18. a). Water year types were provided by DWR for the Santa Monica Bay Hydrologic Unit. The water year types were based on weighting the historical water year precipitation record as 30% wet years, 20% above normal years, 20% below normal years, 15% dry years, and 15% critical years over a 30-year ranking window (DWR 2021). The sliding 30-year ranking window was utilized to account for how absolute precipitation will change in a changing climate. Over the 85-year record of precipitation at the UCLA weather station, DWR classified 12 years as critical, 18 years as dry, 13 as below normal, 17 as above normal and 25 as wet. The water year types have been incorporated into discussions of the historical water budget and change in groundwater storage (see Sections 2.4.2 Estimated Change in Storage and 2.5.4 Characterization of Water Year Types).

2.3 Hydrogeologic Conceptual Model

2.3.1 Geology

The Subbasin straddles the boundary between the Transverse Ranges geomorphic province to the north and Peninsular Ranges geomorphic province to the south (Figures 2-15A and 2-15B; USGS 1965). The Peninsular Ranges geomorphic province extends from the Santa Monica Fault Zone in the north, southward to the California border and into northern Mexico. It is bounded by the Colorado Desert province to the east and includes the offshore islands of Santa Catalina, San Clemente, and Santa Barbara to the west (USGS 1965). The Transverse Ranges geomorphic province is characterized by east-west trending ridges and valleys from Point Arguello at the Coast, inland to the San Bernardino Mountains (USGS 1965). These ridges and valleys form as a result of uplift along a compressional bend in the San Andreas fault system. The southernmost mountain range of the Transverse Ranges is the Santa Monica Mountains, which demarcate the northern boundary of the Subbasin.

Beginning approximately 12 million years ago, widespread extension associated with a releasing bend of the San Gabriel-Chino Hills-Christianitos fault and rotation of the transverse ranges created the Los Angeles Basin[37], a northwest-trending alluvial filled structural trough, approximately 50 miles long and 20 miles wide (USGS 1965; Ingersoll and Rumelhart 1999). The Subbasin lies in the northwestern Los Angeles Basin, where sediment thickness ranges from approximately 6,000 feet at the coast to 13,000 feet at the eastern boundary (Figure 2-16; USGS 1965). In the central part of the Los Angeles Basin sediment thickness is estimated to exceed 30,000 feet (Figure 2-16; USGS 1965). The Los Angeles Basin has historically been one of the most prolific oil producing regions of California, particularly in relation to its size (USGS 1965).

Historically, the Subbasin has been subdivided into local subbasins on the basis of water level discontinuities, mapped fault locations, and changes in groundwater geochemistry (City of Santa Monica 1965; MWD 2007; City of Santa Monica 2013). These five local subbasins, the Olympic, Charnock, Arcadia, Coastal and Crestal subbasin, are frequently referenced in historical studies and reports (Figure 2-17; MWD 2007). However, more recent investigations have found that not all of the subunit boundaries correspond to faults that act as barriers to groundwater flow (USGS 2021). Rather, the differences in observed water quality and groundwater elevation are likely caused by a combination of geologic structures, including folds and faults, and differences in depositional environment and lithologic characteristics between subsurface units of a similar age (USGS 2021). Because more recent interpretation does not support subdividing the Subbasin into distinct local units for the purposes of groundwater management decisions, this GSP does not adopt subunit distinctions within the Subbasin.

2.3.1.1 Geologic Units

Groundwater Bearing Units

Holocene Surface Sediments

The majority of the natural surface sediments in the Subbasin are Holocene gravel, sand, silt, and clay derived from erosion of the Santa Monica and San Gabriel Mountains, as well as other elevated areas surrounding the Subbasin (DWR 1961; City of Santa Monica 2013). The youngest of these sediments (map symbol Qa) are found where the

37 The Los Angeles Basin as used herein refers to the sedimentary structure underlying the larger Los Angeles Plain that extends from the Santa Monica Mountains southeast to the Santa Ana Mountains. It is not to be confused with the multiple groundwater basins that compose this area including the Coastal Plain of Los Angeles Basin.

drainages of the Santa Monica Mountains enter the northern Subbasin, as well as covering extensive portions of the central and southern Subbasin (Figure 2-15A). These youngest Holocene deposits include unconsolidated channel gravel, beach sand, and marshlands deposits that are typically less than a few tens of feet thick in the Subbasin (DWR 1961; Santa Monica 2015). In the southern part of the Subbasin, however, these sediments reach a maximum thickness of approximately 90 feet (DWR 2004). The Bellflower aquitard and Ballona aquifer are the primary geohydrologic units found within the Holocene deposits in the Subbasin.

Late Pleistocene Alluvial Sediments

Late Pleistocene alluvial sediments form much of the elevated plateau areas in the Subbasin and include older dune sands (map symbol Qos) and the Lakewood Formation (map symbol Qoa); reddish brown continental deposits and gravel, sand, silt and conglomerates of marine origin (map symbol Qom) (Figure 2-15A; DWR 1961). The Lakewood Formation thins northward where it is in direct contact with the older consolidated rocks of the Santa Monica Mountains (Figure 2-18). In the Los Angeles Basin, the deposits of the Lakewood Formation include the Exposition, Artesia, Gardena, and Gage aquifers associated with deposition along the Los Angeles and San Gabriel Rivers (USGS 2003). Deposition of the aquifer materials in the Lakewood Formation was controlled by sea-level fluctuations and underlying topography. As a result, the coarse-grained deposits in the Lakewood Formation vary in thickness throughout the greater Los Angeles Basin (USGS 2003). Although the Lakewood Formation includes thin coarse-grained units in the Subbasin these layers are laterally discontinuous and are not contiguous with the named aquifers of the Lakewood Formation elsewhere in the Los Angeles Basin. Consequently, the coarse-grained deposits within the Lakewood Formation are commonly referred to as the Shallow aquifer within the Subbasin, rather than by the specific aquifer units found elsewhere in the Los Angeles Basin (LADWP 2011, City of Santa Monica 2007, City of Santa Monica 2015). In general, groundwater supply wells are not screened within the Lakewood Formation in Subbasin (Figures 2-18 through 2-21). Therefore, the Lakewood Formation is not considered a principal aquifer in this GSP.

Early Pleistocene Marine Sediments

Unconformably underlying the Lakewood Formation in the northern part of the Subbasin are the early Pleistocene marine sediments of the San Pedro Formation (Figures 2-18, 2-21, and 2-22). In the southern part of the Subbasin, these sediments unconformably underlie the recent alluvium. The San Pedro Formation ranges in thickness from about 300 to 500 feet from north to south (DWR 1961). The uppermost units of the San Pedro Formation, which include the Hollydale and Jefferson aquifers elsewhere in the Los Angeles Basin, have been eroded throughout the Subbasin. The lower part of the Upper San Pedro Formation includes the Silverado and Sunnyside aquifers, which are both present in the Subbasin (DWR 1961). The Silverado aquifer is the primary aquifer in the Subbasin and is the aquifer in which the majority of the groundwater production wells in the basin are screened (Figures 2-18 through 2-21).

Pliocene Marine Sediments

Underlying the San Pedro formation are gray and blue-gray marine sand, silt, clay and interbedded gravels of the Pliocene Pico Formation (Figures 2-18 through 2-22). In the northern part of the Subbasin groundwater production wells are screened within the Pico Formation (Figures 2-18 and 2-21). The Pico Formation is a prolific source of petroleum and natural gas in the area and the base of the active freshwater groundwater system occurs within the upper part of the Pico Formation in the Subbasin (DWR 1961, Paulinski et al. 2020). The base of the freshwater groundwater system defines the base of the Subbasin.

Non-Groundwater Bearing Basement Rocks

Underlying the Pico formation are mid-Pliocene and older marine units referred to as the Repetto Formation (DWR 1961), or pre-Repetto Rocks, or the “Repetto” (USGS 2021). Repetto are consolidated units and the base of the Los Angeles Coastal Plain Groundwater Model (LACPGM) Subbasin (USGS 2021).

Other non-groundwater bearing Tertiary sedimentary rocks that underly the Subbasin include the Late Miocene Monterey Formation and the Middle Miocene Topanga formation (Figures 2-15A and 2-15B). These Tertiary units unconformably overlie the Catalina Schist of unknown age (USGS 1965), and the Triassic to Jurassic Santa Monica Slate, which is at the core of the Santa Monica Mountains and represents the oldest rock unit in the region (City of Santa Monica 2013).

2.3.1.2 Structures

The Los Angeles Basin has been broadly divided into structural blocks with boundaries defined by major fault zones (USGS 1965). The Subbasin straddles the Santa Monica Fault Zone, occupying the north part of the Southwestern Block and the southwestern part of the Northwestern Block (Figure 2-23; USGS 1965). The Los Angeles Basin is composed of northwest – southeast trending folds which plunge southeast in the northern part of the Basin, and to the northwest in the southern part of the Basin. The convergence of these folds near the Los Angeles River constitutes the deepest part of the Basin (USGS 1965).

The Subbasin has been uplifted and eroded relative to the other subbasins within the Coastal Plain of the Los Angeles Groundwater Basin resulting in the presence of groundwater only in the Holocene alluvium, and the San Pedro and Pico formations (DWR 1961). The general structure of the offshore region of Santa Monica Bay is a seaward continuation of the Coastal Plain and the aquifers along the Santa Monica Bay are exposed to the ocean (DWR 1961). Therefore, the potential for seawater intrusion exists in the Subbasin. However, the extent of lithologic variation resulting from changes in depositional environment and the possible influence of offshore faulting and folding on seawater intrusion are not well understood.

Faults

Faults in the region have been used to divide the Los Angeles Groundwater Basin into subbasins and geomorphic provinces. Approximate fault locations were instrumental in defining groundwater subunits in the Subbasin that were used in previous reports (e.g., MWD 2007, City of Santa Monica 2013). However, not all of the subunit boundaries correspond to faults that correlate with barriers to groundwater flow (USGS 2021).

Structural information for this GSP was compiled from historical and current sources in which there are variations in some fault locations, orientations, names, and movement. The fault designations described below are based on USGS, DWR, and Dibblee Geologic maps (Figures 2-15A and 2-15B). Faults within the Subbasin are generally oriented either east-west (e.g., the Santa Monica Fault Zone) or north-south (e.g., the Newport-Inglewood Fault Zone).

East-West Trending Faults

Santa Monica Fault Zone

The Santa Monica Fault Zone bisects the City of Santa Monica, extending onshore from the Pacific Ocean across the northern third of the Subbasin in a northeasterly direction where it terminates against the Newport Inglewood

Fault Zone (Figures 2-15A and 2-15B; Paulinski et al. 2020). The northern splay is active, while the southern splay, which may include the Anacapa-Dume fault, is inactive (Dolan, Sieh, and Rockwell 2000). Faults within this fault zone are steep angle north-dipping reverse faults (Dolan, Sieh, and Rockwell 2000).

Anacapa-Dume Fault

The Santa Monica Fault Zone appears to have a left-lateral offset south of Point Dume, with active deformation stepping southwestward to the Anacapa-Dume fault (Dolan, Sieh, and Rockwell 2000). The Anacapa-Dume fault extends off-shore in a general east-west direction from south of Port Hueneme in Ventura County to about two miles east of where it lies inland near Santa Monica Canyon (Figures 2-15A and 2-15B). The onshore portion of the fault is described as a steep angle, north-dipping, reverse fault in agreement with the faults of the Santa Monica Fault Zone (Dolan, Sieh, and Rockwell 2000).

Brentwood Knoll/ Brentwood Fault

The Brentwood Knoll is a northwest to west trending feature that parallels the Santa Monica Fault zone. This feature projects approximately 80 feet above the surrounding alluvium and is thought to represent an anticlinal ridge developed above a shallow blind thrust fault that may be a westward continuation of the easternmost en echelon segment of the Santa Monica Fault Zones (Dolan, Sieh, and Rockwell 2000). Other investigators hypothesize that the Brentwood Knoll is the surface expression of a fault that exhibits the same degree of offset as other faults within the Santa Monica Fault Zone, and that Pico Formation sediments occur directly opposite Lakewood and San Pedro formation sediments on the other side of the fault (City of Santa Monica 2013). The Lakewood and San Pedro formations are thinner to the north relative to their counterparts on the southern side of this structure fault.

North-South Trending Faults

Newport-Inglewood Fault Zone

The Newport-Inglewood Fault Zone is a major southern California structural fault zone that, in the vicinity of the Subbasin, extends from Beverly Hills in the north to Newport Bay in the south (USGS 1965). The eastern boundary of the Subbasin generally coincides with the Newport-Inglewood Fault Zone (Figures 2-15A and 2-15B). East facing eroded scarps and a line of elongated hills define the surface expression of the fault zone (USGS 1965). The Newport-Inglewood Fault Zone is characterized by en echelon, left-stepping, right-lateral strike-slip faulting in the northern reach of the fault zone (Dolan, Sieh, and Rockwell 2000). Historical groundwater elevations suggest that the Newport-Inglewood Fault Zone acts as a significant barrier to westward flow of groundwater through Pleistocene and deeper aquifers (USGS 1959).

Charnock Fault

The near vertical northwest-southeast trending Charnock Fault generally parallels the San Diego Freeway about a quarter mile to the west. The Charnock fault enters the Subbasin from the south and extends to just north of Ballona Creek (Figures 2-15A and 2-15B). Previous studies indicated that the fault extends north approximately to Olympic Boulevard, based on groundwater head differences of up to 120 feet in wells in the area. The hypothesized fault in this area was used as the basis for the western boundary of the locally defined Charnock Subunit within the Subbasin (USGS 1959). However, recent seismic-reflection data indicate that displacement across the Charnock Fault is limited to the Repetto formation, which underlies the Subbasin, with the eastside uplifted as much as 140 feet in relation to the west (USGS 2021). Observed groundwater head differences in the vicinity of the fault near

Olympic Boulevard are now thought to be related to stratigraphic discontinuities rather than restriction of flow across a fault boundary (USGS 2021).

Overland Avenue Fault

About a mile east, and roughly parallel to the Charnock fault, the Overland Avenue fault has been mapped to extend from south of the Ballona Gap to Santa Monica Boulevard (Figures 2-15A and 2-15B; USGS 1959). The Overland Avenue fault is near vertical with the west side displaced approximately 30 feet down in relation to the east side (DWR 1961). Historical groundwater elevations indicated groundwater levels east of the Overland Avenue fault were 60 to 100 feet higher than on the west side, suggesting that the Overland Avenue Fault acts as a barrier to groundwater flow (DWR 1961). However, more recent investigations indicate that the Overland Avenue fault may only be a partial barrier to groundwater flow (GeoTrans 2005).

Palos Verdes Fault

The Palos Verdes fault is located in the Pacific Ocean about two miles off-shore and generally parallels the Newport-Inglewood Fault Zone (Figures 2-15A and 2-15B; Dolan, Sieh, and Rockwell 2000, Paulinski et al. 2020). The Palos Verdes Fault terminates against the eastern end of the Anacapa-Dume Fault (Dolan, Sieh, and Rockwell 2000). In middle to late Pleistocene time, the Palos Verdes Hills were uplifted at least 1,300 feet relative to present sea level, and adjoining parts of the downthrown block were probably depressed 500 to 1,000 feet, largely by movement on the Palos Verdes fault (USGS 1965). The Palos Verdes Fault is the western boundary of the LACPGM (USGS 2021).

Folds

The dominant folds in the Los Angeles Basin are two northwest - southeast inward plunging synclines, the intersection of which is near the Los Angeles River where the basement rock is approximately 30,000 feet below sea level (Figure 2-16; USGS 1965). The east limb of a southeast plunging anticline underlies the Subbasin, the hinge of which lies off the coast of the Pacific Ocean (Figures 2-15A and 2-15B, USGS 1965).

2.3.2 Principal Aquifers and Aquitards

The historical hydrostratigraphic framework of the Subbasin is based on the zones of sands and gravels within the geologic units discussed in Section 2.3.1. These permeable zones were given aquifer names to identify the producing aquifers on a regional scale. Episodes of uplift and erosion, changes in the course of the Los Angeles and San Gabriel Rivers, and sea-level fluctuations result in grain size and permeability variations in sediments of the same age. As a result of these processes, several coarse-grained sequences within the greater Coastal Plain of Los Angeles Basin are absent from the Subbasin (DWR 1961). Within the Subbasin, the primary aquifers and aquitards are restricted to the recent alluvial sediments and the San Pedro Formation (DWR 1961).

The primary producing aquifer in the Subbasin is the Silverado aquifer, which is a coarse-grained sequence in the lower part of the upper San Pedro Formation (Figures 2-18 through 2-21; DWR 1961). The Sunnyside aquifer has also been identified in the Subbasin beneath the Silverado aquifer (Figures 2-18 through 2-21; DWR 1961). These aquifers dip from north to south across the Subbasin and are offset to different depths and thicknesses across major fault zones (DWR 1961).

Overlying the Silverado and Sunnyside aquifers, and separated from them by the vertical extent of the Lakewood Formation, is the Ballona aquifer. The Ballona aquifer, which is in the Holocene (or recent) surface sediments, is not currently used for groundwater supply. The Ballona aquifer is generally overlain by finer grained sediments that compose the Bellflower aquitard. Where present, the Bellflower aquitard partially restricts percolation of surface water (DWR 1961). Consequently, groundwater recharge to the Subbasin is largely from mountain-front recharge along the Santa Monica Mountains and, to a much lesser degree is from percolation of precipitation through areas of discontinuous aquicludes (DWR 1961).

The nature and extent of the sediments that compose the Bellflower aquitard, and the Bellflower, Silverado, and Sunnyside aquifers are discussed in further detail in the following sections.

2.3.2.1 Bellflower Aquitard

The Bellflower aquitard primarily occurs within the Holocene alluvium that forms the surficial deposits in the central and southern parts of the Subbasin. However, the Bellflower aquitard has been referred to as all fine-grained sediments that extend from ground surface to the first aquifer below, which may occur in the Lakewood (DWR 1961). Clay and sandy clay are the predominant sediment types within the aquitard, which reaches a maximum thickness of approximately 40 feet within the Subbasin (Table 2-16; DWR 2004). The Bellflower aquitard overlies the Ballona aquifer.

Table 2-16. Principal Aquifers and Aquitards of the Santa Monica Subbasin

Aquifer/Aquitard	Formation	Max. Thickness (feet)	Transmissivity (gpd/ft)[2]	Yield (gpm)	Specific Yield[3] (%)	Specific Capacity (gpm/ft)[2]
Bellflower Aquitard	Holocene	40[1]	NA	NA	NA	NA
Ballona Aquifer	Holocene/Lakewood	50[1]	70,000	100 – 800[4]	1 - 26	NA
Silverado Aquifer	San Pedro	280[1]	150,000	4,700[1]	1 - 26	159
Sunnyside Aquifer	San Pedro	NA	NA	NA	NA	NA

Notes:
1 From Bulletin 118, DWR 2004
2 From DWR Bulletin 104, 1961 for areas within Coastal Plain of Los Angeles Plain Groundwater Basin but outside of the Santa Monica
3 Range is from Bulletin 118, DWR 2004 for all Subbasin Sediments
4 From DWR Bulletin 104, for southwest part of Subbasin

2.3.2.2 Ballona Aquifer

The Ballona aquifer, also known as the “50-foot Gravel”, is primarily located in the southern half of the Subbasin (Figure 2-24; DWR 1961). Similar to the Bellflower aquitard, the Ballona aquifer primarily occurs within the Holocene-age alluvium, but in places it can occur as part of the Lakewood Formation (DWR 2004, USGS 2003, City of Santa Monica 2015). In the southern portion of the Subbasin, adjacent to the Ballona Escarpment, the base of the Ballona aquifer is about 60 feet below sea level (DWR 1961). The base of the Ballona aquifer is above sea level at its northern extent, near Santa Monica Boulevard.

Reflective of the variation in age and geologic unit association, the lithologic composition of the aquifer varies in the Subbasin. In the southern part of the Subbasin near the Ballona escarpment, the aquifer is generally coarse sand, gravel, and cobbles (DWR 1961). The Santa Monica and San Gabriel Mountains are the suspected source rock for the granitic and metamorphic gravels and cobbles that give the Ballona aquifer the alternate name of the

50-foot Gravel. This term applies in the vicinity of the Ballona Escarpment where the aquifer reaches a maximum depth of 70 feet and a thickness of 30 to 50 feet (DWR 1961).

To the north, the aquifer includes beach and playa deposits, and transitions to heterogeneous fine and coarse-grained deposits north of Interstate 10 and west of Interstate 405 (DWR 1961). In the vicinity of the Olympic Wellfield, the Ballona aquifer comprises silty and clayey sands and gravels interbedded with brown to dark brown sandy and gravelly clays and silts (City of Santa Monica 2015). In this location, the Ballona aquifer is also called the “A-zone aquifer”. Some investigators identified the Ballona aquifer in the vicinity of the Charnock Wellfield (Geotrans 2005), while others identify the shallowest water bearing unit in this area as the Shallow Aquifer (City of Santa Monica 2020). The shallow aquifer is more typically associated with the Lakewood Formation. The base of the Ballona aquifer is above sea level to the north of Pico Boulevard, where the aquifer pinches out (DWR 1961).

Wells screened within the Ballona aquifer have variable yields (100 to 800 gpm), likely reflecting the variable source materials and thickness of the aquifer (DWR 1961). The Ballona aquifer is hydraulically connected to the underlying Silverado aquifer in the vicinity of the Charnock and Olympic Wellfields (City of Santa Monica 2019). However, the City of Santa Monica’s municipal groundwater wells are not screened within the Ballona aquifer in Charnock and Olympic well Wellfields. The only known wells that produce groundwater from the Ballona aquifer are associated with groundwater quality remediation at the Playa Vista development in the southern part of the Subbasin adjacent to the Ballona Escarpment (Playa Capital Company 2020). In the third quarter of 2020 these wells produced approximately 174-acre feet of groundwater from the Ballona aquifer (Playa Capital Company 2020). Analysis of hydrographs for this GSP (Section 2.4.1.3) indicate that the Ballona aquifer is hydraulically connected to the underlying Silverado aquifer in the Playa Vista area.

2.3.2.3 Silverado Aquifer

The Silverado aquifer is the primary groundwater production aquifer in the Subbasin. Located within the San Pedro Formation, the Silverado aquifer comprises continental and marine deposits of interbedded clay, silt, sand, and gravel (yellow-brown where of continental origin, blue to grey where of marine origin) (DWR 1961). Uplift and erosion of the San Pedro Formation have removed the Silverado aquifer materials in the northeastern part of the Subbasin, north of the Anacapa-Dume and Santa Monica Faults (Figure 2-25). Although the San Pedro Formation is present in the western part of the Subbasin, the dominant subsurface materials from 80 feet bgs to 600 feet bgs near the Santa Monica City Hall are clay and silty sandy clay. This suggests that the water-bearing deposits of the Silverado aquifer are not present at the coast.

The primary groundwater producing areas for the Silverado aquifer are the City of Santa Monica’s Olympic and Charnock Wellfields (Figure 2-6). In these areas, the Silverado aquifer reaches a thickness of approximately 300 feet. At the Olympic Wellfield, the top of the Silverado aquifer occurs as shallow as approximately 45 feet bgs and dips to the north-northeast (City of Santa Monica 2015). The upper portion of the Silverado aquifer, referred to as the C-Zone aquifer in the vicinity of the Olympic Wellfield, is separated from the lower portion of the aquifer, referred to as the D-Zone aquifer at the Olympic Wellfield, by an aquitard that consists of several feet of clay to clayey silt at both the Olympic and Charnock Wellfields (Geotrans 2005, City of Santa Monica 2015).

The Silverado aquifer yields significant quantities of groundwater (4,700 gpm) to wells (DWR 2004). Within the City of Santa Monica’s Olympic groundwater production wellfield, wells screened within the Silverado aquifer can produce groundwater at a rate of approximately 900 gpm. Groundwater production rates are higher in the Charnock Wellfield where wells can produce at approximately 1,400 gpm. To the west, at the Santa Monica airport, well yields are approximately 300 gpm.

2.3.2.4 Sunnyside Aquifer

The Sunnyside aquifer lies within the upper San Pedro Formation, below the Silverado aquifer. The Sunnyside aquifer, in conjunction with another unnamed, poorly characterized unit that extends to the base of the upper San Pedro Formation, is designated as the bottom of the Subbasin fresh groundwater. The Sunnyside aquifer and unnamed unit are characterized by alternating fine- and coarse-grained zones with the coarsest material generally being located at the base of the aquifer system where the sediments are as much as 100 feet thick (City of Santa Monica 2015). The Sunnyside aquifer has been identified in core samples collected in the vicinity of the Olympic Wellfield (City of Santa Monica 2015), however, the spatial extent of the aquifer may be limited as other sources have not designated the Sunnyside aquifer as a principal aquifer within the Subbasin (DWR 1961 and 2004).

2.3.2.5 Basin Bottom

Within the Subbasin, the San Pedro formation exists at variable depths due to vertical displacement along the prominent faults (Figures 2-18 to 2-22). The base of the San Pedro formation is estimated to be at a depth of about - 600 feet MSL just south of the Charnock fault where it has a thickness of approximately 400 feet (DWR 1961, Plate 6D). In contrast, in the northern Subbasin, north of the Satna Monica Fault, the base of the San Pedro Formation occurs between 200 and 300 ft MSL, and the San Pedro Formation is less than 100 feet thick. Although few wells extend below the San Pedro formation into the Pico formation, the Pico Formation has been noted to yield poor quality groundwater, or to produce brackish groundwater, and thus the base of the San Pedro formation is considered to be the base of the economic freshwater aquifers throughout the majority of the Subbasin (DWR 1961, USGS 1959, City of Santa Monica 2013, City of Santa Monica 2015).

2.3.3 Groundwater Storage

The groundwater storage capacity of the Subbasin has been estimated to be 1,100,000 AF (DWR 1961). Total available groundwater in storage estimated by City of Santa Monica (2013) was 338,304 AF for the shallowest and 141,368 AF for the deepest historical groundwater conditions (City of Santa Monica 2013). Storage between historical high-water levels (prior to 1961) and sea level was estimated to be 36,000 AF (DWR 1961).

2.3.4 Chemical Character of Native Groundwater

Determination of native groundwater chemical quality is difficult due to the scarcity of pre-development groundwater quality data (USGS 1959). Groundwater from the unconfined aquifer was thought to have been degraded as result of existing land uses by the early 1900's and therefore not representative of native conditions (USGS 1959). Chloride concentrations exceeding 500 mg/L were thought to impact an area of approximately 3,400 acres of in the Ballona aquifer in 1945 (Figure 2-26). TDS in the unconfined coastal aquifer in the vicinity of the Ballona Gap was about 1,000 milligrams per liter (mg/L) (USGS 1959) and more recent analysis from public supply wells within the Subbasin indicated an average TDS concentrations of 916 mg/L (DWR 2004).

Groundwater samples from shallow wells near the central part of the Subbasin indicated sodium-sulfate to sodium-calcium-sulfate character in 1936 (USGS 1959). In contrast, groundwater analyses conducted from 2005 to 2009 within the Subbasin exhibited calcium-bicarbonate-magnesium-sulfate and calcium-bicarbonate-sulfate type waters. Water quality in the Silverado aquifer, was of excellent native quality with groundwater ranging from sodium-calcium-bicarbonate to sodium-bicarbonate, with low dissolved solids and hardness (USGS 1959)

Groundwater quality within the Subbasin is discussed in more detail in Sections 2.4.3 (Seawater Intrusion) and 2.4.4 (Groundwater Quality).

2.3.5 Recharge

The primary source of recharge to the Silverado aquifer is mountain-front recharge from the Santa Monica Mountains to the north the Subbasin (Figure 2-27). The Subbasin is highly urbanized and little recharge occurs via direct infiltration of precipitation in the Subbasin boundaries. Within the watershed that drains into the Subbasin from the southern foothills of the Santa Monica Mountain, approximately 4,400 acres of soil are classified as gravelly loam and sandy loam (Figure 2-28). These soil types are conducive to higher infiltration rates of precipitation.

Within the Subbasin, approximately 800 acres are classified as sandy loam, sand, or slightly decomposed plant material (Figure 2-28). These soils are found in the Baldwin Hills, in the southeastern corner of the Subbasin, in the Ballona wetlands along the southern boundary of the Subbasin, and on the beaches that form the western boundary of the Subbasin (Figure 2-28). In total 2.5 % of the Subbasin has soil types exposed at the surface that are conducive to groundwater recharge.

2.4 Current and Historical Groundwater Conditions

2.4.1 Groundwater Elevation Data

Groundwater elevations in the Subbasin were first measured in the early 1900s, and multiple entities have recorded well groundwater elevations since that time including the LACFCD, Southern California Water Company, and the City of Santa Monica. Prior to the 1920s, groundwater elevation measurements were taken at irregular and infrequent intervals in a limited number of wells (DWR 1961, USGS 1959). In 1925, the City of Santa Monica completed its first well at the Charnock Wellfield and began monitoring groundwater levels. In 1928, the LACFCD began periodically monitoring groundwater levels in a number of wells throughout the Subbasin, and the program has continued to date (USGS 1959). Currently, the City of Santa Monica and County of Los Angeles are the two primary entities monitoring groundwater levels in the Subbasin. Hydrographs for Subbasin wells reviewed for this GSP are included in Appendix E.

2.4.1.1 Historical Groundwater Elevations

Groundwater elevations in the Subbasin are controlled by groundwater inflows (recharge) and outflows. Recharge occurs primarily via percolation of precipitation, return flows from urban irrigation, distribution system leakage, subsurface inflows from adjacent basins, and from subsurface inflows from the adjacent Santa Monica Mountains (Section 2.5.1). Groundwater outflows from the Subbasin occur principally through groundwater withdrawals and as flows to streams and Ballona Creek (Sections 2.5.2). Groundwater outflows occur to a lesser extent as underflow across Subbasin boundaries to other basins (Sections 2.5.2). Groundwater inflows and outflows have also occurred to the Pacific Ocean during different time periods depending on the amount of groundwater recharge and production (Section 2.5.1.5).

Groundwater elevations for representative wells known to be screened in the Ballona or the Silverado aquifers are discussed in the following sections. Several wells that have historically been used to show groundwater levels in coastal areas of the Subbasin are not included in this GSP because their screen intervals are either unknown or are not representative of the depths of the Ballona or Silverado aquifers. These wells have screen intervals, when known, that are less than 15 ft long and their screen depths suggest that they are screened in a water bearing unit below the Ballona aquifer, but likely not in the Silverado aquifer. Many of these wells also have near flat historical groundwater levels which may suggest that they are not hydraulically connected to either the Ballona or the Silverado aquifers.

2.4.1.2 Historical Groundwater Elevation Trends

The USGS (1959) recorded that from groundwater level measurements in 1904 to periodic measurements beginning in 1930 there was no change in groundwater elevation in the Subbasin. Groundwater levels ranged from approximately 8 feet msl near the coast to about 62 feet msl in the eastern part of the Subbasin from 1904 to 1930 (USGS 1959). By the 1930s, however, pumping for irrigation, industrial, and municipal purposes had drawn down groundwater levels in the Subbasin, with groundwater elevations at the coast at approximately -10 feet msl, and groundwater elevations in the vicinity of the Charnock Wellfield at approximately -30 feet msl (USGS 1959). The pumping depression centered over the Charnock Wellfield reportedly extended about 2 miles to the south to Ballona Creek, and three-quarters of a mile to the north, or about halfway to Pico Boulevard (USGS 1959). No distinction was made in early reports of groundwater elevations in the Ballona aquifer and those in the Silverado aquifer.

For wells that are currently monitored in the Ballona aquifer, the earliest water level measurements were recorded in 1999 (Figure 2-29A). In the Silverado aquifer, the longest record of groundwater elevation begins in 1935, with several other records beginning between 1960 and 1990 (Figures 2-29B and C).

Ballona Aquifer

Groundwater elevation records for wells that are currently monitoring groundwater levels in the Ballona aquifer are limited to the Playa Vista and Charnock areas of the Subbasin. Hydrographs for wells MW-M and MW-B (Playa Vista Area, Figure 2-29A) are typical for Ballona aquifer hydrographs for the Playa Vista area , and hydrographs for wells RPZ-4 and RPZ-9 (Charnock Area, Figure 2-29A) are typical of the Charnock area. Wells in the western part of the Playa Vista area generally have static groundwater levels between 5 ft msl and 7 ft msl from 1999 to 2020 (MW-M, Playa Vista Area, Figure 2-29A and Figure 2-30), whereas groundwater elevations in wells in the eastern part of Playa Vista rose from zero ft msl to about 7 ft msl between 1999 and 2006 (MW-B, Playa Vista Area, Figure 2-29A). Between 2006 and 2011 groundwater elevations in the eastern Playa Vista area were stable. Groundwater elevations declined in this area between 2011 and 2020 (Figure 2-29A). Groundwater elevations in the western part of the Playa Vista area do not appear to correlate with trends observed in the cumulative departure from the mean precipitation from 1999 to 2006 or with pumping. However, declines in the Playa Vista eastern area wells from 2006 to 2011 coincide with both renewed pumping in the Charnock Wellfield in 2011 and with the period of drought shown in the cumulative departure from the mean precipitation after 2011.

Groundwater elevations in wells RPZ-4 and RPZ-9 have trends similar to those in the eastern part of the Playa Vista area (Charnock Area, Figure 2-29A). Between 1996 and 2010 groundwater elevations in wells RPZ-4 and RPZ-9 recovered. Groundwater elevations in these wells then declined again after renewed pumping in 2011. However, unlike wells in the eastern part of the Playa Vista area (MW-B), neither RPZ-4 nor RPZ-9 have a level groundwater period suggesting the groundwater elevations in these wells never reached full recovery after the Charnock groundwater production wellfield shut down.

Silverado Aquifer

In the Silverado aquifer, groundwater elevations are highest in the northern part of the Subbasin, adjacent to the Santa Monica Mountains where mountain-front recharge occurs, and lowest in the Olympic and Charnock Wellfields due to groundwater production (Figures 2-29B and 2-29C). In the northern area, groundwater elevations in well Santa Monica #range from about 225 ft msl to 265 ft msl between 1983 and 2019 (Northern Area, Figure 2-29C). Static groundwater elevations in the Arcadia No. 4 well generally range from about 160 ft msl to 240 ft msl (Arcadia Area, Figure 2-29B). In the Olympic area, production well Santa Monica No. 4 and monitoring wells OB-2 and OB-14C have static groundwater levels from about -10 ft msl to about 50 ft msl between 1987 and 2019 (Olympic Area, Figure 2-29B).

In the Charnock Wellfield area, production wells Charnock No. 7 and Charnock No. 16 have groundwater level records from 1937 to present (Charnock Area, Figure 2-29B). No data on when static groundwater levels was recorded for Charnock No. 7, but static groundwater levels for Charnock No. 16 and monitoring wells RMW 3, 28, and 57 have groundwater elevations ranging from approximately -65 ft msl to 35 ft msl between 1983 to 2020 (Charnock Area, Figure 2-29B).

Nearer to the southern end of the Subbasin, monitoring Well 1290P has groundwater elevations ranging from -35 ft msl to 10 ft msl from 1966 to 2019 (Southern Area, Figure 2-29C). The groundwater elevations at Well 1290P appear to have been initially impacted by groundwater production in the area which decreased after about 1977. Between 1998 and 2019 groundwater elevations in this well generally ranged from -5 ft msl to 10 ft msl. At the very southern end of the Subbasin in the Playa Vista area, monitoring wells C-065D, C-087, C-122, have static groundwater levels from approximately -8 ft msl to 9 ft msl (Playa Vista Area, Figure 2-29C).

Groundwater elevations in the northern area of the Subbasin have tracked somewhat with the trends observed in the record of cumulative departure from the mean. Groundwater elevations in well Santa Monica No. 5 experienced rapid increases that appear to correlate with precipitation events in the cumulative departure from the mean precipitation in 1984, 1987, 1999, 2005, and 2011 (Figure 2-28A). Likewise, two periods of declining groundwater elevation in well Santa Monica No. 5 from 1987 to 1992 and from 2011 to 2017 appear to correlate with drought periods in the cumulative departure from the mean precipitation (Northern Area, Figure 2-29C).

Hydrographs for wells in the Arcadia, Olympic, and Charnock pumping areas do not correlate with climatic periods in the cumulative departure from the mean precipitation but do correlate with historical pumping. Groundwater levels in wells Arcadia No. 4 and Charnock No. 16 rebounded after groundwater extraction was stopped in 1996 (Figure 2-28B). Similarly, groundwater levels in well Santa Monica No.4 rebounded after groundwater extraction was stopped in 2003 (Olympic Area, Figure 2-29B). Groundwater levels in wells Santa Monica No.4 and Charnock No. 16 declined after 2011 due to renewed pumping.

Groundwater elevation changes in Well 1290P tend to correlate with local trends in groundwater production more than with precipitation. Between 1966 and 1978, groundwater elevations are relatively level, ranging from approximately -32 ft msl to -35 ft msl (Southern Area, Figure 2-29C). Overall precipitation between 1965 and 1969 was above-average, while overall precipitation from 1969 to 1973 was below-average. The lack of groundwater level response to precipitation changes from 1966 to 1978 suggests that groundwater levels in Well 1290P do not respond to wetter and dryer periods. Between 1978 and 1985, groundwater levels rose, corresponding to a period of higher precipitation and increased pumping in the Subbasin (Southern Area, Figure 2-29C). Groundwater elevations continued to rise between 1986 and 1992, even though precipitation decreased. Pumping between 1986 and 1992 period decreased relative to previous production rates, suggesting that rising groundwater levels in Well 1290P were responding to decreased pumping rather than precipitation. There is a similar response to pumping in Well 1290P during the low pumping period from 1996 to 2011 and from the increase in pumping since 2011. Overall, well 1290P shows a higher correlation with pumping changes than with wetter and dryer precipitation periods.

Hydrographs for wells in the Silverado aquifer in the eastern part of the Playa Vista area indicate that groundwater extraction at the Charnock Wellfield since 2011 have caused groundwater levels in the Silverado aquifer to decline (C-065D and C-087, Playa Vista Area, Figure 2-29C).

In summary, only Silverado aquifer groundwater elevations in the northern part of the Subbasin tracked somewhat with the trends observed in the cumulative departure from the mean precipitation. Groundwater elevations from the Olympic Wellfield area to the Playa Vista area, particularly those in the Olympic and Charnock areas, are better correlated with groundwater production patterns than with precipitation (Figures 2-29B and 2-29C).

2.4.1.3 Current Groundwater Elevation Conditions

Groundwater elevation data are collected from a broad network of monitoring wells within the Subbasin. The majority of these wells were installed to monitor conditions at individual remediation sites, and the timing of groundwater monitoring in these wells occurs on individual regulatory schedules. Therefore, in order to assess the current fall and spring groundwater levels in the Subbasin, defined in this GSP as the fall 2018 and spring 2019 groundwater levels, data collected from a wide range of dates was used. The date range was sufficiently large that the fall 2018 groundwater level assessment includes any groundwater elevation measured in the Ballona and Silverado aquifers in the second half of 2018, and the spring 2019 groundwater level assessment includes any groundwater elevation measured in the first half of 2019 (Figures 2-30 through 2-34).

Ballona Aquifer

Groundwater elevations in the Ballona aquifer in the second half of 2018 ranged from a high of approximately 5 ft msl in the western part of the Playa Vista area at well MW-D to a low of approximately -5 ft msl in the eastern part of the Playa Vista area at well C-087 (Figure 2-31). The direction of groundwater flow in the Playa Vista area was toward the east-northeast. Ballona aquifer wells in the Charnock area were dry during the second half of 2018.

In the first half of 2019, groundwater elevations ranged from a high of approximately 6 ft msl in the western part of the Playa Vista area at well MW-M to a low of approximately -1 ft msl in the eastern part of the Playa Vista area at well MW-B (Figure 2-32). The direction of groundwater flow in the Playa Vista area was toward the east-northeast. Ballona aquifer wells in the Charnock area were dry during the first half of 2019.

Silverado Aquifer

In the second half of 2018, groundwater elevations ranged from a high of approximately 230 ft msl in the northern region of the Subbasin at the Santa Monica No. 5 well to a low of approximately -51 ft msl at the Charnock Wellfield (RMW-28 Figure 2-33). The direction of groundwater flow in the northern half of the Subbasin was toward the Olympic and Charnock Wellfields. The direction of groundwater flow in the southern part of the Subbasin was toward the north-northwest from the Play Vista area toward the Charnock Wellfield.

In the first half of 2019, groundwater elevations ranged from a high of approximately 250 ft msl in the northern region of the Subbasin at the Santa Monica No. 5 well to a low of approximately -61 ft msl at the Charnock Wellfield (RMW-8; Figure 2-34). The direction of groundwater flow in the northern half of the Subbasin was toward the Olympic and Charnock Wellfields. The direction of groundwater flow in the southern half of the Subbasin was toward the north-northwest from the Play Vista area to the Charnock Wellfield.

Groundwater Gradient

Groundwater gradients in the Subbasin were estimated from the second half of 2018 and the first half of 2019 groundwater contour maps (Figures 2-31 through 2-34). The groundwater gradient for much of the Ballona and Silverado aquifers in the Subbasin could not be estimated due to the lack of aquifer specific wells. However, in the second half of 2018 and the first half of 2019, groundwater gradients could be estimated for the Ballona aquifer in the Playa Vista area, and for the pumping areas of the Silverado aquifer.

Wells MW-M and MW-B in the Ballona aquifer were used to estimate the groundwater gradients between the western and eastern parts of the Playa Vista area, respectively (Figures 2-31 and 2-34). In the second half of 2018, the groundwater gradient was 0.0010 ft/ft, and for the first half of 2019 the groundwater gradient was 0.0009 ft/ft.

In the Silverado aquifer, the second half of 2018 groundwater gradients were measured from the 10 ft msl contour just east of Well MW-3 to the northern end of the -50 ft msl contour in the Charnock area, and from the zero ft msl contour near Well 1290P to the southern end of the -50 ft msl contour in the Charnock area (Figure 2-33). The second half of 2018 the groundwater gradient from near well MW-3 to -50 ft msl was 0.0080 ft/ft, and from zero ft msl near Well 1290P to the southern end of the -50 ft msl contour was 0.0065 ft/ft. In the first half of 2019, the zero contour near Well MW-3 and the northern end of the -60 ft msl contour in the Charnock area and the zero ft msl contour near Well 1290P and the southern end of the -60 ft msl contour in the Charnock area were used to estimate the groundwater gradients (Figure 2-34). For the first half of 2019, the groundwater gradients were estimated to be 0.0100 ft/ft and 0.0085 ft/ft, respectively.

The groundwater gradient in the Silverado aquifer between the western and eastern sides of the Playa Vista area was measured between wells C-122 and C-065D for both the second half of 2018 and the first half of 2019, respectively (Figures 2-33 and 2-34). The groundwater gradient for the second half of 2018 was 0.0013 ft/ft and it was unchanged at 0.0013 ft/ft for the first half of 2019.

The hydrographs for the Subbasin suggest that the historical direction of regional groundwater flow was generally away from the Santa Monica Mountains (from 225 to 265 ft msl at Santa Monica No. 5) toward the south (near msl in the Playa Vista area), except near groundwater extraction areas where the hydraulic gradient is toward pumping wells (Figures 2-29A through 2-29C). The groundwater contour in the Silverado aquifer (Figures 2-33 and 2-34) indicate that the groundwater flow is generally from north (230.18 ft msl to 250.58 ft msl at Santa Monica No. 5) to south (near zero in the Playa Vista area). However, in recent years with the resumption of groundwater production at the Charnock wellfield, there is also groundwater flow from the eastern side of the Playa Vista area toward the Charnock Wellfield area.

2.4.2 Estimated Change in Storage

Annual estimates of the change in groundwater in storage were computed using simulation results from the LACPGM, a MODFLOW numerical groundwater flow model that was originally developed by the USGS and updated for this GSP (USGS 2021; Appendix F; See Section 2.5 Water Budget). The updated model was developed in support of this GSP. The LACPGM simulated historical conditions in the Subbasin between calendar years 1971 and 2015. Estimates of the changes in groundwater in storage were extracted from the model results using the Subbasin boundary for water years 1985 through 2015 (Figures 2-35 and 2-36). Municipal groundwater extractions are the primary outflows from the Plan Area. The primary inflows are mountain-front recharge, aerial recharge, and subsurface inflows from adjacent groundwater subbasins.

In all but seven years since 1985, groundwater use has exceeded inflows in the Plan Area (Figures 2-35 and 2-36). Inflows have generally only exceeded groundwater use in years where local precipitation volumes have exceeded the long-term average precipitation, and when groundwater production was reduced at the Charnock Wellfield as a result of MTBE contamination (Figures 2-35 and 2-36; See also Section 2.1.2.3.5 Charnock Wellfield Early Warning System). In years when precipitation volume is close to or below the long-term average, groundwater extractions have generally exceeded inflows. As a result, the LACPGM estimates that between water years 1985 and 2015, groundwater in storage decreased by an average rate of approximately 1,200 AFY (Figure 2-36). This resulted in a cumulative decrease of groundwater in storage of approximately 35,000 AF between water years 1985 and 2015 (See Section 2.5.4 Change in Annual Volume of Groundwater in Storage).

2.4.3 Seawater Intrusion

The term “seawater intrusion” is defined by DWR as the advancement of seawater[38] into a groundwater supply that results in the degradation of groundwater (DWR 2016a). Seawater intrusion is harmful to freshwater aquifers because seawater displaces freshwater in storage, and once seawater intrudes an aquifer is difficult to displace. Aquifers that have experienced seawater intrusion have higher concentrations of TDS and chloride than native groundwater.

Seawater intrusion can occur in coastal aquifers if groundwater extraction lowers groundwater elevations and creates a landward gradient that induces flow of seawater water into a freshwater aquifer. Many of the coastal aquifers in California have experienced some degree of seawater intrusion associated with groundwater production (Izbicki et al. 1998, USGS 2003, Nishikawa et al. 2009). This section summarizes the existing understanding of potential episodes of historical seawater intrusion and the current chloride concentrations in the principal aquifers of the Subbasin.

2.4.3.1 Historical Estimates of Seawater Intrusion

In the early 1900s, several domestic and stock wells were installed in the coastal part of Ballona Gap (USGS 1959). The concentration of TDS in these wells, which were generally 10 to 30 feet deep and produced water from shallow sediments within and overlying the Bellflower aquitard, ranged from 750 mg/L to over 2,000 mg/L. These concentrations were thought to represent native groundwater quality in the shallow sediments of the Ballona Gap (USGS 1959). By the mid-1930s, these wells had been abandoned either because they had gone dry or because TDS concentrations had increased and water quality deteriorated (USGS 1959).

In the Ballona Gap area, the Ballona aquifer in the early 1900’s had TDS concentration, estimated from electrical conductance (EC), ranging from 650 to 750 mg/L (USGS 1959). The USGS (1959, Plate 16) mapped the inland concentration for 1945-1946 of 500 mg/L chloride to Lincoln Boulevard and 100 gm/L chloride between Lincoln and Sepulveda boulevards. Thus, the extent of the area that was likely impacted by seawater intrusion reached inland to Lincoln Boulevard, while between Lincoln and Sepulveda boulevards downward migration of shallow groundwater is the likely the source of increasing TDS and chloride concentrations based on the associated of

38 Seawater has an average salinity of 35,000 mg/L and an average chloride concentration of 19,000 mg/L.

chloride with sulfate concentrations (USGS 1959). By the mid-1950s, the concentration of TDS in the Ballona aquifer had increased to 1,000 to 1,500 mg/L (measured by chemical analyses).

Where measured in the Subbasin, the concentration of TDS in the Silverado aquifer ranged from 480 to 650 mg/L in the early 1900s, and the chloride concentration in the Silverado aquifer ranged from 40 to 70 mg/L (USGS 1959). At the coast, contamination from seawater intrusion was reported in 1946 in the vicinity of the Ballona Gap. By the 1940s, the City of Santa Monica had abandoned its 200 feet deep groundwater production wells at the Marine Street Plant, located near the intersection of Marine and Longfellow Streets, as a result of chloride concentrations that reached 1,100 mg/L (USGS 1959; City of Santa Monica 1966; City of Santa Monica 1968). These wells have been characterized as being in the San Pedro Formation, but it is not clear that they were in the Silverado aquifer, as an electric log of the Venice No. 1 oil well, located approximately 1 mile southwest of the Marine Street Plant and only a few blocks from the coastline indicated that the Silverado aquifer was encountered below 260 ft bgs and contained freshwater in 1960 (City of Santa Monica 1968).

2.4.3.2 Current Understanding of Chloride and TDS Concentrations

Ballona Aquifer

Chloride and TDS concentrations are not commonly measured in wells screened in the Ballona aquifer because there is only a small volume of groundwater produced from this aquifer, and the water that is produced from the Ballona aquifer is not used for drinking water. Rather, groundwater produced from the Ballona aquifer is discharged to Ballona Creek in the vicinity of the Ballona wetlands (RWQCB 2018). The primary understanding of TDS and chloride concentrations in the Ballona aquifer comes from groundwater remediation monitoring wells in Playa Vista (Figure 2-37).

There are 38 wells in Playa Vista that are screened in the Ballona aquifer and have chloride concentration data reported between 2005, when the first chloride concentrations were measured, and 2016. Of these wells, 31 were measured in 2015 and 2016. Chloride concentrations in the groundwater collected from these wells in 2015 and 2016 ranged from 93 to 330 mg/L (Figure 2-37). None of these concentrations exceed 500 mg/L, which is commonly used as an indicator of potential seawater intrusion (USGS 1959, DWR 1961). Furthermore, groundwater concentrations have not increased over time at these wells and there is no gradient of chloride concentrations in the Ballona aquifer from the more coastal wells to the wells farther inland (Figure 2-37). Therefore, seawater intrusion has not occurred in the Ballona aquifer, where chloride concentrations have been measured. Additional monitoring for seawater intrusion may be warranted if groundwater production from the Ballona aquifer increases in the future.

Silverado Aquifer

The most complete set of current chloride and TDS concentration data is from the City of Santa Monica production wells, which are screened in the Silverado aquifer and have been sampled regularly since at least 1985 (Figures 2-38 and 2-39). In August 2018, the highest concentration of chloride measured was 168 mg/L in Charnock Well 13. The TDS concentration in Charnock Well 13 was 1,449 mg/L in August 2018. This concentration is higher than the native concentration of TDS in the Silverado aquifer, but is lower than the TDS concentration measured in this well in 1991, which was 1709 mg/L. Similarly, chloride concentrations at Charnock wells 16 and 19 were lower in 2018 than they were in 1988 and 1992, respectively. The only Charnock well in which the chloride concentration increased between 1988 and 2018, is well 18, in which the concentration of chloride was 62 mg/L in 1988 and 66.8 mg/L in 2018. An increase in the chloride concentration of 5 mg/L over this time period does not indicate mixing with seawater. Because the chloride concentrations in the Charnock production wells have not increased over time, and because the concentrations at all of the wells is below 500 mg/L, degradation of groundwater quality related to seawater intrusion has not occurred in the Silverado aquifer at the Charnock wellfield.

The concentration of chloride in the City of Santa Monica's Olympic Wellfield has increased over time from 76 mg/L measured at Santa Monica Well 3 in 1988 to 120 mg/L in 2018. Similarly, at Santa Monica Well 4, the concentration of chloride increased from 81 mg/L in 1989 to 112 mg/L in 2018. The increasing chloride concentration trends at these wells, are small (<2 mg/L per year) and likely reflect a change in the groundwater quality as groundwater of poorer quality migrates toward the Olympic Wellfield over time. The USGS installed a nested monitoring well at the Olympic Wellfield, with wells completed to depths of 1440 ft bgs, 875 ft bgs, 640 ft bgs, and 370 feet bgs (USGS Wells 340142118280601, 340142118280602, 340142118280603, 340142118280604). The chloride concentration measured in January 2020 in well 340142118280603 was 40.7 mg/L and was and 53.3 mg/L in well 340142118280604. In well 340142118280602, the chloride concentration was 431 mg/L, while the chloride concentration in well 340142118280601 was 11,000 mg/L. The increasing chloride concentration in the deeper wells at this location is consistent with observations in previous studies, and indicates that the water trapped in the pore space of the formations underlying the San Pedro formation has chloride concentrations reflective of the depositional environments in which these sediments were emplaced. The chloride concentration of the shallower USGS wells is lower than that in the groundwater being produced at the Olympic Wellfield production wells and provides further evidence that seawater intrusion has not occurred at the Olympic Wellfield.

The concentrations of chloride at the Arcadia wells and Santa Monica Well 1 follow similar trends to those observed at the Olympic Wellfield and are also attributed to producing poorer quality groundwater over time. Chloride concentrations in these wells are below 150 mg/L and are not indicative of seawater intrusion.

South of the primary groundwater production areas, adjacent to the southern boundary of the Subbasin, chloride concentrations were measured in six wells screened within the Silverado aquifer in 2015 (Figure 2-38). The concentration of chloride measured in these wells, located in Playa Vista, ranged from 170 mg/L (well C-171SI) to 530 mg/L (well C-173SI). Of the six wells measured, none had chloride concentration data reported prior to 2013 and only one had data between 2013 and 2015. The chloride concentration at this well (D2-SI01) was 218 mg/L in 2013 and was 220 mg/ L in 2015. Although the chloride concentration at well C-173SI is higher than 500 mg/L, this concentration may not reflect modern day seawater intrusion. This well is inland of wells C-171SI and C-172SI, both of which had lower chloride concentrations in January 2015, 170 and 220 mg/L, respectively, than well C-173SI. The concentration of chloride at well C-173SI likely reflects vertical migration of water from the shallower sediments with higher chloride concentrations as a result of cleanup activities at the site.

Although widespread intrusion of seawater into the Subbasin due to pumping has not been detected based on the current network of groundwater monitoring wells, the geologic structure of the Santa Monica Bay is such that aquifers along the coast may be exposed to the ocean (DWR 1961; City of Santa Monica 2018a). Thus, the potential for pumping-induced intrusion of seawater into the Subbasin exists. Furthermore, the network of wells available to track seawater intrusion is limited to the areas immediately adjacent to the Charnock and Olympic Wellfields, and the vicinity of Playa Vista. The lack of dedicated monitoring wells for seawater intrusion represents a data gap in the existing monitoring network in the Subbasin.

DWR has established monitoring protocols for seawater intrusion (DWR 2016b). These protocols include collection and analysis of groundwater samples on a semi-annual basis for dissolved chloride, measurement of groundwater levels to characterize changes in head in the vicinity of the leading edge of degraded water quality in each principal aquifer, and the mapping of preferential pathways in the subsurface using geophysical surveys or other methods to evaluate the seawater intrusion front and optimize monitoring well placement. Monitoring protocols for seawater intrusion adopted in this GSP are discussed further in Section 3.5.7.

2.4.4 Groundwater Quality

Groundwater quality data have been collected from wells within the Subbasin since the early 1900s. However, regular sampling and recording of water quality data in the Subbasin did not begin until the 1980s (Geotracker GAMA 2020). Samples from the City of Santa Monica municipal supply wells provide the most complete record of water quality data in the Silverado aquifer. Additional water quality data are available from monitoring wells associated with environmental cleanup sites, of which there are over 40 open sites and 535 total sites in the Subbasin (Geotracker GAMA 2020). These wells are generally associated with spills and/or leaks of hazardous chemicals at ground surface or in the shallow subsurface. Consequently, the majority of these wells are completed in the Bellflower aquitard and the Ballona aquifer. In addition, sampling and analysis at these wells is focused on specific contaminants of concern, with only occasional sampling for parameters that indicate background water quality, such a total dissolved solids, chloride, sulfate, and boron. Given these limitations, data from municipal supply wells in the Subbasin is generally more useful in assessing water quality impacts to beneficial uses of groundwater than data collected from monitoring wells at cleanup sites.

There are 10 active municipal supply wells operated by the City of Santa Monica (Figure 2-6). These wells are monitored monthly for VOCs, quarterly for physical and select chemical parameters, and every 3 years for general mineral and physical and inorganic constituents as part of Title 22 compliance (See Section 3.5.2.2). The City also regularly measures VOC concentrations at 26 observation wells near the Olympic Wellfield and 52 observation wells near the Charnock Wellfield as part of ongoing remediation and assessment due to groundwater contamination at these Wellfields (City of Santa Monica 2019; City of Santa Monica 2020). In addition to these wells, the City owns 5 non-production wells which can be used for water quality sampling but are not currently part of any water quality monitoring program, and data have been reviewed from wells completed in the Ballona and Silverado aquifers in Playa Vista (City of Santa Monica 2018a; Playa Capital Company 2020). The data from the Playa Vista Area are Presented in Appendix G.

The City of Santa Monica complies with the requirements of the SWRCB DDW, which, in addition to requiring that treated water supplies be sampled to demonstrate compliance with drinking water quality standards, requires the City of Santa Monica and other water purveyors in the Plan Area to collect and analyze raw water samples from their drinking water systems (including groundwater wells).

2.4.4.1 Summary of Groundwater Quality Standards

Groundwater quality within the Plan Area is measured against two major standards. The first are California drinking water maximum contaminant levels (MCLs)[39] administered and enforced by the SWRCB DDW under the California SDWA, as codified in 23 CCR. The second set of standards consists of Basin Plan water quality objectives, which establish both narrative and numeric groundwater quality standards aimed at preserving existing and potential beneficial uses (See Section 2.1.2.3).

[39] A maximum contaminant level is the maximum concentration of a contaminant allowed in water delivered to a user of any public water system.

The California SDWA prescribes enforceable primary MCL standards for five major categories of drinking water contaminants: microorganisms, disinfectants and disinfection byproducts, inorganic chemicals, organic chemicals, and radionuclides (i.e., radioactive forms of elements).[40] In addition, secondary MCLs have been established for non-health concerns, based on aesthetic issues, such as taste, odor, or color in the water. The SWRCB and EPA have established secondary MCLs for at least 15 contaminants. For chemical contaminants that do not have established MCLs, the SWRCB establishes notification and response levels, which are health-based advisory concentrations and concentrations above which the SWRCB recommends removal of a drinking water source from service to protect public health, respectively. The SWRCB has established notification levels and response levels for at least 30 constituents.

The Basin Plan presents specific groundwater quality objectives for TDS, sulfate, chloride, boron, nitrate as nitrogen[41], and total coliform bacteria (Table 2-17). For sulfate, chloride, and boron, groundwater quality objectives are more stringent than MCLs. Basin plan objectives are reviewed by the RWQCB at least every three years and updated as needed (RWQCB 2019).

2.4.4.2 Current and Historical Groundwater Quality

Given the long history of urban development in the Subbasin, it is difficult to separate anthropogenic impacts to water quality from natural water quality conditions. Concentrations of inorganic constituents (sodium, calcium, magnesium, chloride, sulfate, and bicarbonate) in groundwater samples from across the Subbasin were consistent with water sourced from natural recharge in the 1960s (Kennedy and Patten 1965). A more recent study of groundwater determined that inorganic water quality at City of Santa Monica production wells is primarily influenced by natural recharge with no evidence of impacts from degraded water sources (e.g., saline intrusion from oilfield brines or seawater; City of Santa Monica 2013).

Table 2-17. Santa Monica Subbasin Basin Plan Water Quality Objectives

Constituent	Basin Plan Objective (mg/L)[a]	MCL (mg/L)
TDS	1,000	1,000[b]
Sulfate	250	500[b]
Chloride	200	500[b]
Boron	0.5	1[c]
Nitrogen (nitrate plus nitrite)	10	10
Total Coliform Bacteria[d]	1.1[d]	0.99[d]

Notes:

a Source: RWQCB 2019
b Secondary Maximum Contaminant Level (SMCL)
c California notification level (NL)
d Total coliform objectives are measured in units of bacteria count per 100 mL

While inorganic water quality appears to be largely influenced by natural recharge, anthropogenic activities have introduced a variety of organic contaminants (such as gasoline byproducts and VOCs) into groundwater in the Subbasin. There are 535 identified contamination sites in various stages of remediation in the Subbasin[42]. These

40 Primary drinking water standards established by the SWRCB under the California SDWA are equivalent or more stringent than those set by the EPA under the federal SDWA
41 By convention, this GSP expresses nitrate in terms of nitrate as nitrogen. "Nitrate," "nitrate-N," "nitrate-nitrogen," and "NO3-N" all refer to nitrate as nitrogen, with an MCL of 10 mg/L.
42 Geotracker Website: https://geotracker.waterboards.ca.gov/

sites are typically current or former industrial locations where leaks from underground storage tanks, surface spills, or surface disposal of contaminants migrated into underlying soil and groundwater. As a result, VOCs have been detected in groundwater quality samples collected from multiple wells in the Subbasin, including in groundwater quality samples from all three of the City of Santa Monica's wellfields. Consequently, groundwater extracted for municipal use must be treated at the Arcadia Advanced Water Treatment Plant to ensure that it meets DDW drinking water standards use before delivery to consumers (City of Santa Monica 2013; City of Santa Monica 2018a).

The Basin Plan defined groundwater quality objectives that provide for the "reasonable protection of beneficial uses of water" for six constituents in the Subbasin: TDS, sulfate, chloride, boron, nitrate, and total coliform bacteria (Table 2-17; RWQCB 2019). In addition to data collected at the City of Santa Monica production wells, concentrations of these constituents were measured in samples collected from City of Santa Monica monitoring wells, and remedial monitoring wells at other sites in the Subbasin. The most recent concentrations of TDS, nitrate, sulfate, and boron for the Ballona and Silverado aquifers are shown in Figures 2-40 through 2-46. The most recent concentrations of chloride in the Ballona and Silverado aquifers are presented in Figures 2-36 and 2-38 (see Section 2.4.3 Seawater Intrusion). No data on total coliform bacteria counts in the Subbasin was available in the GAMA database. Additional analysis of the other five constituents is presented in the following sections.

2.4.4.2.1 Total Dissolved Solids

TDS measurements were measured in samples collected from 54 wells screened in the Ballona aquifer between 2015 and 2019 (Figure 2-40). TDS concentrations in the Silverado aquifer were measured in samples collected from 10 municipal supply wells, 3 non-production wells owned by the City of Santa Monica screened in the San Pedro Formation, and 11 groundwater monitoring wells at groundwater remediation sites screened in the Silverado aquifer (Figures 2-40 and 2-41). TDS concentrations ranged from 575 mg/L to 2,840 mg/L in the Ballona aquifer and 700 mg/L to 2,240 mg/L in the Silverado aquifer. Of these, 23 wells in the Ballona aquifer had TDS concentrations that exceed the Basin Plan objective of 1,000 mg/L and 11 wells in the Silverado aquifer had TDS concentrations that exceed the Basin Plan objective. Concentrations at City of Santa Monica production wells ranged from 832 mg/L to 1,449 mg/L. Five of the ten samples collected at municipal wells were above the secondary MCL and Basin Plan objective of 1,000 mg/L for TDS. However, all groundwater pumped from municipal wells is treated by reverse osmosis to TDS concentrations that are acceptable for potable use.

2.4.4.2.2 Nitrate

Nitrate concentrations were measured in samples collected from 2 wells screened in the Ballona aquifer between 2015 and 2019 (Figure 2-42). Nitrate concentrations in the Silverado aquifer were measured in samples collected from 10 municipal supply wells and 3 non-production wells owned by the City of Santa Monica screened in the San Pedro Formation (Figure 2-43). Nitrate as nitrogen concentrations in the Ballona aquifer ranged from less than the detection limit (0.1 mg/L) to 0.07 mg/L. Nitrate as nitrogen concentrations in the Silverado aquifer ranged from less than the detection limit (0.1 mg/L) to 7.1 mg/L. Groundwater monitoring in the Playa Vista area has indicated that groundwater in both the Ballona and Silverado aquifers at Playa Vista have nitrate-reducing conditions (Playa Capital Company 2020). As a result, nitrate concentrations at nearly all of the wells located at the Playa Vista property were below the detection limit for nitrate as a result of nitrate removal from groundwater through bacterial reduction of nitrate. Nitrate concentrations at City of Santa Monica municipal production wells ranged from 0.5 mg/L to 7.1 mg/L. None of the samples collected from municipal wells had nitrate concentrations above the MCL of 10 mg/L.

2.4.4.2.3 Sulfate

Sulfate concentrations were measured in samples collected from 52 wells screened in the Ballona aquifer between 2015 and 2019 (Figure 2-44). Sulfate concentrations in the Silverado aquifer were measured in samples collected from 10 municipal supply wells, 3 non-production wells owned by the City of Santa Monica screened in the San Pedro Formation, and 9 groundwater monitoring wells at groundwater remediation sites (Figure 2-45). Sulfate concentrations in the Ballona aquifer ranged from 0.31 mg/L to 1,200 mg/L. Sulfate concentrations in the Silverado aquifer ranged from 0.56 mg/L to 740 mg/L. Of these, 22 wells in the Ballona aquifer had sulfate concentrations that exceed the Basin Plan objective of 1,000 mg/L and 10 wells in the Silverado aquifer had sulfate concentrations that exceed the Basin Plan objective. Groundwater monitoring in the Playa Vista area has indicated that groundwater in both the Ballona and Silverado aquifers at Playa Vista have sulfate-reducing conditions (Playa Capital Company 2020). This has resulted in a large variation in sulfate concentrations at the Playa Vista property, with concentrations ranging from < 1 mg/L to > 1,000 mg/L. Sulfate-reducing conditions seem to be most prevalent in the western portion of the Playa Vista property, where sulfate concentrations are generally low, and less prevalent in the eastern portion of the playa vista property (Figure 2-44 and Figure 2-45). Sulfate concentrations at City of Santa Monica municipal production wells ranged from 226 mg/L to 460 mg/L. Six of the 10 municipal supply wells had sulfate concentrations above the Basin Plan objective of 250 mg/L. However, all groundwater pumped from municipal wells is treated by reverse osmosis to sulfate concentrations that are acceptable for potable use.

2.4.4.2.4 Boron

No samples for boron concentrations were collected from wells screened in the Ballona aquifer between 2015 and 2019. Boron concentrations in the Silverado aquifer were measured in samples collected from 2 municipal supply wells and 2 non-production wells owned by the City of Santa Monica screened in the San Pedro Formation (Figure 2-46). Boron concentrations in the Silverado aquifer ranged from 0.20 mg/L to 0.21 mg/L. Boron concentrations at City of Santa Monica municipal supply wells were 0.2 mg/L to 0.21 mg/L. Both concentrations measured at municipal supply wells were below the Basin Plan objective of 0.5 mg/L.

2.4.4.2.5 Chloride

Chloride concentrations in the Ballona and Silverado aquifers are discussed in more detail in Section 2.4.3.2. The chloride concentration measured in samples collected from the City of Santa Monica municipal production wells ranged from 66.8 mg/l to 168 mg/L in 2018. All of the samples collected from municipal supply wells had concentrations below the Basin Plan objective of 200 mg/L.

2.4.4.3 Impacted Soil and Groundwater Sites in the Subbasin

The SWRCB reported 535 sites with contamination in the Subbasin. Of these, 77 are classified as active and the remaining sites are classified as closed by the supervisory agency. The location of the contaminated sites, along with the media affected and the case status, are presented in Figure 2-47

Of the 77 active sites within the Subbasin, 20 sites were classified as impacting soils or soil vapor, and 50 sites were classified as impacting groundwater, including 35 sites listed as affecting the aquifer used for drinking water supply and 5 sites listed as affecting wells used for drinking water supply (note that many sites include impacts to both soils and soil vapor and groundwater). Contaminants of concern present at active sites in the Subbasin include:

- Gasoline, Diesel, Heating Oil/Fuel Oil, Crude Oil, Waste Oil, and Total Petroleum Hydrocarbons (32 sites)
- Chlorinated VOCs, including contaminants of concern marked as *solvents*, *VOCs*, and *chlorinated hydrocarbons* (22 sites)

- BTEX (9 sites)
- MTBE and/or tert-butyl alcohol (3 sites)
- Metals (2 sites).

As noted above, contamination from industrial sites is known to have impacted groundwater at the City of Santa Monica wellfields. As a result, groundwater used for municipal supply in the Subbasin is treated at the Olympic Advanced Water Purification Facility (AWPF). More detailed discussion of contaminated at City Wellfields, including sources of VOCs and treatment methodologies, are presented in the following section.

2.4.4.4 Contaminant Impacts at City of Santa Monica Wellfields

Arcadia Wellfield

The Arcadia wellfield was shut down in October of 1996 due to detection of MTBE in groundwater from the wellfield (City of Santa Monica 2013). The source of MTBE in these wells was determined to be a gas station that was formerly located near the wellfield (City of Santa Monica 2013). The wells were subsequently returned to production later in 1996, and water from the wells was aerated and blended with water from MWD to decrease the concentration of VOCs so that the wells could continue to be used (City of Sant Monica 2013). However, due to continued contamination detected in the wells, the wellfield was shut down again in 1998 and remained out of service until November of 2010. In 2006, the parties responsible for the MTBE contamination in the Arcadia Wellfield (along with contamination in the Charnock Wellfield) reached an agreement with the City to restore the contaminated wellfields so that they were suitable to provide drinking water to the community and groundwater production from the Arcadia wellfield resumed in 2010 (City of Santa Monica 2018a).

Water from all three city wellfields is piped to the Arcadia Water Treatment Plant for treatment. Treatment includes greensand filtration to remove iron and manganese, reverse osmosis to remove calcium and magnesium, and aeration to remove VOCs (City of Santa Monica 2013; City of Santa Monica 2018a).

Charnock Wellfield

Elevated concentrations of MTBE were first detected in the Charnock Wellfield in 1995, and production from the wellfield was shut down in June 1996 as a result of continued contamination (City of Santa Monica 2016). As with the Arcadia Wellfield, it was determined that MTBE contamination in the Charnock Wellfield came from nearby gasoline stations (RWQCB 2002). The City of Santa Monica reached an agreement with the parties responsible for the contamination in 2006 to restore the contaminated wellfield to operational status (City of Santa Monica 2007).The City of Santa Monica upgraded the Arcadia water treatment plant and constructed a new treatment facility at the Charnock wellfield that provides granular activated carbon filtration for three contaminated wells out of the total five wells at the Charnock wellfield, before conveying the water to the Arcadia Water Treatment Plant for additional treatment (City of Santa Monica 2018a).

In January 2020, detectable concentrations of MTBE in the upper Silverado aquifer ranged from 0.52 micrograms per liter (μg/L) to 4.6 μg/L (City of Santa Monica 2020b). The MCL for MTBE is 5 μg/L. In addition to MTBE, the fuel oxygenate tert-butyl alcohol (TBA), fuel constituents, and several VOCs, including PCE, TCE, 1,2-dichloroethane, cis-1,2-dichloroethene, 1,1-dichloroethylene and chloroform were detected in the upper Silverado aquifer (City of Santa Monica 2020b). While the exact source of these additional VOCs has not been determined, they likely originated from local industrial activities and nearby dry cleaners.

Concentrations of contaminants of concern in the vicinity of the Charnock wellfield are monitored by the City of Santa Monica as part of the voluntary Charnock regional groundwater monitoring program (see Section 2.1.2.3.5). The program was designed to augment the monitoring and remediation activities at the original individual sites surrounding the wellfield and is overseen by the SWRCB. Additionally, the City of Santa Monica conducts groundwater quality monitoring at 12 wells that are part of the Early Warning Groundwater Monitoring Program overseen by DDW (see Section 2.1.2.3.5). The program was designed to provide early warning of contaminant migration to the Charnock wellfield, which is currently removing contaminant mass from the Subbasin (City of Santa Monica 2019).

Olympic Wellfield

VOCs, including TCE, PCE, 1,4-dioxane, cis-1,2-dichloroethylene, 1,1-dichloroethane, 1,1-dichloroethylene, chloroform, and 1,2,3-trichloropropane, have been detected in groundwater produced from the Olympic Wellfield (City of Santa Monica 2020a). The source of these VOCs is industrial activities that have historically occurred in the vicinity of the Olympic Wellfield (City of Santa Monica 2018a). Water from the Olympic Wellfield is currently treated with groundwater from the other wellfields at the Arcadia Water Treatment Plant (City of Santa Monica 2018a). However, pumping from the Olympic Wellfield is currently limited due to the levels of VOC present. The City is planning to construct a separate pipeline to convey water from the Olympic Wellfield to a new well head treatment facility, Olympic AWTF, that will be co-located at the Arcadia Water Treatment Plant capable of treating 1,4-dioxane and 1,2,3-trichloropropane.

The Olympic Wellfield is currently removing contaminant mass from the Subbasin (City of Santa Monica 2020a). Groundwater remediation activities at the Olympic Wellfield are currently overseen by the RWQCB.

2.4.4.4.1 Map of Oil and Gas Deposits

According to the California Department of Conservation, Geologic Energy Management Division, six oil fields are located entirely or partially within the Subbasin: Venice Beach (abandoned); Playa Del Rey; Inglewood; Sawtelle; Cheviot Hills; and Beverly Hills (Figure 2-48; CalGEM 2020). There are 428 active oil and gas wells located within the boundaries of the Subbasin (CalGEM 2020). 355 of these active wells are located in the Inglewood field located in the southeast corner of the Subbasin. Within the Subbasin, 40 wells are located in the Playa Del Rey field; 14 are located in the Cheviot Hills field; 13 are located in the Sawtelle field; and 6 are located within Beverly Hills field. Oil and gas production occur in aquifers that are significantly deeper than the aquifers used for water supply in the Subbasin (DOGGR 1992). Groundwater quality in the Silverado aquifer wells does not show evidence of contamination from oil and gas wells (City of Santa Monica 2013).

2.4.4.4.2 Map of Locations of Impaired Surface Water

Several impaired surface waters (i.e., 303(d) listed reaches) overlie the Subbasin. These include Ballona Creek and the Ballona Creek Estuary, Sepulveda Canyon, Santa Monica Canyon, Marina Del Rey Harbor Beach, Marina Del Rey Harbor – Back Basins, Ballona Creek Wetlands, Will Rogers Beach, Santa Monica Beach, Venice Beach, and Dockweiler Beach (Figure 2-49; SWRCB 2016). The impairments listed for each reach are included in Table 2-18, 303(d) Listed Reaches.

Table 2-18. 303(d) Listed Reaches

Reach	Listed Impairments
Ballona Creek	Copper; Cyanide; Indicator Bacteria; Lead; Toxicity; Trash; Viruses (enteric); Zinc
Ballona Creek Estuary	Cadmium; Chlorodane; Copper; Dichlorodiphenyltrichloroethane (DDT); Indicator Bacteria; Lead; Polyaromatic Hydrocarbons (PAHs); Polychlorinated biphenyls (PCBs); Silver; Toxicity; Zinc
Ballona Creek Wetlands	Exotic Vegetation; Habitat Alterations; Reduced Tidal Flushing; Trash
Dockweiler Beach	Indicator Bacteria
Marina Del Rey Harbor Beach	Indicator Bacteria
Marina Del Rey Harbor-Back Basins	Chlorodane; Copper; DDT; Dieldrin; Indicator Bacteria; Lead; Dissolved Oxygen; PCBs; Toxicity; Zinc
Santa Monica Beach	Indicator Bacteria
Santa Monica Canyon	Indicator Bacteria; Lead
Sepulveda Canyon	Copper; Indicator Bacteria; Lead; Selenium; Zinc
Venice Beach	Indicator Bacteria
Will Rogers Beach	Indicator Bacteria

Source: SWRCB 2016 California Integrated Report

2.4.5 Subsidence

The primary causes of land subsidence in California are tectonic forces and aquifer system compaction as a result of fluid withdrawal. Aquifer system compaction occurs when there is a reduction of fluid (e.g., oil or groundwater) pressure in the pores of unconsolidated sediments. Land subsidence resulting from aquifer deformation may be either elastic or inelastic. Elastic deformation is reversible and temporary, and typically occurs in response to seasonal groundwater recharge or extraction. Inelastic subsidence is irreversible and permanent and occurs as pore spaces within fine-grained sediments collapse in response to lowered water levels and reduced fluid pressure. Inelastic deformation can occur when groundwater elevations drop below the historical low elevations and fine-grained sediments become depressurized. Once this process occurs, the pore space cannot be re-inflated by rising water levels (Borchers and Carpenter 2014).

Within the Subbasin, land subsidence is monitored using global positioning system (GPS) monuments and interferometric synthetic aperture radar (InSAR). Both of these techniques measure changes in land surface elevation over time. Neither technique can separate the effects of tectonic motion from motion induced by fluid withdrawal.

There is one continuous GPS station in the Subbasin (UNAVCO Station UCLP; Figure 2-50). This station, which is maintained by UNAVCO, a non-profit geoscience research consortium, is located on the UCLA campus. Land surface elevation has been recorded at the UCLP station since 1996 (Figure 2-51). Between 1996 and 2020, the land surface elevation at the UCLP station rose by 1 to 2 centimeters (0.4 to 0.8 inches), indicating that subsidence has not occurred in this area of the Subbasin since 1996.

In addition to the continuous GPS measurements, InSAR data collected by the European Space Agency Sentinel-1A satellite provide a record of changes in land surface elevation throughout the Subbasin since 2015 (Figure 2-50). The InSAR data show that land surface elevations in the central part of the Subbasin have declined by 0.01 to 0.02 feet (0.3 to 0.5 cm) since 2015 (Figure 2-50). Land surface elevations rose by a roughly equivalent measure on both the northern and southern margins of the Subbasin over the same time period.

Changes in land surface elevation detected in the InSAR data do not distinguish between those resulting from tectonic forces and those resulting from groundwater withdrawal. If observed declines in land surface elevation in the vicinity of the groundwater production wellfields are linked to groundwater withdrawals, groundwater elevations would have to be at or below the historical low water level for a multi-year period, and sufficient fine grained material would have to exist in the subsurface to allow for compaction of the pore space. Between 2015 and 2019 groundwater elevations were above historical low groundwater elevations measured in the Subbasin for the majority of the time (Figures 2-29A through C). In the areas where groundwater elevations reached a new historical low between 2015 and 2019, the aquifer units are sandy, and not prone to rapid collapse of the pore structures. For this reason, DWR ranked the Subbasin as being at low risk for future subsidence related to groundwater withdrawals (DWR 2014). Therefore, the observed decline in land surface elevation in the central part of the Subbasin between 2015 and 2019 is likely associated with tectonic forces rather than groundwater withdrawal.

2.4.6 Interconnected Groundwater and Surface Water

Groundwater and surface water are often connected hydrologically, either by the daylighting of groundwater into surface water in springs and gaining streams, or by percolation of surface water into shallow permeable aquifers. In areas of groundwater-surface water connection, groundwater production has the potential to lower near surface groundwater levels, which can cause reduced groundwater contribution to streams and can impact groundwater dependent ecosystems (GDEs). Stream–aquifer exchanges are controlled by several factors, including stream discharge and stage, the magnitude and distribution of hydraulic conductivities of the streambed and aquifer sediments, streambed thickness and its variation, the hydraulic gradient between the stream and the aquifer, and the geometric/morphological characteristics of the stream channel (USGS 2012).

Surface water in the Plan Area is principally drained by 245 miles of storm-drains constructed of reinforced concrete, brick, cast iron, clay and other impermeable materials. Of these, approximately 135 miles drain the Ballona Creek watershed into Ballona Creek. Open channel surface waters in the Plan Area include portions of Ballona Creek, Centinela Creek, and the Rustic Canyon and Santa Monica Canyon Channels. The Rustic Canyon and Santa Monica Canyon channels drain the Santa Monica Canyon Watershed, discharging onto Will Rogers State Beach. Within the Plan Area 100% of the extent of these channels is concrete-lined and therefore disconnected from interaction with underlying groundwater. Centinela Creek flows in a channel that is concrete-lined upstream of its intersection with Ballona Creek.

The Ballona Creek channel is concrete-lined upstream of Centinela Avenue, approximately 3 miles inland from the coast. Downstream of Centinela Avenue, Ballona Creek has paved or boulder-lined banks with an unpaved bottom until its discharge into Santa Monica Bay (County of Los Angeles 2020). At this transition location, the channel is located within the sediments of the Bellflower aquitard and has an approximate elevation of 6 feet above mean sea level. Infiltration of surface water into the Bellflower aquitard downstream of Centinela Avenue, contributes to the palustrine Ballona Creek Wetlands, located approximately half a mile downstream. These wetlands constitute the primary area of groundwater-surface water interaction in the Subbasin.

Shallow groundwater elevations adjacent to Ballona Creek and upstream of the Ballona wetlands have been stable between 2005 and 2020 (Figure 2-52). Elevations in this area are typically at or above sea level for wells screened in the upper Bellflower aquitard. In contrast, groundwater elevations in the shallow and Silverado aquifers in the vicinity of the Charnock wellfield ranged from -55 to +25 ft MSL over the same time period (Figure 2-52). The difference in measured groundwater elevation and in groundwater elevation response to production at the Charnock wellfield between the shallow wells adjacent to the Ballona Wetlands and the monitoring wells adjacent to the Charnock wellfield demonstrates that the shallow surface water in the Bellflower aquitard adjacent to the unlined portions of the Ballona Creek Channel is disconnected from the primary production aquifer in the Subbasin (Figure 2-52).

While any surface water in the Subbasin that percolates into the shallow subsurface can contribute recharge to the upper shallow alluvium, the principal aquifers used for groundwater extraction in the Subbasin are separated hydrogeologically from the upper alluvium by the Bellflower Aquitard (see Section 2.3.2 Principal Aquifers and Aquitards). Also, given the principally concrete-lined channels of the Santa Monica Canyon and Ballona Creek channels, the extensive paved area in the Subbasin, and the largely urbanized storm drain system that conveys precipitation to Santa Monica Bay, minimal interaction between the groundwater and surface water occurs within the Plan Area.

2.4.7 Groundwater Dependent Ecosystems

SGMA defines GDEs as "ecological communities or species that depend on groundwater emerging from aquifers or on groundwater occurring near the ground surface" (23 CCR § 351[m]). Within the Subbasin, 43 vegetation communities and 15 wetlands were identified as potential GDEs in the Natural Communities Commonly Associated with Groundwater (NCCAG) dataset provided by DWR to assist GSAs with identifying and mapping GDEs. NCCAG includes 48 state and federal mapping datasets that reference the location of springs, seeps, wetlands, and vegetation commonly associated with groundwater. Not all of the listed locations in the NCCAG have site-specific groundwater elevation data. Consequently, locations that are included in the NCCAG are considered a starting point, or potential GDEs that warrant further investigation.

Within the Subbasin, communities of potential GDEs, including both potential wetland habitats and potential groundwater dependent vegetation, were identified in three grouped units: along the Pacific Coast Highway near the northwestern limit of the Plan Area, in Kenneth Hahn State Park, and in the vicinity of the BWER (Figure 2-53). Local groundwater elevations, aerial photographs, lithology, and previous technical evaluations were reviewed, if available, in the vicinity of each NCCAG listed community in these areas to assess local groundwater elevations. If groundwater elevations were found to support the wetlands or vegetation communities, these communities were categorized as GDEs (Figure 2-54). Where groundwater elevations were not found to support NCCAG listed communities, the communities are not considered GDEs for this GSP. If insufficient information was available on local groundwater conditions, the NCCAG listed communities were categorized as potential GDEs. Discussion of the available data and assessment of the listed communities is presented by area in the text below.

2.4.7.1 Pacific Coast Highway Unit

Two areas of Red Willow (*Salix Laevigata*) and Arroyo Willow (*Salix Lasiolepis*), totaling 2.6 acres, were identified in the NCCAG dataset along the Pacific Coast Highway on either side of the outlet of Potrero Canyon near the northwestern boundary of the Subbasin (Figure 2-53). Red Willow and Arroyo Willow are phreatophytes, plants with roots that reach the groundwater table, that have a low tolerance for saline conditions and generally grow where depth to groundwater is less than 15 feet (Robinson 1958). A localized perched groundwater zone was detected at approximately 17 feet bgs in the vicinity of these phreatophyte communities (MARRS Services Inc. 2019). The suspected source of this groundwater was a nearby surface drainage, rather than emerging groundwater (MARRS Services Inc. 2019). However, based on the shallow depth to groundwater in the vicinity of the willow communities and the low tolerance of willows to saline conditions, these communities are considered to be GDEs.

The nearest groundwater production well to the Pacific Coast Highway GDEs is Santa Monica No. 1, located approximately 1.75 miles to the northeast. This well was drilled in 1966 and is perforated between 151 and 250 feet bgs. Groundwater production from this well has averaged approximately 326 AFY since 1983 and groundwater elevations have ranged from approximately 83 ft MSL to 224 ft MSL. The groundwater producing aquifer in the vicinity of Santa Monica No. 1 is not connected to the local perched groundwater at the Pacific Coast Highway GDEs.

2.4.7.2 Kenneth Hahn State Recreation Area Unit

Within the Kenneth Hahn State Recreation Area approximately 0.09 acres of wetland, classified as "Palustrine, Unconsolidated Bottom, Permanently Flood", was identified in the NCCAG database in one of the small ponds located in the Kenneth Hahn State Recreation Area (Figure 2-53). No groundwater dependent vegetation was identified in the database at this location. Ponds at the park are fed by potable water provided by LADWP. Water from the smaller pond flows north into a larger pond before entering the lake, at which point water is cycled back up to the smaller pond by a pump. The ponds and lake are all constructed with hard-bottoms and are therefore disconnected from underlying groundwater. Because LADWP provides water to the lake system, this area is not a wetland fed by emerging or shallow groundwater. Therefore, this area is not considered wetland in this GSP.

2.4.7.3 Ballona Wetlands Ecological Reserve

BWER, which is adjacent to the southern and western boundaries of the Subbasin, comprises approximately 600 acres of open space, bisected by Ballona Creek, under the jurisdiction of the California Department of Fish and Wildlife and the California State Lands Commission (Figure 2-53). BWER is divided into three primary areas. Area A comprises approximately 139 acres of undeveloped land north of Ballona Creek, bounded to the east by Lincoln Boulevard and to the north and west by Fiji Way (USEPA 2012). Area B comprises approximately 338 acres south of Ballona Creek, and is bounded to the east by Lincoln Boulevard, to the south by Cabora Drive and the Del Rey Bluffs, and to the west by sand dunes and homes along Vista Del Mar. The largest area of unfilled wetlands within the BWER are found in Area B (USEPA 2012). Area C comprises approximately 64 acres north of Ballona Creek, bounded to the west by Lincoln Boulevard, to the east by the Marina Expressway, and to the north by apartment buildings along Fiji Way. These areas are mostly undeveloped except for four baseball fields located in Area C between Culver Boulevard and Ballona Creek (Figure 2-53).

Historical groundwater elevations within the BWER ranged from -6 to 26 ft MSL (4 to 18 ft bgs) in Area A, 3 to 7 ft MSL (0.1 to 4.5 ft bgs) in Area B, and -2 to 8 ft MSL (2 to 23 ft bgs) in Area C (USACE 2017 [Appendix E]). These groundwater elevations were measured from borings within the Bellflower aquitard, which is not currently used as a source of groundwater supply for the Subbasin.

Within the BWER, the Bellflower aquitard is an approximately 35 to 50 feet thick sequence of interbedded clay and silt, with local, discontinuous sand layers, that limits hydraulic communication between the shallow surficial groundwater system and the underlying Ballona aquifer (DWR 1961; USACE 2017 [Appendix E]; see also Section 2.3.1 Geology). Boring logs from the geotechnical investigation associated with a CDFW proposed restoration project indicate that the undisturbed clay layers of the Bellflower aquitard are found between 5 and 20 feet bgs in Area A, 0 and 15 feet bgs in Area B, and 8 and 20 feet bgs in Area C (USACE 2017 [Appendix E]). The interbedded clays and silts of the Bellflower aquitard underlie surficial fill deposits and were identified in boring logs as being 35 to 50 feet thick in Areas A and B, and 40 to 50 feet thick in Area C (USACE 2017 [Appendix E]).

The NCCAG identifies 37.3 acres of freshwater emergent wetland and freshwater forested shrub/wetland vegetation communities within the BWER (Table 2-18). Of these, 8.7 acres are in Area A, 25.3 acres are in Area B, and 3.3 acres are in Area C. Although the dominant species vary between the individual areas within BWER, mule fat (*Baccharis salicifolia),* quailbush (*Atriplex lentiformis*), arroyo willow (*Salix lasiolepis*), spreading alkalai weed (*Cressa truxillensis)*, and desert saltgrass *(Distichlis spicata)* compose the top five species identified. This vegetation, as well as other non-groundwater dependent vegetation, provides habitat for 17 special status species confirmed present within the boundaries of the BWER (Table 2-19; USACE 2017 [Appendix D]).

Table 2-19. NCCAG Vegetation Communities in BWER

Vegetation Type	Common Name	Acres
Area A		
Baccharis salicifolia	Mule fat	1.9
Atriplex lentiformis	Quailbush	6.8
Area B		
Anemopsis californica	Yerba Mansa	0.1
N/A	Californian warm temperate marsh/seep	0.1
N/A	Southwestern North American riparian/wash scrub	0.3
Leymus triticoides	Creeping Wildrye	0.3
Arundo donax	Giant Reed	0.6
Schoenoplectus americanus	Three-square Bulrush	0.7
N/A	Arid West freshwater emergent marsh	1.6
Baccharis salicifolia	Mule Fat	3.6
Salix lasiolepis	Arroyo Willow	7.1
Cressa truxillensis–Distichlis spicata	Spreading Alkaliweed – Desert Saltgrass	10.9
Area C		
Atriplex lentiformis	Quailbush	1.2
Baccharis salicifolia	Mule fat	2.1
	Total	37.3

Source: NCCAG Database

Table 2-20. Special Status Species Confirmed Present in BWER

Vegetation Type	Common Name
Camissoniopsis lewisii (=Camissonia lewisii)	Lewis's evening primrose
Chaenactis glabriuscula var. *orcuttiana*	Orcutt's pincushion
Erysimum suffrutescens (=Erysimum insulare subsp. suffrutescens)	Suffrutescent wallflower
Phacelia ramosissima var. *austrolitoralis*	*Phacelia ramosissima* var. *austrolitoralis*
Suaeda taxifolia	Wooly seablite
Euphilotes battoides allyni	El Segundo Blue Butterfly
Danaus plexippus	Monarch Butterfly
Panoquina errans	Wandering (= saltmarsh) Skipper
Anniella stebbinsi (=Anniella pulchra pulchra)	Southern California legless lizard (=Silvery legless lizard)
Diadophis punctatus modestus	San Bernardino Ringneck Snake
Passerculus sandwichensis beldingi	Belding's Savannah Sparrow

Table 2-20. Special Status Species Confirmed Present in BWER

Vegetation Type	Common Name
Melozone crissalis	California Towhee
Accipiter cooperii	Cooper's Hawk
Vireo bellii pusillus	Least Bell's Vireo
Sturnella neglecta	Western Meadowlark
Elanus leucurus	White-tailed Kite
Microtus californicus stephensi	South coast marsh vole

Source: USACE 2017 (Appendix D)

The overall health of the ecosystems in the BWER has been impacted by the channelization of Ballona Creek, construction of nearby roads, and modifications to the land surface during construction of Marina del Rey when the site was used as a receiving area for dredge spoils and fill materials (USEPA 2012). Degradation of the wetland habitat through time has resulted in a loss of vital ecosystem function. The California Department of Fish and Wildlife has proposed a restoration project for the BWER to restore wetland and other ecological functions, while also maintaining flood management (CDFW 2019).

The stated intent of the project is to restore tidal flow to BWER in all practicably feasible areas to reestablish native wetland vegetation and enhance physical and biological functions (USACE 2017). Alterations that would occur under the approved project include removing armored levees on a portion of Ballona Creek, realigning the creek to a natural meander-shaped pattern, and removing historical dredge materials north of Ballona creek to create a floodplain (USACE 2017). These alterations are expected to establish 81 acres of new wetlands and 39 acres of new non-wetland waters of the U.S., as well as enhance 106 acres of native wetland and 58 acres of existing non-wetland waters of the U.S.

There is no direct link between the shallow surface water in the Bellflower aquitard at BWER and the Silverado aquifer in the vicinity of the primary production wellfields. Therefore, groundwater production from existing wells will not impact groundwater elevations or the identified GDEs within the BWER.

2.4.7.4 Ballona Freshwater Marsh

Adjacent to the northeastern boundary of Area B, the California State Lands Commission owns 26 acres of freshwater marsh that was constructed between 2001 and 2003 as a mitigation site for the Playa Vista development (USEPA 2012). The freshwater marsh treats urban runoff and stormwater from the Playa Vista development and also receives treated groundwater that is pumped from the Ballona aquifer and Bellflower aquitard in Playa Vista (USEPA 2012; RWQCB 2018). Because the freshwater marsh is a managed ecosystem that would not exist without the surface water flows in Centinela Creek, no natural communities commonly associated with groundwater were identified in the NCCAG database within the boundaries of the freshwater marsh.

2.5 Water Budget

This section presents the historical, current, and future water budgets prepared for the Subbasin in accordance with 23 CCR §354.18.

The historical groundwater budget for the Subbasin is based on the LACPGM with some modification. The LACPGM uses a model period of 1971 to 2015, while the historical water budget in this GSP uses the 31-year period from

1985 through 2015 Additionally, modifications were made to better represent the hydrogeologic interactions in the model domain specific to the Subbasin (Appendix F). The modified LACPGM model was developed specifically to support the historical, current, and future groundwater budget analysis discussed in Section 2.4.5.3, Quantification of Future Water Budget (see Appendix F).

Water Sources

The Subbasin receives water from several sources. The predominant sources consist of rainfall that infiltrates within the Subbasin boundaries, rainfall that infiltrates to the north of the Subbasin in the Santa Monica Mountain watershed and enters the Subbasin at its margin (mountain-front recharge), and subsurface inflows from the adjacent Hollywood and Central Subbasins.

Other water sources for the Subbasin consist of the deep percolation of a portion of the water that is applied to residential and commercial lands, to public open spaces and golf courses, and from the leakage of water distribution systems. These other water sources may include both extracted groundwater and imported water. SWP and Colorado River water is imported by MWD (see Section 2.1.1.2 Water Agencies Relevant to the Plan Area). LADWP provides Los Angeles Aqueduct water and extracted groundwater from outside the Subbasin as well as imported SWP and Colorado River water received from the MWD. The City of Beverly Hills uses some groundwater extracted from four wells in the Hollywood Groundwater Basin as well as imported water from MWD (City of Beverly Hills 2015). The CAWC uses groundwater from the West Central Basin, and supplemental water purchased from the West Basin Municipal Water District who is an authorized wholesaler of potable treated water received from the MWD (CAWC 2019).

The City of Santa Monica currently captures and treats some dry weather urban runoff at the Santa Monica Urban Runoff Recycling Facility to produce recycled water that is used for irrigation and toilet flushing to offset potable water demand (City of Santa Monica 2018a). From 2012 to 2015 the Santa Monica Urban Runoff Recycling Facility recycled water use averaged 101 AFY (City of Santa Monica 2018a, Table 2-1).

Water Purveyors

Water purveyors that supply water to the Subbasin include the City of Santa Monica, GSWC, LADWP, the City of Beverly Hills, Los Angeles County Waterworks District 29, and CAWC (Figure 2-3; see Section 2.1.1.2 Water Agencies Relevant to the Plan Area).

Estimate of Total Water Supply

An estimate of the total water supply to the Subbasin was made using the population within the Subbasin and applying an estimate for the per capita water demand (Table 2-21) shows the estimated population of the Subbasin using maps similar to Figure 2-5 Population and Disadvantaged Communities for US Census years 1990, 2000, and 2010. For US Census year 1980, the City of Santa Monica's population data, the City's area within the groundwater basin relative to the basin area, and the ratio for other Census years was used to estimate the population because a similar census map was not available. Growth was assumed to be linear between census years.

Table 2-21. Imported Water Estimate

Year	Estimated Population	Estimated Per Capita Water Use (Gallons per capita per day)	Estimated Water Use (AF)	Groundwater Extraction for Per Capita Use (AF)	Estimated Imported (AF)	Estimated 5% Leakage (AF)	Estimated Groundwater Used for Golf Courses[d](AF)	Total Water Used in the Santa Monica Subbasin (AF)	Percent Imported of Total (%)
1985	**436,252**[a]	173	83,019	9,049	73,970	4,151	1,020	84,039	88.0%
1986	440,722	173	83,869	9,215	74,655	4,193	1,020	84,889	87.9%
1987	445,192	173	84,720	8,840	75,880	4,236	1,020	85,740	88.5%
1988	449,662	173	85,571	8,985	76,585	4,279	1,020	86,591	88.4%
1989	454,131	**173**[b]	86,421	7,760	78,661	4,321	1,020	87,441	90.0%
1990	**458,601**[a]	172	86,566	5,002	81,564	4,328	1,020	87,586	93.1%
1991	459,788	170	86,082	5,636	80,445	4,304	1,020	87,102	92.4%
1992	460,976	169	85,594	7,982	77,612	4,280	1,020	86,614	89.6%
1993	462,163	167	85,103	9,439	75,664	4,255	1,020	86,123	87.9%
1994	463,350	166	84,608	9,447	75,161	4,230	1,020	85,628	87.8%
1995	464,538	165	84,109	10,035	74,074	4,205	1,020	85,129	87.0%
1996	465,725	163	83,607	5,696	77,911	4,180	1,020	84,627	92.1%
1997	466,912	162	83,101	2,854	80,247	4,155	1,020	84,121	95.4%
1998	468,099	160	82,591	2,676	79,916	4,130	1,020	83,611	95.6%
1999	469,287	**159**[b]	82,078	2,980	79,098	4,104	1,020	83,098	95.2%
2000	**470,474**[a]	157	81,121	3,302	77,819	4,056	1,020	82,141	94.7%
2001	472,269	155	80,262	3,210	77,052	4,013	1,020	81,282	94.8%
2002	474,063	152	79,394	2,307	77,087	3,970	1,020	80,414	95.9%
2003	475,858	150	78,517	1,449	77,068	3,926	1,020	79,537	96.9%
2004	477,653	148	77,631	1,144	76,487	3,882	1,020	78,651	97.2%
2005	479,448	146	76,736	2,162	74,573	3,837	1,020	77,756	95.9%
2006	481,242	143	75,832	2,040	73,792	3,792	1,020	76,852	96.0%
2007	483,037	**141**[c]	74,919	2,283	72,636	3,746	1,020	75,939	95.7%
2008	484,832	**134**[c]	71,464	2,354	69,110	3,573	1,020	72,484	95.3%
2009	486,626	**127**[c]	67,982	2,362	65,620	3,399	1,020	69,002	95.1%
2010	**488,421**[a]	**121**[c]	65,009	3,589	61,419	3,250	1,020	66,029	93.0%
2011	490,216	**123**[c]	66,326	8,286	58,040	3,316	1,020	67,346	86.2%

Table 2-21. Imported Water Estimate

Year	Estimated Population	Estimated Per Capita Water Use (Gallons per capita per day)	Estimated Water Use (AF)	Groundwater Extraction for Per Capita Use (AF)	Estimated Imported (AF)	Estimated 5% Leakage (AF)	Estimated Groundwater Used for Golf Courses[d](AF)	Total Water Used in the Santa Monica Subbasin (AF)	Percent Imported of Total (%)
2012	492,010	**126**[c]	68,193	8,804	59,388	3,410	1,020	69,213	85.8%
2013	493,805	**127**[c]	68,985	10,146	58,838	3,449	1,020	70,005	84.0%
2014	495,600	**126**[c]	68,690	11,004	57,686	3,435	1,020	69,710	82.8%
2015	497,395	**109**[c]	59,638	10,914	48,723	2,982	1,020	60,658	80.3%
Average	472,403	151	78,314	5,837	72,477	3,916	1,020	79,334	91.2%
Min	440,722	109	59,638	1,144	48,723	2,982	1,020	60,658	80.3%
Max	497,395	173	86,566	11,004	81,564	4,328	1,020	87,586	97.2%

Notes:

a Bold values are the 1990, 2000, and 2010 US Census; 1985 was based on City of Santa Monica's population data, the City's area within the groundwater basin relative to the basin area and the ratio for other Census year. Growth was assumed to be linear between the years with census or population data and those without.

b LADWP 2016 (Exhibit 2B) data for 1989, and 1999 (bold values) was used to estimate years 1985 to 2006 (not bold). Decline was assumed to be linear between 1989 and 2006.

c City 2018 (Figure 2-4) was used for years 2007 through 2015 (bold values).

d City of Santa Monica 2018 (Page 34).

Per capita water demand estimates between 1985 and 2006 in Table 2-21 are based on the LADWP reported per capita water demand in 1989 and 1999 (LADWP 2016). From 2007 to 2015 per capita water demand was reported by the City of Santa Monica (City of Santa Monica 2018; Figure 2-4). The reported Santa Monica data were compared to the reported LADWP per capita water demand in 2010 and 2015 (LADWP 2016; City of Santa Monica 2018). The two demands are similar. In 2010, the Santa Monica per capita water demand was 121 gpd and the LADWP per capita water demand was 123 gpd.

Estimate of Total Imported Water Supply

The total imported water used is estimated as the per capita water demand minus the groundwater extracted for per capita use (Table 2-21). The extracted groundwater volumes are based on reported extractions from the City of Santa Monica and additional extractions incorporated into the LACPGM (Table 2-22). The LACPGM does not include the estimated groundwater extracted for golf courses (Table 2-21). Total groundwater extractions for the golf courses were estimated from the total irrigated acreage for each of three golf courses in the Subbasin, and an assumed water consumption of 2.5 AFY per acre of grass (City of Santa Monica 2018). The estimated combined acreage of the three golf courses is approximately 408, and the total estimated water demand for the golf courses is 1,020 AFY.

The total water used in the Subbasin from 1985 to 2015 averaged 79,334 AFY and ranged from 60,658 AFY to 87,586 AFY (Table 2-21). Imported water accounted for most of the water used ranging from 80.3% to 97.2% of the total and averaging 91.2% from 1985 to 2015.

2.5.1 Inflow to the Santa Monica Subbasin Groundwater System

Recharge, or inflows, to the Subbasin groundwater aquifers mostly comes from direct infiltration of areal precipitation, mountain-front recharge from the adjacent Santa Monica Mountains, urban return flows, and from adjacent subsurface inflows from the Hollywood and Central Subbasins. Depending on the years, some inflow to the Santa Monica Subbasin may come from the ocean or from groundwater in storage. Additionally, the Subbasin receives recharge from distribution system leakage of water-supply pipelines, sewer lines, and storm drains. This recharge is not specifically included in the LACPGM, however for the purposes of this GSP, it is assumed to be about 5 percent of the total amount of supplied water (Sharp 2010). The estimated distribution system leakage in the Subbasin averaged 3,916 AFY from 1985 to 2015and ranged from 2,982 AFY to 4,328 AFY (Table 2-21). The deep percolation of water applied to residential and commercial lands (generally called Municipal and Industrial water or M&I) was estimated by the USGS and is included in the estimate of total aerial recharge. Each of these recharge components are discussed in the following sections and presented in Table 2-22.

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Table 2-22. Summary of Inflows, Outflows, and Change in Storage in the Santa Monica Subbasin

Year	Water Year Type	INFLOWS (Acre-Feet)				OUTFLOWS (Acre-Feet; Negative Values are inflows into Santa Monica Basin)								Change in Storage (Acre-Feet)[1]
		Mountain-Front Recharge[2]	*Areal Recharge*[3]	*Return Flow from Urban Irrigation*	*Total Recharge*	*To Ephemeral Streams in the Santa Monica Mountains*	*To Ballona Creek*	*To the Hollywood Basin*	*To the Central Basin*	*To the West Coast Basin*	*Net Flow to the Ocean*	*Groundwater Extractions*	*Total Outflow*	
1985	Dry	2,800	400	900	4,100	1,900	100	-200	-400	1,400	-1,000	9,000	11,000	-6,900
1986	Wet	6,600	1,500	3,200	11,300	2,700	100	-100	-400	1,400	-1,000	9,200	11,900	-500
1987	Below Normal	1,300	200	600	2,100	900	0	-300	-400	1,300	-1,300	8,800	9,100	-7,000
1988	Dry	2,500	400	900	3,700	900	0	-200	-400	1,000	-1,600	9,000	8,700	-4,900
1989	Dry	2,300	400	800	3,500	600	0	-200	-400	1,100	-1,600	7,800	7,300	-3,800
1990	Critical	400	100	300	700	100	0	-300	-400	1,500	-1,200	5,000	4,700	-4,000
1991	Critical	3,500	400	700	4,600	300	0	-200	-300	1,500	-1,100	5,600	5,800	-1,200
1992	Wet	9,400	1,900	3,400	14,700	2,100	0	0	-400	1,600	-1,300	8,000	10,000	4,800
1993	Wet	14,200	6,100	6,200	26,500	4,800	100	100	-500	1,000	-1,200	9,400	13,700	12,800
1994	Above Normal	1,900	400	1,300	3,700	1,900	0	-200	-500	500	-1,400	9,400	9,700	-6,000
1995	Wet	11,100	4,100	6,500	21,700	4,400	100	0	-500	400	-1,100	10,000	13,200	8,500
1996	Above Normal	3,900	900	2,300	7,100	2,500	100	-200	-500	1,200	-800	5,700	8,000	-1,000
1997	Below Normal	6,800	1,900	3,800	12,400	3,100	200	-100	-500	1,800	0	2,900	7,300	5,200
1998	Wet	13,800	6,700	8,400	28,900	6,000	1,400	100	-700	2,000	700	2,700	12,100	16,700
1999	Above Normal	1,400	400	1,500	3,400	2,900	900	-200	-600	2,500	600	3,000	9,100	-5,700
2000	Dry	3,600	700	1,700	6,000	2,200	800	-200	-500	2,500	600	3,300	8,700	-2,600
2001	Below Normal	6,700	1,600	3,400	11,600	3,000	900	-100	-500	2,500	700	3,200	9,700	2,000
2002	Dry	700	100	600	1,400	1,200	700	-200	-500	2,900	700	2,300	7,100	-5,600
2003	Below Normal	2,000	400	1,200	3,600	900	700	-200	-500	2,900	800	1,400	6,100	-2,500
2004	Below Normal	2,600	400	1,000	4,100	600	700	-200	-400	2,900	900	1,100	5,600	-1,500
2005	Wet	13,400	5,900	6,900	26,200	4,600	1,800	100	-500	3,000	1,200	2,200	12,400	13,900
2006	Wet	3,300	600	1,600	5,500	2,200	1,000	-100	-400	2,700	900	2,000	8,400	-2,800
2007	Critical	400	100	400	900	800	700	-200	-300	2,600	700	2,300	6,600	-5,700
2008	Critical	4,600	600	900	6,200	1,300	700	-100	-300	2,700	700	2,400	7,400	-1,300
2009	Dry	1,900	300	800	2,900	600	600	-200	-300	3,000	700	2,400	6,800	-3,900
2010	Above Normal	5,000	800	2,000	7,900	1,200	600	0	-300	2,900	500	3,600	8,500	-600
2011	Wet	4,600	1,200	2,900	8,800	1,400	500	100	-400	1,800	-100	8,300	11,600	-2,800
2012	Below Normal	500	100	600	1,200	300	200	-100	-300	1,700	-500	8,800	10,000	-8,900
2013	Critical	500	100	500	1,200	100	100	-100	-300	1,500	-900	10,100	10,500	-9,300
2014	Critical	800	100	200	1,100	0	0	-100	-300	1,700	-1,400	11,000	10,900	-9,800
2015	Critical	2,100	500	1,100	3,800	100	0	-100	-300	1,200	-1,700	10,900	10,100	-6,300
	Average	***4,300***	***1,300***	***2,200***	***7,800***	***1,800***	***400***	***-100***	***-400***	***1,900***	***-300***	***5,800***	***9,100***	***-1,300***
	Min	***400***	***100***	***200***	***700***	***0***	***0***	***-300***	***-700***	***400***	***-1,700***	***1,100***	***4,700***	***-9,800***
	Max	***14,200***	***6,700***	***8,400***	***28,900***	***6,000***	***1,800***	***100***	***-300***	***3,000***	***1,200***	***11,000***	***13,700***	***16,700***

Notes:

1 Negative values are a loss of basin storage.

2 Mountain-front recharge is calculated as applied recharge at model boundary cells.

3 Areal recharge is calculated as Total Recharge (Mountain-Front Recharge + Return Flow from Urban Irrigation).

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2.5.1.1 Recharge from Rainfall Infiltration

The LACPGM did not specifically estimate areal rainfall recharge to the Subbasin. Instead, areal rainfall recharge to the Subbasin was calculated by subtracting mountain-front recharge and return flows from urban irrigation from the LACPGM calculated total recharge in the Subbasin (Table 2-22). Calculation of mountain-front recharge and return flows from urban irrigation is discussed in the Sections 2.5.1.2 and 2.5.1.3.

2.5.1.2 Mountain-front Recharge

Mountain-front recharge, which is not explicitly modeled in the LACPGM, was estimated by comparing the total recharge amounts in grid cells along the margin of the model at the base of the Santa Monica Mountains, with recharge values in the adjacent grid cells within the Subbasin. Mountain-front recharge ranged from 388 AF in 1990 to 14,196 AF in 1993, with an annual average of 7,773 AFY from 1985 to 2015 (Table 2-22). Mountain-front recharge was estimated to compose between 39% and 76% of the total recharge to the Subbasin, and average approximately 57 percent of the total recharge to the Subbasin (Table 2-22).

2.5.1.3 Return Flow from Urban Irrigation

Urban irrigation in the LACPGM model was based on data from a USGS (2016) report on urban irrigation in the Los Angeles Basin. The USGS simulated results with and without urban irrigation for the eight Los Angeles Basin watershed model subdomains containing the area of the Los Angeles groundwater study area (USGS 2016). Estimates for Subbasin urban return flows from urban irrigation from 1985 to 2014 are similarly based on the USGS (2016) report (see Appendix F). The average ratio of urban return flows to the total recharge from 1985 to 2014 was approximately 30%. This ratio was applied to 2015, to estimate the urban return flows for this model year. Recharge from urban return flows ranged from 186 AF in 2014 to 8,371 AF in 1998, with an annual average of 2,153 AFY from 1985 to 2015 (Table 2-22). These volumes compose between 15% and 50% of the total recharge to the Subbasin.

2.5.1.4 Underflow from Adjacent Basins

Groundwater underflows occur between the Subbasin and the adjacent Hollywood, Central, and West Coast Subbasins (Table 2-22). For the Hollywood and Central Subbasins these underflows are typically directed towards the Santa Monica Subbasin and result in inflows to the Santa Monica Subbasin. Negative values in Table 2-22 indicate that subsurface groundwater flow is directed into the Santa Monica Subbasin. The average subsurface inflows from the Hollywood and Central Basins from 1985 to 2015 were 115 AFY and 420 AFY, respectively (Table 2-22).

Underflows between the Santa Monica Subbasin and the West Coast Basin have historically been outflows from the Santa Monica Subbasin. The average subsurface outflow from the Subbasin to the West Coast Basin from 1985 to 2015 was 1,897 AFY (Table 2-22).

2.5.1.5 Inflow and Outflow to the Ocean

Inflow and outflow of groundwater to the Pacific Ocean were estimated at the general head boundaries on the western edge of the LACPGM model. The location of the western boundary of the model layers varies because of the complex depositional and structural history of the Subbasin. General head boundaries are located at the coast for model layers 2 and 3. These layers are referred to as the Mesa and Pacific A chronostratigraphic layers within the model domain and are associated with the Lakewood Formation in the Subbasin (USGS 2021). Model layers 5, 7, and 8, which are referred to as the Harbor, Upper Wilmington A, and Upper Wilmington B chronostratigraphic units in the model domain, and are associated with the Lakewood and San Pedro Formations in the Subbasin, have general head boundaries that are farther to the west and not directly at the coast (USGS 2021). Model layers 1, 4, and 6 are not present at the coast.

Flows estimated at the general head boundaries are dependent on the water level heads at the boundary. Flow is directed into the Subbasin when the water level at the general head boundary is below sea level and is directed out of the Subbasin if the water level at the general head boundary is above sea level. Flows into the Subbasin in the Mesa and Pacific A chronostratigraphic layers are shown in the "Inflow through General Head Boundary" column of Table 2-23 and flows out of the Subbasin in these layers are shown in the "Outflow through the General Head Boundary" column. Additionally, outflows and inflows at the general head boundaries in the Harbor, Upper Wilmington A, and Upper Wilmington B chronostratigraphic layers are indicated in the column called "To the Ocean and outside the model boundary". Note that in some years (1997, 2011 and 2012) both inflow and outflow occur at the general head boundary, and in 1996 and 1997 there was inflow through the Mesa and Pacific A general head boundaries, but outflow through the Harbor, Upper Wilmington A, and Upper Wilmington B boundaries. Flows in the shallow Mesa and Pacific A chronostratigraphic layers are hydraulically connected with the lower layers.

Table 2-23. Inflows and Outflows to the Ocean

Water Year	Water Year Type	Inflows and Outflows to the Ocean (AF)			
		Inflow Through the General Head Boundary[1]	*Outflow Through the General Head Boundary[2]*	*Outflow to the Ocean and Outside the Model Boundary[2]*	*Net Flow[1]*
1985	Dry	820	0	-140	950
1986	Wet	870	0	-140	1010
1987	Below Normal	1070	0	-220	1290
1988	Dry	1270	0	-300	1560
1989	Dry	1320	0	-240	1560
1990	Critical	1190	0	-40	1230
1991	Critical	1090	0	-60	1150
1992	Wet	1150	0	-190	1350
1993	Wet	930	0	-300	1230
1994	Above Normal	1040	0	-380	1420
1995	Wet	830	0	-310	1140
1996	Above Normal	790	0	30	760
1997	Below Normal	210	10	160	50
1998	Wet	0	520	220	-730
1999	Above Normal	0	480	150	-630
2000	Dry	0	440	160	-610
2001	Below Normal	0	540	180	-720
2002	Dry	0	470	220	-690
2003	Below Normal	0	460	340	-800
2004	Below Normal	0	510	360	-860
2005	Wet	0	790	370	-1150
2006	Wet	0	600	280	-880
2007	Critical	0	520	200	-710

Table 2-23. Inflows and Outflows to the Ocean

Water Year	Water Year Type	Inflows and Outflows to the Ocean (AF)			
		Inflow Through the General Head Boundary[1]	*Outflow Through the General Head Boundary*[2]	*Outflow to the Ocean and Outside the Model Boundary*[2]	*Net Flow*[1]
2008	Critical	0	500	220	-720
2009	Dry	0	410	250	-660
2010	Above Normal	0	360	180	-550
2011	Wet	50	130	-150	60
2012	Below Normal	420	0	-130	550
2013	Critical	770	0	-140	910
2014	Critical	1150	0	-270	1420
2015	Critical	1450	0	-270	1720
	Average	**530**	**210**	**0**	**310**
	Min	**0**	**0**	**-380**	**-1150**
	Max	**1450**	**790**	**370**	**1720**

Notes:
1 Positive values are inflows to the Subbasin. Negative flows are outflows.
2 Positive values are outflows to the Subbasin. Negative values are inflows.

Flow into the Subbasin within the Mesa and Pacific A chronostratigraphic layers is likely to be seawater, with the layer boundaries occurring directly at the coastline. However, flow into the Subbasin in the deeper Harbor, Upper Wilmington A, and Upper Wilmington B chronostratigraphic units may not be seawater at this time. Historical groundwater conditions, prior to development of the onshore groundwater resources, would have had freshwater flowing offshore driven by the higher heads inland than at the coast. This flow may have pushed the seawater/ freshwater interface offshore, and groundwater flowing back into the Subbasin across this boundary today may be freshwater stored in the formation rather than seawater. However, as any freshwater stored offshore moves onshore, it will be replaced at the western boundary by seawater, which could eventually migrate into the Subbasin.

2.5.1.6 Inflow and Outflow to Storage

Depending on inflow and outflow conditions groundwater can enter or leave storage in different locations in the Subbasin and at different times during the year. The LACPGM model tracks inflows and outflows to storage. The net annual change in storage is reported in Table 2-22.

2.5.2 Outflows from Groundwater System

Groundwater outflows from the Subbasin can consist of outflows to other subbasins as discussed in Section 2.5.1.4, outflows to the ocean as discussed in Section 2.5.1.5, and outflows to groundwater in storage as discussed in Section 2.5.1.6. Additionally, outflows from the Subbasin occur to extraction wells, to streams, and to Ballona Creek. These outflows are discussed in the following sections.

2.5.2.1 Groundwater Extraction

Groundwater extractions are the largest outflows from the Subbasin averaging 5,837 AFY from 1985 to 2015 (Table 2-22). Groundwater extractions are modeled at 16 current and historical production wells (Table 2-24). Currently, the City of Santa Monica produces the majority of the groundwater in the Subbasin and is the sole producer of drinking water in the Subbasin. There are no domestic users of groundwater in the Subbasin. Historically, GSWC also produced groundwater for potable use (about 1,305 AF total, or 163 AFY on average, from 1985 to 1993). This historical groundwater production was not included in the LACPGM. In addition to the City of Santa Monica wells, the LACPGM model includes 3 irrigation wells at the Holy Cross Cemetery & Mortuary in Culver City (Table 2-24). As noted in Section 2.5, groundwater extraction in Table 2-24 does not include the estimated 1,020 AFY from the Brentwood Country Club, Riviera Country Club, and Los Angeles Country Club golf courses.

Table 2-24. Groundwater Production

Well Extractions (AF)																		
		City of Santa Monica													*Holy Cross Cemetery & Mortuary*			
		Santa Monica Wells				*Charnock Wells*							*Arcadia Wells*		*Culver City Area*			
Year	*Water Year Type*	*#1*	*#2*	*#3*	*#4*	*#12*	*#13*	*#15*	*#16*	*#18*	*#19*	*#20*	*#4*	*#5*	*202940*	*200215*	*200214*	*Total*
1985	Dry	330	670	1,136	747	986	1,835	213	1,642	965	0	0	376	0	0	149	0	9,049
1986	Wet	348	242	1,250	292	678	790	902	1,770	2,456	0	0	377	0	0	110	0	9,215
1987	Below Normal	415	274	111	34	1,095	1,003	1,836	1,236	2,340	0	0	371	0	0	126	0	8,840
1988	Dry	387	0	0	1	934	927	1,462	1,941	2,843	0	0	372	0	0	119	0	8,985
1989	Dry	392	0	65	0	0	520	1,624	2,132	2,503	0	0	357	0	0	166	0	7,760
1990	Critical	384	0	84	0	0	79	1,130	1,173	1,748	0	0	205	183	0	15	0	5,002
1991	Critical	370	3	13	1	0	1,114	612	1,061	1,940	0	0	0	389	0	134	0	5,636
1992	Wet	358	0	571	39	0	1,543	1,399	743	2,560	237	0	43	352	0	135	0	7,982
1993	Wet	344	0	1,689	832	0	1,787	557	1,677	1,653	476	0	59	331	0	33	0	9,439
1994	Above Normal	399	0	1,456	1,271	0	1,155	1,421	977	1,694	657	0	0	418	0	0	0	9,447
1995	Wet	354	0	1,490	1,330	0	1,457	1,174	1,222	978	1,488	0	237	305	0	0	0	10,035
1996	Above Normal	387	0	1,353	1,303	0	391	595	344	489	463	0	63	307	0	0	0	5,696
1997	Below Normal	351	0	1,207	1,261	0	0	0	0	0	0	0	0	0	0	35	0	2,854
1998	Wet	371	0	945	1,326	0	0	0	0	0	0	0	0	0	0	34	0	2,676
1999	Above Normal	365	0	1,288	1,284	0	0	0	0	0	0	0	0	0	0	44	0	2,980
2000	Dry	352	0	1,226	1,331	0	0	0	0	0	0	0	0	275	0	119	0	3,302
2001	Below Normal	335	0	1,142	1,331	0	0	0	0	0	0	0	0	354	0	48	0	3,210
2002	Dry	156	0	781	887	0	0	0	0	0	0	0	0	438	0	45	0	2,307
2003	Below Normal	241	0	173	178	0	0	0	0	0	0	0	66	389	320	15	67	1,449
2004	Below Normal	310	0	75	0	0	0	0	0	0	0	0	263	137	327	17	16	1,144
2005	Wet	203	0	1,292	0	0	0	0	0	0	0	0	0	395	252	18	2	2,162
2006	Wet	188	0	1,198	0	0	0	0	0	0	0	0	0	366	272	15	0	2,040
2007	Critical	214	0	1,363	0	0	0	0	0	0	0	0	0	417	222	65	2	2,283
2008	Critical	350	0	511	815	0	0	0	0	0	0	0	0	347	301	27	3	2,354
2009	Dry	336	0	1,213	174	0	0	0	0	0	0	0	0	340	235	61	3	2,362
2010	Above Normal	293	0	1,012	1,140	0	194	153	161	11	74	0	109	200	174	67	2	3,589
2011	Wet	197	0	1,045	1,273	0	1,938	1,546	336	339	1,010	0	58	192	325	24	5	8,286
2012	Below Normal	120	0	1,359	1,277	0	1,759	1,061	898	877	602	148	106	224	351	2	19	8,804
2013	Critical	167	0	469	1,141	0	2,229	0	1,491	1,486	735	1,885	145	122	151	102	24	10,146
2014	Critical	306	0	290	1,301	0	2,359	0	1,678	1,594	875	1,873	0	408	298	12	12	11,004
2015	Critical	299	0	559	1,402	0	2,333	0	1,571	1,666	740	1,804	66	255	45	149	24	10,914
	Average	**310**	**38**	**850**	**709**	**119**	**755**	**506**	**711**	**908**	**237**	**184**	**106**	**230**	**105**	**61**	**6**	**5,837**
	Min	**120**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**1,144**
	Max	**415**	**670**	**1,689**	**1,402**	**1,095**	**2,359**	**1,836**	**2,132**	**2,843**	**1,488**	**1,885**	**377**	**438**	**351**	**166**	**67**	**11,004**

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2.5.2.2 Streams and Ballona Creek

Groundwater outflows occur to ephemeral streams that enter the Subbasin from the Santa Monica Mountains and to Ballona Creek (Figure 2-3). During dry years the modeled outflows are typically less than a few hundred AFY (Table 2-25). However, in wet years such as 1998 and 2005, these flows can exceed 4,000AF (Table 2-25). The combined outflows to ephemeral streams and to Ballona Creek totaled 7,300 AFY and 6,400 AFY in 1998 and 2005, respectively.

Table 2-25. Outflows to Streams

Year	Water Year Type	Stream and Creek Outflows (AF)		
		To Ephemeral Streams	*To Ballona Creek*	*Total*
1985	Dry	1,900	100	2,000
1986	Wet	2,700	100	2,800
1987	Below Normal	900	0	1,000
1988	Dry	900	0	900
1989	Dry	600	0	600
1990	Critical	100	0	100
1991	Critical	300	0	300
1992	Wet	2,100	0	2,100
1993	Wet	4,800	100	4,900
1994	Above Normal	1,900	0	1,900
1995	Wet	4,400	100	4,500
1996	Above Normal	2,500	100	2,600
1997	Below Normal	3,100	200	3,300
1998	Wet	6,000	1,400	7,300
1999	Above Normal	2,900	900	3,900
2000	Dry	2,200	800	3,000
2001	Below Normal	3,000	900	3,900
2002	Dry	1,200	700	1,900
2003	Below Normal	900	700	1,600
2004	Below Normal	600	700	1,300
2005	Wet	4,600	1,800	6,400
2006	Wet	2,200	1,000	3,200
2007	Critical	800	700	1,600
2008	Critical	1,300	700	2,000
2009	Dry	600	600	1,200
2010	Above Normal	1,200	600	1,800
2011	Wet	1,400	500	1,900
2012	Below Normal	300	200	500
2013	Critical	100	100	200
2014	Critical	0	0	0
2015	Critical	100	0	100
Average		**1,800**	**400**	**2,200**
Min		**0**	**0**	**0**
Max		**6,000**	**1,800**	**7,300**

2.5.2.3 Native Vegetation and Managed Wetlands

As part of the water budget development, each Plan is required to characterize total groundwater outflows for all water use sectors present in the Basin (23 CCR §354.18 (b)(3)). Water use sectors include municipal and irrigation users, as well as managed wetlands and native vegetation. Groundwater production outflows are described in Section 2.5.2.1.

Evapotranspiration of shallow groundwater by native vegetation may contribute to the total groundwater outflows in the Subbasin. These losses are not explicitly modeled by the LACPGM but were accounted for in the calculation of net groundwater recharge during the model development and calibration phase. The net groundwater recharge estimate was based on the watershed rainfall-runoff INFIL model, which accounts for evapotranspiration. The groundwater budget reported in the GSP represents water budget terms for the deep groundwater system. The omission of evapotranspiration losses in the LACPGM water budget is a reasonable assumption as much of the groundwater evapotranspiration in the basin is from vegetation and wetland communities (adjacent to the Pacific Ocean) that are reliant on surface water and/or shallow groundwater. These shallow groundwater evapotranspiration losses were not considered significant for the deeper groundwater system and were also in areas distant from groundwater production (Section 2.4.7) with minimal groundwater management implications.

The Ballona Wetlands and Pacific Coast Unit GDEs identified in the Subbasin total approximately 39.9 acres. Because these habitats compose approximately 0.01% of the total Subbasin area, their effects on the overall water budget are considered negligible. Groundwater outflows from the potential GDEs in the Subbasin are not well constrained by measured data and simulated groundwater elevations in this region of the model domain are influenced by proximity to the Pacific Ocean.

2.5.3 Surface Water Available for Groundwater Recharge or In-Lieu Use

The Subbasin does not use local surface water for groundwater recharge or as in-lieu groundwater supply. The Subbasin does have access to SWP and Colorado River water that could be used for recharge and is currently being used in-lieu of some groundwater pumping (see Section 2.5 Estimates of Imported Water).

2.5.4 Characterization of Water Year Types

Each GSP is required to characterize the annual supply, demand, and change in groundwater in storage by water year type (23 CCR 354.18(6)). DWR provided water year classifications for historical precipitation in the Subbasin. The water years are divided into five categories: critical, dry, below-average, above-average, and wet. Water years 1985 through 2012 included four critical precipitation years, four above-average precipitation years, six dry water years, six below-average water years, and eight wet water years. Water years 2013 through 2015 were all critical water years. The average change in storage by water year type is provided in Table 2-26.

Table 2-26. Change in Storage By Water-Year Type

Water Year Type	*Water Years 1985 through 2015*		
	Number of Years	*Total Change in Storage (AF)*	*Average Change in Storage (AFY)*
Critical	7	37,700	-5,400
Dry	6	27,800	-4,600

Table 2-26. Change in Storage By Water-Year Type

Water Year Type	*Water Years 1985 through 2015*		
	Number of Years	*Total Change in Storage (AF)*	*Average Change in Storage (AFY)*
Below Normal	6	12,800	-2,100
Above Normal	4	13,300	-3,300
Wet	8	-50,400	6,300

Note: Negative values indicate loss of storage from the Subbasin

During all but wet water years, storage is lost from the Subbasin (Table 2-26). However, storage loss and gain are a function of both recharge and discharge from the Subbasin. During water years 1985 through 2015, groundwater production rates varied from approximately 1,100 AFY to 11,000 AFY (Table 2-24), as the City of Santa Monica's Charnock and Olympic Wellfields were taken offline as a result of MTBE contamination between 1996 and 2010 (see Section 2.1.2.3 Water Quality). During this period, storage in the Subbasin increased, on average, during both wet water years and below normal water years, but decreased on average during critical, dry, and above-average water years (Figures 2-35 and 2-36). Therefore, analysis of water year type, independent from other influences on the groundwater conditions in the Subbasin is not a good indicator of storage change.

2.5.5 Quantification of Historical, Current, and Future Water Budget

Each GSP is required to include an accounting of the total annual volume of surface water and groundwater entering and leaving the basin during historical, current, and projected conditions (23 CCR 354.18). Historical conditions for the Plan Area were defined using data for the period between water years 1985 and 2015. Current conditions for the Plan Area were defined using data for the period between 2013 and 2015. The projected water budgets were prepared for a 61-year period from water year 2016 through water year 2074. Descriptions of the historical, current, and projected water budgets are provided in Sections 2.5.5.1, 2.5.5.2, and 2.5.5.3.

No surface water is diverted for use within the Subbasin. Surface flows occur within lined channels and are generally disconnected from the underlying groundwater system (see Section 2.4.6 Interconnected Groundwater and Surface Water). Therefore, the following discussion focuses on the volume of groundwater entering and leaving the Subbasin during the historical, current, and future projected conditions.

2.5.5.1 Quantification of Historical Water Budget

Between water years 1985 and 2012, the Subbasin received approximately 8,900 AFY of recharge, on average. Over the same time period, net outflows from the Subbasin averaged approximately 9,300 AFY, resulting in a net cumulative loss of storage of approximately 15,700 AFY over the historical time period (Figure 2-55).

Table 2-27. Historical Water Budget: 1985 to 2012

Water Year Type	*Inflows (AFY)*		*Outflows (AFY)*				*Change in Storage (AFY)*	*Change in Storage - Inflow from Ocean (AFY)*[2]
	Mountain -front Recharge	*Areal Recharge*	*Groundwater Production*	*Flow to Streams*	*Net Flow to Adjacent Basins*	*Flow to Ocean*[1]		
Critical	2,200	900	3,900	1,100	1,500	-200	-3,000	-3,400
Dry	2,400	1,400	5,700	1,800	1,400	-300	-4,600	-5,000

Table 2-27. Historical Water Budget: 1985 to 2012

Water Year Type	*Inflows (AFY)*		*Outflows (AFY)*				*Change in Storage (AFY)*	*Change in Storage - Inflow from Ocean (AFY)*[2]
	Mountain -front Recharge	*Areal Recharge*	*Groundwater Production*	*Flow to Streams*	*Net Flow to Adjacent Basins*	*Flow to Ocean*[1]		
Below Normal	3,200	2,600	4,500	2,000	1,600	100	-2,100	-2,000
Above Normal	3,500	2,600	5,900	2,900	1,100	-300	-3,300	-3,600
Wet	9,400	8,300	6,100	3,800	1,300	-200	6,300	6,000
Average	**4,700**	**3,700**	**5,300**	**2,500**	**1,400**	**-300**	**-600**	**-900**

Notes:
1 Negative values indicate inflow of seawater into to the Subbasin.
2 Change in storage shown equals the modeled change in storage minus subsurface inflows across the western boundary of the Subbasin.

In general, mountain-front recharge is similar in critical, dry, below normal, and above normal years (Table 2-27). Aerial recharge increases with water-year type and the Subbasin receives the majority of its recharge during wet years (Table 2-27).

Groundwater production is the dominant outflow from the Subbasin. Because the majority of the groundwater production in the Subbasin is for drinking water, rather than agriculture, groundwater production volumes do not correlate with water year type (Table 2-27). Subsurface outflows to adjacent basins and to the Pacific Ocean are better correlated with groundwater production, than with water year type, as these outflows depend on groundwater elevations in the Subbasin. Consequently, only net flow to ephemeral streams and Ballona Creek, which occur in the non-production layers of the model, decrease during below normal, dry, and critical water years.

The modeled change in storage suggests that the Subbasin only gained storage during wet water years between 1985 and 2012 (Table 2-27). Storage loss during dry years was highest, followed by storage loss during above normal water years, critical water years, and below normal water years. Thus, change in storage is correlated with groundwater production during all non-wet water year types.

As discussed in Section 2.5.1.5 Inflow and Outflow to the Ocean, flow across the western boundary of the Subbasin may not currently be seawater intrusion in the model layers associated with the Silverado aquifer. However, any freshwater stored offshore will eventually be replaced with seawater if the groundwater gradient is directed landward. The modeled change in storage includes flows across the western boundary without regard for their chemical characteristics. If these inflows are seawater in nature, then they are not a positive contribution of freshwater to the Subbasin. Therefore, the final column of Table 2-27 shows the change in storage without inflows across the western boundary as a potential upper estimate of storage change. This upper estimate of storage change follows the same pattern as the modeled storage change, indicating storage is only gained in the Subbasin during wet water years, and storage loss is correlated with groundwater production during all other water years (Table 2-27).

2.5.5.2 Quantification of Current Water Budget

Water years 2013 through 2015, which were all critical water years, were used to represent the current water budget in the Subbasin (Figure 2-55). Groundwater recharge to the Subbasin averaged approximately 2,000 AFY during these years, while groundwater discharge averaged approximately 11,800 AFY (Table 2-28). Additionally, flow was directed into the Subbasin from the Pacific Ocean, indicating the potential for seawater intrusion during this time period. The average loss of freshwater from storage between 2013 and 2015 was approximately 9,800 AFY.

Table 2-28. Current Water Budget: 2013 to 2015

Water Year Type	*Inflows (AFY)*		*Outflows (AFY)*				Change in Storage (AFY)	Change in Storage - Inflow from Ocean (AFY)[2]
	Mountain-front Recharge	*Areal Recharge*	*Groundwater Production*	*Flow to Streams*	*Net Flow to Adjacent Basins*	*Flow to Ocean*[1]		
Critical	1,100	900	10,700	100	1,000	-1,300	-8,500	-9,800

Notes:
1 Negative values indicate inflow of seawater into to the Subbasin.
2 Change in storage shown equals the modeled change in storage minus subsurface inflows across the western boundary of the Subbasin.

2.5.5.3 Quantification of Projected Water Budget

A model period from 1959 to 2019 was used for all future scenarios. This period starts and ends close to the zero cumulative departure from the mean precipitation and includes several dry and wet periods (Figure 2-13). Therefore, this 61-year model period is representative of long-term conditions in the Subbasin and was selected for the future model simulations.

Three total future scenarios are discussed below. These include a future baseline scenario, as well as two future scenarios that incorporate climate change. Climate change factors provided by DWR for the years 2030 and 2070 were applied to the future baseline hydrology to adjust temperature, evapotranspiration, and precipitation based on projected climate conditions in the Subbasin (see Section 2.2.3 Historical, Current, and Projected Climate). Additionally, DWR provided sea level forecasts for 2030 and 2070 that include sea level rise of 15 cm and 45 cm, respectively. Current sea level was maintained in the future baseline scenario.

For all future model scenarios, pumping by the City of Santa Monica and the Holy Cross Cemetery & Mortuary Culver City was held constant at 9,232 AFY. This production rate was chosen to represent the City of Santa Monica's anticipated future water demands and includes groundwater recharge anticipated to occur as part of the City of Santa Monica's Sustainable Water Infrastructure Project. The Sustainable Water Infrastructure Project will provide approximately 1,500[43] AFY of water to recharge local groundwater aquifers (see Section 4.6 Recharge Local Groundwater Aquifers), thereby allowing the City to maximize groundwater pumping, within sustainable yield limits, from the Olympic Wellfield (City of Santa Monica 2018a). For modeling purposes, no surface recharge was modeled, but future groundwater production of 10,500 AFY was adjusted to 9,000 AFY to account for up to 1,500 AFY of artificial recharge to the Subbasin.

The estimated population is projected to increase from 2019 to 2045 by 77,808 (Table 2-8). While this increase will likely have minor impact to return flows from urban irrigation because the Subbasin is already highly urbanized with parks and open space occupying just 11.5% of the Subbasin (Table 2-7; Figure 2-7), urban return flows were not separated from areal recharge in the future simulations.

43 This sustainable water infrastructure program anticipated providing 1,100 AFY of recharge in the City of Santa Monica's Sustainable Water Master Plan (City of Santa Monica, 2018). Output from this program was increased to 1,500 AFY for modeling the future scenarios.

Surface water supply availability and reliability was not changed for future conditions. MWD and its member agencies have developed new projects to increase the diversity and capacity of imported water supplies while encouraging its member agencies, including the City of Santa Monica, to develop local supply projects to meet the needs of their customers (City of Santa Monica 2018a). The diversity of additional potential water supply projects in the broader Los Angeles Coastal Plain is discussed further in Appendix H.

Future Baseline Scenario Results

The future baseline scenario without climate change or sea level rise suggests that at a groundwater production rate of 9,200 AFY the Subbasin would experience an average annual loss of storage of approximately 100 AFY (Figure 2-56). However, this change in storage includes flow across the western boundary of the model, into the Subbasin, which may indicate seawater intrusion (see Section 2.5.1.5 Inflow and Outflow to the Ocean). If this is seawater, rather than freshwater that has flowed offshore, the annual loss of freshwater from storage could be as high as approximately 2,200 AFY. As with the historical model, the Subbasin only gains water in storage in wet water years (Table 2-29). Flow to ephemeral streams and Ballona Creek is lower in the future baseline model than in the historical mode, as is the net subsurface flow to adjacent basins (Table 2-21). Annual model results for the future baseline scenario are included in Appendix I, and uncertainties associated with these future water budget estimates are discussed below in Section 2.5.5.4.

Table 2-29. Future Baseline Water Budget Summary

Water Year Type	*Inflows (AFY)*		*Outflows (AFY)*				*Change in Storage (AFY)*	*Change in Storage – Inflow from Ocean (AFY)*[2]
	Mountain-front Recharge	*Areal Recharge*	*Groundwater Production*	*Flow to Streams*	*Net Flow to Adjacent Basins*	*Flow to Ocean*[1]		
Critical	2,000	1,600	9,200	400	-400	-2,100	-3,500	-5,600
Dry	2,700	2,100	9,200	800	-500	-2,200	-2,600	-4,800
Below Normal	2,900	2,300	9,200	800	-500	-2,000	-500	-2,500
Above Normal	3,800	3,000	9,200	1,200	-300	-2,200	1,000	-1,200
Wet	9,100	7,200	9,200	3,300	-400	-1,900	6,000	4,100
Average	**4,500**	**3,600**	**9,200**	**1,500**	**-400**	**-2,100**	**100**	**-2,000**

Notes:

1 Negative values indicate inflow of seawater into to the Subbasin.

2 Change in storage shown equals the modeled change in storage minus subsurface inflows across the western boundary of the Subbasin.

2030 Climate Change Scenario Results

Average recharge to the Subbasin in the 2030 climate scenario is approximately 8,200 AFY, which is similar to the average recharge of 8,100 AFY in the future baseline scenario (Table 2-30). Average outflow from the subbasin in the 2030 climate scenario is the same as the average outflow in the baseline scenario, except flow to the West Coast Basin increases from approximately 100 to 200 AFY in the 2030 climate scenario (Table 2-30). Annual model results for the 2030 climate scenario are included in Appendix I, and uncertainties associated with these future water budget estimates are discussed below in Section 2.5.5.4.

2070 Climate Change Scenario Results

Average recharge to the Subbasin in the 2070 climate scenario is approximately 8,500 AFY, which is slightly higher than the average recharge of 8,100 AFY in the future baseline scenario (Table 2-30). The increase in recharge is reflected in the increase outflows to ephemeral streams and Ballona Creek, as well as the increased outflow to storage in the 2070 climate scenario relative to the future baseline and 2030 climate scenarios (Table 2-30). Additionally, average inflow across the western boundary is approximately 100 AFY less in the 2070 climate scenario than the future baseline or 2030 climate scenarios. Annual model results for the 2030 climate scenario are included in Appendix I, and uncertainties associated with these future water budget estimates are discussed below at the end of Section 2.5.5.4.

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Table 2-30. Summary of Future Scenario Results: 2016 through 2076

Future Model Scenario	Summary	INFLOWS (AFY)			OUTFLOWS (AFY) [Negative values are inflow to the Subbasin]								Change in Storage (AFY) [2]	Change in Freshwater Storage (AFY) [3]
		Inflows from Storage (Results in a decrease in groundwater head)	*Total Recharge*	*Total IN*	*Outflow to Storage (Results in an increase in groundwater head)*	*Net Production from Pumping wells*	*To Ephemeral Streams and Ballona Creek*	*To Hollywood Basin*	*To Central Basin*	*To Ocean[1]*	*To West Coast Basin*	*Total OUT*		
Baseline (No Climate Change)	Average	3,700	8,100	11,800	3,600	9,200	1,500	-100	-400	-2,100	100	11,800	-100	-2,200
	Min	1,200	2,400	6,600	0	9,200	100	-300	-700	-2,700	-100	6,600	16,200	13,500
	Max	6,100	29,500	35,600	22,300	9,200	6,100	200	-200	-1,400	600	35,600	-5,400	-6,800
2030 Climate Factors	Average	3,700	8,200	11,900	3,600	9,200	1,500	-100	-400	-2,100	200	11,900	-100	-2,200
	Min	1,100	2,400	6,600	0	9,200	100	-300	-600	-2,700	0	6,600	15,900	13,200
	Max	6,200	29,300	35,500	22,000	9,200	6,200	200	-200	-1,400	600	35,500	-5,400	-6,800
2070 Climate Factors	Average	3,800	8,500	12,300	3,900	9,200	1,600	-100	-400	-2,000	200	12,300	0	-2,000
	Min	1,000	2,400	6,700	0	9,200	100	-300	-700	-2,700	-100	6,700	16,800	14,100
	Max	6,200	29,400	35,500	22,000	9,200	6,300	200	-200	-1,200	600	35,500	-5,600	-6,800

Notes:

1 Negative values indicate flow of water into the Subbasin.
2 Negative values indicate loss of storage from the Subbasin.
3 Change in freshwater storage shown equals the modeled change in storage minus subsurface inflows across the western boundary of the Subbasin.

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2.5.5.4 Water Budget Uncertainties

There are limitations and uncertainties associated with all groundwater models, and with water budget terms used for both the historical and future conditions. These uncertainties result from both the necessary simplifying of natural conditions in a mathematical framework and from data gaps in the physical understanding of influences on groundwater conditions in the model domain. Although not an exhaustive list, the primary water budget limitations and/or uncertainties that apply to the historical, current, and future water budget estimates include the following:

- Groundwater pumping not included in the model is limited, but as noted in Section 2.5, groundwater extractions in Table 2-24 do not include the estimated 1,020 AFY from the Brentwood Country Club, Riviera Country Club, and Los Angeles Country Club golf courses. Additionally, some historical pumping extracted by the GSWC for potable use estimated to be about 1,305 AF (163 AFY) from 1985 to 1993 was not included.
- Subsurface inflows and outflows across Subbasin boundaries are not measurable. There is no groundwater level data in much of the Subbasin area to provide a clear indication of gradients between other subbasins and the ocean. Attempts to estimate inflows and outflows across Subbasin boundaries using measured groundwater elevation data would require eliminating data gaps by increasing the number of well locations screened in the Silverado aquifer at the Subbasin boundaries. This would help confirm results for subsurface inflows and outflows and make estimates of seawater intrusion more reliable.
- Currently, Silverado aquifer groundwater level maps are not reliable to estimate aquifer change in groundwater storage due to the limited number and distribution of groundwater wells. Dedicated monitoring wells could be installed and equipped with groundwater-level measuring data loggers in key locations in the Silverado aquifer. This would help decrease uncertainty in estimates of future changes in groundwater storage by enabling use of groundwater-level maps to check groundwater model change in storage calculations.
- Recharge components such as infiltration from precipitation, urban return flows, and mountain-front recharge are not directly measurable. Groundwater models use estimates for these recharge components from precipitation values and, for return flows, from estimates of water use. The values for these recharge components are usually adjusted during model calibration to achieve a better match between model predicted groundwater levels at a calibration well and the actual measured groundwater levels. It is very difficult to quantify these recharge components, but good estimates for groundwater extraction, change in groundwater storage, a good conceptual model improve estimates of recharge.
- A model sensitivity analysis indicated that the water balance results are most sensitive to vertical conductivity of Layer 7, which represents the pumping aquifer and is connected to layer 5 above and layer 8 below, as well as to the general head boundary conductance, which is the rate at which seawater inters the formation. The model head calibration was not significantly impacted by changes to these parameters, but large water balance changes occur with small changes to these parameters (Appendix F). Currently the USGS is working on updating the model, which may refine the vertical conductivity of Layer 7, but additional studies may be needed to better refine the vertical conductivity of Layer 7. These studies would likely involve construction of monitoring wells and include aquifer testing to better constrain these subsurface properties.
- The model simulates greater hydraulic connection between Marina del Rey wells and pumping wells than is observed and there are few long-term groundwater level records near Marina del Rey to assess calibration. As discussed in Section 2.4.1 (Groundwater Elevation Data), several of the wells that have historically been used to monitor groundwater levels in coastal areas of the Subbasin have screen intervals that are either unknown or are not representative of the depths of the Ballona or Silverado

aquifers. Historical groundwater levels in many of these wells are relatively flat, showing little variation with groundwater production or groundwater recharge, suggesting that they are not hydraulically connected to either the Ballona or the Silverado aquifers. New aquifer-specific monitoring wells could help with future model calibration.

- Historical chloride concentrations show no evidence of seawater intrusion in the Subbasin, but there are large areas of the Subbasin, particularly between Marina del Ray and the City of Santa Monica's groundwater production wellfields, that lack wells with groundwater quality data. Therefore, seawater intrusion may be occurring closer to the coast, and has not yet been detected because of this data gap. Additional monitoring wells would help fill data gaps.

Each of the uncertainties identified above has the potential to influence the model assessment of change in storage as well as the simulated relationship between seawater intrusion and groundwater production. Refining the understanding of these relationships is critical to assessing the sustainable yield of the Subbasin. The estimates of sustainable groundwater production rates are anticipated to change, and may increase, as data gaps are filled and uncertainty is reduced in the Subbasin.

2.5.6 Quantification of Overdraft

DWR has designated the Subbasin as a medium-priority basin. The GSP Emergency Regulations require that the water budget "include a quantification of overdraft over a period of years during which water year and water supply conditions approximate average conditions" if the Subbasin is found to be experiencing overdraft (23 CCR 354.18, Water Budget). Groundwater overdraft is defined in DWR Bulletin 118 as:

> *"…the condition of a groundwater basin or subbasin in which the amount of water withdrawn by pumping exceeds the amount of water that recharges the basin over a period of years, during which the water supply conditions approximate average conditions. Overdraft can be characterized by groundwater levels that decline over a period of years and never fully recover, even in wet years"* (DWR 2003).

Historical water levels indicate that the Plan Area is not in overdraft, as they have declined and recovered as production is adjusted in the Subbasin. Over the period of drought from 2012 through 2015, water levels and storage declined in the Subbasin, however this is not considered overdraft because three of those four years were critical water years and the remaining year was a below-average water year. Recharge to the Subbasin tends only to occur in wet water years. Therefore, water levels and storage would be expected to decline during these years. The modeled future production rate may approximate or even slightly exceed the sustainable yield of the Subbasin (see Sections 2.4.1 Groundwater Elevation Data, 2.4.2 Estimated Change in Storage, 2.5.3 Change in Annual Volume of Groundwater in Storage, and 2.6 Sustainable Yield Estimate; Appendix I). Groundwater conditions that define whether this production rate will cause undesirable results are discussed in Chapter 3, Sustainable Management Criteria.

2.6 Sustainable Yield Estimate

As defined by SMGA, "sustainable yield" means the maximum quantity of groundwater, calculated over a base period representative of long-term conditions in the Subbasin and including any temporary surplus, that can be withdrawn annually from a groundwater supply without causing an undesirable result. This definition differs from generally accepted historical references to sustainable yield, which usually refer to the average annual amount of groundwater that could be extracted without producing a change in groundwater in storage over time. Thus, historical references to sustainable yield refer to a groundwater budget extraction amount that produced sustainability for the Subbasin relative to the water balance recharge. These historical estimates do not factor in undesirable results. Historical estimates for the Subbasin's sustainable yield are presented below along with how the historical, current, and future water budgets relate to the SMGA definition of sustainable yield.

Subbasin Historical Sustainable Yield

Historical estimates for the sustainable yield of the Subbasin range from 10,800 AFY to 19,700 AFY (City of Santa Monica 2018a). These estimates are typically broken down by production area[44] within the Subbasin and the Charnock and Olympic production areas are commonly thought to have the highest yields within the Subbasin (City of Santa Monica 2018a).

SMGA Sustainable Yield

SGMA defines the sustainable yield of a basin as the long-term average annual pumping that does not cause an undesirable result relative to the six sustainability indicators. Prior studies have estimated the sustainable yield of the Subbasin to be between 10,800 AFY and 19,700 AFY (City of Santa Monica 2018). While these estimates have acknowledged the possibility of seawater intrusion, the undesirable result that is most likely to occur in the Subbasin if groundwater production rates exceed the sustainable yield over a period of ten or more years, they did not specifically analyze the potential for significant and unreasonable impacts to any of the six sustainability indicators.

Seawater intrusion was documented in the Ballona aquifer prior to 1946, but there is no current evidence for seawater intrusion in either the Ballona or Silverado aquifers, as measured by chloride concentrations in the groundwater (see Section 2.4.3). Because the Ballona aquifer is not an active source of groundwater and the current pumping is from the Silverado aquifer, there is at present, no evidence of an undesirable result related to seawater intrusion occurring in the Subbasin. This GSP recognizes that there are data gaps both in well locations and water quality measurements in the coastal area of the Silverado aquifer, however, and recommends filling these data gaps in future studies. At the present time, however, historical and current pumping do not appear to have caused seawater intrusion in the Silverado aquifer.

Seawater intrusion estimates for the three future model scenarios in this GSP (Future Baseline, DWR 2030 and DWR 2070 in Section 2.5.5) all show potential seawater intrusion in amounts from 2,000 AFY to 2,100 AFY (Table 2-30), but as noted in Section 2.5.5.4, water budget uncertainties indicate that these values could be lower or higher depending mostly on the model vertical conductivity of Layer 7 and the general head boundary conductance. Thus, until data gaps concerning seawater intrusion are filled by additional monitoring wells, the proposed future groundwater extraction rate of 9,200 AFY is assumed to be within the sustainable yield of the Subbasin and adjustments to the proposed future production rate are not required at this time.

Until data gaps are filled, and refinements to the LACPGM are made in within the Subbasin, this GSP adopts the historical range of estimates for the sustainable yield for the Subbasin of 10,800 AFY to 19,700 AFY.

44 This GSP adopts the term "production area" to refer to the historical subbasins to avoid confusion with references to the Santa Monica Subbasin itself.

2.7 Management Areas

No management areas are proposed for the Subbasin.

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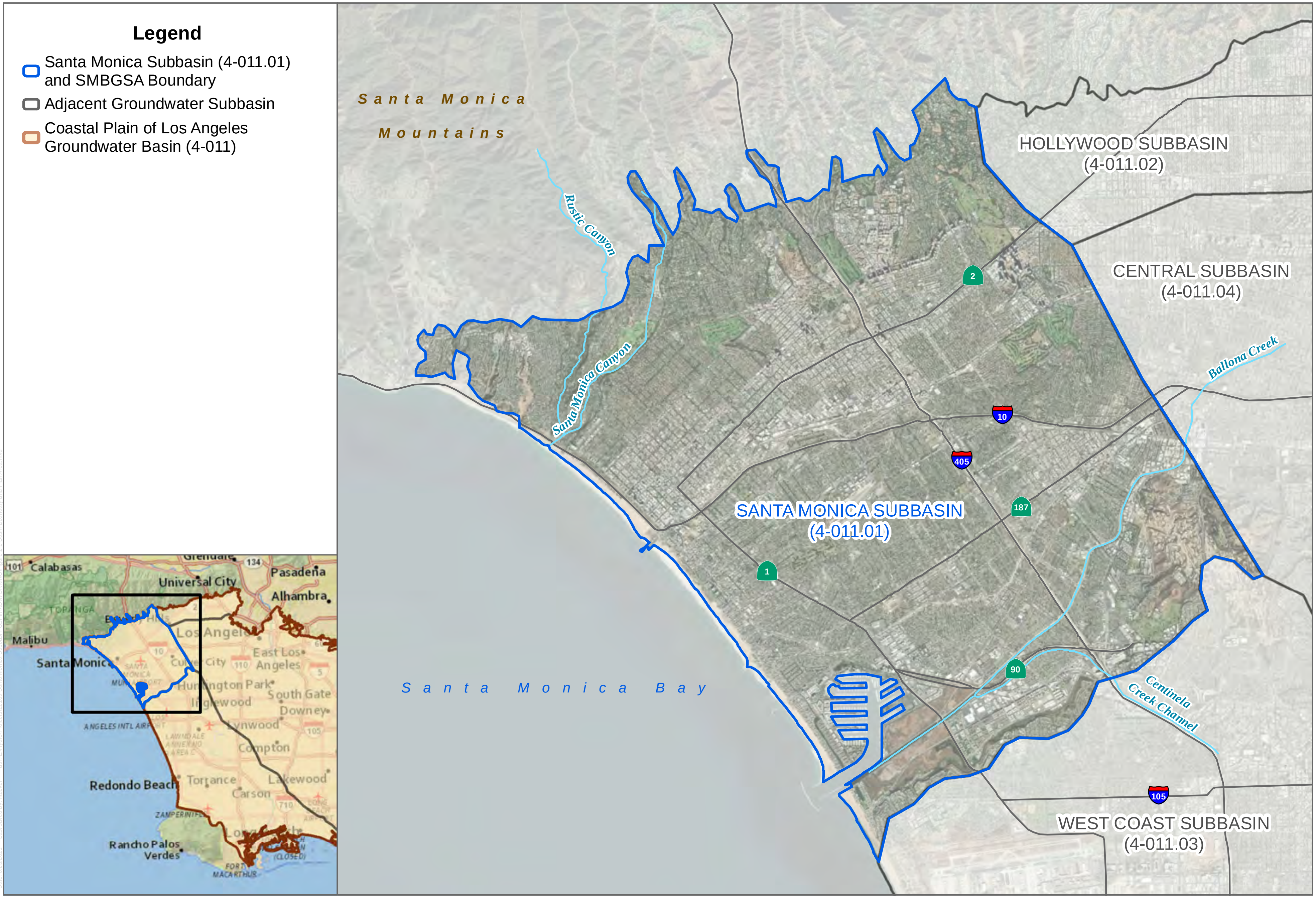

SOURCE: ESRI; DWR; USGS

DUDEK

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FIGURE 2-1

Basin Boundary and Plan Area

Groundwater Sustainability Plan for the Santa Monica Subbasin

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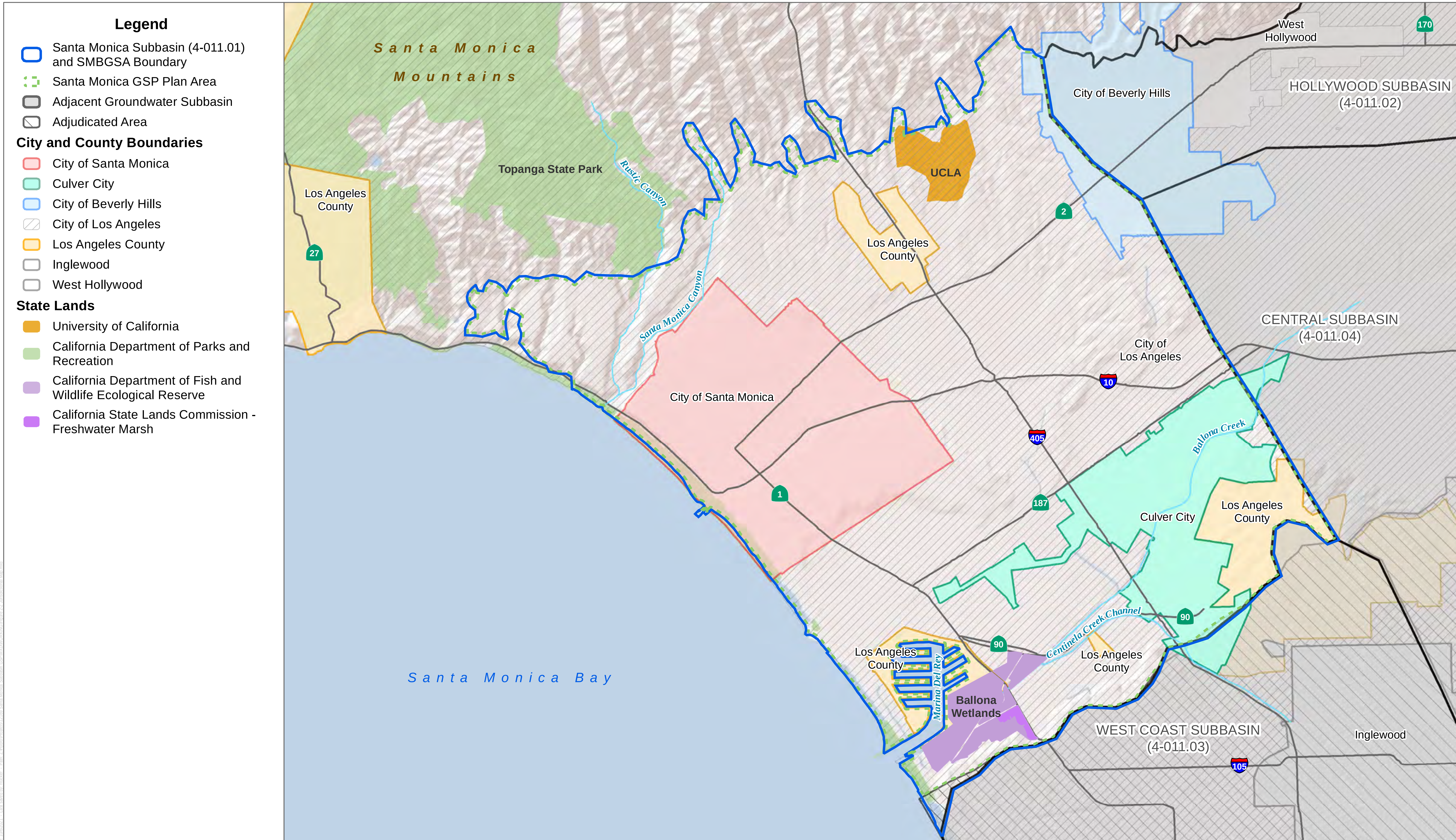

SOURCE: ESRI; DWR; USGS; Los Angeles County

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FIGURE 2-2

Jurisdictional Boundaries

Groundwater Sustainability Plan for the Santa Monica Subbasin

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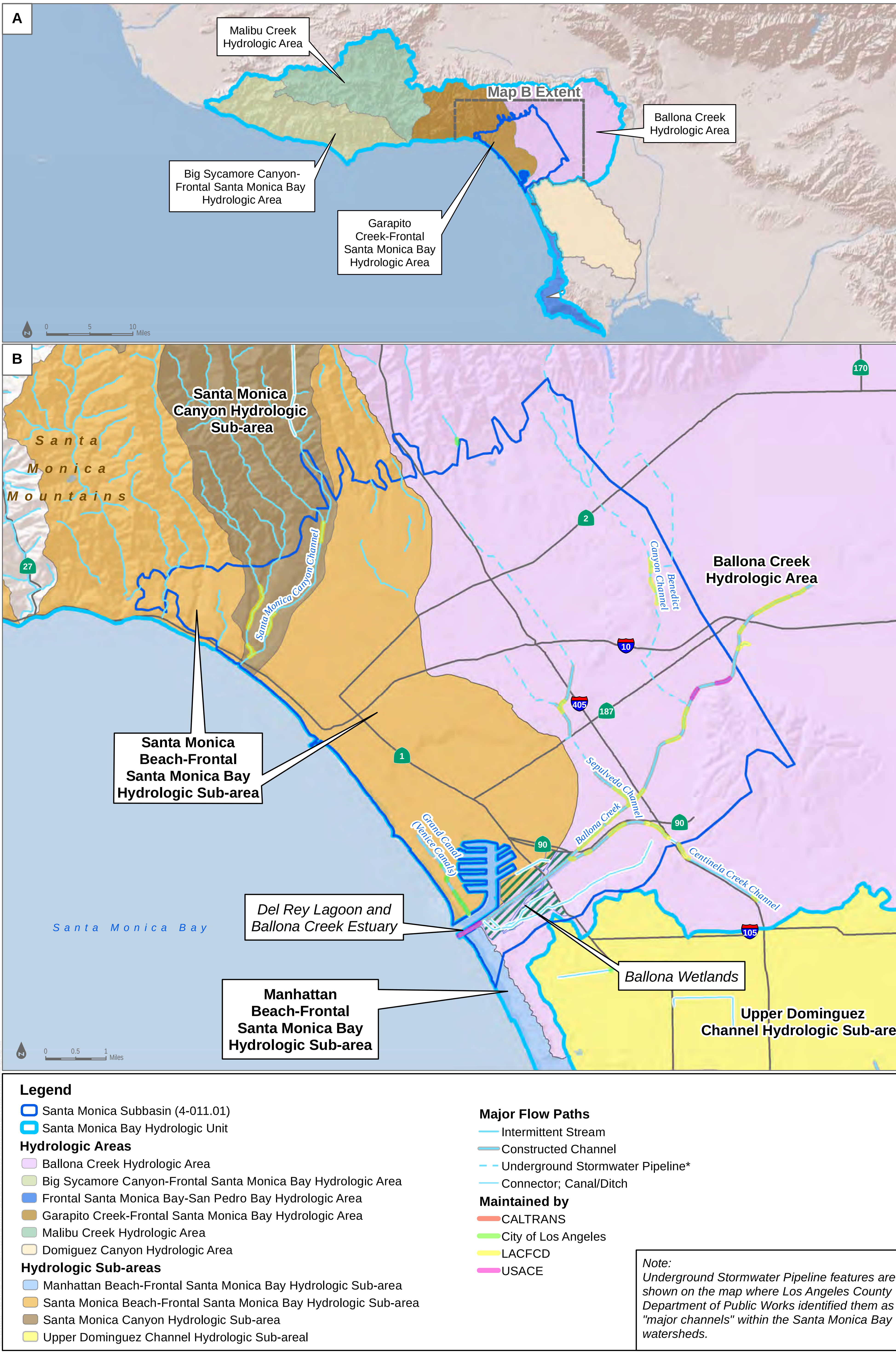

SOURCE: ESRI; DWR; USGS; LACDPW

FIGURE 2-3

Watersheds and Drainage Map

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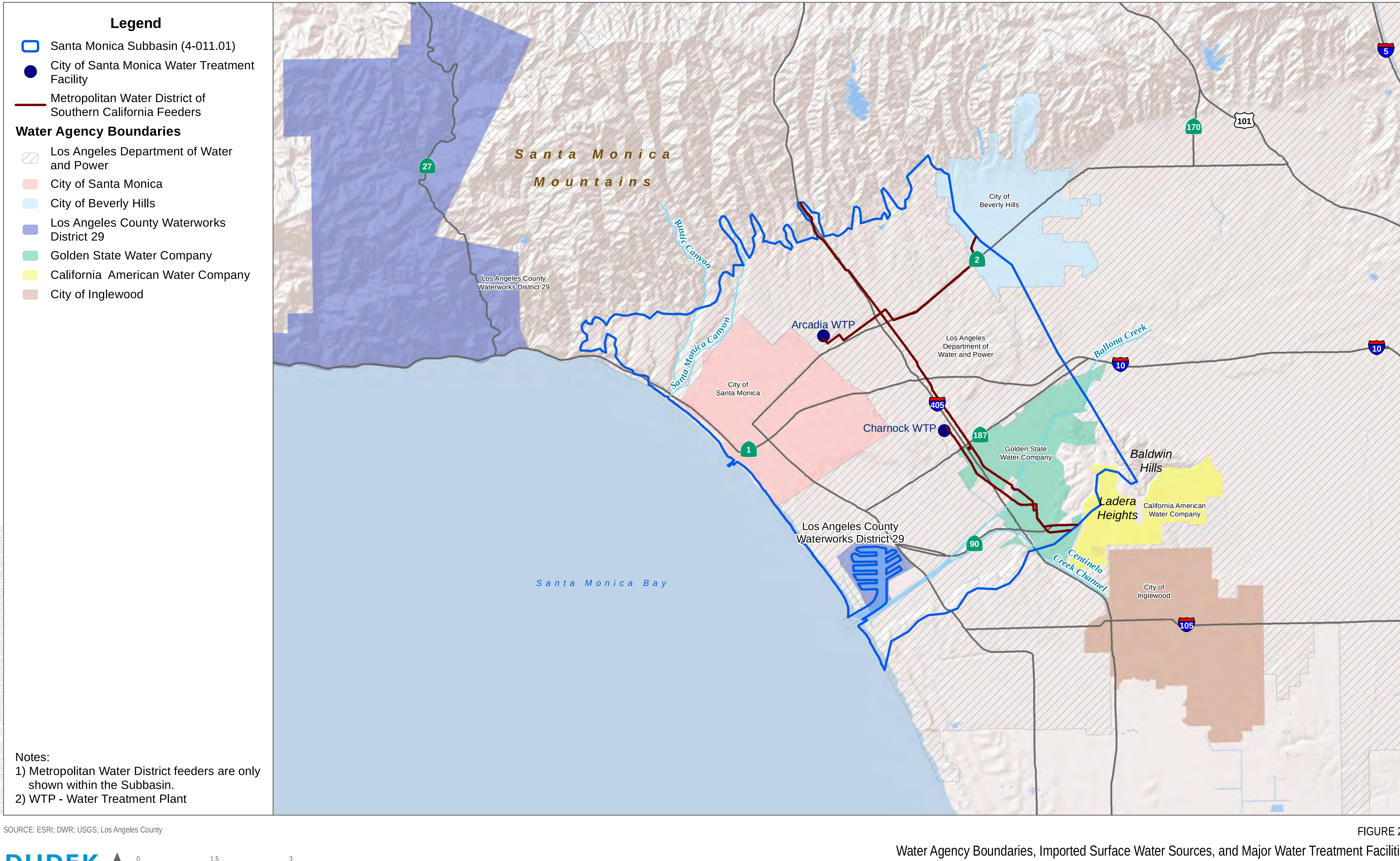

SOURCE: ESRI; DWR; USGS; Los Angeles County

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FIGURE 2-4

Water Agency Boundaries, Imported Surface Water Sources, and Major Water Treatment Facilities

Groundwater Sustainability Plan for the Santa Monica Subbasin

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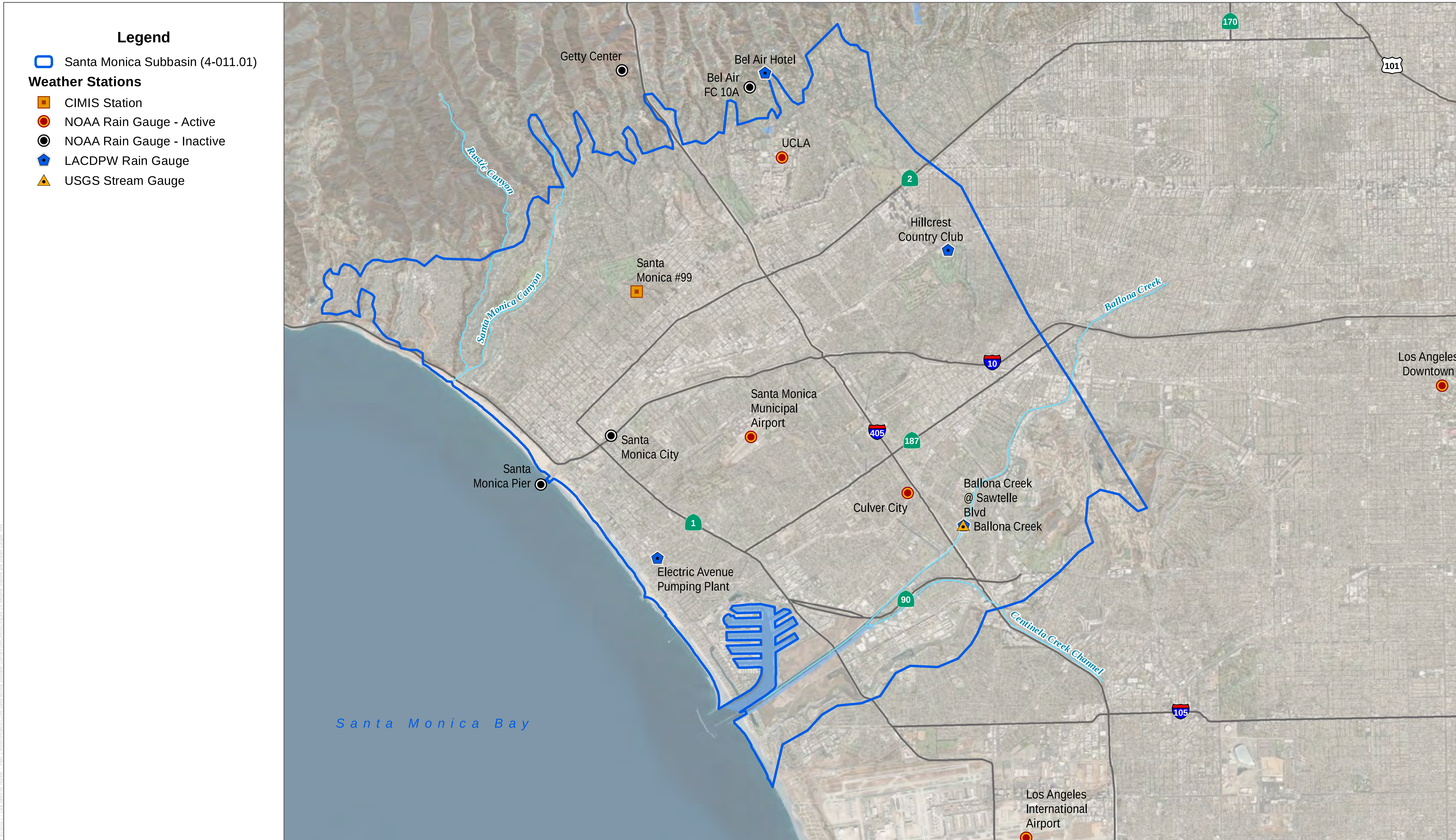

SOURCE: ESRI; DWR; USGS; NOAA; CIMIS

DUDEK

0 1 2 Miles

FIGURE 2-5

Weather Stations and Stream Gauges

Groundwater Sustainability Plan for the Santa Monica Subbasin

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Legend

- Santa Monica Subbasin (4-011.01)
- Inactive Santa Monica Production Well
- Santa Monica Production Wells

Charnock Regional Monitoring Wells

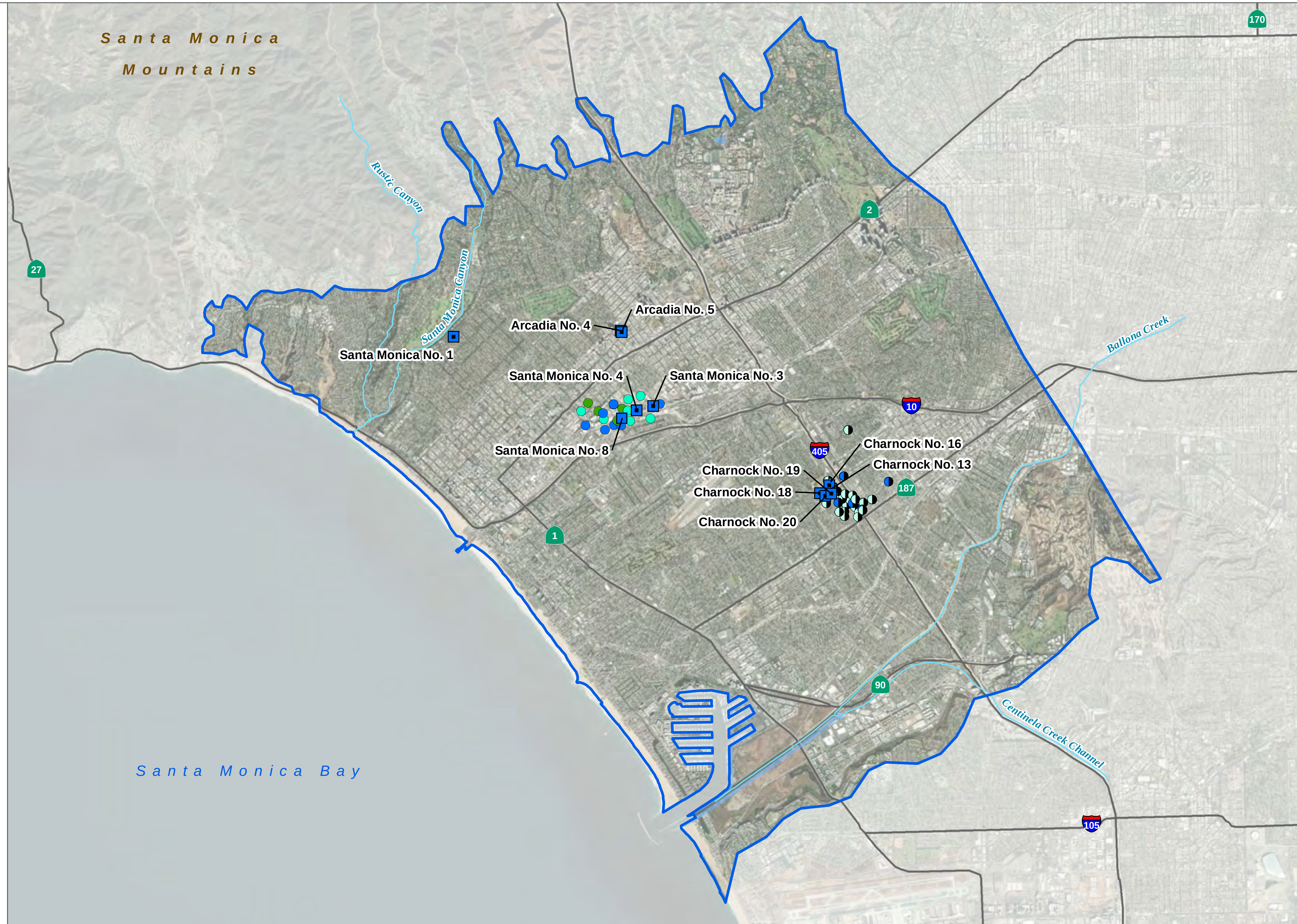
Aquifer

- Shallow (Ballona/Lakewood) Aquifer
- Silverado Aquifer

Olympic Well Field Management Plan Monitoring Wells

Zone

- B Zone (Lakewood) Aquifer
- B and C Zones (Lakewood/Silverado) Aquifer
- C Zone (Silverado) Aquifer



SOURCE:Geotracker GAMA; City of Santa Monica

DUDEK

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FIGURE 2-6

City of Santa Monica Production Wells and Associated Monitoring Networks

Groundwater Sustainability Plan for the Santa Monica Subbasin

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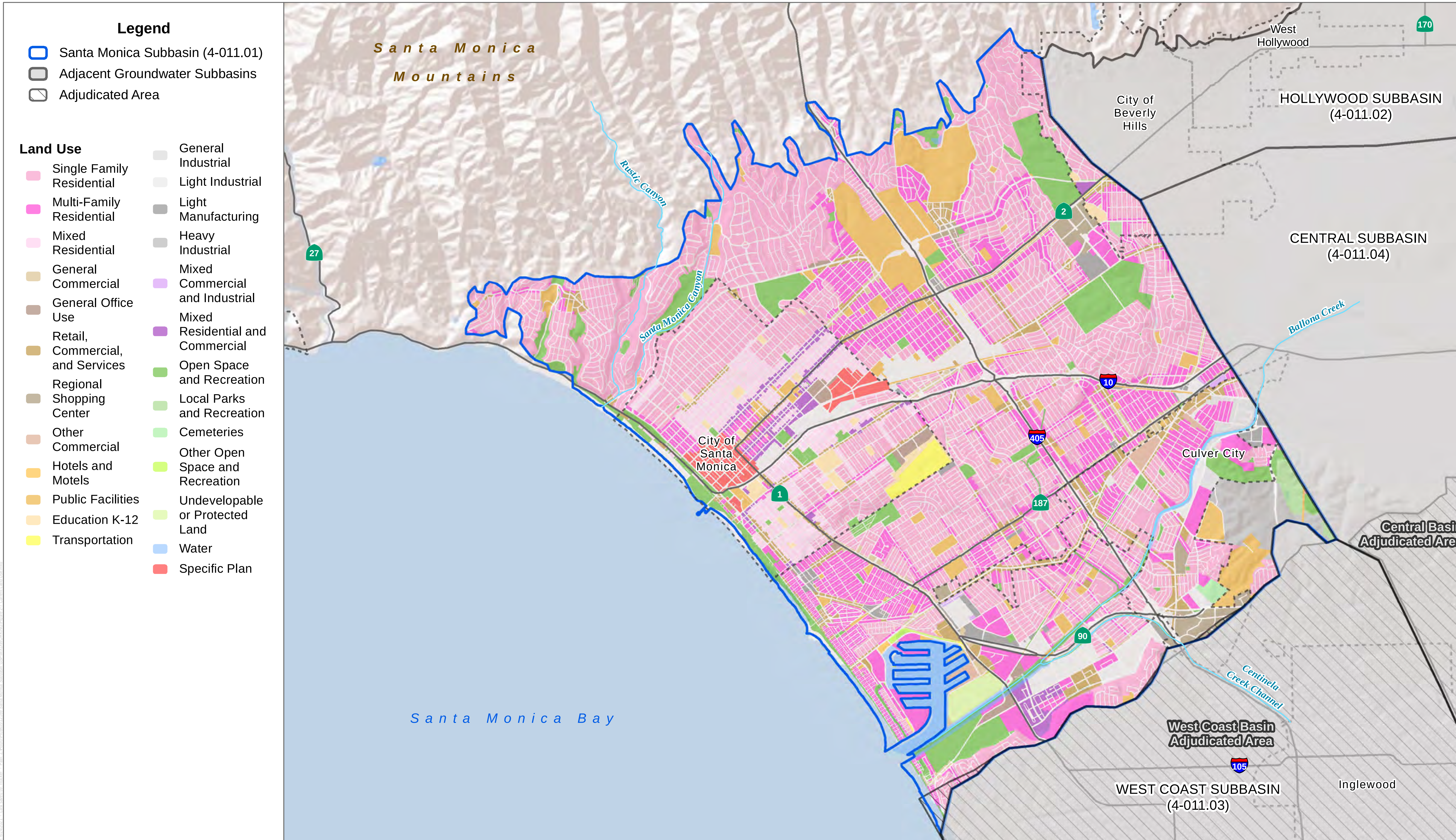

SOURCE: ESRI; DWR; USGS; Los Angeles County

DUDEK

FIGURE 2-7

Current Land Use

Groundwater Sustainability Plan for the Santa Monica Subbasin

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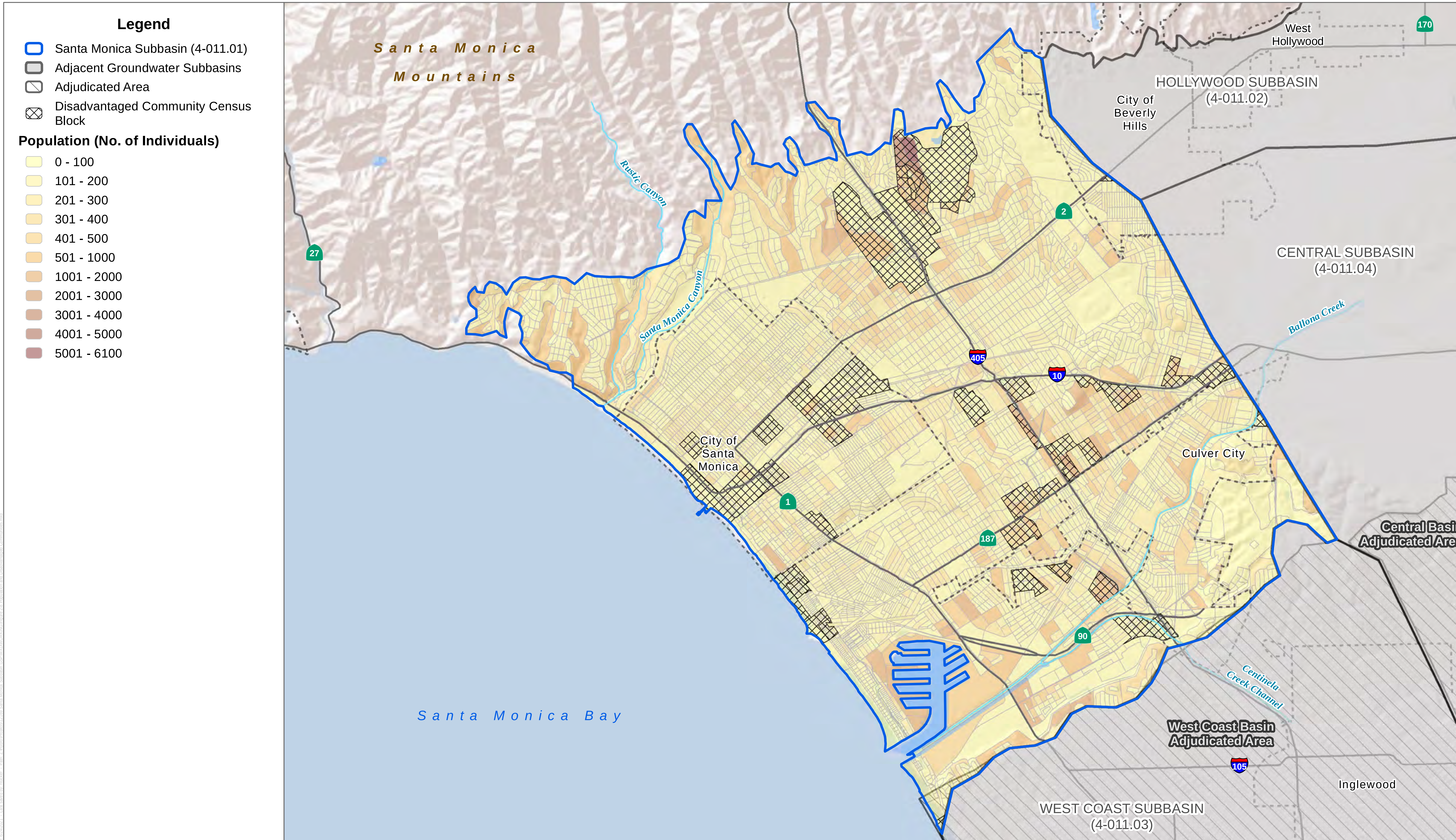

SOURCE: ESRI; DWR; USGS; Los Angeles County; Census 2010

DUDEK

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FIGURE 2-8

Population and Disadvantaged Communities

Groundwater Sustainability Plan for the Santa Monica Subbasin

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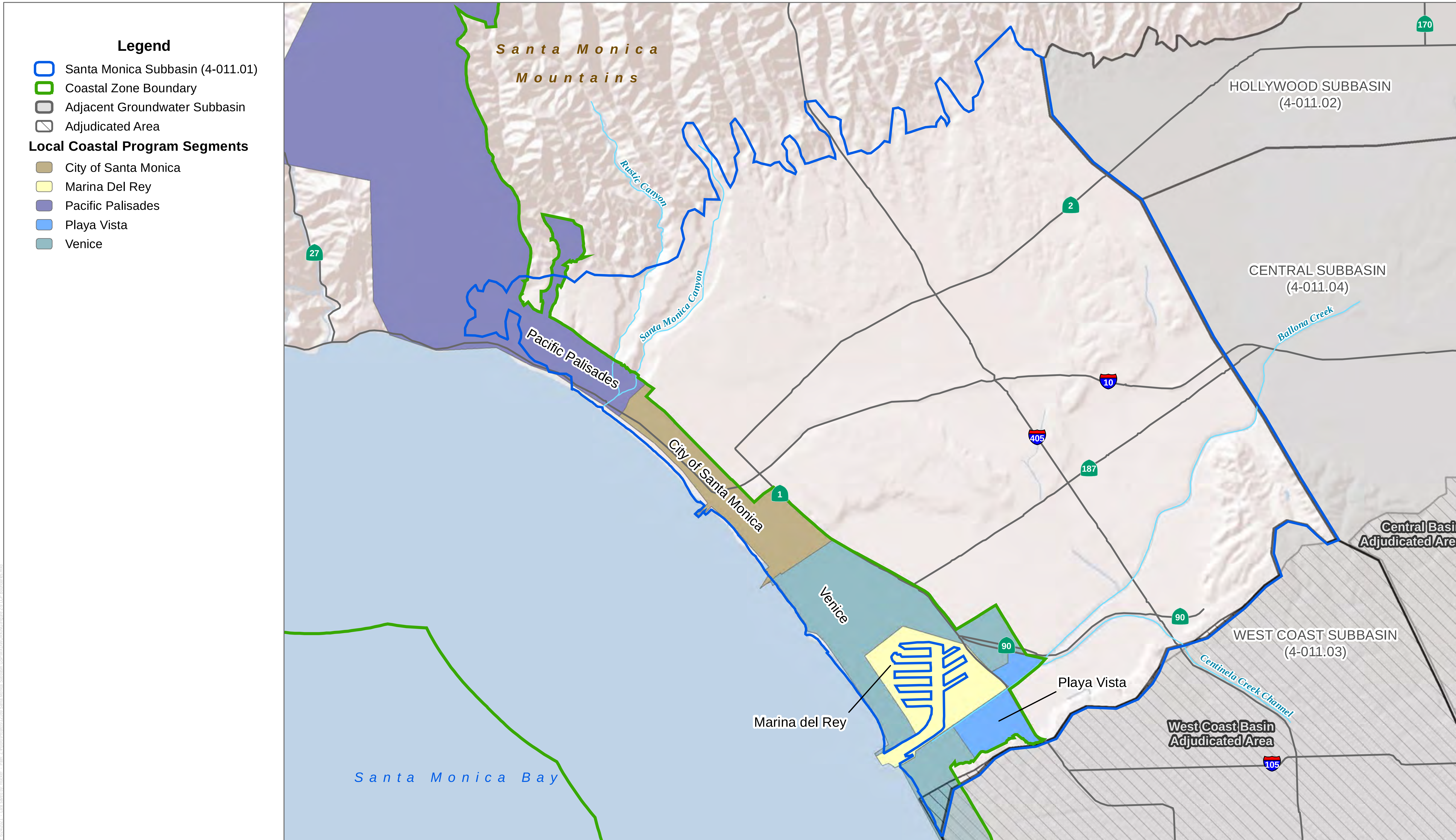

SOURCE: ESRI; DWR; USGS; Los Angeles County

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FIGURE 2-9

Local Coastal Program Segments

Groundwater Sustainability Plan for the Santa Monica Subbasin

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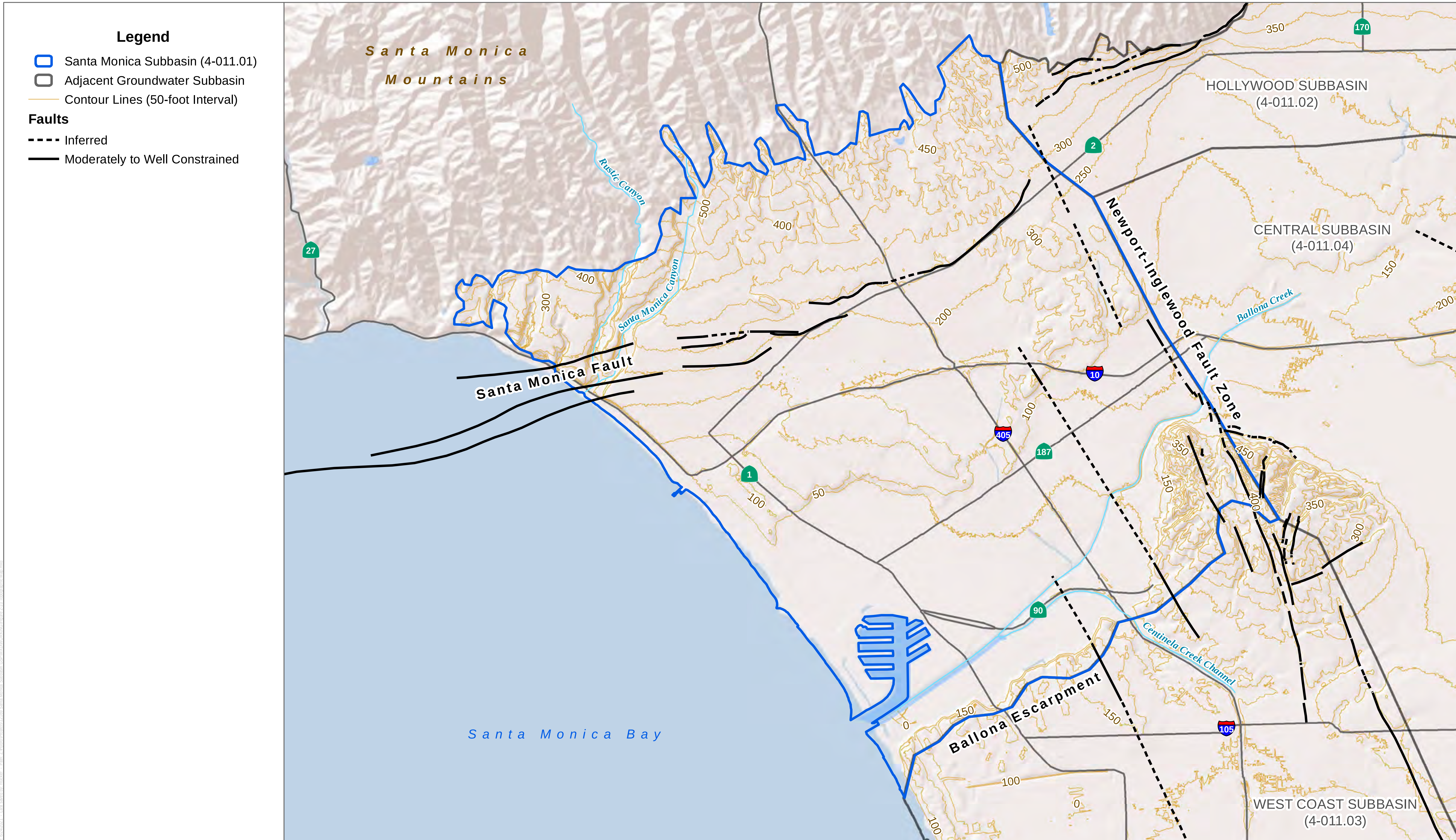

SOURCE: ESRI; DWR; USGS; LARIAC

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FIGURE 2-10

Topographic Map

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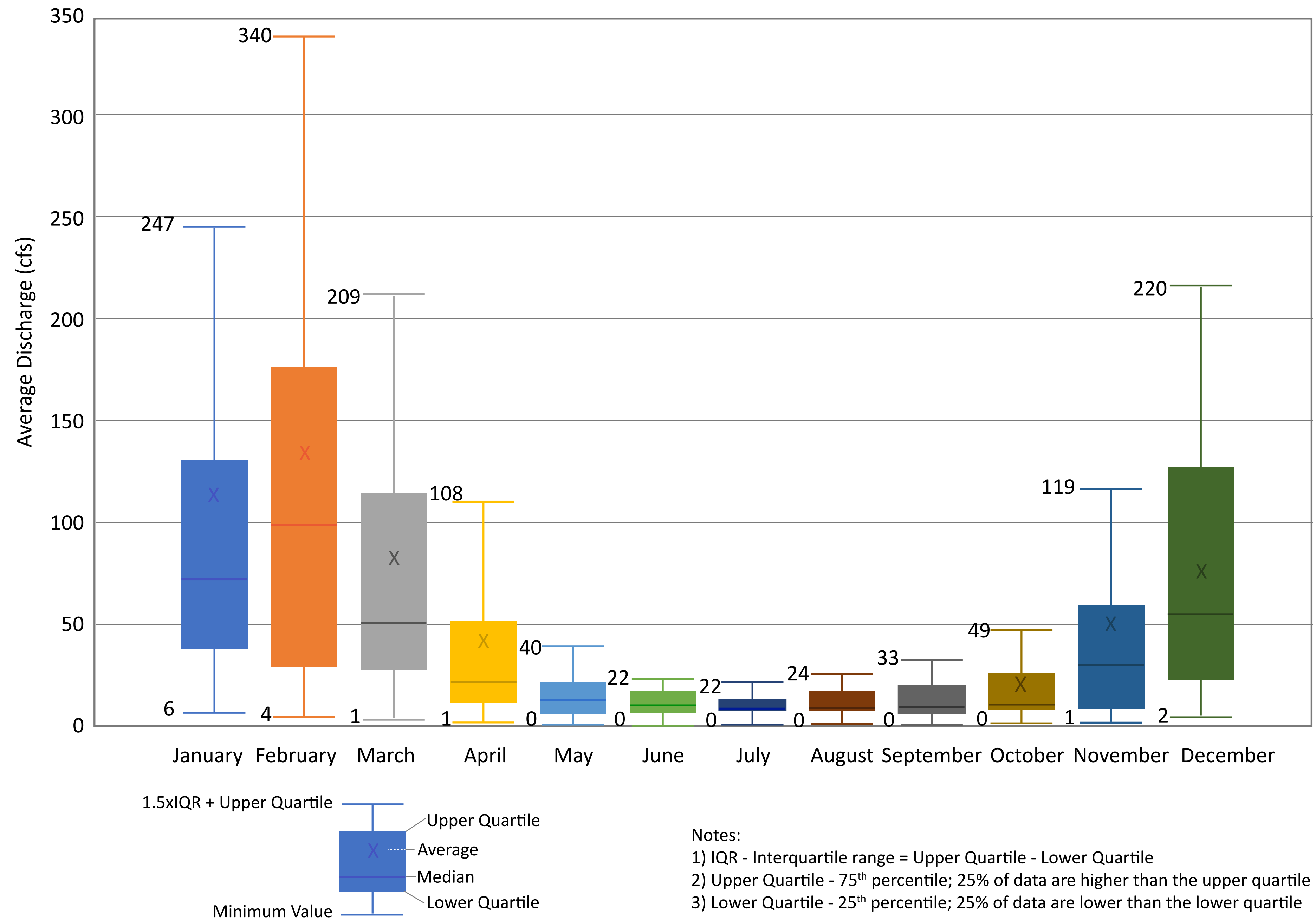

Notes:
1) IQR - Interquartile range = Upper Quartile - Lower Quartile
2) Upper Quartile - 75th percentile; 25% of data are higher than the upper quartile
3) Lower Quartile - 25th percentile; 25% of data are lower than the lower quartile

SOURCE: USGS

DUDEK

FIGURE 2-11
Historical Streamflow Distribution on Ballona Creek
Groundwater Sustainability Plan for the Santa Monica Subbasin

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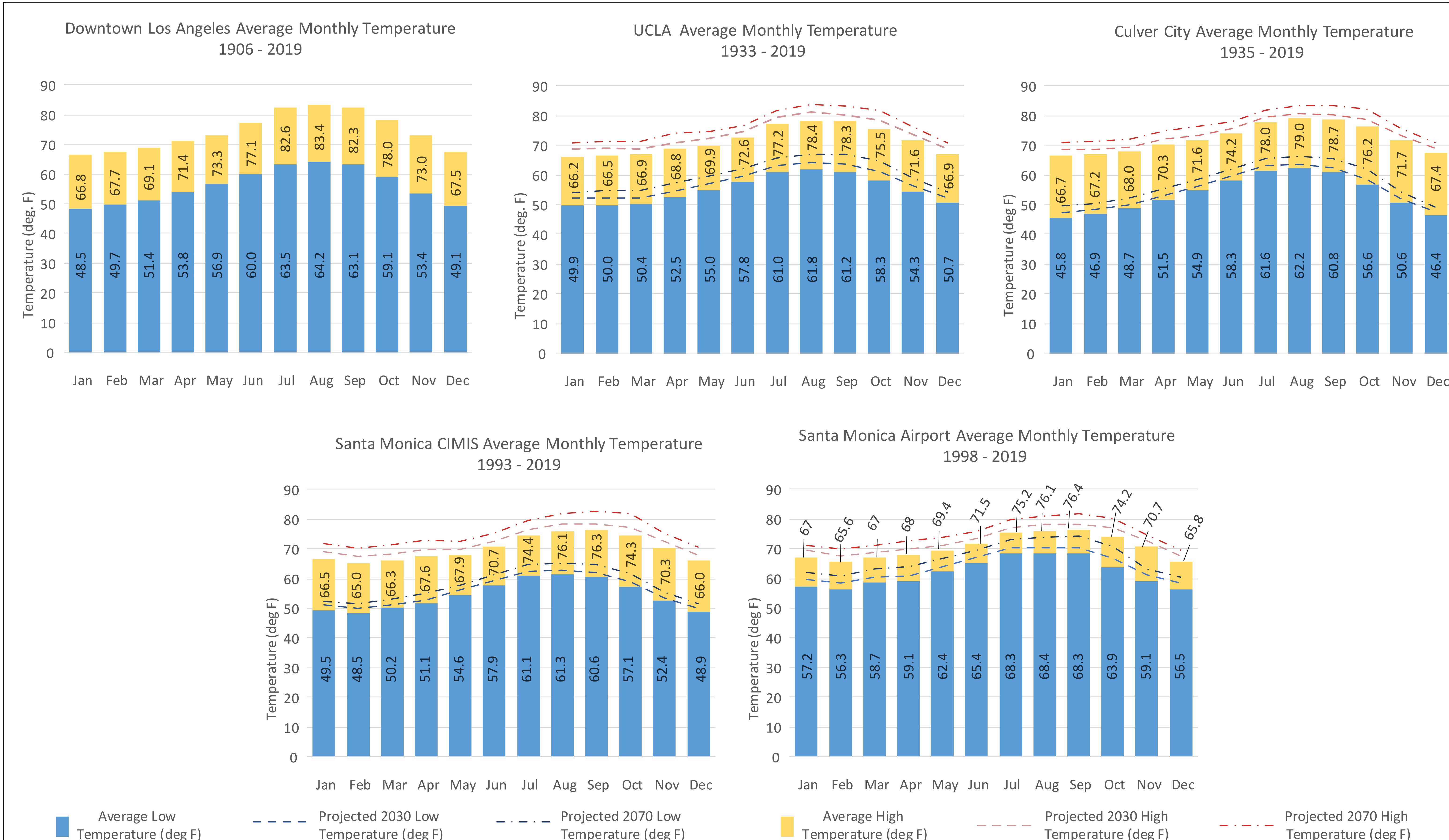

SOURCE: NOAA; CIMIS

DUDEK

FIGURE 2-12

Average Historical and Projected Monthly Temperature

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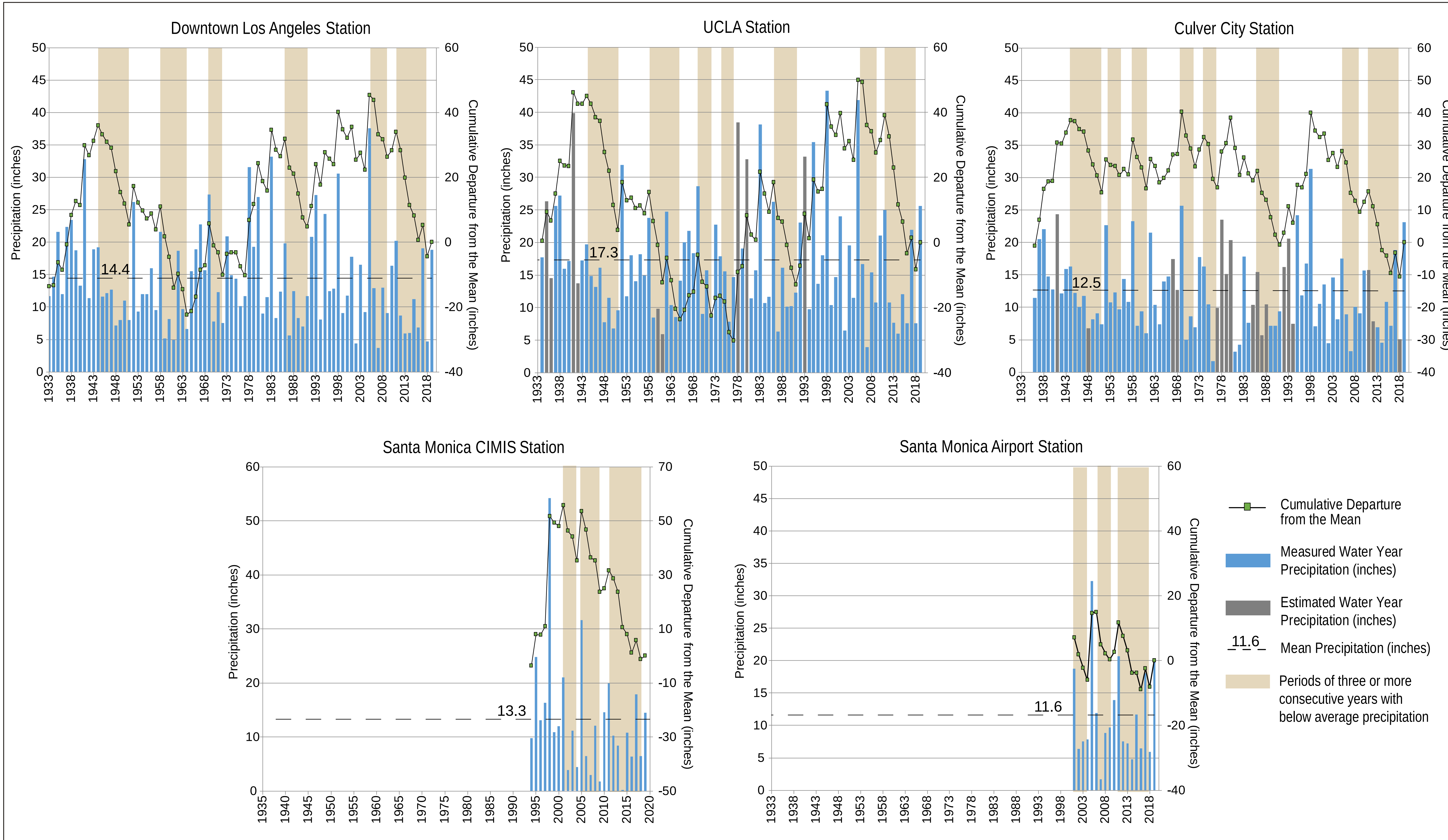

SOURCE: NOAA; CIMIS
NOTE: 1) Water Year is October 1 through September 30; 2) Estimated Water Year Precipitation Reconstructed from Correlation with Downtown LA Station

DUDEK

FIGURE 2-13
Water Year Precipitation
Groundwater Sustainability Plan for the Santa Monica Subbasin

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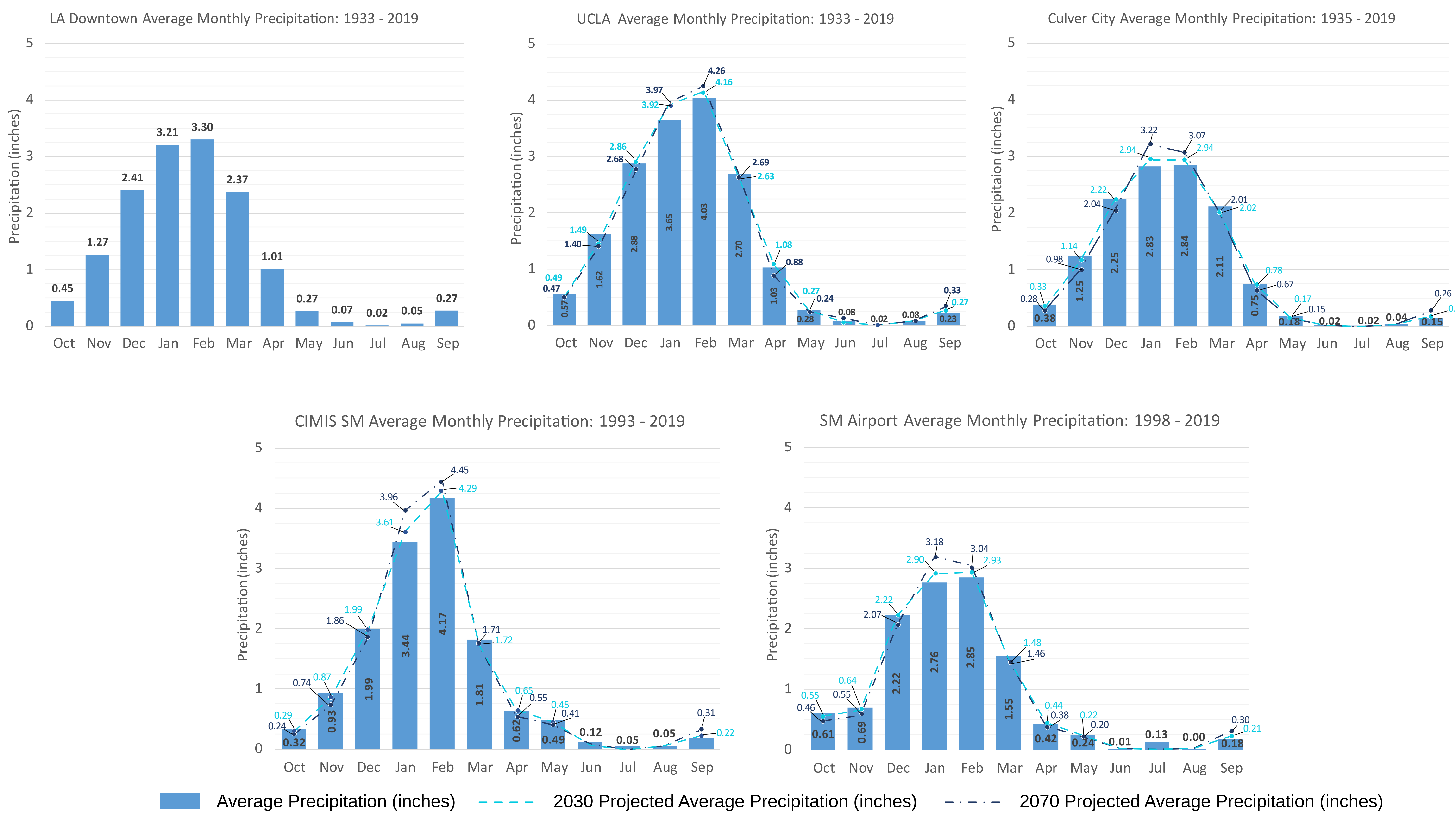

SOURCE: NOAA; CIMIS

FIGURE 2-14

Average Monthly Precipitaion

DUDEK

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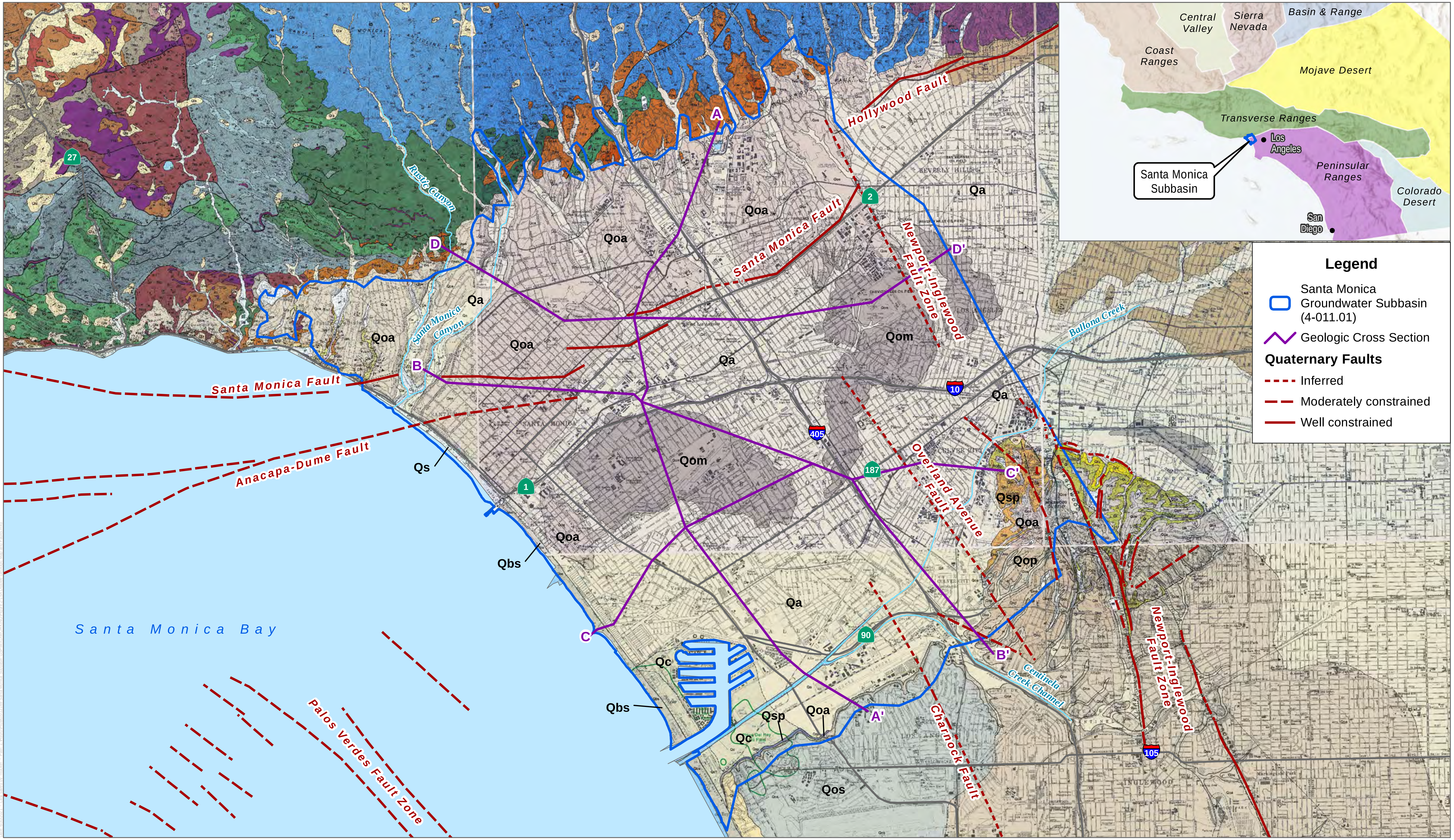

SOURCE: ESRI; DWR; USGS; Dibblee

DUDEK

0 1 2 Miles

Notes:
Map Legend is in Figure 2-15B
Cross Section details are in Figures 2-18 to 2-21

FIGURE 2-15A

Geologic Map

Groundwater Sustainability Plan for the Santa Monica Subbasin

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SURFICIAL SEDIMENTS
Unconsolidated detrital sediments; generally undissected

af *Artificial cut and fill*
Qs/Qbs *Beach sand*
Qa *Alluvial gravel, sand and silt-clay, derived mostly from Santa Monica Mountains; includes gravel and sand of stream channels*

LANDSLIDE DEBRIS
Unconsolidated detrital sediments; generally undissected

Qls *Landslide debris*

OLDER SURFICIAL SEDIMENTS
Unconsolidated to weakly consolidated alluvial sediments, dissected where elevated; late Pleistocene age

Qae *Alluvial fan sediments of granitic sand at West Hollywood, derived from adjacent Santa Monica Mountains*
Qop *Paleosoil in Baldwin Hills (Fox Hills residual paleosoil of Weber et al. 1982), gray to rusty brown, sandy, locally pebbly, moderately indurated "hardpan" on* **Qoa**
Qoa *Older alluvium of gray to light brown pebble-gravel, sand, silt and clay derived from Santa Monica Mountains; slightly consolidated; in Baldwin Hills designated as Baldwin Hills sandy gravel by Weber et al, 1982, where it is much dissected and eroded*

— UNCONFORMITY —
in mountain areas

SHALLOW MARINE SEDIMENTS
Shallow marine and some alluvial detrital sediments, weakly consolidated, dissected where elevated; Pleistocene age

Qom *Marine deposits of Hoots 1931: light gray to light brown sand, pebbly sand gravel and silt; probably in part non-marine alluvium*
Qsp *San Pedro Sand (of Wright 1987; Culver Sand of Weber et al. 1982, in Baldwin Hills): light gray to light brown sand, fine to coarse grained or pebbly, locally contains shell fragments*
Ql *Inglewood Formation (of Wright 1987; Weber et al. 1982, in Baldwin Hills): light gray, friable; fine grained sandstone and interbedded soft gray siltstone; base not exposed*

OLDER SURFICIAL SEDIMENTS
Unconsolidated to weakly consolidated alluvial sediments, dissected where elevated; age, late Pleistocene

Qos *Old sand dune deposits*
Qae *Alluvial gravel, sand, and clay, slightly elevated and dissected*
Qop *Paleosol in Baldwin Hills (Fox Hills paleosol of Weber et al., 1982), gray to rusty brown, sandy, locally pebbly, moderately indurated "hardpan" on* **Qoa**
Qoa *Older alluvium of gray to light brown pebble-gravel, sand, and silt-clay, elevated and dissected; in Baldwin Hills designated as Baldwin Hills sandy gravel by Weber et al., 1982, where it is much dissected and eroded*

UNAMED SHALE
(Upper member of Modelo Formation of Hoots 1931; upper Modelo Formation of Durrell 1954; equivalent to Sisquoc Formation of Dibblee 1989, in Ventura Basin)
Marine clastic and biogenic; late Miocene age
("Delmontian" and upper Mohnian Stages)

Tud *Soft, white-weathering diatomaceous shale to diatomite, bedded, soft, semi-punky, porous; grades laterally westward into* **Tush**

MONTEREY FORMATION
(Lower member of Modelo Formation of Hoots 1931; Lower Modelo Formation of Durrell 1954; equivalent to Monterey Formation of Dibblee 1989, in Ventura Basin)
Marine biogenic; mostly late Miocene age (Mohnian, possibly late Luisian Stage)

Tm *White-weathering, thin bedded, platy dark brown siliceous shale; moderately hard; porcelaneous, locally brittle and cherty in lower part*
Tmss *Tan to light gray semi-friable bedded sandstone; locally includes interbedded shale; deposited as deep sea fans (Tarzana Fan of Sullwold 1960); locally on south side of mountains, basal sandstone member consists of hard pebbly graywacke of slate on Santa Monica Slate*
Tmu *Mostly shale similar to Tm but includes interbedded tan friable sandstone similar to* **Tmss**
Tmc *Gray claystone at base, includes minor gray sandstone; crumbly where weathered*

— UNCONFORMITY —

UPPER TOPANGA FORMATION
(Of Durrell 1954; part of Topanga Formation of Hoots 1931; may be equivalent to Calabasas Formation of Yerkes and Campbell 1979)
Marine clastic; middle Miocene age

Ttush *Gray micaceous clay shale*
Ttucg *Light gray conglomerate of pebbles and cobbles of granitic and metaporphyritic rocks and of subangular dense black andesite (derived from* **Tva***) in soft sandy matrix*
Ttusl *Mostly gray micaceous clay shale or claystone, crumbly where weathered, and thin interbeds of light gray to tan semi-friable sandstone; locally includes pebbly sandstone and lenses of pebble-cobble conglomerate; poorly exposed*
Ttusc *Light gray sandstone and pebble-cobble conglomerate*

UNAMED STRATA
[Kss, Ksh, Kcg - "Chico" Formation of Durrell 1954; Fritsche 1973; A.E.G. maps 1982; equivalent (?) to Tuna Canyon Formation of Yerkes and Campbell 1979]
Mostly marine clastic; late Cretaceous age

Kss *Tan moderately hard sandstone, and some interbedded micaceous clay shale*
Ksh *Gray micaceous shale with minor thin sandstone strata*
Kcg *Gray to light brown, crudely bedded cobble conglomerate of granitic, metavolcanic and quartzite detritus in hard sandstone matrix; Locally includes interbedded sandstone; marine (?)*
Kcr *"Trabuco" Formation (of Durrell 1954; Colburn, in Fritsche 1973): rusty brown conglomerate similar to* **Kcg***, which locally includes reddish sandstone and claystone; probably nonmarine*

— UNCONFORMITY —
CRYSTALLINE BASEMENT ROCKS

QUARTZ DIORITE
Intrusive into Santa Monica Slate; (Silver*, in Dibblee 1982)
*Cretaceous (?) age (*102+/- m.y.)*

qd *Gray to light gray medium grained granitic rock composed of about 1/4 quartz, 1/2 sodic plagioclase feldspar, and 1/4 biotite; rock massive to locally vaguely gneissoid; much fractured and deeply weathered; incoherent where weathered*

SANTA MONICA SLATE
(Of Hoots 1931)
Metamorphosed marine sedimentary rocks; (Imlay, in Dibblee 1982)*
** late Jurassic age*

sms *Dark bluish gray slate-phyllite, weathers brown; cleavage parallel to bedding; metamorphosed from shale, possibly in part from graywacke; fine grained, composed of mica, quartz, and feldspar; in eastern exposures cleavage planes spotted with dark microflake clusters of biotite on cordierite (Hoots 1931); in places contains veinlets of quartz; slate hard, platy, but much fractured, commonly sheared; weathers to reddish brown soil*

MIDDLE TOPANGA FORMATION AND VOLCANIC ROCKS
(Middle Topanga Formation of Durrell 1954: part of Topanga Formation of Hoots 1931)
Marine clastic; middle Miocene age (Tvb and Ttsi intercalated)

Ttsi *Mostly interbedded gray to tan semi-friable sandstone and gray micaceous claystone; locally includes lenses of pebbly sandstone and pebble-cobble conglomerate*
Ttcg *Light gray conglomerate of cobbles and pebbles of granitic metamorphic and quartzitic rocks in soft sandy matrix*
Tts *Tan semi-friable sandstone, poorly exposed*
Tvb *Basaltic volcanic rocks: dark gray to black, fine grained, massive, rarely vesicular; composed of mafic minerals (augite and olivine) and plagioclase feldspar; incoherent where weathered; occurred as lenticular flows and/or injected sills; probably equivalent to and related to Conejo Volcanics of Yerkes and Campbell 1979*
Tva *Andesitic volcanic rocks, black where fresh, weathers dark gray to brown, fine grained, in part vesicular, brecciated; may range to basaltic*
bi *Intrusive basalt-andesite*

LOWER TOPANGA FORMATION
(Of Durrell, 1954; Topanga Formation of Hoots 1931)
Marine clastic; middle or early Miocene age

Ttls *Mostly tan, semi-friable to hard arkosic sandstone; locally includes gray micaceous shale*
Ttlc *Mostly gray cobble conglomerate of granite and some metavolcanic detritus, locally in sandstone matrix*

— UNCONFORMITY —

SANTA SUSANA FORMATION
(Of Colburn and Novak 1989; equivalent to Coal Canyon Formation of Yerkes and Campbell 1979)
Marine and nonmarine(?) clastic; Paleocene age

Tsu *Light gray to tan fine grained sandstone and gray, vaguely bedded micaceous silty claystone; locally with fossiliferous nodules*
Tsl *Simi Conglomerate Member: gray, vaguely bedded, cobble conglomerate of smooth cobbles of gray quartzite, metavolcanic rocks and hard granitic rocks in sandstone matrix; locally includes a few thin layers of nonmarine(?) red sandstone and claystone*

SOURCE: ESRI; DWR; USGS; Dibblee

DUDEK

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FIGURE 2-15B
Figure 2-15A Legend
Groundwater Sustainability Plan for the Santa Monica Subbasin

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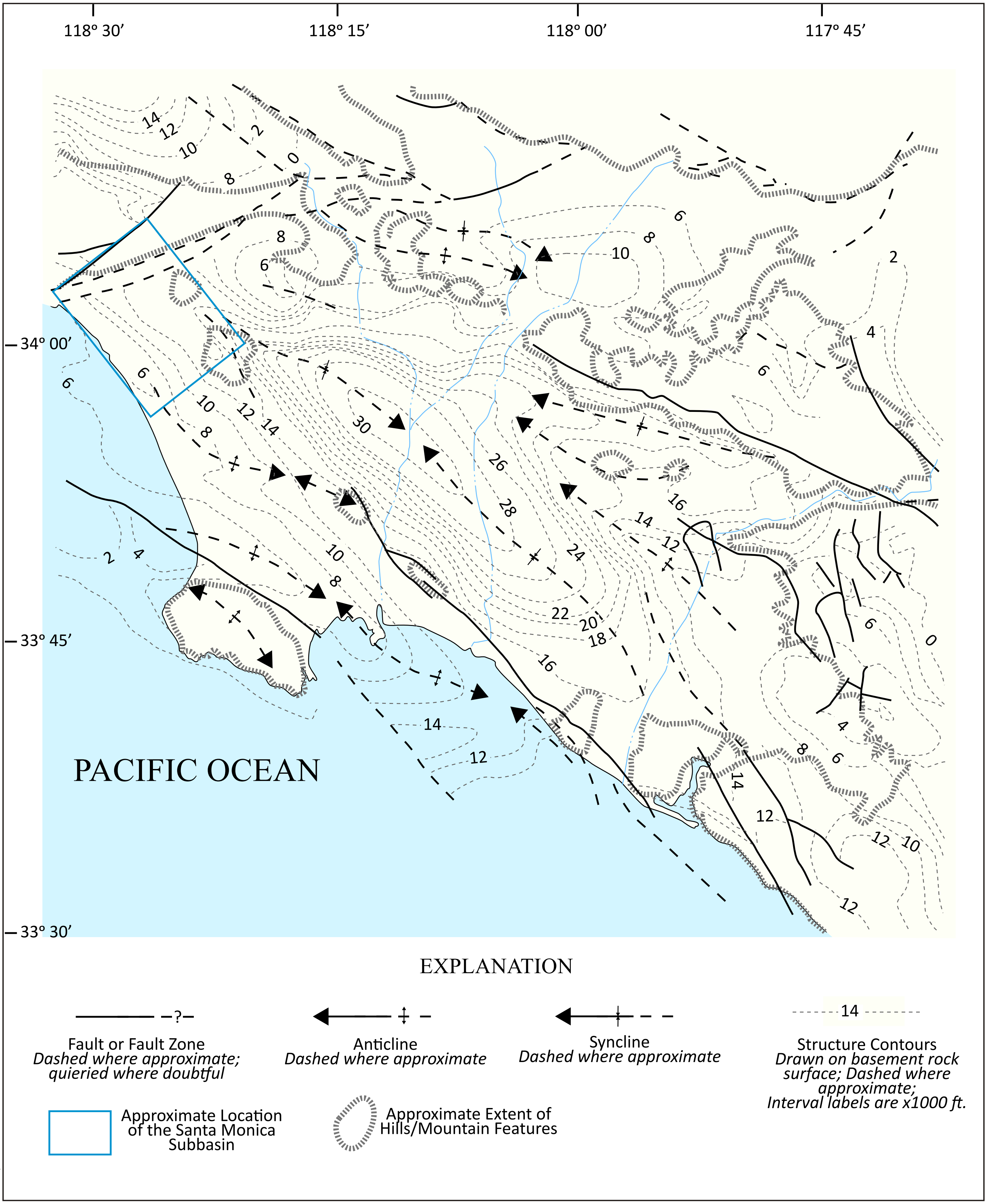

SOURCE: Excerpted from USGS 1965

FIGURE 2-16

Major Structural Features and Structure Contours on the Basement Surface of the Los Angeles Basin

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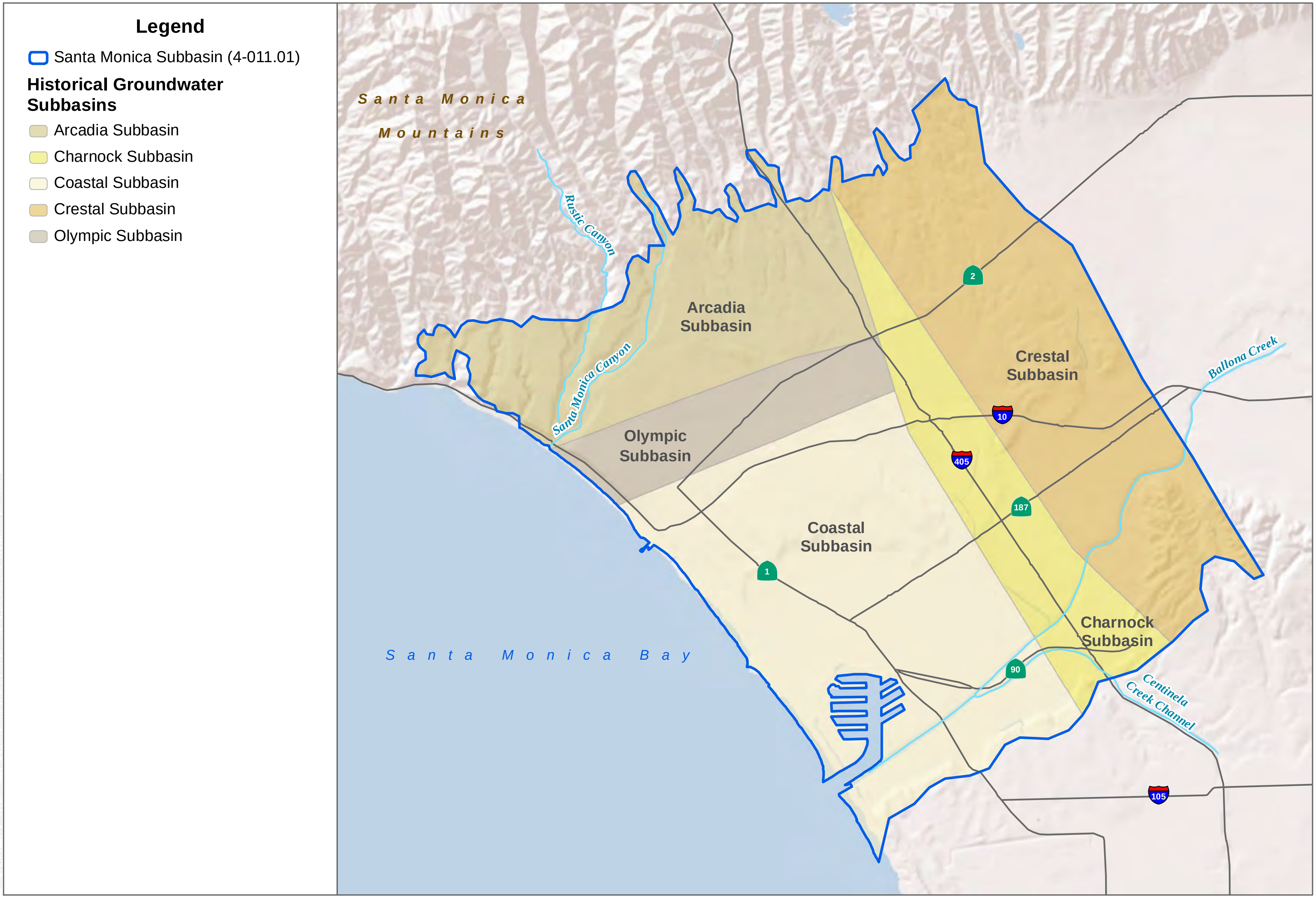

SOURCE: ESRI; DWR; USGS; City of Santa Monica 2018

DUDEK

0 0.5 1 Miles

FIGURE 2-17

Historical Subbasins within the Santa Monica Subbasin

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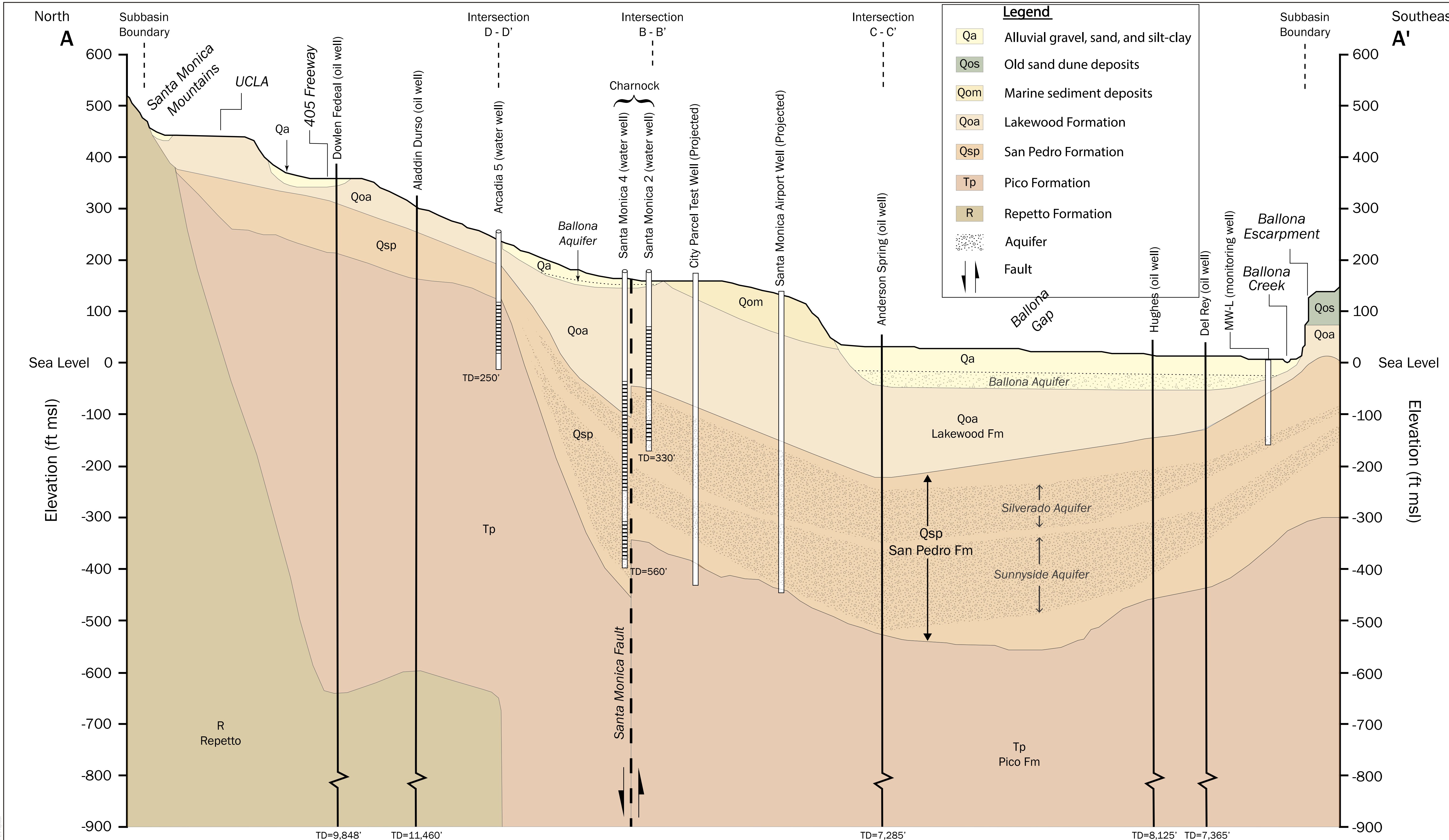

SOURCE: Adopted from Santa Monica 2013

Horizontal Scale: 1 inch = 3,475 feet

FIGURE 2-18

Geologic Cross Section A - A'

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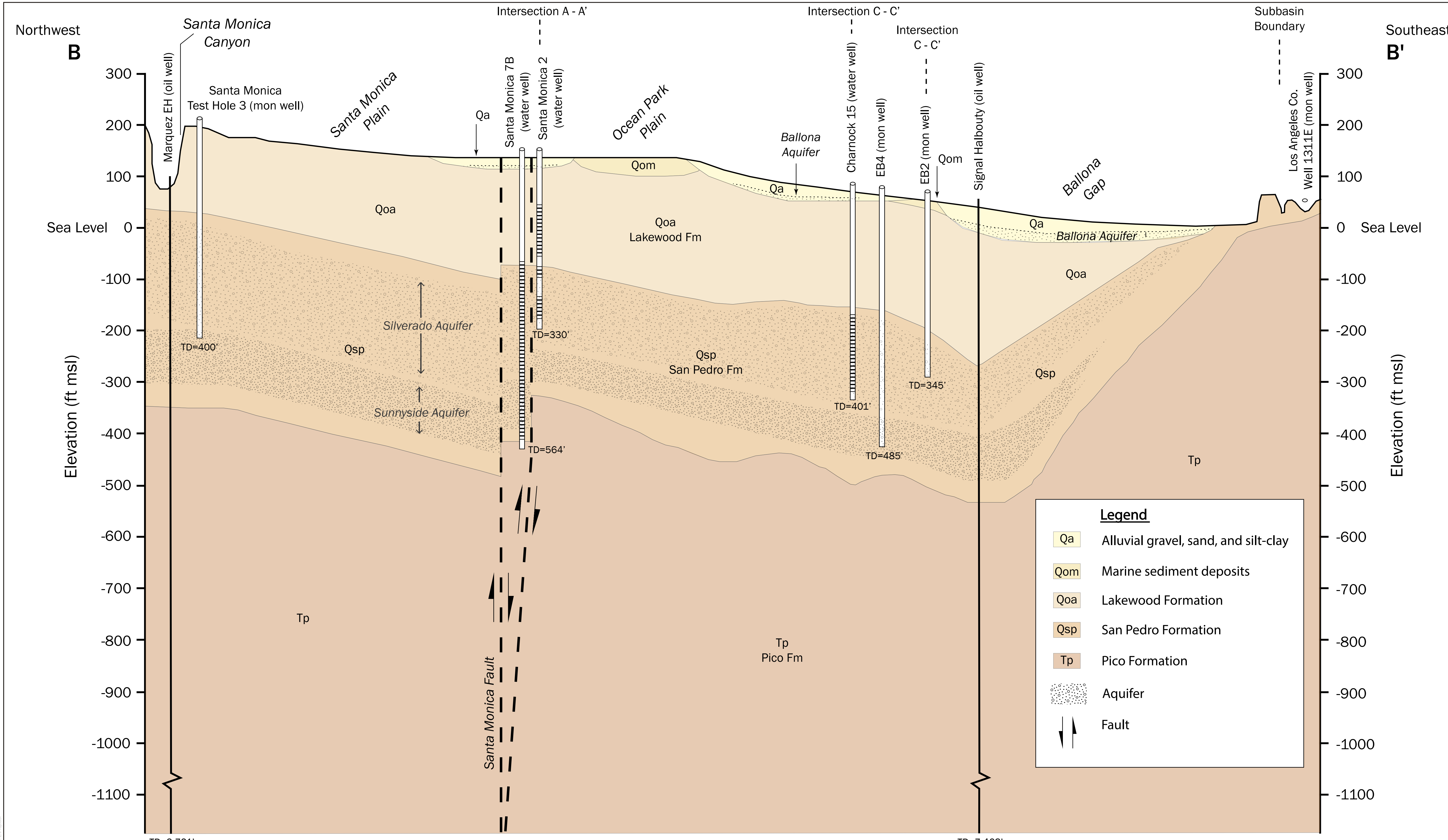

SOURCE: Adopted from Santa Monica 2013

Horizontal Scale: 1 inch = 3,475 feet

FIGURE 2-19

Geologic Cross Section B - B'

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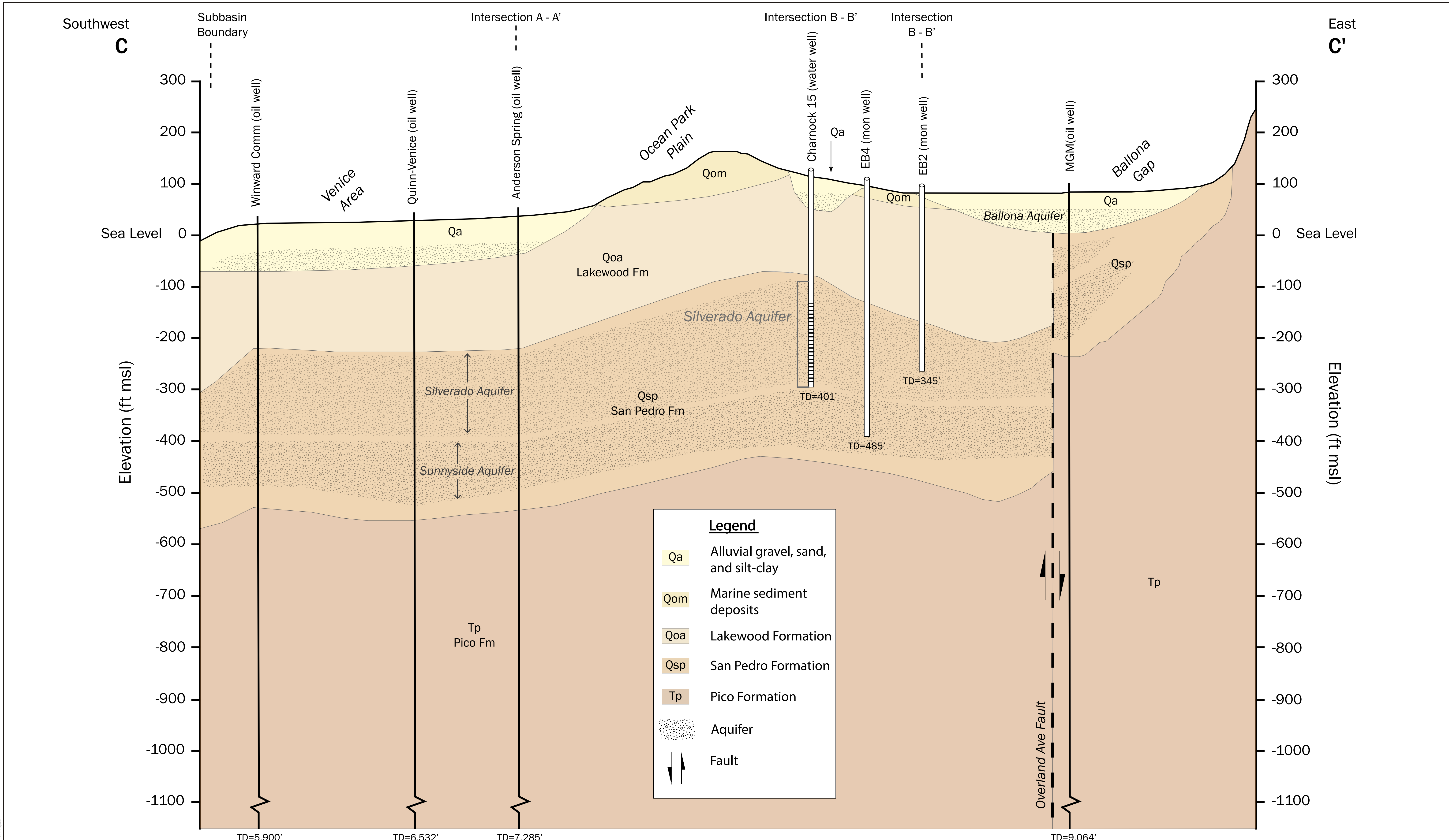

SOURCE: Adopted from Santa Monica 2013

Horizontal Scale: 1 inch = 2,750 feet

DUDEK

FIGURE 2-20

Geologic Cross Section C - C'

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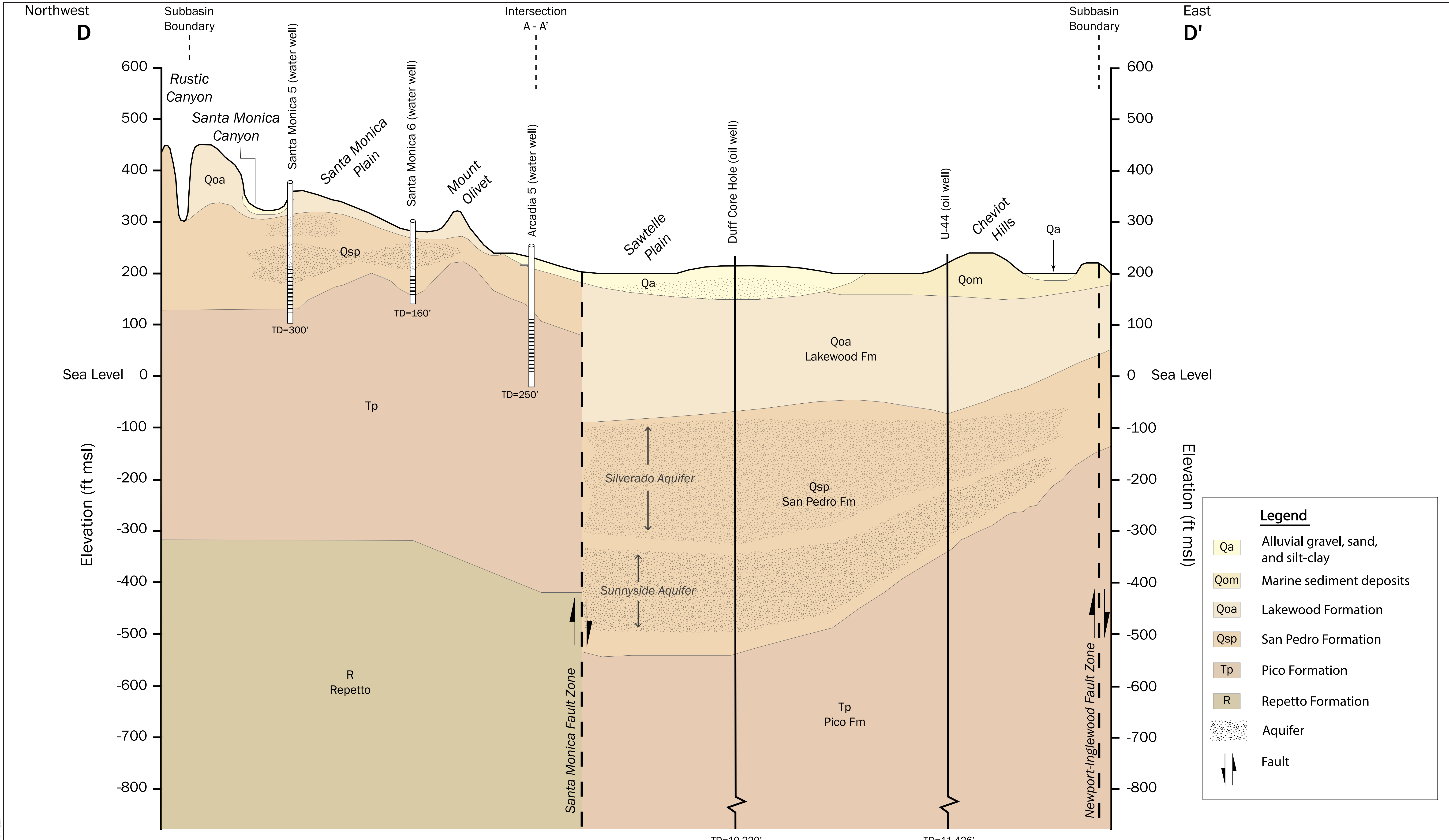

SOURCE: Adopted from Santa Monica 2013

Horizontal Scale: 1 inch = 3,500 feet

FIGURE 21

Geologic Cross Section D - D'

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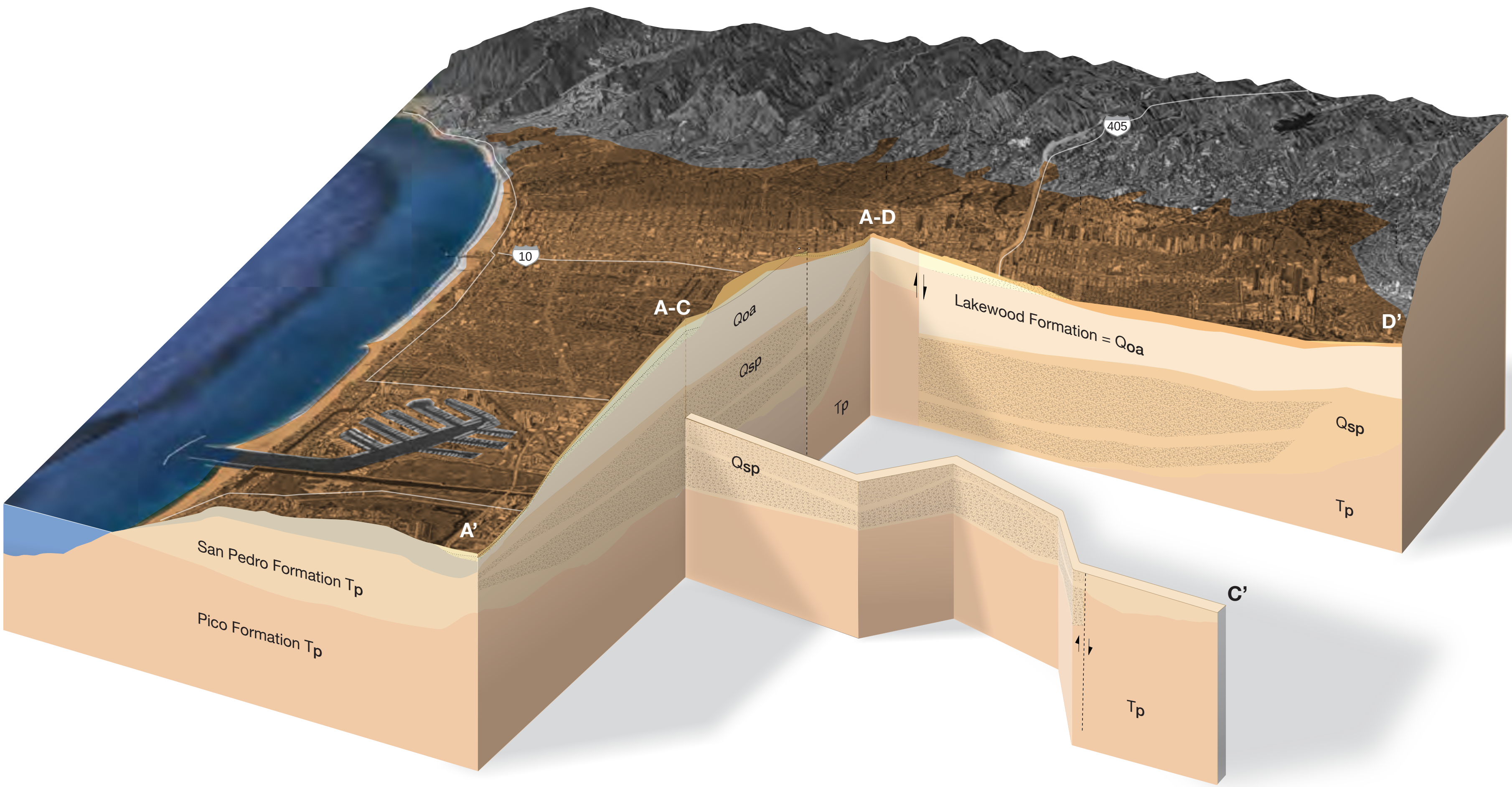

SOURCE: City of Santa Monica 2018

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FIGURE 2-22

Geologic Cross Section Block Diagram

Groundwater Sustainability Plan for the Santa Monica Subbasin

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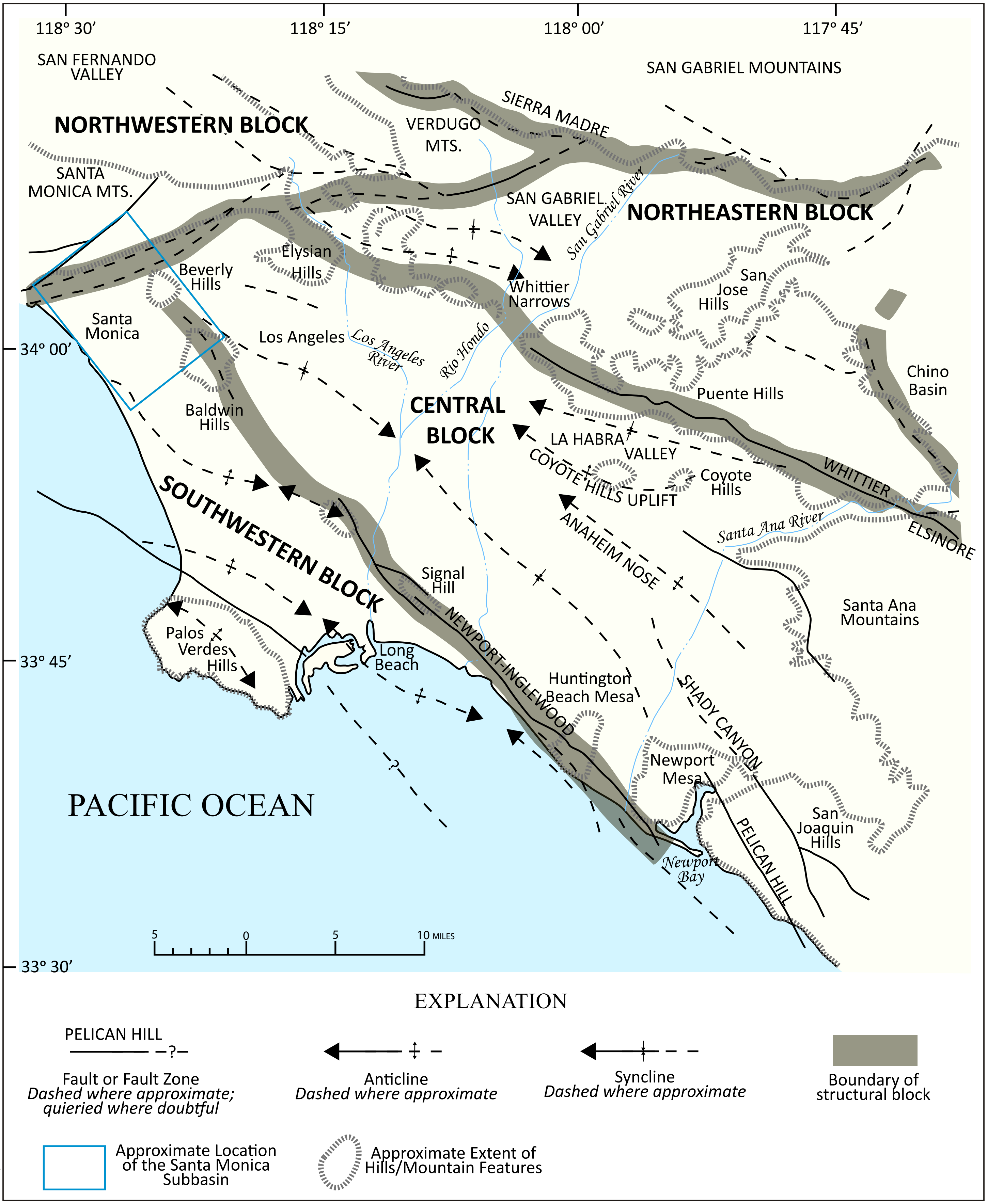

SOURCE: Excerpted from USGS 1965

FIGURE 2-23

Physiographic Features and Major Structural Features on the Basement Surface of the Los Angeles Basin

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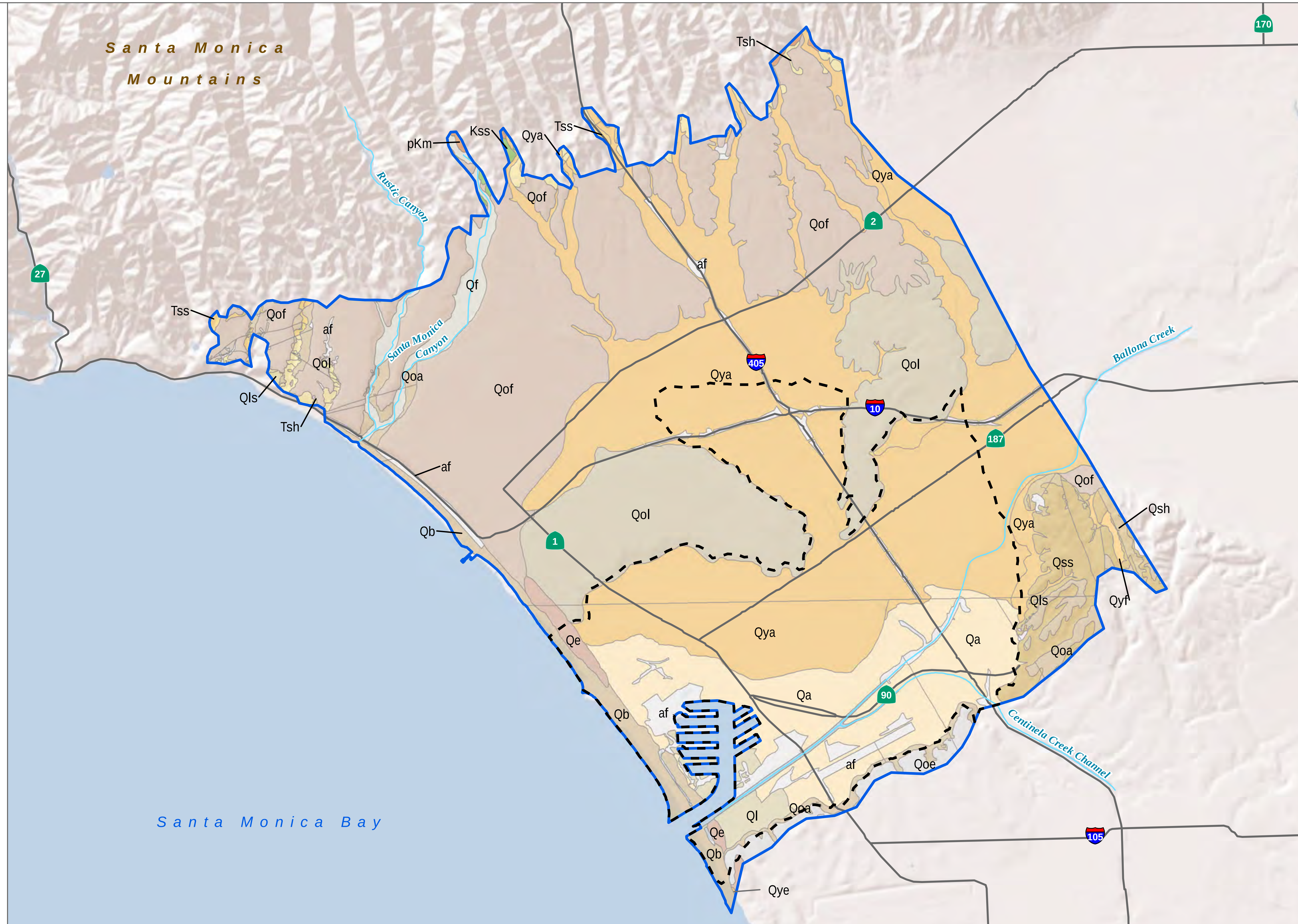
Legend

- Santa Monica Subbasin (4-011.01)
- Approximate Extent Ballona Aquifer

Surficial Geologic Deposits

Geologic Unit, Name

- Kss, Coarse-grained Cretaceous age formations of sedimentary origin
- Qa, Alluvial Valley Deposits
- Qb, Beach Deposits
- Qe, Eolian and Dune Deposits
- Qf, Alluvial Fan Deposits
- Ql, Lacustrine, Playa and Estuarine (Paralic) Deposits
- Qls, Landslide Deposits; may include debris flows and older landslides
- Qoa, Old Alluvial Valley Deposits
- Qoe, Old Eolian and Dune Deposits
- Qof, Old Alluvial Fan Deposits
- Qol, Old Lacustrine, Playa and Estuarine (Paralic) Deposits
- Qsh, Fine-grained formations of Pleistocene age and younger
- Qss, Coarse-grained formations of Pleistocene age and younger; primarily sandstone and conglomerate
- Qya, Young Alluvial Valley Deposits
- Qye, Young Eolian and Dune Deposits
- Qyf, Young Alluvial Fan Deposits
- Tsh, Fine-grained Tertiary age formations of sedimentary origin
- Tss, Coarse-grained Tertiary age formations of sedimentary origin
- Tv, Tertiary age formations of volcanic origin
- af, Artificial Fill
- pKm, Cretaceous and Pre-Cretaceous metamorphic formations of sedimentary and volcanic origin



SOURCE: ESRI; DWR; USGS; CGS

DUDEK

0 1 2 Miles

FIGURE 2-24

Ballona Aquifer Extent

Groundwater Sustainability Plan for the Santa Monica Subbasin

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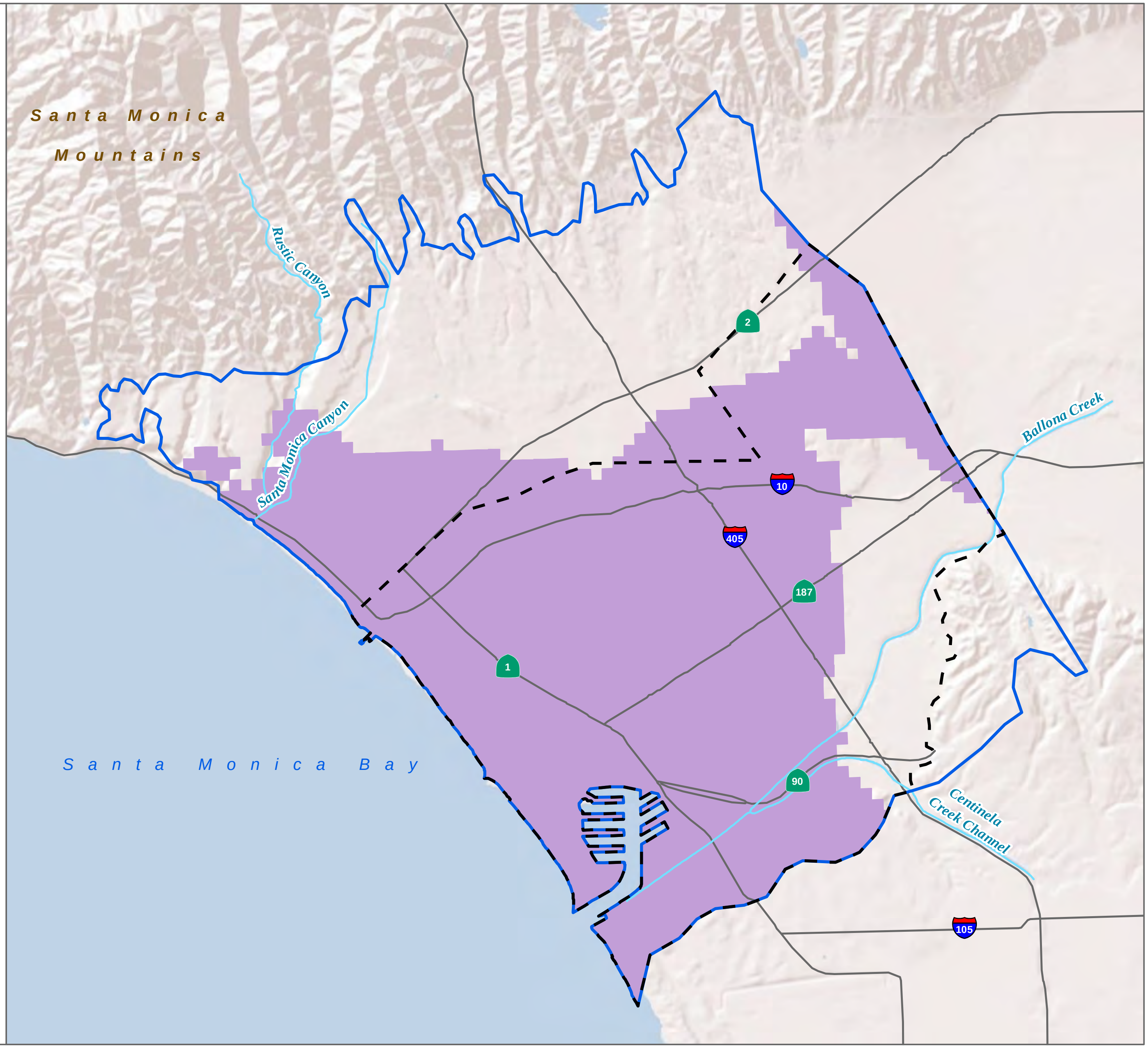
Legend

- Santa Monica Subbasin (4-011.01)
- USGS Approximate Extent Silverado Aquifer
- DWR Approximate Extent Silverado Aquifer



SOURCE: ESRI; DWR 1961; USGS 2021

DUDEK

0 0.5 1 Miles

FIGURE 2-25

Silverado Aquifer Extent

Groundwater Sustainability Plan for the Santa Monica Subbasin

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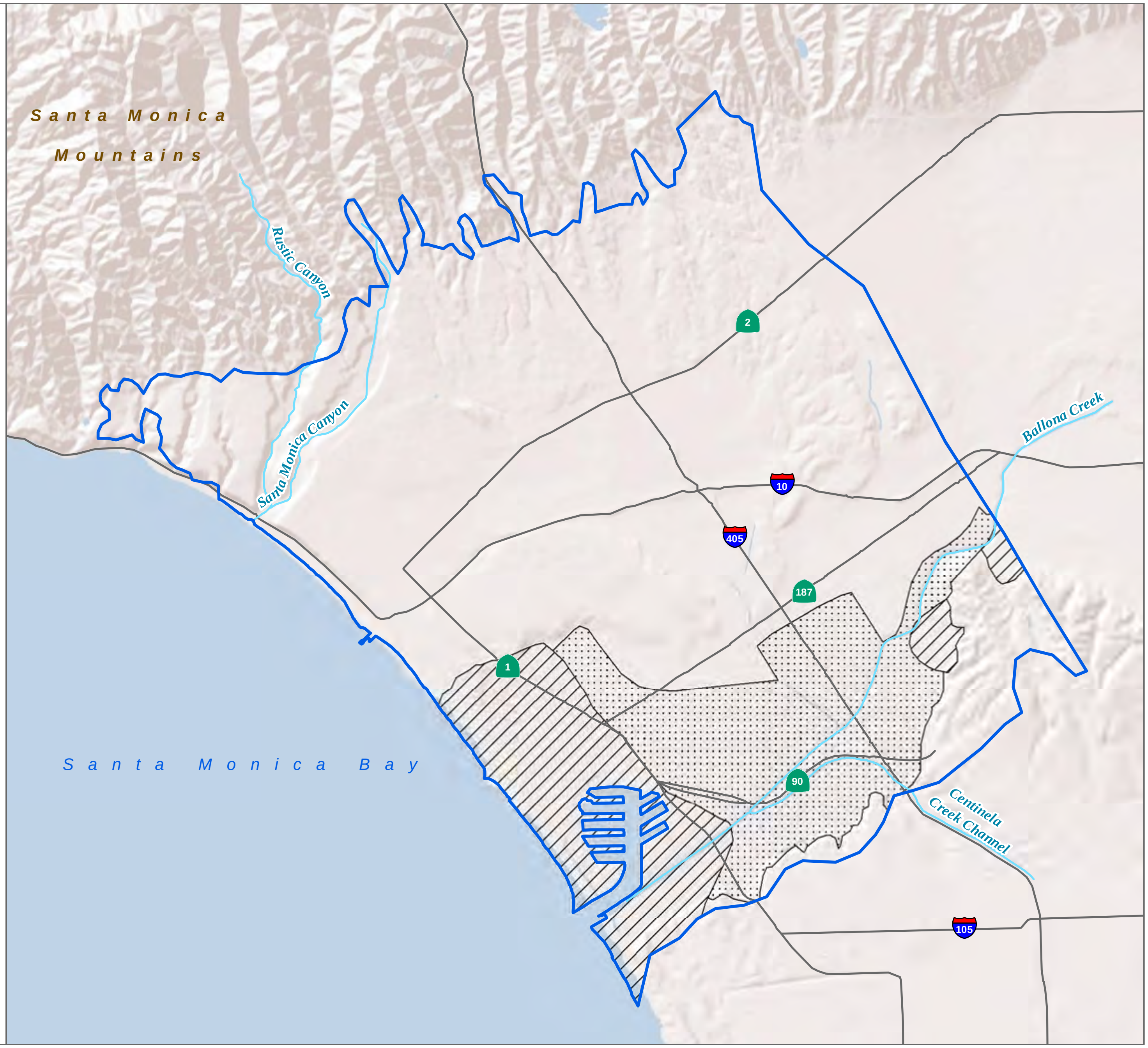
Legend

- Santa Monica Subbasin (4-011.01)
- Chloride Content >100 ppm
- Chloride Content >500 ppm



Note: The historical extent of estimated seawater intrusion is limited to the western area of the Subbasin where chloride concentrations were greater than 500 mg/L.

SOURCE: ESRI; DWR; USGS 1959

DUDEK

0 0.5 1 Miles

FIGURE 2-26

Historical Estimate of Seawater Intrusion Extent

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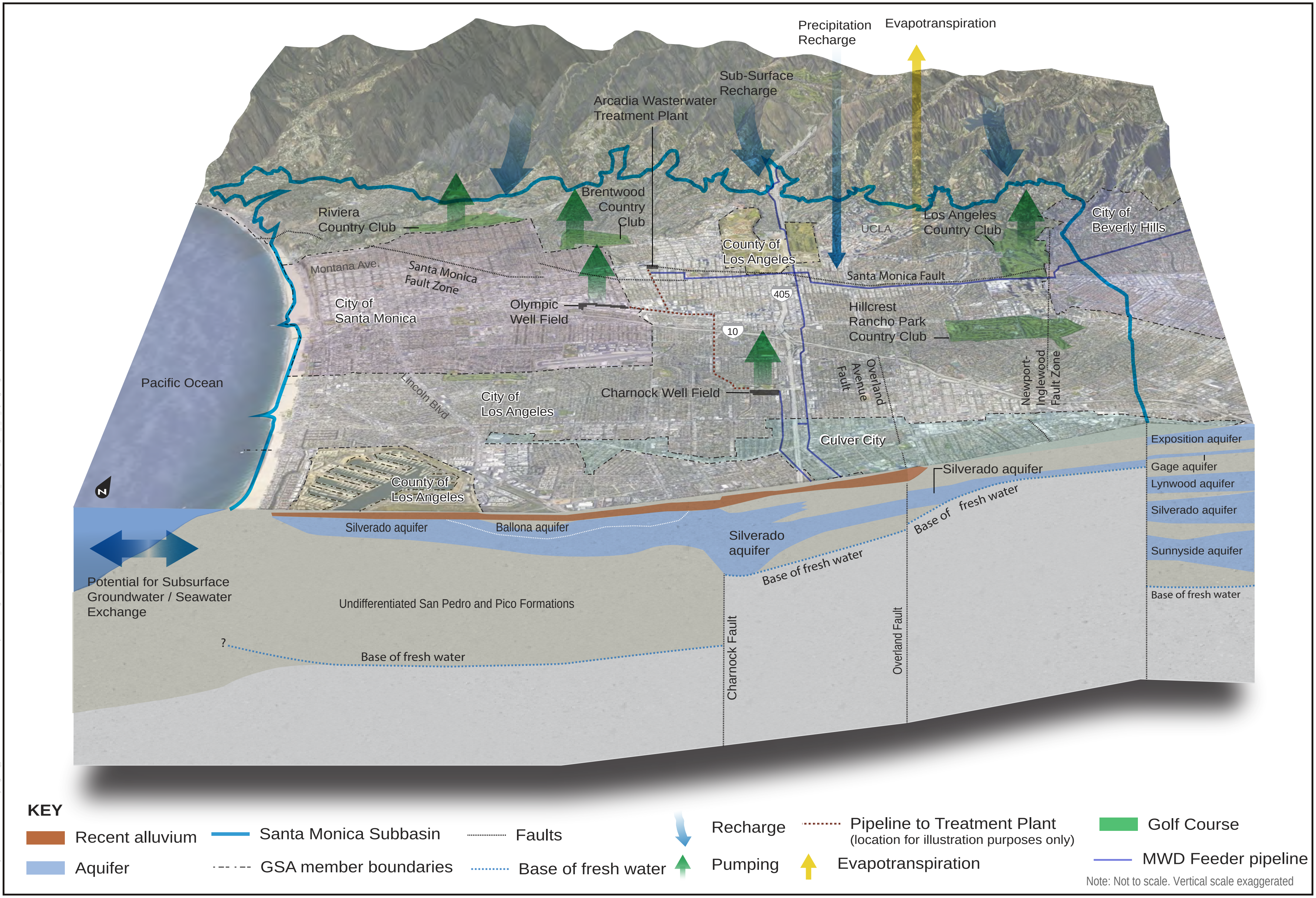

SOURCE: Google Earth, USGS 1959

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FIGURE 2-27

Hydrogeologic Conceptual Model

Groundwater Sustainability Plan for the Santa Monica Subbasin

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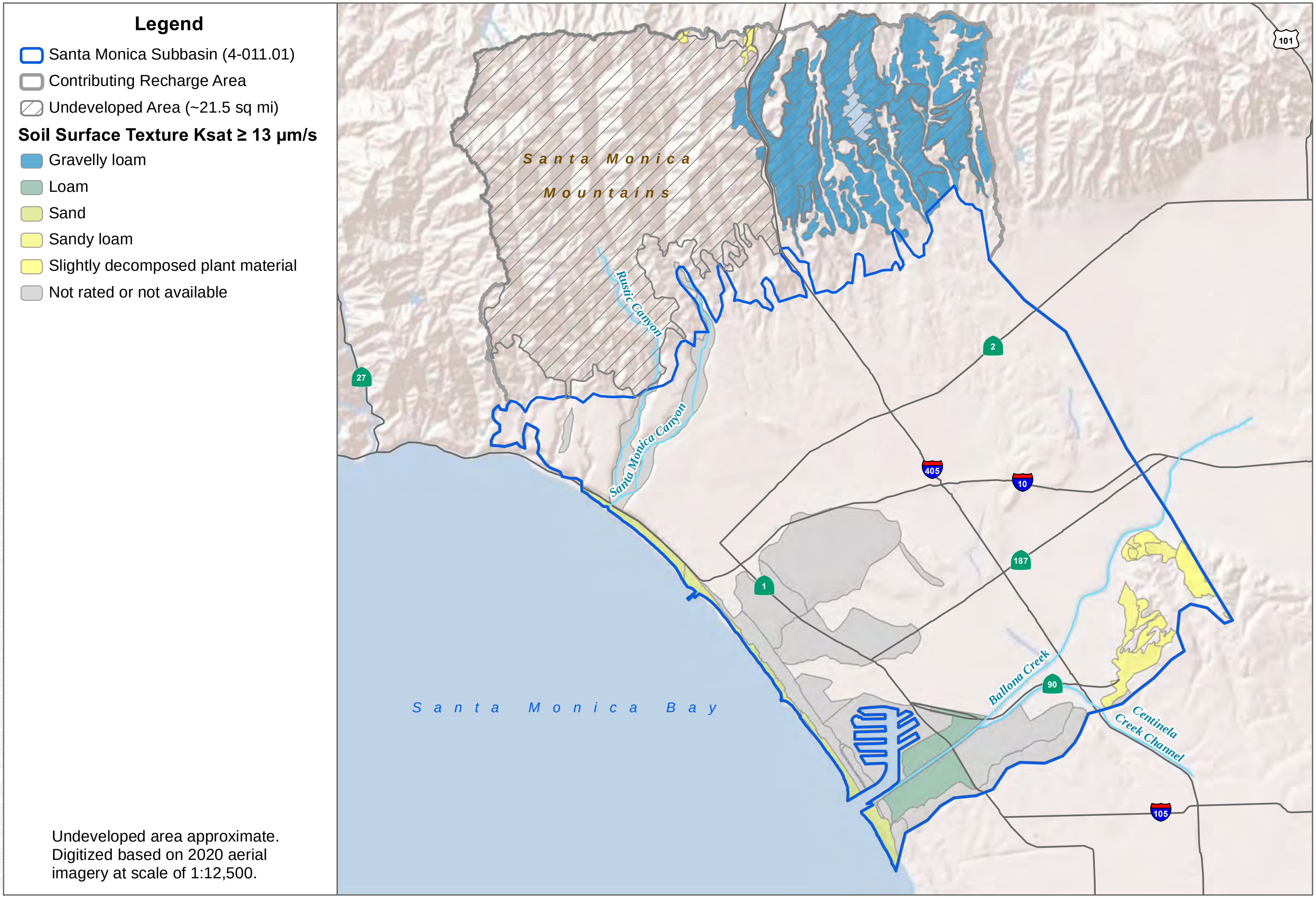

SOURCE: ESRI; DWR; USGS; NRCS

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FIGURE 2-28

Recharge Areas and Soils

Groundwater Sustainability Plan for the Santa Monica Subbasin

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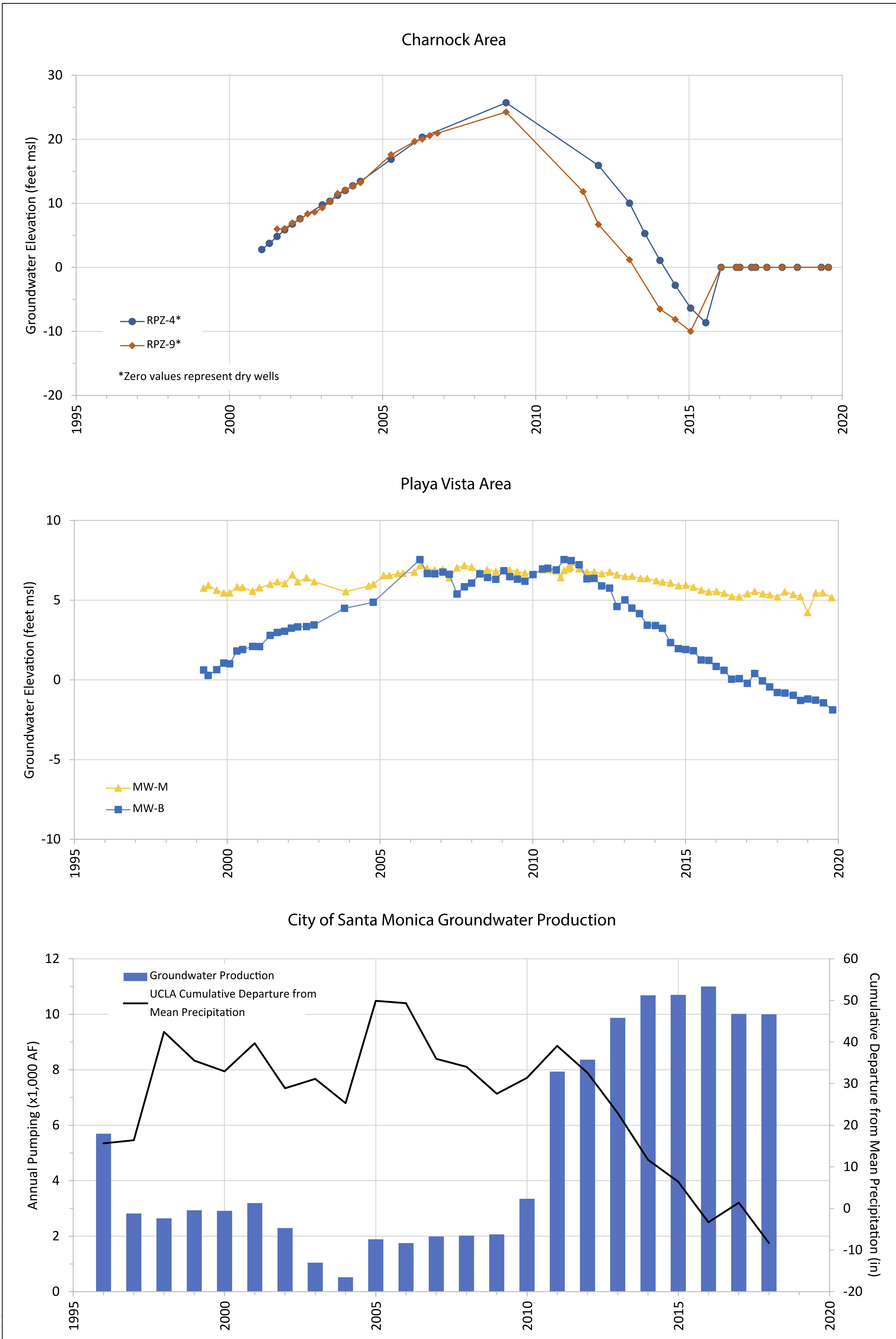

SOURCE: City of Santa Monica; State Water Resources Control Board; County of Los Angeles

FIGURE 2-29A

Groundwater Elevation Hydrographs in the Ballona Aquifer

Groundwater Sustainability Plan for the Santa Monica Subbasin

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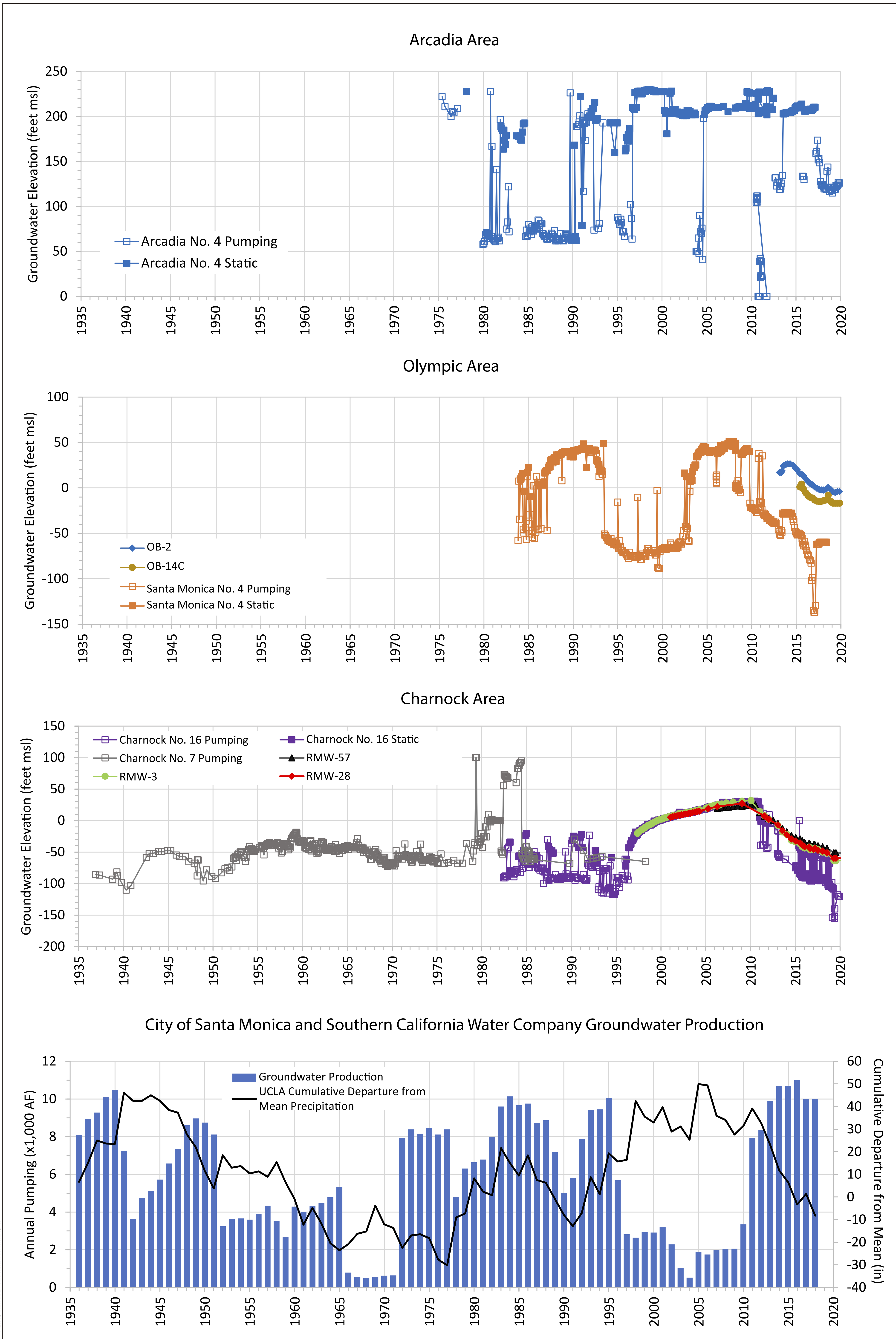

SOURCE: City of Santa Monica; State Water Resources Control Board; County of Los Angeles

FIGURE 2-29B

Groundwater Elevation Hydrographs in the Silverado Aquifer - Arcadia, Olympic, and Charnock Areas

Groundwater Sustainability Plan for the Santa Monica Subbasin

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