Home Gardens County Water District

Groundwater Sustainability Plan

Temescal Basin

January 2022

TODD GROUNDWATER

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County Water District

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SIGNATURE PAGE

Chad N. Taylor, PG, CHG
Principal Hydrogeologist, Todd Groundwater

PROFESSIONAL GEOLOGIST
CHAD N TAYLOR NO. 8443
STATE OF CALIFORNIA

CERTIFIED HYDROGEOLOGIST
CHAD N TAYLOR NO. 915
STATE OF CALIFORNIA

Maureen K Reilly, PE
Senior Engineer, Todd Groundwater

REGISTERED PROFESSIONAL ENGINEER
MAUREEN K. REILLY
C 67841
EXP. 6/30/23
CIVIL
STATE OF CALIFORNIA

Gus Yates, PG, CHG
Senior Hydrologist, Todd Groundwater

CERTIFIED HYDROGEOLOGIST
Eugene B. Yates
No. 740
Exp. 1/31/22
STATE OF CALIFORNIA

PROFESSIONAL GEOLOGIST
Eugene B. Yates
No. 7178
Exp. 1/31/22
STATE OF CALIFORNIA

Michael P. Maley, PG, CHG, CEG, PE
Principal Hydrogeologist, Todd Groundwater

CERTIFIED HYDROGEOLOGIST
MICHAEL PAUL MALEY
No. 654
Exp. 3/31/23
STATE OF CALIFORNIA

PROFESSIONAL GEOLOGIST
MICHAEL PAUL MALEY
No. 5270
Exp. 3/31/23
STATE OF CALIFORNIA

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Acronyms

1,2,3-TCP	1,2,3- Trichloropropane
AF	acre-feet
AFY	acre-feet per year
Basin Plan	Water Quality Control Plan for the Santa Ana River Basin
Basin	Temescal Subbasin
BMP	Best management practices
CASGEM	California Statewide Groundwater Elevation Monitoring
CDA	Chino Desalter Authority
CEQA	California Environmental Quality Act
cfs	cubic feet per second
cfs/mi	cubic feet per second per mile
CIMIS	California Irrigation Management Information System
COC	constituent of concern
Corona	City of Corona
DAC	disadvantaged community
DBP	disinfection byproduct
DDW	State Water Resources Control Board Division of Drinking Water
DMS	Data Management System
DWR	California Department of Water Resources
DWSAP	Drinking Water Source Water Assessment Program
ET	Evapotranspiration
ET_o	Reference evapotranspiration
ft	feet
ft/day	feet per day
GAMA	Groundwater Ambient Monitoring and Assessment
GDE	groundwater dependent ecosystem
GIS	geographic information system
gpcd	gallons per-capita per day
gpd/ft^2	gallons per day per square foot
GPS	global positioning system
GSA	Groundwater Sustainability Agency
GSP	Groundwater Sustainability Plan
GWMP	Groundwater Management Plan
HCP	habitat conservation plan
HGCWD	Home Gardens County Water District
in/yr	inches per year
InSAR	Synthetic Aperture Radar
IRWMP	Integrated Regional Water Management Plan
JPA	joint powers authority
K	hydraulic conductivity
km^2	square kilometers
LSCE	Luhdorff and Scalmanini Consulting Engineers

M&I	Municipal, commercial, and industrial
MA	Management Area
MCL	Maximum Contaminant Level
Met	Metropolitan Water District of Southern California
mg/L	milligrams per liter
mgd	million gallons per day
mi^2	square miles
mm	millimeter
MO	Measurable Objective
MODFLOW	United States Geological Survey modular finite-difference flow model
MOU	Memorandum of Understanding
MSHCP	Western Riverside County Multiple Species Habitat Conservation Plan
msl	mean sea level
MT	Minimum Threshold
NAD83	North American Datum of 1983
NAVD88	North American Vertical Datum of 1988
NCCAG	Natural Communities Commonly Associated with Groundwater
NDMI	Normalized Difference Moisture Index
NDVI	Normalized Difference Vegetation Index
NO_3	nitrate
NOAA	National Oceanic and Atmospheric Administration
Norco	City of Norco
NPS	nonpoint source
NRCS	U.S. Department of Agriculture, Natural Resources Conservation Service
NTU	Nephelometric Turbidity Unit
NWIS	National Water Information System
O&M	operation and maintenance
ORP	oxidation-reduction potential
Outreach Plan	Stakeholder Outreach Plan
OWOW Plan	One Water One Watershed Plan
OWTS	On-Site Wastewater Treatment System
PCE	Tetrachloroethylene
pCi/L	picocuries per liter
PFAS	per and polyfluoroalkyl substances
PFOA	perfluorooctanoic acid
PFOS	perfluorooctane sulfonate
PLSS	Public Land Survey System
POTW	publicly owned treatment works
ppt	parts per trillion
PVC	polyvinyl chloride
QA/QC	Quality Assurance and Quality Control

RCDEH	Riverside County Department of Environmental Health
RCFCWCD	Riverside County Flood Control and Water Conservation District
RFP	request for proposals
RMP	Recharge Master Plan
RO	reverse osmosis
RWMP	Reclaimed Water Master Plan
RWQCB	Santa Ana Regional Water Quality Control Board
SAR	Santa Ana River
SARHCP	Upper Santa Ana River Habitat Conservation Plan
SARWQCB	Santa Ana Regional Water Quality Control Board
SAWPA	Santa Ana Watershed Project Authority
SCAG	Southern California Association of Governments
SDAC	severely disadvantaged community
SFR	Streamflow Routing Package
SGMA	Sustainable Groundwater Management Act
SMCL	Secondary maximum contaminant level
SNMP	Salt and Nutrient Management Plan
SSURGO	Soil Survey Geographic Database
SWP	State Water Project
SWRCB	State Water Resources Control Board
TAC	Technical Advisory Committee
TCE	Trichloroethylene
TCP	1,2,3-Trichloropropane
TDS	total dissolved solids
Temescal GSA	Temescal Groundwater Sustainability Agency
TMDL	Total Maximum Daily Load
TSS	total suspended solids
TVWD	Temescal Valley Water District
µg/L	micrograms per liter
USBR	United States Bureau of Reclamation
USDA	United States Department of Agriculture
USEPA	United State Environmental Protection Agency
USFS	United States Forest Service
USGS	United States Geological Survey
UWMP	Urban Water Management Plan
VOCs	volatile organic compounds
WMWD	Western Municipal Water District
WRCRWA	Western Riverside County Regional Wastewater Authority
WRF	Water Reclamation Facility
WSCP	water shortage contingency plan

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EXECUTIVE SUMMARY

The Sustainable Groundwater Management Act (SGMA) requires local agencies in groundwater basins designated as high- or medium-priority to form Groundwater Sustainability Agencies (GSAs) and develop a Groundwater Sustainability Plan (GSP) to plan for achieving and/or maintaining sustainability within 20 years of implementing the plan. The Temescal Groundwater Subbasin (Basin) has been designated by the California Department of Water Resources (DWR) as medium priority and must prepare a GSP.

Wishing to provide a framework for cooperative groundwater management and SGMA compliance, the City of Corona (Corona), City of Norco (Norco), and the Home Gardens County Water District (HGCWD) executed a Memorandum of Understanding (MOU) in March 2017 establishing the Temescal Basin Groundwater Sustainability Agency (Temescal GSA). In August 2017, the Temescal GSA became the GSA for the Basin by submitting a formation notice to DWR. While Corona is leading this effort, the GSP will be developed jointly among the three agencies, with coordinated implementation toward sustainable management.

ES-1 BASIN SETTING

Figure ES-1 shows the Basin located in western Riverside County. **Figure ES-1** also shows the adjacent Bedford Coldwater, Chino, and Riverside-Arlington Subbasins of the Upper Santa Ana Groundwater Basin and the Coastal Plain of Orange County Basin. The Temescal Basin is bounded on the west by the Santa Ana Mountains and the east by low-lying El Sobrante de San Jacinto and La Sierra hills.

The Basin is located within one of the structural blocks of the Peninsular Ranges of Southern California. The Basin occurs in a linear low-lying block, referred to as the Elsinore-Temecula trough, between the Santa Ana Mountains on the west and the Perris Plain on the east (Todd and AKM 2008). The trough extends from Corona to the southeast some 30 miles and was formed along an extensive northwest-southeast trending fault zone including the Elsinore, Chino, and related faults. The Elsinore and Chino fault zones bound the Basin on the west and trend along the mountain fronts.

The basin-fill alluvial deposits and, to some extent, the underlying sedimentary units make up the aquifers in the Basin. However, these deposits do not fall neatly into two categories of permeability, such as bedrock and basin fill. Aquifer packages composed of various geologic units have been defined based on depositional environment, degree of consolidation, groundwater production, and location throughout the Basin.

Three aquifer packages provide water supply to wells in Basin: the Channel Aquifer, the Alluvial Fan aquifers, and, to a lesser extent, consolidated sandstone aquifers (Todd and AKM 2008). Of these three aquifers, the Channel Aquifer is the only principal aquifer as it the most productive aquifer and provides most of the groundwater supply in the Basin, **Figure ES-2**.

Figure ES-1. Temescal Basin

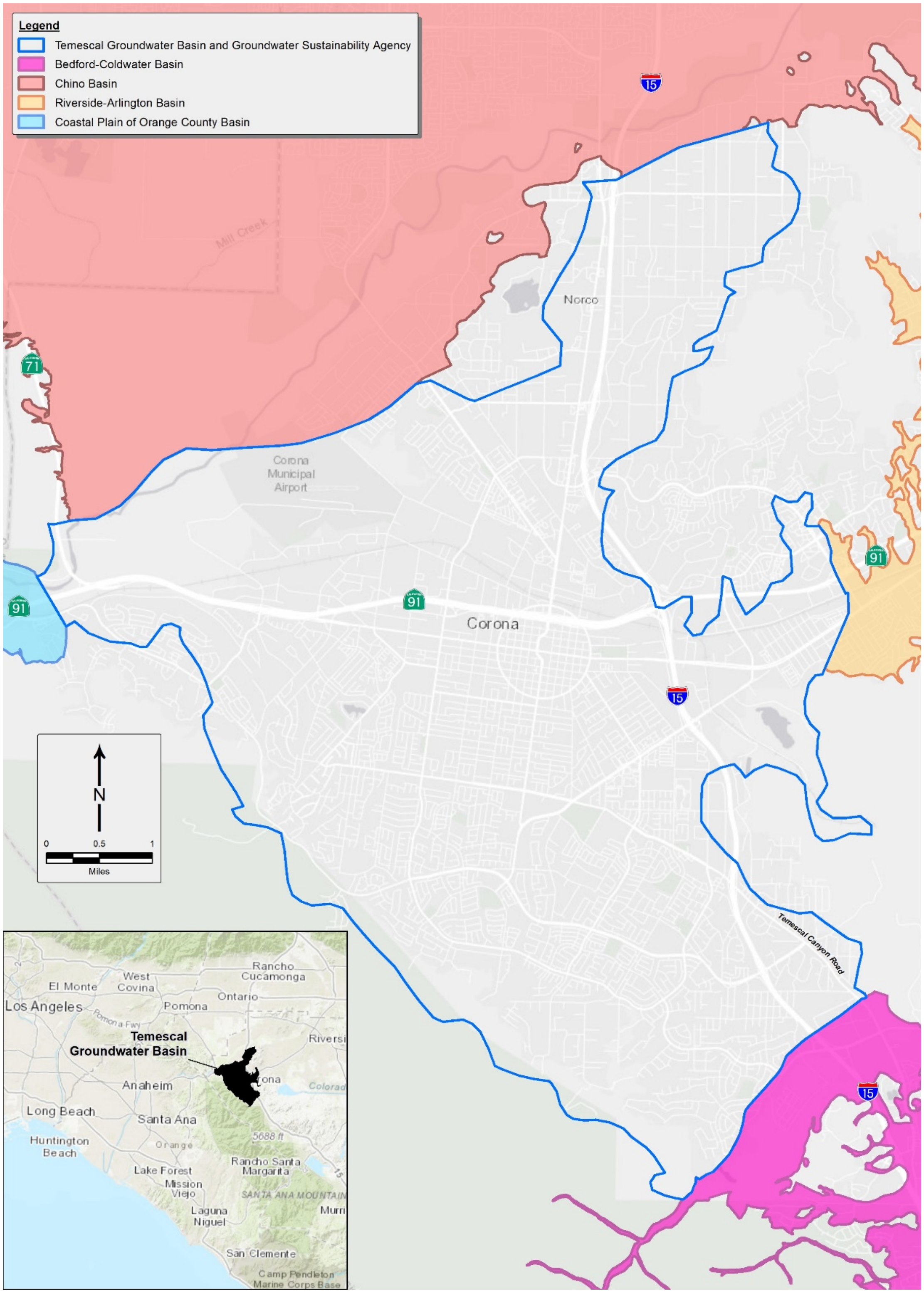
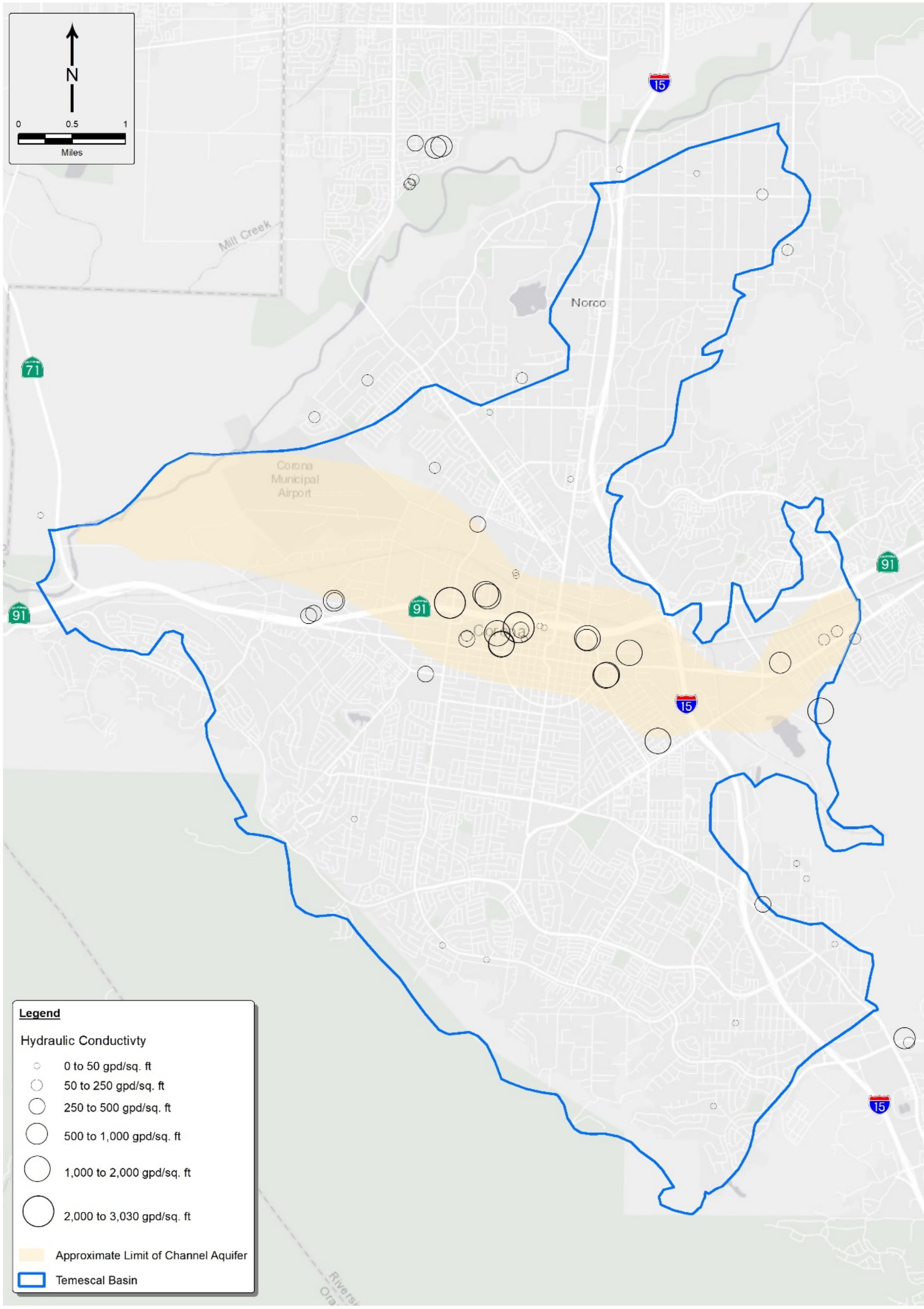


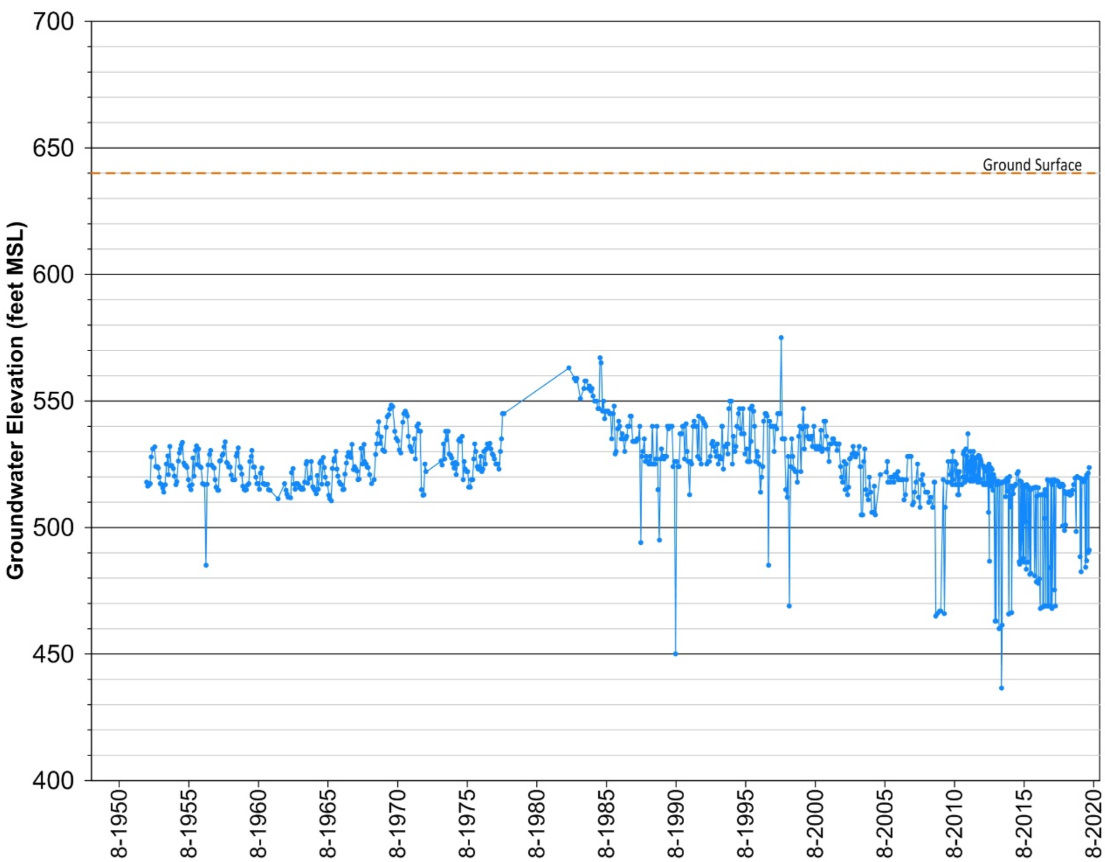
Figure ES-2. Channel Aquifer



ES-2 GROUNDWATER CONDITIONS

Water levels in the Channel Aquifer vary in response to wet and dry hydrologic cycles. Increased pumping and prolonged drought have resulted in a slight decline in water levels over the past twenty years. Groundwater levels reached their respective highs in the early 1980s in response to a wet hydrologic cycle that began in 1978. These higher levels also correlate to a period of relatively low pumping in the Basin. During a later wet cycle from 1992 to 1998, water levels did not recover to 1980s levels, likely related to an increase in Basin pumping. The lowest groundwater levels generally correspond to dry periods and periods of increased pumping, though the responses throughout the Basin are not uniform.

Figure ES-3. Representative Hydrograph, Corona Well 15



1980s levels; pumping in the Basin had increased in this period. Hydrographs from most wells show lowering water levels from 2000 to 2004, a period that was not hydrologically dry but had increased pumping in Corona. In the Well 15 hydrograph, the lowest water levels occurred during the 2015 to 2017 period, during and following drought conditions. There have been slight increases since then in 2018 through 2019 due in part to increased precipitation after 2015.

Total Dissolved Solids (TDS) and nitrate are the primary constituents of concern in the Basin. Groundwater in the Basin is somewhat mineralized, with high TDS concentrations in many monitored wells. Recent average TDS concentrations in the Basin are above the 500 milligrams per liter (mg/L) lower secondary maximum contaminant level (SMCL) for drinking water, but below the upper SMCL of 1,000 mg/L.

Groundwater in the Basin has been impacted by human activities both in the Basin and watershed including agricultural, urban, and industrial land uses. Elevated nitrate concentrations have been documented in the Basin since at least the 1950s. Recent average nitrate as nitrate (NO_3) concentrations in the Basin are moderate; the recent average concentration in the Basin is 42.8 mg/L. The maximum contaminant level (MCL) for nitrate as NO_3 in drinking water is 45 mg/L.

ES-3 WATER SUPPLY

Sources of water supply for agricultural, municipal and industrial (M&I), and domestic uses include groundwater, imported water, and recycled water. Metropolitan Water District of Southern California (Met) is the wholesaler for imported water and its sources of water include the Colorado River and the State Water Project. Both Corona and Norco receive imported water from Met for distribution in the Basin.

Groundwater has been an important component of water supply in the Basin for more than 100 years. Until the 1970s, most of the groundwater production in the Basin was for agricultural supply. A few well owners have also produced small amounts of groundwater for domestic and industrial use. There are no current private domestic groundwater users in the Basin. Production for municipal supply increased in the 1960s and 1970s and continues today.

For more than 50 years, Corona and HGCWD have relied on groundwater from the Basin for municipal uses, and these agencies have long been responsible for managing groundwater conditions in the Basin. Norco has also relied on groundwater but their wells are located outside of the Temescal Basin (in the unadjudicated portion of the Chino Subbasin). Corona, in coordination with HGCWD and Norco, adopted a Groundwater Management Plan (GWMP) in 2008 that covers the Basin.

ES-4 WATER BUDGET

A water balance (or water budget) is a quantitative tabulation of all inflows, outflows, and storage change of a hydrologic system. This GSP contains a detailed water balance for both the groundwater system and surface water system of the Basin. The water budgets were developed for time periods representing historical, current, future no project (baseline), and future growth plus climate change (growth plus climate change) conditions.

Surface water and other inflows came from multiple sources. Monthly inflows in Temescal Wash were obtained from the baseline and growth plus climate change simulations produced by the Bedford-Coldwater Subbasin groundwater model (Todd, H&H, and Stantec 2021), which is concurrently being used to develop the GSP for that subbasin. Small stream and bedrock inflows simulated for 1993 to 2017 of the calibration model period were repeated twice to obtain 50 years of data.

In the historical model, the Basin water budgets were overall negative for the historical and current analysis periods, due to a variety of reasons and reflecting the different time periods. Storage declines during the early years of the simulation may have resulted from incorrectly estimated initial water levels. During 2000 to 2011, relatively high amounts of municipal groundwater pumping might have caused a gradual decrease in storage. Since 2011, the predominantly dry climatic conditions have resulted in reduced inflows and thus a decrease in storage. These historical storage declines have not resulted in undesirable results related to water levels or groundwater storage in the Basin to date. Most groundwater production in the Basin is for Corona municipal use, and Corona and the other GSA agencies have a portfolio of alternative water supply sources for future use.

Two future scenarios were simulated to test sustainability. In the baseline scenario, land use remains the same as the current conditions. The growth plus climate change scenario incorporated anticipated effects of climate change, urban development, and associated changes in water and wastewater management.

In both future scenarios, the total pumping was adjusted to pump within the sustainable yield of the Basin; the remaining municipal water demand will be supplied by imported and recycled water. Simulating pumping within the sustainable yield of the Basin in the groundwater model produced essentially no long-term storage change in the future baseline simulation.

Growth and climate change had relatively small effects that tended to offset each other. The warmer, drier climatic conditions tended to decrease stream percolation and rainfall recharge. Urban growth—much of which is projected to be in tributary watershed areas—tended to increase recharge because of irrigation deep percolation, pipe leaks and percolation of runoff from disconnected impervious areas. Notably, total water use and percolation of reclaimed water were assumed not to change appreciably, consistent with assumptions in the Corona's Urban Water Management Plan (UWMP) (Michael Baker 2021) that population growth will be offset by decreases in per-capita water use. Consequently, individual inflows and outflows in the growth plus climate change scenario were identical to or very close to the values in the future baseline scenario.

Average annual storage changes during both future scenarios were very slightly positive, with total inflows about34 AFY greater than total outflows. This was the intentional result of adjusting Corona pumping to achieve close to zero net storage change during 2019 to 2068.

ES-5 SUSTAINABLE MANAGEMENT CRITERIA

The sustainable management goal of the Temescal Basin is to sustain groundwater resources for the current and future beneficial uses of the Basin in a manner that is adaptive and responsive to the following objectives:

- Provide a long-term, reliable and efficient groundwater supply for municipal, industrial, and other uses
- Provide reliable storage for water supply resilience during droughts and shortages
- Protect groundwater quality
- Support beneficial uses of interconnected surface waters, and
- Support integrated and cooperative water resource management.

This goal is consistent with SGMA and is based on information from the Plan Area, Hydrogeologic Conceptual Model, Groundwater Conditions, and Water Budget sections of this GSP that:

- Identify beneficial uses of Temescal Basin groundwater and document the roles of local water and land use agencies
- Describe the local hydrogeologic setting, groundwater quality conditions, groundwater levels and storage, and inflows and outflows of the Basin
- Document the ongoing water resource monitoring and conjunctive management of groundwater, local surface water, recycled water, and especially imported water sources that help protect groundwater quality and maintain water supply.

A GSP must develop quantitative sustainability criteria for all applicable sustainability indicators that allow the GSA to define, measure, and track sustainable management. These criteria include the following:

- Undesirable Result – significant and unreasonable conditions for any of the six sustainability indicators.
- Minimum Threshold (MT) – numeric value used to define undesirable results for each sustainability indicator.
- Measurable Objective (MO) – specific, quantifiable goal to track the performance of sustainable management.

The sustainability indicators and sustainable management criteria are clearly defined and provide a quantitative analysis of the Basin’s sustainability. As the Basin has been managed without significant undesirable results, the following sustainability criteria are defined to avoid future undesirable results:

- The Minimum Threshold for defining undesirable results relative to chronic lowering of groundwater levels is defined at each Key Well by historical groundwater low levels. Undesirable results are indicated when two consecutive exceedances occur in each of two consecutive years, in sixty percent or more of the Key Wells.

- The Minimum Threshold for reduction of groundwater storage for all Management Areas is fulfilled by the minimum threshold for groundwater levels as proxy.
- The Minimum Threshold for subsidence is defined as a cumulative decline equal to or greater than one foot since 2015, which represents current conditions and the SGMA start date. This corresponds to a rate of decline equal to or greater than 0.2 feet in any five-year period.
- The Minimum Thresholds for degradation of water quality address nitrate and total dissolved solids (TDS) for the entire Basin.
    - The Minimum Threshold for nitrate is defined initially as the percentage of wells with concentrations exceeding the nitrate MCL (45 mg/L) based on current conditions (2015-2019).
    - The Minimum Threshold for TDS is defined initially as the percentage of wells with concentrations exceeding the TDS value of 1,000 mg/L based on current conditions (2015-2019).
- The Minimum Threshold for depletion of interconnected surface water is the amount of depletion that occurs when the depth to the water along the southern edge of the Prado Wetlands is greater than 15 feet for a period exceeding one year.

ES-6 MONITORING NETWORK

The monitoring network for GSP implementation has been established to document groundwater and related surface conditions as relevant to the sustainability indicators, MTs, and MOs. The components of the monitoring network are built from existing programs and will be carried out by the Temescal GSA.

The Temescal GSA, Corona specifically, has actively engaged in assessment and improvement of its monitoring network. This process has been intensified as part of the GSP, given the need to identify data gaps and to assess uncertainty in setting and tracking sustainability criteria. Monitoring improvements such as adding or replacing monitoring infrastructure are part of GSP implementation and will be reviewed and updated for each five-year GSP update.

ES-7 PROJECTS AND MANAGEMENT ACTIONS

During the preparation of the GSP, the Temescal GSA identified five specific management actions (Actions) and three projects (Projects) to achieve the sustainability goal. The Actions are generally focused on data collection, storage and reporting of information necessary to monitor sustainability, and assessment of when Actions may be necessary (i.e., when MTs are approached or exceeded). The projects are generally designed to reduce uncertainty in areas where data gaps have been identified during development of the GSP. These projects and management actions are aimed at achieving sustainability goals and responding to changing conditions in the Basin. The projects and management actions are divided into three groups:

- Group 1 - Existing or established projects and management actions
    - Groundwater Treatment

    - Water Reclamation Facility (WRF) Percolation Ponds
    - Water Level Quality Assurance and Quality Control (QA/QC)
    - Water Shortage Contingency Plans
    - Water Conservation Program
    - Participation in Integrated Regional Water Management Plans (IRWMP)
    - Western Riverside County Regional Wastewater Authority (WRCRWA)
    - Santa Ana Watershed Involvement
- Group 2 - Projects and management actions that have been or are under development
    - Shallow Monitoring Well Installation
    - Potable Reuse Feasibility Study
    - Mountain Runoff Capture Feasibility Study
- Group 3 - Conceptual projects and management actions that can be considered in the future if any Group 2 projects fail to be implemented or additional intervention is required to achieve basin sustainability goals
    - Groundwater Treatment
    - Stormwater Capture, Treatment, and Recharge
    - Santa Ana River Wastewater Discharge Coordination for Shallow

The Projects and Actions will be implemented by a combination of existing resources from the three agencies within the Plan Area and contracted resources.

ES-8 IMPLEMENTATION

The official adoption of the GSP by the Temescal GSA will initiate Plan implementation. After submittal of the GSP to DWR, and during the DWR review period, the Temescal GSA will continue to communicate with stakeholders via the Corona’s website and begin implementing the projects and management actions described in this GSP. The Plan will be implemented to sustainably manage groundwater in the Basin under the authority of the Temescal GSA and its member agencies.

The Temescal GSA is required to submit an annual report to DWR by April 1st of each year following adoption of the GSP. The first annual report will be due in April of 2022. The Temescal GSA has committed to implementing the GSP upon adoption and completing the projects and management actions necessary to monitor and maintain sustainability within the first five years of initiation of the GSP.

1. INTRODUCTION

The City of Corona (Corona) is actively managing the Temescal Subbasin (Basin) of the Upper Santa Ana River Groundwater Basin (**Figure 1-1**) in collaboration with the City of Norco (Norco) and Home Gardens County Water District (HGCWD). Corona, Norco, and HGCWD have previously participated in active management of water resources in the Basin. This management has included cooperation in preparing the 2008 Groundwater Management Plan (Todd and AKM 2008) and participation in regional planning and management. This historical experience provides a good foundation for continuation of groundwater management consistent with the Sustainable Groundwater Management Act (SGMA).

Wishing to provide a framework for cooperative groundwater management and SGMA compliance Corona, Norco, and HGCWD executed a Memorandum of Understanding (MOU) in March 2017 (**Appendix A**) establishing the Temescal Basin Groundwater Sustainability Agency (Temescal GSA). In August 2017, the Temescal GSA became the GSA for the Basin by submitting a formation notice to the California Department of Water Resources (DWR). This notice included publication of the MOU and each individual party's resolutions to become a GSA to DWR through the SGMA web portal. In the MOU, Corona has accepted the primary responsibility to develop a GSP for the Basin, to submit the GSP to DWR, and to prepare Annual Reports and GSP updates thereafter. While Corona is leading this effort, the GSP will be developed jointly among the three agencies, with coordinated implementation toward sustainable management.

The GSP reflects the rigorous, systematic process through which the Temescal GSA will manage the Basin. **Figure 1-1** shows the Plan Area for this GSP, which encompasses the entire Basin.

Sustainable management of the Temescal Basin is critical to local water supply reliability. The three local agencies (both individually and jointly) in the Temescal GSA have developed water supply portfolios including imported water, groundwater from multiple local basins, and reclaimed water for landscape irrigation. Water conservation measures also have been implemented (as documented in the recent Corona and Norco Urban Water Management Plans (Michael Baker 2021, Norco 2021)), providing an important tool for responding to water shortages. Local agencies are active in regional water management and recognize that local groundwater is a primary source of supply and needs to be reliable. The Temescal Basin area historically has experienced significant land use changes—shifting from agricultural to urban land uses—and subsequent water demand and supply changes. This transition was achieved in part with reliance on local groundwater. In fact, the Corona Groundwater Management Plan indicated that overdraft conditions occurred in the Temescal Basin during the last three years of the 1990 to 2004 period as pumping increased. While conditions subsequently improved, this illustrates that overdraft can occur. Concerns about water supply reliability persist, given the uncertainties of imported water and climate change. Moreover, groundwater quality generally is poor; in fact, sustainable groundwater use is dependent on treatment at the Temescal Desalter. SGMA and the GSP process provide an important set of tools for Corona and the Temescal GSA partners to address these conditions and plan for water supply reliability into the future.

1.1. PURPOSE OF THE GROUNDWATER SUSTAINABILITY PLAN

The purpose of this GSP is to assess water resource and land use conditions within the Basin, through an open and collaborative process, and to implement management activities to achieve (or maintain) long-term groundwater sustainability as defined by SGMA.

The GSP assesses sustainability related to each of the six SGMA defined sustainability criteria listed below:

- Lowering Groundwater Levels
- Reduction of Groundwater Storage
- Seawater Intrusion
- Degraded Water Quality
- Land Subsidence
- Surface Water Depletion.

The GSP presents conditions in the Basin relevant to each of these categories, defines thresholds for maintaining sustainability, outlines groundwater monitoring protocols, and management actions and projects designed to improve monitoring capabilities and/or to protect and enhance groundwater conditions. The GSP also includes a schedule and cost estimate for GSP implementation. Each element of the GSP is designed to promote Basin health and achieve and maintain the sustainability goal established for the Basin by the GSA.

1.2. SUSTAINABILITY GOAL

The sustainability goal is to sustain groundwater resources for the current and future beneficial uses of the Basin in a manner that is adaptive and responsive to the following objectives:

- Provide a long-term, reliable, and efficient groundwater supply for municipal, industrial, and other uses
- Provide reliable storage for water supply resilience during droughts and shortages
- Protect groundwater quality
- Support beneficial uses of interconnected surface waters, and
- Support integrated and cooperative water resource management.

1.3. AGENCY INFORMATION

The GSA agencies collaborated on preparation of this GSP, as described in the March 2017 MOU between the agencies. The City of Corona, City of Norco, and HGCWD each passed resolutions to authorize the MOU to establish the GSA:

- City of Corona - On March 15, 2017, Corona held a public hearing to determine whether to become a GSA, and adopted Resolution No. 2017-013, electing to jointly become a GSA with Norco and HGCWD.
- Norco - On March 15, 2017, Norco held a public hearing to determine whether to become a GSA, and adopted Resolution No. 2017-12, electing to jointly become a GSA with Corona and HGCWD.

- HGCWD - On March 23, 2017, HGCWD held a public hearing to determine whether to become a GSA, and, by minute action, elected to jointly become a GSA with Corona and Norco.

On May 10, 2017, Temescal GSA submitted to DWR a Notice of Decision to Become a Groundwater Sustainability Agency, along with required information including a boundary map of the GSA and a list of interested parties. After the 90-day review period, on August 8, 2017, Temescal GSA became the groundwater sustainability agency for the Basin.

As required by GSP Regulations §354.6 and SGMA §10723.8, the Notices of Decision to become a Groundwater Sustainability Agency are included in **Appendix B**. These each include the resolution, list of interested parties, and boundary map.

The point of contact for the Temescal GSA is:

Katie Hockett, Assistant General Manager
City of Corona Department of Water and Power
Temescal Basin GSA
755 Corporation Yard Way Corona, CA 92880
(951) 279-3601
Katie.Hockett@CoronaCA.gov

1.4. GROUNDWATER SUSTAINABILITY AGENCY INFORMATION

As described above, the Temescal GSA was formed through a MOU between Corona, Norco, and HGCWD to act as the GSA for the Basin (Temescal Subbasin of the Upper Santa Ana Valley Basin, Basin Number 8-002.09), which is a DWR-designated medium priority basin. The Temescal GSA is dedicated to participating in the collective goal of reaching groundwater sustainability in California.

Corona, Norco, and HGCWD have relied on groundwater from the Basin for municipal use for decades. In 2008, Corona adopted a Groundwater Management Plan that covers the entire Basin.

1.4.1. Decision Making

As detailed in the MOU, decisions in by the Temescal GSA are reached by unanimous consent of the parties; however, if unanimous consent is not possible, a majority vote of the three agencies rules.

1.4.2. Roles and Responsibilities

The MOU also documents the responsibilities of the individual agencies, including:

- Corona shall have the primary responsibility to develop a GSP within the boundaries of the Temescal GSA and submit the GSP to DWR for review and evaluation.Corona shall also have the primary responsibility to prepare and submit the annual and five year reports to DWR pursuant to SGMA and DWR's implementing regulations.

- The parties will work jointly to fulfill the purpose of the MOU within the boundaries of the Temescal GSA.
- The parties will meet regularly to discuss SGMA, GSP development, and implementation activities, assignments, and ongoing work progress.
- The parties may form committees as necessary from time to time to discuss issues that impact the Temescal GSA.
- Corona is responsible for implementing the GSP in areas of the Temescal GSA that are within Corona's service area boundaries and within Corona's sphere of influence.
- Norco is responsible for implementing the GSP in areas of the Temescal GSA that are within Norco's service area boundaries.
- HGCWD is responsible for implementing the GSP in areas of the Temescal GSA that are within HGCWD's service area boundaries.

1.4.3. Legal Authority of the GSA

The GSA has authority to develop a GSP and implement SGMA in the Temescal Basin. SGMA specifies additional enabling powers; for example, GSAs may choose to adopt standards for measuring and reporting water use, develop and implement metering, and manage extraction from individual wells.

Corona's Authority. Corona is a local agency qualified to become a GSA because Corona manages water, has a water supply, and has land use responsibilities over a portion of the Basin.

Norco's Authority. Norco is also a local agency qualified to become a GSA because Norco manages water, has a water supply, and has land use responsibilities over a portion of the Basin.

HGCWD's Authority. HGCWD is also a local agency qualified to become a GSA because HGCWD is a county water district formed and operating pursuant to and in accordance with Division 12 of the California Water Code that manages water, has a water supply and overlies a portion of the Basin.

Those portions of the Basin outside of these service areas are not within the area of any other proposed GSA. While the service areas of Corona, Norco, and HGCWD do not cover the entire Basin, these agencies do propose to serve as the GSA for the entire Basin. The three agencies in the GSA are coordinating with Riverside County Flood Control and Water Conservation District (RCFCWCD) for these currently unmanaged areas. Specifically, the RCFCWCD recognized the ongoing efforts for this GSA and offered to participate in any advisory or stakeholder committee formed by the GSA.

1.4.4. GSP Development Costs and Funding Sources

In November 2017, the City of Corona applied for a Sustainable Groundwater Management Planning (SGMP) Grant to fund preparation of this GSP. In April 2018, DWR awarded the City of Corona with full funding of $732,338.

Each party will be financially responsible for collecting data or information from within that party's service area that is required to be provided for development of the GSP. Norco and HGCWD will not incur any financial expense related to development of the GSP and submittal of the GSP to the DWR.

Implementation costs include costs to continue monitoring as described in Chapter 7, implement management actions and projects as described in Chapter 8, and complete annual reports and periodic GSP evaluation and updates as required by SGMA. As summarized in Chapter 9, total annual costs (2021 dollars) are estimated at approximately $100,000 per year and single occurrence costs for projects and management actions anticipated to occur in the first five years of GSP implementation and the first periodic GSP evaluation and update total approximately $515,000 to $575,000 (2021 dollars).

The funding method for operating expenses and GSP implementation costs is by contributions by GSA member agencies (Corona, Norco, and HGCWD). This is the same mechanism utilized to fund development of the GSP (with significant supplemental contribution though California Proposition 1 Grant funding). Corona will be responsible for most of the ongoing implementation costs, which are within budget projections for the next several years. Funding for planning and implementation of some projects and management actions may be achieved with local, state, and federal sources. The local agencies track opportunities for outside financing (grants or loans) from state water programs and federal infrastructure funding. For local financing, the agencies update their financial plans and rates as needed.

1.5. GSP ORGANIZATION

This GSP is organized generally to follow the GSP Annotated Outline provided by DWR as one of its Guidance Documents (DWR 2016a). Major sections include:

- **Executive Summary**
- **Chapter 1 – Introduction**, purpose of the GSP, sustainability goal, agency information, and GSP organization.
- **Chapter 2 – Plan Area** description, water use sectors, water supply sources, water resources monitoring and management programs, current general plans, and other GSP elements.
- **Chapter 3 – Hydrogeologic Conceptual Model**, description of the physical basin setting including surface water features, soils, geologic setting, faults, and aquifers, defined basin bottom, recharge and discharge areas, and cross sections.
- **Chapter 4 – Current and Historical Groundwater Conditions**, discussion of groundwater elevations, land subsidence, groundwater quality and current monitoring, constituents of concern regarding water quality, interconnection of surface water and groundwater and the effects on groundwater dependent ecosystems (GDEs).
- **Chapter 5 – Water Budget**, discussion of the water budget, groundwater model, surface water and groundwater balance, change in groundwater storage, and estimate of sustainable yield.

- **Chapter 6 – Sustainable Management Criteria**, sustainability goal and sustainability criteria for the six undesirable results.
- **Chapter 7 – Monitoring Network**, discussion of the monitoring that will continue to assess sustainability in the future.
- **Chapter 8 – Projects and Management Actions**, descriptions of projects and management actions for the Basin.
- **Chapter 9 – Implementation Plan**, estimate of GSP implementation costs, schedule, and plan for annual reporting and periodic evaluations.
- **Chapter 10 – References**

A Preparation Checklist providing further organizational guidance to the GSP content requirements is provided in **Table 1-1** and the GSP Elements Guide detailing GSP content in comparison to SGMA articles is included in **Appendix C**.

Table 1-1. GSP Preparation Checklist

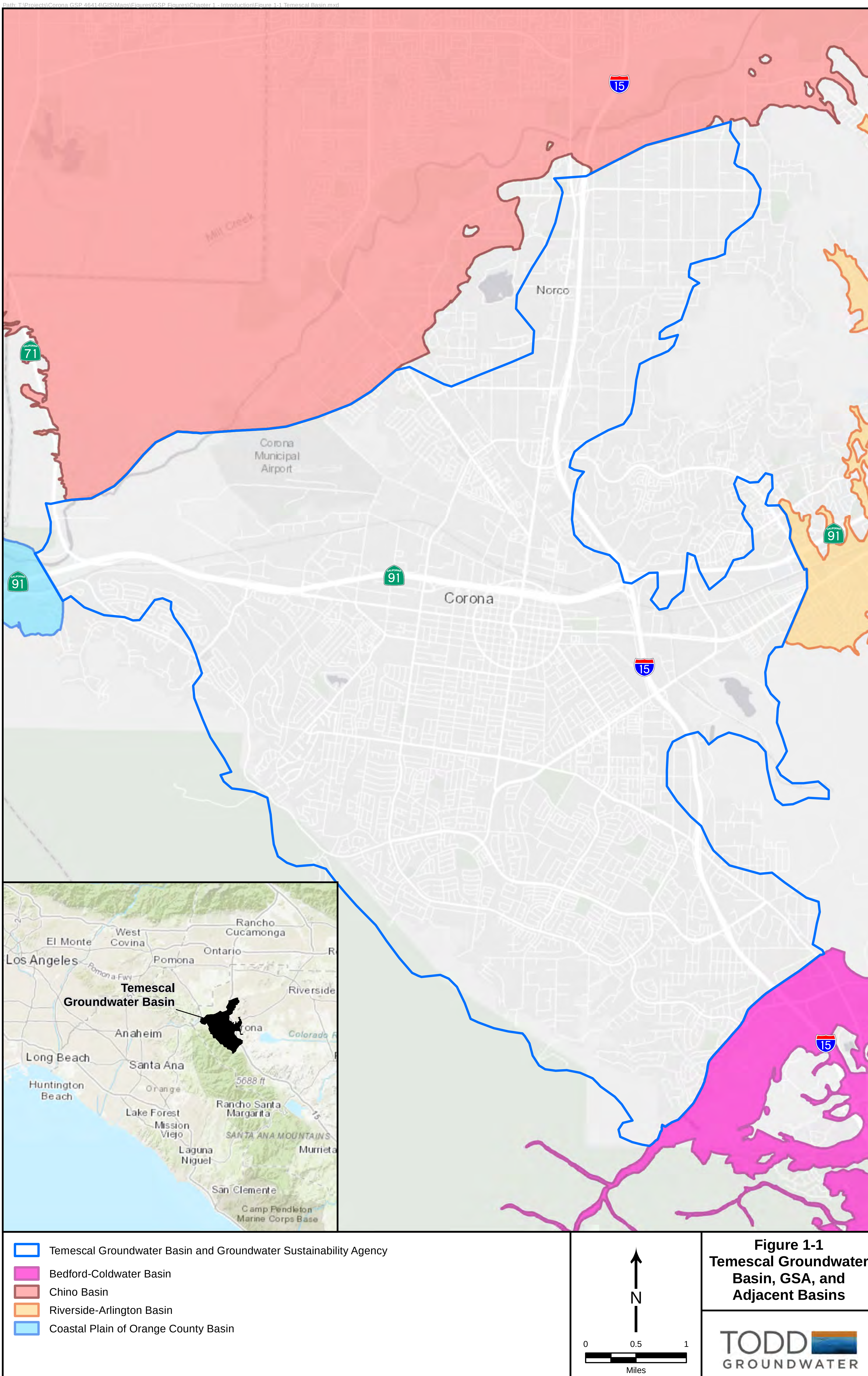
GSP Regulations Section	Water Code Section	Requirement	Description	Section(s) or Page Number(s) in the GSP
Article 3. Technical and Reporting Standards				
352.2		Monitoring Protocols	- Monitoring protocols adopted by the GSA for data collection and management - Monitoring protocols that are designed to detect changes in groundwater levels, groundwater quality, inelastic surface subsidence for basins for which subsidence has been identified as a potential problem, and flow and quality of surface water that directly affect groundwater levels or quality or are caused by groundwater extraction in the basin	Section 7.2
Article 5. Plan Contents, Subarticle 1. Administrative Information				
354.4		General Information	- List of references and technical studies	Section 10
354.6		Agency Information	- GSA mailing address - Organization and management structure - Contact information of Plan Manager - Legal authority of GSA - Estimate of implementation costs	Section 1.3
354.8(a)	10727.2(a)(4)	Map(s)	- Area covered by GSP (Figure 1-1) - Adjudicated areas, other agencies within the basin, and areas covered by an Alternative (Figure 1-1) - Jurisdictional boundaries of federal or State land (Figure 2-1) - Existing land use designations (Figures 2-7, 2-8) - Density of wells per square mile (Figures 2-3 through 2-6)	Section 2
354.8(b)		Description of the Plan Area	- Summary of jurisdictional areas and other features	Section 2.1
354.8(c) 354.8(d) 354.8(e)	10727.2(g)	Water Resource Monitoring and Management Programs	- Description of water resources monitoring and management programs - Description of how the monitoring networks of those plans will be incorporated into the GSP - Description of how those plans may limit operational flexibility in the basin - Description of conjunctive use programs	Section 2.4,2.5 Section 2.4 Section 2.6 Section 2.3.2
354.8(f)	10727.2(g)	Land Use Elements or Topic Categories of Applicable General Plans	- Summary of general plans and other land use plans - Description of how implementation of the GSP may change water demands or affect achievement of sustainability and how the GSP addresses those effects - Description of how implementation of the GSP may affect the water supply assumptions of relevant land use plans - Summary of the process for permitting new or replacement wells in the basin - Information regarding the implementation of land use plans outside the basin that could affect the ability of the Agency to achieve sustainable groundwater management	Section 2.6 Section 2.6.4 Section 2.6.5 Section 2.7.3 Section 2.7.6
Article 5. Plan Contents, Subarticle 1. Administrative Information (Continued)				
354.8(g)	10727.4	Additional GSP Contents	**Description of Actions related to:** - Control of saline water intrusion - Wellhead protection - Migration of contaminated groundwater - Well abandonment and well destruction program - Replenishment of groundwater extractions - Conjunctive use and underground storage - Well construction policies - Addressing groundwater contamination cleanup, recharge, diversions to storage, conservation, water recycling, conveyance, and extraction projects - Efficient water management practices - Relationships with State and federal regulatory agencies - Review of land use plans and efforts to coordinate with land use planning agencies to assess activities that potentially create risks to groundwater quality or quantity - Impacts on groundwater dependent ecosystems	Section 2.7
354.10		Notice and Communication	- Description of beneficial uses and users - List of public meetings - GSP comments and responses - Decision-making process - Public engagement - Encouraging active involvement - Informing the public on GSP implementation progress	Section 2.3 Section 2.8 and Appendices E and F Appendix J (pending) Section 1.4.1 Appendix D Section 2.8 Section 2.8

Table 1-1. GSP Preparation Checklist

GSP Regulations Section	Water Code Section	Requirement	Description	Section(s) or Page Number(s) in the GSP
Article 5. Plan Contents, Subarticle 2. Basin Setting				
354.14		Hydrogeologic Conceptual Model	- Description of the Hydrogeologic Conceptual Model - Two scaled cross-sections - Map(s) of physical characteristics: topographic information, surficial geology, soil characteristics, surface water bodies, source and point of delivery for imported water supplies	Section 3, Figure 3-6 through 3-9
9	10727.2(a)(5)	Map of Recharge Areas	- Map delineating existing recharge areas that substantially contribute to the replenishment of the basin, potential recharge areas, and discharge areas	Figure 3-12
	10727.2(d)(4)	Recharge Areas	- Description of how recharge areas identified in the plan substantially contribute to the replenishment of the basin	Section 3.9
354.16	10727.2(a)(1) 10727.2(a)(2)	Current and Historical Groundwater Conditions	- Groundwater elevation data - Estimate of groundwater storage - Seawater intrusion conditions - Groundwater quality issues - Land subsidence conditions - Identification of interconnected surface water systems - Identification of groundwater-dependent ecosystems	Section 4
354.18	10727.2(a)(3)	Water Budget Information	- Description of inflows, outflows, and change in storage - Quantification of overdraft - Estimate of sustainable yield - Quantification of current, historical, and projected water budgets	Section 5.7 Not Applicable Section 5.9 Section 5.7
	10727.2(d)(5)	Surface Water Supply	- Description of surface water supply used or available for use for groundwater recharge or in-lieu use	Sections 2.3.2, 2.4.6, and 5.6.2
354.20		Management Areas	- Reason for creation of each management area - Minimum thresholds and measurable objectives for each management area - Level of monitoring and analysis - Explanation of how management of management areas will not cause undesirable results outside the management area - Description of management areas	Not Applicable
Article 5. Plan Contents, Subarticle 3. Sustainable Management Criteria				
354.24		Sustainability Goal	- Description of the sustainability goal	Section 6.1
354.26		Undesirable Results	- Description of undesirable results - Cause of groundwater conditions that would lead to undesirable results - Criteria used to define undesirable results for each sustainability indicator - Potential effects of undesirable results on beneficial uses and users of groundwater	Section 6.2.1, 6.3.1, 6.5.1, 6.6.1, 6.7.1 Section 6.2.2, 6.3.2, 6.5.2, 6.6.2, 6.7.2 Section 6.2.3, 6.3.3, 6.5.3, 6.6.3, 6.7.3 Section 6.2.4, 6.3.4, 6.5.4, 6.6.4, 6.7.4
354.28	10727.2(d)(1) 10727.2(d)(2)	Minimum Thresholds	- Description of each minimum threshold and how they were established for each sustainability indicator - Relationship for each sustainability indicator - Description of how selection of the minimum threshold may affect beneficial uses and users of groundwater - Standards related to sustainability indicators - How each minimum threshold will be quantitatively measured	Sections 6.2 through 6.7
354.30	10727.2(b)(1) 10727.2(b)(2) 10727.2(d)(1) 10727.2(d)(2)	Measureable Objectives	- Description of establishment of the measureable objectives for each sustainability indicator - Description of how a reasonable margin of safety was established for each measureable objective - Description of a reasonable path to achieve and maintain the sustainability goal, including a description of interim milestones	Sections 6.2 through 6.7

Table 1-1. GSP Preparation Checklist

GSP Regulations Section	Water Code Section	Requirement	Description	Section(s) or Page Number(s) in the GSP
Article 5. Plan Contents, Subarticle 4. Monitoring Networks				
354.34	10727.2(d)(1) 10727.2(d)(2) 10727.2(e) 10727.2(f)	Monitoring Networks	- Description of monitoring network - Description of monitoring network objectives - Description of how the monitoring network is designed to: demonstrate groundwater occurrence, flow directions, and hydraulic gradients between principal aquifers and surface water features; estimate the change in annual groundwater in storage; monitor seawater intrusion; determine groundwater quality trends; identify the rate and extent of land subsidence; and calculate depletions of surface water caused by groundwater extractions - Description of how the monitoring network provides adequate coverage of Sustainability Indicators - Density of monitoring sites and frequency of measurements required to demonstrate short-term, seasonal, and long-term trends - Scientific rational (or reason) for site selection - Consistency with data and reporting standards - Corresponding sustainability indicator, minimum threshold, measureable objective, and interim milestone - Location and type of each monitoring site within the basin displayed on a map, and reported in tabular format, including information regarding the monitoring site type, frequency of measurement, and the purposes for which the monitoring site is being used - Description of technical standards, data collection methods, and other procedures or protocols to ensure comparable data and methodologies	Section 7.1 Section 7.0
354.36		Representative Monitoring	- Description of representative sites - Demonstration of adequacy of using groundwater elevations as proxy for other sustainability indicators - Adequate evidence demonstrating site reflects general conditions in the area	Section 7.3
354.38		Assessment and Improvement of Monitoring Network	- Review and evaluation of the monitoring network - Identification and description of data gaps - Description of steps to fill data gaps - Description of monitoring frequency and density of sites	Section 7.5 Section 7.5.1 Section 7.5.2 Section 7.1.1
Article 5. Plan Contents, Subarticle 5. Projects and Management Actions				
354.44		Projects and Management Actions	- Description of projects and management actions that will help achieve the basin's sustainability goal - Measureable objective that is expected to benefit from each project and management action - Circumstances for implementation - Public noticing - Permitting and regulatory process - Time-table for initiation and completion, and the accrual of expected benefits - Expected benefits and how they will be evaluated - How the project or management action will be accomplished. If the projects or management actions rely on water from outside the jurisdiction of the Agency, an explanation of the source and reliability of that water shall be included. - Legal authority required - Estimated costs and plans to meet those costs - Management of groundwater extractions and recharge	Section 8.0
354.44(b)(2)	10727.2(d)(3)		- Overdraft mitigation projects and management actions	Not Applicable
Article 8. Interagency Agreements				
357.4	10727.6	Coordination Agreements - Shall be submitted to the Department together with the GSPs for the basin and, if approved, shall become part of the GSP for each participating Agency.	**Coordination Agreements shall describe the following:** - A point of contact - Responsibilities of each Agency - Procedures for the timely exchange of information between Agencies - Procedures for resolving conflicts between Agencies - How the Agencies have used the same data and methodologies to coordinate GSPs - How the GSPs implemented together satisfy the requirements of SGMA - Process for submitting all Plans, Plan amendments, supporting information, all monitoring data and other pertinent information, along with annual reports and periodic evaluations - A coordinated data management system for the basin - Coordination agreements shall identify adjudicated areas within the basin, and any local agencies that have adopted an Alternative that has been accepted by the Department	Not Applicable



Temescal Groundwater Basin and Groundwater Sustainability Agency
Bedford-Coldwater Basin
Chino Basin
Riverside-Arlington Basin
Coastal Plain of Orange County Basin

Figure 1-1
Temescal Groundwater Basin, GSA, and Adjacent Basins

TODD GROUNDWATER

2. PLAN AREA

This chapter provides a general description of the Temescal Baasin Groundwater Sustainability Plan Area (GSP Area, Plan Area or Basin), consistent with GSP Regulations §354.8, and is organized into the follow sections:

- Geographic Area
- Jurisdictional Agencies
- Water Supply
- Water Resources Monitoring and Management Programs
- General Plans
- Additional GSP Elements
- Notice and Communication

The description of the Plan Area was developed from previous reports and studies, including the 2008 Groundwater Management Plan (2008 GWMP) for the City of Corona (Corona) (Todd and AKM 2008).

2.1. GEOGRAPHIC AREA

The GSP Area is the Temescal Subbasin of the Upper Santa Ana Valley Groundwater Basin (DWR 2016b) located in Riverside County. The Temescal Subbasin (Basin) underlies the southwest portion of the upper Santa Ana Valley, as shown on **Figure 2-1**.

The GSP Area is coincident with the Basin and covers approximately 23,500 acres or 37 square miles. The Basin borders the Chino Subbasin to the north, the Riverside-Arlington Subbasin to the east, the Bedford-Coldwater Subbasin of the Elsinore Basin to the south, and the Coastal Plain Subbasin of the Orange County Basin to the west. These adjacent basins are shown on **Figures 2-1**.

In general, the Basin is bounded by the Santa Ana River to the north, the El Sobrante de San Jacinto and La Sierra Hills and the Riverside-Arlington Subbasin to the east, the Santa Ana Mountains to the west, and Bedford-Coldwater Subbasin to the south (DWR 2016b).

2.2. LAND USE AND WATER MANAGEMENT JURISDICTIONAL AGENCIES

Land use and land management activities can influence water demands, recharge potential, and water quality. This section identifies and describes the agencies with land use management responsibilities within the Basin. Detailed discussion of land use planning and policies relevant to groundwater management is included in Section 2.6. In general, these agencies can be categorized as follows:

- Counties
- Cities
- Federal

- State
- Conservation Easements
- Water Management Entities.

The jurisdictional boundaries for agencies that have land use management responsibilities in the Basin are shown on **Figures 2-2** and **2-3.**

2.2.1. Counties

The Basin lies within the northwestern portion of Riverside County. Riverside County has jurisdiction for land use planning for unincorporated areas in the County. Small portions of the Basin along its northwestern side are unincorporated areas in Riverside County. Riverside County also has responsibility for on-site wastewater treatment systems (i.e., septic systems) through its Department of Environmental Health. Riverside County Department of Environmental Health (RCDEH) is also responsible for regulation of the construction, destruction, and maintenance of groundwater wells.

2.2.2. Cities

The Basin is almost entirely overlaid by Corona's sphere of influence and the City of Norco (Norco). Corona and Norco have land use planning authority within their respective boundaries. General plan elements relevant to the GSP are discussed in Section 2.6. In addition to land use planning, the cities of Corona and Norco are responsible for stormwater management for their respective jurisdictions, which can impact basin recharge and therefore shallow ground water quality.

2.2.3. Federal

Federal Lands in the Basin, presented on **Figure 2-3**, include small portions of the northwestern Basin owned by the Department of Defense. Land along the southwestern edge of the Basin is US Forest Service (USFS) Cleveland National Forest and other federal Non-Forest Service Land within USFS. Resource management efforts in the Cleveland National Forest target fire, ecology, archaeological resources, and recreational resources. These management activities can impact basin recharge, surface run-off, and surface and groundwater quality.

Prado Dam lies in the northwest corner of the Basin and is owned and operated by the U.S. Army Corps of Engineers. The Prado Dam and Reservoir is the principle regulating structure on the Santa Ana River.

2.2.4. State

State Lands in the Basin are presented on **Figure 2-3**. A very small portion of northwestern edge of the Basin is in the Chino Hills State Park.

2.2.5. Conservation Easements

Conservation easements for the Dos Lagos Golf Course, Temescal Canyon, and Lee Lake are held by the Riverside-Corona Resource Conservation District (RCRCD) just to the south of the Basin. RCRCD aims to conserve natural resources, including soil, water, plants, and wildlife in western Riverside and San Bernardino counties. RCRCD activities include conducting conservation projects, educating the community, and providing technical advice to land users.

Additionally, there is a 13-acre Fresno Canyon conservation easement that partially overlaps a small area of the westernmost portion of the Basin.

2.2.6. Water Management Entities

While Corona and Norco are the primary water suppliers in the Basin, other water management entities have jurisdictional and/or monitoring and management responsibilities in the Basin.

The Riverside County Flood Control and Water Conservation District (Flood Control District) is located in the western portion of Riverside County and overlies the Basin. The Flood Control District regulates development in relation to floodplains and drainage, identifies potential flood hazards, and constructs flood control structures.

The Santa Ana Watershed Project Authority (SAWPA) is a joint power authority formed of several water agencies in the Santa Ana River watershed aimed at protecting the watershed and maximizing beneficial uses within the watershed. SAWPA focuses on water resource issues including water supply reliability, water quality improvement, recycled water, wastewater treatment, groundwater management, brine disposal, and integrated regional planning. SAWPA also administers the Basin Monitoring Program Task Force for the watershed, which monitors and reports surface water quality as well as produces Santa Ana River Wasteload Allocation Model Reports. These monitoring and reporting activities are necessary to determine compliance with the nitrogen and total dissolved solids (TDS) objectives for the watershed.

The Orange County Water District (OCWD) owns and operates the Prado Wetlands, 2,150 acres of constructed wetlands behind the Prado Dam, located just north of the northeast corner of the Basin. These wetlands improve water quality in the Santa Ana River by removing nitrate from the water.

Chino Basin Watermaster manages groundwater in the adjacent basin, Chino Basin (Upper Santa Ana Valley Basin 8-002.01). Chino Basin is upgradient of Temescal Basin and groundwater management in Chino will likely impact Temescal Basin. The GSA has been in communication with Chino Basin Watermaster through the GSP preparation process.

2.3. WATER SUPPLY

Water supply for municipal and industrial uses include groundwater and imported water from the Western Municipal Water District (WMWD). In addition, recycled water is used for non-potable uses. The water providers within the Basin and additional detail on their various water sources are described in the following sections.

2.3.1. Water Providers

Corona serves water to the majority of the population within the Basin. Norco and the Home Gardens County Water District (HGCWD) serve water to smaller portions of the Basin.

Corona provides water and wastewater services to residential, institutional, commercial, and industrial customers within the city as well as to the unincorporated communities of El Cerrito, Coronita, and parts of Temescal Canyon. Corona's water service area encompasses approximately 39 square miles. Corona's water sources include groundwater pumped from the Basin and the Coldwater Subbasin and imported water purchased from WMWD.

Norco is the sole water purveyor for the residents and businesses within its city boundaries, which encompass approximately 15 square miles. Norco purchases imported water from WMWD, purchases desalinated groundwater from the Chino Desalter Authority (CDA), and pumps groundwater from the Basin.

HGCWD serves water to a portion of the census-designated place of HGCWD and purchases all water from Corona.

The 2020 water supplies for each water purveyor from each water source are shown on **Figure 2-4**. Purchased imported water and groundwater from the Basin make up 53 percent and 47 percent of Corona's supply, respectively (Michael Baker 2021). Purchased imported water and groundwater from the Chino Subbasin make up 93 percent and 7 percent of Norco's supply, respectively (Norco 2021). Purchased imported water makes up 100 percent of the supply for HGCWD. Note that all of HGCWD purchased supply and a portion of Norco's purchased supply are from Corona and are thus included in Corona's total supply. It should be noted that these water supply distributions are based on year 2020 only and typically vary from year to year.

2.3.2. Water Supply Sources

2.3.2.1. Groundwater

Corona is the primary producer of groundwater in the Basin. Corona has 18 wells that extract water from the Basin for the purpose of potable water supply (Michael Baker 2021). Norco has four active wells but they are located in the unadjudicated portion of the Chino Subbasin not the Basin.

A number of private wells were historically installed in the Basin. Well densities for domestic wells, production wells, public wells, and all groundwater wells completed and reported to DWR are shown on **Figures 2-5, 2-6, 2-7**, and **2-8** respectively. Well density varies throughout the Basin from 0 to 15 wells per square mile section. These well density maps show all the well completion reports that have been submitted to DWR over time. There are no records of which of these wells are currently active. However, the GSA agencies searched for existing active wells within the Basin. This search included reviewing water use records and contacting owners of large private properties (domestic, commercial, and industrial), inquiring about private wells in discussions with knowledgeable local residents and community leaders, and polling interested parties during public meetings. This effort indicated that the only private pumpers in the Basin are All American Asphalt, Dart Corporation, and 3M. No active private domestic wells were identified in this search.

Corona owns and operates the 10 million gallons per day (mgd) Temescal Desalter, a reverse osmosis (RO) treatment facility where groundwater from the Basin high in TDS is forced one-way through membranes that reject salts as waste brine. Corona then blends this water with locally produced groundwater. The location of the Temescal Desalter is shown along with other Corona water and wastewater facilities in **Figure 2-9**.

In addition to pumping groundwater from the Basin, Norco purchases groundwater from the CDA, which is extracted from the Chino Subbasin. This water purchase is further described in Section 2.3.2.3.

2.3.2.2. Local Surface Water

No surface water is used as a water supply source within the Basin. Just to the south of the Basin, Corona utilizes surface flows from Coldwater Canyon in percolation basins and then extracts groundwater from the Coldwater portion of the Bedford-Coldwater Subbasin.

2.3.2.3. Purchased or Imported Water

The Basin's primary sources of imported water are supplied through WMWD, a member agency of Metropolitan Water District of Southern California (Met). Imported water supply from WMWD consists of treated surface water, untreated surface water and desalinated brackish groundwater.

WMWD supplies treated surface water via the Mills Pipeline from Henry J. Mills filtration plant. The Mills Pipeline delivers treated water directly to Corona through metered turnout WR-24. This connection has an effective capacity of 6.5 mgd (Michael Baker 2021). Norco also receives water from WMWD via the Mills Pipeline, which is then wheeled through a metered connection from Corona to Norco (Norco 2021).

WMWD supplies untreated surface water via the Lower Feeder. The Lower Feeder supplies raw water to Corona's Lester Water Treatment Plant through metered turnout WR-19 and to Corona's Sierra del Oro Water Treatment Plant through metered turnout WR-33. The Lester Plant has a peak capacity of 30 mgd, and the Sierra del Oro Plant has a peak capacity of 9.0 mgd (Michael Baker 2021).

WMWD supplies desalinated brackish groundwater via the Arlington Desalter to both Corona and Norco. Norco entered into a purchase water agreement with WMWD to purchase a minimum of 4,400 acre-feet per year (AFY) of treated groundwater annually from the Arlington Desalter reverse-osmosis treatment facility (Norco 2021). Excess production from the desalter is made available to Corona (Michael Baker 2021).

Norco is a member agency of the CDA, a Joint Powers of Authority. Norco has an annual obligation to purchase 1,000 AFY of reverse osmosis treated potable groundwater water from CDA (City of Norco 2021).

The City of Corona operates well(s) for HGCWD and supplies them with all their water supply.

The reliability of imported water is documented in WMWD's 2020 UWMP (WSC 2021). The WMWD UWMP details the potential constraints facing Met, the wholesaler that provides most of the imported water supply for WMWD, Corona, and Norco. Various past and ongoing actions address the water supply threats including water conservation, increased storage programs, and augmenting water supplies. Because of their robust planning efforts, WMWD's UWMP indicates there would be 99 percent of supply available in a single dry year and 100 percent of supply in multiple dry years. In addition, Corona maintains a two-way connection with the City of Riverside that can be used in the event of an emergency.

2.3.2.4. Recycled Water

As shown on **Figure 2-9**, three wastewater reclamation facilities are located in the Basin. Existing reclaimed water supply is provided by three Water Reclamation Facilities (WRF1, WRF2 and WRF3) and two non-potable wells owned and operated by Corona. The average annual production from these sources is approximately 11.35 mgd or 12,700 AFY. Corona is a member of the Western Riverside County Regional Wastewater Authority (WRCRWA), which operates a new wastewater reclamation facility in Eastvale. When WRCRWA is fully implemented, Corona's level of recycled water production will stay the same. However, the location of sources of supply will shift to the north and Corona will have access to additional recycled water supply from WRCRWA (Corona 2018).

Norco is also a member of WRCRWA but does not currently receive and distribute recycled water.

2.3.2.5. Conjunctive Use/Managed Recharge/In-Lieu Recharge

In 2013, Corona prepared a Recharge Master Plan (RMP) for the Basin that defines the groundwater management objectives for the Basin. The RMP lays out goals and alternatives for artificial recharge in the Basin. Implementation of the RMP is ongoing. Corona currently discharges tertiary treated effluent from its Wastewater Treatment Plants No. 1 and No. 2 to the Lincoln/Cota Ponds, where the effluent is either lost to evapotranspiration or percolated to groundwater (WEI 2013).

2.3.3. Water Use Sectors

Water use sectors are defined in the GSP Regulations as categories of water demand based on the general land uses to which the water is applied, including urban, industrial, agricultural, managed wetlands, managed recharge, and native vegetation.

The distribution of current land use types in the Basin is presented on **Figure 2-10**. While the land use types are more detailed than the water sector categories, the land use mapping provides relevant background information for understanding the various water uses and locations of these uses in the Basin. A significant portion of the Basin is characterized as single-family residential land use. The next most common land use type within the Basin is industrial. Water use and land use by sector for Corona, Norco, and the Basin are presented in **Table 2-1**.

Table 2-1. Water Use and Land Use by Sector (2020)[1]

Water Use Sector	Corona Water Use	Norco Water Use	Basin Land Use
Urban[2]	87 percent	82 percent	70 percent
Industrial[3]	13 percent	18 percent	11 percent
Agricultural	0 percent	0 percent	1 percent
Managed Wetlands	0 percent	0 percent	0 percent
Managed Recharge	0 percent	0 percent	0 percent
Native Vegetation	0 percent	0 percent	18 percent

Notes:
1) Water use data is provided by Corona and Norco's Urban Water Management Plans (UWMPs) (Michael Baker 2021 and Norco 2021) and land use data is based on an analysis of the land use parcels included in the Basin as shown in **Figure 2-10**.
2) Urban water use for Corona does not include commercial uses, which is reported as combined with industrial.
3) Industrial water use includes commercial uses.

2.4. WATER RESOURCES MONITORING PROGRAMS

This section summarizes the following water resources monitoring activities in the Basin:

- Climate
- Surface Water Flow
- Surface Water Quality
- Groundwater Levels
- Groundwater Quality
- Groundwater Production
- Conjunctive Use/Managed Recharge
- Recycled Water
- Imported Water
- Land Use
- Land Subsidence
- Incorporation of Existing Monitoring into GSP

Several ongoing monitoring programs provide data and information relevant to the Basin. Corona, Norco, other local agencies, state agencies and federal agencies are responsible for the various monitoring programs, which are summarized briefly below (Sections 2.4.1 through 2.4.12).

2.4.1. Climate

The State Water Resources Control Board (SWRCB) Division of Drinking Water (DDW) compiles climate data in the California Irrigation Management Information System (CIMIS). This database includes total solar radiation, soil temperature, air temperature/relative humidity, wind direction, wind speed, and precipitation. While the CIMIS database is a comprehensive source for climate data, there are no CIMIS stations in the Basin. The closest CIMIS stations are:

- Chino No. 255 - This station is located north of the Basin (Latitude: 33.985350, Longitude: -117.656528).
- U.C. Riverside No. 44 - This station is located east of the Basin (Latitude: 33.964942, Longitude: -117.33698).

2.4.2. Surface Water Flows

United States Geological Survey (USGS) owns and operates two streamflow gauges in the Basin. These include:

- TEMESCAL C AB MAIN ST A CORONA CA (11072100) - This station is located on the Temescal Creek near Main Street in Corona.
- SANTA ANA R BL PRADO DAM CA (11074000) - This station is located along the Santa Ana River below Prado Dam.

2.4.3. Surface Water Quality

Corona and Norco are both members of the Middle Santa Ana River Watershed Total Maximum Daily Load (TMDL) Task Force. The Task Force is a collaborative effort of public- and private-sector agencies and interests focused on the development of pathogen TMDLs for Santa Ana River Reach 3, its tributaries, and other water bodies in the Chino Basin area, located immediately north of the Basin. Formed in 2007, the Task Force has been working on several pathogen-related activities and studies for the Chino Basin. The objectives of this Task Force are to implement a number of tasks identified by the Regional Board in their 2005 Amendment to the water quality control plan (Basin Plan) (SWRCB 2020a). These include the implementation of a watershed-wide monitoring program to assess compliance with water contact recreation (REC-1) beneficial use water quality objectives for fecal coliform, evaluate numeric targets established for E. coli, and identify and implement measures to control sources of impairment. The Task Force works with the Regional Board in the formulation of pathogen TMDL allocation and implementation strategies (SAWPA 2018).

The Upper Temescal Valley Salt and Nutrient Management Plan (SNMP) developed by Elsinore Valley Municipal Water District and Eastern Municipal Water District includes several management actions, one of which is the implementation of a monitoring program. This monitoring program includes seven surface water monitoring sites, one of which is in the GSP Area. This privately-owned continuous flow gage is located at the All American Aggregate pit in Corona, the discharge point of the Temescal Wash (WEI 2017).

Data is also collected by OCWD and other monitoring entities associated with local habitat conservation programs (HCPs) throughout the Santa Ana River region, including in the Prado Management Area. These data have been and will continue to be incorporated into the GSA's database.

Releases to the Temescal Wash are monitored by various dischargers through NPDES permit requirements (Todd and AKM 2008), and these data also have been and will continue to be incorporated into the GSA's database.

2.4.4. Groundwater Levels

Corona has monitored water quality in production wells in the Basin to protect water quality and to comply with regulations over time. Since 1998, Corona has conducted a monitoring program including water level measurements in about 19 production wells, maintaining these data in a water level database. In 2006, Corona expanded the water level monitoring program to include wells that are not currently pumping (or pump on a limited basis). These wells include inactive irrigation wells, inactive or periodically used production wells, and dedicated monitoring wells installed by Corona (Todd and AKM 2008).

In addition, groundwater levels are measured in and around the Basin by Western Riverside County Regional WastewaterAuthority, OCWD, Chino Basin Watermaster, monitoring programs through the Upper Santa Ana River Habitat Conservation Plan (SARHCP). Data from these ongoing programs are used to supplement GSA collected data and inform the understanding of the Basin.

2.4.5. Groundwater Quality

Groundwater quality monitoring occurs at Corona's active production wells on a continuous basis, ranging in frequency from semi-monthly to semiannual depending on the water quality constituent. However, no formal water quality monitoring program has been established at the monitoring wells, primarily because of an inability to pump some of the wells. Additional groundwater quality is available from neighboring basins including OCWD and Chino Basin Watermaster. The SWRCB groundwater ambient monitoring program (GAMA) Groundwater Information System (SWRCB 2020b) also compiles available water quality data from cooperating agencies. Data from these sources has been compiled and assessed as needed.

2.4.6. Groundwater Production

Corona's groundwater pumping accounts for most groundwater production from the Basin, however, there are also a few known private pumpers. WMWD serves as the Santa Ana Watershed water master and records annual production for the watershed.

According to Watermaster records, other current and historical pumpers include:

- All American Asphalt
- Dart Corporation
- 3M Company (formerly Minnesota Mining and Manufacturing Company).

2.4.7. Conjunctive Use/Managed Recharge

Corona currently discharges tertiary treated effluent from its Wastewater Treatment Plants No. 1 and No. 2 to the Lincoln/Cota Ponds, where the effluent is either lost to evapotranspiration or percolated to groundwater. Effluent discharge quantity is monitored and recorded by Corona (WEI 2013).

2.4.8. Recycled Water

Corona records recycled water flows and quality at the three reclamation facilities: WRF1, WRF2 and WRF3. Corona also records recycled water deliveries to the 282 metered connections in the recycled water service areas for landscape irrigation, toilet flushing via dual plumbed systems, firefighting, dust control and various construction applications.

2.4.9. Imported Water

Corona maintains records of imported water purchases and deliveries from WMWD and water delivered to Norco and HGCWD.

2.4.10. Land use

Land use data for the Basin are available through the Southern California Association of Governments (SCAG), as well as the planning departments of the cities of Corona and Norco. The most recent land use mapping data from SCAG are from 2016, while the latest general plans from Corona and Norco were adopted in 2004 and 2014, respectively. The current land use shows much of the Basin is now single-family residential homes with very little agricultural area.

The Basin was historically an agricultural area and has significantly urbanized since the middle 1980s. In the 1950s and 1960s, the Basin consisted mainly of irrigated agricultural lands with a variety of crops, especially citrus. The 1984 land use map on **Figure 2-11** suggests that much of the southern part of the Basin continued to be used for agriculture, but most of this land was likely fallow or non-irrigated pasture by 1984.

The contributing watersheds that surround the Basin consist mostly of native vegetation or grasslands used for grazing. With the exception of urbanization of the small watershed on the northeastern side of the Basin, land use in the contributing watersheds has not changed significantly over the last 20 years.

2.4.11. Natural Resources

Additional monitoring from OCWD and other local HCP programs focus on natural resources including biological surveys and other information.

2.4.12. Land subsidence

While the potential for subsidence was recognized in the 2008 Groundwater Management Plan, it has not been a known issue in the Basin and ground surface elevations have not been monitored until recently. The TRE Altamira Interferometric Synthetic Aperture Radar

(InSAR) Dataset, provided by the California Department of Water Resources (DWR) through the Sustainable Groundwater Management Act (SGMA) Data Viewer (DWR 2020), shows vertical ground surface displacement from June 2015 to September 2019 and indicates that the Basin has been characterized by uplift over that period, likely reflecting tectonic factors. No known available sources of data indicate subsidence in the Basin.

2.4.13. Incorporation of Existing Monitoring into GSP

Data from existing monitoring programs have been collected and incorporated into the GSP. The existing monitoring data and locations are discussed further as part of the Monitoring Plan, Chapter 7 of this GSP.

2.5. WATER RESOURCES MANAGEMENT

This section summarizes previous plans related to different aspects of water resources management in the Basin. Generally, this previous work falls into two main categories: groundwater basin management and water resources management. The categorization helps to provide some context for the summaries that follow:

- **Groundwater Basin Management** - Plans and studies focusing on groundwater management include the 2008 GWMP, the monitoring program in the 2008 GWMP, and the 2013 RMP. Management of groundwater quality is described in general in the Water Quality Control Plan for the Santa Ana Basin.
- **Water Resources Management** - There are a number of water resources planning documents. WMWD's Updated Integrated Regional Water Management Plan (IRWMP) (Kennedy/Jenks 2008) and SAWPA's One Water One Watershed Plan (OWOW Plan) (SAWPA 2018) provide information on water resources on a regional scale. However, WMWD's IRWMP plan is over 10 years old and SAWPA's OWOW Plan is very high level as it covers the entire Santa Ana River Watershed. Additional plans developed by Corona and Norco are more recent and more focused on the Basin. The 2020 Corona Urban Water Management Plan and the 2020 Norco Urban Water Management Plan include information on existing and future water demands and supplies, including groundwater, imported water, surface water, and recycled water (Michael Baker 2021 and Norco 2021). The 2020 Urban Water Management Plans (UWMPs) also identified water supply strategies for meeting future demands. The Reclaimed Water Master Plan (Corona 2018) provides recommendations for expansion of Corona's reclaimed water program.

2.5.1. AB3030 Groundwater Management Plan

The GWMP was prepared in June 2008 and includes the Basin and the Bedford-Coldwater Subbasin (Todd and AKM 2008). The goals of the 2008 GWMP included operating the groundwater basin in a sustainable manner for beneficial uses and increasing the reliability of water supply for basin users.

The major components of the 2008 GWMP included:

- Data compilation and management
- State of the groundwater basins
- Corona water demand and supply
- Basin management objectives
- Basin management strategies
- Implementation plan.

The 2008 GWMP included a thorough evaluation of the groundwater conditions and conceptual model. The study found that the Basin was potentially in a state of overdraft from 2001 through 2004, when groundwater pumping in the Basin increased from a previous average of 10,000 AFY to an average of 20,000 AFY. The 2008 GWMP recommended numerous strategies for managing groundwater while maintaining groundwater production including:

- Develop new wells that will allow flexibility in pumping distribution and maintenance of water levels
- Enhance recharge directly into the Basin
- Provide the infrastructure necessary for the conveyance of water to recharge facilities
- Provide replacement water sources for a portion of the groundwater demand, potentially decreasing Basin production
- Increase monitoring of groundwater levels and storage for the tracking of overdraft mitigation.

Since 2008, Corona has added new wells, which allow flexibility in pumping distribution.

2.5.2. Groundwater Monitoring Program and Protocols

The 2008 GWMP included a groundwater monitoring program for the Basin and the Bedford-Coldwater Subbasin (Todd and AKM 2008).

Objectives of the 2008 GWMP monitoring program included:

- Characterize water levels and water quality basin-wide
- Monitor areas of concern to address specific problems
- Evaluate the performance of groundwater management activities
- Track changes in groundwater levels, quality and storage over time.

2.5.3. Recharge Master Plan for the Temescal Basin

The RMP for Corona's use of the Temescal Basin was prepared in September 2013 by Wildermuth Environmental to address the groundwater overdraft identified in the 2008 GWMP. The major components of the RMP included:

- Define goals for artificial recharge and develop planning criteria
- Characterize potential source waters for artificial recharge
- Characterize the universe of potential sites for artificial recharge

- Develop alternatives for artificial recharge
- Evaluate and rank alternatives for artificial recharge.

The RMP recommended implementation of Alternative 1 (Divert base flow in Temescal Creek for Recharge at the Lincoln/Cota Ponds) and Alternative 4b (Stormwater and recycled water recharge at the Main Street and Oak Street basins), which would result in about 7,200 to 9,300 AFY of new recharge to the Temescal Basin. This would exceed the goal for the RMP to increase recharge by 4,000 AFY and would allow Corona to decrease its reliance on purchased imported water and decrease the total cost of its water supply.

Since 2013, Corona conducted research on Alternative 4b and found that the water quality analysis of stormwater is not high enough to use for recharge to the Basin. Implementing this alternative would require the additional use of clarifying equipment to address debris and silt in the stormwater runoff. Although it may be pursued in the future, Alternative 4b is not being pursued at this time.

2.5.4. Water Quality Control Plan for the Santa Ana River Basin

The Water Quality Control Plan for the Basin Plan provides the framework for how surface water and groundwater quality in the Santa Ana Region should be managed to provide the highest water quality reasonably possible. The Basin Plan (i) designates beneficial uses for surface and ground waters, (ii) sets narrative and numerical objectives that must be attained or maintained to protect the designated beneficial uses and conform to the state's antidegradation policy, and (iii) describes implementation programs to protect all waters in the Santa Ana Region (SWRCB 2020a).

The Basin Plan includes site-specific objectives for un-ionized ammonia, cadmium, copper, and lead for the Santa Ana River System, which includes Temescal Creek. These objectives aim to prevent chronic toxicity to aquatic life in the Santa Ana River. The Basin Plan also states water quality objectives for the Temescal Groundwater Management Zone for 770 milligrams per liter (mg/L) TDS and 10.0 mg/L nitrate as nitrogen.

The Basin Plan outlines the statewide monitoring activities aimed at assessing attainment of water quality goals and objectives specified in the Basin Plan. The groundwater monitoring program relies on data collected by municipal supply districts. The Santa Ana Regional Water Quality Control Board (SARWQCB) contributes to the data collection effort.

2.5.5. Integrated Regional Water Management Plan Update

Corona and Norco purchase imported water from WMWD. Therefore, it is relevant to track WMWD planning efforts that affect the Corona and Norco service areas or the imported water delivered to Corona and Norco.

WMWD completed its most recent Integrated Regional Water Management Plan in 2008 (Kennedy/Jenks 2008). The purpose of the IRWMP was to address long range water quantity, quality, and environmental planning needs within WMWD’s service area.

The 2008 WMWD IRWMP focused on:

- Identifying and evaluating water management strategies that could increase local water supply, thereby improving water supply reliability.
- Evaluating local and regional water quality, environmental, and disadvantaged community issues.

The IRWMP also includes discussion of other regional planning efforts that impact water management within the WMWD service area as well as compilation of estimates of water demands by member agencies, water supplies (e.g., local groundwater, recycled water, surface water, and imported water) available to the agencies, and efforts to coordinate investments in water management, as appropriate, between agencies.

The IRWMP included several projects relevant to Corona:

- New water wells
- Replacement water wells
- Groundwater blending program
- Improvement of groundwater quality/quantity monitoring program
- Recharge basins within Oak Avenue detention basin
- Recharge basins within Main Street detention basin
- Upgradient injection wells
- Recycled water injection wells
- Lincoln and Cota street percolation ponds maintenance program.

Several of these projects include groundwater recharge projects that were also recommended in the 2013 RMP.

2.5.6. Santa Ana River Watershed One Water One Watershed Plan

Corona, Norco, and HGCWD are involved in SAWPA, which in 2018 updated its One Water One Watershed Plan (OWOW Plan). The OWOW Plan's goals for the entire Santa Ana River Watershed are as follows:

- Achieve resilient water resources through innovation and optimization
- Ensure high-quality water for all people and the environment
- Preserve and enhance recreational areas, open space, habitat, and natural hydrologic function
- Engage with members of disadvantaged communities and associated supporting organizations to diminish environmental injustices and their impacts on the watershed
- Educate and build trust between people and organizations
- Improve data integration, tracking, and reporting to strengthen decision making.

The Plan includes ongoing water management projects and programs undertaken by Corona, Norco, and HGCWD.

2.5.7. Corona and Norco Urban Water Management Plans

The California Urban Water Management Planning Act requires preparation of Urban Water Management Plans (UWMPs) by urban water providers with 3,000 or more connections. The UWMPs, generally required every five years, provide information on water supply and water demand—past, present, and future—and allow comparisons as a basis for ensuring reliable water supplies. UWMPs examine water supply and demand in normal years and during one-year and multi-year droughts. UWMPs also provide information on per-capita water use, encourage water conservation, and present contingency plans for addressing water shortages.

According to its 2020 UWMP, Corona is in compliance with the state requirements to reduce per capita water use by 20 percent by 2020 (Senate Bill X7-7). The 2020 per capita daily water use of 180 gallons per capita per day (gpcd) was below the target of 213 gpcd (Michael Baker 2021). Per the UWMP, Corona should be able to meet demands through 2040 in normal, dry, and multiple-dry years using their existing water sources.

For the City of Norco, the 2020 per capita daily water use of 151 gpcd was currently below the target of 263 gpcd (Norco 2021). Per its 2020 UWMP, Norco is in compliance with Senate Bill X7-7 and should be able to meet demands through 2040 in normal, dry, and multiple-dry years using their existing water sources.

2.5.8. Reclaimed Water Master Plan

The purpose of the 2018 Reclaimed Water Master Plan (RWMP) (Corona 2018) was to assist Corona with meeting its goals for reclaimed water use by recommending the implementation of appropriate projects, programs, and additional studies. The RWMP identified, evaluated, prioritized, and scheduled 33 projects. The recommendations from the RWMP fell into four categories:

- Improvements involving receiving future supply from WRCWRA
- Improvements to add demand for reclaimed water
- Enhancements to data collection
- Additional studies related to future uses of reclaimed water

The RWMP does not include projects relating to recharge of the Basin with reclaimed water.

2.5.9. Water Resources Management Implementation Status

Most of the previous plans summarized above have included recommendations for water resources management activities in the Basin. Since the time of publication, many of these recommendations have been implemented.

2.6. GENERAL PLANS

This section presents elements of general plans and other land use planning in the Basin as relevant to groundwater sustainability. It focuses on planning goals and objectives that are aligned with potential groundwater management activities. In addition, this section highlights the potential for future changes in land use that may influence water demands and infiltration/recharge of the Basin.

The goals, objectives, policies, and implementation measures as described in the general plans for Riverside County, Corona, and Norco, which together encompass the Basin, are summarized below. The jurisdictional boundaries in the Basin are presented on **Figure 2-2**.

Applicable general plans include:

- The Riverside County General Plan - The entire Basin is within Riverside County (Riverside County 2015).
- Corona General Plan - Most of the Basin is within the Corona jurisdictional boundary. Corona's General Plan includes plans and policies applicable to the entire city as well as its sphere of influence (Corona 2021).
- Norco - The northeastern portion of the Basin is within the Norco jurisdictional boundary (Norco 2009).

The goals and policies that are water resources related are summarized as follows.

2.6.1. Riverside County General Plan

The Riverside County General Plan was adopted in 2015. The General Plan covers the entire unincorporated portion of the County and also includes 19 detailed Area Plans covering most of the County.

The Multipurpose Open Space Element of the Riverside County General Plan addresses the conservation, development, and use of natural resources including water, soils, rivers, and mineral deposits. A number of policies are related to water supply and conveyance, water conservation, watershed management and groundwater recharge. Several of these policies are summarized in **Table 2-2**.

2.6.2. City of Corona General Plan

The City of Corona's General Plan was updated in 2021 and covers the 37.6 square miles within City limits and provides guidance to Riverside County for the 35.2 square miles within the Corona Sphere of Influence. The General Plan chapters most relevant to water resource management are the chapters on Infrastructure and Public Services and Environmental Resources. Additional relevant policies are in the Land Use and Public Health and Safety chapters as well.

Relevant policies included in the General Plan are summarized in **Table 2-3**.

Table 2-2. Select Policies in the Riverside County General Plan

Category	Policy[1]
Water Supply and Conveyance	Balance consideration of water supply requirements between urban, agricultural, and environmental needs.
	Provide active leadership in the regional coordination of water resource management and sustainability efforts affecting Riverside County.
	Promote the use of recycled water for landscape irrigation.
Water Conservation	Implement water-efficient landscape ordinance and policies.
	Seek opportunities to coordinate water-efficiency policies and programs with water service providers.
Watershed Management	Encourage wastewater treatment innovations, sanitary sewer systems, and groundwater management strategies that protect groundwater quality in rural areas.
	Minimize pollutant discharge to storm drainage systems, natural drainages, and aquifers
	Where feasible, decrease stormwater runoff by reducing pavement in development areas, reducing dry weather urban runoff, and by incorporating “Low Impact Development,” green infrastructure and other Best Management Practice design measures.
Groundwater Recharge	Support efforts to create additional water storage where needed, in cooperation with federal, state, and local water authorities.
	Participate in the development, implementation, and maintenance of a program to recharge the aquifers underlying the county.
	Ensure that aquifer water recharge areas are preserved and protected.
	Use natural approaches to managing streams, to the maximum extent possible, where groundwater recharge is likely to occur.
	Discourage development within watercourses and areas within 100 feet of the outside boundary of the riparian vegetation, the top of the bank, or the 100 year floodplain, whichever is greater.

Notes:

[1] : Some policy statements have been shortened for use in this table. The full text is included in the Riverside County General Plan.

Table 2-3. Selected Policies in the City of Corona General Plan

Category	Policy[1]
Land Use	Accommodate the types, densities, and mix of land uses that can be adequately supported by transportation and utility infrastructure (water, sewer, etc.) and public services (schools, parks, libraries, etc.)
	Require new residential, commercial, office, and industrial development be designed to minimize consumption of and sustain scarce environmental resources through methods including drought-tolerant species and recycled water for irrigation in landscaping, capturing rainwater and using it onsite, and water efficient fixtures.
Infrastructure and Utilities	Establish guidelines and standards for water conservation and actively promote use of water conserving devices and practices in both new construction and major alterations and additions to existing buildings.
	Encourage the use of recycled water by industrial, commercial, and institutional, users through incentives such as differential pricing.
	Require the use of recycled water for landscaped irrigation, grading, and other non-contact uses in new developments, parks, golf courses, sports fields, and comparable uses, where feasible.
	Encourage the use of rainwater capture and storage facilities in residential and nonresidential developments.
Environmental Resources	Prohibit the discharge of toxins, debris, refuse, and other pollution into watercourses, other drainages and groundwater basins.
	Balance consideration of water supply requirements between urban, agricultural, and environmental needs so that sufficient supply is available to meet each of these different demands.
	Provide active leadership in the regional coordination of water resource management and sustainability efforts affecting Riverside County and continue to monitor and participate in, as appropriate, regional activities to prevent overdraft caused by population growth.
	Support efforts to create additional water storage where needed, in cooperation with federal, State, and local water authorities. Additionally, support and/or engage in water banking in conjunction with these agencies where appropriate, as needed.
	In cooperation with Riverside County, participate in the development, implementation, and maintenance of a program to recharge the aquifers underlying Corona and SOI areas.
	Retain storm water at or near the site of generation for percolation into the groundwater to conserve for future uses and mitigate flooding.
	Use natural approaches to managing streams, to the maximum extent possible, where groundwater recharge is likely to occur.
	Require new private or public developments to preserve and enhance riparian habitat and prevent obstruction of natural watercourses.
	Consider wetlands for use as natural water treatment areas that will result in improvement of water quality
Public Health & Safety	Promote the collection of relevant data on groundwater levels and liquefaction susceptibility, as a basis for future refinement of liquefaction policies or procedures.
	Use natural watercourses as Corona's primary flood control channels, whenever feasible and practical.
	Minimize the potential risk of contamination to surface water and groundwater resources and implement restoration efforts to resources adversely impacted by past urban and rural land use activities.

Notes:

[1] : Some policy statements have been shortened for use in this table. The full text is included in the City of Corona General Plan.

Des by: EG
Ckd by: IW

2.6.3. City of Norco General Plan

Norco's General Plan Update includes several elements, of which Conservation is the most relevant for water resources planning (Norco 2014). Relevant policies included in the General Plan are listed in **Table 2-4.**

Table 2-4. Selected Policies in the City of Norco General Plan

Category	Policy[1]
Water Supply	Continue to promote water conservation through the use of xeriscape designs in new development and public spaces where feasible.
	Continue to provide information to the public on ways to conserve water and reduce consumption.
	Monitor the demand for reclaimed water and file for Petitions of Change with the SARWQCB as-needed to reduce the amount of reclaimed water that is discharged from treatment facilities and make that water available for transmission into Norco's reclaimed water infrastructure system.
	Insure that there are adequate increases in water production and distribution capabilities to meet future growth demands.
Water Quality	Develop and maintain inter-agency agreements and infrastructure improvements to have back-up water supply sources from adjoining water districts during times of emergencies and system maintenance requirements.
	Continue public information campaigns to all residents with large animals to ensure awareness that manure spreading as a means of disposal is strictly prohibited to prevent contamination to groundwater supplies.

Notes:
1. Some policy statements have been shortened for use in this table. The full text is included in the City of Norco General Plan Update.

2.6.4. General Plan Influences on Groundwater Sustainability Agency Ability to Achieve Sustainability

The general plans for Riverside County, Corona, and Norco all include policies to increase water conservation and protect groundwater and surface water quality. They also include policies promoting the preservation of natural floodplains, which contribute to groundwater recharge. However, the planned growth in the Basin would convert open space uses that allow groundwater infiltration to more developed land use types with more impervious cover that will likely not allow the same amount of groundwater infiltration. Use of low impact development practices and stormwater best management practices (BMPs) that promote infiltration would help mitigate loss of infiltration due to land use changes.

Riverside County. The Riverside County General Plan addresses the importance of groundwater. The policies and implementation of the land use and public facilities/services elements indicate that the County role is to support and encourage local water agencies in ensuring that water supply is available. Similarly, with wastewater issues and protection of water quantity and quality, the County role is limited to encouragement of other agencies, developers, and landowners. The General Plan contains little policy to manage land use within the constraints of available water supply other than to encourage drought resistant plants and the use of recycled water.

Corona serves a population that is predicted to increase from 170,100 in 2020 to about 185,600 residents by 2045 (Michael Baker 2021). Some of this growth will be along the southern edge of Corona in the Eagle Creek area within and adjacent to the Basin. The UWMP anticipates future growth in the City will be offset by lower per capita water use. However, the general plan indicates that Met may build an additional treatment plant in the area to meet increased water demand, if warranted. Corona land use policies generally are protective of agricultural land and hillsides, and conservation policies address water efficiency, water recycling, sustainability measures, and coordination with other agencies, including HGCWD and Norco.

The increased development included in the general plans was simulated by the numerical model described in Chapter 5. Based on these scenarios, the Basin remains sustainable even with future growth.

2.6.5. GSP Influences on General Plans

The Temescal Groundwater Sustainability Agency (Temescal GSA) agencies will work together to implement this GSP and rely on their portfolio of water supply to maintain sustainability. Future growth is expected to be limited based on the general plans.

City of Corona. Implementation of the GSP will support Corona in providing continued groundwater to its population. In addition, the GSP will ensure good quality water in sufficient quantities to serve its residents into the future, including drought periods.

Riverside County. The Riverside County General Plan generally assumes that local water agencies can ensure adequate high-quality water supplies into the future. The GSP provides additional specific information, documents potential challenges to water supply, and explores undesirable results that may occur with future increases in groundwater demand. Undesirable results will be defined with sustainability criteria, and if identified, will be addressed with management actions. These management actions may have ramifications for County land use planning. For example, GSPs are authorized within the GSP Plan Areas to impose well spacing requirements and control groundwater pumping and control extractions by regulating, limiting, or suspending extractions from individual groundwater wells. Such regulation may present a constraint on potential land uses.

2.7. ADDITIONAL GSP ELEMENTS

The GSP requirements include a list of additional GSP elements from Water Code Section 10727.4 that may or may not be relevant to a GSP. As shown in **Table 2-5**, several of these elements are not applicable to the Basin. The elements that are applicable to the Basin, are presented in the sections below.

Table 2-5. Additional GSP Elements included in Water Code Section 10727.4

Water Code Section 10727.4 Elements	GSP Section or N/A
a) **Control of saline water intrusion**	N/A
b) **Wellhead protection areas and recharge areas**	2.7.1
c) **Migration of contaminated groundwater**	2.7.2
d) **A well abandonment and well destruction program**	2.7.3
e) **Replenishment of groundwater extractions**	N/A
f) **Activities implementing, opportunities for, and removing impediments to, conjunctive use or underground storage**	N/A
g) **Well construction policies**	2.7.3
h) **Measures addressing groundwater contamination cleanup, groundwater recharge, in-lieu use, diversions to storage, conservation, water recycling, conveyance, and extraction projects**	N/A
i) **Efficient water management practices, as defined in Section 10902, for the delivery of water and water conservation methods to improve the efficiency of water use**	2.7.4
j) **Efforts to develop relationships with state and federal regulatory agencies**	2.7.5
k) **Processes to review land use plans and efforts to coordinate with land use planning agencies to assess activities that potentially create risks to groundwater quality or quantity**	2.7.6
l) **Impacts on groundwater dependent ecosystems**	4.10 and 6.7

2.7.1. Wellhead Protection Areas and Recharge Areas

In 2002, Corona conducted an assessment of the vulnerability of their drinking water wells under the California Drinking Water Source Assessment Program. This program, developed by the California Department of Public Health, delineates the area around drinking water sources, such as wells, through which contaminants might reach the water supply. This assessment identified surface recharge areas in the vicinity of Corona's wells. In addition, the analysis in the 2008 GWMP identified the main areas of basin recharge for the aquifers tapped by Corona's wells. These areas include the entire footprint of the unconfined Channel Aquifer, recharge areas along washes and alluvial fans, and areas of subsurface inflow such as Temescal Canyon and Arlington Gap (Todd and AKM 2008).

2.7.2. Groundwater Contamination Migration and Clean-up

There are several groundwater contaminated sites in the Basin in varied stages of remediation. The pollutants of concern for these sites include gasoline, diesel, and volatile organic compounds (VOCs). The status of each site is summarized in **Table 2-6**. The remediation activities for contaminated sites directly over the Basin are managed and tracked by the SARWQCB. GeoTracker is the SWRCB data management system for sites that impact groundwater or have the potential to impact groundwater. GeoTracker provides information on sites that require groundwater cleanup and the status of required clean-up activities. In the Basin, there are a number of closed sites (where clean-up activities have been completed) and five open sites, as shown on **Figure 2-12**.

Table 2-6. Status of Contamination Sites in the Basin

Site	Contaminants of Concern	Status
ARCO #1924	Gasoline	OPEN – Eligible for closure as of 2/18/2016
Thomas Ranch (Schofield)	Benzene, other acid or corrosive, other petroleum, xylene	OPEN – Site assessment as of 8/21/1986
Dry Clean Express	Tetrachloroethylene (PCE), Trichloroethylene (TCE)	OPEN - Inactive as of 2/13/2020
Private Residence	Diesel	OPEN - Inactive as of 11/17/2017
All American Asphalt Landfill	Non-Specified	OPEN – Operating as of 11/1/2014

2.7.3. Well Permitting, Construction, and Destruction Requirements

The RCDEH is responsible for issuing well permits. Permits are required for the construction and/or abandonment of all water wells including, but not limited to driven wells, monitoring wells, cathodic wells, extraction wells, agricultural wells, and community water supply wells. The process includes an application by the property owner and certified well driller, and a site inspection by the County. The wells are also inspected during different stages of construction to help verify standards are being met. All drinking water wells are evaluated once they complete installation to ensure they comply with State well standards and meet minimum drinking water standards. If found in compliance, the land or well owner is issued a clearance letter authorizing their use.

Corona and Norco have not developed their own well construction standards but do require compliance with DWR standards and RCDEH standards.

Through their Water Engineering Program, RCDEH requires that a permit be obtained for the abandonment of any well in the County (RC DEH 2020). Guidance for well abandonment procedures is consistent with the standards developed by DWR and included in the California Water Code (§ 13800 through 13806) for drilling and destroying wells in California. The 2008 GWMP recommended increased coordination with RCDEH Water Engineering Program regarding well abandonment procedures.

2.7.4. Efficient Water Management Practices

Corona and Norco encourage and facilitate efficient water management practices, which are discussed at a high level in each city's General Plan (Corona 2021 and Norco 2014). In addition, specific water conservation targets and demand management measures, including metering, conservation pricing, public education, water loss auditing, and other water conservation program activities, are documented in each city's 2020 UWMP (Michael Baker 2021 and Norco 2021). As documented in Section 2.5.7 of this GSP, Corona and Norco have both met and exceeded their 2020 water efficiency goals.

Water conservation reduces reliance on potable water supplies, including groundwater. Increasing water conservation through the implementation of water efficiency practices may reduce groundwater pumping and promote sustainable groundwater management.

2.7.5. Relationships with State and Federal Agencies

The Temescal GSA has developed an interested parties list, which includes stakeholders, neighboring water agencies, local groups, State and Federal agencies, and others who have expressed interest in the GSP process. Notices have been sent to these interested parties throughout GSP preparation. In addition, State and Federal agencies have had the opportunity to participate in the Technical Advisory Committee (TAC), attend public meetings, and review and comment on public drafts of the GSP.

2.7.6. Land Use Plan Coordination

Land use planning agencies have been invited as interested parties to the GSP planning process. The GSA recognizes the importance of the natural recharge areas, where stormwater is recharged into the Basin and has developed projects and management actions to further assess enhanced recharge in coordination with local land use planning efforts (see Chapter 8).

2.8. NOTICE AND COMMUNICATION

As described in this and later chapters, groundwater is a major source of supply in the Basin and supports a range of beneficial uses: municipal, industrial, commercial, agricultural, and environmental. To some degree in the Basin, all land and property owners, residents, businesses, employees, and visitors are potentially affected by groundwater use. This reflects the orientation of the communities in the Basin and the amenities for small-city living and recreation. While recognizing the critical importance of imported supply, reliable groundwater is essential.

The Temescal GSA has encouraged public participation in the ongoing planning and development activities supporting the GSP process. Corona organized a TAC to support the GSP process; regularly scheduled TAC meetings have been announced on the GSA website and have been open to the public. In addition, public workshops regarding development of the GSP have been conducted to encourage public participation and to provide educational outreach. Early in the GSP preparation process the GSA contacted potential interested partis, including private well owners, environmental stakeholder, local and regional community organizations, and the community at large. Parties that expressed interest were included on the list of interested maintained pursuant to Water Code Section 10723.2.

Organizations and individuals that expressed interest throughout GSP preparation were added to this list. Meeting notices were provided to all those on the interested parties list in advance of all public meetings relating to the GSP and when draft portions of the GSP were made available on the GSA website. Additionally, GSP development information and meeting notices have been regularly posted to the GSA website.

The Communication Plan in **Appendix D** provides an overview of outreach to the public by means of public TAC meetings, public workshops, informational materials (e.g., Fact Sheets), focused outreach, and the GSA website. These inform the public about the GSP development and implementation process and encourage active involvement by interested parties.

The GSA developed and maintained an interested parties list and has communicated to the individuals and organizations on the list during GSP development. These parties represent a variety of interests and perspectives. Additionally, the interested parties group brings a variety of expertise, including public and private groundwater users, local business interests, public water systems, land use planning agencies, regulatory agencies, etc. These parties have been engaged throughout the development of this GSP to provide them with information about the purpose of the GSP, educate about Basin characteristics, and obtain input on sustainability goals and management actions. A list of public meetings held during development of the GSP, comments received on the draft GSP prior to adoption, and how those comments were addressed is included in **Appendix E**.

2.8.1. Technical Advisory Committee (TAC)

The Temescal GSA formed a TAC to provide input and guidance to the staff and consultant team of the GSA during preparation of the GSP based on their expertise, knowledge, resources, and understanding of their communities, environment, commerce, and applicable regulations. The intent of the TAC is to contribute community and stakeholder perspectives and interests in GSP planning and GSP and SGMA implementation in the Basin. The TAC includes representatives from the following public and private organizations:

- 3M Industrial Mineral Products Division
- All American Asphalt
- Santa Ana Regional Water Quality Control Board (RWQCB)
- City of Norco
- Home Gardens County Water District
- Riverside County Flood Control and Water Conservation District
- Corona City Council
- City of Corona Department of Water and Power.

The TAC held quarterly meetings throughout the GSP preparation period that were open to the public. Notification for these meetings was posted on the GSA's website prior to meeting dates and presentation materials and meeting summaries were posted following each meeting. Meeting summaries and presentation materials from the TAC meetings are included in **Appendix F**.

2.8.2. Public Workshops

Three public workshops were held during preparation of the GSP to engage with interested parties and stakeholders. The GSA agencies publicized these public meetings through the GSA website, social media, and distribution of targeted bilingual Fact Sheets. The workshops were held virtually in 2020 and 2021 and all presentations and materials were presented simultaneously in English and Spanish. These workshops were also streamed on Corona's website, Facebook, and YouTube channels and on Corona TV (locally Channel 29 on Time Warner Spectrum and Channel 99 on AT&T).

Meeting summaries, presentation materials, and associated Fact Sheets from the public workshops are included in **Appendix G**.

2.8.3. Directed Outreach and Coordination

The GSA focused significant outreach efforts to engage and inform important local and regional stakeholders. This included engaging community leaders in historically underserved communities in the Basin and coordination with neighboring basins and local agencies.

2.8.4. Disadvantaged Community Outreach

Areas of the Basin identified as disadvantaged and severely disadvantaged communities (DACs and SDACs) are shown on **Figure 2-13**. These DACs and SDACs are within the service areas of Corona and HGCWD and receive water supply from those agencies. There are no active private wells in these DAC and SDAC areas. This fact notwithstanding, the GSA worked to identify individuals and/or organizations in or representing these DACs and SDACs and engage them in the GSP process. Outreach to DAC and SDAC areas of the Basin included communication with and distribution of Fact Sheets to and through local churches and community centers in the DAC/SDAC areas and individual and group meetings with politically active individuals, community leaders, and community action organizations, and elected officials. This outreach focused on presentations regarding SGMA, the Basin, the GSP process and components, and encouraged participation in public meetings and GSP review. These meetings also generated feedback on additional outreach that the GSA could undertake, much of which was implemented. Notes from these meetings are included in **Appendix H**.

2.8.5. Neighboring Basin Coordination

The GSA held meetings to facilitate communication and coordination with groundwater basins neighboring the Temescal Basin. This included meetings with representatives of the Chino Basin, Riverside-Arlington Basin GSA, and Coastal Plain of Orange County Basin GSA. The meetings focused on data sharing between basins, water budget coordination, and GSP preparation timelines. Summary notes from these meetings are included in **Appendix H**.

2.8.6. Comments and Responses on Draft GSP

On September 15, 2021, the GSA notified stakeholders, including local City and County agencies, of their intent to adopt this GSP after a 90-day review period. Two letters with comments on the Draft GSP were received in mid-December. These letters, along with responses from the GSA and indications of how the GSP has been modified are included in **Appendix I**.

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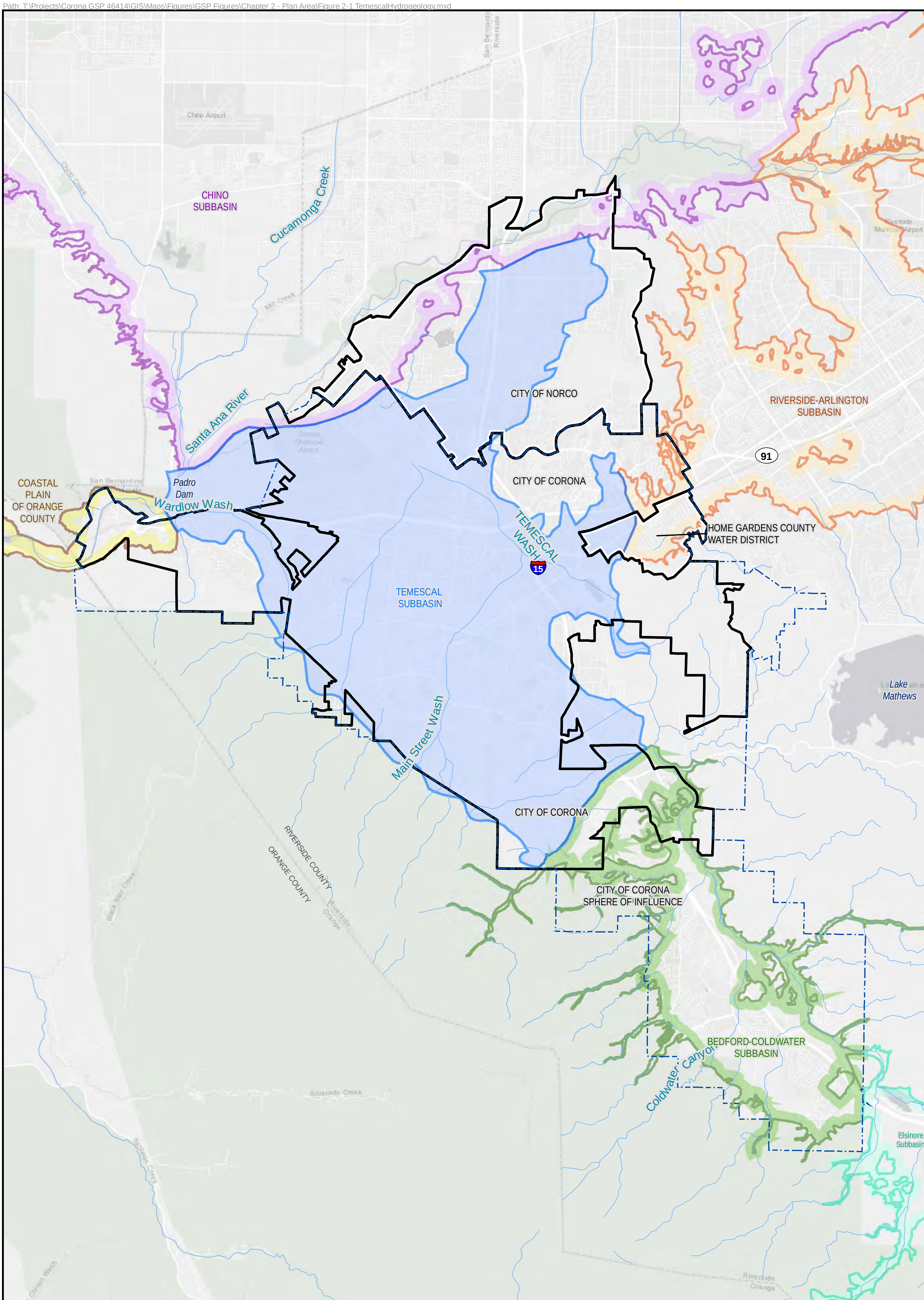

Streams
Temescal Basin GSP Area
Coastal Plain of Orange County Basin
Bedford-Coldwater Subbasin
Chino Subbasin
Elsinore Valley Subbasin
Riverside-Arlington Subbasin
Cities
City of Corona Sphere of Influence

Data Sources:
Cal-Atlas, DWR Bulletin 118, National Hydrography Dataset, SAWPA

Disclaimer:
Features shown in this figure are for planning purposes and represent approximate locations. Engineering and/or survey accuracy is not implied.

N
0 0.5 1
Miles

Figure 2-1
Temescal Basin GSP Area

carollo
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TODD GROUNDWATER

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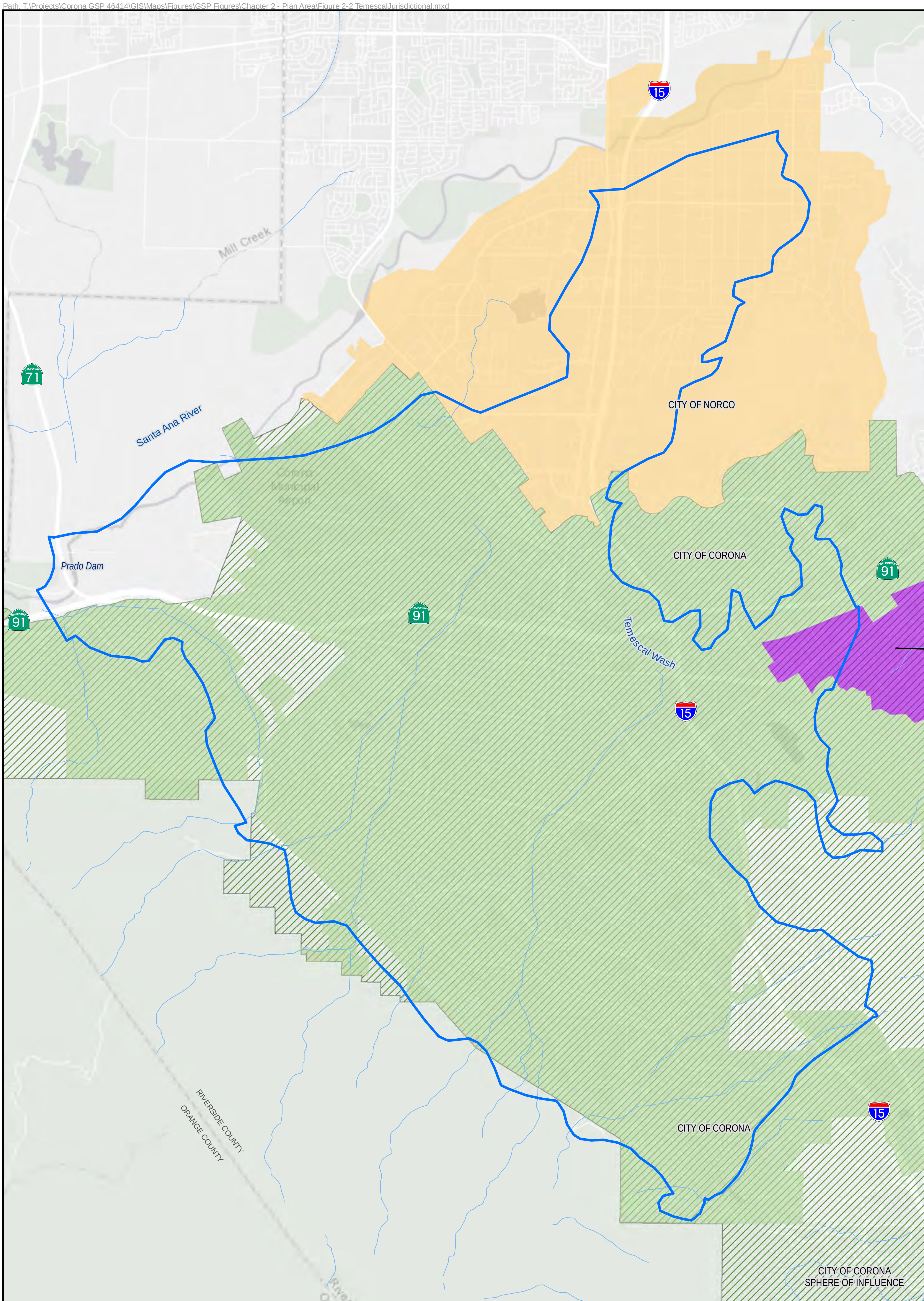

Streams
Temescal Basin
City of Corona
City of Norco
Home Gardens County Water District
City of Corona Sphere of Influence

Data Sources:
Cal-Atlas, DWR Bulletin 118, National Hydrography Dataset, SAWPA

Disclaimer:
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Figure 2-2
Jurisdictional Areas

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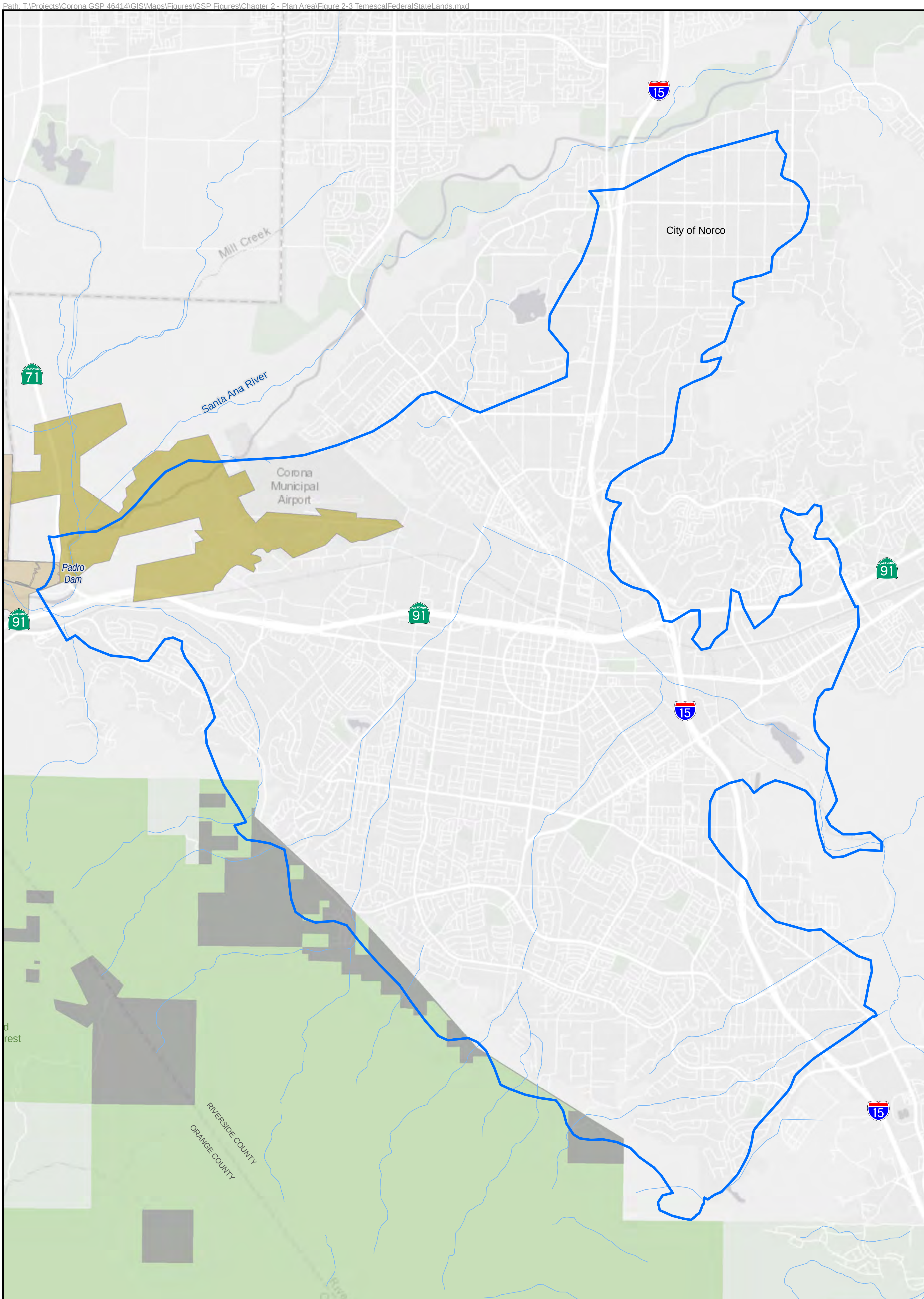

- Department of Defense
- State of California
- Federal Lands - Non-Forest Service Land within USFS
- Federal Lands - US Forest Service
- Temescal Basin

Data Sources:
EVMUD, Cal-Atlas, DWR Bulletin 118, BLM

Disclaimer:
Features shown in this figure are for planning purposes and represent approximate locations. Engineering and/or survey accuracy is not implied.

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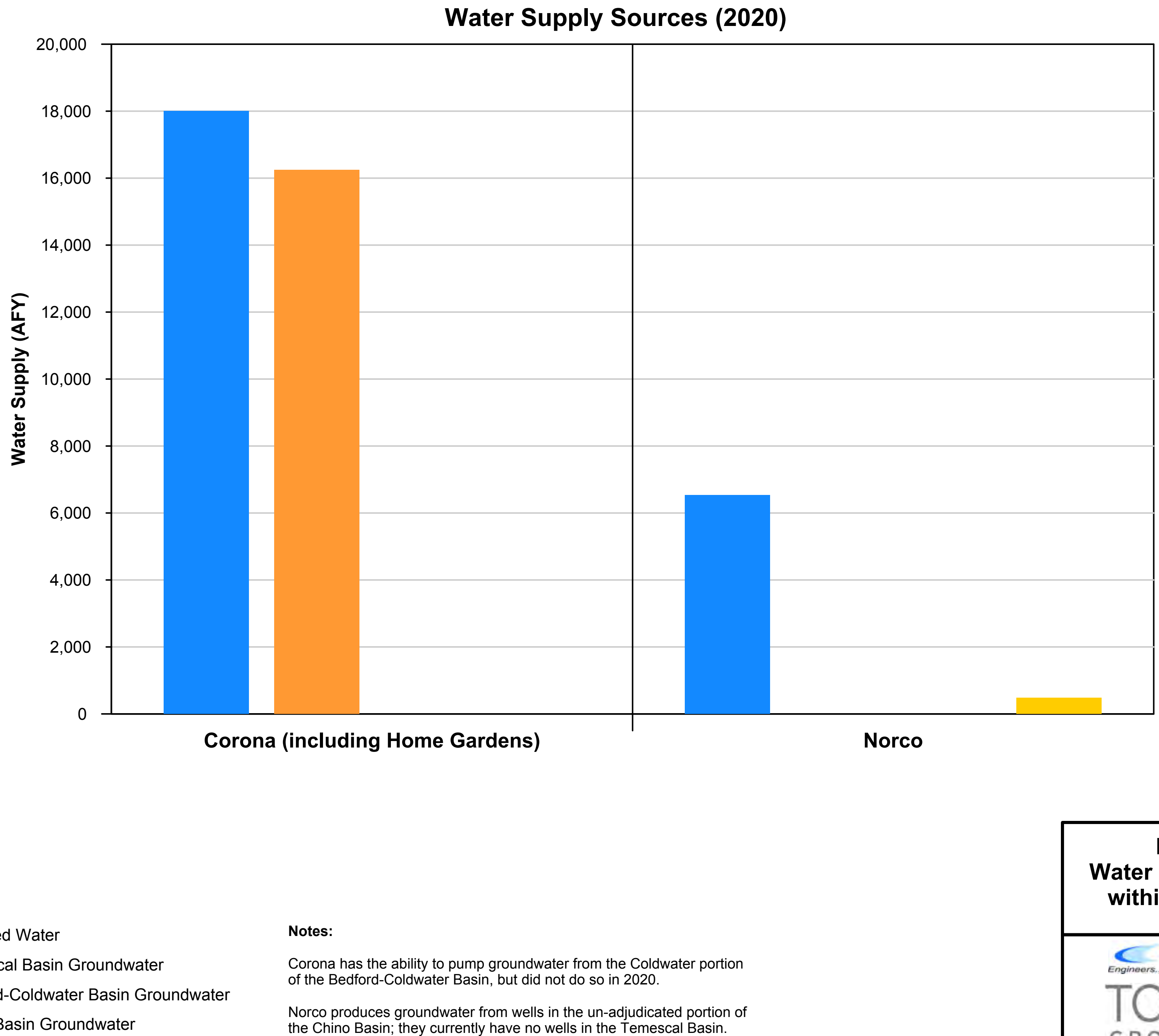
Figure 2-3
Federal and State Lands



Notes:

Corona has the ability to pump groundwater from the Coldwater portion of the Bedford-Coldwater Basin, but did not do so in 2020.

Norco produces groundwater from wells in the un-adjudicated portion of the Chino Basin; they currently have no wells in the Temescal Basin.

Figure 2-4
Water Supply Sources within Basin - 2020

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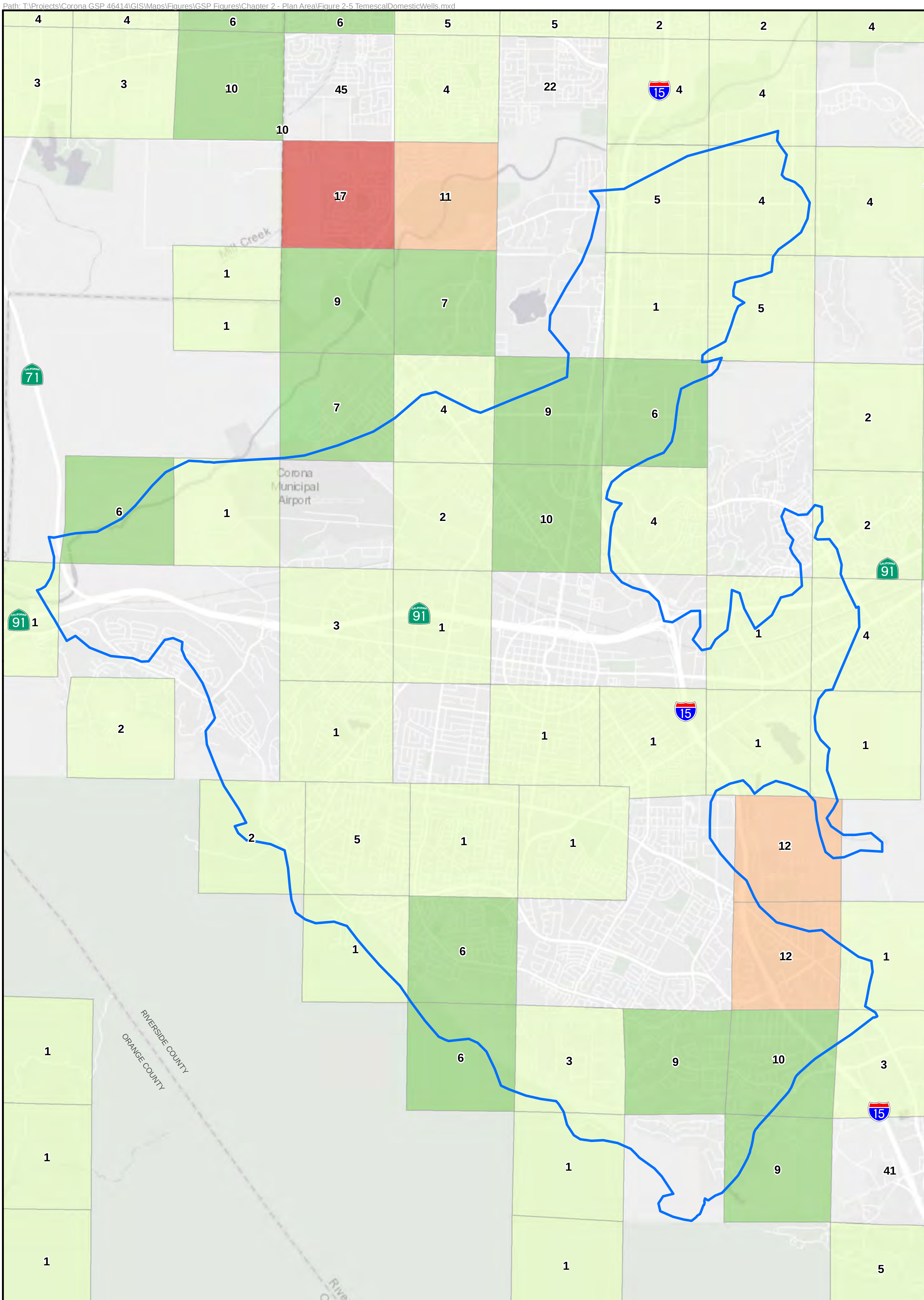

Domestic Wells by Section

- 1 - 5
- 6 - 10
- 11 - 15
- 16 - 20
- Temescal Basin

Data Sources:
Cal-Atlas, DWR Bulletin 118, National Hydrography Dataset

Disclaimer:
Features shown in this figure are for planning purposes and represent approximate locations. Engineering and/or survey accuracy is not implied.

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Miles

Figure 2-5
Basin Domestic Groundwater Wells

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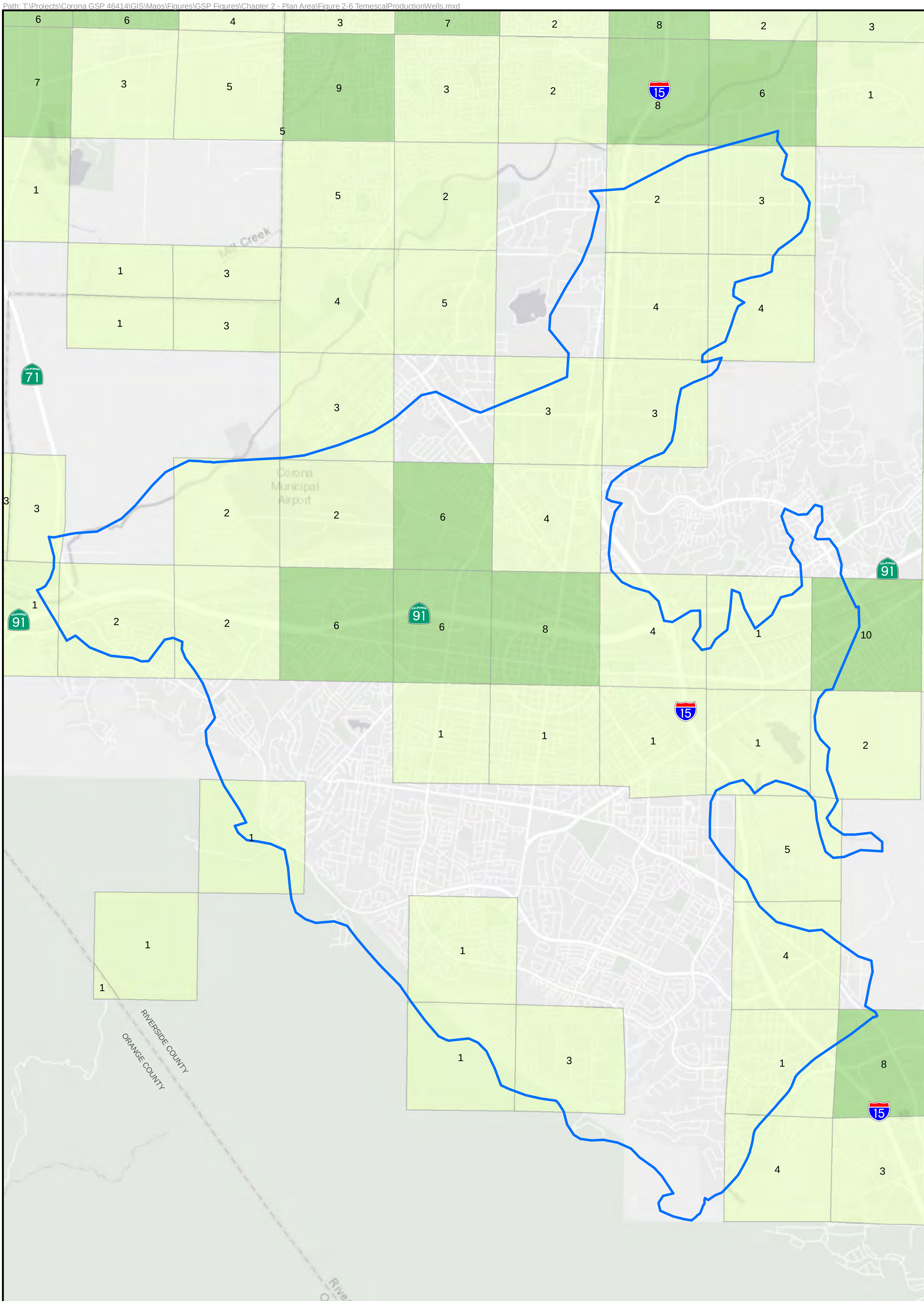

Production Wells by Section

- 1 - 5
- 6 - 10
- 11 - 15
- 16 - 20
- Temescal Basin

Data Sources:
Cal-Atlas, DWR Bulletin 118, National Hydrography Dataset

Disclaimer:
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N

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Miles

Figure 2-6
Basin Production Groundwater Wells

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TODD GROUNDWATER

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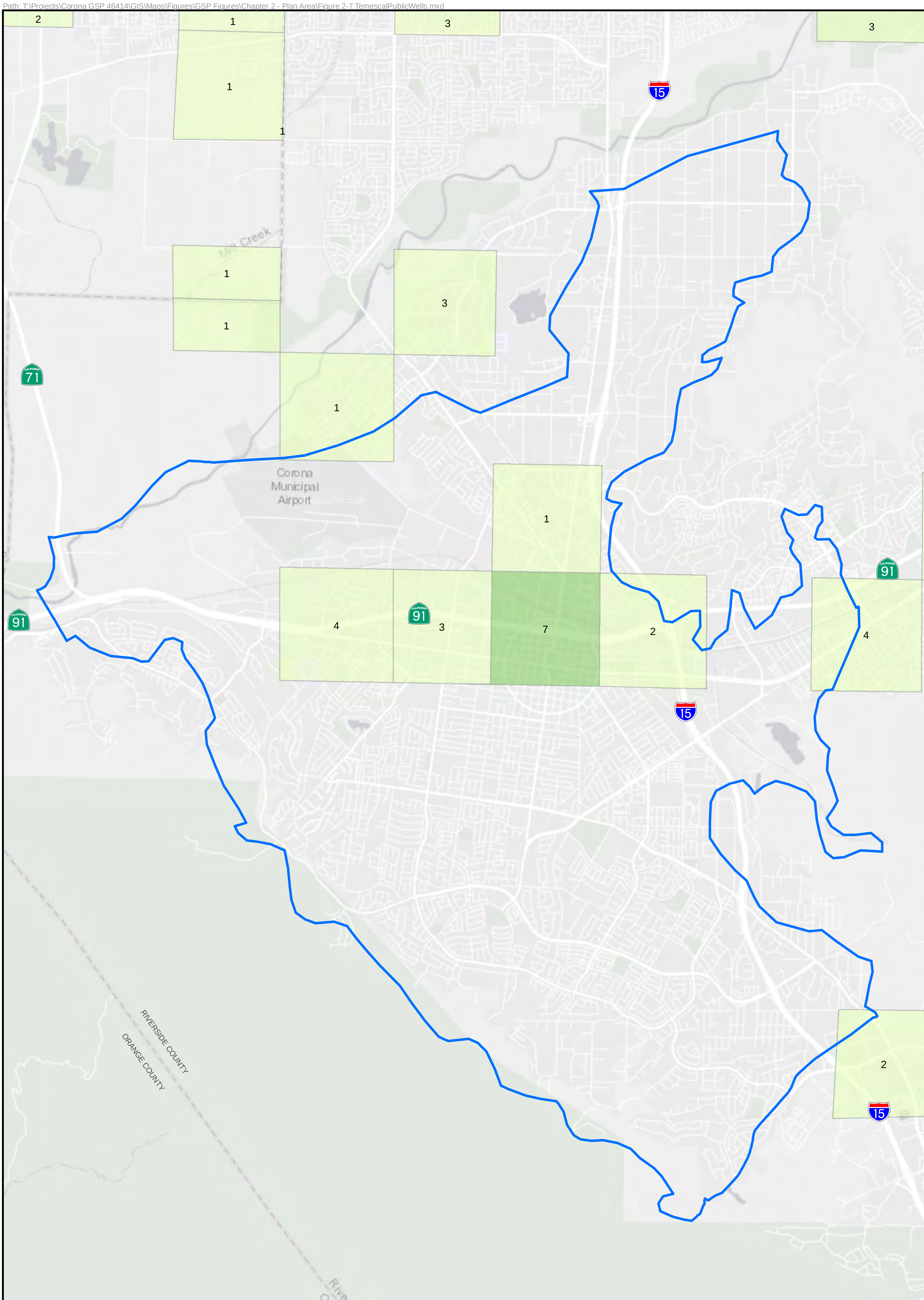

Public Wells by Section

- 1 - 5
- 6 - 10
- 11 - 15
- 16 - 20
- Temescal Basin

Data Sources:
Cal-Atlas, DWR Bulletin 118, National Hydrography Dataset

Disclaimer:
Features shown in this figure are for planning purposes and represent approximate locations. Engineering and/or survey accuracy is not implied.

N

0 0.5 1
Miles

Figure 2-7
Basin Public Groundwater Wells

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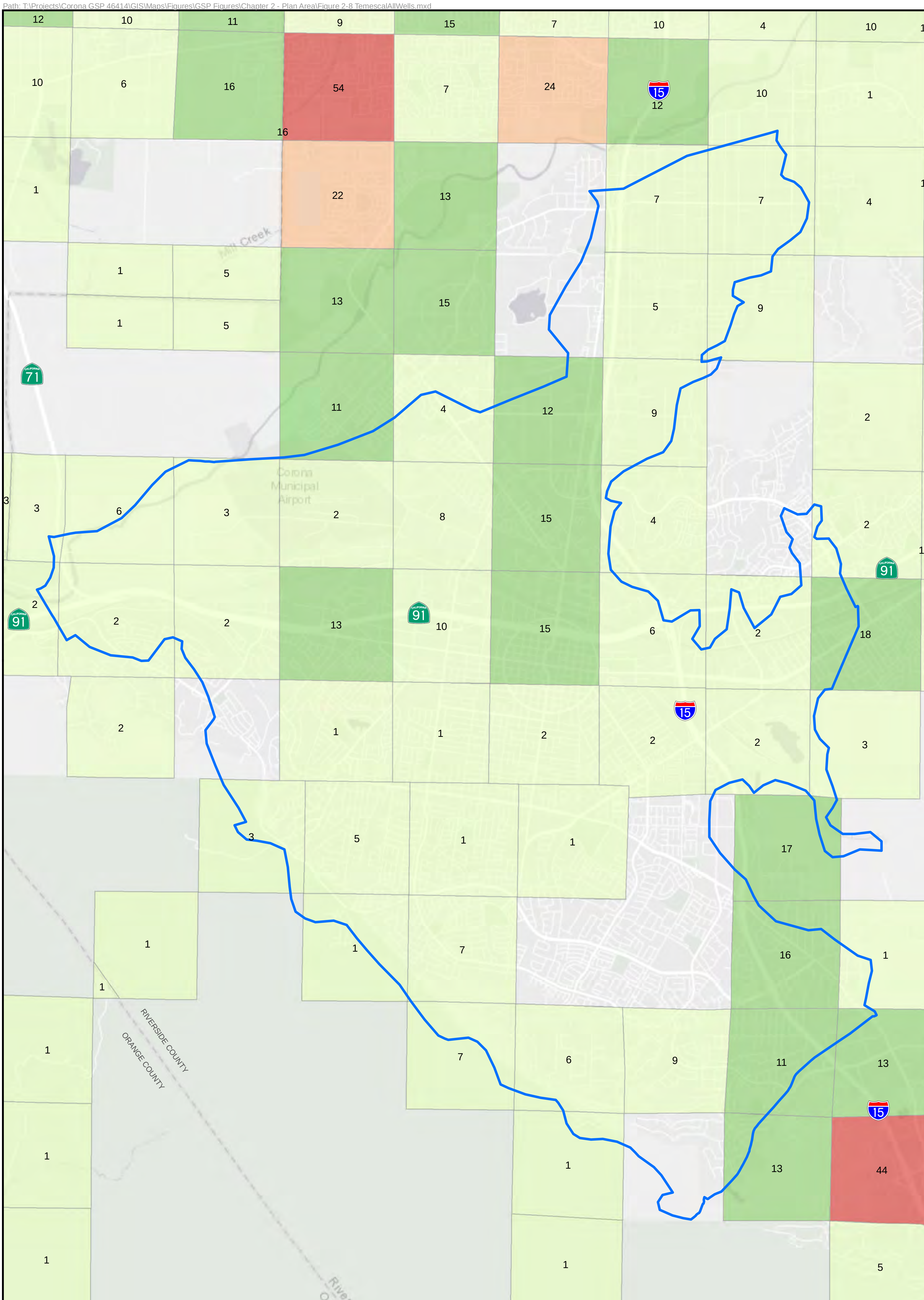

All Wells by Section

- 1 - 10
- 11 - 20
- 21 - 40
- 41 - 80
- Temescal Basin

Data Sources:
Cal-Atlas, DWR Bulletin 118, National Hydrography Dataset

Disclaimer:
Features shown in this figure are for planning purposes and represent approximate locations. Engineering and/or survey accuracy is not implied.

N

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Miles

Figure 2-8
All Basin Groundwater Wells

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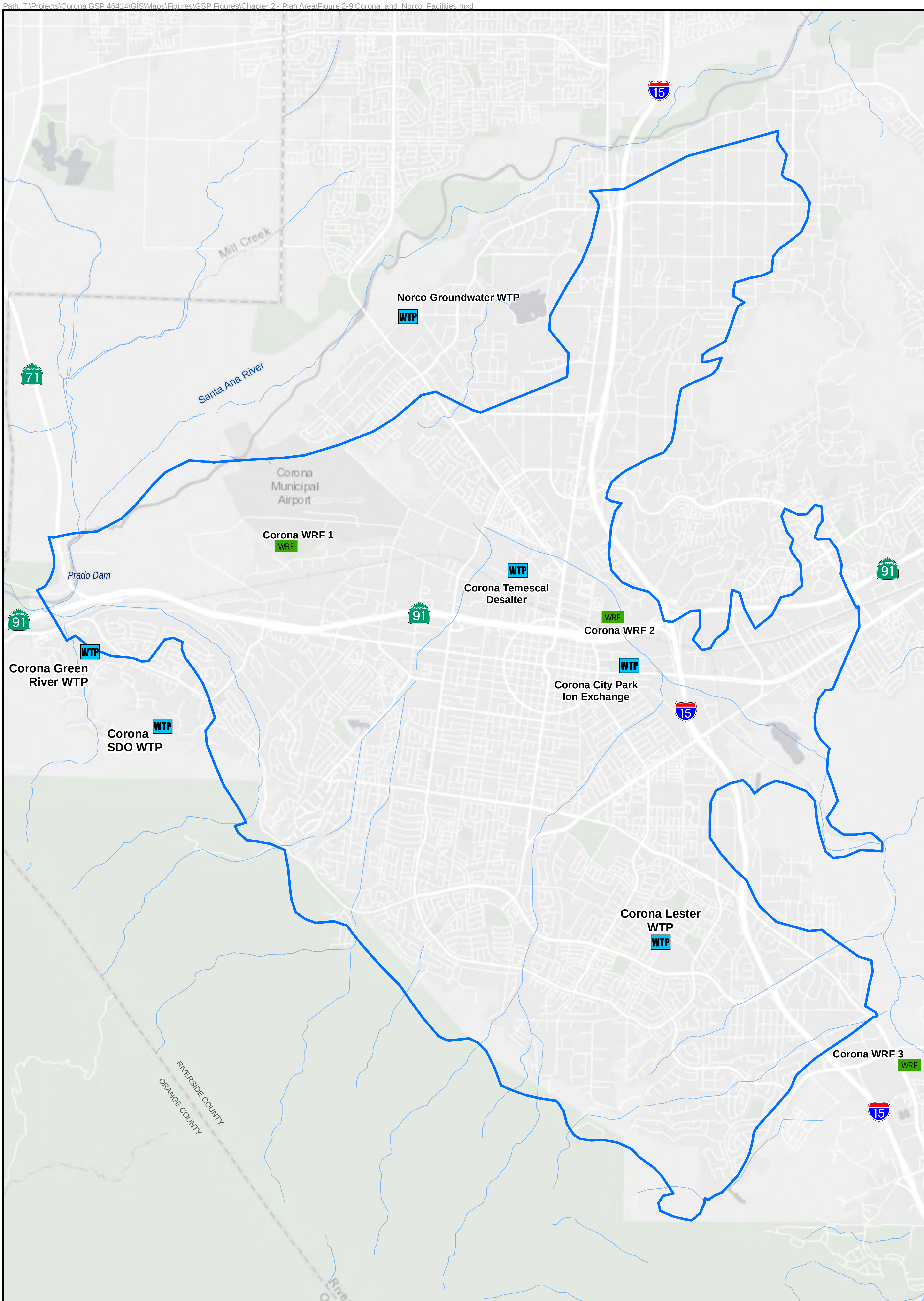

WTP Water Treatment Plant

WRF Water Reclamation Facility

Temescal Basin

Data Sources:
Cal-Atlas, DWR Bulletin 118, National Hydrography Dataset, SAWPA

Disclaimer:
Features shown in this figure are for planning purposes and represent approximate locations. Engineering and/or survey accuracy is not implied.

N

0 0.5 1

Miles

Figure 2-9
Corona and Norco Facilities

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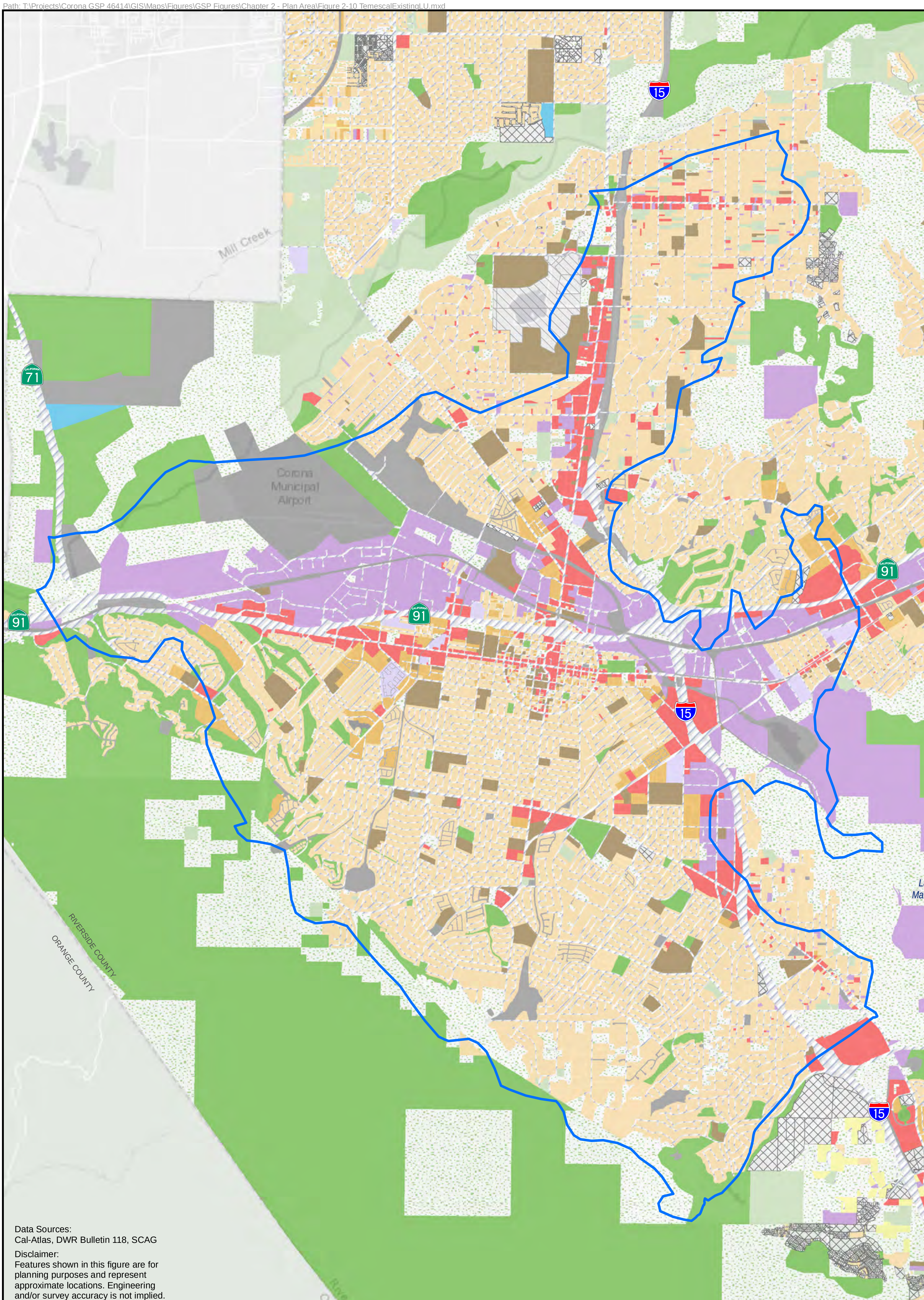
Path: T:\Projects\Corona GSP 46414\GIS\Maps\Figures\GSP Figures\Chapter 2 - Plan Area\Figure 2-10 TemescalExistingLU.mxd



Data Sources:
Cal-Atlas, DWR Bulletin 118, SCAG

Disclaimer:
Features shown in this figure are for planning purposes and represent approximate locations. Engineering and/or survey accuracy is not implied.

- Agriculture
- Commercial
- Industrial
- Military Installations
- Mixed Residential; Mixed Use
- Mobile Homes and Trailer Parks
- Multi-Family Residential
- Open Space/Recreation
- Public
- Rural Residential
- Single Family Residential
- Specific Plan
- Transportation/Utilities
- Undevelopable/Protected
- Under Construction
- Unknown
- Vacant
- Water
- Temescal Basin

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Miles

Figure 2-10
Existing Land Use

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TODD GROUNDWATER

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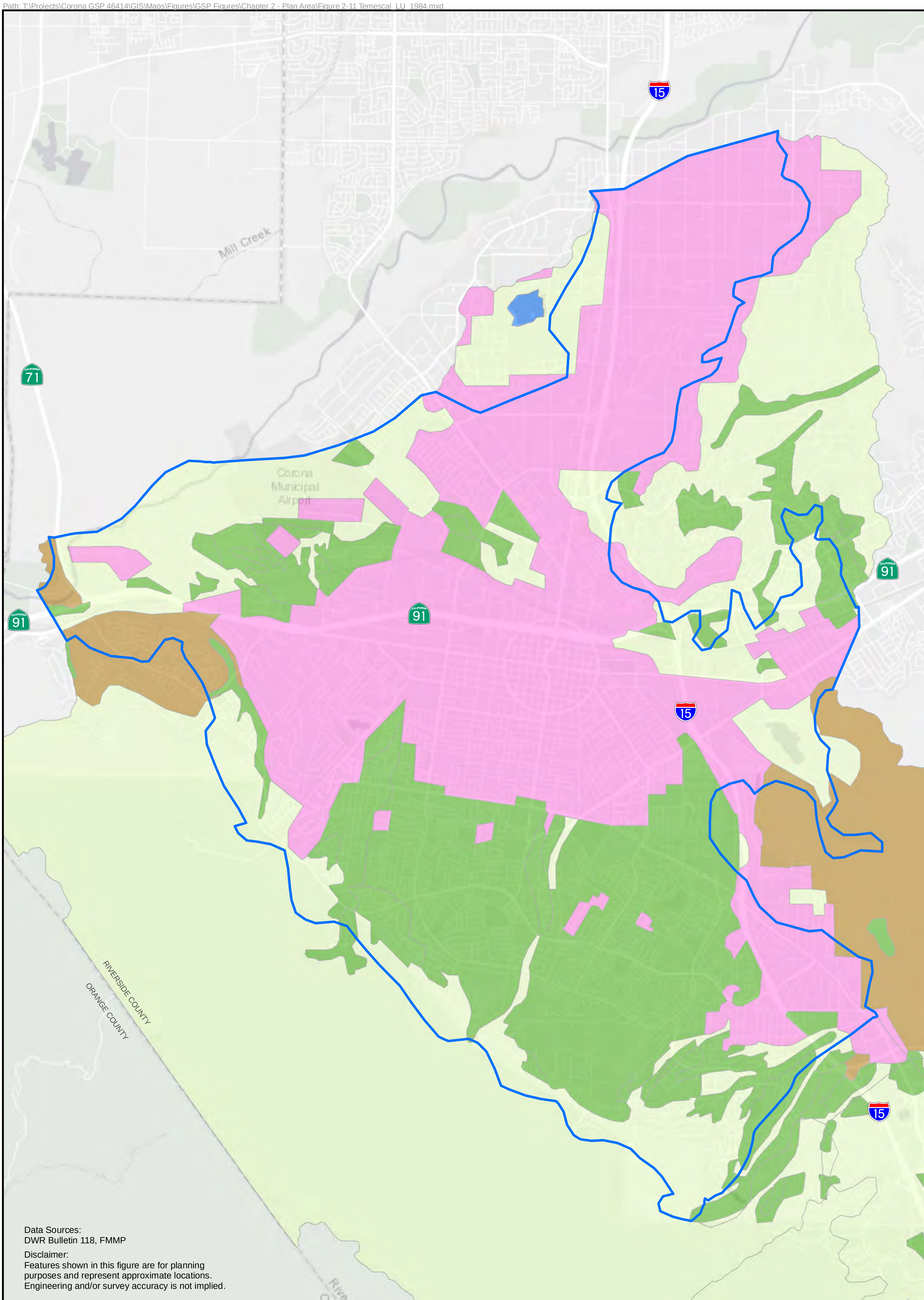

Data Sources:
DWR Bulletin 118, FMMP

Disclaimer:
Features shown in this figure are for planning purposes and represent approximate locations. Engineering and/or survey accuracy is not implied.

- Urban
- Grazing Land
- Agricultural Areas
- Water
- Native
- Temescal Basin

N

0 0.5 1
Miles

Figure 2-11
1984 Land Use

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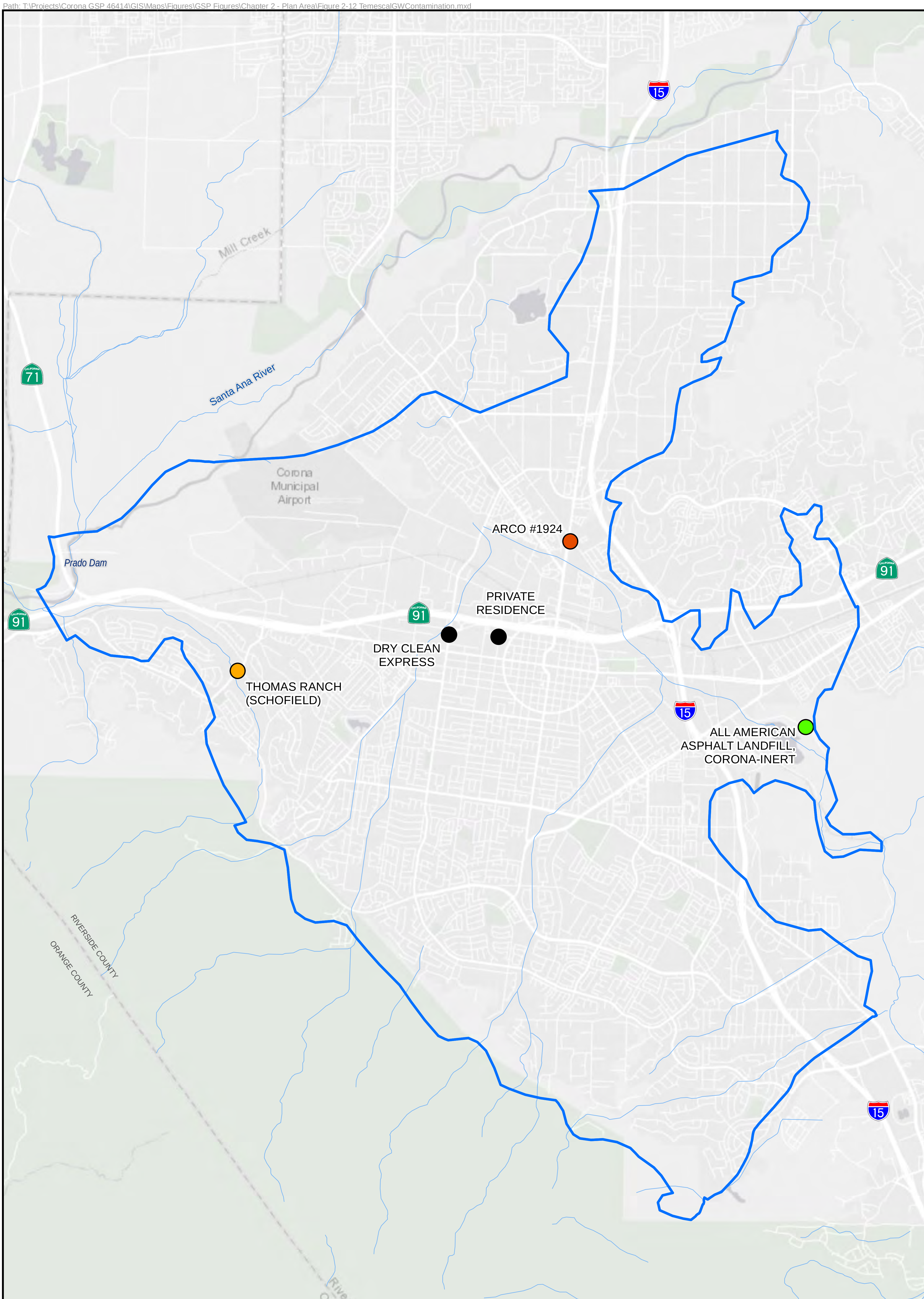

Open - Eligible for Closure
Open - Inactive
Open - Operating
Open - Site Assessment
Temescal Basin

Data Sources:
Cal-Atlas, DWR Bulletin 118, National Hydrography Dataset, CA GeoTracker

Disclaimer:
Features shown in this figure are for planning purposes and represent approximate locations. Engineering and/or survey accuracy is not implied.

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Miles

Figure 2-12
Groundwater Contamination Sites

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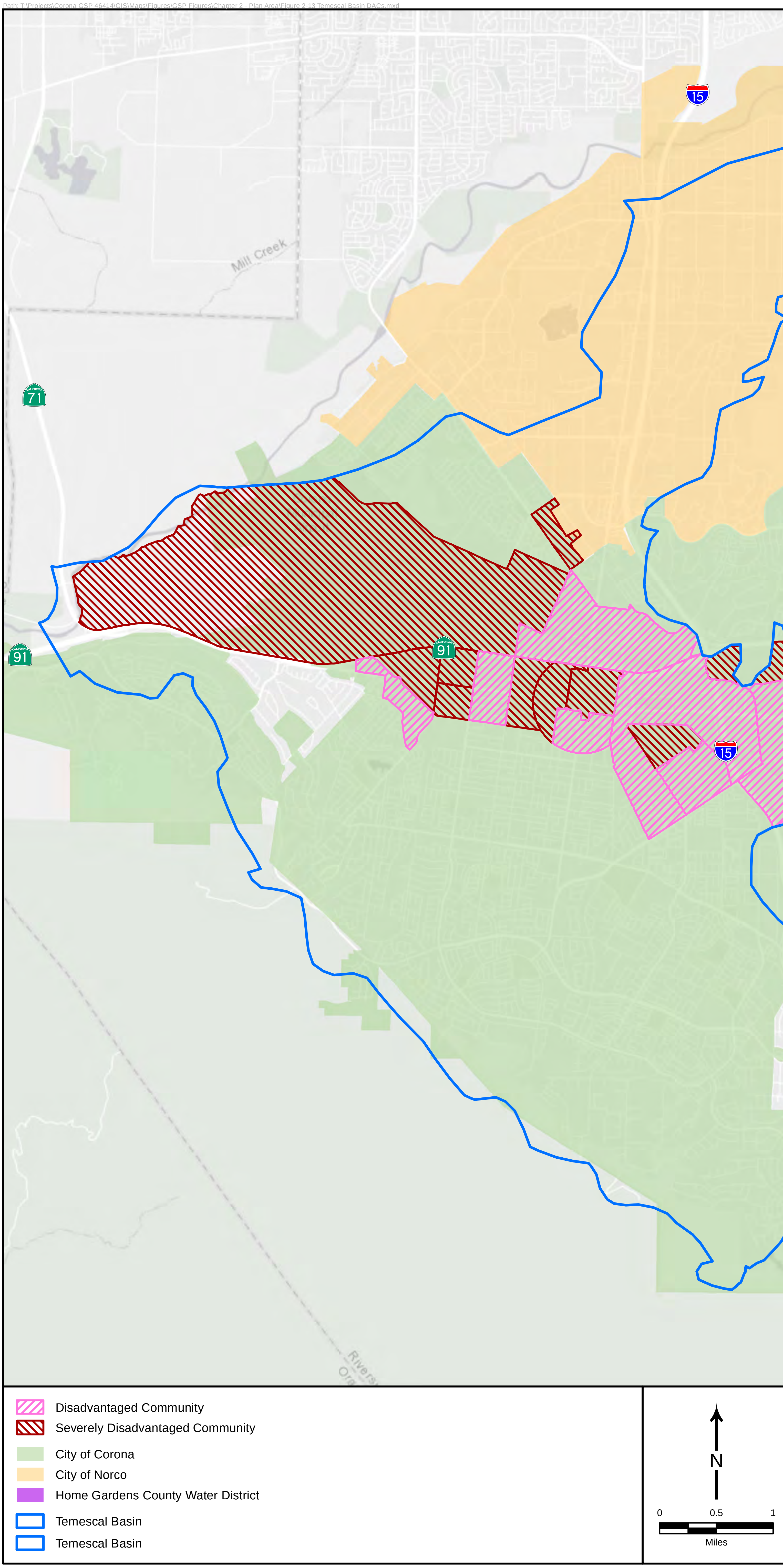

Figure 2-13
Disadvantaged and Severely Disadvantaged Communities

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TODD GROUNDWATER

3. HYDROGEOLOGICAL CONCEPTUAL MODEL

This chapter describes the hydrogeologic conceptual model of the Temescal Subbasin (Basin) of the Upper Santa Ana Groundwater Basin, including the Basin boundaries, geologic formations and structures, and principal aquifer units. The chapter also discusses groundwater recharge and discharge areas. The hydrogeologic conceptual model presented here is a summary of relevant and important aspects of the Basin hydrogeology that influence groundwater sustainability. While the Chapter 1 Introduction and Chapter 2 Plan Area establish the institutional framework for sustainable management in the Groundwater Sustainability Plan (GSP), this chapter, along with Chapter 4 Groundwater Conditions and Chapter 5 Water Budget, sets the physical framework.

The hydrogeologic conceptual model and basin conditions description document the Basin's hydrogeology as the technical foundation for management. Later sections addressing the water budget and sustainability criteria will refer to and rely on the technical material contained here.

3.1. PHYSICAL SETTING AND TOPOGRAPHY

The Temescal Basin as defined by the California Department of Water Resources (DWR) is bounded on the west by the Santa Ana Mountains and the east by low-lying El Sobrante de San Jacinto and La Sierra hills. **Figure 3-1** illustrates the topography of the Basin.

The Basin is connected to three adjacent groundwater basins, the Chino and Riverside-Arlington Subbasins of the Upper Santa Ana Groundwater Basin and the Bedford-Coldwater Subbasin of the Elsinore Groundwater Basin. The boundary with the Chino Subbasin (DWR Basin No. 8-2.01) to the north is generally marked by the Santa Ana River and a series of low-lying hills in the Norco area. The Basin is connected to the Riverside-Arlington Subbasin (DWR Basin No. 8-2.03) in a narrow valley groundwater restriction between the El Sobrante de San Jacinto and La Sierra hills, referred to as the Arlington Gap. Groundwater flows into the Basin from the Riverside-Arlington Subbasin through the Arlington Gap. The southern boundary of the Basin is located at the Bedford Canyon where it connects with the Bedford-Coldwater Subbasin of the Elsinore Groundwater Basin (DWR Basin No. 8-4).

The floor of Basin slopes from about 1,500 feet above mean sea level (msl) along the base of the Santa Ana Mountains in the southwest to about 500 feet msl in the northwest. The ground surface elevation in the city center is about 650 feet msl. In the southeast where the Temescal Wash enters the Basin from the Bedford-Coldwater Subbasin, the ground surface elevation is approximately 850 feet msl (**Figure 3-1**).

The Basin receives runoff and recharge from over 8,000 acres of uplands in the adjacent Santa Ana Mountains. Watersheds contributing runoff from the east are almost as large but contribute less runoff because of lower elevations and corresponding precipitation.

3.2. SURFACE WATER FEATURES

The Basin includes a portion of the Santa Ana River watershed and a main tributary to the Santa Ana River, Temescal Wash, which flows through the Basin from the southeast to northwest. Surface water in the Basin originates as runoff from undeveloped tributary watersheds on the eastern slopes of the Santa Ana Mountains, wastewater treatment plant discharges, urban runoff within the Basin, flow in Temescal Wash, and flow in the Santa Ana River where it arrives at the Prado (flood control) Basin. Temescal Wash originates at Lake Elsinore, 17 miles upstream of the Basin and passes from south to north through the Bedford-Coldwater Subbasin and then through the Basin before discharging into the Prado Basin wetlands. This waterway is ephemeral and dry much of the year, flowing mainly during the winter. Tributary streams in the Santa Ana Mountains adjacent to the west side of the Basin flow primarily in response to rainstorm events, with limited base flow that enters groundwater where streams enter the Basin.

Figure 3-2 shows surface water features including rivers, streams, lakes, and ponds. The sub-watersheds that drain into and through the Basin are shown on **Figure 3-3**.

3.3. SOILS

Characteristics of soils are important factors in natural and managed groundwater infiltration (recharge) and are therefore an important component of a hydrogeologic system. Soil hydrologic group data from the U.S. Department of Agriculture (USDA) Natural Resources Conservation Service (NRCS) Soil Survey Geographic Database (SSURGO) (NRCS 2020) are shown on **Figure 3-4**. The soil hydrologic group is an assessment of soil infiltration rates determined by the water transmitting properties of the soil, which include hydraulic conductivity and percentage of clays in the soil, relative to sands and gravels. The groups are defined as:

- Group A – High Infiltration Rate: water is transmitted freely through the soil; soils typically less than 10 percent clay and more than 90 percent sand or gravel.
- Group B – Moderate Infiltration Rate: water transmission through the soil is unimpeded; soils typically have between 10 and 20 percent clay and 50 to 90 percent sand.
- Group C – Slow Infiltration Rate: water transmission through the soil is somewhat restricted; soils typically have between 20 and 40 percent clay and less than 50 percent sand.
- Group D – Very Slow Infiltration Rate: water movement through the soil is restricted or very restricted; soils typically have greater than 40 percent clay, less than 50 percent sand.

The hydrologic group of the soil generally correlates with the potential for infiltration of water to the subsurface. However, a correlation does not necessarily exist between the soils at the ground surface and underlying geology or hydrogeology.

3.4. GEOLOGIC SETTING

The Basin is located within one of the structural blocks of the Peninsular Ranges of Southern California. The Basin occurs in a linear low-lying block, referred to as the Elsinore-Temecula trough, between the Santa Ana Mountains on the west and the Perris Plain on the east (Todd and AKM 2008). The trough extends from the City of Corona (Corona) to the southeast some 30 miles and was formed along an extensive northwest-southeast trending fault zone including the Elsinore, Chino, and related faults. The Elsinore and Chino fault zones bound the Basin on the west and trend along the mountain fronts. The surficial geology and the surrounding area are shown on **Figure 3-5**.

The oldest rocks in the Basin crop out in the Santa Ana Mountains. These uplands are composed principally of volcanic (including the Santiago Peak Volcanics) and metamorphic rocks (including the Bedford Canyon Formation) of Jurassic and Cretaceous age. A thin rim of younger sedimentary units of Tertiary age crops out along the mountain front generally lying between the Elsinore and Chino faults. This zone of sedimentary units broadens to the north and contains numerous mapped formations of Cretaceous and Tertiary age. The northeastern side of the valley is flanked primarily by granitic rocks of Cretaceous age. Erosion of these units has filled in the trough over time resulting in quaternary-age alluvial fan, channel, and other deposits making up the permeable portions of the Basin (USGS 2004 and 2006).

The geologic map on **Figure 3-5** shows the distribution of these units in the Basin (USGS 2004 and 2006). The main surficial deposits on the floor of the Basin include younger and older alluvial fans deposited from the erosion of volcanic rocks and Bedford Canyon Formation to the west. These units prograde across the Basin to the northeast and are truncated by channel deposits along Temescal Wash.

3.5. FAULTS

The Basin was formed along an extensive northwest-southeast trending fault zone including the Elsinore, Chino, and related faults. The Elsinore and Chino fault zones bound the Basin on the west and trend along the mountain fronts. Fault locations and orientations are shown on **Figure 3-5.**

3.6. AQUIFERS

The basin-fill alluvial deposits and, to some extent, the underlying sedimentary units make up the aquifers in the Basin. However, these deposits do not fall neatly into two categories of permeability, such as bedrock and basin fill. Aquifer packages composed of various geologic units have been defined based on depositional environment, degree of consolidation, groundwater production, and location throughout the Basin.

Three aquifer packages provide water supply to wells in Basin: the Channel Aquifer, the Alluvial Fan aquifers, and, to a lesser extent, consolidated sandstone aquifers (Todd and AKM 2008). Of these three aquifers, only the Channel Aquifer is a principal aquifer as it is the most productive aquifer and provides most of the groundwater supply in the Basin. The

Alluvial Fan and consolidated sandstone are secondary aquifers with limited production capacity and historical use. These aquifers meet one another in multiple areas throughout the Basin along erosional and depositional contacts. These contacts are permeable, and the aquifers are hydraulically connected. The geometry of these aquifers within the Basin are shown in cross sections presented on **Figures 3-6** through **3-9**. The thicknesses of these units vary significantly across the Basin, as indicated in the cross sections.

3.6.1. Description of Principal Aquifer Units

The Channel Aquifer is the principal aquifer in the Basin. This aquifer is a package of relatively homogeneous and highly permeable sands up to 200 feet thick that have been encountered in many of the Corona wells in the northern half of Basin. This sand package is interpreted as channel deposits of an ancestral arm of the Santa Ana River and, as such, has been referred to as the Channel Aquifer (Todd and AKM 2008). The alignment of the aquifer suggests that an ancestral river channel had entered the Basin at Arlington Gap, eroding the sedimentary units and possibly older alluvial fan deposits in the area. Permeable channel sands were deposited in the eroded channel over time. From the Arlington Gap, the Channel Aquifer trends northwest toward Prado Dam.

The orientation of The Channel Aquifer is illustrated on cross sections A to A', B to B', and C to C' on **Figures 3-7, 3-8,** and **3-9**, respectively (Todd and AKM 2008). Cross Section A to A' extends from the Santa Ana Mountains to the northeast across Temescal Wash to the bedrock high in the northeast. As shown on the section, the Channel Aquifer occurs in the northeastern portion of the Basin and has a saturated thickness that ranges from 125 to 150 feet along this section. As illustrated on the section, Channel Aquifer sediments lie directly above granitic bedrock beneath Temescal Wash and above the Sandstone Aquifer in other areas (**Figure 3-7**).

The Channel Aquifer at Arlington Gap is shown on Cross Section B to B' (**Figure 3-8**). Here the saturated thickness is approximately 200 feet and well data indicate a thick and permeable sand package. The Channel Aquifer is underlain by the Sandstone Aquifer throughout most of this area.

Cross-section C to C' is located north of A-A' and extends from the Santa Ana Mountains through the Norco area (**Figure 3-9**). The Channel Aquifer is shown on the western side of the section southeast of the Prado Management Area. Similar to Cross Section A-A', the saturated thickness of the Channel Aquifer is about 100 to 150 feet thick. The cross section also shows the absence of the Channel Aquifer in the Norco area and illustrates the shallow depth to bedrock there (generally less than 100 feet). The saturated thickness of alluvial sediments in Norco is generally less than 50 feet. Also indicated on the section is a groundwater divide in the Norco area (near Well 53-499) indicating possible groundwater outflow from the Norco area to the Santa Ana River (**Figure 3-9**).

Figure 3-10 shows estimated values of hydraulic conductivity (K) derived from test data on driller's logs and/or Corona well aquifer testing data and the aerial extents of the Channel Aquifer. The K value is an indicator of the aquifer's permeability and is expressed in gallons per day per square foot (gpd/ft^2) or feet per day (ft/day). As shown on **Figure 3-10**, the wells within the limits of the Channel Aquifer have the highest hydraulic conductivity values in the Basin. The lower K values shown within the extent of the Channel Aquifer area on **Figure 3-10** are generally from deeper wells tapping the underlying Sandstone Aquifer. The average K value of City of Corona production wells screened solely in the Channel Aquifer (Wells 7A, 8A, 9A, 17, 25, and 28) is 2,062 gpd/ft^2 (276 ft/day) (Todd and AKM 2008).

The Channel Aquifer adjoins the secondary aquifers described below as shown in the cross sections on **Figures 3-7** through **3-9** and the map on **Figure 3-10**. These adjoining aquifers do have hydraulic connection and there is groundwater flow between the aquifers where they meet.

3.6.1.1. Secondary Aquifers

The recent alluvial fan aquifers and sandstone aquifer are also present within the Basin and have historically been used to a lesser extent than the principal aquifer. These secondary aquifers are described below.

3.6.1.1.1. Alluvial Fan Aquifers

Both older and recent alluvial fans have been deposited through time along the mountain front on the western edge of the Basin. These fans have prograded across the Basin from west to east (**Figure 3-5**). Although these deposits are relatively thick, the entire unit is heterogeneous and cannot be considered one single aquifer. Rather, sand lenses within the deposits collectively form the Alluvial Fan Aquifers. Lithologic data from wells are insufficient to map out the extent of the aquifers or characterize the deposits. Limited data indicate relatively fine-grained textures throughout much of the area, especially with depth (Todd and AKM 2008).

The geometry of these units in the subsurface, including the contact with the Channel Aquifer, is illustrated on Cross Section A to A’ on **Figure 3-7**. The section illustrates the alluvial fan deposits that have infilled the Basin. The fans have prograded across the Basin and a thin veneer of these deposits likely overlies the Channel Aquifer at the surface (not shown on the section). Wells that penetrate the entire thickness of the Channel Aquifer in the east do not appear to encounter alluvial fan deposits on top of the Sandstone Aquifer. The total thickness of the deposits is unknown but appears to exceed 1,400 feet in the central Basin.

Only limited data exist for estimating K values in the alluvial fan deposits of Basin. Sparse data from a few wells indicate a K value of generally less than 50 gpd/ft^2 in the Alluvial Fan Aquifers and in the Norco area (**Figure 3-10**). Specific capacity data from a City of Corona production well (Well 27) drilled in the Alluvial Fan, indicated a lower K value of about 7 ft/day (PBS&J 2004).

3.6.1.1.2. Sandstone Aquifer

Some of the sedimentary units underlying the alluvial Basin provide sufficient well yields to categorize them as aquifers. Although generally grouped with other bedrock units, the subsurface sedimentary rocks of Tertiary age in the northeast Basin area contain sandstone layers that are screened in several Corona wells. The estimated K value is 22 gpd/ft^2 (3 ft/day) for one Corona production well (Well 24) screened solely in the Sandstone Aquifer (below the Channel Aquifer) (Todd and AKM 2008). Due to the limited production, small areal extent, increasing depths, and relatively low permeability in most areas, the Sandstone Aquifer is not considered a primary source of water supply.

3.6.2. Description of Lateral Boundaries

The lateral boundaries of the Basin are formed by contacts with bedrock units and borders with neighboring basins. The entire western Basin boundary and much of the eastern boundary of the Basin are contacts between Basin sedimentary units and upland bedrock outcrops. Along the north, the Basin is bounded by the contact with the Chino Subbasin, which is generally marked by the Santa Ana River and a series of low-lying hills in the Norco area. The boundary between the Basin and the Riverside-Arlington Subbasin is in the Arlington Gap and there is some flow into the Basin through this boundary. The southern boundary of the Basin is located at the Bedford Canyon where it connects with the Bedford-Coldwater Subbasin of the Elsinore Groundwater Basin.

Within the Basin the Channel Aquifer is bounded by its physical extents which are controlled by erosion and deposition. Near the Temescal Wash, an unnamed fault truncates the Channel Aquifer with an indeterminate amount of offset. The lateral extents of the Channel Aquifer are shown on **Figure 3-10**.

3.7. STRUCTURES AFFECTING GROUNDWATER

The Basin is defined by the lateral extents of the alluvial material described above. This material is bounded by bedrock in the Santa Ana Mountain on the west and the Peninsular Ranges to the east. The southern and northern boundaries of the Basin are formed by areas of thin alluvial material over shallow bedrock in narrow valleys (Todd and AKM 2008 and WEI 2015). A topographic rise in the subsurface bedrock appears to make a groundwater divided in the Norco area. The units in the Basin are also truncated by an inferred unnamed fault as part of the Elsinore and Chino fault zone along the base of the Santa Ana Mountains. The location and effect of the Elsinore and Chino fault zone on the units of the Basin are shown on cross sections on **Figures 3-6** through **3-9**.

3.8. DEFINABLE BASIN BOTTOM

The Basin bottom is defined by bedrock, which is shallow around the perimeter and deep in the center, as shown on **Figure 3-11**. Depth to bedrock ranges in depth from 10 feet to approximately over 1,000 feet (Todd and AKM 2008 and WEI 2015). The depth to the bottom of the alluvial materials in the Basin and the contact with the bedrock bottom of the Basin are shown in the contours presented in **Figure 3-11**.

The thickest portion of the alluvial Basin (the deepest depth to bedrock) occurs in the central-west portions of the Basin as seen on **Figure 3-7**. The formation of a trough along the Elsinore and Chino fault zone is indicated by the asymmetric basin geometry. Unconsolidated sediments are estimated to be more than 1,000 feet thick in this area.

Bedrock is much shallower in the eastern portion of the Basin, however there is a slight deepening near the Arlington Gap, as indicated on **Figure 3-8**. Here, unconsolidated sediments are approximately 250 feet thick. This area is interpreted to have been eroded by a branch of the ancestral Santa Ana River, accounting for the depth. Sediments throughout the northern portion of the Basin, including in the Norco area, are about 100 feet thick as shown on **Figure 3-8**. Outcropping bedrock in the northern and eastern portions of the Basin is further evidence of the thin alluvial sediments.

3.9. RECHARGE AND DISCHARGE AREAS

Recharge to the Basin occurs primarily from wastewater discharge and subsurface inflow from outside the Basin, and to a lesser extent from deep percolation of precipitation, urban return flows, and infiltration of agriculture irrigation runoff as shown in **Figure 3-12**.

Discharge from wastewater treatment and subsurface inflow are the largest inflows to the Basin. Recharge associated with wastewater occurs when treated wastewater is discharged to ponds. Subsurface inflow occurs along the Basin boundaries and is a significant source of recharge to the Basin (Todd and AKM 2008).

Deep percolation of precipitation is the process by which precipitation enters groundwater. Recharge to groundwater from deep percolation occurs throughout the Basin (Todd and AKM 2008). To a more limited extent, Basin recharge comes from the infiltration of runoff from precipitation in the Santa Ana Mountains west of the Basin and the Peninsular Ranges east of the Basin. Large amounts of runoff from the mountains flows into channels and the shallow subsurface at the edges of the Basin and then into and through the Basin. The amount of water available for recharge varies annually with changes in rainfall and runoff. Runoff into the Basin is subject to evapotranspiration, infiltration, and continued surface flow to and in the Temescal Wash. The watersheds contributing to the Basin include multiple drainages, all of which flow across the Basin in generally east-west orientations. Wet years generate large amounts of water that exceed the recharge capacity of the Basin (Todd and AKM 2008).

Return flows are those portions of applied water (e.g., landscape irrigation) that are not consumed by evapotranspiration and hence return to the groundwater system through deep percolation or infiltration. Return flows associated with urban, industrial, and agricultural water uses all have the potential to contribute to recharge to the Basin (Todd and AKM 2008).

Discharge from the Basin is primarily from groundwater pumping. A significant discharge also occurs to the Santa Ana River near the Prado Management Area (Todd and AKM 2008).

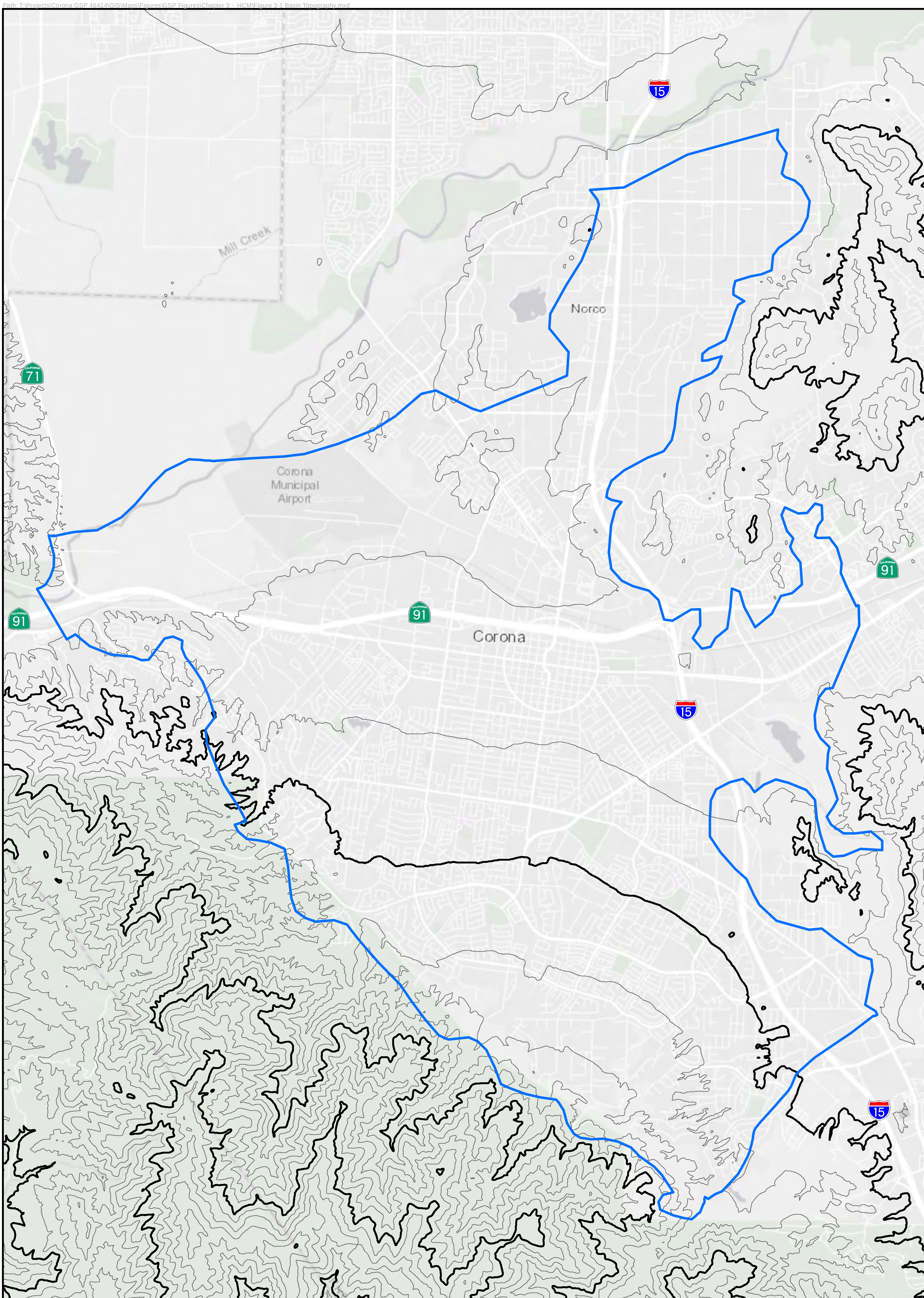
3.10. PRIMARY GROUNDWATER USES

The primary groundwater uses from both the principal and secondary aquifers in the Basin include municipal, rural residential, small community water systems, and small commercial uses. Groundwater pumped from the Basin aquifers supplies water for urban, agricultural, and industrial uses. Municipal uses account for most of this groundwater production. Groundwater pumping also represents most of the outflow from the Basin.

3.11. DATA GAPS IN THE HYDROGEOLOGIC CONCEPTUAL MODEL

The hydrogeologic conceptual model has not identified data gaps in available information.

Path: T:\Projects\Corona GSP 46414\GIS\Maps\Figures\GSP Figures\Chapter 3 - HCM\Figure 3-1 Basin Topography.mxd



200 foot Ground Surface Elevation Contour
1,000 foot Ground Surface Elevation Contour
Temescal Basin

N

0 0.5 1
Miles

Figure 3-1
Basin Topography

TODD GROUNDWATER

Path: T:\Projects\Corona GSP 46414\GIS\Maps\Figures\GSP Figures\Chapter 3 - HCM\Figure 3-2 Tributary Surface Water.mxd

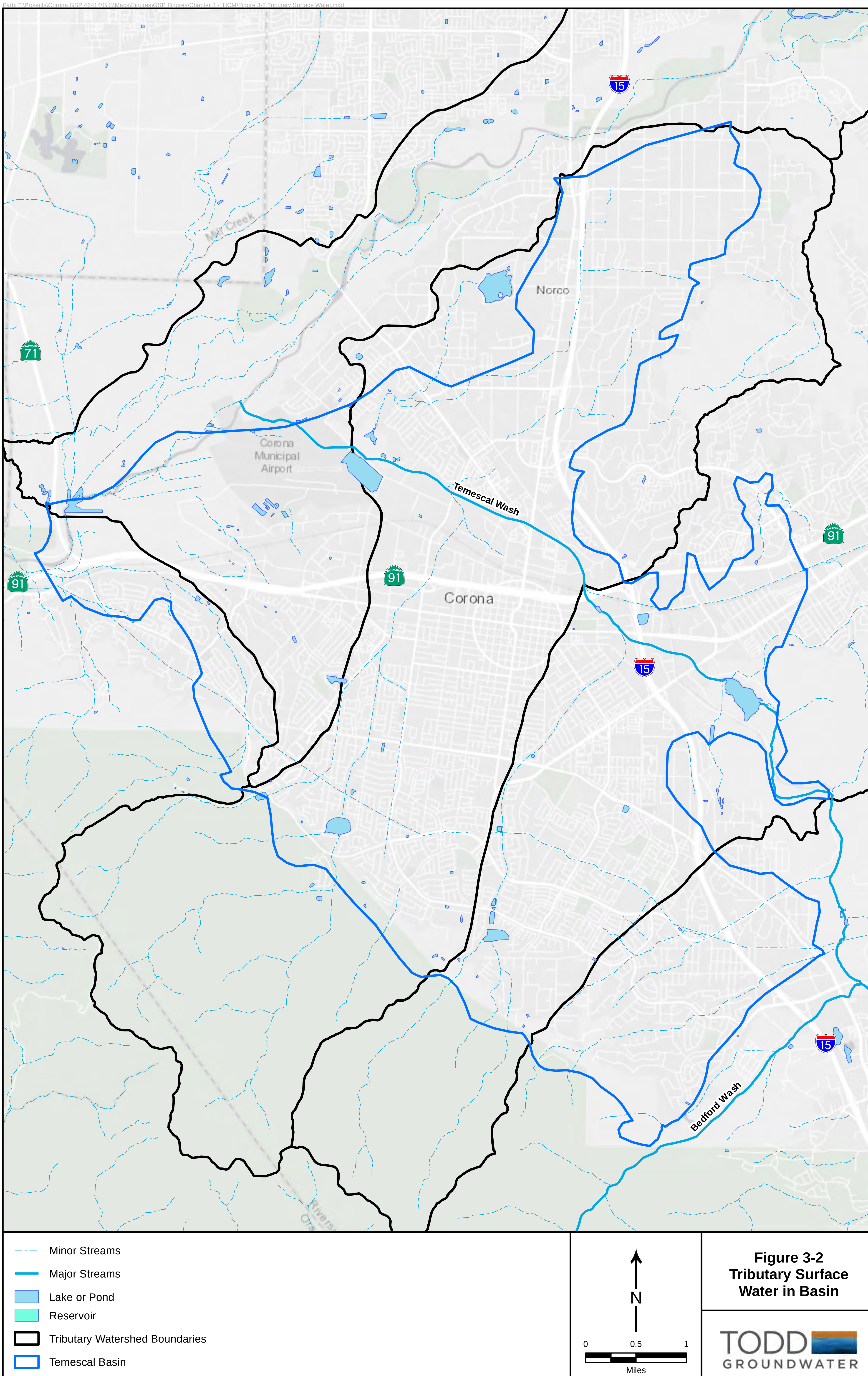
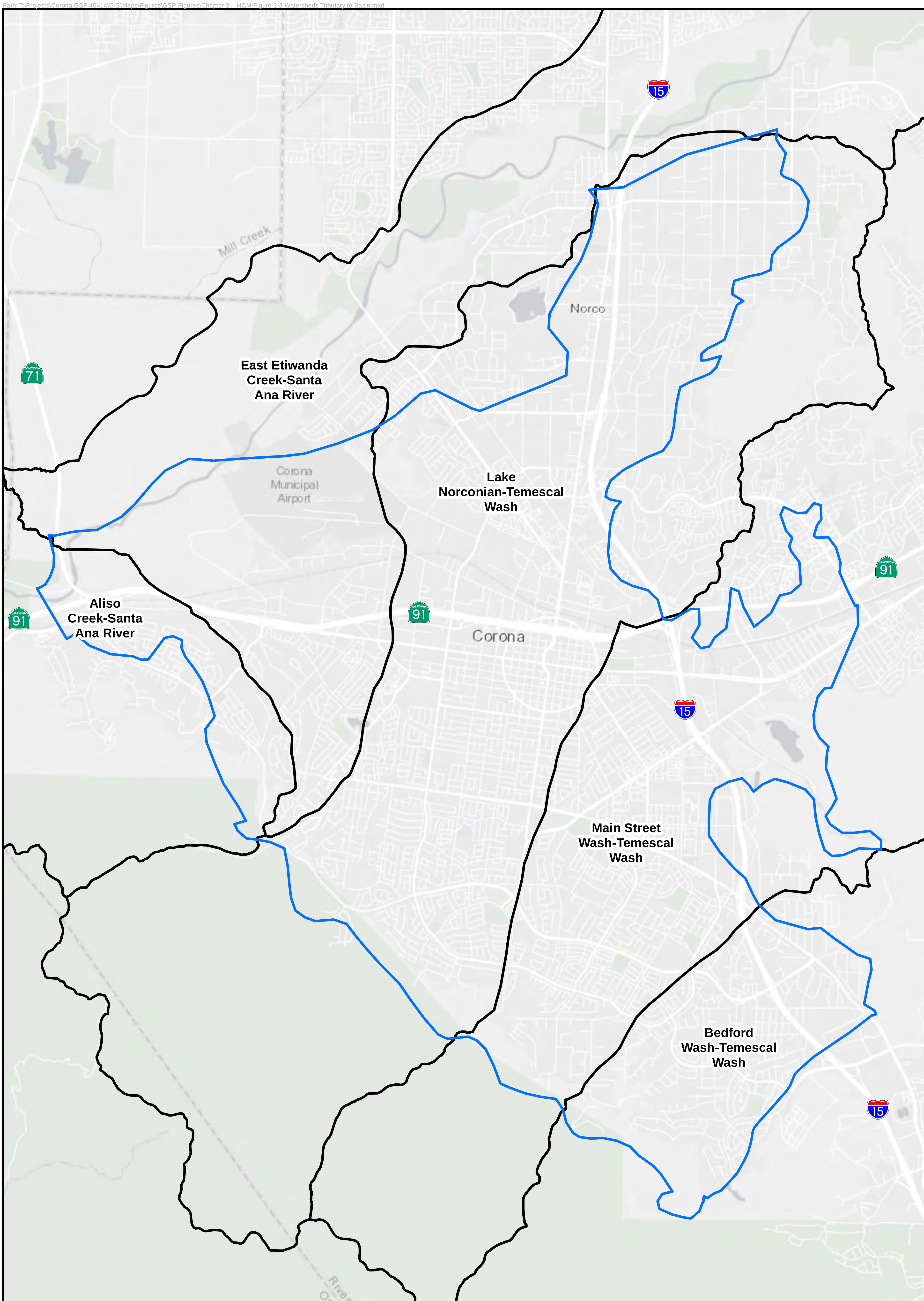


Figure 3-2
Tributary Surface Water in Basin

Path: T:\Projects\Corona GSP 46414\GIS\Maps\Figures\GSP Figures\Chapter 3 - HCM\Figure 3-3 Watersheds Tributary to Basin.mxd



Tributary Watershed Boundaries

Temescal Basin

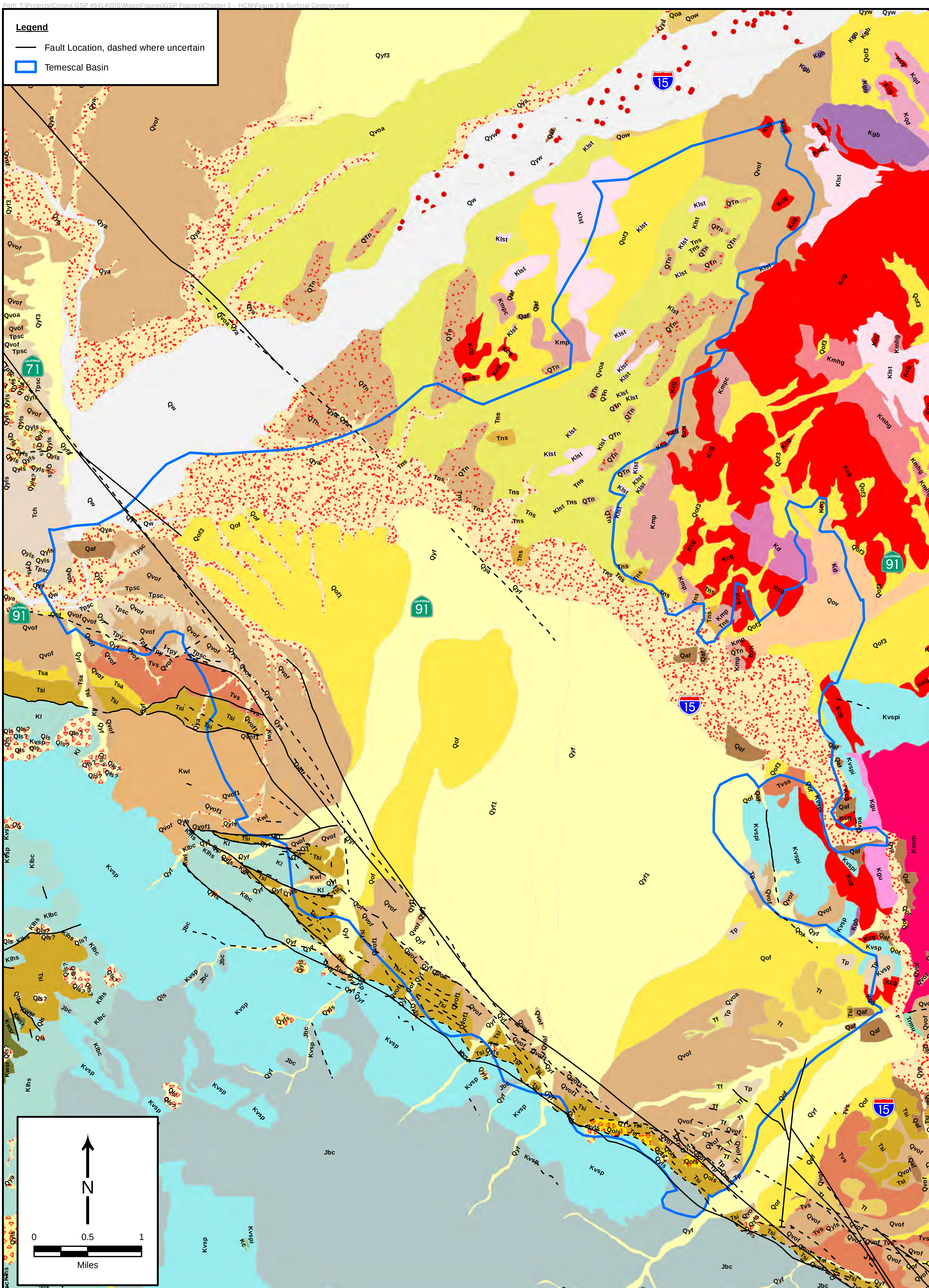
Figure 3-3
Watersheds Tributary to Basin

TODD GROUNDWATER

Path: T:\Projects\Corona GSP 46414\GIS\Maps\Figures\GSP Figures\Chapter 3 - HCM\Figure 3-4 Basin Soil Hydrologic Properties.mxd

Figure 3-4
Basin Soil Hydrologic Properties

TODD GROUNDWATER

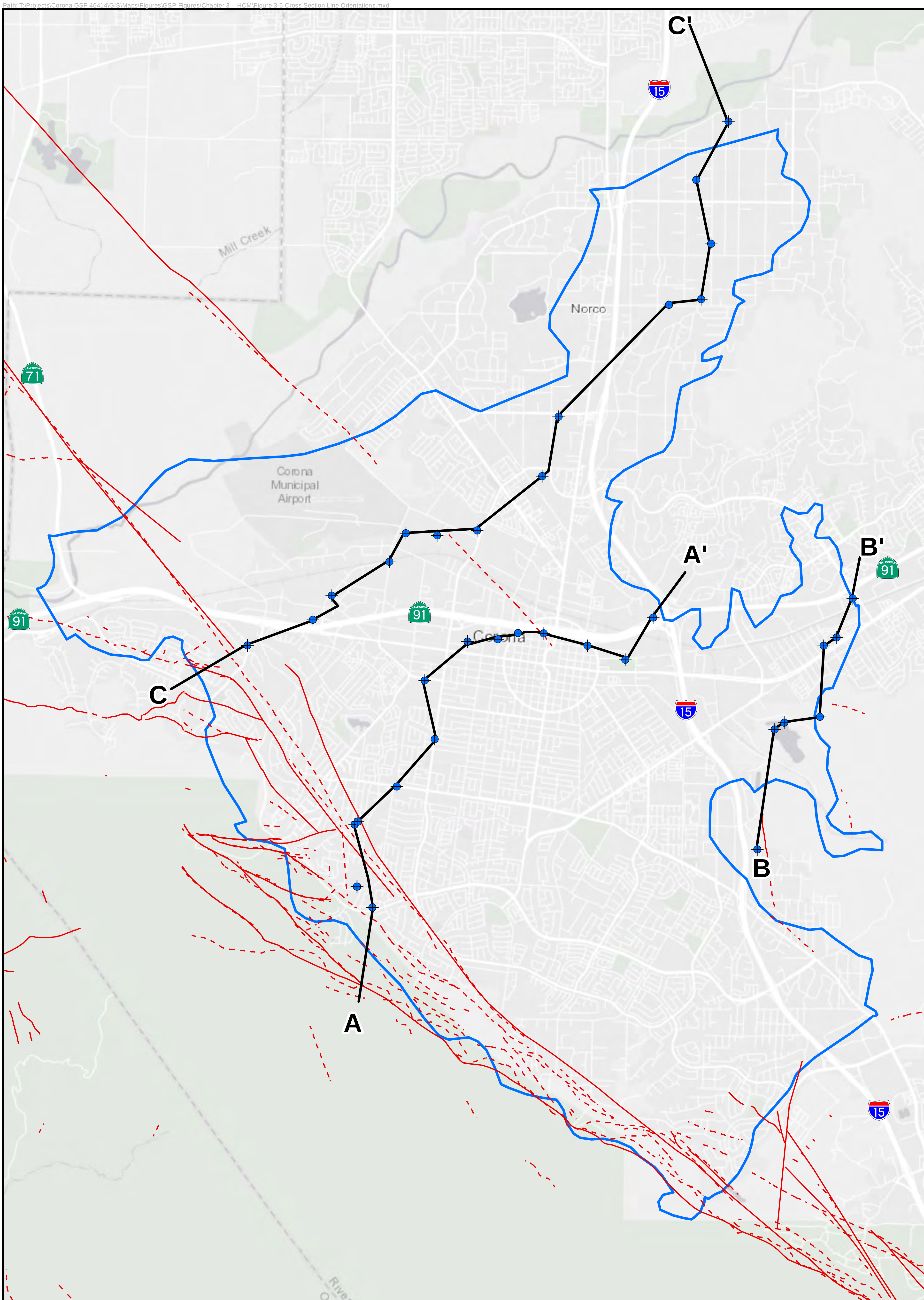


- Qaf, Artificial fill
- Qw, Very young wash deposits
- Qyw, Young wash deposits
- Qyf/Qyf1/Qyf3, Young alluvial-fan deposits; Qyf3
- Qya, Young axial-channel deposits
- Qyls, Young landslide deposits
- Qls/Qls, Landslide Deposit
- Qof, Old alluvial-fan deposits
- Qoa, Old axial-channel deposits
- Qow, Old wash deposits
- Qov, Old alluvial-valley deposits
- Qols, Old landslide deposits
- Qvof, Very old alluvial-fan deposits
- Qvoa, Very old axial-channel deposits
- QTc, Conglomerate of Riverside West 7.5 Quad
- QTt, Conglomerate of Temescal area
- QTn, Sedimentary rocks of Norco area
- QTs, Sedimentary rocks in Riverside and Corona areas
- Tch, Chino Hills, sandstone and conclomerate
- Tcga, Conglomerate of Arlington Mountain
- Tf, Fernando Formation
- Tns, Sandstone of Norco Area
- Tsa, Santiago Formation
- Tp/Tpsc/Tpsq/Tpy, Puente Formation; Tplv
- Tt, Topanga Group
- Tvs/Tvss, Vaqueros and Sespe Formations, undifferentiated
- Tsi, Silverado Formation
- Kc, Carbonate Silicate Rock
- Kcg/Kcgq/Kcto, Cajalco Pluton
- Kd, Diorite, undifferentiated
- Kgu, Granite, undifferentiated
- Kgb, Gabbro, undifferentiated
- Khg, Heterogeneous granitic rocks
- Kl/Klbc/Klhsc/Klhs, Ladd Formation
- Klst, La Sierra Tonalite
- Kmhg, Mount Hole Granodiorite
- Kmp/Kmpc, Micropegmatite
- Kqd, Quartz diorite
- Krg, Granite of Riverside area
- Ks, Serpentinite
- Kt, Tonalite, undifferentiated
- Ktr, Trabuco Formation
- Kvsp/Kvspi, Santiago Peak Volcanics
- Kvem/Kvs, Estelle Mountain volcanics of Herzig
- Kwl, Williams and Ladd Formations
- Kwps/Kwsr, Williams Formation
- Jbc, Bedford Canyon Formation
- Trmu, Rocks of Menifee Valley

Figure 3-5
Surficial Geology

TODD GROUNDWATER

Path: T:\Projects\Corona GSP 46414\GIS\Maps\Figures\GSP Figures\Chapter 3 - HCM\Figure 3-6 Cross Section Line Orientations.mxd



Wells on Cross Sections

Cross Section Line Orientation

Fault Location, dashed where uncertain

Temescal Basin

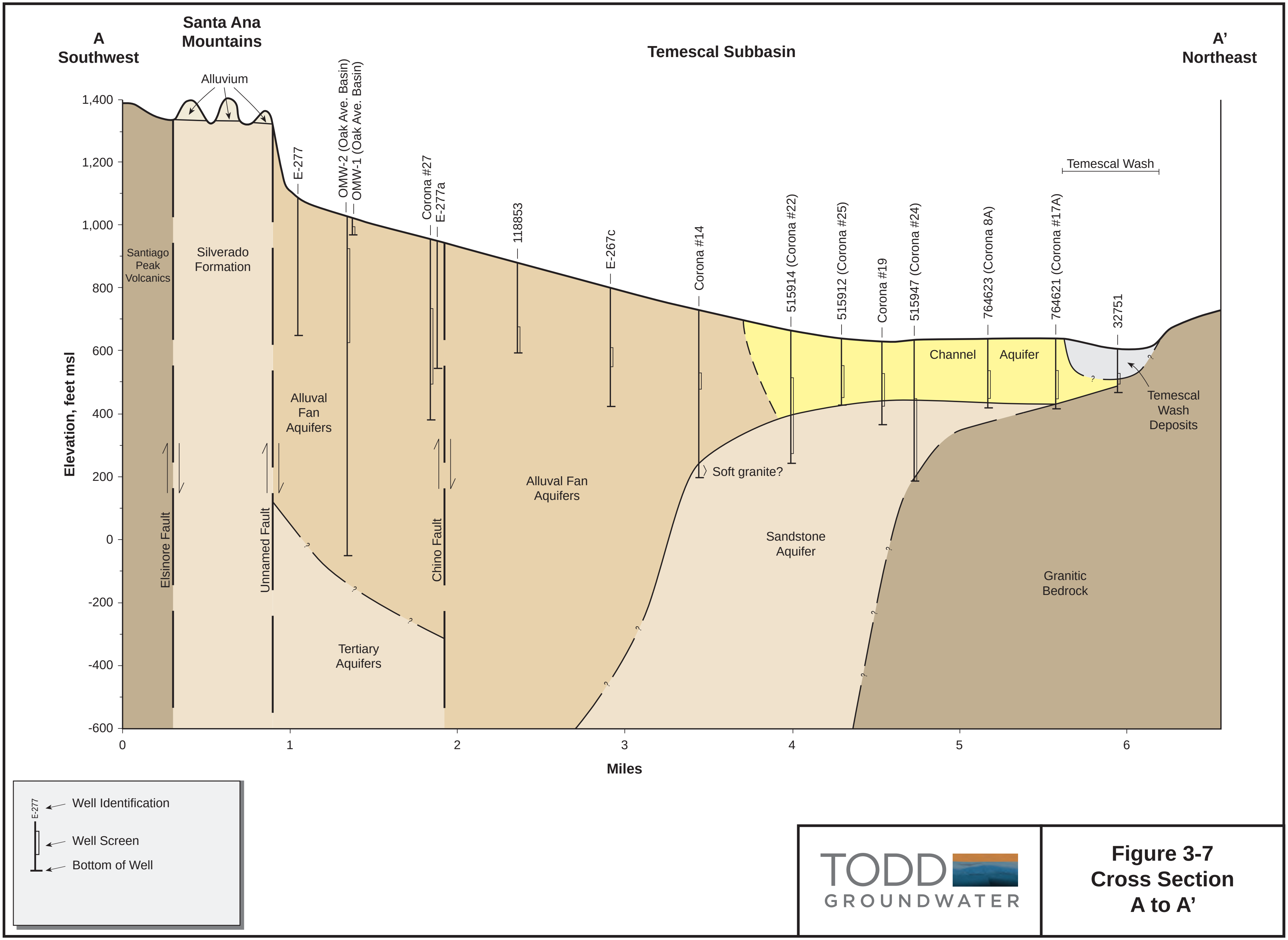
N

0 0.5 1

Miles

Figure 3-6
Cross Section
Line Orientation

TODD GROUNDWATER



TODD GROUNDWATER

Figure 3-7
Cross Section
A to A'

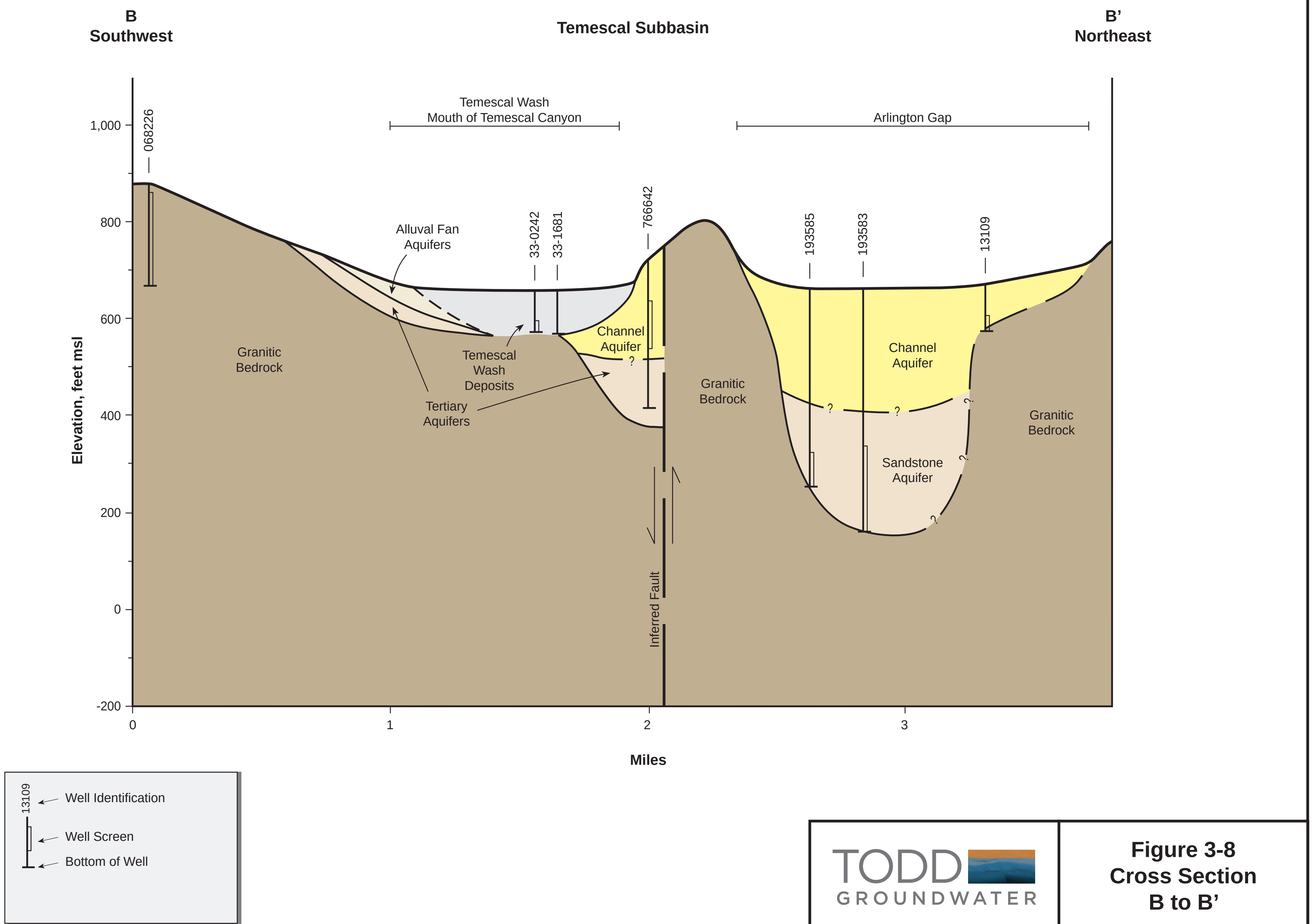
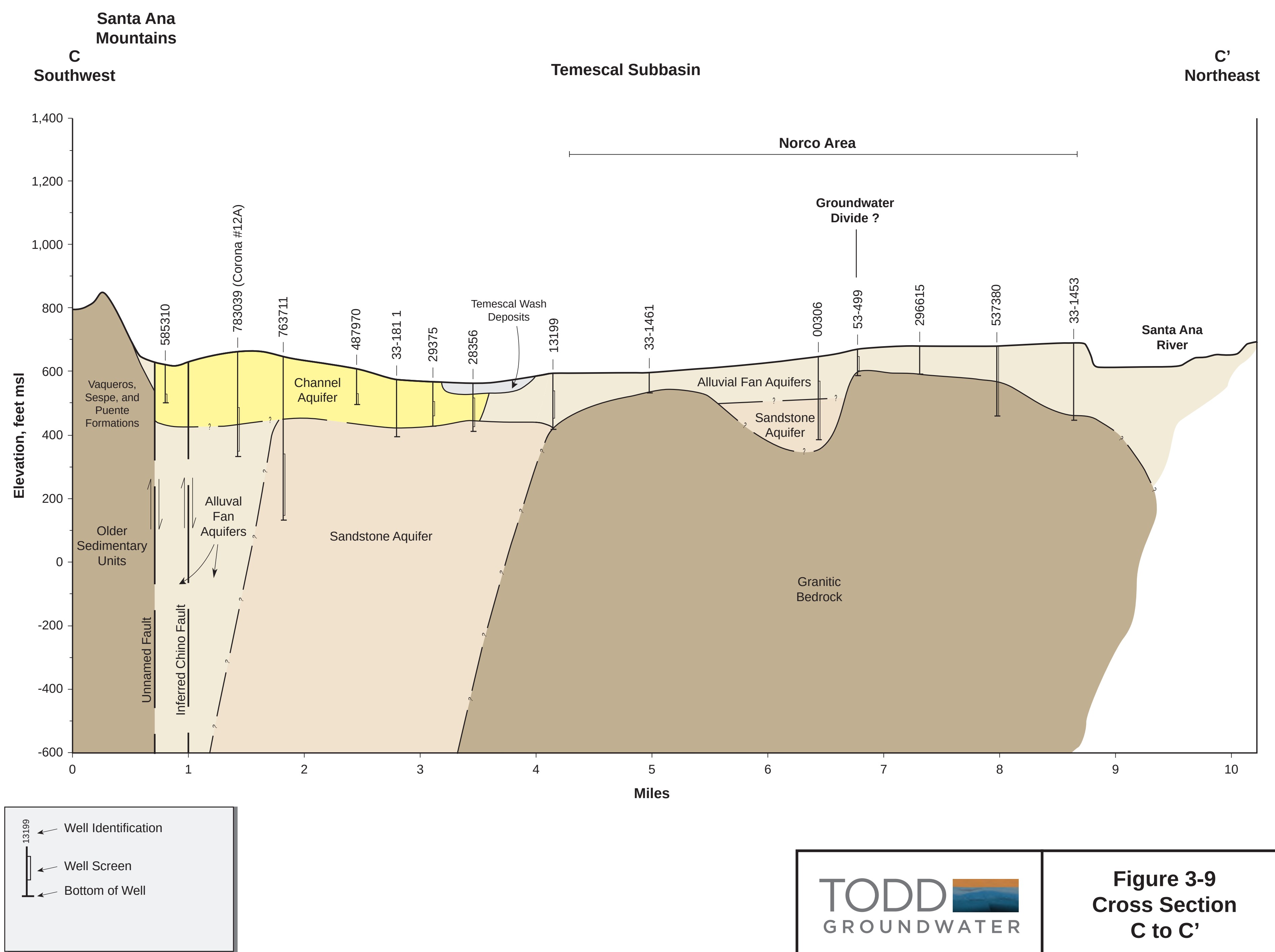


Figure 3-8
Cross Section
B to B'



TODD GROUNDWATER

Figure 3-9
Cross Section
C to C'

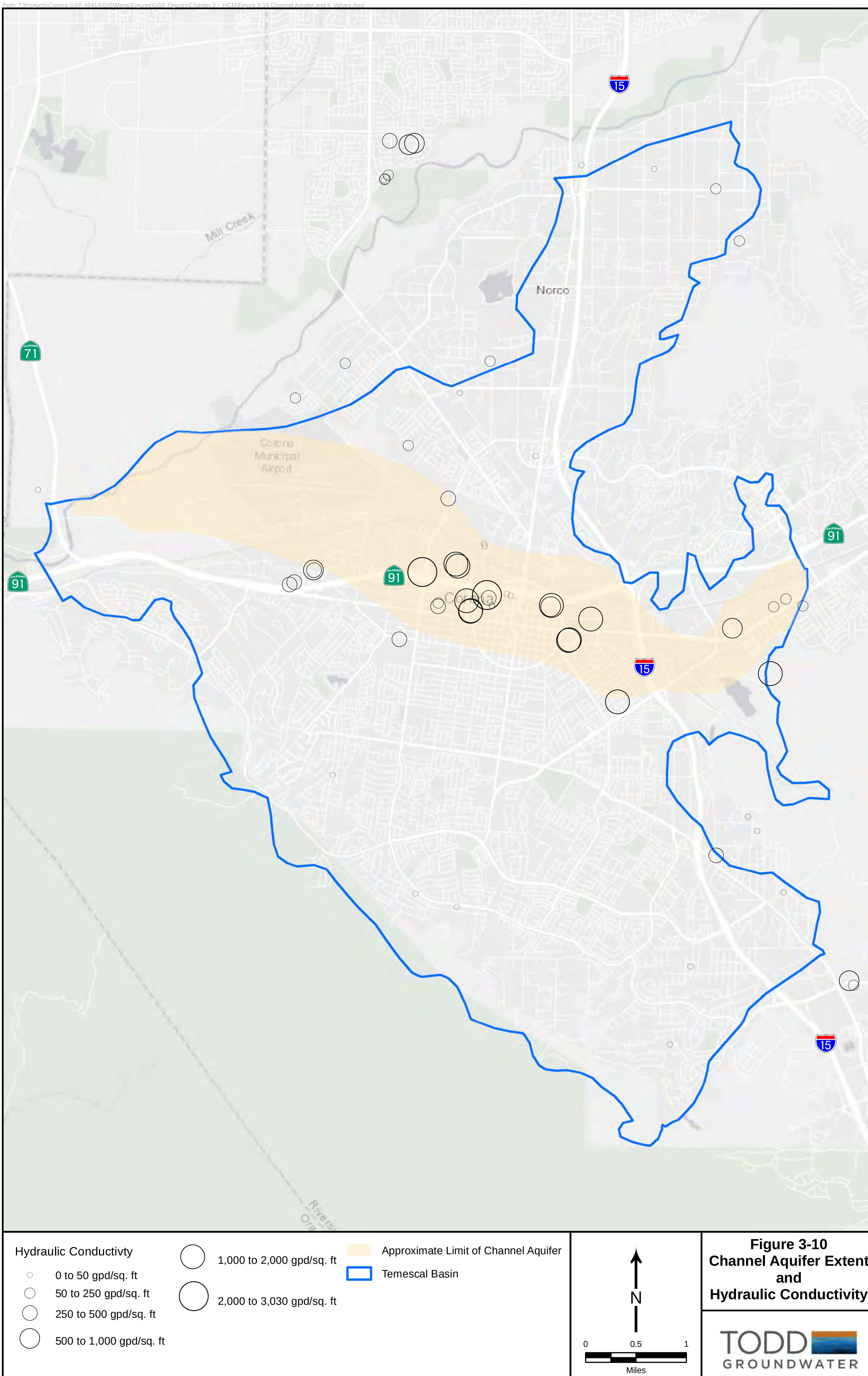
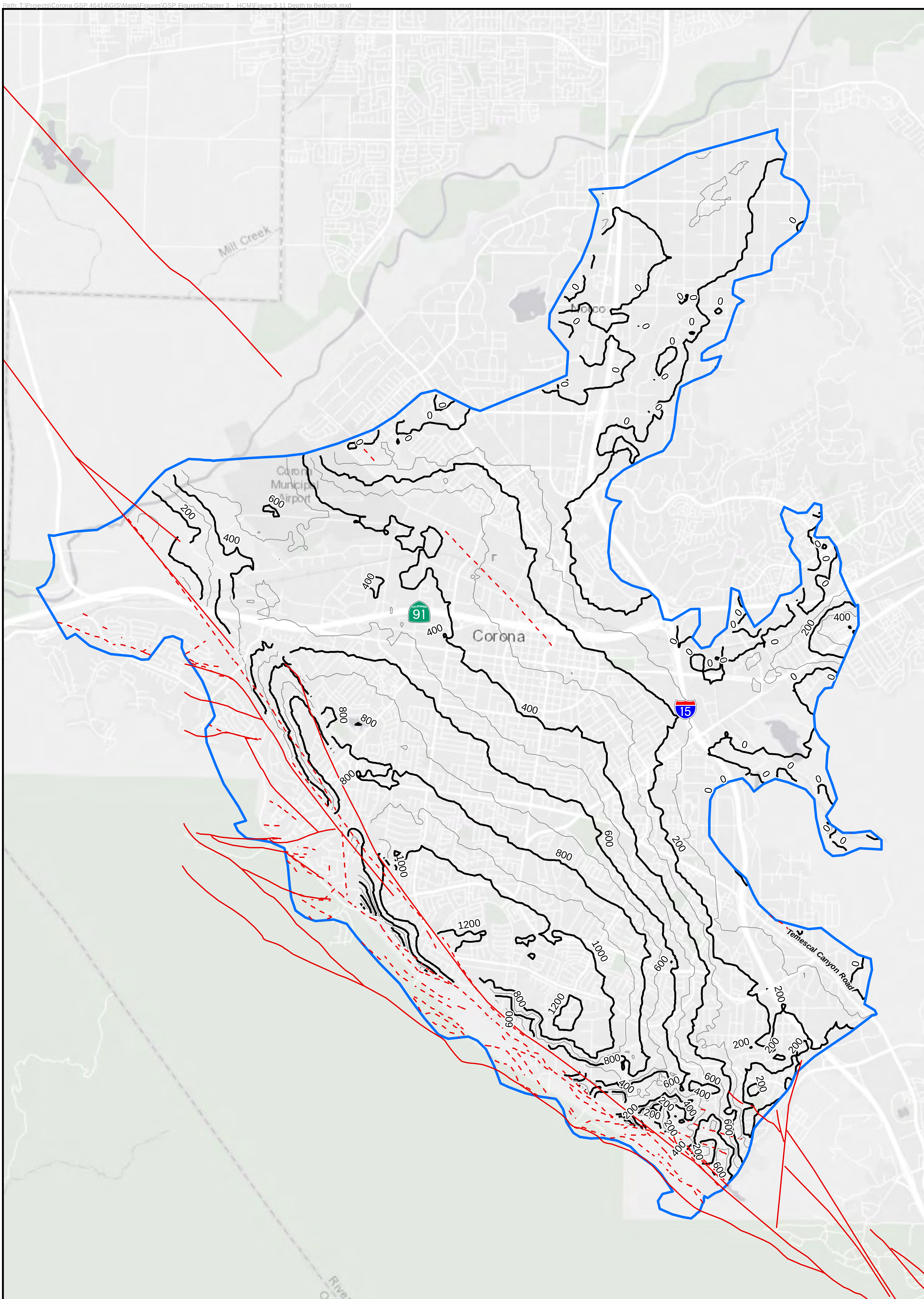


Figure 3-10
Channel Aquifer Extent and Hydraulic Conductivity

TODD GROUNDWATER

Path: T:\Projects\Corona GSP 46414\GIS\Maps\Figures\GSP Figures\Chapter 3 - HCM\Figure 3-11 Depth to Bedrock.mxd



50-foot Depth to Bedrock Contour

200-foot Depth to Bedrock Contour

Fault Location, dashed where uncertain

Temescal Basin

N

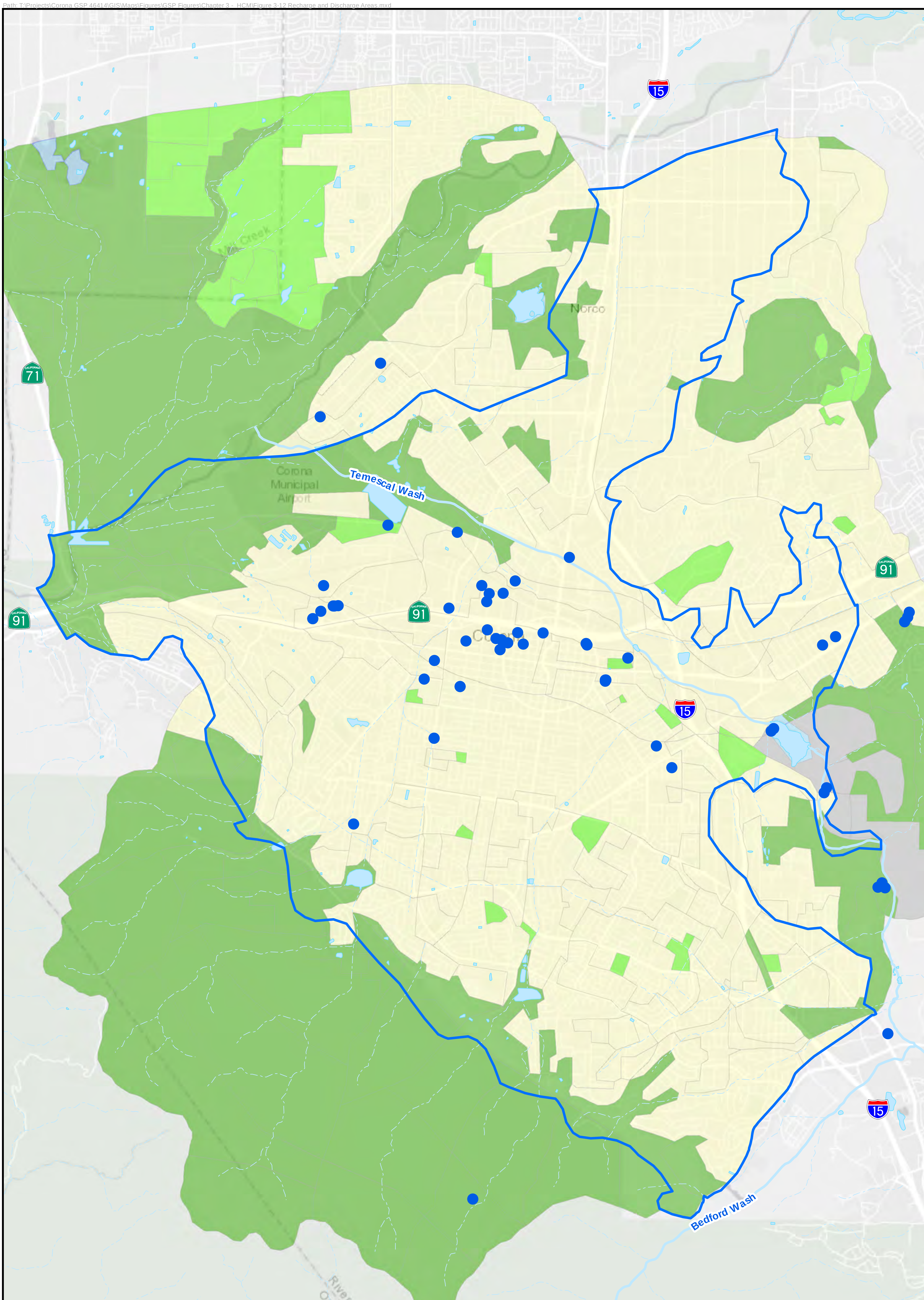
0 0.5 1

Miles

Figure 3-11
Depth to Bedrock

TODD GROUNDWATER

Path: T:\Projects\Corona GSP 46414\GIS\Maps\Figures\GSP Figures\Chapter 3 - HCM\Figure 3-12 Recharge and Discharge Areas.mxd



Known Production Wells
Lake or Pond
Major Streams
Minor Streams
Urban Recharge
Irrigated Area Recharge
Unirrigated Area Recharge
Quarries
Water
Temescal Basin

N

0 0.5 1
Miles

Figure 3-12
Groundwater Recharge and Discharge Areas

TODD GROUNDWATER

4. CURRENT AND HISTORICAL GROUNDWATER CONDITIONS

This chapter describes the current and historical groundwater conditions in the Basin. The Sustainable Groundwater Management Act (SGMA) requires definition of various study periods for current, historical, and projected future conditions. Current conditions, by SGMA definition, include those occurring after January 1, 2015 and accordingly, historical conditions occurred before that date. A historical period must include at least 10 years.

The study period 1990 through 2019 is based on the cumulative departure from mean precipitation at Riverside, Claremont-Pomona, and Lake Elsinore climate monitoring stations. This period is representative and includes droughts and wet periods, with an average annual rainfall of 9.34 inches, comparable to the long-term average of 9.48 inches (1961 to 2019). Accordingly, groundwater conditions over time are described through 2020.

Groundwater conditions are described in terms of the six sustainability indicators identified in SGMA; these include:

- Groundwater elevations
- Groundwater storage
- Potential subsidence
- Groundwater quality
- Seawater intrusion (which is not likely to occur in this inland basin)
- Interconnected surface water and groundwater dependent ecosystems.

4.1. GROUNDWATER ELEVATIONS

4.1.1. Available Data

Groundwater elevation records were collected from multiple sources, including the City of Corona, United States Geological Survey (USGS) National Water Information System (NWIS), California Department of Water Resources (DWR) California Statewide Groundwater Elevations Monitoring (CASGEM), and others. All wells with water level data are shown on **Figure 4-1**. Data from these sources were collected, reviewed, and compiled into a single unified groundwater elevation dataset (USGS 2020a and DWR 2010). Wells with groundwater level data are not distributed evenly throughout the Basin, and most measurement points are within Corona. Many wells have historical water level observations but have not been measured in recent years. In addition, there are temporal gaps in some of the data records and these are discussed in the data gaps section below.

4.1.2. Groundwater Occurrence

As summarized in Chapter 3, groundwater is present in one principal aquifer and two secondary aquifers and these aquifers are hydraulically connected. Groundwater in the Basin occurs under unconfined conditions and there are insufficient data to define vertical zones and to provide zone-specific groundwater elevation hydrographs or maps.

4.1.3. Groundwater Elevations and Trends

Hydrographs showing groundwater elevation trends over time were prepared for all 39 wells with regular water level measurements in the Basin (**Figure 4-1**); these hydrographs were reviewed to identify wells with long term data that could be used to present representative hydrographs. The selection of representative wells was based a quantitative approach that considered hydrographs with long records characteristic of an area and distribution of wells across the Basin. In brief, all available groundwater elevation data for these wells were plotted as hydrographs and well locations were plotted on a basin-scale map. All wells with water level data are shown in **Figure 4-1**. Representative wells with long term hydrographs were selected based the following criteria:

- Location – Wells were prioritized considering broad distribution across the Basin availability of other wells nearby.
- Ongoing and/or recent monitoring – Wells were selected that are part of the active monitoring network or have recent data.
- Trends – Each hydrograph was assessed for continuity of monitoring, representation of local or regional trends, and presence of outliers or unrealistic data.

Recent and historical water level data inconsistently identified groundwater level measurements that were recorded during or immediately after pumping. Most groundwater level records are not identified as either pumping or static measurements. Review of these data showed some records identified as pumping water levels to be closely related to water levels not correlated with pumping. As such, for this study all water levels excluding obvious reporting errors are shown to preserve the overall trends.

Hydrographs in **Figures 4-2** through **4-9** show groundwater level trends over time. In general, water levels correlate to wet and dry hydrologic. In general, water levels have been less responsive to wet and dry periods since 2000. Wells in some portions of the Basin show relatively stable groundwater levels over the past 20 years, while others show non-pumping water level changes during this period by up to 25 feet. The hydrographs do not show dramatic changes in historical water levels in the Basin. The range of historical non-pumping water levels in most wells is under 50 feet.

Figure 4-2 is the long-term hydrograph for Corona Well 15, showing water level changes in the Basin from 1953 to 2020. Since 1953, water levels in Well 15 have fluctuated a total of about 45 feet, from an elevation of 560 feet msl to about 515 feet msl (assuming the spikes below that level are influenced by local drawdown in the pumping well).

The highest water levels in wells with long-term data were measured in the early 1980s in response to a wet hydrologic cycle that began in 1978. These higher levels also correlate to a period of relatively low pumping in the Basin. During a later wet cycle from 1992 to 1998, water levels did not recover to 1980s levels, likely related to an increase in Basin pumping. Groundwater elevation responses to changes in pumping and precipitation patterns are discussed further in Chapter 5 – Water Budget.

The lowest groundwater levels generally correspond to dry periods and periods of increased pumping, though the responses throughout the Basin are not uniform. Hydrographs from most wells show lowering water levels during 2000 to 2004, a period that was not hydrologically dry but had increased pumping in Corona. In the long-term hydrograph from Corona Well 15 (**Figure 4-2**), within Corona, the lowest water levels occurred during the 2015 to 2017 period, after very low rainfall during 2011 through 2015. From 2010 to 2015, water levels declined 10 to 15 feet. Slight increases occurred in 2018 through 2019, likely the result of increased precipitation after 2015. Current levels are near record lows.

Overall, other wells in the Basin follow similar trends, although some wells have more variation in water levels in response to wet and dry periods. The westernmost hydrograph in the Basin is from Corona Well 11 and it shows very little groundwater level change from 2002 through 2020 (**Figure 4-3**). The wells further east in the Channel Aquifer show similar patterns, including Corona Well 22 (**Figure 4-4**), Corona 19 (**Figure 4-5**), Corona 17 A (**Figure 4-7**), and Corona 8a (**Figure 4-8**). Groundwater elevations in these wells were at their highest elevations in 2010 and declined at slow but steady rates through the most recent drought period of 2014 through 2016. Water level declines ranged from 10 to 20 feet from 2011 to 2015. Water levels in these four wells have remained stable or increased since 2018.

Corona Well 26 (**Figure 4-6**) is located on the northeastern part of the Channel Aquifer. Groundwater elevations in this well were also high in 2010, but then decreased sharply in 2013, perhaps due to increased local pumping. The pumping water level in this well is significantly lower than the static water level, which could indicate lower specific capacity on the edges of the Channel Aquifer. Since 2013, water levels have been stable or increasing in Corona Well 26.

Corona Well 13 (**Figure 4-9**), located on the southeastern part of the Channel aquifer shows little change in groundwater levels from 2014 through 2020

4.1.4. Groundwater Flow

Figures 4-10 and **4-11** are groundwater elevation contour maps constructed to examine current groundwater flow conditions using data from fall 2015 and spring 2017. These time periods were chosen to represent dry and wet conditions, respectively. Contours were developed based on available groundwater elevation data for all wells. The median water levels during each season were used. These contours were prepared assuming no barriers to horizontal groundwater flow, including local faults. Due to limited water level data in the southern portion of the Basin, there is a higher level of uncertainty in groundwater flow direction and gradient in the south. Contours in zones with a higher level of uncertainty are shown with dashed lines.

Groundwater flow in the Basin is generally from the surrounding uplands toward Temescal Wash and then north and northwest toward the groundwater and surface water discharge location at Prado Dam. The fall 2015 groundwater elevation contours (**Figure 4-10**) indicate flow from south to north in the Basin. The groundwater elevations in this period represent relatively dry conditions at the end of a drought period. A small depression is depicted in the northern portion of the Basin, most likely due to pumping.

Spring 2017 groundwater elevation contours (**Figure 4-11**) look very similar to groundwater conditions in fall 2015, indicating almost identical groundwater flow conditions. Spring 2017 was a wet period following the 2011 to 2015 dry period. This groundwater elevation surface also indicates flow generally south to north with a small depression in the Corona area. This period was selected because every well with water level data during fall 2015 also had data collected during spring 2017. In areas with similar data availability, spring 2018 groundwater elevation contours also look like the spring 2017 contours.

The similarities between these two groundwater elevation surfaces suggest that the groundwater levels and flow direction in the Basin are not entirely controlled by wet and dry periods and the groundwater flow conditions have been relatively constant in recent years. Several hydrographs support this, with many showing little change in water levels over the past five years.

4.1.5. Vertical Groundwater Gradients

The current monitoring network for groundwater elevations provides little information about vertical head (groundwater elevation) gradients within the Basin. Available data are almost entirely from water supply wells, which typically have long screened zones and are not appropriate for evaluating vertical groundwater gradients. The potentiometric head at the depth of the well screens can be different from the true water table, which is the first zone of saturation reached when drilling down from the ground surface.

Vertical head gradients are an important factor affecting the viability of riparian vegetation. As discussed in greater detail in Section 4.10.3, Riparian Vegetation, phreatophytic vegetation along streams generally survives droughts even when groundwater elevations are tens of feet below the ground surface for two or more years. This suggests that some shallow zones of saturation persist even when the water level in deep aquifers declines. This implies the presence of large vertical head gradients within the aquifer system.

4.2. CHANGES IN GROUNDWATER STORAGE

Change in storage estimates based on evaluation of groundwater elevation changes have not historically been completed for the Basin. Such storage change estimates are based on available groundwater elevation data that are limited geographically and temporally and thus include uncertainty. In addition, the storativity, or storage coefficient (the volume of water released from storage per unit decline in hydraulic head), is largely unknown across the Basin. The volume of groundwater storage change over time is sometimes calculated by multiplying the groundwater elevation changes during a period by the storage coefficient. Storage coefficient values and storage change estimates representing the Basin were developed for the numerical model, as described in **Appendix J**. The numerical model is the best tool for estimating groundwater storage changes. The resulting change in storage estimates are presented in the Water Budget chapter.

4.3. LAND SUBSIDENCE AND POTENTIAL FOR SUBSIDENCE

Land subsidence is the differential lowering of the ground surface, which can damage structures and facilities. This may be caused by regional tectonism or by declines in groundwater elevations due to pumping. The latter process is relevant to the GSP. In brief, as groundwater elevations decline in the subsurface, dewatering and compaction of predominantly fine-grained deposits (such as clay and silt) can cause the overlying ground surface to subside.

This process is illustrated by two conceptual diagrams shown on **Figure 4-12**. The upper diagram depicts an alluvial groundwater basin with a regional clay layer and numerous smaller discontinuous clay layers. Groundwater elevation declines associated with pumping cause a decrease in water pressure in the pore space (pore pressure) of the aquifer system. Because the water pressure in the pores helps support the weight of the overlying aquifer, the pore pressure decrease causes more weight of the overlying aquifer to be transferred to the grains within the structure of the sediment layer. If the weight borne by the sediment grains exceeds the structural strength of the sediment layer, then the aquifer system begins to deform. This deformation consists of re-arrangement and compaction of fine-grained units[1], as illustrated on the lower diagram of **Figure 4-12**. The tabular nature of the fine-grained sediments allows for preferred alignment and compaction. As the sediments compact, the ground surface can sink, as illustrated by the right-hand column on the lower diagram of **Figure 4-12**.

Land subsidence due to groundwater withdrawals can be temporary (elastic) or permanent (inelastic).

Elastic deformation occurs when sediments compress as pore pressures decrease but expand by an equal amount as pore pressures increase. A decrease in groundwater elevations from groundwater pumping causes a small elastic compaction in both coarse-and fine-grained sediments; however, this compaction recovers as the effective stress returns to its initial value. Because elastic deformation is relatively minor and fully recoverable, it is not considered an impact.

Inelastic deformation occurs when the magnitude of the greatest pressure that has acted on the clay layer since its deposition (preconsolidation stress) is exceeded. This occurs when groundwater elevations in the aquifer reach a historically low groundwater elevation. During inelastic deformation, or compaction, the sediment grains rearrange into a tighter configuration as pore pressures are reduced. This causes the volume of the sediment layer to reduce, which causes the land surface to subside. Inelastic deformation is permanent because it does not recover as pore pressures increase. Clay particles are often planar in form and more subject to permanent realignment (and inelastic subsidence). In general, coarse-grained deposits (e.g., sand and gravels) have sufficient intergranular strength and do not undergo inelastic deformation within the range of pore pressure changes

[1] Although extraction of groundwater by pumping wells causes a more complex deformation of the aquifer system than discussed herein, the simplistic concept of vertical compaction is often used to illustrate the land subsidence process (LSCE et al. 2014).

encountered from groundwater pumping. The volume of compaction is equal to the volume of groundwater that is expelled from the pore space, resulting in a loss of storage capacity. This loss of storage capacity is permanent but may not be substantial because clay layers do not typically store significant amounts of usable groundwater. Inelastic compaction, however, may decrease the vertical permeability of the clay resulting in minor changes in vertical flow.

The following potential impacts can be associated with land subsidence due to groundwater withdrawals (modified from LSCE et al. 2014):

- Damage to infrastructure including foundations, roads, bridges, or pipelines;
- Loss of conveyance in canals, streams, or channels;
- Diminished effectiveness of levees;
- Collapsed or damaged well casings; and
- Land fissures.

Inelastic subsidence has not been a known issue in the Basin.

4.3.1. Interferometric Synthetic Aperture Radar (InSAR)

InSAR data are provided by DWR on its SGMA Data Viewer (DWR 2020) and document vertical displacement of the land surface across a broad area of California from June 13, 2015 to September 19, 2019. The TRE Altamira InSAR data, shown on **Figure 4-13**, shows land surface deformation between 2015 and 2019.

The TRE Altamira InSAR data indicates effectively no change in ground surface elevation within the Basin (**Figure 4-13**). Further review of the TRE Altamira InSAR data shows that ground surface elevations in the Basin rose by up to 0.08 feet (0.96 inches) between June 2015 and September 2019, with most of the Basin rising by about 0.02 feet (0.24 inches). A few small areas within the Basin subsided by up to 0.08 feet (0.96 inches). Given this data and the understanding of the hydrogeological conceptual model, there is no issue with subsidence at this time.

4.4. GROUNDWATER QUALITY

The natural quality (chemistry) of groundwater is generally controlled by interactions between rainwater and rocks/soil in the vadose zone and aquifer (Drever 1988). As rainfall infiltrates the soil column, anions and cations from sediments are dissolved into the water. These changes are influenced by soil and rock properties, weathering, organic matter, and geochemical processes occurring in the subsurface. Once in the groundwater system, changing geochemical environments continue to alter groundwater quality. A long contact time between the water and sediments may allow for more dissolution and overall higher salinity level in groundwater (Drever 1988). The natural groundwater quality in a basin is the net result of these complex subsurface processes that have occurred over time. Under natural conditions, older, deeper groundwater often has higher salinity than shallow groundwater because of a longer residence time.

Human processes can increase soil salinity and introduce higher levels of nitrate, inorganic chemicals, and organic compounds to soils in the vadose zone. When recharging water flows through saline soils, ions are dissolved into the infiltrating water and the salinity of shallow groundwater increases.

Most of the groundwater pumped in Temescal Subbasin (Basin) by the City of Corona is treated at the Temescal Desalter, a reverse osmosis membrane treatment facility. The facility treats nitrates, per-fluorinated compounds, 1,2,3-Trichloropropane (1,2,3-TCP), perchlorates, and suspended and dissolved solids. The remaining groundwater is treated at the City Park Ion Exchange Treatment Plant which utilizes two different types of resin, the first treats for perchlorates and the second for nitrates. Water delivered to municipal users is tested regularly to ensure all drinking water standards are met (Corona 2019). There are no other active domestic users of groundwater in the Basin, see Sections 2.3.2.1 and 6.2. The City of Corona recognizes the human right to water and is committed to providing safe drinking water to City residents and has expanded service to the Home Gardens County Water District (HGCWD) service area.

The water quality of the groundwater discussed in this section is the ambient water quality of Basin and does not reflect the treated water delivered to customers by Corona.

Groundwater quality data for this study were sourced from the California Water Boards Groundwater Ambient Monitoring and Assessment (SWRCB 2020a) datasets (which includes data collected by Division of Drinking Water, USGS, DWR, and Regional Water Quality Control Board). In addition, water quality data collected by Corona were included in the analysis. **Figure 4-14** shows the location and data source of the 113 wells with water quality data since 2010 that are in the Basin. The distribution of wells within the Basin is not uniform. Water quality data are primarily available for the Corona wells in the north-central portion of the Basin. In total, 22 wells with recent water quality data were used to assess water quality in the Basin.

Additional monitoring wells for facilities regulated by the Regional Water Quality Control Board do exist in several clusters within the Basin, but these wells were excluded from this groundwater quality assessment. The Regional Water Quality Control Board wells monitor facilities with point source contamination, and their measurements may not be representative of the ambient water quality in the Basin.

A 2008 analysis of the inorganic water quality in the Basin showed that water quality is primarily a sodium/calcium-bicarbonate water type (Todd and AKM 2008). However, the major ion concentration ratios can vary by region. By analyzing the ion ratio characteristics of different areas, the 2008 Corona Groundwater Management Plan identified regions with groundwater mixing and supported the groundwater flow paths identified in the conceptual model. The inorganic major ion analyses identified the following regional trends:

- Groundwater in the Bedford Canyon portion of Temescal Wash or Temescal Canyon has a higher ratio of calcium-to-sodium and sulfate-to-chloride than wells located in Arlington Gap. Groundwater in the Temescal Wash area upgradient of the Norco area has relative cation concentrations that are most like that of the Arlington Gap groundwater. However, the relative cation concentrations do suggest some mixing with waters from the Temescal Canyon area.

- Groundwater in wells located in the Norco area have a lower ratio of calcium-to-sodium and sulfate/bicarbonate-to-chloride than most other areas.
- Groundwater in wells located in the southwestern alluvial fan have the highest ratio of calcium-to-sodium and sulfate-to-chloride/bicarbonate compared to groundwater in other areas. The water type in the alluvial fan may result from geochemical interaction between rainfall runoff and the outcropping Santiago Peak volcanics in the western catchment area of Basin prior to aquifer recharge along the base of the mountains.
- Cation concentrations indicate that groundwater in wells located in Temescal Wash downgradient of the Norco area appear to be mixtures of groundwater from three sources: Temescal Wash upgradient of the Norco area, Arlington Gap, and the western alluvial fan.

This water quality assessment indicates the major sources of water by analyzing the blending of different water quality from different areas. Identifying major areas of inflow and outflow is critical to developing a strong conceptual model of the aquifer. These results are particularly useful given the sparse water level data available in the southern part of the Basin. Based on water quality type, the groundwater in the Channel Aquifer appears to be derived mainly from Arlington Gap and to lesser extent Temescal Wash. In addition to these sources, the western Channel Aquifer also receives inflow from the Alluvial Fan.

4.5. KEY CONSTITUENTS OF CONCERN

The review of available water quality data indicates that total dissolved solids (TDS) and nitrate are the primary constituents of concern (COCs) in the Basin. Other substances known to contribute to poor groundwater quality were reviewed and are discussed later in this chapter.

Elevated TDS concentrations in groundwater are common, resulting from dissolution of minerals from soil and rocks. TDS in groundwater can also be an indicator of anthropogenic impacts from sources such as urban runoff, agricultural return flows, and wastewater disposal. TDS data are available for both inflows and outflows from the Basin.

Nitrate is the primary form of nitrogen detected in groundwater. While natural nitrate levels in groundwater are generally very low, elevated concentrations of nitrate in groundwater are associated with agricultural activities, septic systems, landscape fertilization, and wastewater treatment facility discharges.

Recent water quality results indicate average TDS concentrations of 785 milligrams per liter (mg/L) and nitrate concentrations of 42.8 mg/L (All nitrate concentrations are reported in terms of nitrate as NO_3). These values represent the average concentrations of these constituents from the most recent water quality data for all drinking water and ambient groundwater monitoring events between water year 2010 and water year 2019. Water quality samples from regulated facilities were not included in the analysis. These average conditions serve as a snapshot of water quality conditions within the Basin.

4.5.1. Total Dissolved Solids (TDS)

Groundwater in the Basin is somewhat mineralized, with high TDS concentrations in many monitored wells. The recent average TDS concentrations in the Basin referenced previously are above the 500 mg/L lower secondary maximum contaminant level (SMCL) for drinking water, but below the upper SMCL of 1,000 mg/L. The SMCLs are based on aesthetic considerations (such as taste) and are not health-based.

Most of the recent maximum TDS concentrations from monitored wells in the Basin were above the 500 mg/L SMCL, as indicated on **Figure 4-15**. In total, all but two of the 20 wells with data have TDS concentrations over 500 mg/L, and most of the recent TDS measurements were similar to the median and mean TDS concentrations reported for the respective wells in the 2000 to 2019 period. The highest TDS concentrations on **Figure 4-15** are in wells near the City of Corona, where concentrations from several wells exceed 1,000 mg/L. A total of three wells in the Basin have median TDS concentrations over 1,000 mg/L.

TDS concentrations in some wells have fluctuated by several hundred mg/L during the 2010 to 2019 period. The two wells on **Figure 4-15** with TDS concentrations less than 250 mg/L, Corona Wells 11A and 13, have only shown low TDS concentrations in recent years. Prior to 2016, TDS measurements in these wells were generally greater than 700 mg/L.

4.5.2. Nitrate as Nitrate (NO_3)

Elevated nitrate concentrations have been documented in the Basin since at least the 1950s. Recent data indicate that the average nitrate concentration in the Basin is 42.8 mg/L. The maximum contaminant level (MCL) for nitrate as NO_3 in drinking water is 45 mg/L.

The most recently reported nitrate as NO_3 concentrations for wells in the Basin are shown on **Figure 4-16**. Water quality data indicate nitrate concentrations ranging from less than 1 mg/L to 100 mg/L. Nine wells in the Basin have recent median nitrate concentrations greater than 45 mg/L. The highest nitrate concentrations are those associated with wells at the Arlington Gap. Eight water supply wells in the Basin have had nitrate concentrations exceeding the MCL and have required treatment and/or blending to meet regulatory requirements.

Nitrate contamination in groundwater is commonly related to activities at the ground surface (e.g., fertilizer application, septic systems), and as a result, shallow groundwater typically has higher concentrations than deep groundwater. The wide range of nitrate concentrations in wells in the Basin could be due to vertical variations in nitrate concentrations, but well construction information for monitored wells are limited so it is not possible to adequately assess nitrate concentration variation with depth.

4.6. OTHER CONSTITUENTS

While recent water quality data are limited, available data do not indicate that other constituents of concern pose a significant threat to beneficial uses of groundwater in the Basin. The ambient water quality is discussed in Section 4.4 but this does not reflect on the quality of available drinking water. As noted, groundwater pumped from the Basin for domestic and municipal use is treated at the Temescal Desalter or the City Park Treatment facility prior to distribution by Corona. There are no other domestic groundwater users, either public or private, in the Basin. Nonetheless, these and other naturally occurring and emerging anthropogenic constituents will continue to be monitored and analyzed.

4.6.1. Naturally Occurring Contaminants

Arsenic, uranium, fluoride, and hexavalent chromium are chemicals that can naturally occur at elevated concentrations in groundwater. These contaminants originate in the eroded rocks that make up aquifer sediments and enter groundwater through reactions between groundwater and the sediments. In general, the occurrence of arsenic, uranium, fluoride, and hexavalent chromium depend on regional geology and local groundwater conditions. As documented in this section, no naturally occurring contaminants were identified as widespread constituents of concern in the Basin. However, continued monitoring of these chemicals is recommended.

4.6.1.1. Arsenic

Arsenic in a known carcinogen with a MCL of 10 micrograms per liter (µg/L). Elevated arsenic concentrations occur in groundwater throughout the United States, often in aquifers with low-oxygen (reducing) conditions or high pH levels (USGS 2020b). In the Basin, groundwater in all but one well recorded arsenic concentrations under 5 µg/L. The one well showing groundwater with high arsenic concentrations (32 µg/L) is located near the Arlington Gap (HGCWD Well 5) and it is near a well with arsenic concentrations less than 2 µg/L. This suggests that arsenic may be depth-dependent in the Arlington Gap, but the depths of both wells are unknown.

4.6.1.2. Uranium

Uranium in California groundwater is often derived from eroded granite, such as the Mesozoic granites east of the Basin (Jurgens et al. 2010). The MCL for uranium is 20 picocuries per liter (pCi/L), equivalent to about 30 µg/L. At this concentration, the effect of radiation is negligible, but the chemical properties of uranium can cause kidney damage. Uranium often occurs in shallow, oxygen-rich groundwater (Jurgens et al. 2010). Uranium has been measured in 18 wells in the Basin since 2010. Groundwater in two wells, one in the Arlington Gap region (34 pCi/L) (HGCWD Well 5) and one in Corona (20.8 pCi/L) (Corona Well 19), indicate uranium concentrations greater than the 20 pCi/L MCL. The well with high uranium concentrations in the Arlington Gap is adjacent to a well with groundwater with a uranium concentration of 12.7 pCi/L.

4.6.1.3. Fluoride

Fluoride is a necessary component of a healthy diet to prevent dental cavities, and a fluoride concentration of 0.7 mg/L in drinking water is recommended by the United States Department of Health and Human Services (USDHHS 2015). At extremely high concentrations, however, fluoride can cause mottling of teeth and damage bones. Groundwater in aquifers with sediment originating from igneous rocks can often have fluoride concentrations above the 2 mg/L MCL for fluoride. One well in the Basin had a recent fluoride concentration above the MCL, with a recent concentration of 2.7 mg/L (Corona 26).

4.6.1.4. Hexavalent Chromium

Hexavalent chromium, the oxidized form of the metal chromium, occurs in oxygen-rich groundwater in western California, near chromium-bearing rocks. Hexavalent chromium in California drinking water is currently regulated along with total chromium; the MCL for total chromium is 50 µg/L. In 2014, California adopted a 10 µg/L MCL for hexavalent chromium, but this was overturned in 2017 due to a ruling that the California Department of Public Health had failed to consider the economic feasibility of complying with the MCL (SWRCB 2020c). All 18 wells recently monitored for hexavalent chromium showed groundwater concentrations under 4 µg/L, far below the 50 µg/L MCL.

4.6.2. 1,2,3- Trichloropropane

1,2,3- Trichloropropane (1,2,3- TCP) is a human-made chemical used in pesticide products and as a cleaning and degreasing solvent. It has a high chemical stability and can remain in groundwater for long periods of time (SWRCB 2020d). 1,2,3-TCP has been shown to cause cancer to laboratory animals and is believed to be carcinogenic to humans. California OEHHA established a 0.0007 ug/L public health goal (PHG) for 1,2,3-TCP in 2009. The notification level of 1,2,3-TCP is 0.005 ug/L. In total, 24 wells in the Basin have been tested for 1,2,3-TCP. Seven wells have detected 1,2,3-TCP above the notification level and public health goal. These wells are located near or in the City of Corona in the central part of the Basin.

Water pumped from wells with high concentrations of 1,2,3- TCP have been identified and all water produced by these wells is treated using RO technology at the Temescal Desalter before delivery to customers (Corona 2019). There are no active domestic wells in the Basin and no future domestic pumping is expected. Corona will continue to treat groundwater for 123-TCP and other constituents and provide the and HGCWD with safe drinking water.

4.6.3. Per- and Polyfluoroalkyl Substances (PFAS)

Per- and polyfluoroalkyl substances (PFAS) are a group of emerging contaminants that may pose a danger to reproductive, developmental, immunological, and renal health in humans. Contaminants of emerging concern, or emerging contaminants, are chemicals that have only recently been identified as being present in soil and groundwater or were not previously monitored or detected but pose a risk to human health (USEPA 2019). The two most common PFAS are perfluorooctane sulfonate (PFOS) and perfluorooctanoic acid (PFOA). Currently, California has a drinking water response level of 10 parts per trillion (ppt) for

PFOA and 40 ppt for PFOS. PFAS have been used in products including firefighting foams, nonstick cookware, and stain- and water-repellant fabrics for many decades. PFAS contamination of groundwater often occurs near firefighting training facilities or landfills.

The California State Water Resources Control Board has undertaken PFAS monitoring throughout the state, measuring PFAS concentrations in groundwater and identifying point sources of PFAS contamination (SWRCB 2020e). A study of PFAS in the Santa Ana River Watershed has identified elevated PFAS concentrations in groundwater and contamination sources within the Basin (Behrooz 2020). Because of the emerging nature of PFAS, these studies are ongoing. Additionally, the state is still developing guidelines and regulatory limits for PFAS in water supplies.

4.6.4. Monitoring Networks

City of Corona
The Corona water system includes water supply wells in the Basin that are actively monitored for water quality. Since 2010, Corona has routinely collected water quality data from 19 active and inactive wells in the Basin.

Division of Drinking Water
Public drinking water systems in the Basin report water quality data to the State Water Resources Control Board (SWRCB) Division of Drinking Water (DDW). Each system monitors and reports water quality parameters to DDW and is required to participate in the Drinking Water Source Water Assessment Program (DWSAP) to assure wells are not subject to local contamination. While most of the public supply well water quality data was received directly from Corona, some additional data are available from DDW.

Orange County Water District (OCWD)
OCWD also monitors groundwater quality near Temescal Basin in the Prado area. OCWD is currently installing more than a dozen shallow monitoring wells in the Prado area to provide more information on shallow groundwater conditions. These wells will provide additional data on impacts interconnected surface water and groundwater dependent ecosystems in the Prado Area.

Other Agencies
The Santa Ana Regional Water Quality Control Board (RWQCB) monitors clean-up sites throughout the Basin. Water quality data from 91 wells in this system have been collected. However, data from these wells are not used in this analysis because they often represent point source contamination and cannot accurately capture the ambient water quality in the Basin.

Wells with water quality data from all available sources are shown on **Figure 4-14**.

4.7. THREATS TO WATER QUALITY

4.7.1. Regulated Facilities

The Santa Ana Regional Water Quality Control Board (RWQCB) regulates thirteen cleanup sites in the Basin. These sites include a military site, leaking underground storage tanks, and dry cleaning facilities. Since 2010, 91 wells at regulated facilities have been monitored for chemical constituents.

4.7.2. Septic Systems

Limited areas of the Basin are not served by municipal sewers and rely on on-site wastewater treatment (OWTS or septic systems). These represent sources of TDS and nitrate loading to groundwater, as well as potential sources of other contaminants. Riverside County Department of Environmental Health is the permitting agency for septic systems and wells in the County. The Riverside County Department of Environmental Health maintains an inventory of septic system installations. While it is unclear how many of these septic systems still exist, it is assumed minimal because most of the Groundwater Sustainability Agency (GSA) area is served by municipal wastewater collection systems.

4.7.3. Non-point Sources

Nonpoint source (NPS) pollution is defined by the SWRCB as contamination that *does not originate from regulated point sources and comes from many diffuse sources*. NPS could occur when rainfall carries contaminants to surface waterways or percolates contaminants to groundwater. One example is loading to groundwater of nitrate from agricultural or landscaping land applications. While groundwater may have natural salinity, increasing TDS concentrations from soil salinization is another common non-point source pollution.

4.8. VERTICAL VARIATIONS IN WATER QUALITY

Water quality monitoring programs in the Basin do not show a distinct difference of water quality in depth, in part because most of the ambient monitoring wells have long screened intervals or are collected from wells with unknown construction.

4.9. SEAWATER INTRUSION CONDITIONS

The Basin is located approximately 25 miles inland from the Pacific Ocean and the lowest elevation at the northwestern boundary of the Basin is about 450 feet above sea level. No risk of seawater intrusion exists in the Basin given its location.

4.10. INTERCONNECTION OF SURFACE WATER AND GROUNDWATER

Interconnection of groundwater and surface water occurs wherever the water table intersects the land surface and groundwater discharges into a stream channel or spring. These stream reaches gain flow from groundwater and are classified as gaining reaches. Conversely, connection can occur along stream reaches where water percolates from the stream into the groundwater system (losing reaches), provided that the regional water table is close enough to the stream bed elevation that the subsurface materials are fully saturated along the flow path.

Groundwater pumping near interconnected surface waterways or springs can decrease surface flow by increasing the rate of percolation from the stream or intercepting groundwater that would have discharged to the stream or spring. If a gaining stream is the natural discharge point for a groundwater basin, pumping anywhere in the Basin can potentially decrease the outflow, particularly over long time periods such as multi-year droughts.

Because of the long dry season that characterizes the Mediterranean climate in Riverside County, vegetation exploits any near-surface water sources, including the water table along perennial stream channels, the wet soil areas around springs, and areas where the water table is within the rooting depth of the plants. Plants that draw water directly from the water table are called phreatophytes. They are able to continue growing vigorously during the dry season and typically stand out in summer and fall aerial photographs as patches of vegetation that are denser, taller and brighter green than the adjacent vegetation.

4.10.1. Stream Flow Measurements

Stream flow in the Basin includes runoff from undeveloped tributary watersheds on the eastern slopes of the Santa Ana Mountains, wastewater treatment plant discharges, urban runoff within the Basin, flow in Temescal Wash, and flow in the Santa Ana River where it arrives at the Prado (flood control) Basin. The flow regimes in these waterways are quite different. The locations of surface water features mentioned in this discussion are shown in **Figure 4-17**. Tributary streams in the Santa Ana Mountains adjacent to the west side of the Basin flow primarily in response to rainstorm events, but accretions of groundwater from fractured bedrock create a small, more persistent base flow. These small flows rapidly percolate where the creek enters the Basin and generally do not reach Temescal Wash. None of the local tributaries is gaged, but a gage was installed in 2018 on Coldwater Canyon Creek about five miles south of the Basin, and its watershed is similar to those of the Basin tributaries. Daily flows at that gage and two Temescal Wash gages during water years 2013 through 2020 are shown in **Figure 4-18**.

Temescal Wash originates at Lake Elsinore, 17 miles upstream of Basin. It passes from south to north through the Bedford-Coldwater Subbasin and then through Basin before discharging into the Prado Basin wetlands. There are two stream gages on Temescal Wash, one below Lee Lake at the upstream end of the Bedford-Coldwater Subbasin (Temescal Wash at Corona Lake; USGS 11071900) and one at Main Street downstream of the wastewater treatment plant in Corona (Temescal Creek above Main Street at Corona; USGS 11072100). The flow regime at the outlet of Lee Lake is probably similar to the flow regime at the upstream end of Basin. Surface flow occurs primarily during and immediately following rainstorm events. No flow was recorded for three consecutive years during the recent drought.

Reduction in wastewater treatment plant discharges to Temescal Wash over the preceding 10 to 20 years is thought to have contributed to the exceptionally low flows during the drought (Russell 2020). A comparison of total flow in Temescal Wash with recycled water discharges entering the wash confirms that base flow did decrease after 2012 but by only a small amount relative to total flows entering the Prado Wetlands. **Figure 4-19** shows monthly average flows at the gauge above Main Street in Corona and monthly recycled water discharges to Temescal Wash from three water reclamation facilities. Gaged flows above Main Street experienced many more peak flow events than seen at gages farther upstream. Most of these additional flow events probably derive from impervious runoff in the surrounding urban area. Base flow closely tracks the discharge from Corona Wastewater Reclamation Facility 1 (WRF-1), which is located less than 1 mile upstream of the gage on the concrete-line Temescal Wash channel. There might be additional contributions of so-called nuisance water (for example, sprinkler overspray onto paving, or pipe leaks). Average discharges from WRF-1 decreased by about 2 cubic feet per second (cfs) following a SWRCB decision approving the City of Corona's petition to decrease minimum discharges from 4.57 cfs to 2.25 cfs (SWRCB 2012). In December 2012, the RWQCB issued Order R8-2012-0028, which allowed the Temescal Valley Water District (TVWD) to recycle or percolate all reclaimed water at the Lee Lake WRF and cease all discharges to Temescal Wash. That WRF is located 4 miles upstream of Temescal Basin. Those discharges had already been decreasing and were less than 1 cfs during 2010 to 2012, which means they would have been consumed entirely by percolation and evapotranspiration before reaching Temescal Basin. The decrease in Lee Lake WRF discharges would not have affected Temescal Wash inflow to the Prado Wetlands. By the same token, discharges from the City of Corona WRF-3 (located 2.2 miles upstream of the Temescal Basin) were also too small to affect inflow to Prado Wetlands. For comparison, median annual outflow from Prado Dam decreased by 129 cfs, or fifty times more than the decrease in Temescal Wash base flow at the Main Street gage in Corona.

A review of 27 high-resolution aerial photographs (Google Earth 2021) between 1994 and 2020 revealed localized flowing or ponded reaches of Temescal Wash along a 2-mile reach where the Wash traverses bedrock between the Bedford-Coldwater Subbasin and the Basin. The location of this reach along with vegetation and estimated depth to groundwater in spring 2017 are shown in **Figure 4-20**. Open water was also visible in the Wash channel in some of the air photos from the Minnesota Road bridge down to Temescal Wash Lake, a 33-acre lake that is a former gravel mining pit. The greater resistance of bedrock to subsurface flow appears to force groundwater into the creek channel and/or riparian root zone as it crosses the bedrock. Upon entering the Basin a short distance downstream of the Minnesota Road bridge, surface flow percolates back into the ground. Groundwater levels are probably far below the creek bed in that area, however, sufficient surface flow reaches Temescal Wash Lake to make it a perennial water body. For 3.4 miles below Temescal Wash Lake, the creek flows in a cement-lined culvert, finally discharging into the outer fringes of Prado Basin at North Lincoln Avenue.

Aerial photographs from 1967 show almost no riparian vegetation along the bedrock reach of Temescal Wash between the Bedford-Coldwater Subbasin and Temescal Basin. Precipitation had been consistently below-average since 1947 and pumping along Temescal

Wash in the Bedford-Coldwater Subbasin during that period was 167 percent of recent pumping (WEI 2015). Thus, dense riparian vegetation has not been a constant feature of Temescal Wash but has waxed and waned over the past several decades in response to changes in surface flow and groundwater levels.

4.10.2. Depth to Groundwater

Depth to groundwater provides a general indication of locations where gaining streams and riparian vegetation are likely to be present. However, available data are of limited use for this purpose due to insufficient vertical and geographic coverage. Available data are almost entirely from water supply wells, which are typically screened far below the water table. The groundwater elevation (potentiometric head) at the depth of the well screen can be different from the true water table, which is the first zone of saturation reached when drilling down from the ground surface. Because recharge occurs at the land surface and pumping occurs at depth, deep alluvial basins such as this one typically have large downward head gradients within the aquifer system. Thus, water level information from wells can potentially underestimate the locations where the water table is shallow enough to support phreatophytic riparian vegetation. Conversely, in areas where groundwater discharges into streams or wetlands—such as in the Prado Basin—vertical water-level gradients are typically upward.

The geographic coverage of water-level data for the Basin is limited because the wells with data are clustered near the north-central part of the Basin. The closest well to Temescal Wash is about 0.5 mile away. The error associated with extrapolating water levels to Temescal Wash could easily be greater than 10 feet. Horizontal water table gradients can be high near losing streams. Creeks and rivers that lose water commonly form a mound in the water table near the creek. The height and width of the mound depends on the transmissivity of the shallowest aquifer. For example, groundwater elevations in a shallow well adjacent to the Arroyo Seco in the Salinas Valley rose 5 to 10 feet more than groundwater elevations in wells 1,000 feet away when the river started flowing (Feeney 1994). A groundwater ridge up to 12 feet high develops beneath Putah Creek in Yolo County during the flow season, but the width of this ridge was estimated to be only a few hundred feet (Thomasson et al. 1960). These examples suggest that shallow wells within 100 to 200 feet of a stream channel would be needed to confirm the presence of hydraulic connection between surface water and groundwater.

Groundwater does not discharge into streams unless the water table is equal to or higher than the elevation of the stream bed. In addition, the water table does not provide water to phreatophytic vegetation unless it is at least as high as the base of the root zone. The depth of the root zone is uncertain, partly because the relatively few studies of rooting depth have produced inconsistent results and partly because rooting depth for some riparian species is facultative. This means that the plants will grow deeper roots if the water table declines. Many species (including cottonwood and willow) germinate on moist soils along the edge of a creek in spring. As the stream surface recedes during the first summer, the seedlings survive if the roots grow at the same rate as the water-level decline. Over a period of years, roots grow deeper as the land surface accretes from sediment deposition and/or the creek channel meanders away from the young tree or shrub. For screening purposes, a depth to water of less than 30 feet in water supply wells near streams was selected as a threshold for identifying possible phreatophyte areas. This depth allows for 10 to 15 feet of root depth, 5 feet of elevation difference between the water level in the well and the overlying true water table, and 15 feet of topographic elevation difference between well heads and the bottoms of nearby creek channels where the vegetation is located.

In spite of these accuracy limitations, contours of depth to water measured in wells—in combination with depth to water data for the downstream end of the Bedford-Coldwater Subbasin (also shown in **Figure 4-20**)—indicates that there are only two areas in or near the Basin where depth to water is likely shallow enough to be within the root zone of vegetation or possibly discharge into stream channels or wetlands (**Figure 4-20**). One of the areas is the 2-mile bedrock reach of Temescal Wash between the Bedford-Coldwater Subbasin and Basin, and the other is the Prado Wetlands, where contouring suggests groundwater discharges into the wetlands. Depth to water in spring of 2017 was less than 20 feet downstream of about North Lincoln Avenue.

Depth to water in the Corona area was incorrectly characterized in a shallow groundwater and evapotranspiration assessment competed for the Upper Santa Ana River Integrated Model summary report (Ballau 2018). The map of shallow groundwater areas in slide 8 of Appendix E of that report shows shallow groundwater conditions extending up Temescal Wash from Prado Basin to the center of Corona. Shallow groundwater conditions were inferred from the presence of perennial flow in the Wash, as shown on the National Hydrography Dataset map. There is perennial flow, but it consists almost entirely of wastewater discharges from the Corona WRF-1 treatment plant, which is located about 1 mile upstream of the Main Street gage. All wells in that area—including deep supply wells and shallow monitoring wells at cleanup sites—have water levels generally more than 70 feet below the ground surface. Furthermore, the reach of Temescal Wash that is perennial is lined with concrete and not suitable for riparian habitat.

4.10.3. Riparian Vegetation

Vegetation data provides evidence that the water table near some reaches of Temescal Wash is shallow enough to supply water to phreatophytes. Where tree and shrub roots are able to reach the water table, riparian vegetation is typically denser and greener than along reaches where vegetation is supplied only by stream flow or residual soil moisture from the preceding wet season. Patches of dense riparian vegetation are visible in multiple historical photographs and are indicated by a crosshatch pattern in **Figure 4-21**. The figure also shows the distribution of vegetation classified as Natural Communities Commonly Associated with Groundwater (NCCAG) by the Nature Conservancy. Based on multiple historical vegetation surveys, the Nature Conservancy prepared detailed statewide mapping of NCCAG vegetation that is accessible on-line (DWR et al. 2020). Note that the NCCAG map does not include the corridor of dense riparian trees and shrubs along the bedrock reach of Temescal Wash between the Bedford-Coldwater Subbasin and the Basin. It does include 44 acres of red willow and 12 acres of cottonwood between Minnesota Road and Temescal Wash Lake, which is a reach where surface flow and shallow groundwater are probably leaking downward to a deeper regional water table. Red willow is a facultative phreatophyte, which means it will exploit a water table if it is within a reachable depth but otherwise survive on soil moisture (typically with smaller stature and greater spacing between plants).

Another waterway mapped as supporting riparian vegetation in the NCCAG database is the lower reach of Wardlow Wash, which drains the northwest corner of the Basin to the Santa Ana River. Most of the mapped vegetation is facultative phreatophytes (mainly sycamore), but one polygon of Fremont cottonwood (an obligate phreatophyte) is mapped about 0.5 mile from the southern edge of the Prado Wetlands, in an area where shallow depth to water is plausible.

An additional test for groundwater dependence of riparian vegetation was to compare changes in groundwater elevation with changes in vegetation health during the recent drought. Vegetation health can be detected by changes in the way the plant canopy absorbs and reflects light. The spectral characteristics of satellite imagery can be processed to obtain two metrics commonly used to characterize vegetation health: the Normalized Difference Vegetation Index (NDVI) and the Normalized Difference Moisture Index (NDMI). Both are calculated as ratios of selected visible and infrared light wavelengths. The Nature Conservancy developed a second on-line mapping tool called GDE Pulse that provides annual dry-season averages of NDVI and NDMI for each mapped NCCAG polygon for 1985-2018 to assist with the identification of groundwater dependent ecosystems (GDEs) (TNC 2020). For the Fremont cottonwood polygon, NDVI and NDMI declined by 0.25 and 0.26, respectively, from 2012 to 2017, and for the red willow areas, the metrics declined by 0.15 and 0.16. These fairly substantial declines were clearly related to the drought. Field observations of riparian vegetation documented riparian tree mortality of approximately 80 percent between 2014 and 2016 along the downstream end of Bedford-Coldwater Subbasin, the bedrock reach, and the Basin reach down to Temescal Wash Lake (Russell 2020 and Google Earth 2021). The question is whether the cause of the moisture stress was reduced rainfall, reduced streamflow or lower groundwater levels. After the relatively wet winters of 2019 and 2020, the stands of riparian trees are now recovering.

In summary, riparian vegetation along the bedrock reach of Temescal Wash is very likely phreatophytic and therefore affected by groundwater levels in the thin ribbon of channel deposits along the Wash. Once the Wash enters the Basin, however, the regional water table is far below the channel. The depth to water in the three wells with historical water level data closest to the Temescal Wash vegetation (south of well Corona 13 in Figure 4-1) was historically 50 to 150 feet below the ground surface. Depth to water increases from the center of the Channel Aquifer area toward the margins of the Basin because the ground slope (0.04-0.13 ft/ft from Figure 3-1) is four or more times steeper than the water table slope (about 0.01 ft/ft from Figures 4-10 and 4-11). Thus, the depth to water at the Temescal Wash riparian vegetation is likely greater than the 50 to 150 foot range of the three wells farther north. Groundwater elevations at the vegetation location is not considered a data gap because available data indicate that the regional water table could not plausibly be less than 30 ft below the ground surface. The riparian vegetation along that reach is probably supported by perched groundwater along the channel sustained by percolation of surface flow in Temescal Wash as it exits the bedrock reach.

4.10.4. Wetlands and Interconnected Surface Water

The north end of the Basin is beneath the Santa Ana River and surrounding Prado Wetlands, which is a managed wetland maintained by operation of Prado Dam. Prado Dam impounds the river to regulate flood flows in winter and sustain a perennial wetland. In some previous reports, the impoundment area was referred to as the Prado Flood Control Basin. “Basin” in this case refers to a surface water feature. The RWQCB Basin Plan designates the area behind Prado Dam up to an elevation of 566 feet as the “Prado Basin Management Zone”. This GSP refers to the dense wetland and riparian vegetation within that area as the Prado Wetlands. Surface water behind the dam is maintained at a specified elevation, which currently is 505 feet. The extent of wetland vegetation has increased from 1.8 square miles (mi^2) in 1960 to about 6.8 mi^2 today, with most of the increase occurring prior to 1985 (WEI 2020). Approximately 1.4 mi^2 of the total is within the Basin.

Evapotranspiration is higher in wetland and riparian vegetation areas where plant roots can access the water table than in areas where the water table is too deep to be accessed by roots. Thus, maps of remotely-sensed evapotranspiration (ET) show where the water table is shallow and being utilized by plants. Color-coded ET maps based on spectral analysis of Landsat imagery are available annually, and the maps from 1986 through 2016 consistently show a very sharp and stable boundary between high- and low-ET regions defining the southern edge of the Prado Wetlands (Ballau 2018). Temescal Basin along the lower reach of Temescal Wash between the wetlands and downtown Corona did not exhibit high ET between 1986 and 2016. This further confirms that the assumption of shallow groundwater in that region based on perennial flow in the channel was erroneous, as discussed earlier.

A systematic comparison of factors potentially related to groundwater levels in the Prado Wetlands was completed for this GSP. The Prado Basin Habitat Sustainability Program includes monitoring of groundwater levels and quality in scores of wells in and north of the Prado Wetlands, including 18 monitoring wells constructed specifically to detect changes in the shallow water table elevation within the wetlands (WEI 2020). It was found that wetland vegetation and riparian vegetation along the lower reaches of two north-side tributary creeks were associated with depths to water of 15 feet or less. **Figure 4-22** compares water levels in shallow wells in Prado Wetlands with water levels to the north and south of the wetlands. For the wells in and to the north of the wetlands, the wells show the maximum depth to water between 2010 and 2020. In the central part of the wetlands, the maximum depth to water was 13 feet or less at all wells, which is shallow enough to be accessible to roots of established riparian vegetation. The most common species mapped in that area is red willow. In contrast, the minimum depths to water in wells in Temescal Basin south of the wetlands were all greater than 40 feet (beyond the reach of vegetation roots) except for the well closest to the wetlands, where it was 23 feet (within the possible rooting depth range of some riparian tree species). Those water levels are from water supply wells, which are relatively deep. To check for the possible presence of a shallow aquifer with higher water levels, data for shallow monitoring wells at groundwater contamination sites were obtained from the SWRCB Geotracker database and reviewed (SWRCB 2021). GeoTracker has information for six sites in the central part of Corona, and in all cases the depths to water were 42 to 172 feet, which is roughly consistent with the water supply wells and beyond the reach of vegetation roots. Thus, somewhere near the southern edge of the Prado Wetlands there is an abrupt transition to deeper water levels.

Various factors that could potentially affect shallow groundwater levels in the Prado Wetlands were evaluated for this GSP by comparing their variations over time between 2000 and 2019. **Figure 4-23** shows depth to water hydrographs for four Prado Wetland wells, annual pumping at the Chino Basin desalter wells and in all wells in the Temescal Basin, water levels in several wells in the Temescal Basin, annual discharge in the Santa Ana River below Prado Dam and annual precipitation in Riverside. The 2012 through 2016 period is highlighted in the figure for discussion purposes. The Prado wells all show water-level declines from 2012 to 2015 followed by a rise in 2016. If groundwater pumping caused the declines during 2012 to 2015, it would have been above average during that period. However, pumping at the Chino desalter wells (locations shown in **Figure 4-22**) was relatively constant during that period, and Temescal Basin pumping actually declined. Furthermore, the large step increase in desalter pumping from 2005 to 2007 was not associated with a corresponding decrease in Prado Wetland groundwater levels.

Groundwater elevation trends in the Temescal Basin also show no correlation with shallow groundwater levels in the Prado Wetlands. The most common trend was a steady decline of 10 to 20 feet during 2012 through 2016. This is counterintuitive given the decrease in Temescal Basin pumping during that period. It suggests that sources of recharge—primarily percolation from Temescal Wash and stormwater retention basins on other streams—decreased during the drought by a total amount greater than the decrease in pumping.

A variable that does correlate with Prado Wetland groundwater levels is annual discharge in the Santa Ana River at the gage below Prado Dam. The flow at that location is a direct measure of the amount of surface water flowing through the wetlands. Annual discharge declined during 2011 through 2015, increased slightly in 2016 and even more in 2017. Median and average annual discharge are shown in the figure and exhibit similar patterns. Median discharge emphasizes moderate, steady flows such as discharges from wastewater treatment plants. Average discharge also includes the effects of runoff during large storm events. In wetter years such as 2011 and 2017 the average flow is considerably larger than the median flow. Annual precipitation at Riverside also correlates with the Prado groundwater trends. Precipitation was high in 2010 through 2011 and 2017 and low during 2012 through 2016.

The correlation of precipitation and river flow with Prado groundwater levels and the lack of correlation with groundwater pumping north and south of the wetlands indicates that the wetlands are primarily sustained by surface inflows.

Another evaluation of factors potentially correlated with changes in NDVI in the Prado Wetlands was presented in the 2019 annual report of the Prado Basin Habitat Sustainability Committee (WEI 2020). Using a spatially and temporally detailed statistical analysis of trends in time series plots for 1984 through 2019, no correlation was found between NDVI and groundwater levels. However, in some years changes in NDVI correlated with annual precipitation, growing-season average maximum and minimum temperatures, wastewater discharges, vegetation management activities or wildfires. These results are consistent with those presented above and support a conclusion that the wetlands are now primarily supported by surface inflows including storm runoff and reclaimed water discharges.

Prado Dam operation also strongly influences water availability in the wetlands because the impounded pool of water is more perennial than it would be in a natural condition.

Modeling completed for other studies projected large water-level declines in the Temescal Basin, with an implication that groundwater is being over-exploited and potentially impacting Prado Wetlands. However, actual water-level data from Temescal Basin show that the simulated declines are incorrect. The simulated declines were first presented in the Prado Basin Adaptive Management Plan (WEI 2016; see Figure 1-4 of that report). The same results were presented again in the 2019 Annual Report of the Prado Basin Habitat Sustainability Committee (WEI 2020; see Figure 1-3). The simulations indicated 20 feet of cumulative water level decline from 2005 to 2030 near the southern edge of the Prado Wetlands, increasing to 60 feet near downtown Corona. In reality, water levels in the Temescal Basin have shown no net increase or decrease from 2005 to 2020 (see, for example, **Figure 4-23**). It is possible that the groundwater model used for those simulations included the southward propagation of drawdown from the Chino desalter wells but did not fully include recharge from Temescal Wash and small streams in the Temescal Basin.

The low importance of groundwater as a factor in managing Prado Wetlands is also implicit in the Upper Santa Ana River Habitat Conservation Plan (HCP) (ICF 2020). Groundwater modeling completed for the HCP projected declining groundwater levels for the region surrounding the Prado Wetlands. However, none of the management actions in the HCP target groundwater pumping or levels beyond simply monitoring them. The actions focus on establishing an HCP Preserve, enhancing channel morphology, substrate, and in a few places flow to improve habitat quality. The thirty-three "avoidance and mitigation measures" listed in the HCP deal exclusively with land and vegetation disturbance and related construction activities. Most of the proposed actions are along the mainstem of the Santa Ana River. The surface hydrology model, for example, extended only about 2 miles up Temescal Wash—a reach that is concrete-lined, has no habitat value and is not connected to groundwater.

Small wetlands might be present outside of the Prado Wetlands. The Nature Conservancy NCCAG mapping includes a wetland layer separate from the riparian vegetation layer. It indicates the locations of possible wetlands outside of the Prado Wetlands area. Along Temescal Wash, the largest mapped polygons are within the riparian vegetation polygons between Minnesota Road and Temescal Wash Lake. Additional small polygons are shown along the shore of the lake. As stated earlier, water levels in wells are thought to be far below the creekbed and lake at that location, which would indicate that the wetlands and lake are sustained by surface discharges, not groundwater. The mapping also shows two strips of wetland in the channelized reach of the Wash downstream of the lake. The channel has a cement bottom, so wetlands are not likely present (i.e., there is a mapping error). The mapping shows no off-channel wetlands in the Basin, which is not surprising given its largely urban land cover.

The Western Riverside County Multiple Species Habitat Conservation Plan (MSHCP) was reviewed for additional information regarding plant species that might be affected by groundwater (RCRCA 2020). Two large regions mapped as *narrow endemic plants* and *criteria area species* partially overlap the Basin. However, those categories together contain 16 upland plant species that are unaffected by groundwater.

4.10.5. Animals and Interconnected Surface Water

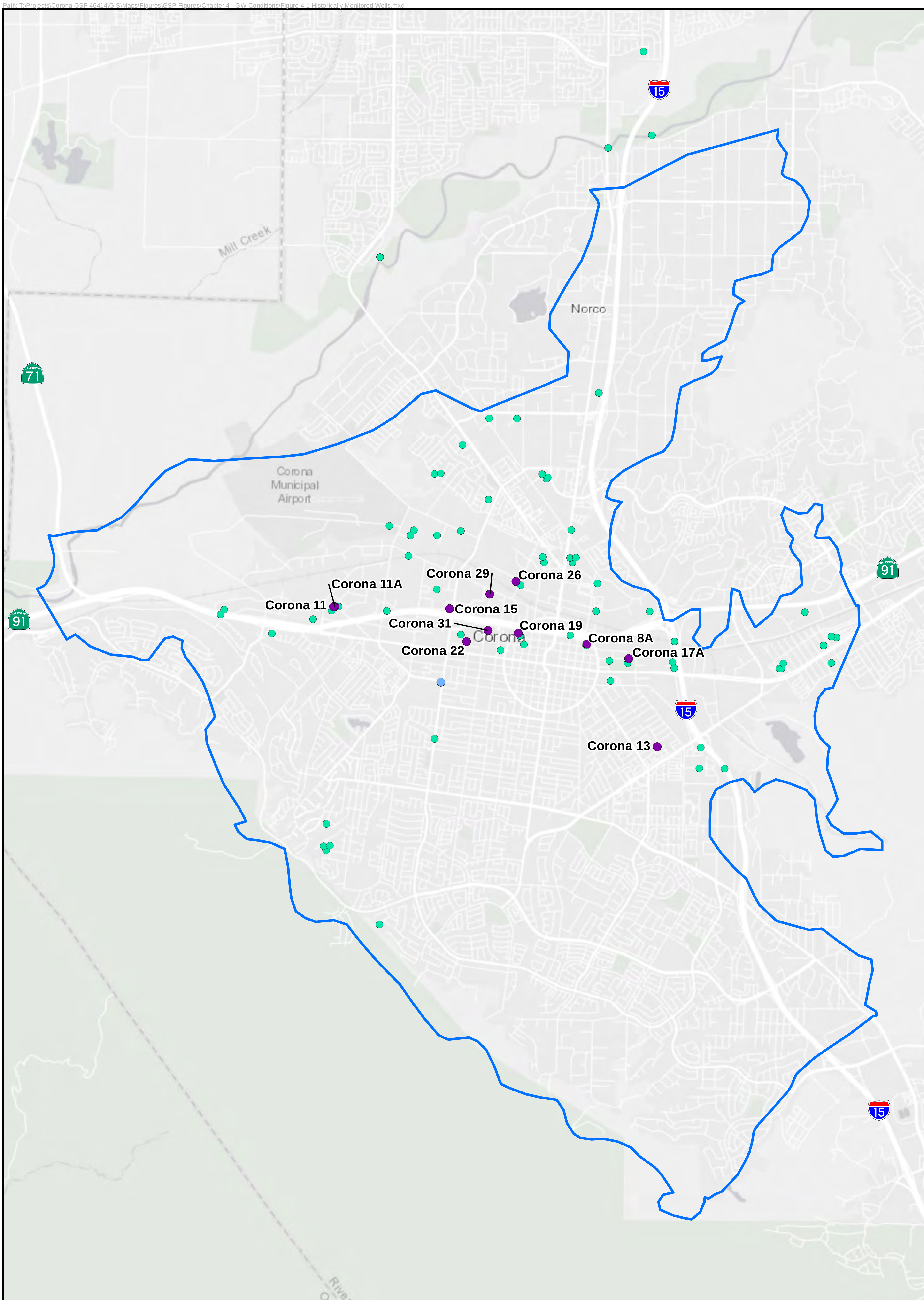
Animals that depend on groundwater include fish and other aquatic organisms that rely on groundwater-supported stream flow, amphibious or terrestrial animals that lay their eggs in water and birds that inhabit riparian vegetation. Management of habitat for animals typically focuses on species that are listed as threatened or endangered under the state or federal Endangered Species Acts. That convention is followed here. Flow in Temescal Wash is too ephemeral to support migration of anadromous fish, although the population of rainbow trout in Coldwater Canyon Creek above the Bedford-Coldwater Subbasin is thought to be the remnant of a steelhead trout population present as recently as the 1930s (Russell 2020). No native fish species presently inhabit Temescal Wash. Resident fish are nonnatives such as bass, bullhead, sunfish, and carp. Arroyo chub (*Gila orcuttii*) is a native fish listed as a species of special concern that is present in Prado Wetlands and could potentially inhabit some reaches of Temescal Wash. The Riverside-Corona Resource Conservation District implemented the Temescal Wash Native Fish Restoration Project during 2007 through 2009. The focus of that effort was on eradication of nonnative plants and animals, particularly arroyo chub predators. Modifying flow conditions was not part of the project. No habitat areas for arroyo toad or red-legged frog are mapped within the Basin.

The Upper Santa Ana River HCP documents historical sightings and current potentially suitable habitat for a number of listed species, including six at various locations along Temescal Wash between Lake Elsinore and the Prado Wetlands: Arroyo chub, California glossy snake (*Arizona elegans occidentalis*), southwestern pond turtle (*Emys pallida*), yellow-breasted chat (*Icteria virens*), least Bell's vireo (*Vireo bellii pusillus*), and southwestern willow flycatcher (*Empidonax traillii extimus*). In all cases there were either a number of historical sightings but little suitable habitat or vice versa. Apparently, habitat restoration opportunities are richer along the Santa Ana River than along Temescal Wash, and this led to the HCP's focus on the former.

Two bird species that inhabit the Prado Wetlands are federally listed as endangered: least Bell's vireo and southwestern willow flycatcher. Critical habitat areas have been delineated by the U.S. Fish and Wildlife Service for many listed species. Critical habitat maps for three species are shown in **Figure 4-21**. Critical habitat for the least Bell's vireo and southwestern willow flycatcher in the Temescal Basin region more or less coincide with the extent of the Prado Wetlands. Critical habitat for the coastal California gnatcatcher (*polioptila californica californica*) includes areas on the eastern slopes of the Santa Ana Mountains that very slightly overlap the western edge of the Temescal Basin. The only vegetation in those areas that might utilize groundwater would be along tributary streams, where a small amount of base flow is sustained by groundwater discharging at a low rate from fractured bedrock. That discharge would not be affected by pumping and water levels in the Basin, so Basin management would not impact the extent or health of vegetation along streams in the mapped habitat areas.

In summary, groundwater management is unlikely to impact habitat in the Prado Wetlands and along Temescal Wash with possible minor exceptions where Temescal Wash first enters the Basin from the bedrock reach and along the southern edge of the Prado Wetlands. Additional data are needed regarding the presence of a shallow water table in those locations to reach a more definitive conclusion.

Path: T:\Projects\Corona GSP 46414\GIS\Maps\Figures\GSP Figures\Chapter 4 - GW Conditions\Figure 4-1 Historically Monitored Wells.mxd



- Wells with Regular Monitoring
- Wells with Representative Hydrographs (labeled)
- Other Historically Monitored Wellls
- Temescal Basin

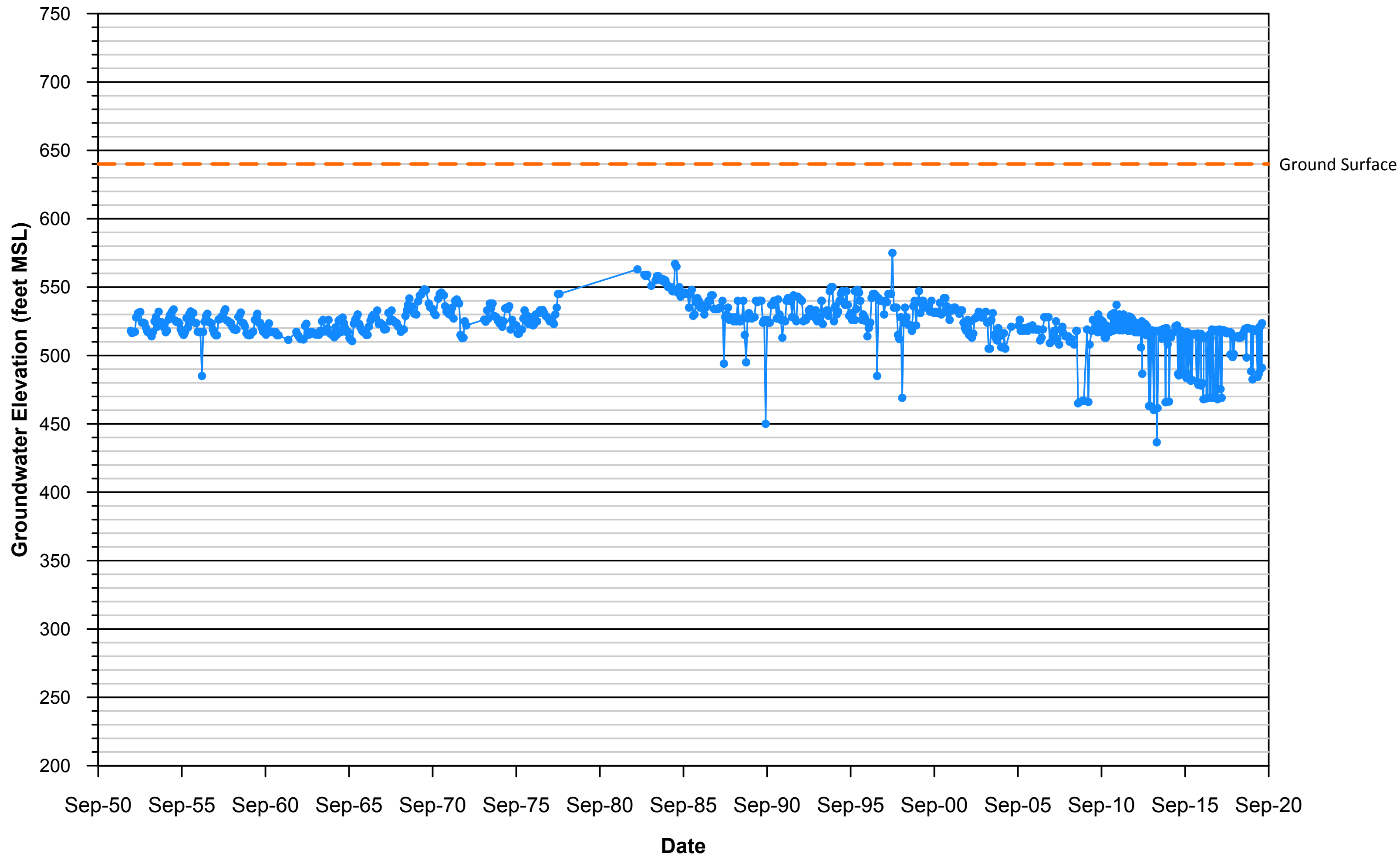
N

0 0.5 1

Miles

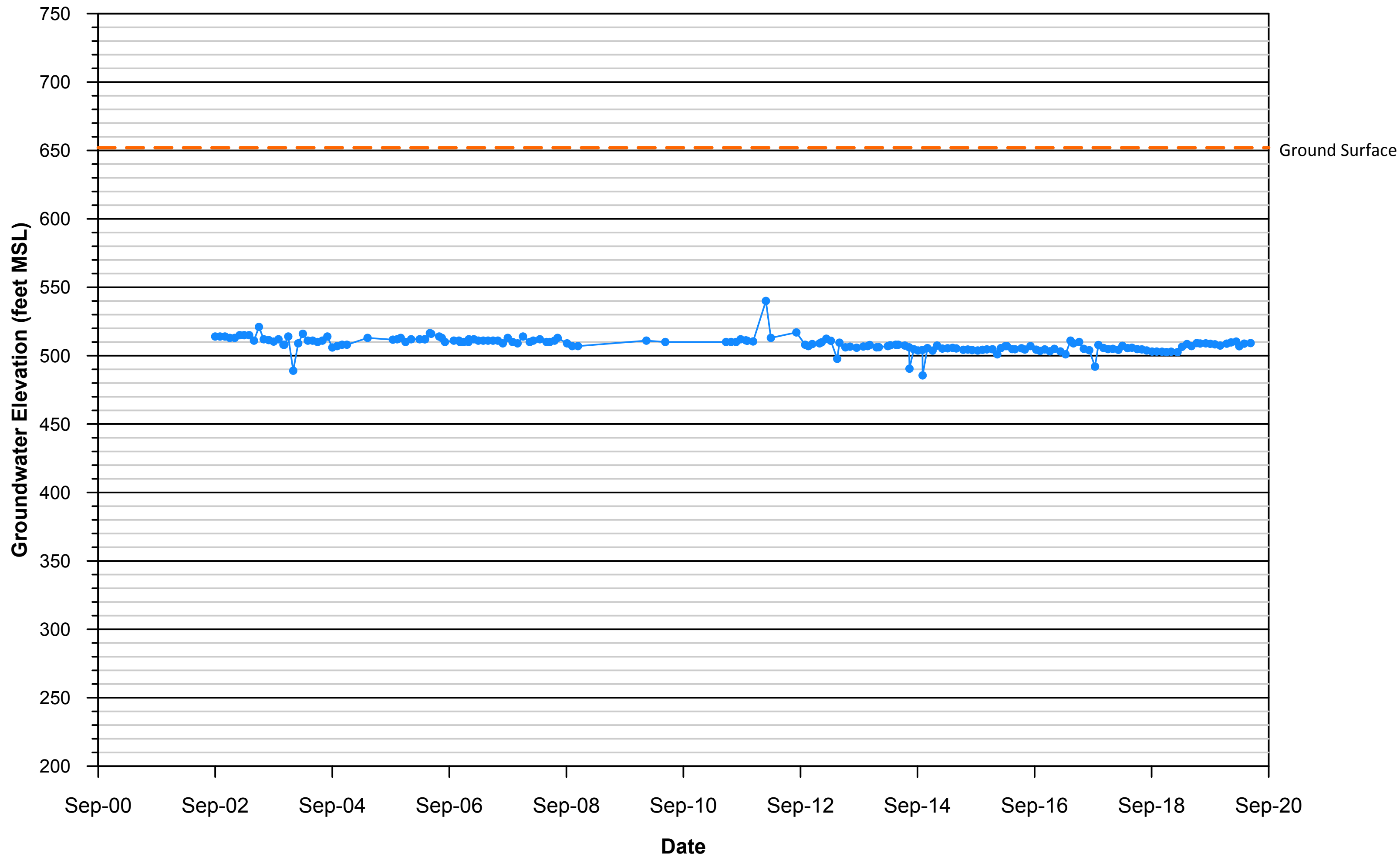
Figure 4-1
Historically Monitored Wells

TODD GROUNDWATER



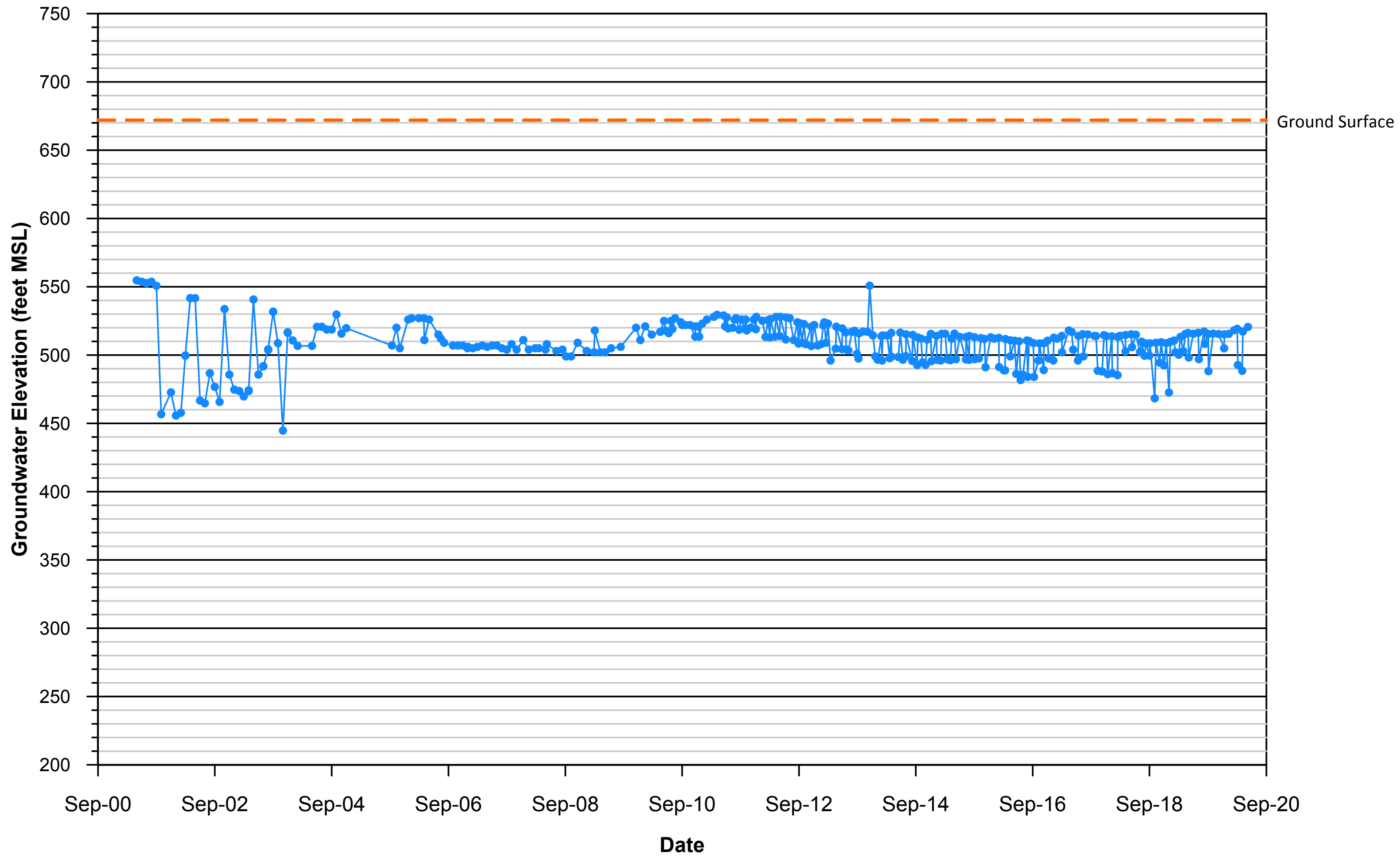
TODD GROUNDWATER

Figure 4-2
Representative Hydrographs
Corona Well 15



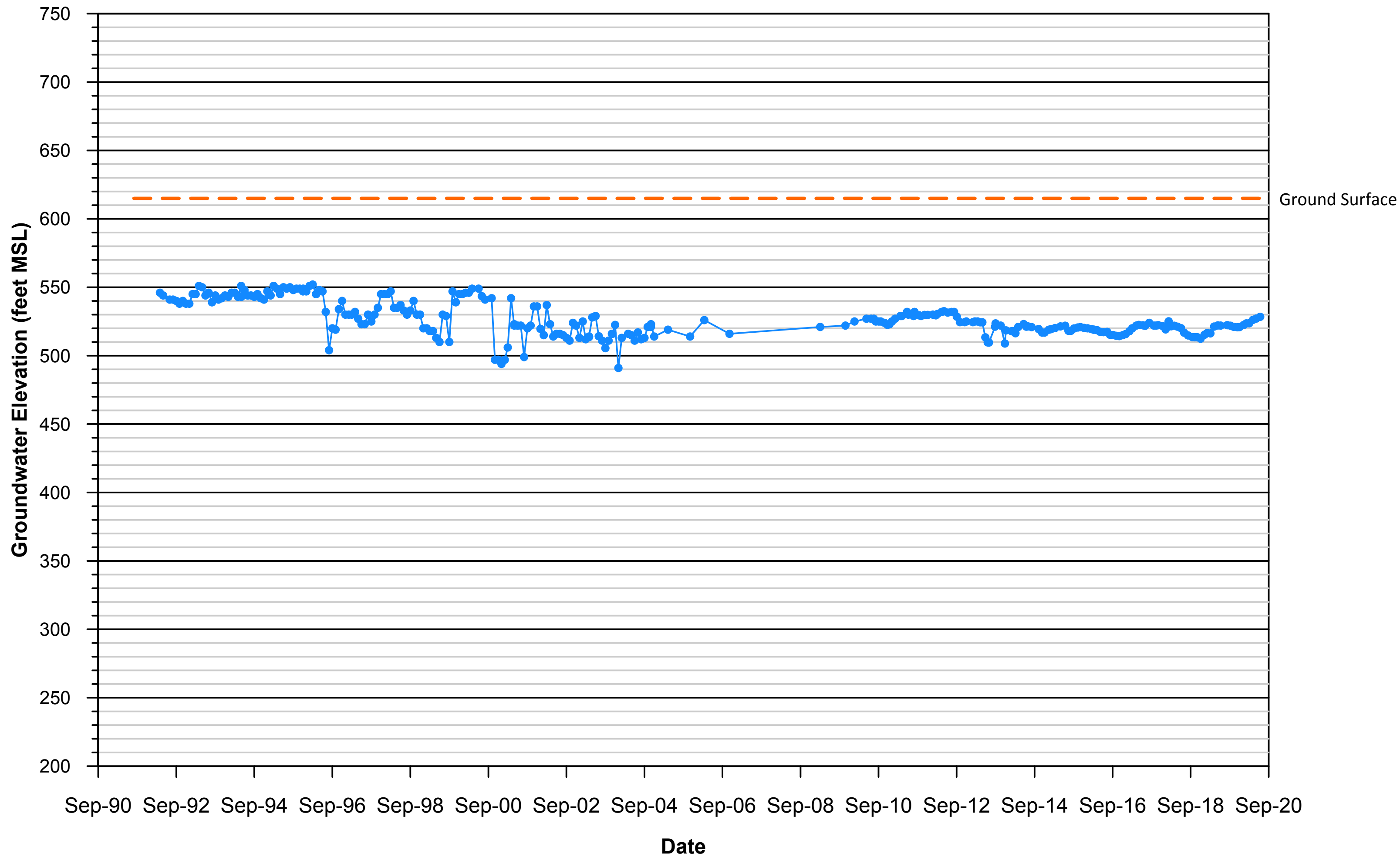
TODD GROUNDWATER

Figure 4-3
Representative Hydrographs
Corona Well 11



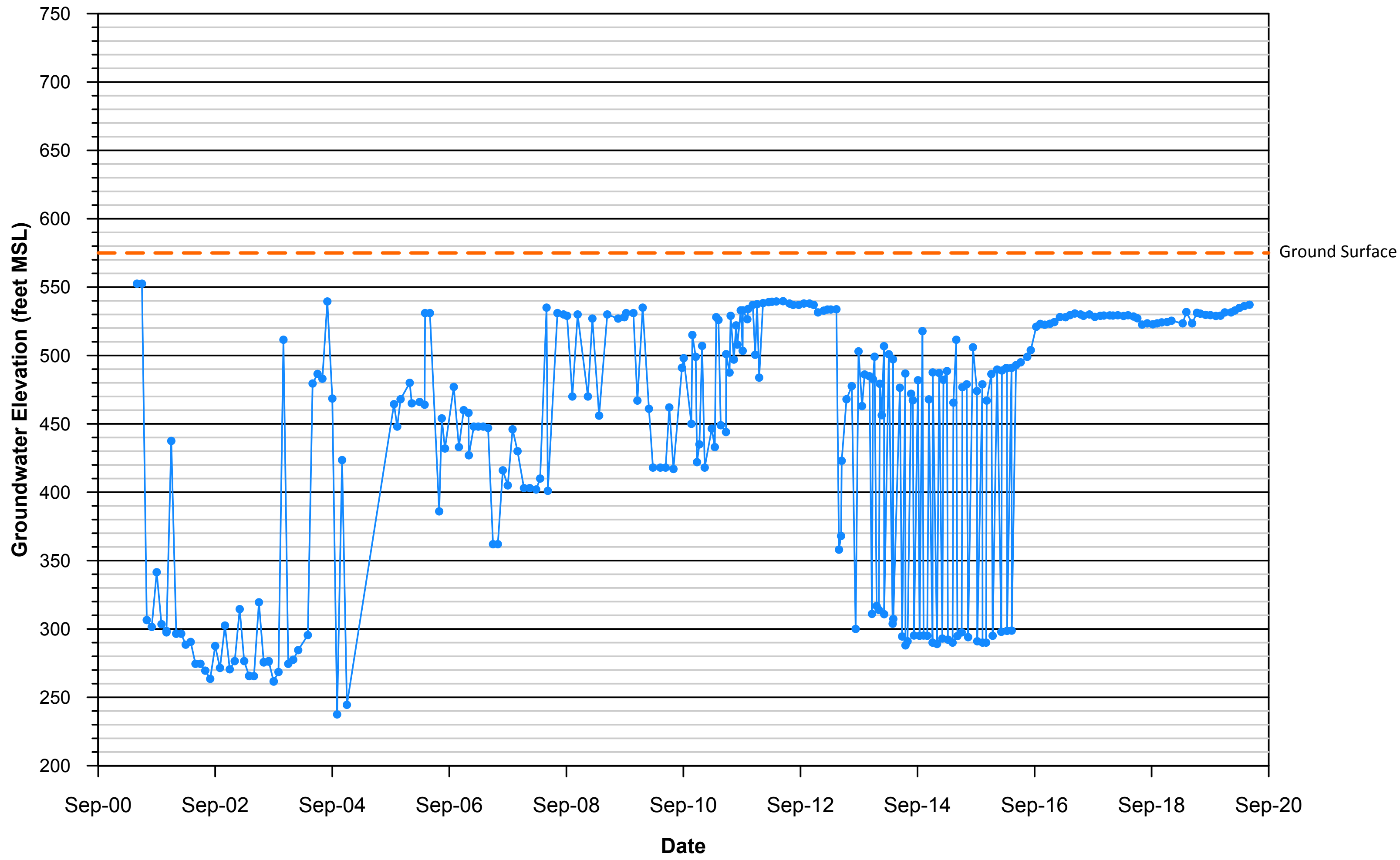
TODD GROUNDWATER

Figure 4-4
Representative Hydrographs
Corona Well 22



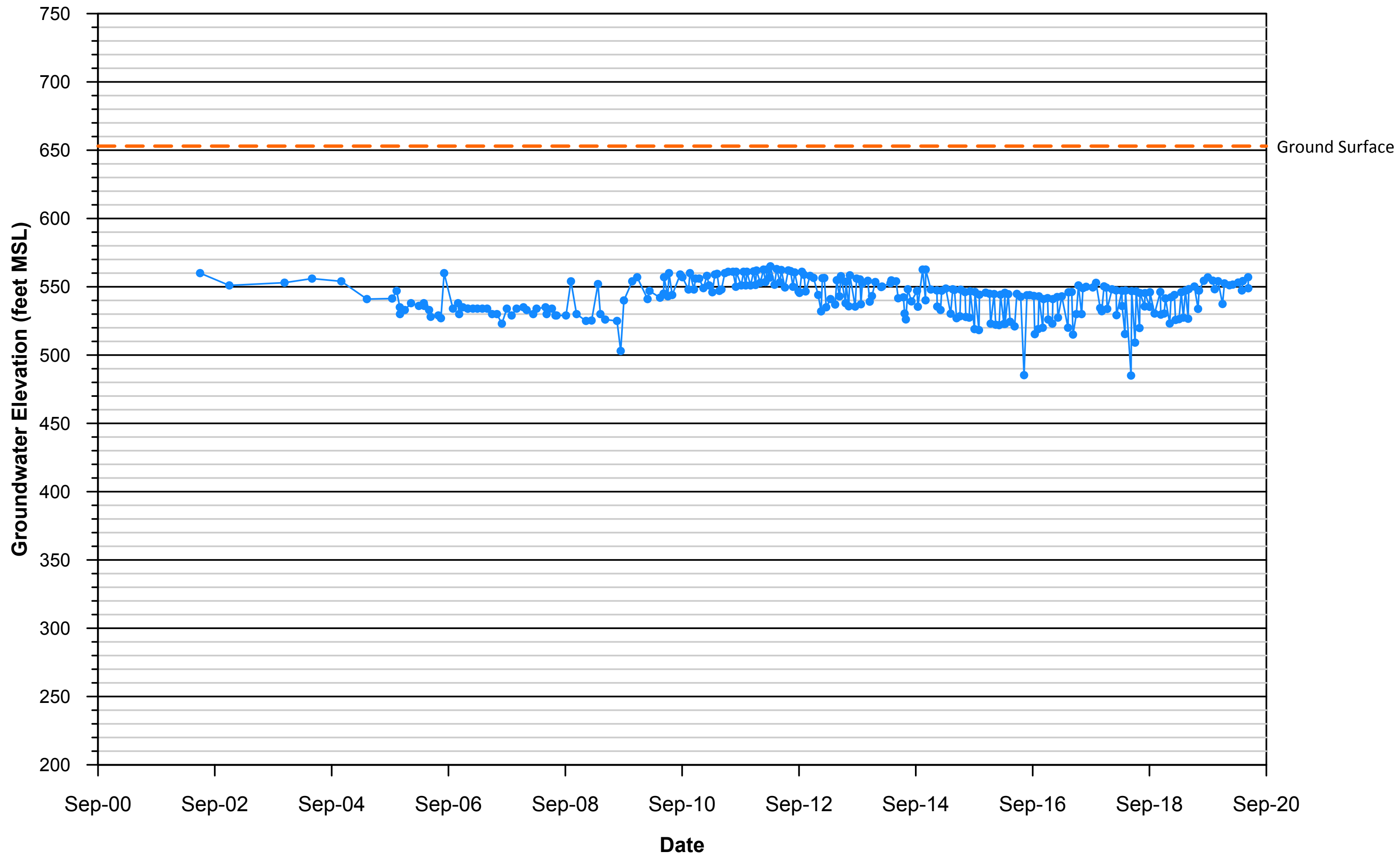
TODD GROUNDWATER

Figure 4-5
Representative Hydrographs
Corona Well 19



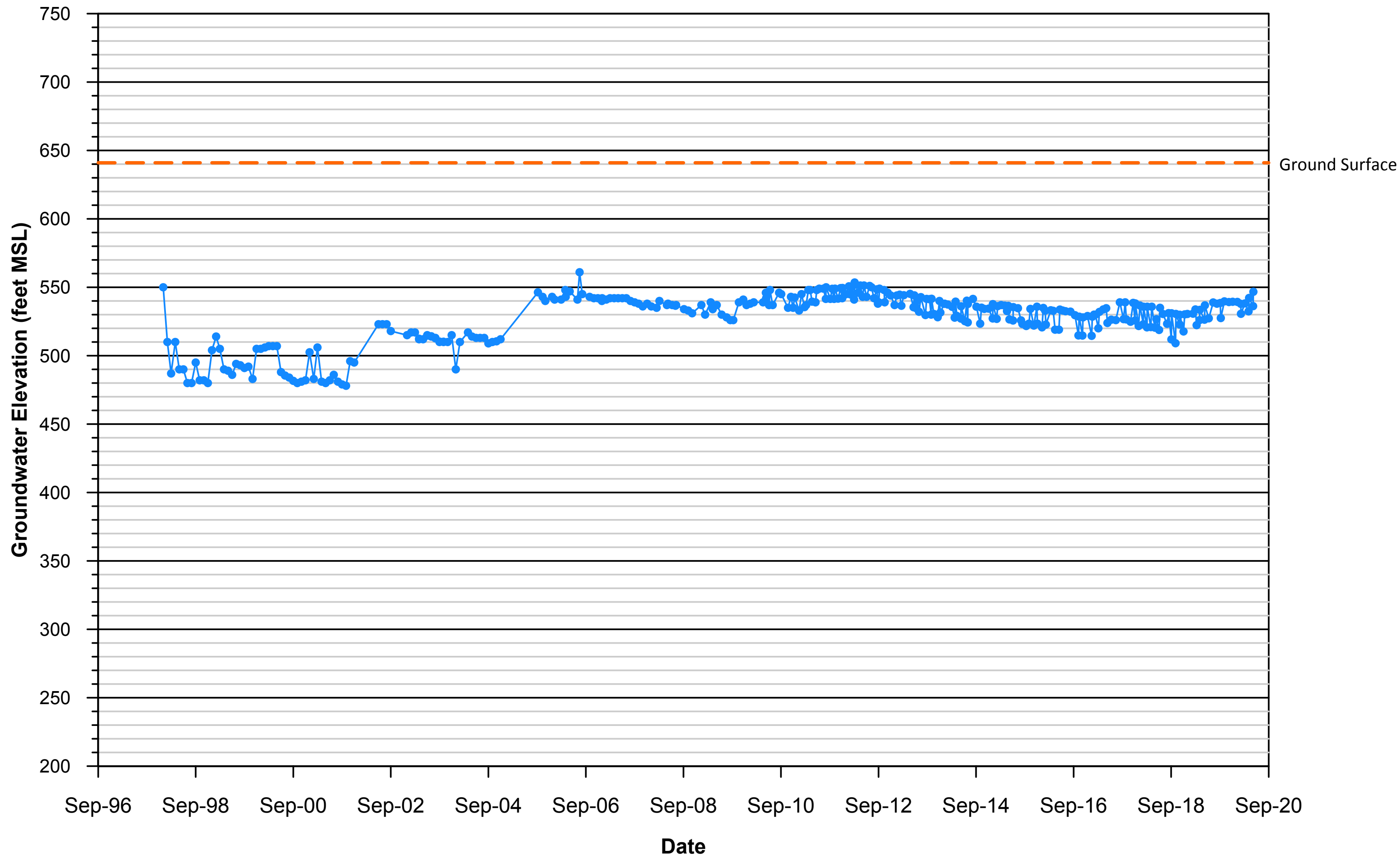
TODD GROUNDWATER

Figure 4-6
Representative Hydrographs
Corona Well 26



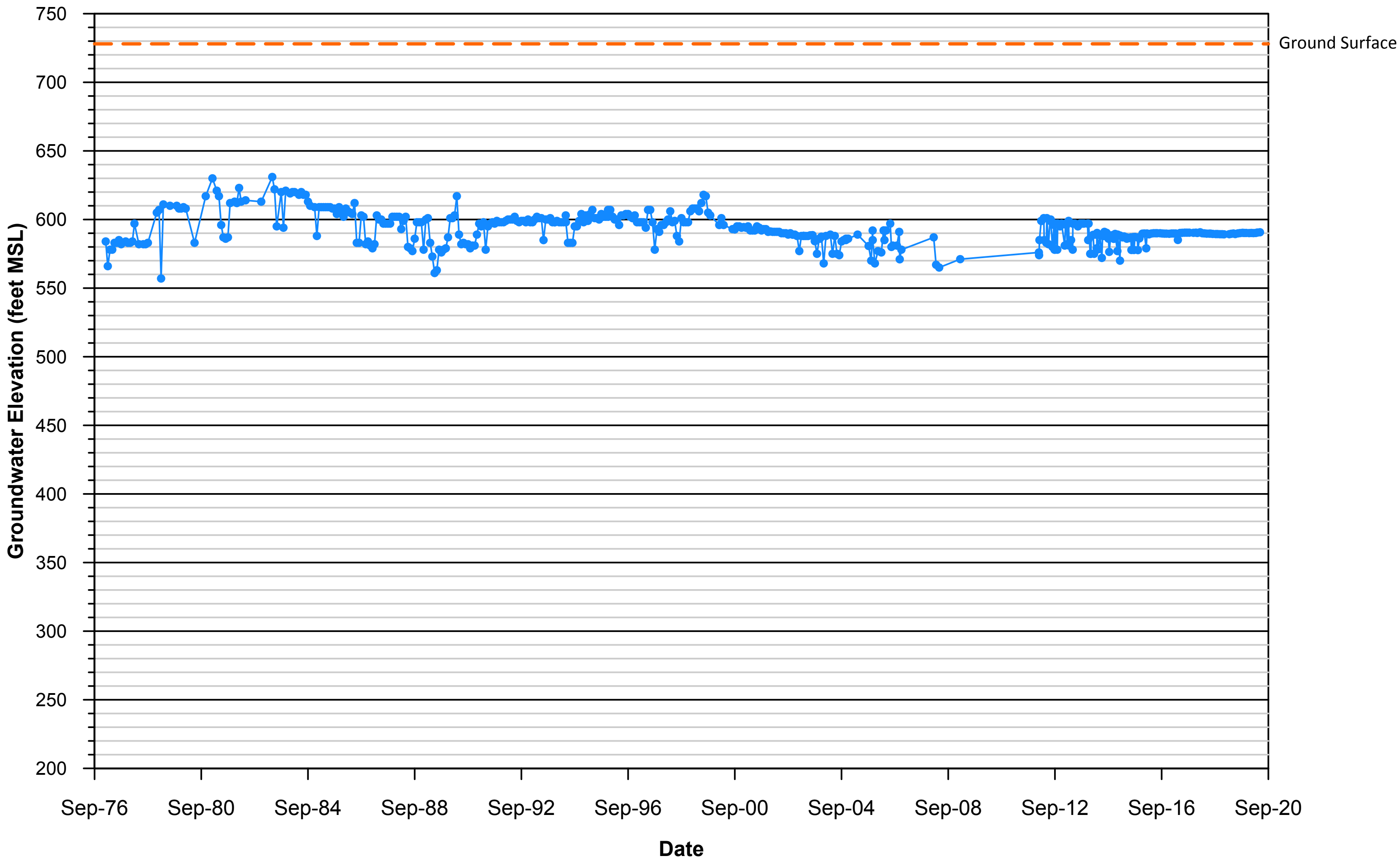
TODD GROUNDWATER

Figure 4-7
Representative Hydrographs
Corona Well 17A



TODD GROUNDWATER

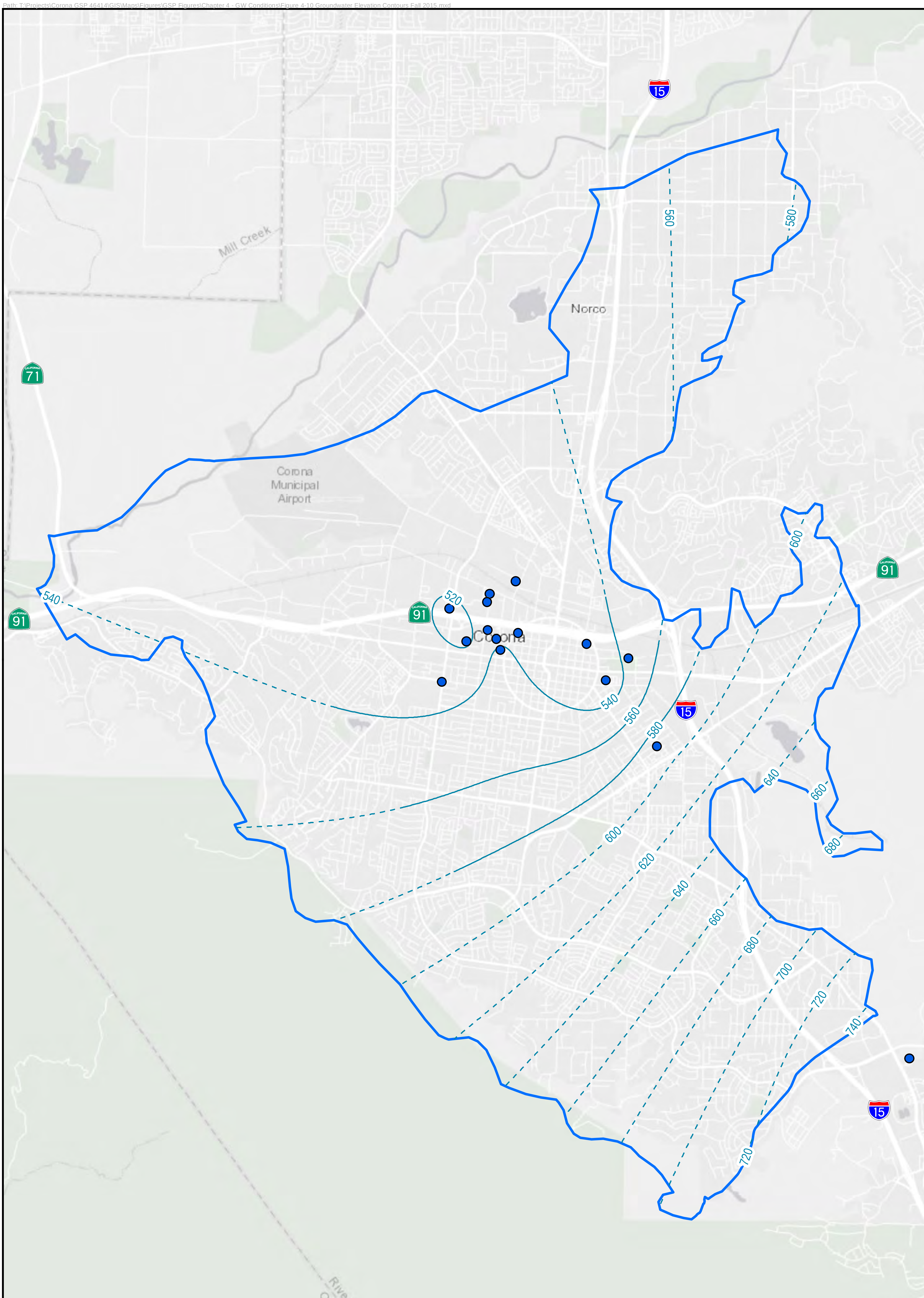
Figure 4-8
Representative Hydrographs
Corona Well 8A



TODD GROUNDWATER

Figure 4-9
Representative Hydrographs
Corona Well 13

Path: T:\Projects\Corona GSP 46414\GIS\Maps\Figures\GSP Figures\Chapter 4 - GW Conditions\Figure 4-10 Groundwater Elevation Contours Fall 2015.mxd



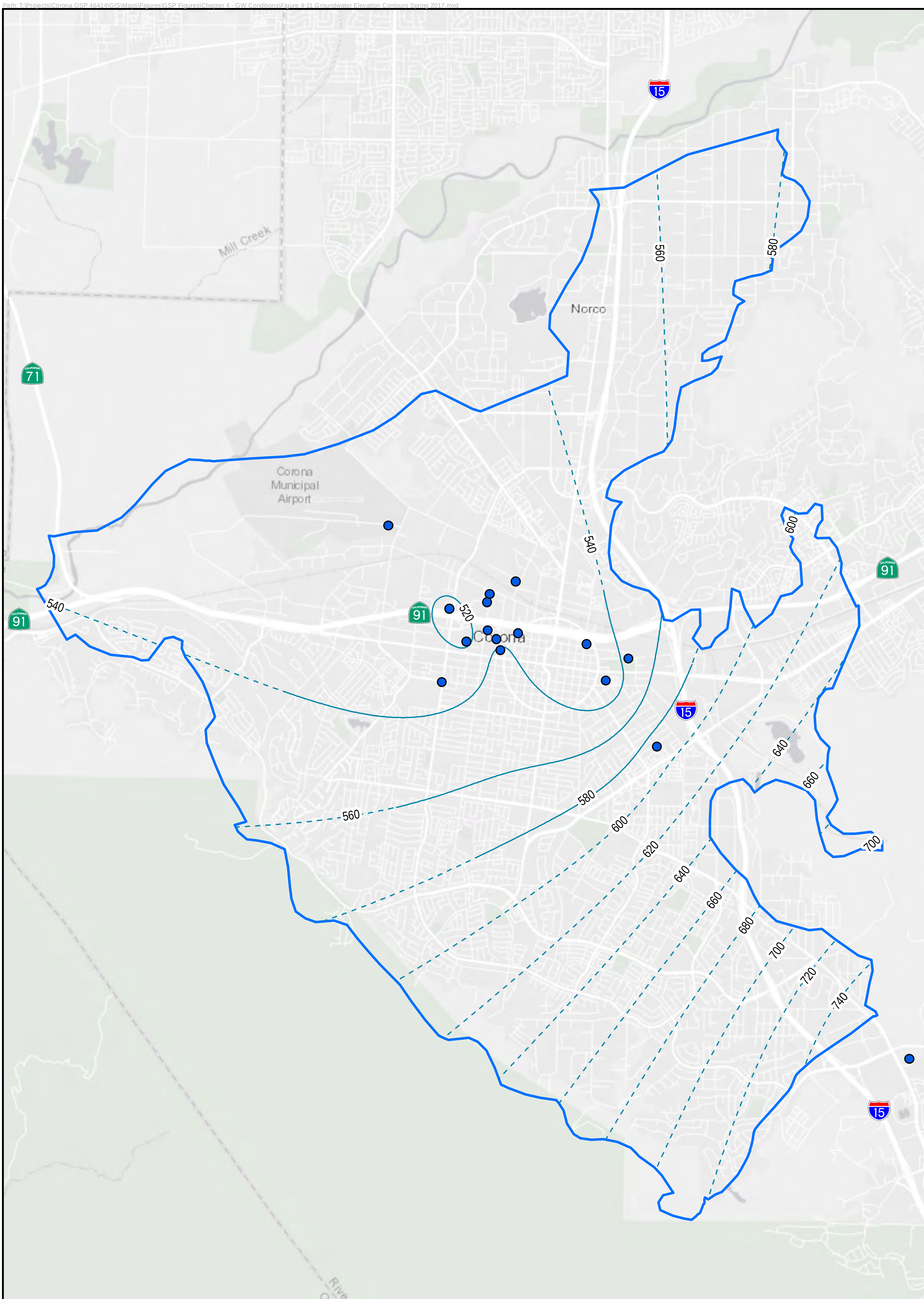
- ● Well Monitored Fall 2015
- — Groundwater Elevation Contour - feet above mean sea level, Fall 2015 (dashed where inferred)
- ▭ Temescal Basin

N

0 0.5 1
Miles

Figure 4-10
Groundwater Elevation Contours Fall 2015

TODD GROUNDWATER



● Well Monitored Spring 2017

— Groundwater Elevation Contour - feet above mean sea level, Spring 2017 (dashed where inferred)

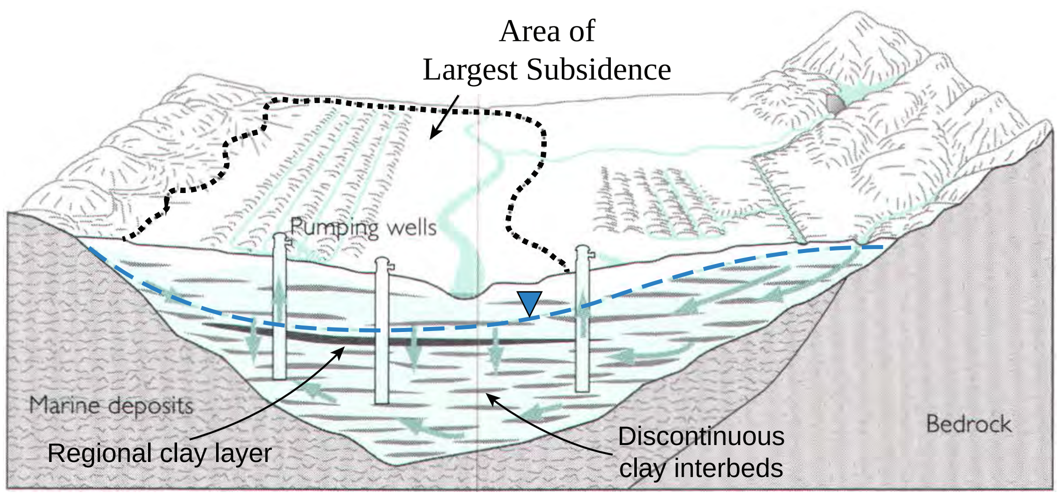
▭ Temescal Basin

N

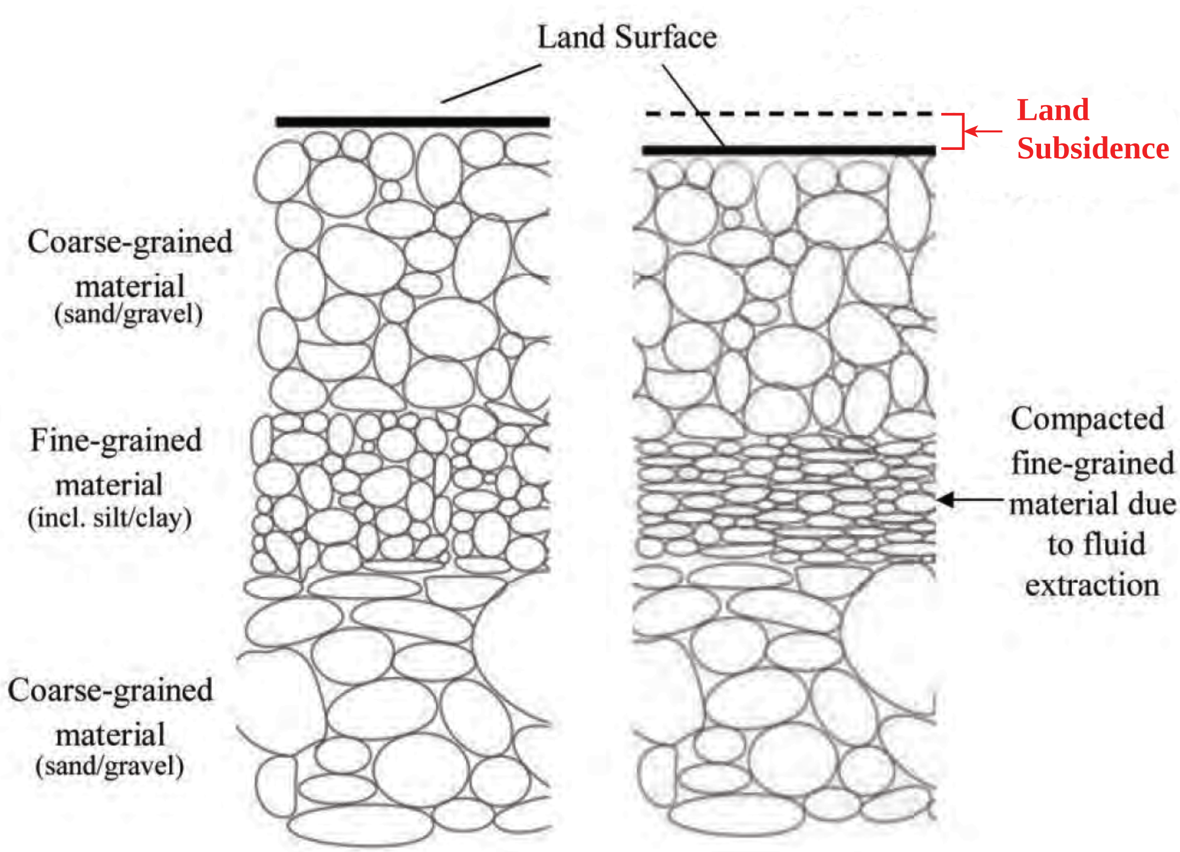
0 0.5 1
Miles

Figure 4-11
Groundwater Elevation Contours
Spring 2017

TODD GROUNDWATER



Source: Galloway et al., 1999.

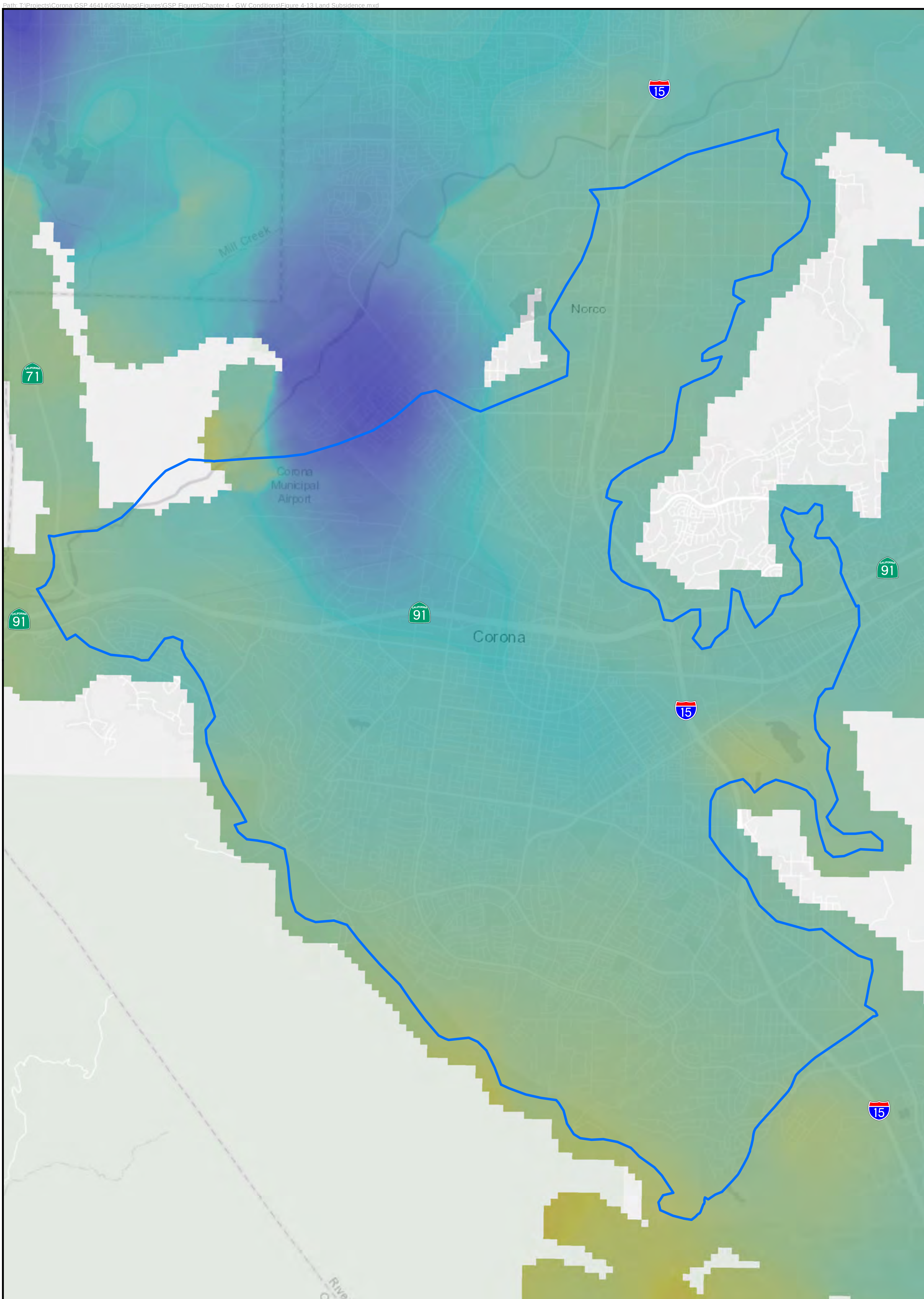


After LSCE et al., 2014.

TODD GROUNDWATER

Figure 4-12
Concepts of
Land Subsidence

Path: T:\Projects\Corona GSP 46414\GIS\Maps\Figures\GSP Figures\Chapter 4 - GW Conditions\Figure 4-13 Land Subsidence.mxd



Ground Surface Vertical Displacement (feet)

High : 0.08

Low : -0.08

Temescal Basin

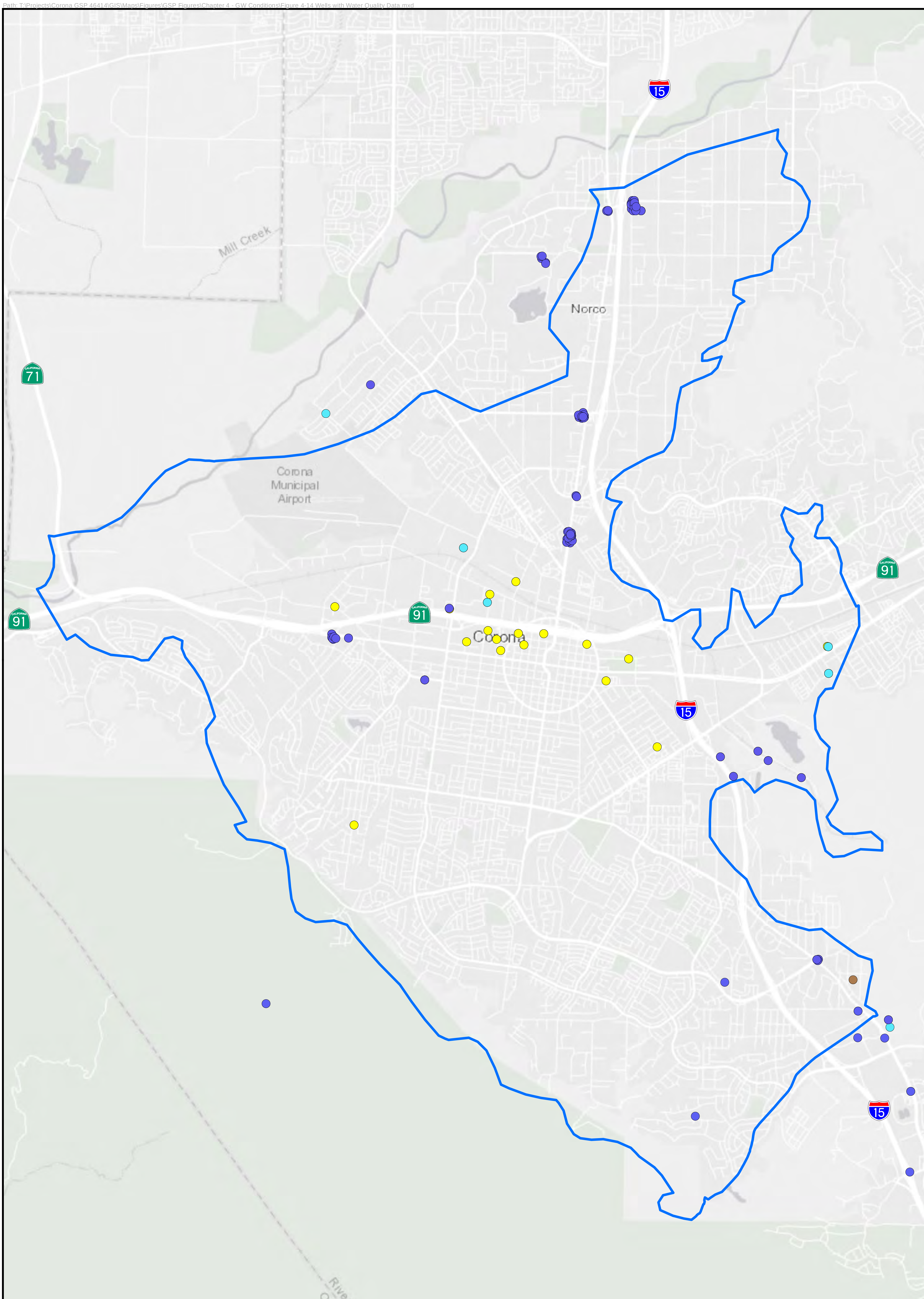
Data Source:
Subsidence estimates from satellite measurements provided by the TRE ALTAMIRA InSAR provided by the California Department of Water Resources, June 13 2015 to September 19 2019 (downloaded July 31 2020).
https://gis.water.ca.gov/arcgisimg/rest/services/SAR/Vertical_Displacement_TRE_ALTAMIRA_v2019_Total_Since_20150613_20190919/ImageServer

N

0 0.5 1
Miles

Figure 4-13
Basin-Wide Subsidence Estimates from Satellite Measurements

TODD GROUNDWATER



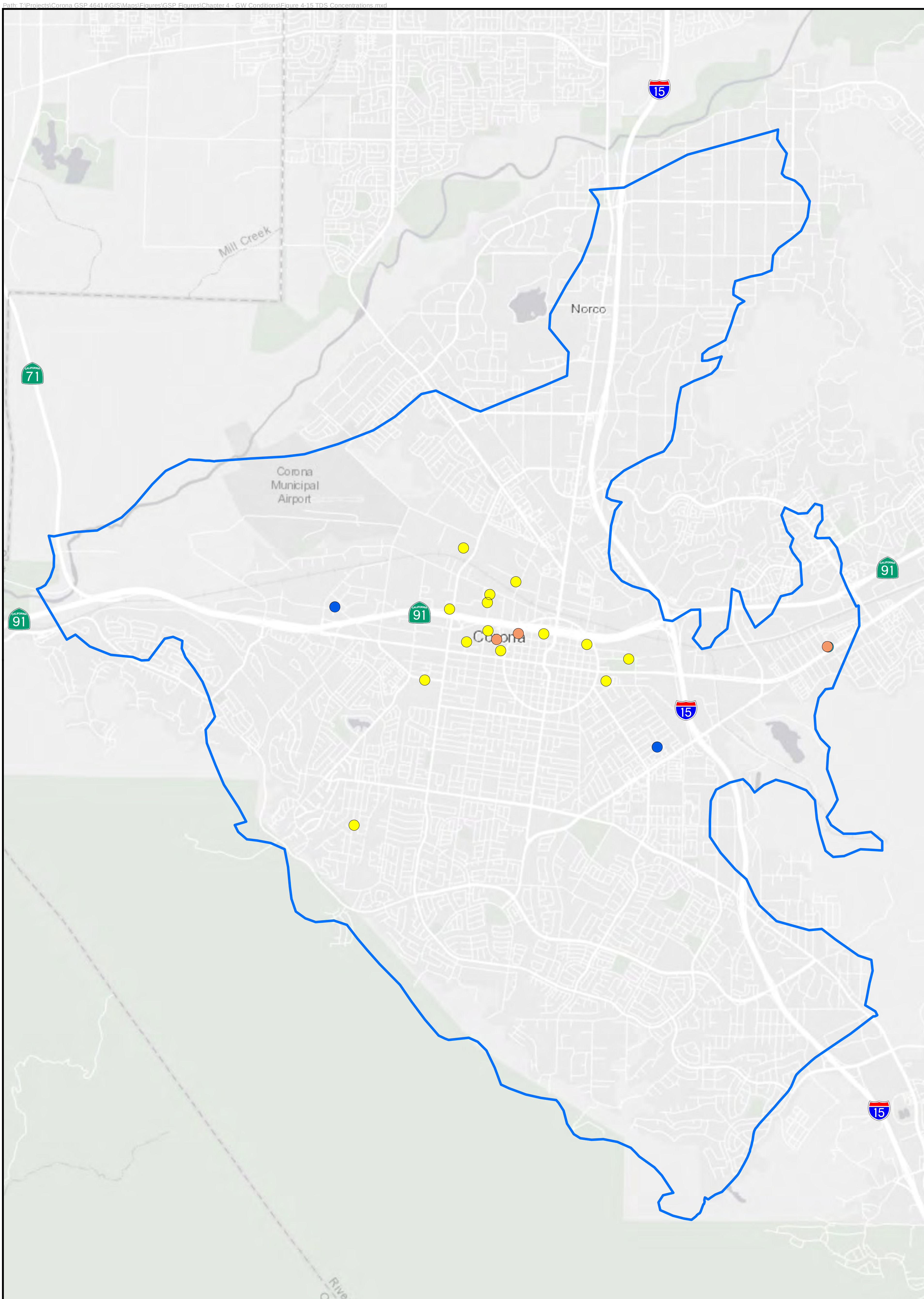
Well with Water Quality Data from the City of Corona
Well with Water Quality Data from State Water Resources Control Board Division of Drinking Water
Well with Water Quality Data from Regional Water Quality Control Board
Well with Water Quality Data from United States Geologic Survey
Temescal Basin

N
0 0.5 1
Miles

Figure 4-14
Wells with
Water Quality Data

TODD GROUNDWATER

Path: T:\Projects\Corona GSP 46414\GIS\Maps\Figures\GSP Figures\Chapter 4 - GW Conditions\Figure 4-15 TDS Concentrations.mxd



Recent Average Total Dissolved Solids Concentration in Wells

- <250 mg/L
- 250 - 500 mg/L
- 500 - 1 000 mg/L
- 1,000 - 1,500 mg/L
- >1,500 mg/L
- Temescal Basin

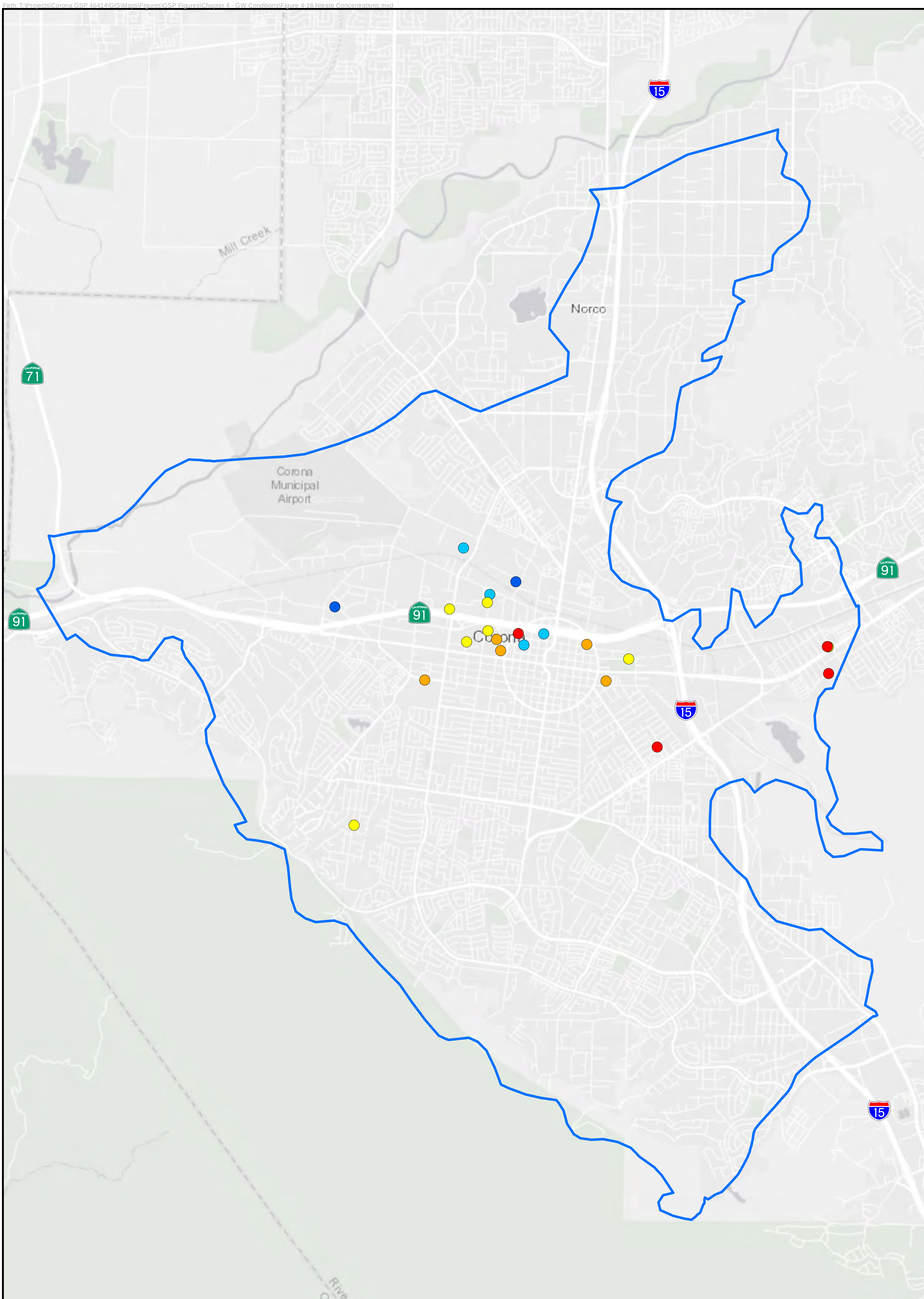
N

0 0.5 1
Miles

Figure 4-15
Total Dissolved Solids Concentrations in Wells
Water Years 2010 through 2019

TODD GROUNDWATER

Path: T:\Projects\Corona GSP 46414\GIS\Maps\Figures\GSP Figures\Chapter 4 - GW Conditions\Figure 4-16 Nitrate Concentrations.mxd



Recent Average Nitrate as Nitrate (NO3) Concentration in Wells

- 0 - 2
- 3 - 10
- 11 - 45
- 46 - 75
- 76 - 150
- Temescal Basin

N

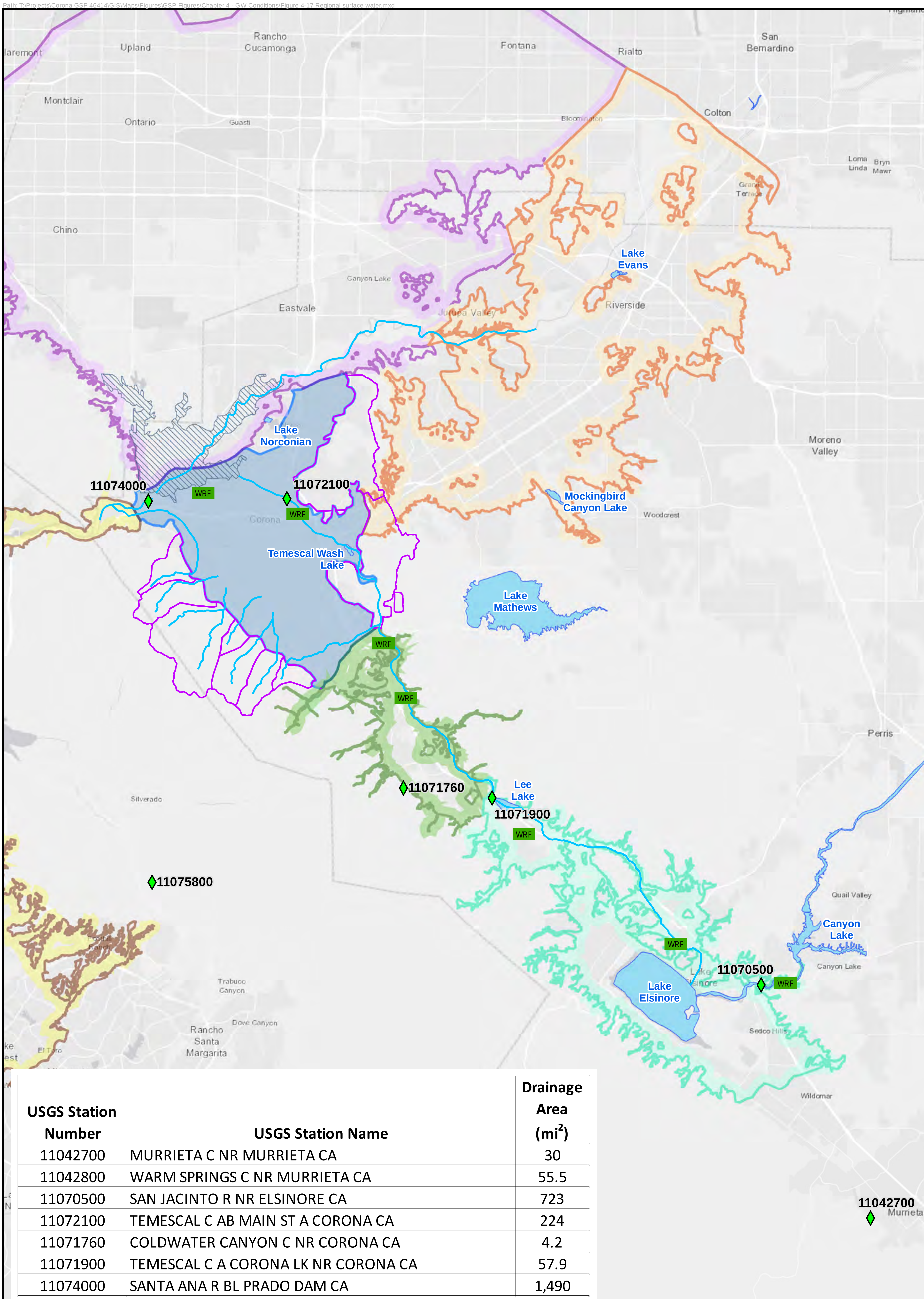
0 0.5 1

Miles

Figure 4-16
Nitrate Concentrations in Wells, Water Years 2010 through 2019

TODD GROUNDWATER

Path: T:\Projects\Corona GSP 46414\GIS\Maps\Figures\GSP Figures\Chapter 4 - GW Conditions\Figure 4-17 Regional surface water.mxd



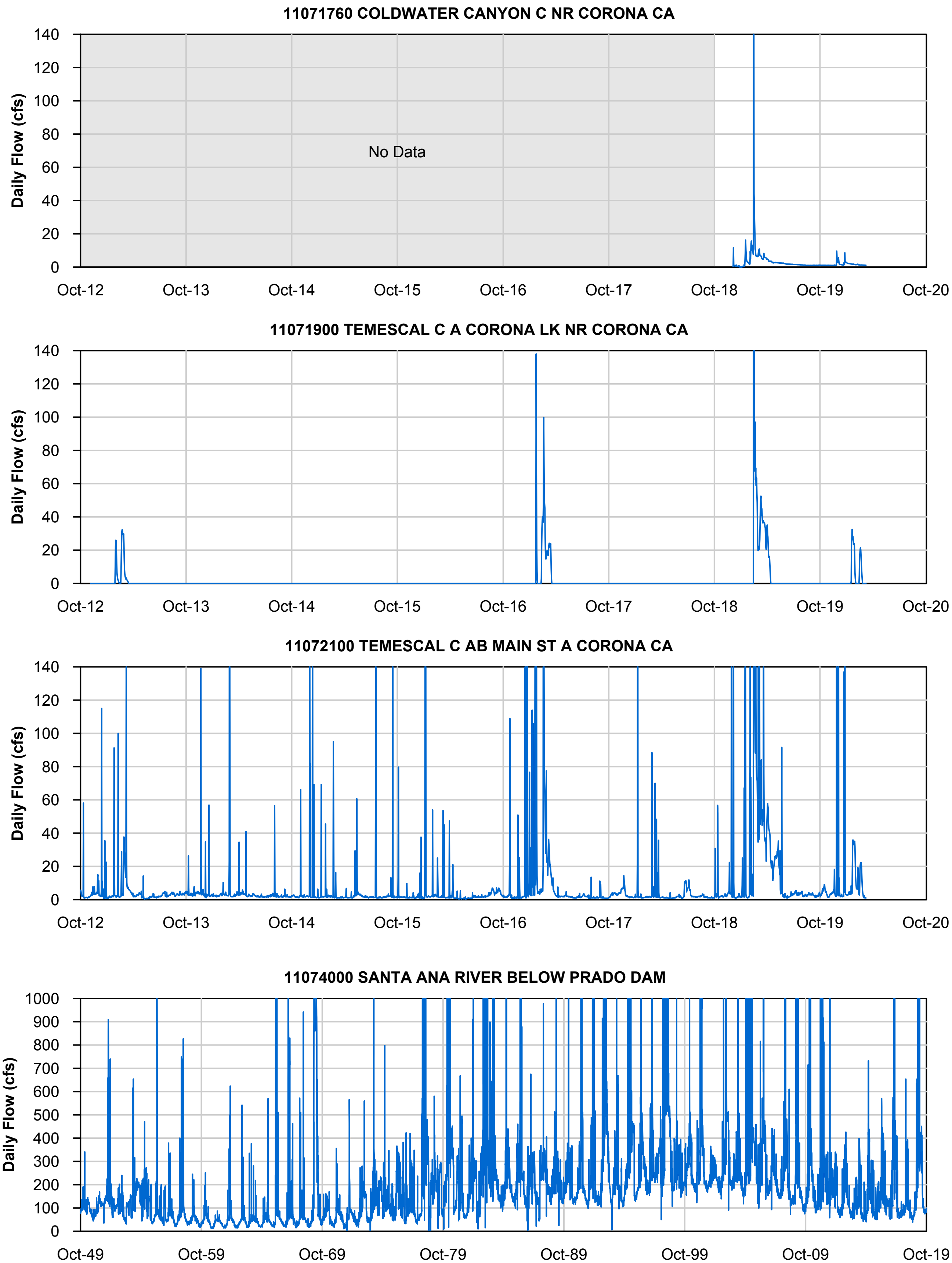
USGS Station Number	USGS Station Name	Drainage Area (mi^2)
11042700	MURRIETA C NR MURRIETA CA	30
11042800	WARM SPRINGS C NR MURRIETA CA	55.5
11070500	SAN JACINTO R NR ELSINORE CA	723
11072100	TEMESCAL C AB MAIN ST A CORONA CA	224
11071760	COLDWATER CANYON C NR CORONA CA	4.2
11071900	TEMESCAL C A CORONA LK NR CORONA CA	57.9
11074000	SANTA ANA R BL PRADO DAM CA	1,490

WRF Water Reclamation Facility
Stream Gauge
Stream
Tributary Watersheds
Prado Wetlands
Coastal Plain of Orange County Basin
Bedford-Coldwater Subbasin
Chino Subbasin
Elsinore Valley Subbasin
Riverside-Arlington Subbasin
Temescal Basin

N
0 1.5 3
Miles

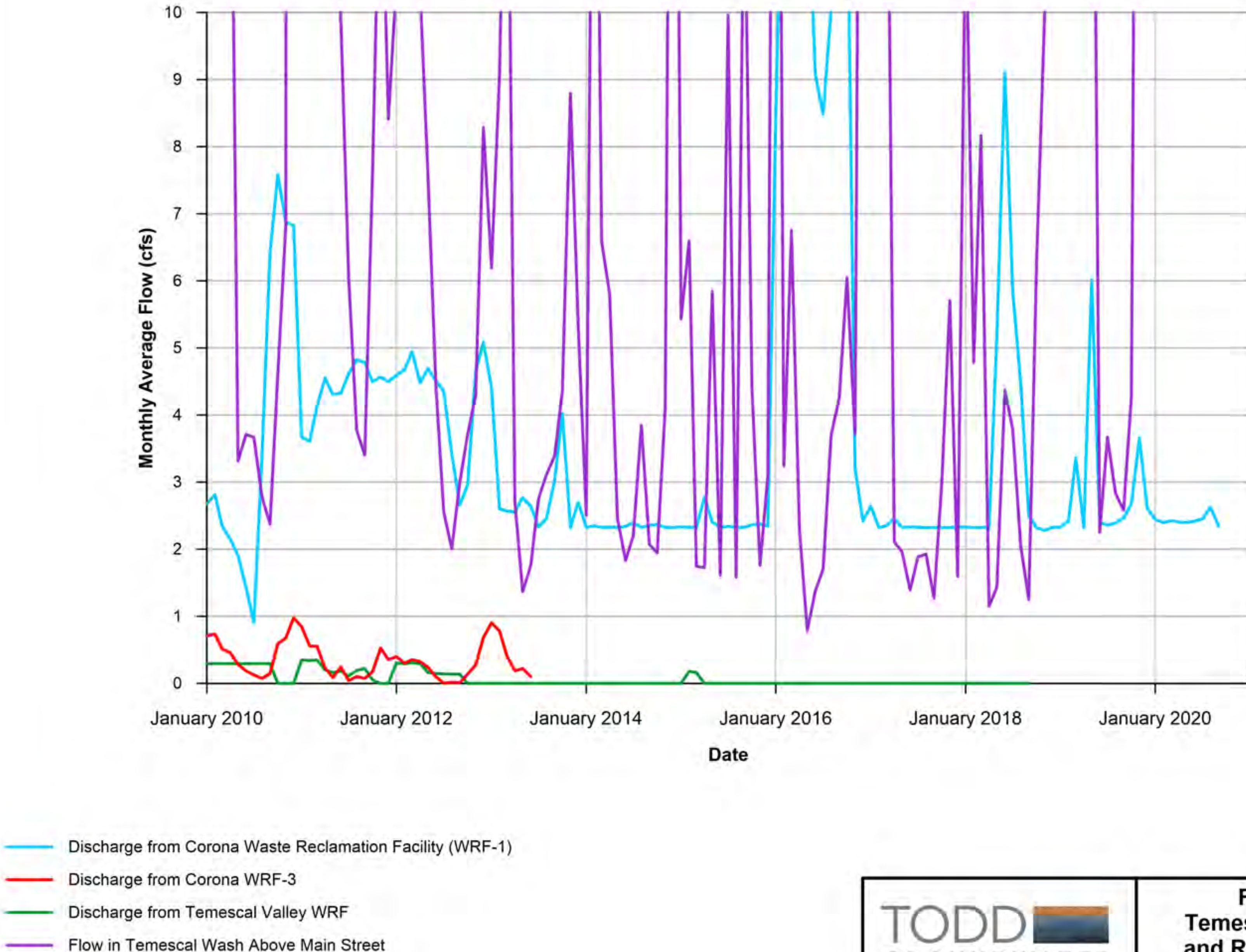
Figure 4-17
Regional Surface Water Features

TODD GROUNDWATER



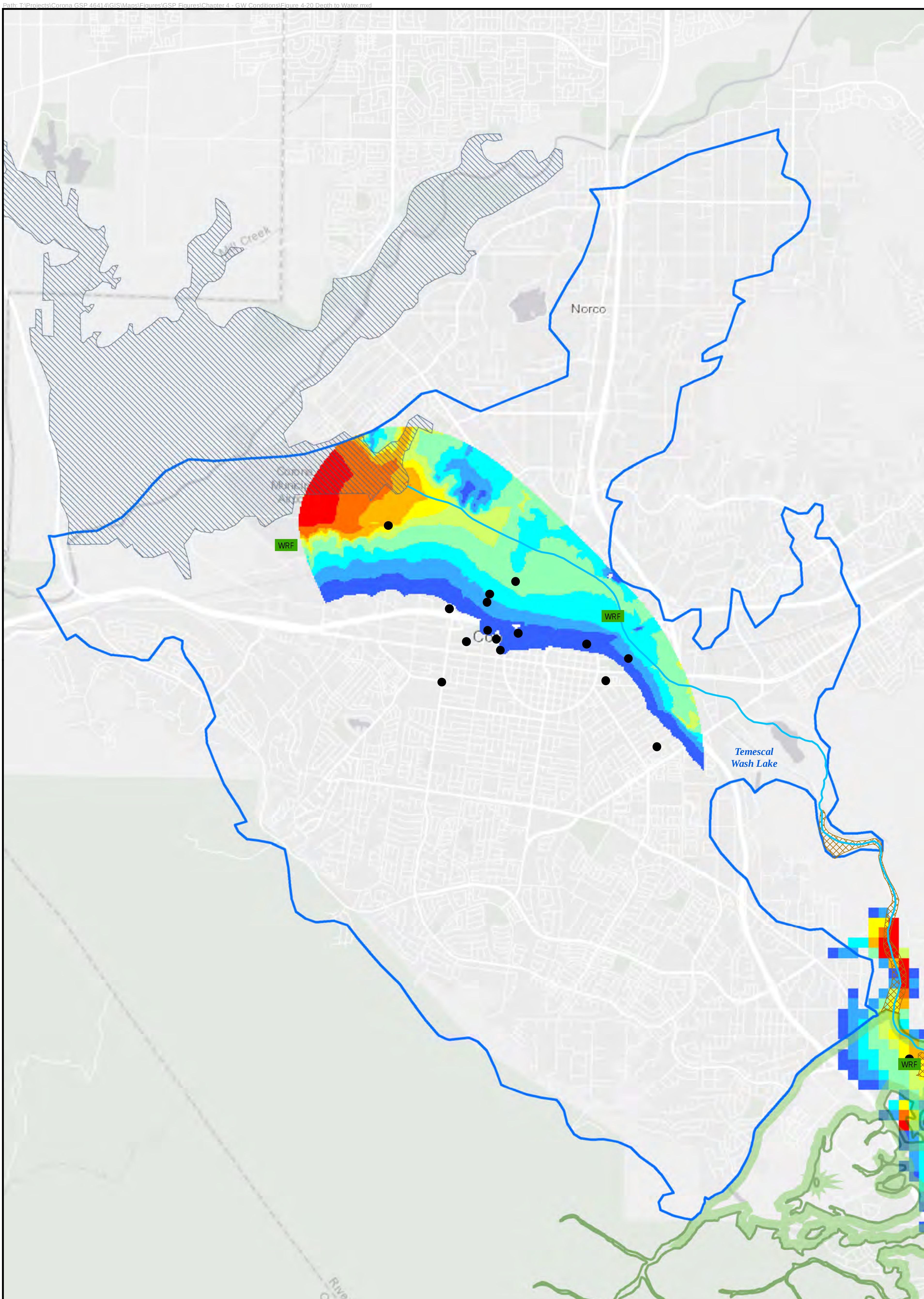
TODD GROUNDWATER

Figure 4-18
Stream Flow
at Four Gages



TODD GROUNDWATER

Figure 4-19
Temescal Wash Flow and Reclaimed Water Discharge



WRF Water Reclamation Facility
● Spring 2017 Water Level Wells

Depth To Water, Spring 2017

- < 0 feet
- 0 to 10 feet
- 10 to 20 feet
- 20 to 30 feet
- 30 to 40 feet
- 40 to 60 feet
- 60 to 80 feet
- 80 to 100 feet
- 100 to 120 feet
- > 120 feet

Dense Riparian Vegetation
Prado Wetlands
Bedford-Coldwater Subbasin
Temescal Basin

N

0 0.5 1
Miles

Figure 4-20
Depth to Water
Spring 2017

TODD GROUNDWATER

Path: \\todd-file\Data\Projects\Corona GSP 46414\GIS\Maps\Figures\GSP Figures\Chapter 4 - GW Conditions\Figure 4-21 Critical Habitat Areas.mxd

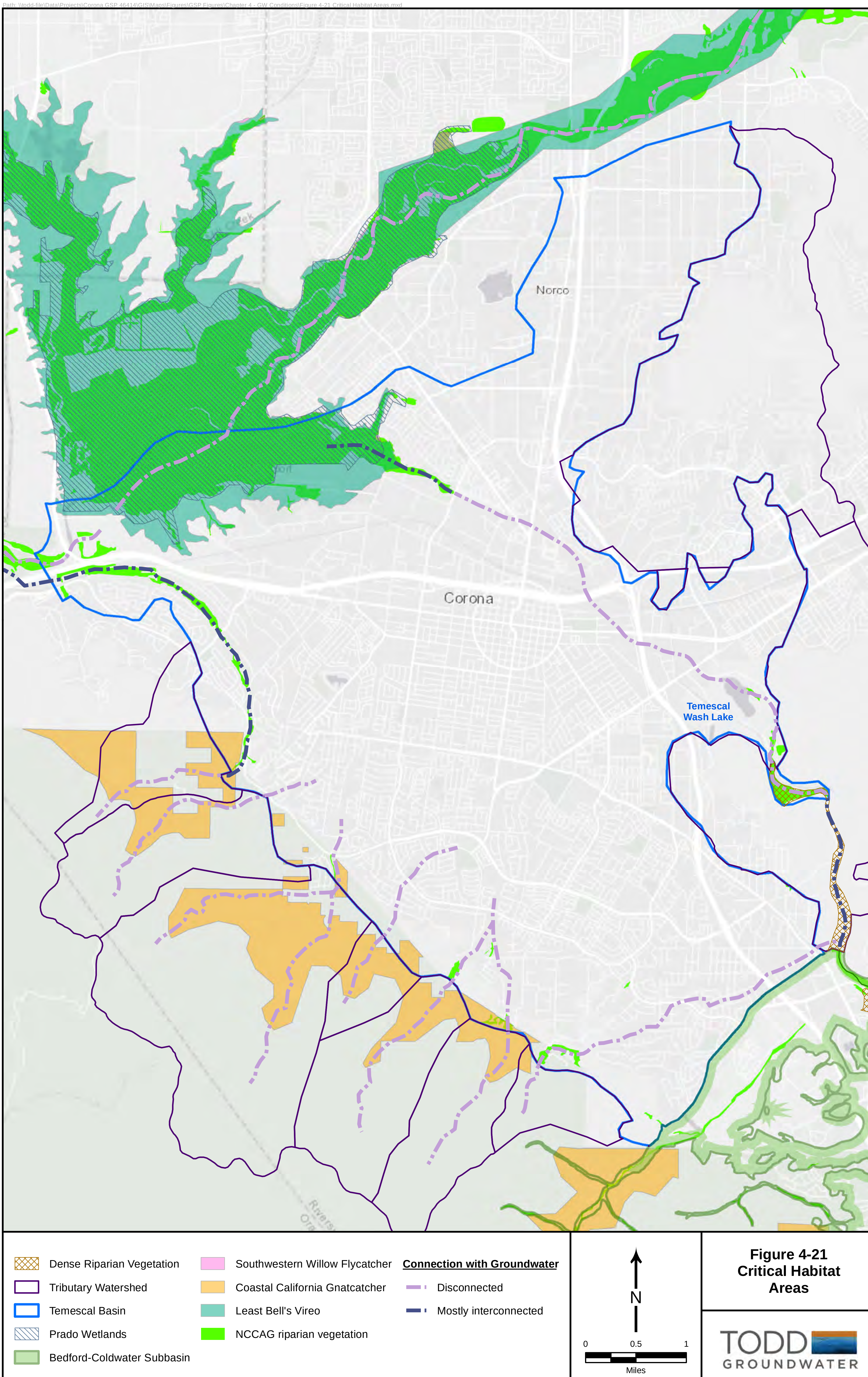


Figure 4-21
Critical Habitat Areas

TODD GROUNDWATER

Path: T:\Projects\Corona GSP 46414\GIS\Maps\Figures\GSP Figures\Chapter 4 - GW Conditions\Figure 4-22 Depth to Water Near Prado.mxd

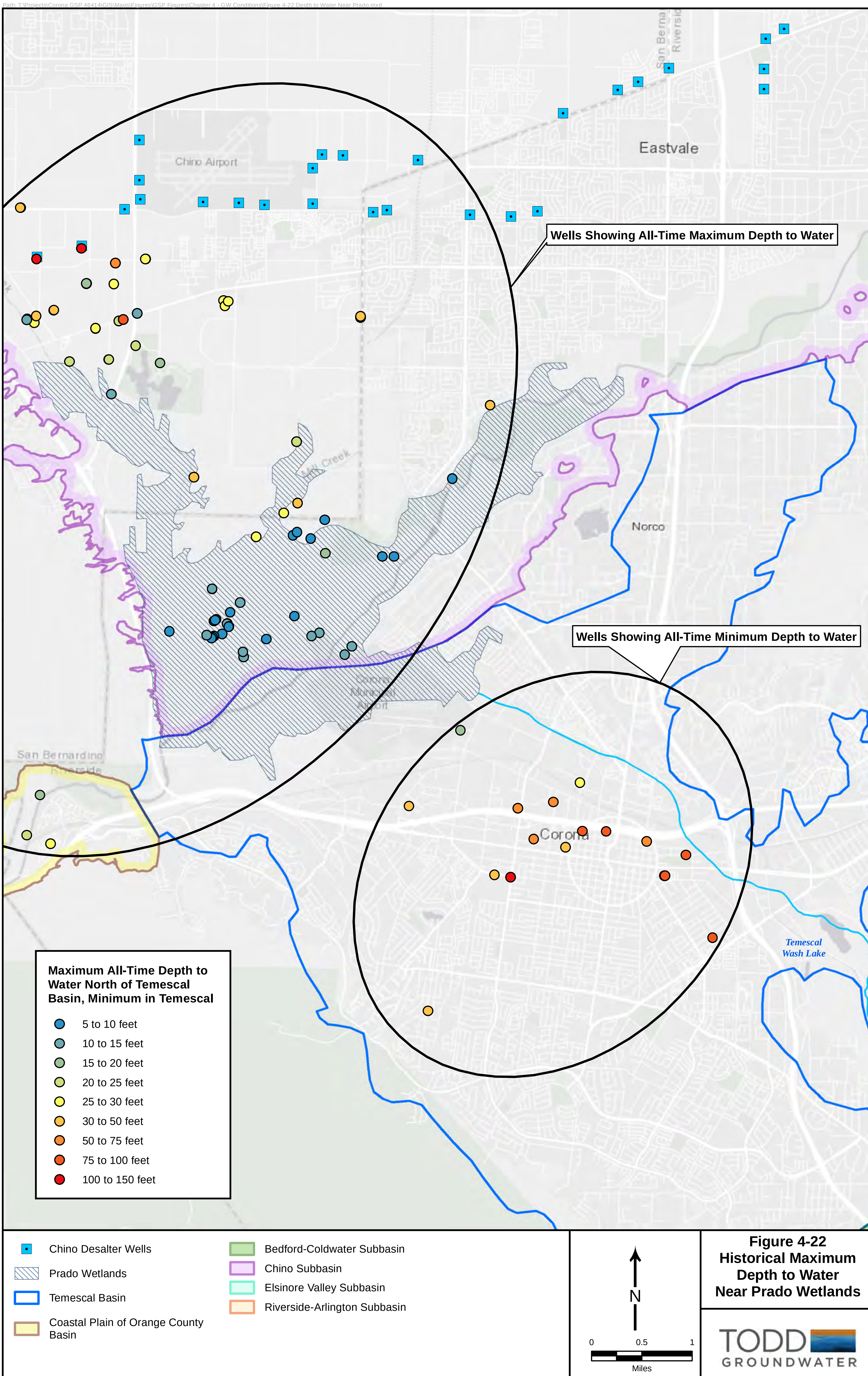
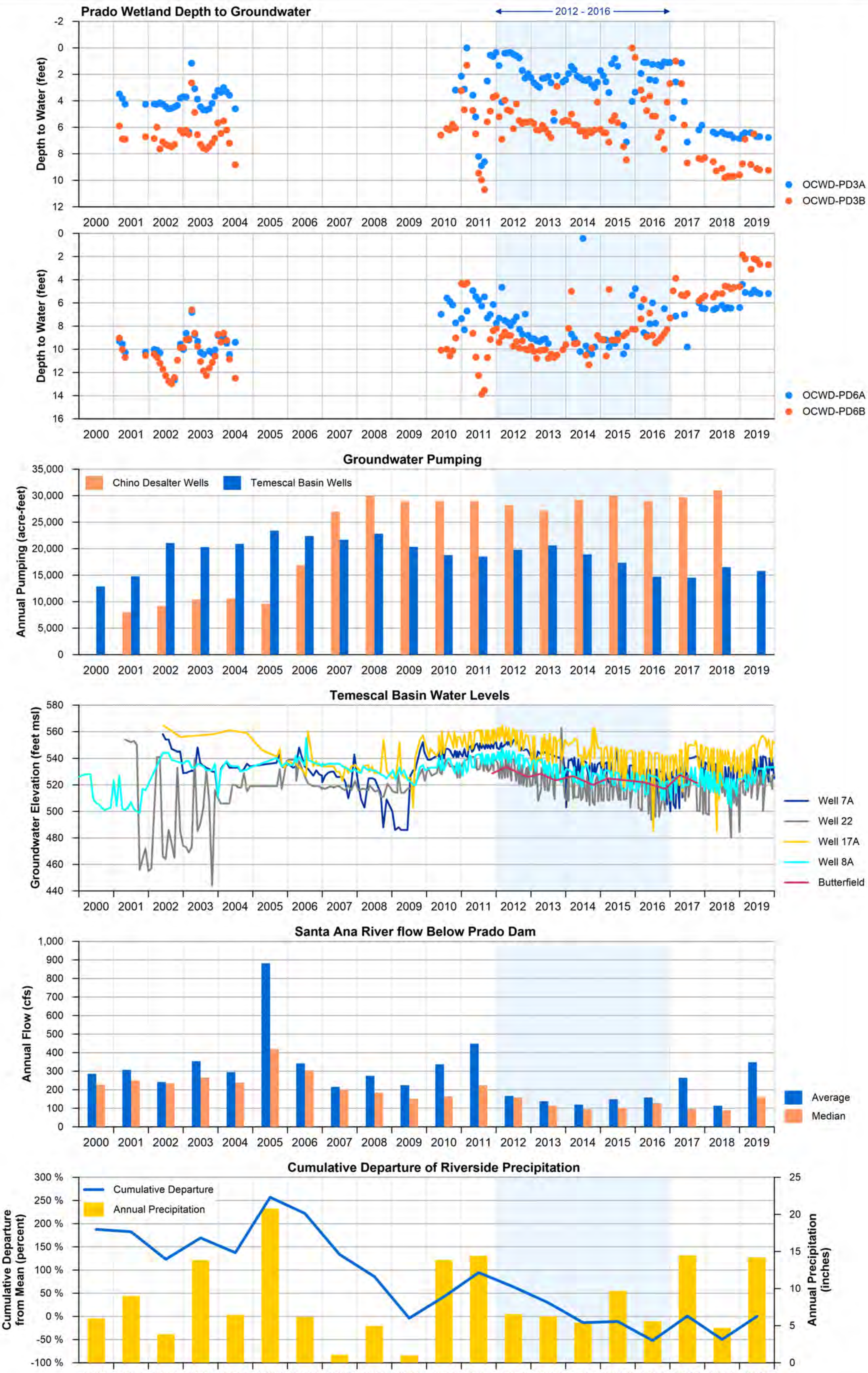


Figure 4-22
Historical Maximum Depth to Water Near Prado Wetlands



TODD GROUNDWATER

Figure 4-23 Factors Related to Prado Wetland Groundwater Levels

5. WATER BUDGET

A water balance (or water budget) is a quantitative tabulation of all inflows, outflows, and storage change of a hydrologic system. The Sustainable Groundwater Management Act (SGMA) requires that water balances be prepared for the groundwater system and surface water system of a basin. If a basin contains multiple management areas, separate balances must be developed for each of them. Management areas have not been defined for the Temescal Subbasin (Basin). Furthermore, water budgets must be developed for time periods representing historical, current, future no project (baseline), and future growth plus climate change (growth plus climate change) conditions.

This chapter presents the basis for selecting the water budget analysis periods for the Basin, describes modeling tools used to estimate some water budget items, and presents the surface water and groundwater budgets.

5.1. WATER BUDGET METHODOLOGY

Annual balances were developed for water years 1990 through 2018, the period simulated by the numerical groundwater model. The model is described in **Appendix J** and provides estimates for several items in the water balance for which direct measurements are not available: flows between groundwater and surface water bodies, flows to and from adjacent basins, evapotranspiration of riparian vegetation, and storage change. The numerical model allows a dynamic and comprehensive quantification of the water balance wherein all estimated water balance elements fit together and are calibrated to groundwater level changes over time. Accordingly, the numerical model is the best tool to quantify those water balance items. It will be updated regularly through the Groundwater Sustainability Plan (GSP) process, providing a better understanding of the surface water-groundwater system and a tool to evaluate future conditions and management actions.

5.2. DRY AND WET PERIODS

Dry and wet periods in historical hydrology can be identified on the basis of individual years or sequences of dry and wet years. GSP Regulations require that each year during the water budget analysis period be assigned a water year type*,* which is a classification based on the amount of annual precipitation. **Figure 5-1** shows annual precipitation at Elsinore (National Oceanic and Atmospheric Administration (NOAA) Station GHCND:USC00042805) for water years 1899 through 2020. Water year types are also indicated and are assigned to five categories corresponding to quintiles of annual precipitation. The categories used here (dry, below normal, normal, above normal, and wet) accurately describe the quintiles but differ from the categories commonly used in the Central Valley (critical, dry, below normal, above normal, and wet). Those categories do not accurately describe quintiles and are based on the Sacramento River Index, which has little relevance to conditions in the Basin. The quintile divisions for precipitation during 1899 to 2020 at the Lake Elsinore station are shown in **Table 5-1**.

Table 5-1. Water Year Type Classification

Water Year Type		Range as Percent of Mean	Precipitation Range (inches)
Wet	W	>139	> 16.5
Above Normal	AN	101 to 139	12.0 to 16.5
Normal	N	75 to 101	8.9 to 12.0
Below Normal	BN	56 to 75	6.6 to 8.9
Dry	D	<56	< 6.6

Average precipitation for 1899 to 2020 was 11.89inches per year

Individual wet and dry years are not particularly useful for groundwater management in basins where groundwater storage greatly exceeds annual pumping and recharge, which is the case in the Basin. In those basins, multi-year droughts and sequences of wet years are more relevant, because they relate to the amount of operable groundwater storage needed to support sustainable groundwater management. Multi-year wet and dry periods can be identified from a plot of cumulative departure of annual precipitation, which is also shown on **Figure 5-1**. Wet periods appear as upward-trending segments of the cumulative departure curve, and droughts appear as declining segments. By far the largest climatic deviations in this record were the sustained wet conditions from 1937 to 1944 and dry conditions from 1946 to 1965. These events pre-dated the most recent 30 years, which is the period the California Department of Water Resources (DWR) states should be used for determining year types (DWR 2016c). They also pre-date the period simulated by the groundwater model. However, large wet and dry events like those could recur in the future, and it is prudent to consider climate uncertainty in planning for groundwater sustainability.

5.3. WATER BALANCE ANALYSIS PERIODS

GSP regulations require evaluation of the water balances over historical, current, and future periods. The historical period must include at least 10 years, and the future period must include exactly 50 years. The duration of the current period is not specified, but to be consistent with SGMA concepts it needs to include several years around 2015, which was the implementation date of SGMA. Historical and current analysis periods for the Basin were selected from within the 1990 through 2018 modeling period. Ideally, each period is characterized by average precipitation and relatively constant land and water use. In the Basin, urbanization increase has been gradual throughout the 1990 to 2018 period. The historical period is represented by water years 1993 through 2007, and the current period by water years 2010 to 2013. Those periods had 101 percent and 102 percent of the 1899 to 2020 average annual rainfall, respectively.

The future period is intended to represent conditions expected to occur over the next 50 years. The model simulation period is only 29 years (1990 to 2018). To obtain a 50-year period, simulations of future conditions used the 1993 through 2017 sequence of rainfall and natural stream flow repeated twice. Average annual precipitation during 1993 to 2017 was 94 percent of the long-term average. For the baseline scenario, no adjustments were made to the hydrologic sequence. Adjustments made to simulate future climate change are described in Section 5.5.3.

5.4. MANAGEMENT AREAS

As defined in the GSP regulations, a Management Area (MA) is an area within a basin for which the GSP may identify different minimum thresholds, measurable objectives, monitoring, or projects and management actions based on differences in water use sector, water source type, geology, aquifer characteristics, or other factors. The Channel Aquifer area is more permeable than the alluvial fan aquifer areas, and it is where almost all groundwater pumping now occurs. However, there is no reason that monitoring, sustainability criteria, and management actions need to be different for the Channel Aquifer and alluvial fan aquifer areas. Accordingly, the Channel Aquifer area is not designated as a management area, and the Temescal Basin is managed as a whole.

5.5. METHODS OF ANALYSIS

Complete, itemized surface water, and groundwater balances were estimated by combining raw data (rainfall, stream flow, municipal pumping, and wastewater percolation from septic tanks and wastewater treatment plant discharge) with values simulated using models[2]. Collectively, the models simulate the entire hydrologic system, but each model or model module focuses on part of the system, as described below. In general, the models were used to estimate flows in the surface water and groundwater balances that are difficult to measure directly or that relate to time-dependent groundwater levels. These include surface and subsurface inflows from tributary areas, percolation from stream reaches within the Basin, groundwater discharge to streams, potential subsurface flow to and from neighboring basins, the locations and discharges of pumping wells, consumptive use of groundwater by riparian vegetation, and changes in groundwater storage. Descriptions of the inflows and outflows to the surface water and groundwater models are included below in Sections 5.6 and 5.7.

5.5.1. Rainfall-Runoff-Recharge Model

This Fortran-based model developed over a number of years by Todd Groundwater staff simulates hydrologic processes that occur over the entire land surface, including

[2] Water balance values are shown to nearest acre-foot to retain small items, but entries are probably accurate to only two significant digits.

precipitation, interception[3], infiltration, runoff, evapotranspiration, irrigation, effects of impervious surfaces, pipe leaks in urban areas, deep percolation below the root zone, and shallow groundwater flow to streams and deep recharge. The model simulates these processes on a daily time step for 286 recharge zones delineated to reflect differences in physical characteristics as well as basin and jurisdictional boundaries. Simulation of watershed areas outside the Basin are included to provide estimates of stream flow and subsurface flow entering the Basin. Daily simulation results were subtotaled to monthly values for input to the groundwater model. Additional details regarding the rainfall-runoff-recharge model can be found in **Appendix J** and the model code is available on request.

5.5.2. Groundwater Model

A numerical groundwater flow model of the Basin was completed in 2008 for the Groundwater Management Plan (Todd and AKM 2008). For this GSP, the model was revised, expanded to include the entire Basin, updated with new geological information, and updated through water year 2018.

The revised and updated model uses the MODFLOW 2005 code developed by the U.S. Geological Survey that is a public domain open-source software as required by GSP regulation §352.4(f)(3). The model produces linked simulation of surface water and groundwater, as described below. Additional documentation of the model update and calibration is provided in **Appendix J**.

5.5.2.1. Surface Water Module

Stream flow in MODFLOW is simulated using the Streamflow Routing Package (SFR) where a network of stream segments represents the small streams entering the Basin from Temescal Wash and tributary watersheds.

Surface water inflows to Temescal Wash were obtained from a similar groundwater flow model of the Bedford-Coldwater Subbasin. Small stream inflows were estimated using the rainfall-runoff-recharge model. Each stream segment is divided into reaches, one per model grid cell traversed by the segment. Flow is routed down each segment from reach to reach. Along each reach mass balance is conserved in the stream, including inflow from the upstream reach and tributaries, inflow from local runoff, head-dependent flow across the stream bed to or from groundwater, evapotranspiration losses, and outflow to the next downstream reach. Flow across the stream bed is a function of the wetted channel length and width, the bed permeability and the difference in elevation between the stream surface and groundwater at the reach cell. Wetted width and depth of the stream are functions of stream flow.

5.5.2.2. Groundwater Module

The MODFLOW groundwater model is constructed to cover the entire Basin. The model grid size is oriented north-south and has a uniform 100 feet (ft) horizontal grid spacing to

[3] Interception refers to precipitation that does not reach the soil, but instead falls on (and is intercepted by) plant leaves, branches, and plant litter, and is subject to evaporation loss.

provide sufficient resolution to resolve hydraulic gradients, well drawdown cones, and groundwater-surface water interactions in the Basin.

The model covers the entire Basin as delineated by DWR and also the southern part of the Chino Basin. Including part of the Chino Basin improves the ability of the model to simulate groundwater conditions beneath Prado Basin.

The numerical model has been constructed to reflect the hydrogeological conceptual model developed for the GSP, Chapter 3. The vertical extent of the Basin is based on the mapped depth to consolidated rock. The elevation of surface features and streambed elevations have been derived from geographic information system (GIS) files developed from the local topography and stream information.

Citrus orchards irrigated with groundwater were common in the Basin in the early 1990s, but except for one small grove those have all been replaced by urban development. Agricultural irrigation pumping of the orchards was estimated by the rainfall-runoff-recharge model, with pumping assigned to a hypothetical irrigation well at the center of each irrigated recharge zone. This pumping was phased out over time as urban development occurred. Urban irrigation is supplied by the municipal water system, which uses imported water and local wells. Municipal well extractions are known and are entered directly into the model. All major pumpers in the Basin report their annual production to Western Municipal Water District (WMWD), which was the source of data for several non-municipal pumping wells. Pumping at private domestic wells is not reported and there is currently no private domestic groundwater use in the Basin so none is included in the model.

5.5.3. Simulation of Future Conditions

GSP regulations §354.18(c)(3) require simulation of three future scenarios to determine their effects on water balances, yield and sustainability indicators. The growth and climate change scenarios were combined, resulting in the following two scenarios:

> **Baseline.** This represents a continuation of existing land and water use patterns, imported water availability, and climate.
>
> **Growth Plus Climate Change.** This scenario implements anticipated changes in land use and associated water use, such as urban expansion, and anticipated effects of future climate change on local hydrology (rainfall recharge and stream percolation) and on the availability of imported water supplies.

Both of the future simulations assume that the level of development and related water demand are constant throughout the simulation. That is, development in the growth plus climate change simulation is not phased in over time but rather corresponds to 2068 development throughout the simulation. This is the best way to demonstrate whether 2068 land use is sustainable because it allows for assessment of the effects of variations in climatic conditions (wet and dry cycles) on groundwater conditions, avoids subjective decisions about the concurrent timing of droughts and development, and provides time for the full effect of future conditions on groundwater to become apparent.

5.5.3.1. Baseline Scenario

The baseline simulation is a 50-year period, as required by SGMA regulations, with water budget components developed using the criteria and assumptions described below. Initial water levels are simulated water levels for September 2018 from the historical calibration simulation. That year represents relatively recent, non-drought conditions. These simulated water levels are internally consistent throughout the model flow domain and reasonably matched measured water levels at wells with available data (see **Appendix J** for discussion of model calibration).

Surface water and other inflows came from multiple sources. Monthly inflows in Temescal Wash were obtained from the baseline and growth plus climate change simulations produced by the Bedford-Coldwater Subbasin groundwater model (Todd, H&H, and Stantec 2021), which was used to develop the GSP for that subbasin. Small stream and bedrock inflows simulated for 1993 to 2017 of the calibration model period were repeated twice to obtain 50 years of data.

In the baseline scenario, land use remains the same as the current conditions. In the model, land use is represented by 2014 land use mapped by remote sensing methods and obtained from DWR (2017), adjusted for subsequent urbanization identified in Google Earth imagery (Google Earth 2021).

Municipal, commercial, and industrial (M&I) pumping was set equal to the estimated sustainable yield. M&I pumping was relatively high during 2002 to 2014 and exceeded the sustainable yield, as evidenced by the steady declines in groundwater storage during that period. Using the groundwater model, City of Corona (Corona) pumping (which represents 97 percent of the M&I total) was decreased until the future baseline scenario no longer produced long-term storage declines. The adjusted M&I pumping equaled 98 percent of the 2010 to 2018 average, or 15,615 acre-feet per year (AFY). Total municipal use was assumed to equal the 2010 to 2018 average. This reflects an assumption that the amounts of imported water are adjusted to make up the difference between total water demand and sustainable groundwater yield. In the groundwater model, total municipal water use was used only to estimate pipe leaks.

The Baseline scenario also assumes that wastewater percolation and recycling continue as they have in recent years. Discharges from Water Reclamation Facility 1 (WRF-1) and WRF-2 to percolation ponds, streams and recycled uses were estimated as the average amounts during 2010 to 2018.

5.5.3.2. Growth Plus Climate Change Scenario

The growth plus climate change scenario incorporated anticipated effects of climate change, urban development, and associated changes in water and wastewater management. In this scenario, rainfall and reference evapotranspiration (ET_0) were adjusted to 2070 conditions using monthly multipliers developed by DWR based on climate modeling studies. The multipliers were applied to historical monthly data for the 1993 to 2017 hydrologic period used in the model. DWR prepared a unique set of multipliers for each four square kilometer (km^2) cell of a grid covering the entire state. Nine climate grid cells overlie the Basin and its tributary watershed areas. For each recharge analysis polygon in the rainfall-runoff-recharge model, multipliers from the nearest climate grid cell were used. The climate in 2070 is expected to be drier and warmer than it presently is.

Figure 5-2 compares average monthly precipitation and ET_0 before and after applying the climate change multipliers. Simulations of irrigated turf in the rainfall-runoff-recharge model indicated that the combined effect of the warmer and drier climate will increase annual irrigation demand by about 10 percent.

In the growth plus climate change scenario, bedrock inflow and surface inflow from tributary streams along the perimeter of the Basin were re-simulated using the rainfall-runoff-recharge model to reflect the effects of urban development in some of the tributary watersheds and of climate change. Urbanization also increased surface runoff within the Basin, which was routed to small streams and Temescal Wash.

For inflows from Temescal Wash, Cucamonga Creek and Chino Creek (which were not simulated using the rainfall-runoff-recharge model) and future baseline flows were adjusted to 2070 conditions using DWR streamflow multipliers. The DWR data set ends in 2011. Multipliers for 1987 to 1992 were used for 2012 to 2017 based on similarity of cumulative departure of precipitation for the two periods. Then 1992 to 2017 adjusted stream flows were used twice in succession to simulate 2019 to 2068. Surface discharges from the WRCRWA reclaimed water facility were from future projections developed during planning studies for that facility.

Land use in 2018 is shown in **Figure 5-3**. Land use maps for 1990, 2018 and 2068 were developed on the basis of Riverside County digital crop maps (1993 and 2000), Google Earth historical imagery (Google Earth 2021), a 2014 statewide crop map developed by DWR (DWR 2017), Corona General Plan 2020 to 2040 (Corona 2021), and Corona's 2020 Urban Water Management Plan (Michael Baker 2021). Corona was one of the fastest growing cities in the United States during the past several decades. From 1990 to 2018, the dominant land use change was conversion of citrus groves and natural grassland to residential use. **Table 5-2** lists the acreages of several categories of land use in the Basin and tributary watersheds in 1990, 2018 and 2068.

The rate of growth is expected to slow considerably during the next few decades. Within the current Corona city limits, population is expected to increase by 11 percent between 2020 and 2040, and commercial/industrial building space by 18 percent. The Urban Water Management Plan (UWMP) directs more growth to its sphere of influence areas outside the Corona city limits, with a projected 55 percent increase in population and 490 percent increase in commercial/industrial building space. Redevelopment within Corona will have minor effects on groundwater recharge, but development in the sphere of influence areas will have a major effect.

Land use is held constant at the 2068 level of development throughout the 50-year simulation period. This approach avoids errors that can arise from the assumed timing of future droughts and provides a long hydrologic analysis period for assessing the sustainability of 2068 land and water use conditions.

The 2020 draft UWMP (Michael Baker 2021) anticipates a steady decline in per-capita water use from 180 gallons per-capita per day (gpcd) in 2020 to 155 gpcd in 2045. This is plausible but possibly optimistic given that per-capita use has not been declining in recent years and rebounded slightly from drought-related decreases achieved during 2015 to 2016. It was conservatively assumed here that per-capita water use would not continue to decline during 2045 to 2068.

Combining the estimates of population and per-capita water use for 2068, total municipal water use in 2068 would be 34,490 AFY, or essentially the same as the 2010 to 2018 average (about 1 percent higher).

Pipe leaks were assumed to remain at the existing percentage of total water use in Corona and Norco. Municipal groundwater pumping was assumed to remain at the sustainable yield level, which was tentatively estimated to equal average production during 2010 to 2018.

Percolation of reclaimed water at WRF-2 was assumed to remain at the average for 2010 to 2018. This assumes that future decreases in per-capita water use will be achieved primarily through reductions in landscape irrigation. It also implies that future increases in wastewater generation due to population growth will be partially offset by increased indoor water conservation, and any remaining increase will become recycled water for irrigation.

Flow across the northern model boundary that cuts through the Chino Basin was set to zero, consistent with the mandated objective of *hydraulic control*. Hydraulic control is the elimination of groundwater discharge from the Chino Basin to the Prado Wetlands and Santa Ana River, achieved by pumping from a line of desalter wells located roughly parallel to and 2 to 4 miles north of the Santa Ana River. The objective of hydraulic control was included in the 2004 update of the Santa Ana River Basin Plan (SWRCB 2020a). Hydraulic control is considered necessary to maximize the safe yield and to prevent degraded groundwater from discharging from the Chino Basin to the Santa Ana River and impacting downstream beneficial uses (WEI 2005 and 2019).

Subsurface inflow from the Arlington Basin through Arlington Gap was assumed to be zero, consistent with long-term declining trends and modeling of future conditions in the Arlington Basin (Shaw 2020).

Table 5-2. Temescal Basini Land Use in 1990, 2018, and 2068 (acres)

Land Use	Channel Aquifer			Alluvial Fan Aquifder			Prado/Chino Area			Tributary Watersheds		
	1990	2018	2068	1990	2018	2068	1990	2018	2068	1990	2018	2068
Citrus	0	0	0	2,997	0	0	0	0	0	29	0	0
Truck crops	0	0	0	0	0	0	93	93	93	0	0	0
Pasture	0	0	0	0	0	0	379	379	379	0	0	0
Non-irrigated grain	0	0	0	0	0	0	2,499	1,176	1,176	0	0	0
Grassland	47	86	86	193	190	190	406	406	406	72	72	72
Shrubs/Trees	782	782	782	0	0	0	3,719	3,719	3,719	0	0	0
Dense riparian	0	0	0	0	0	0	0	0	0	0	0	0
Sparse riparian	0	0	0	499	1,036	1,734	0	0	0	234	1,097	2,414
Open water	799	799	799	6,425	10,956	10,867	1,389	2,833	2,833	704	2,704	2,704
Low-density residential	37	103	103	100	231	231	25	25	25	121	247	247
Residential	1,138	2,431	1,978	434	2,987	2,718	0	174	174	204	538	538
Turf	98	98	573	5	52	717	0	0	0	0	0	1,105
Commercial	1	1	1	219	121	0	0	0	0	142	646	368
Industrial	11	11	11	884	332	166	0	0	0	0	91	0
Quarry	0	0	0	0	0	0	0	0	0	0	0	0
Vacant	0	0	0	0	0	0	0	0	0	0	0	0

5.6. SURFACE WATER BALANCE

This section describes and quantifies the water balance of creeks and rivers that cross the Basin. All significant inflows to and outflows from these surface water bodies are included in the water balance. The surface water balance shares two flows in common with the groundwater balance: 1) percolation from surface water to groundwater and 2) seepage of groundwater into surface water. Each of these is an outflow from one system and an inflow to the other. Key features of the surface water balances for each management area and analysis period are described below, followed by additional information about the methods used to quantify items in the water balances.

Historical annual surface water balances for the Temescal Basin during 1990 to 2018 are shown in **Figure 5-4** (upper graph). Average annual surface water budgets for the model, historical, current, and future budget analysis periods are listed in **Table 5-3** and detailed surface water budget tables are included in **Appendix K**. The largest inflows to the Temescal Basin are from Temescal Wash and tributary watersheds along the western and eastern edges of the Basin, and those occur predominantly in wet years. The only other surface flow of significance is the small but relatively steady discharge of reclaimed water from WRF-1 to Butterfield Drain, which enters Temescal Wash just upstream of the Prado Wetlands. Outflow is almost entirely surface outflow from Temescal Wash to the Prado Wetlands, with some losses to percolation along unlined reaches of stream channels.

Surface flows in the Prado Wetlands and southern Chino Basin part of the groundwater model flow domain are generally steadier than surface flows in the Temescal Basin part of the model (**Figure 5-4**, middle graph). This is partly because the data shown in the graph are monthly flows used in the groundwater model, which may exclude some ephemeral high flow events. But in addition, flow in the Santa Ana River consists to a significant degree of discharges from wastewater treatment plants, which are relatively steady. Outflows from Prado Dam are also relatively steady because streamflow fluctuations upstream are absorbed to some extent by storage fluctuations in the wetlands.

A substantial amount of water has been imported into the Basin since before 1990. It is delivered directly to users and does not flow into streams or lakes. Use of imported water by Corona is shown in **Figure 5-4** (bottom graph). Imported water consists of State Water Project (SWP) water purchased from the Metropolitan Water District of Southern California (Met) and delivered to Corona.

Table 5-3 Average Annual Surface Water Budgets

Inflow or Outflow	Historical 1993 to 2007	Current 2010 to 2013	Baseline[1] 2019 to 2068	Growth Plus Climate Change[1] 2019 to 2068
Inflows				
Temescal Wash	18,560	10,761	14,920	12,857
Tributary inflow	25,617	23,016	21,399	4,643
Wastewater discharges	3,644	2,761	2,895	2,895
Groundwater flow into streams	5,980	4,917	990	1,380
Total Inflows	53,801	41,455	40,206	21,776
Outflows				
Stream percolation	-10,046	-10,544	-1,661	-1,714
Surface outflows	-44,001	-38,894	-38,544	-20,062
Total Outflows	-54,048	-49,437	-40,206	-21,776

[1] The 50-year future baseline simulation uses historical hydrology for 1993 to 2017 two times in succession.

5.6.1. Inflows to Surface Water

5.6.1.1. Precipitation and Evaporation

Precipitation and evapotranspiration on the land surface are accounted for in the rainfall-runoff-recharge model. Those processes are not included in the surface water balances, which address only water in stream channels, lakes, and imported water. Precipitation and evaporation on the surface of creeks and rivers are invariably miniscule percentages of total stream flow and are not included in the water budget.

5.6.1.2. Tributary Inflows

Tributary inflows to the Basin are from Temescal Wash and tributary watersheds along the east and west sides of the Basin. Temescal Wash inflows were obtained from the Bedford-Coldwater Subbasin groundwater model. Surface inflows from seven Santa Ana Mountain watersheds and four watersheds along the east side of the Basin were calculated on a daily basis by the rainfall-runoff-recharge model. Daily flows could not simply be averaged over each month to produce inflows for the groundwater model because the model would then overestimate the amount of stream recharge. This error stems from the ephemeral occurrence of stream flow and the nonlinear relationship between stream flow and percolation. The error can best be illustrated by a hypothetical example in which daily stream flows during a month consist of one day of flow at 60 cubic feet per second (cfs) and zero flow the rest of the days. If the percolation capacity of the stream reach over the groundwater basin is 10 cfs, total percolation for the month would be 10 cfs for one day, or 19.83 acre-feet (AF). The 50 cfs that exceeded the percolation capacity would flow out to the Santa Ana River. If the daily flows were simply averaged over a 30-day month, the monthly flow would be 2 cfs. The groundwater model would calculate that all of that water would percolate because 2 cfs is less than the percolation capacity of the channel. This would result in 2 cfs of percolation over the course of 30 days, or 119 AF, during the month.

To minimize this error, daily flows entering the Basin from each tributary were clipped at the estimated percolation capacity of the unlined reach of channel overlying the Basin. That is, daily flows in excess of the estimated percolation capacity were assumed to flow out to the Santa Ana River. Averaging the clipped daily flows produced monthly flows realistically capable of percolating. **Figure 5-5** compares average annual stream flow with and without clipping. The largest decreases were where large watersheds discharged into channels that are cement-lined along most of their length overlying the Basin, leaving only a short reach where percolation can occur.

5.6.1.3. Valley Floor Runoff

The rainfall-runoff-recharge model simulates runoff from valley floor areas, which include impervious surfaces in urban areas. Runoff from valley floor areas was added to flows in tributary streams or Temescal Wash at several locations.

5.6.1.4. Wastewater Discharges

The only discharge of reclaimed water to surface waterways in the Temescal Basin is the discharge from Corona WRF-1 plant to Butterfield Drain, which enters Temescal Wash at the southern edge of the Prado Wetlands. In 2012, the State Water Resources Control Board allowed Corona to decrease the discharge from 4.57 cfs to 2.25 cfs (1,625 AFY).

5.6.1.5. Groundwater Discharge to Streams

Groundwater can discharge into streams when the water table next to the stream is higher than the stream bed or the water level in the stream. The depth to groundwater is tens of feet in the southern part of the Temescal Basin, but the depth decreases to the north (see **Figure 4-22**). At the Butterfield well near the southern edge of the Prado Wetlands, depth to water was 18 to 35 feet during 2012 to 2018 (the period of record for that well). The only natural outflow path from the Basin is discharge to the Santa Ana River near Prado Dam. Somewhere between the Butterfield Well and Prado Dam the depth to water presumably decreases to zero. No shallow wells are available in that region to confirm and monitor depth to water.

5.6.2. Outflows of Surface Water

5.6.2.1. Net Evaporation

Evaporation from streams is almost always a negligible fraction of total flow and is not explicitly itemized in the water budgets or simulated in the model.

5.6.2.2. Surface Water Percolation to Groundwater

The lower reaches of almost all streams entering the Temescal Basin are concrete-lined. The only opportunity for percolation is along the unlined reaches near the Basin margin (see **Figure 4-17**). The percolation capacities of the unlined reaches of tributary streams were estimated to be approximately 5 cfs per mile (cfs/mi). This would be the percolation rate along a creek channel with a wetted width of 16 feet and a bed permeability of 5 feet per day. Temescal Wash was estimated to have a percolation capacity of 20 cfs/mi along the 2-mile unlined reach where it enters the Basin, based on greater channel width and permeability. These capacities were applied to simulated daily flows to obtain a time series of flows capable of percolating. Those flows were averaged to monthly values and used in the groundwater model, which included adjustments for shallow depth to groundwater (relevant only near Prado). Based on these assumptions and calculations, percolation from streams contributes on the order of 10,000 AFY of recharge to the Basin, which is about 18 to 20 percent of total recharge on an average annual basis.

5.6.2.3. Surface Outflow from the Basin

Surface outflow from the Temescal Basin equals stream inflows minus percolation losses plus groundwater discharge to streams. Over periods of months or years, storage change of surface water is negligible in the absence of lakes or reservoirs. Surface outflow is by far the largest outflow, especially in wet years. The values in **Table 5-3** understate the dominance of this outflow because the table excludes peak flows that were not passed to the groundwater model.

5.7. GROUNDWATER BALANCE

Annual groundwater inflows and outflows for the Basin for the 1990 to 2018 model simulation period are shown as stacked bars in **Figure 5-6**. Inflows are stacked in the positive (upward) direction and outflows are stacked in the negative (downward) direction. A similar stacked-bar chart for the baseline simulation is shown in **Figure 5-7** and for the growth plus climate change simulation in **Figure 5-8**. Average annual groundwater budgets for the Channel Aquifer area and the alluvial fan aquifer area during each of the water budget analysis periods are listed in **Table 5-4**. Detailed groundwater budget tables are included in **Appendix K**. Highlights of the water budgets are described below, followed by additional information on methods used to quantify each budget item.

Percolation from streams and percolation of reclaimed water have been the largest sources of recharge to the Basin, followed by rainfall recharge in non-irrigated areas. Percolation from streams varies substantially from year to year but averaged about 34 to 39 percent of total inflows in the historical and current scenarios. In the baseline and growth plus climate change scenario stream percolation represented a slightly smaller portion of inflows. Percolation of reclaimed water was of a similar magnitude in the historical and future scenarios but became a larger percentage of total inflow because of decreases in other inflows. Inflows from irrigation deep percolation, bedrock inflow and pipe leaks were of similar magnitudes in the historical and current periods (7 to 9 percent of total inflows). Because of urbanization in recent years, irrigation deep percolation and pipe leaks became larger percentages of total inflow in the future scenarios. Inflow from the Chino Basin is the smallest inflow, amounting to only 2 to 6 percent of total inflows in all scenarios.

Pumping by municipal wells increased during the historical simulation, increasing from 43 percent of total outflows in the historical period to 59 percent in the current period. Although municipal pumping was smaller in the future simulations, it represented a larger percentage (71 percent) of total outflows because of decreases in other outflows. The next largest outflows were of roughly similar magnitudes: groundwater discharge to streams, riparian evapotranspiration (ET) and subsurface outflow to the Chino Basin. These each accounted for 10 to 19 percent of total outflows during the historical and current periods and slightly smaller percentages in the future simulations. Pumping at agricultural wells decreased rapidly in the 1990s, dwindling to negligible amounts in the current period.

The Basin water budgets were negative for the historical and current analysis periods, due to a variety of reasons and reflecting the different time periods. During 2000 to 2011, relatively high amounts of municipal groundwater pumping contributed to a gradual decrease in storage. Since 2011, the predominantly dry climatic conditions have resulted in reduced inflows and thus a decrease in storage. As documented in Section 4.1, water levels in wells located in the Channel Aquifer decreased slightly over the historical period. The observed water level decline was not significant and did not impact beneficial users of the Basin. However, relatively high estimated storativity in the Channel Aquifer and the slight water level decline resulted in a net negative change in storage over the time period.

Storage declines during the early years of the simulation may have resulted from incorrectly estimated initial water levels. Initial conditions in the model are user defined and act as boundary conditions, if initial groundwater levels are set too high at the start of the simulation, the model will reduce water levels to reach equilibrium. The result is a calculated change in storage that may be an artifact of the prescribed starting water levels. Geographically distributed water level data is not available pre-1990 and the initial conditions are largely set by interpolating sparsely observed water levels. Additional improvements and sensitivity analysis could provide more information on the effect of the initial conditions and should be considered for the next GSP update.

The future baseline scenario is intended to represent a continuation of existing conditions. For most of the budget items that are inputs to the model (for example, irrigation deep percolation, pipe leaks, reclaimed water percolation and pumping), average values during 2010 to 2018 were used. An exception was municipal pumping by Corona, which was relatively high during 2002 to 2014. Using the 2010 to 2018 average produced storage depletion in the future baseline simulation. While the numerical model simulates declines in storage over the historical period, groundwater level declines have been relatively small and undesirable results relative to groundwater levels or storage have not occurred in the Basin.

Corona's objective is to pump within the sustainable yield of the Basin and to supply the remaining municipal water demand with imported and recycled water. This policy is reflected in the generally decreasing amounts of municipal pumping from 2008 to 2017. Through iteration, using the groundwater model, municipal pumping of 15,600 AFY was found to produce essentially no long-term storage change in the future baseline simulation. This equals 98 percent of average Corona pumping during 2010 to 2018 but is more than the amounts of Corona pumping in 2016 and 2017.

However, adaptive management and continued assessment of pumping volumes will be critical to maintaining sustainability as inflow to the Basin can vary widely based on hydrology and the model simulation is only a forecast of future conditions.

Growth and climate change had relatively small effects that tended to offset each other. The warmer, drier climatic conditions tended to decrease stream percolation and rainfall recharge. Urban growth—much of which is projected to be in tributary watershed areas—tended to increase recharge because of irrigation deep percolation, pipe leaks and percolation of runoff from disconnected impervious areas. Notably, total water use and percolation of reclaimed water were assumed not to change appreciably, consistent with assumptions in the Corona's UWMP that population growth will be offset by decreases in per-capita water use. Consequently, individual inflows and outflows in the growth plus climate change scenario were identical to or very close to the values in the future baseline scenario.

Table 5-4. Average Annual Groundwater Budgets

Water Balance Items	Temescal Basin				
	SGMA Historical 1993 to 2007	SGMA Current 2010 to 2013	25-Year Historical 1993 to 2017	Baseline[1] 2019 to 2068	Growth Plus Climate Change[2] 2019 to 2068
Groundwater Inflow					
Percolation from streams	8,112	9,942	7,976	7,918	8,817
Bedrock inflow	1,024	952	980	1,084	1,314
Dispersed recharge: non-irrigated land	4,921	4,380	4,331	2,742	2,668
Dispersed recharge: irrigated land	2,042	1,680	1,892	3,172	3,253
Pipe leaks	2,585	2,520	2,560	2,151	2,174
Reclaimed water percolation	8,915	6,200	7,885	6,122	6,122
Inflow from Adjoining Basins	2,003	1,400	1,895	1,026	126
Total Inflow	**29,601**	**27,075**	**27,520**	**24,213**	**24,473**
Groundwater Outflow					
Wells - M&I and domestic	-13,631	-17,239	-14,668	-15,615	-15,615
Wells - agricultural	-3,622	-1,386	-2,722	-22	-23
Groundwater discharge to streams	-4,545	-1,295	-3,179	-1,739	-1,504
Riparian evapotranspiration	-4,980	-3,922	-4,482	-4,538	-4,997
Outflow to Adjoining Basins	-2,966	-2,085	-2,664	-2,364	-2,301
Total Outflow	**-29,744**	**-25,927**	**-27,714**	**-24,278**	**-24,439**
Net Change in Storage					
Inflows minus outflows	-143	1,148	-194	-65	34

Notes:

[1] : The 50-year future baseline simulation uses historical rainfall and evapotranspiration for 1993 to 2017 two times in succession.

[2] : Future baseline rainfall and evapotranspiration are adjusted for climate change in this scenario.

5.7.1. Inflows to Groundwater

Inflows to the Temescal Basin groundwater flow system include dispersed recharge from rainfall and irrigation, percolation from streams, percolation of reclaimed water and subsurface inflow. The methods and data used to calculate each of these flows is described below.

5.7.1.1. Dispersed Recharge from Rainfall and Irrigation

Dispersed recharge from rainfall and applied irrigation water is estimated by the rainfall-runoff-recharge model. The model simulates soil moisture storage in the root zone, with inflows from rainfall infiltration and irrigation, and outflows to evapotranspiration and deep percolation. Simulation is on a daily basis. In recharge zones with irrigated crops—which includes urban landscaping and agricultural irrigation (citrus)—irrigation is assumed to be applied when soil moisture falls below a certain threshold. When soil moisture exceeds the root zone storage capacity, the excess becomes deep percolation. Rainfall and irrigation water comingle in the root zone and in deep percolation. For the purposes of displaying an itemized water balance, the amount of deep percolation derived from irrigation is estimated as a percentage of the simulated irrigation quantity, and the remainder of the dispersed recharge is attributed to rainfall. Deep percolation of applied irrigation water (irrigation return flow) is generally similar from year to year, whereas rainfall percolation varies significantly on an annual basis. Because urban landscape irrigation increased while agricultural irrigation decreased during the simulation period, total recharge on irrigated lands decreased only slightly. Water pipe leaks were estimated as the percentage of unaccounted for water listed in the 2015 Corona UWMP, which was seven percent of delivered water (KWC Engineers 2016), distributed uniformly over areas of urban land use. Sewer pipes convey only water used indoors, and their leak rate was assumed to be half of the leak rate for water pipes. For input to the groundwater model, the one-dimensional dispersed recharge rates are mapped onto model grid cells overlying each recharge polygon on an area-weighted average basis.

Figure 5-9 shows a map of average annual dispersed recharge during 1993 to 2007, which is a relatively long averaging period that includes a wide range of year types. Most dispersed recharge occurs during relatively wet years. Average annual recharge rates ranged from less than 0.3 to slightly over 12 inches per year (in/yr). Much of the southern half of the Temescal Basin converted from citrus orchards to residential development during that period. Recharge from agricultural irrigation was replaced by irrigation from landscape irrigation, pipe leaks and percolation of runoff from disconnected impervious surfaces. As a result, average annual dispersed recharge in that part of the Basin was similar to recharge in the northern part, which was urbanized throughout the simulation period. Dispersed recharge in tributary watersheds appears to be low because most of the deep percolation beneath the root zone was assumed to become stream base flow rather than deep recharge.

5.7.1.2. Percolation from Streams

Inflows to the stream network in the surface water module of the groundwater model include a combination of simulated runoff from tributary watersheds and valley floor areas obtained from the rainfall-runoff-recharge model and simulated inflows from adjacent groundwater models of the Bedford-Coldwater and Chino Basins.

The surface water module of the groundwater model simulates percolation reach by reach along each stream that crosses the Basin. The percolation rate is a function of stream bed permeability, wetted area, and the difference in elevation between the stream surface and the underlying water table. Along reaches with natural channel materials, a permeability of 5 feet per day (ft/day) was assumed. Most of the streams that cross the Temescal Basin are lined with concrete along much of their length. Those reaches were assigned a permeability of zero. The natural channel reaches of the tributary streams are probably tens of feet above the water table, which means they are not hydraulically connected to groundwater. Percolation is a function of wetted area and permeability only.

Converting from daily to monthly analysis can introduce large errors in estimated percolation. If daily flows are averaged over a month, estimated stream flow appears to be much more moderate and perennial than the actual stream flow. The groundwater model would overestimate percolation in that case. To avoid this error, monthly flows were obtained from daily flows by first clipping the daily flows to values less than or equal to the estimated percolation capacity of the unlined reach of channel. Those flows were then be averaged to obtain monthly flow for input to the groundwater model.

The Santa Ana River, Cucamonga Creek and Chino Creek are not lined. Monthly inflows to those waterways were obtained from an existing groundwater model of the Chino Basin (WEI 2019).

5.7.1.3. Reclaimed Water Percolation

Reclaimed wastewater is currently percolated at the Lincoln Cota Percolation Ponds, which are adjacent to the left bank of Temescal Wash between Lincoln Avenue and Cota Street. They are just outside the Channel Aquifer area. Prior to 1998, reclaimed water was also percolated in ponds at WRF-1 next to the Prado Wetlands. Since then, water from that facility has been sent to the Lincoln Cota ponds. Measured percolation volumes are added directly to the top layer of the groundwater model.

5.7.1.4. Subsurface Groundwater Inflow

Subsurface inflows from tributary watersheds and neighboring basins are estimated by various methods. Subsurface flow from tributary watersheds is calculated by the rainfall-runoff-recharge model by partitioning rainfall deep percolation into stream base flow and subsurface inflow. The subsurface flow is added as specified monthly volumes of water to model cells adjacent to the tributary watershed. Although the Bedford-Coldwater Basin and Temescal Basin share a boundary, models of both basins indicated little flow across it because groundwater tends to flow parallel to the boundary toward Temescal Wash. Based on previous studies, a small amount of subsurface inflow from the Arlington Basin through the Arlington Gap was included in historical simulations. That flow is expected to decrease to zero in the future. Flow between the Temescal and Chino Basins is simulated by the groundwater model as a function of water-level gradients and permeability along the boundary between the basins.

5.7.2. Outflows from Groundwater

Major outflows from the water budget analysis areas are groundwater pumping (municipal, industrial, and agricultural), subsurface outflow, groundwater discharge into streams, and evapotranspiration by riparian vegetation.

5.7.2.1. Pumping by Wells

Pumping from M&I wells has been measured and recorded for many years by Corona and WMWD. Those data are used in the groundwater model. Agricultural pumping to irrigate citrus orchards in the 1990s was estimated using the rainfall-runoff-recharge model, which produces estimates of irrigation demand based on reference evapotranspiration, crop type and growth state, and availability of soil moisture from rainfall. Ten percent of applied irrigation water was assumed to percolate past the root zone and return to the groundwater supply. As described in Section 5.7, Corona pumping for the future baseline and growth plus climate change scenarios was set at 98 percent of the 2010 to 2018 average historical pumping.

5.7.2.2. Subsurface Outflow

Subsurface outflows to the Chino Basin were calculated with the groundwater model by the same methods used to simulate subsurface inflows. There are no outflows from the Temescal Basin to the Arlington or Bedford-Coldwater Basins because the water level gradients are always toward the Temescal Basin.

5.7.2.3. Groundwater Discharge to Streams

Where streams are hydraulically connected to the water table, discharges of groundwater into the streams are simulated by the groundwater model based on streambed wetted area, permeability, and on the amount by which the simulated groundwater elevation in a model stream cell is higher than the simulated surface water elevation. This condition is present primarily along the lower reaches of the Santa Ana River and other channels within the Prado Wetlands.

5.7.2.4. Riparian Evapotranspiration

Evapotranspiration of groundwater by phreatophytic riparian vegetation is influenced by available soil moisture and by depth to the water table. Like other types of vegetation, phreatophytes use soil moisture supplied by rainfall when it is available. Any remaining evapotranspiration demand is met by drawing water from the water table. Phreatophyte use of groundwater is assumed to decrease from the maximum rate when the water table is at the land surface to zero when the water table is 20 feet or more below the ground surface. These calculations are applied at model cells within the Prado Wetlands. A patch of dense riparian vegetation is also present where Temescal Wash enters the Basin from an upstream bedrock reach. However, that vegetation appears to be supported by percolation from the Wash, not groundwater, because the water table appears to be more than 30 feet below the ground surface in that area. The water demand of riparian vegetation was assumed to equal reference evapotranspiration.

5.8. CHANGE IN GROUNDWATER STORAGE

Figure 5-10 shows the cumulative change in Basin storage from the model during 1990 through 2068. The baseline and growth plus climate change scenario results for 2019 to 2068 are displayed as continuations of the historical storage changes from 1990 to 2018.

As shown, groundwater storage decreased fairly steadily during 1990 to 2018. Average annual storage changes for the current and two historical periods ranged from decreases of 194 AFY to an increase of 1,148 AFY, as shown in **Table 5-4**. Total outflows were between 0.7 percent greater and 4.2 percent lower than total inflows. Factors that could have contributed to this simulated decline include incorrectly estimated initial water levels, relatively high amounts of municipal groundwater pumping during the early 2000s, and predominantly dry climatic conditions since 2011.

Average annual storage changes during both future scenarios were very slightly positive, with total inflows about two percent greater than total outflows. This was the intentional result of adjusting Corona pumping to achieve close to zero net storage change during 2019 to 2068. The abruptness of the transition from historical to future conditions is primarily the result of decreased pumping, but also to the effects of drought conditions at the end of the historical period. The similarity of the future baseline and growth plus climate change scenarios is due to the small differences in all water budget items between those two scenarios. Also, the effects of urban growth tended to offset the effects of the warmer, drier climate.

5.9. ESTIMATE OF SUSTAINABLE YIELD

The sustainable yield is defined as the volume of pumping that the Basin can sustain without causing undesirable effects. It is not a fixed or inherent natural characteristic of a groundwater basin. Rather, it is influenced by land use activities, importation of water, wastewater and stormwater management methods, potential recharge with recycled water, and the locations of wells with respect to interconnected streams. The estimates of sustainable yield presented in this section reflect the current status of those variables under the historical and future scenarios.

A long analysis period is needed to evaluate yield because of the episodic nature of natural recharge. Whereas pumping, irrigation return flow, and pipe leaks are fairly constant from year to year, recharge from precipitation and streams varies widely. Because of evolving land use during 1990 to 2018, no subset of years is ideal for estimating sustainable yield. For the purposes of this GSP historical sustainable yield was calculated based on 1993 to 2017, which is representative of long-term average conditions in terms of precipitation and stream flow. Sustainable yield was estimated for the historical simulation (using 1993 to 2017) and the two future simulations (both using all 50 years of the simulation), as shown in **Table 5-5**.

Table 5-5. Estimated Sustainable Yield

25-Year Historical 1993 to 2017[1] (AFY)	Baseline 2019 to 2068[2] (AFY)	Growth Plus Climate Change 2019 to 2068[2] (AFY)
17,195	15,572	15,672

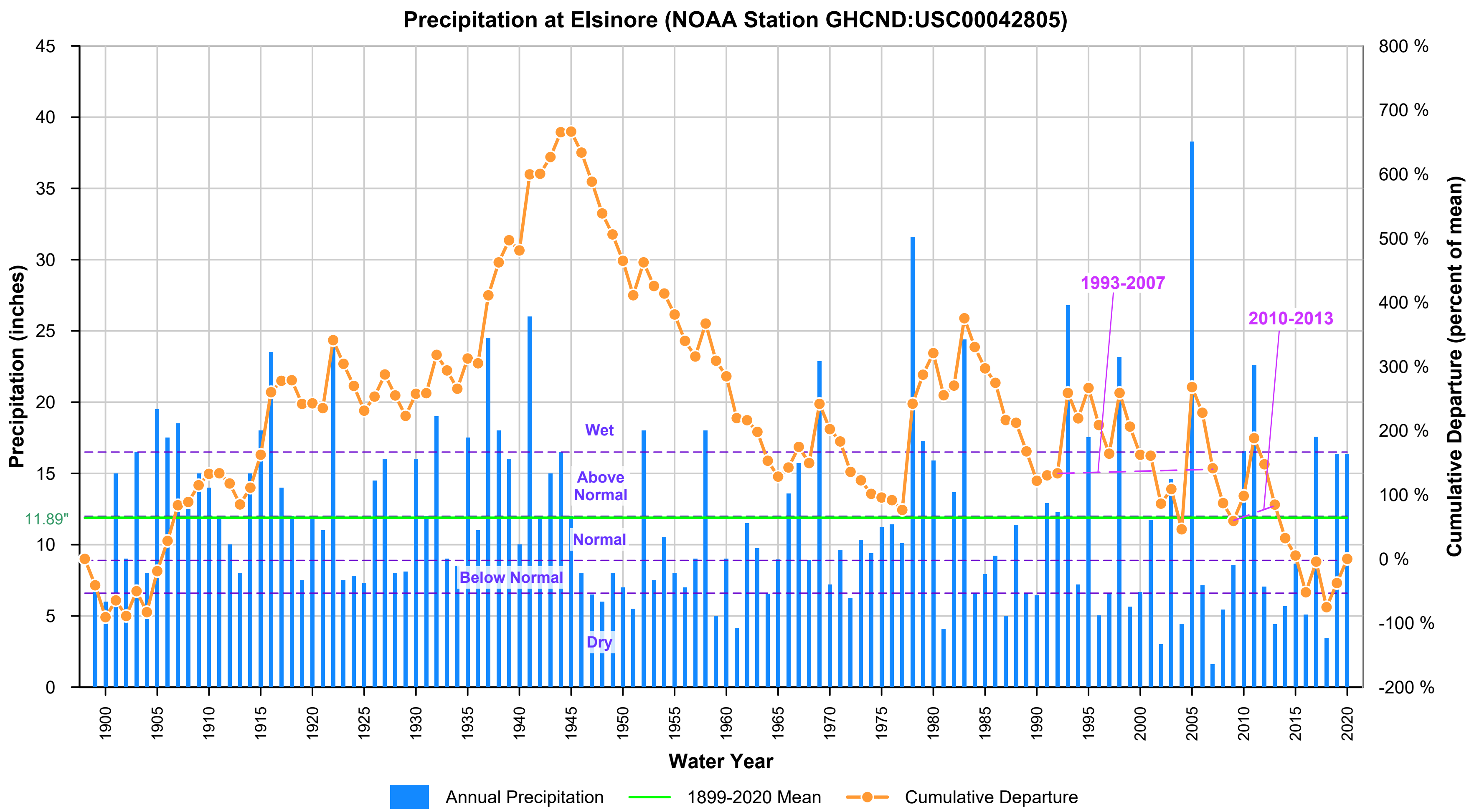
[1] For the historical sustainable yield estimate, average annual water budgets during 1993 to 2017 were used.
[2] The 50-year future simulation uses historical hydrology for 1993 to 2017 two times in succession.

These sustainable yield estimates equal total pumping plus storage change. This simple method of estimating yield ignores the interaction of pumping with other head-dependent boundaries, including interconnected surface water, riparian vegetation ET and subsurface inflows and outflows. All four of those types of boundaries are present in the Temescal Basin, which means that increasing the amount of pumping can theoretically increase the yield of the Basin, by increasing head-dependent inflows and decreasing head-dependent outflows. Conversely, a decrease in pumping will not result in an equal decrease in the rate of storage depletion because the other head dependent boundaries absorb some of the change in pumping. The amount of pumping in the future baseline simulation accounts for these complex interactions. It was obtained by trial and error as the amount of Corona pumping that resulted in close to zero long-term storage change. That means it also results in zero long-term change in other head-dependent boundary flows such as groundwater discharge to the Prado Wetlands. Large changes in those flows could cause undesirable results for groundwater dependent ecosystems.

The yield estimates in the table are for total groundwater pumping in the Basin, not just Corona pumping. Although Corona pumping is currently about 93 percent of total pumping, several industrial users also pump groundwater and others might do so in the future.

The yield estimates based on the future scenarios are probably a better basis for planning than the estimates based on the historical and current periods because the latter periods were influenced by factors that do not apply to the future period and because the future scenarios have a long hydrologic averaging period. Sustainable yields calculated from the future scenarios are based on projections far into the future. Slight imbalances in estimated water budgets can result in large cumulative changes in storage, and hence in the calculated yields. By the same token, the long planning horizon provides ample time to adjust water management (recharge and pumping) to maintain basin operation within the sustainable yield if long-term rising or falling trends in cumulative storage in fact occur. In the context of this GSP, sustainable yield estimated from the water budget is contingent on the absence of undesirable results related to water levels, storage, subsidence, water quality, or depletion of interconnected surface water. Quantitative sustainability criteria are presented in Chapter 6 that define thresholds at which groundwater conditions become undesirable for each of those sustainability indicators. For example, if pumping at the above estimates of sustainable yield caused subsidence or significant impacts on riparian or aquatic habitats, the yield may need to be reduced to avoid those impacts. It should be noted that the future sustainable yield is calculated in the model using projected hydrological conditions. Conditions vary widely in the Basin between wet years and dry years and the actual precipitation (along with ET and other inflows) would influence the available yield of the Basin.

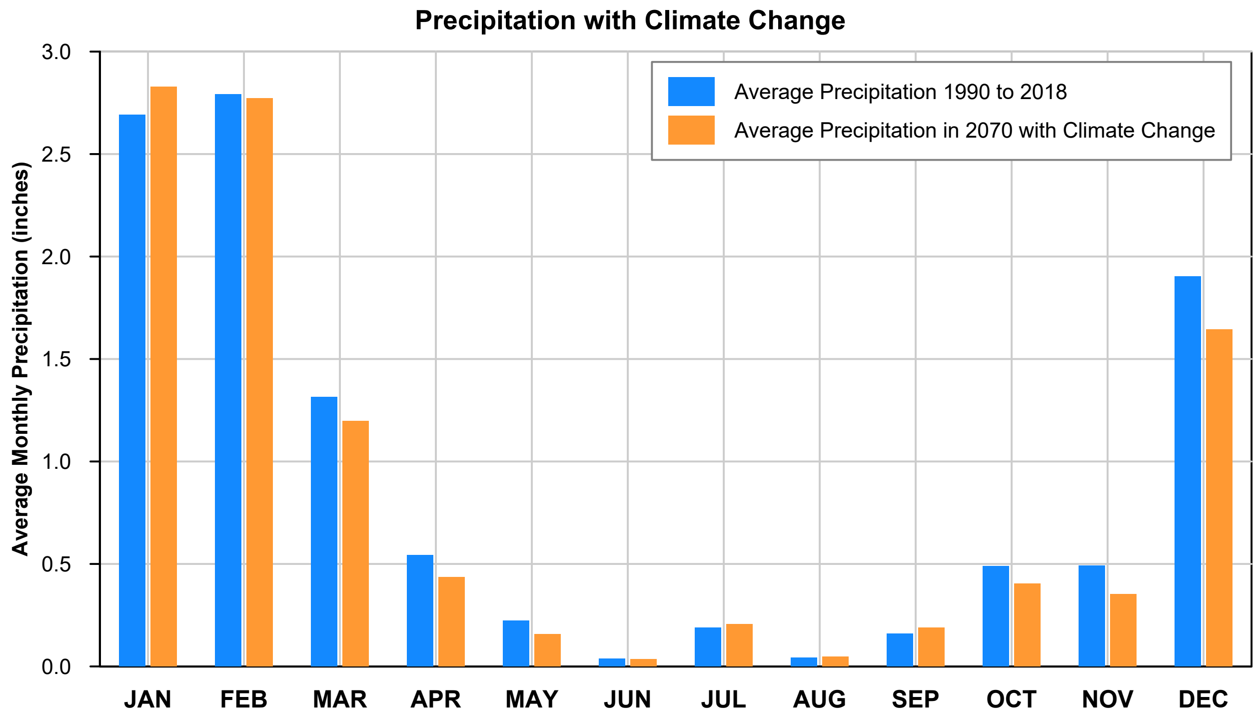
Accordingly, this sustainable yield value is a broad indicator. It indicates no overdraft based on the water budget, but it must be interpreted through evaluation of undesirable results.

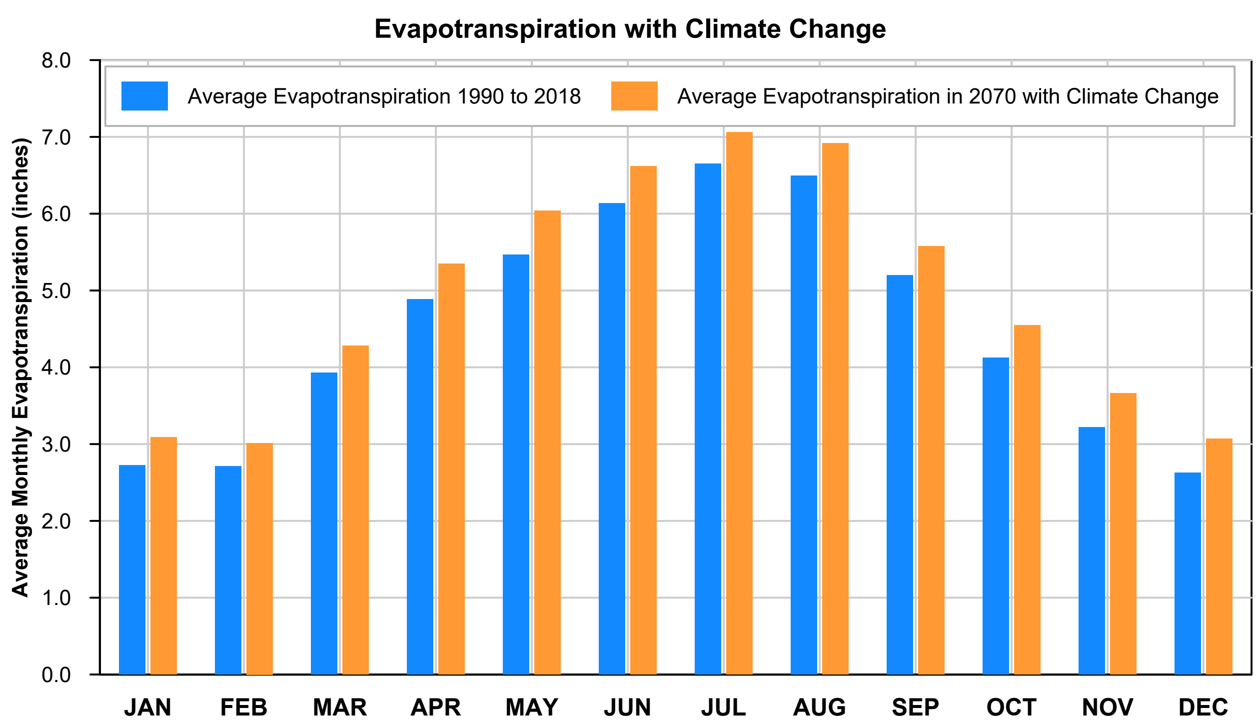


Path: T:\Projects\Corona GSP 46414\GRAPHICS\Figure 5-1 Cumulative Departure of Precipitation.grf

TODD GROUNDWATER

Figure 5-1
Cumulative Departure of Annual Precipitation at Lake Elsinore





TODD GROUNDWATER

Figure 5-2
Effect of Climate Change on Precipitation and Evapotranspiration

Path: T:\Projects\Bedford Coldwater GSP 80802\GRAPHICS\Figure 5-3 Effect of Climate Change on Precipitation and Evapotranspiration.gpj

Path: T:\Projects\Corona GSP 46414\GIS\Maps\Figures\GSP Figures\Chapter 5 - Water Budget\Figure 5-3 2018 land use_r1.mxd

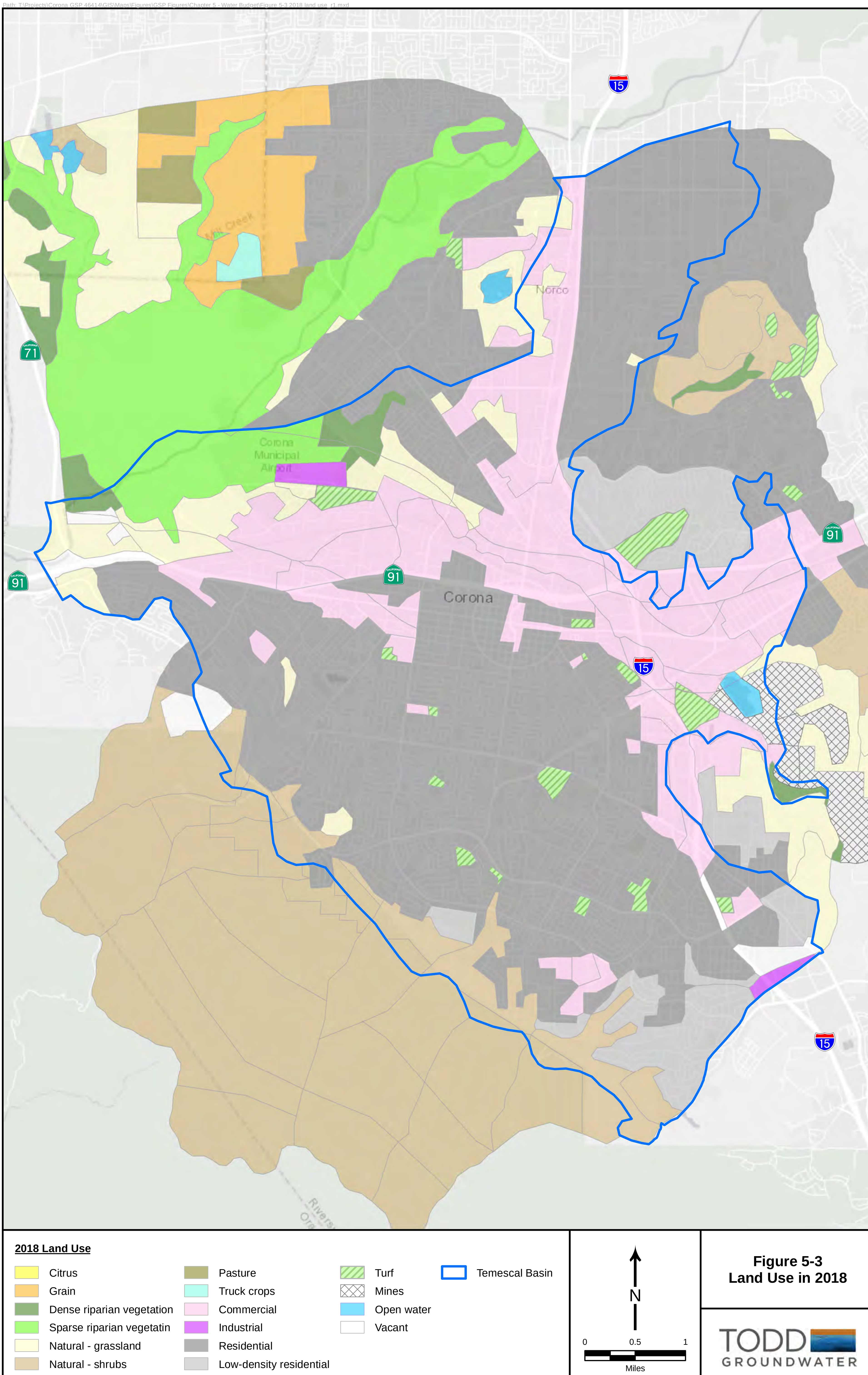
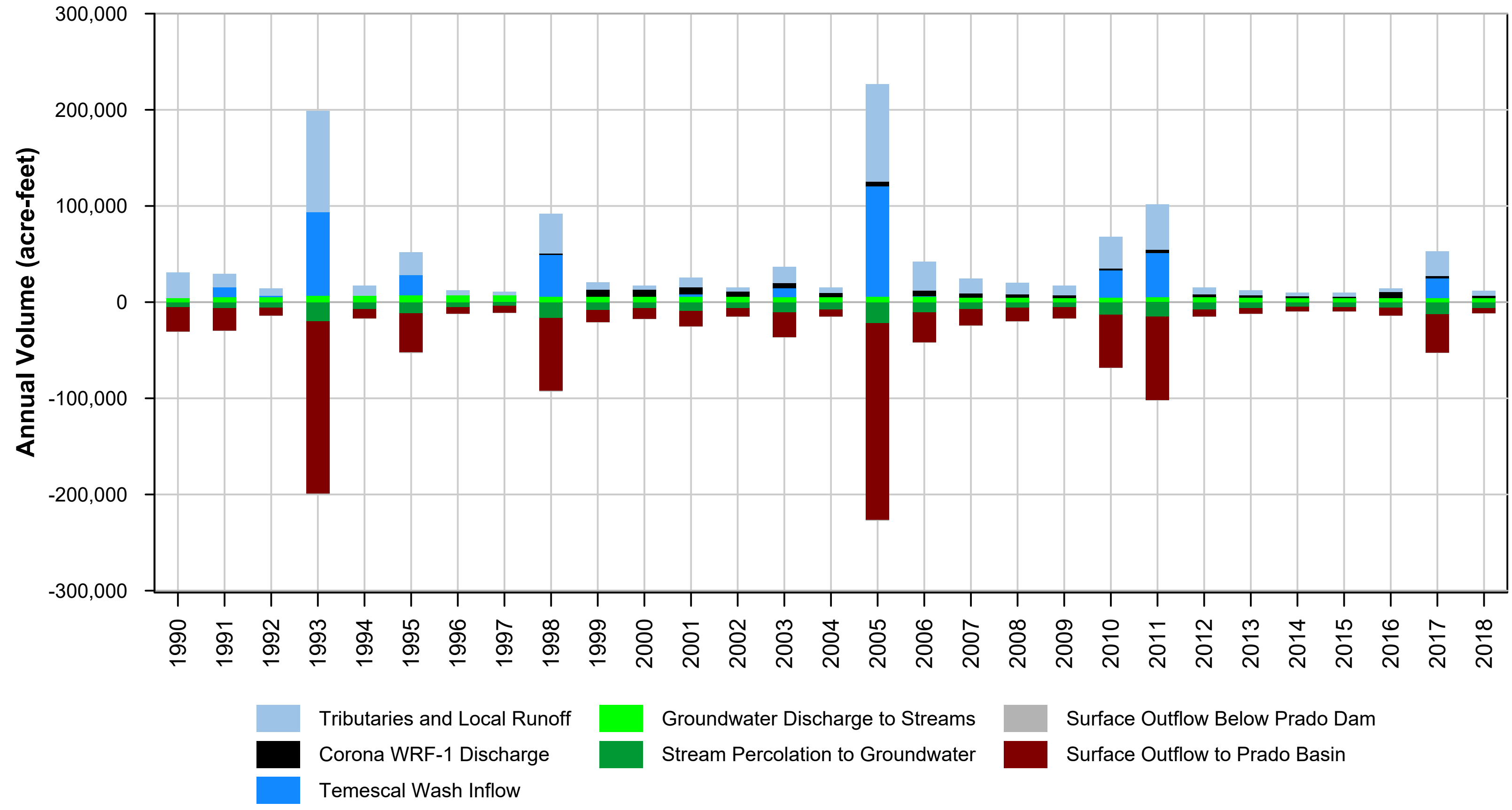


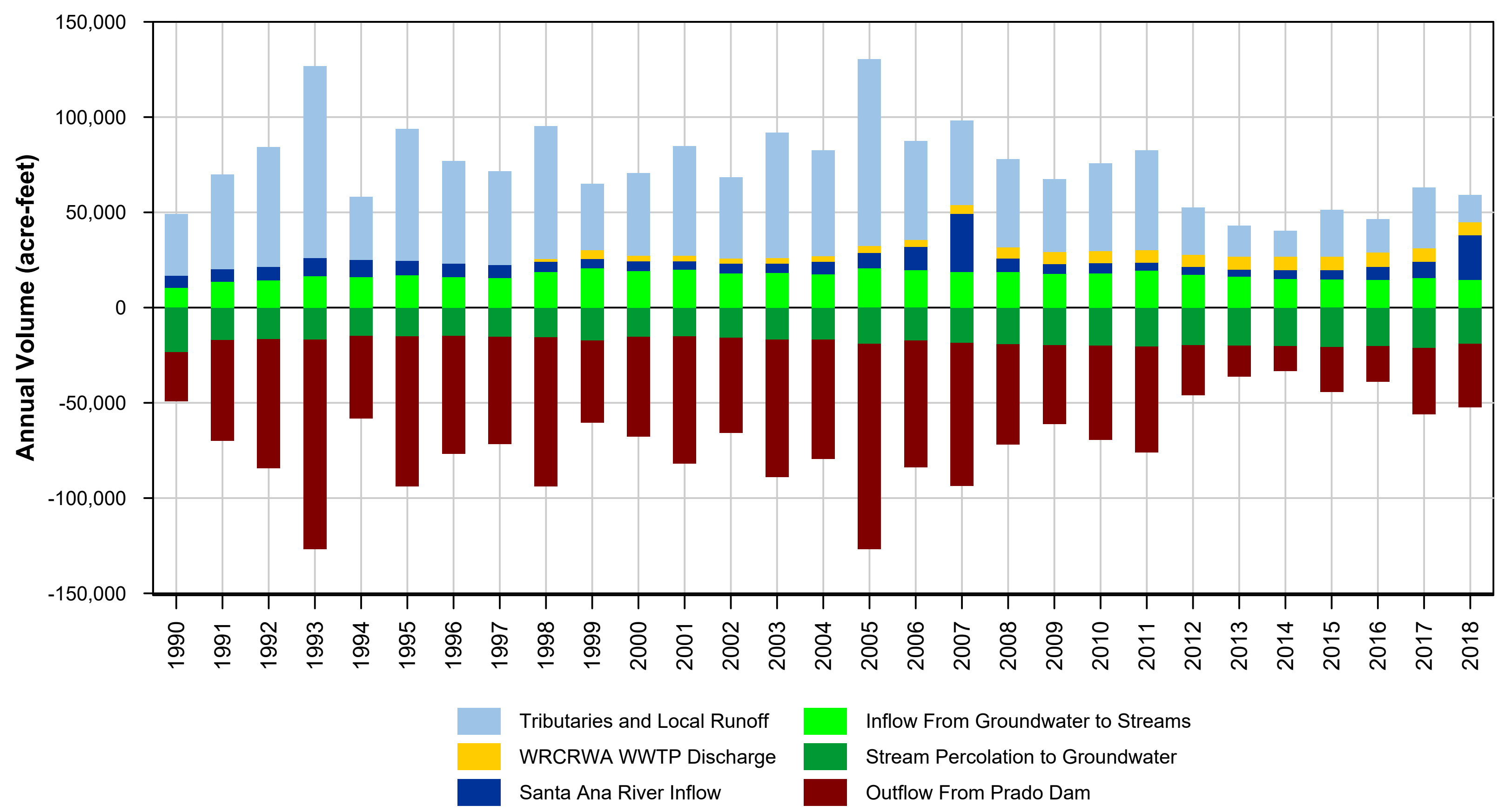
Figure 5-3
Land Use in 2018

TODD GROUNDWATER

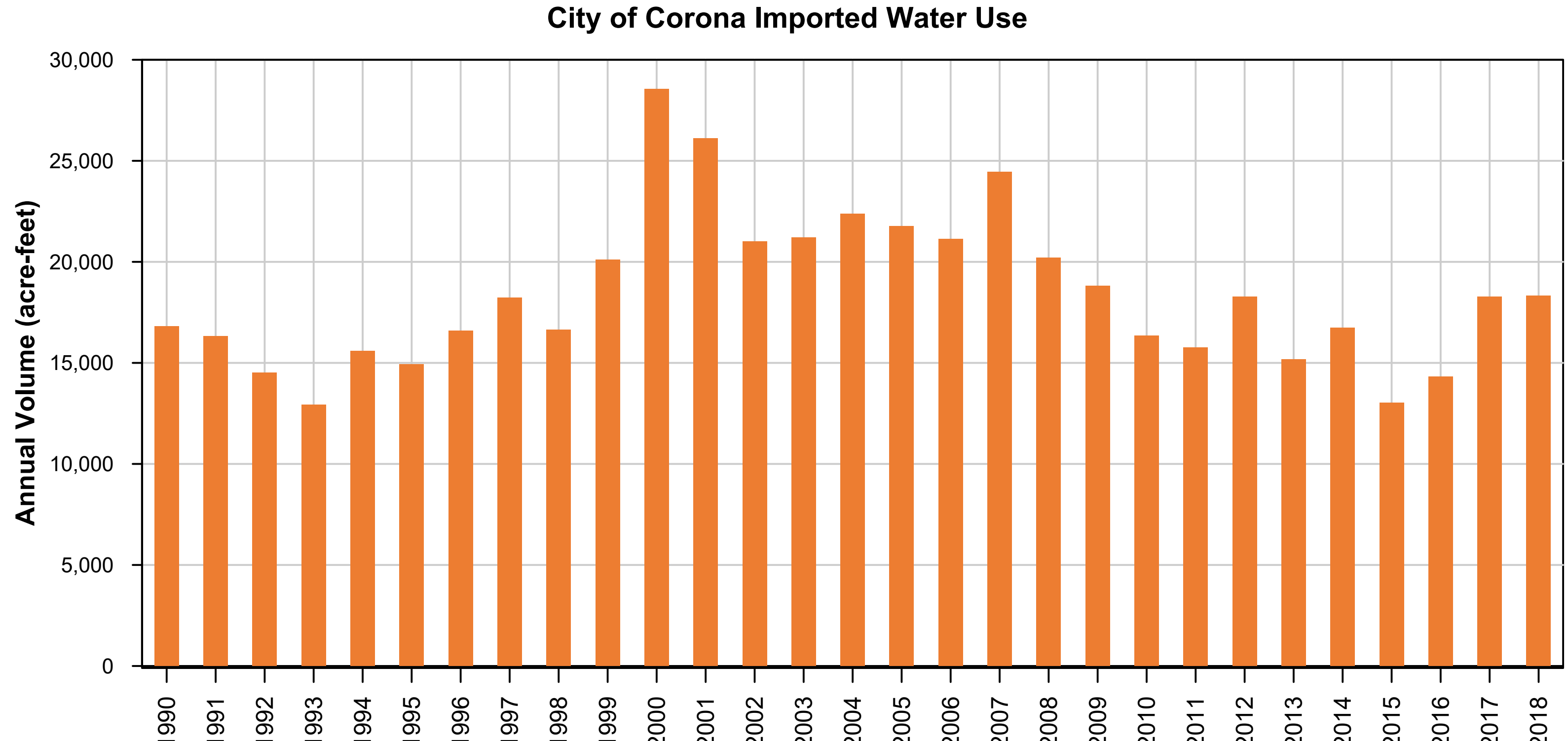
Temescal Basin Surface Water Budget



Southern Chino Basin Surface Water Budget

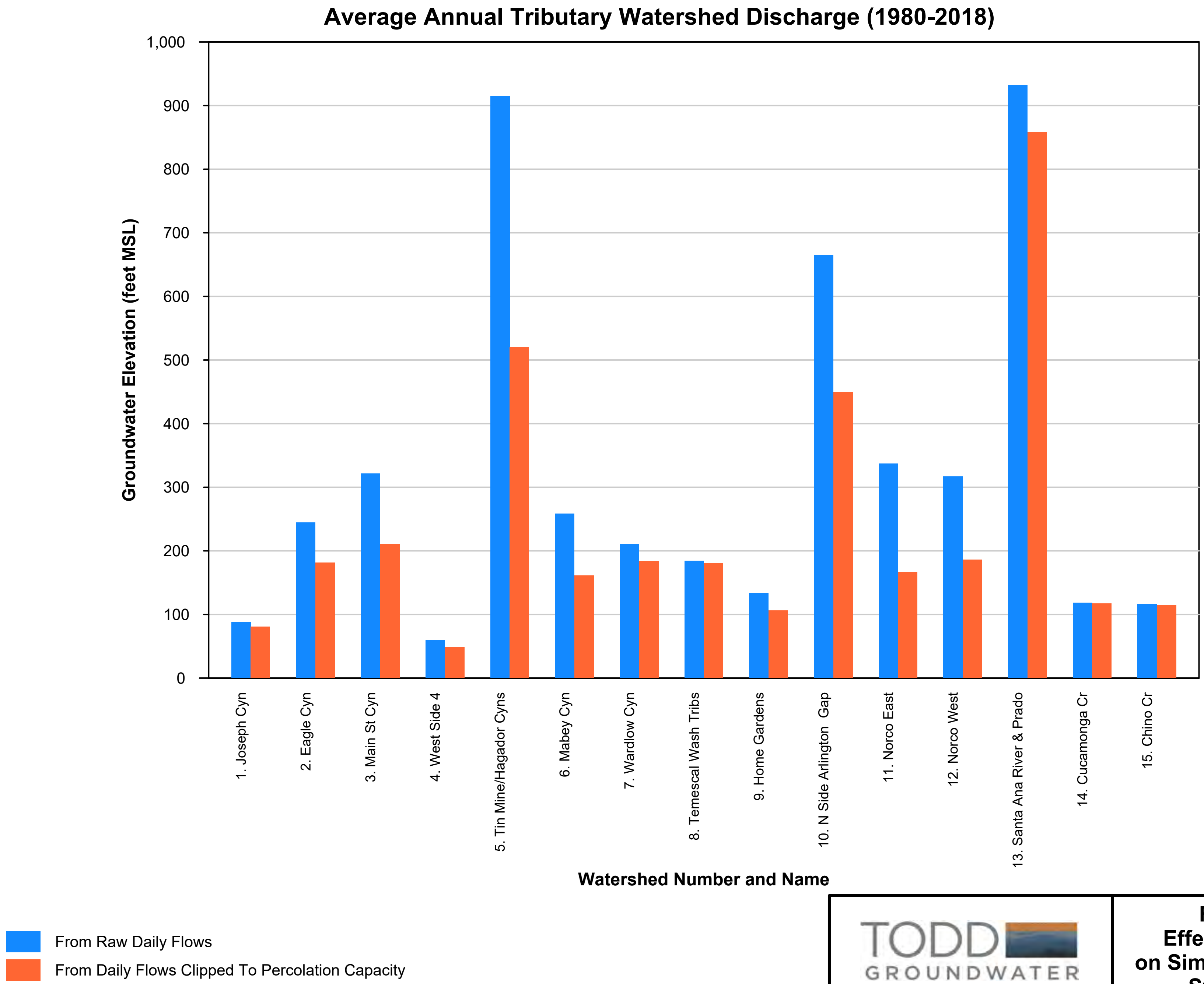


City of Corona Imported Water Use



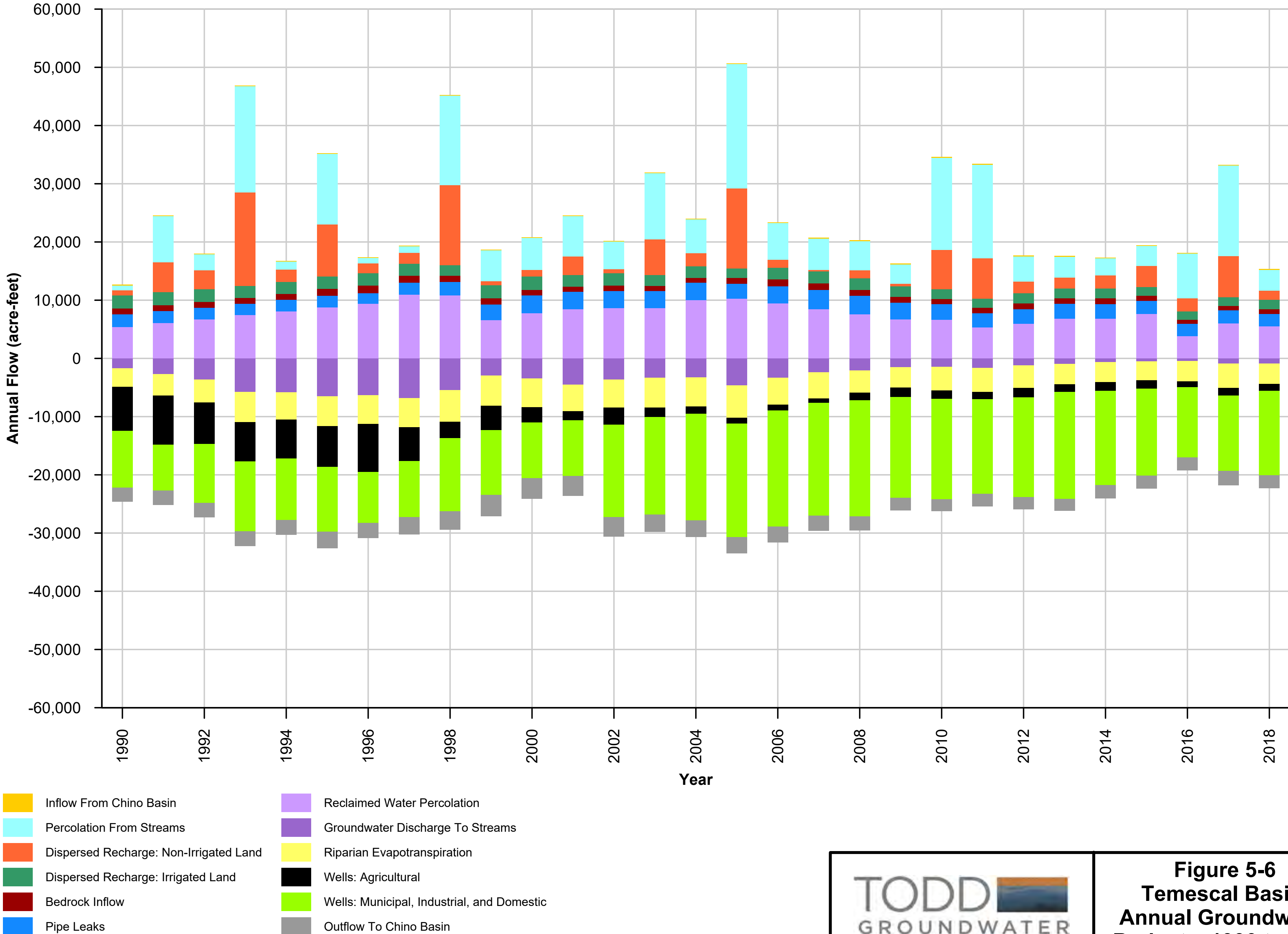
TODD GROUNDWATER

Figure 5-4
Surface Water Budgets
1990 through 2018



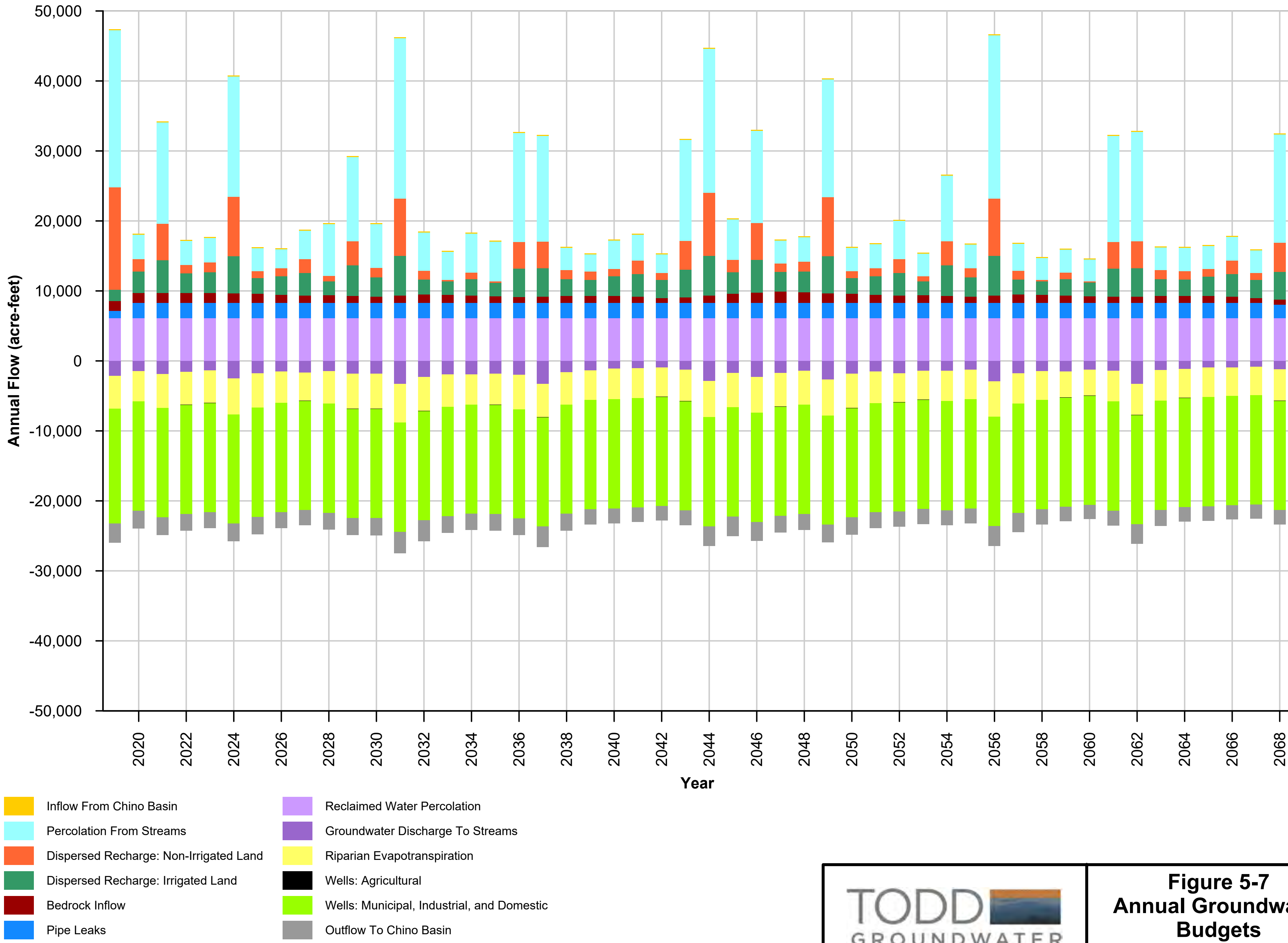
TODD GROUNDWATER

Figure 5-5
Effect of Clipping on Simulated Tributary Stream Flow



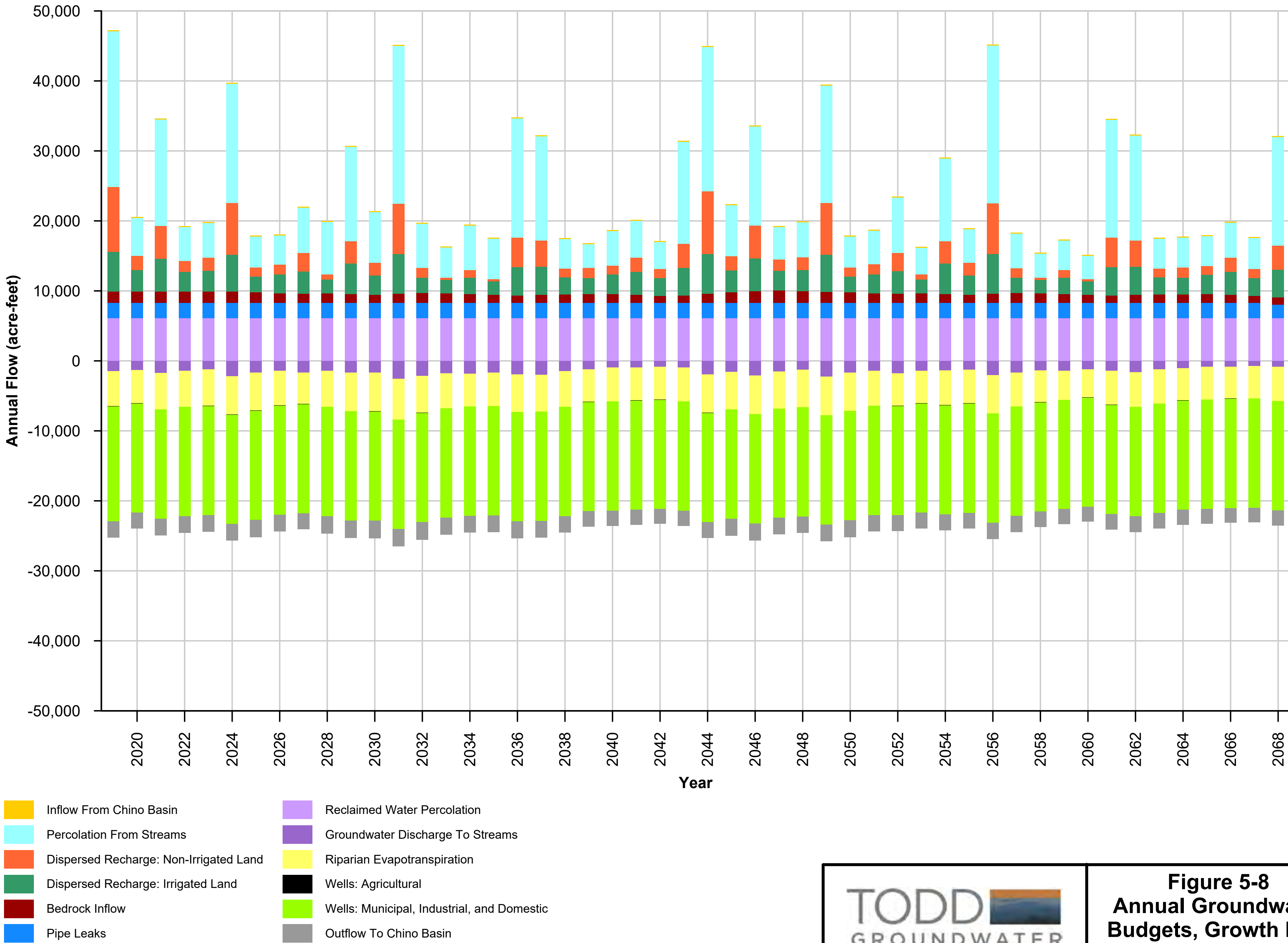
TODD GROUNDWATER

Figure 5-6
Temescal Basin
Annual Groundwater
Budgets, 1990 to 2018



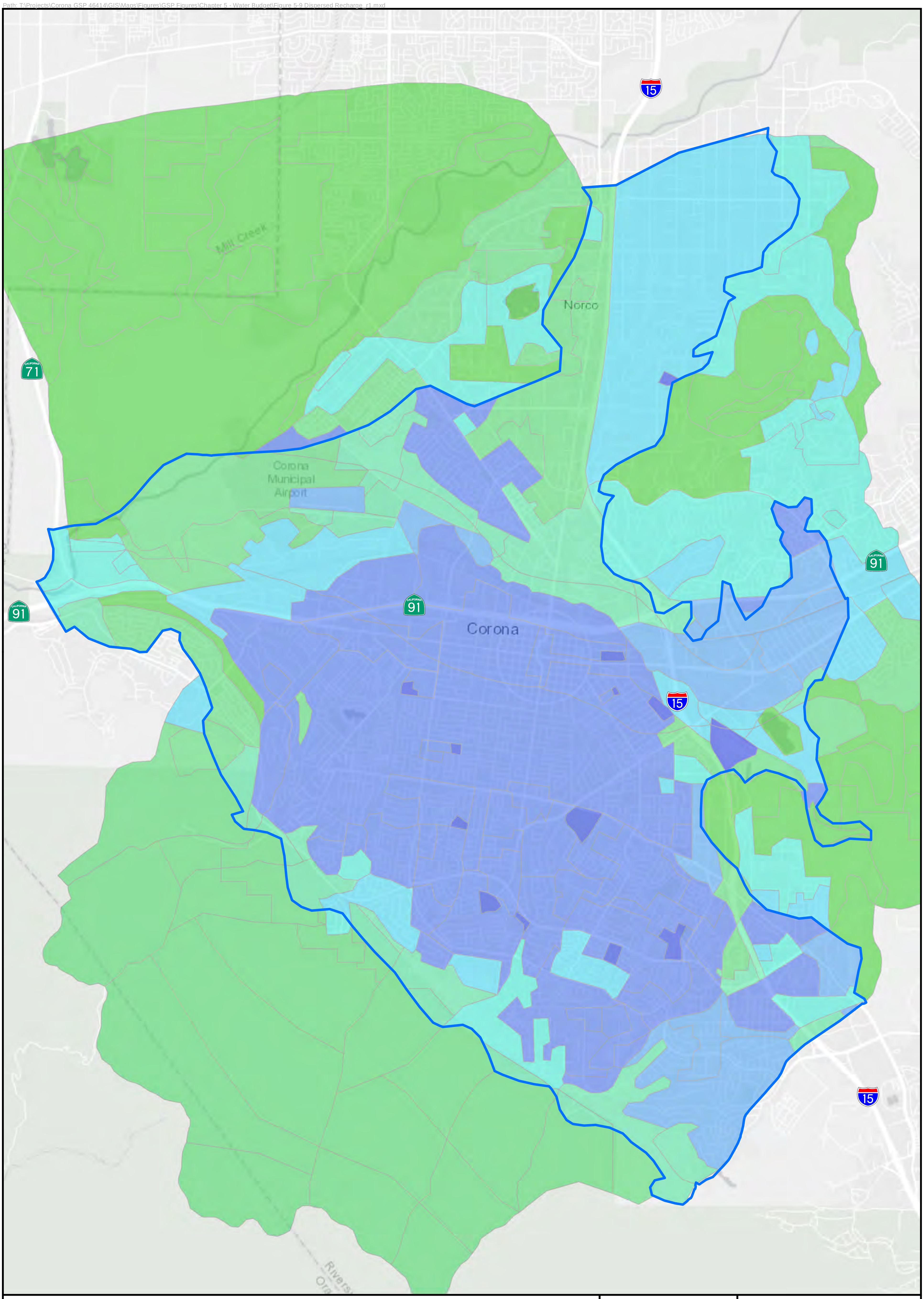
TODD GROUNDWATER

Figure 5-7
Annual Groundwater Budgets
Future Baseline



TODD GROUNDWATER

Figure 5-8
Annual Groundwater Budgets, Growth Plus Climate Change

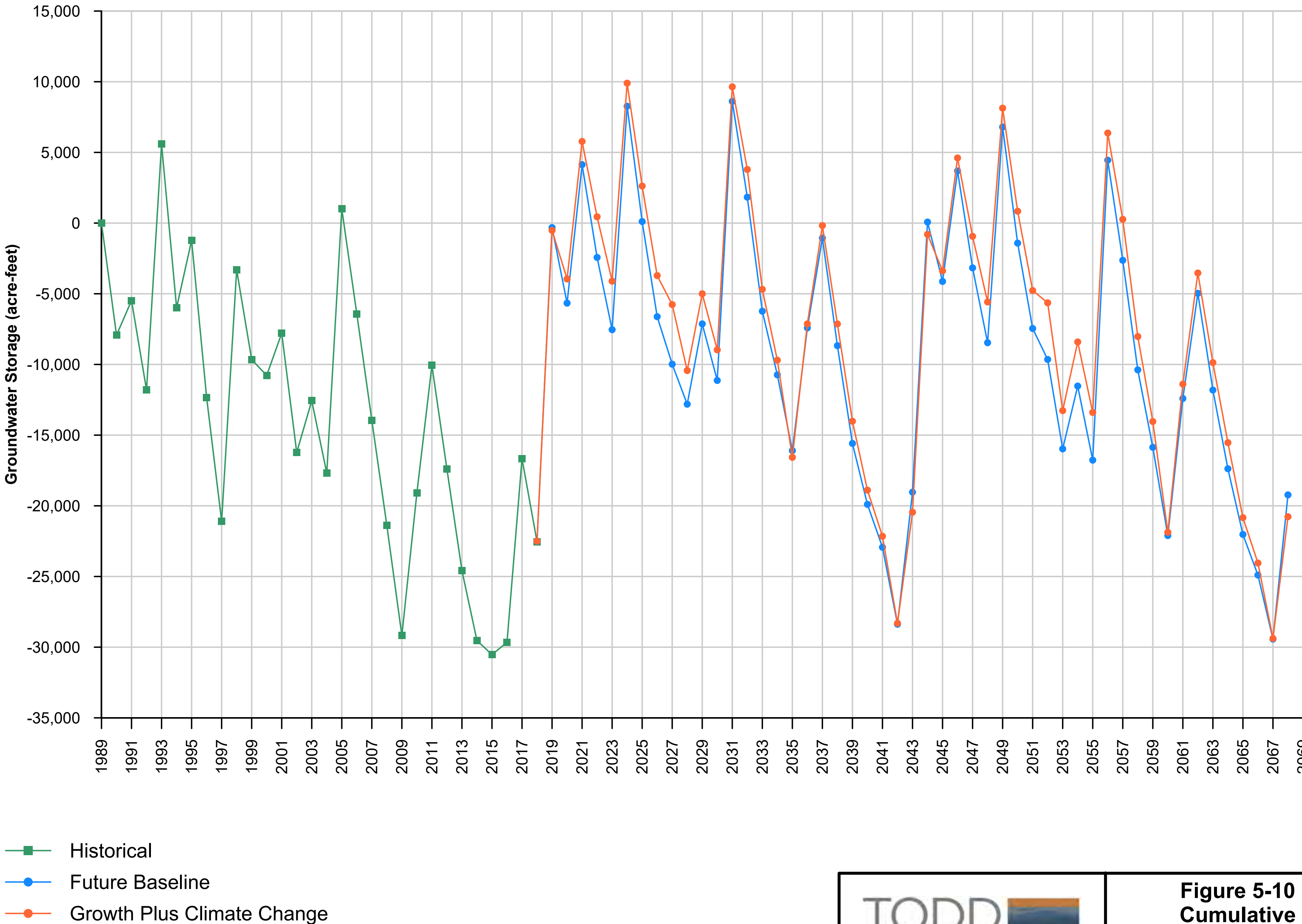


Average Annual Dispersed Recharge 1993-2007 (in/yr)

- 0 - 0.3
- 0.3 - 1
- 1 - 2
- 2 - 3
- 3 - 4
- 4 - 5
- 5 - 8
- 8 - 13
- Temescal Basin

Figure 5-9
Dispersed Recharge

TODD GROUNDWATER



TODD GROUNDWATER

Figure 5-10
Cumulative Storage Changes 1990 to 2068

6. SUSTAINABLE MANAGEMENT CRITERIA

The Sustainable Groundwater Management Act (SGMA) defines sustainable management as the use and management of groundwater in a manner that can be maintained without causing *undesirable results*, which are defined as significant and unreasonable effects caused by groundwater conditions occurring throughout a groundwater basin:

- Chronic lowering of groundwater levels indicating a significant and unreasonable depletion of supply
- Significant and unreasonable reduction of groundwater storage
- Significant and unreasonable seawater intrusion
- Significant and unreasonable land subsidence that substantially interferes with surface land uses
- Significant and unreasonable degraded water quality, including the migration of contaminant plumes that impair water supplies
- Depletions of interconnected surface water that have significant and unreasonable adverse impacts on beneficial uses of the surface water

For these sustainability indicators[4], a Groundwater Sustainability Plan (GSP) must develop quantitative sustainability criteria that allows the Groundwater Sustainability Agency (GSA) to define, measure, and track sustainable management. These criteria include the following:

- Undesirable Result – significant and unreasonable conditions for any of the six sustainability indicators
- Minimum Threshold (MT[5]) – numeric value used to define undesirable results for each sustainability indicator
- Measurable Objective (MO) – specific, quantifiable goal to track the performance of sustainable management
- Interim Milestone – target value representing measurable groundwater conditions, in increments of five years, set by the GSA as part of the GSP.

Together, these sustainability criteria provide a framework to define sustainable management, delineate between favorable and unfavorable groundwater conditions, and support quantitative tracking that identifies problems promptly, allows assessment of management actions, and demonstrates progress in achieving the goal of sustainability.

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[4] If one or more undesirable results can be demonstrated as not present and not likely to occur, a GSA is not required to establish the respective sustainability criteria per GSP Regulations §354.26(d); in the inland Temescal Basin seawater intrusion is not present and not likely to occur.

[5] The abbreviations for Minimum Threshold (MT) and Measurable Objective (MO) are provided because these terms are used often; however, the full unabbreviated term is used when helpful for clarity or when included in a quotation.

6.1. SUSTAINABILITY GOAL

The sustainability goal can be described as the mission statement of the GSA for managing the Basin; it embodies the purpose of sustainably managing groundwater resources and reflects the local community's values—economic, social, and environmental. The sustainability goal for the Temescal Subbasin (Basin), stated below, was developed through discussion at several public meetings with the GSA and the Technical Advisory Committee (TAC).

6.1.1. Description of Sustainability Goal

To sustain groundwater resources for the current and future beneficial uses of the Basin in a manner that is adaptive and responsive to the following objectives:

- Provide a long-term, reliable and efficient groundwater supply for municipal, industrial, and other uses
- Provide reliable storage for water supply resilience during droughts and shortages
- Protect groundwater quality
- Support beneficial uses of interconnected surface waters, and
- Support integrated and cooperative water resource management.

This goal is consistent with SGMA and is based on information from the Plan Area, Hydrogeologic Conceptual Model, Groundwater Conditions, and Water Budget sections of this GSP that:

- Identify beneficial uses of Temescal Basin groundwater and document the roles of local water and land use agencies
- Describe the local hydrogeologic setting, groundwater quality conditions, groundwater levels and storage, and inflows and outflows of the Basin
- Document the ongoing water resource monitoring and conjunctive management of groundwater, local surface water, recycled water and especially imported water sources that help protect groundwater quality and maintain water supply.

6.1.2. Approach to Sustainability Indicators

The approach to assessing the sustainability indicators and setting the sustainability criteria has been based on 1) review of available information from the Plan Area, Hydrogeologic Conceptual Model, Groundwater Conditions, and Water Budget sections of this GSP and 2) discussions with Temescal Basin stakeholders and local agency representatives, for example at TAC meetings and workshops.

This approach has developed since mid-2020 and generally began with definition of what an undesirable result is; this initially has been exploratory and qualitative and based on plain-language understanding of what *undesirable* means. Potential minimum thresholds have been explored in terms of when, where, how long, why, under what circumstances, and what beneficial use is adversely affected. This step identified seawater intrusion as not present and not likely to occur.

Beyond a qualitative identification of undesirable, the approach to defining sustainability indicators varies among the undesirable results. Several of the undesirable results are directly or indirectly related to groundwater levels, including conditions related to groundwater storage, subsidence, and interconnected surface water. The definition began in terms of groundwater levels in individual wells but has recognized that storage depletion, subsidence, and impacts on connected surface water occur as water levels decline. As a result, the sustainability criteria for those indicators are interrelated across space and time, coordinated and as consistent as is reasonable and as available data allow.

The consideration of the causes and circumstances of undesirable results is important in the Basin particularly for groundwater quality because general quality is poor throughout much of the Basin and has been poor for decades. Sustainable management relating to groundwater quality is all about use and management of groundwater without *causing* undesirable results but does not necessarily include reversing natural undesirable conditions. Moreover (per SGMA §10727.2(b)(4)), a GSP may but is not required to address undesirable results that occurred before and have not been corrected by the SGMA benchmark date of January 1, 2015.

While native groundwater quality is poor, salt and nitrate loading are recognized as potential sources of groundwater quality deterioration throughout much the Basin. Such loading has been occurring for more than 100 years, however changes in groundwater quality at depth (where groundwater typically is pumped) will lag behind the salt and nutrient loading at the ground surface by decades. This means that groundwater quality monitoring data can be misleading, sustainability criteria potentially could be reactive to decades-old land use conditions and insensitive to the future, and the effects of management activities will not be seen for decades. Given all that, implementation of management actions is recognized as needed and such actions will be helpful in the long term.

Another important aspect to defining sustainability criteria has been considering what we know and more importantly what we don’t know about undesirable results that may be detected or may potentially occur in the Basin. From a big picture perspective, the Basin is well managed—historical groundwater levels have been largely stable, subsidence has not been perceived, groundwater storage has been managed such that recent drought impacts have been minimized, local groundwater quality degradation is being addressed through treatment and blending, and inter-connected surface water and groundwater dependent ecosystems (GDEs) are being maintained. While water resource monitoring has been useful and adaptive, significant data gaps and uncertainties exist. Because groundwater conditions are regarded generally as good and because considerable uncertainties exist, the process of setting sustainability criteria has been directed toward open discussion of uncertainties, in-depth identification of data gaps and the means to fill them, and a strong intention for flexibility and adaptive management.

The intent is to quantify and qualify sustainability criteria such that they guide good management without setting off false alarms or triggering costly, ineffective, or harmful management actions.

6.1.3. Summary of Sustainable Management Criteria

This section documents the six sustainability criteria as relevant to the Basin and as guided by the Sustainability Goal. The GSAs have managed the Basin without experiencing undesirable results, but continuation and improvement is needed of existing management actions—most notably continuing to use imported water and its conjunctive use with groundwater. It also will include improvement and expansion of management actions and monitoring; these are addressed for each sustainability criterion's Measurable Objective in a subsection, Discussion of Monitoring and Management Measures to be Implemented.

While significant and unreasonable undesirable results have not been experienced in the Basin, the following sustainability criteria are defined in this section because potential exists for undesirable results.

- The Minimum Threshold relative to **chronic lowering of groundwater levels** is defined at designated Key Wells by historical groundwater low levels. Undesirable results are indicated when two consecutive exceedances occur in each of two consecutive years, in 60 percent or more of the Key Wells. The Measurable Objective is to maintain groundwater levels above the MTs and to maintain groundwater levels within the historical operating range.
- The Minimum Threshold for **reduction of storage** is fulfilled by the minimum threshold for groundwater levels as proxy. The Measurable Objective for storage is fulfilled by the MT for groundwater levels, which maintains groundwater levels within the historical operating range.
- The Minimum Threshold for **land subsidence** is defined as a rate of decline equal to or greater than 0.2 feet (ft) in any five-year period. This has been considered in terms of a potential cumulative decline equal to or greater than one foot of decline since 2015; 2015 represents current conditions and the SGMA start date. The extent of cumulative subsidence across the Basin will be monitored and evaluated using Interferometric Synthetic Aperture Radar (InSAR) data. Subsidence is closely linked to groundwater levels and it is unlikely that significant inelastic subsidence would occur if groundwater levels remain above their minimum thresholds.
- The Minimum Thresholds for **degradation of water quality** address nitrate and total dissolved solids (TDS). The MT for nitrate is defined initially as no statistically significant increase in the percentage of wells with 5-year average concentrations exceeding the nitrate maximum contaminant limit (MCL) of 45 milligrams per liter (mg/L) based on current conditions (2015 through 2019). The MT for TDS is defined initially as no statistically significant increase in the percentage of wells with 5-year average concentrations exceeding the TDS Secondary MCL of 1,000 mg/L based on current conditions. The Measurable Objectives for both are defined as maintaining or reducing the percentage of wells with average concentrations exceeding the MTs.
- The Minimum Threshold for **depletion of interconnected surface water** is defined as a depth to water of 15 feet in shallow monitoring wells in the southern Prado

area, where declines to lower water levels are correlated with Temescal Basin pumping and/or water levels.

6.2. CHRONIC LOWERING OF GROUNDWATER LEVELS

Chronic lowering of groundwater levels can indicate significant and unreasonable depletion of supply, causing undesirable results to domestic, industrial, or municipal groundwater users if continued over the planning and implementation horizon. As a clarification, drought-related groundwater level declines are not considered chronic if groundwater recharge and discharge are managed such that groundwater levels recover fully during non-drought periods.

Declining groundwater levels directly relate to other potential undesirable effects (for example regarding groundwater storage, land subsidence and interconnected surface water); these are described in subsequent sections. Effects on well users are described here.

Groundwater elevation trends in Basin are documented in Groundwater Conditions Section 4.1; hydrographs of representative wells are presented for the Basin. The Basin is not characterized by overdraft with widespread chronic groundwater level declines. Groundwater levels in broad areas of the Basin have been maintained at relatively high levels because of the availability of imported water supplies. In addition, while groundwater level declines still occur with dry and critically-dry years, recent drought-related declines have not been as rapid or deep as in previous droughts. Many areas of the Basin experienced record lows during the most recent drought. However, the Basin was not marked by reports of significant water level decline impacts to production wells.

6.2.1. Description of Undesirable Results

As groundwater levels decline in a well, a sequence of increasingly severe undesirable results will occur. These include an increase in pumping costs and a decrease in pump output (in gallons per minute). With further declines, the pump may break suction, which means that the water level in the well has dropped to the level of the pump intake. This can be remedied by lowering the pump inside the well, which can cost thousands of dollars. Chronically declining water levels will eventually drop below the top of the well screen. This exposes the screen to air, which can produce two adverse effects. In the first, water entering the well at the top of the screen will cascade down the inside of the well, entraining air; this air entrainment can result in cavitation damage to pumping equipment. The other potential adverse effect is accelerated corrosion of the well screen. Corrosion eventually creates a risk of well screen collapse, which would likely render the well unusable. If water levels decline by more than about half of the total thickness of the aquifer (or total length of well screen), water might not be able to flow into the well at the desired rate regardless of the capacity or depth setting of the pump. This might occur where the thickness of basin fill materials is relatively thin. While describing a progression of potential adverse effects, at some point the well no longer fulfills its water supply purpose and is deemed to have “gone dry.” For the purposes of this discussion, a well going dry means that the entire screen length (to the bottom of the deepest screen) is unsaturated.

For purposes of setting a Minimum Threshold, undesirable results are defined as a well going dry. This appears to be a low standard and not protective of private wells; but this is an initial definition to start the analysis. The rationale is summarized as follows with more explanation in the following sections:

- There are very few active private wells in the Basin (see Section 2.3.2.1). The owners and operators of those wells are known and they have not reported any adverse effects to those wells in the past.
- None of the existing private well owners report that their wells went dry or were otherwise affected during the recent drought. Because of this, some flexibility exists for purposes of analysis.
- Responsibility for potential undesirable results to shallow wells is shared between a GSA and a well owner; there is a reasonable expectation that a well owner would construct, maintain, and operate the well to provide its expected yield over the well's life span, including droughts.
- As discussed below, MTs are set at historical groundwater level lows.
- No private wells have been reported to have water shortages for the Basin in the DWR led *Household Water Supply Shortage Reporting System* (DWR 2021), Including during recent dry periods corresponding to historical groundwater level lows in some monitored wells.

6.2.2. Potential Causes of Undesirable Results

For the Basin, the primary potential cause of groundwater level undesirable results would be reduction of surface water supplies and associated increase in groundwater use and reduction in groundwater recharge from return flows. Reduction of imported water could have direct adverse impacts on municipal and industrial water users throughout the Basin.

Given that the Basin is not characterized by basin-wide chronic groundwater level declines, then the undesirable results of a well losing yield, having damage, or "going dry" represent a more complex interplay of causes and shared responsibility.

Some of the potential causes are within GSA responsibility; most notably, a GSA is responsible for groundwater basin management without causing undesirable results such as chronic groundwater level declines. SGMA also requires that a GSA address significant and unreasonable effects caused by groundwater conditions *throughout the basin.* This indicates that a GSA is not solely responsible for local or well-specific problems and furthermore that responsibility is shared with a well owner. A reasonable expectation exists that a well owner would construct, maintain, and operate the well to provide its expected yield over the well's life span, including droughts, and with some anticipation that neighbors also might construct wells (consistent with land use and well permitting policies). As indicated above, there are very few active private wells in the Basin and those wells have not shown impacts in the past.

6.2.3. Definition of Undesirable Results

As context, the Basin Sustainability Goal has the objective to provide a long-term, reliable and efficient groundwater supply for municipal, industrial, and other uses.

In that light, the definition of undesirable results would be the chronic lowering of groundwater levels indicating a significant and unreasonable depletion of supply if continued over the planning and implementation horizon. This is defined by groundwater conditions occurring throughout the Basin. This definition also recognizes that chronic lowering of groundwater levels could affect groundwater flow to or from the hydraulically connected Bedford-Coldwater, Chino, and Coastal Plain of Orange County basins, and thereby potentially affect the maintenance of sustainability in those basins.

As documented in Groundwater Conditions Section 4.1, analysis of hydrographs reveals that the Basin is not characterized by basin-wide chronic groundwater level declines. While affected at times by drought, groundwater levels in broad areas of the Basin have been maintained at relatively high levels because of the availability of imported water. Moreover, the Basin has not been marked by reports of significant water level decline impacts to shallow supply wells. In the absence of reported well problems, it can be concluded that undesirable results for the chronic lowering of water levels are not occurring in Basin and that the Basin is managed sustainably relative to groundwater levels.

While water levels have declined slightly in recent years due to dry climatic conditions, modeling of future expected conditions show these declines are not expected to continue in the future (see Chapter 5). This finding is consistent with the water budget analyses that indicate (within the range of uncertainty) balanced inflows and outflows in the future.

6.2.4. Potential Effects on Beneficial Uses and Users

Groundwater is a significant source of supply in the Basin and supplies wells municipal, industrial, and other beneficial uses. Groundwater has been and is being used for the range of beneficial uses, even during drought, and with reasonable operation and maintenance by well owners. Historically, changes in water levels in production wells have not correlated with changes in vegetation health or density in the Prado Wetlands (see Sections 4.10.4). The mutual consistency of the water-level MT and interconnected surface water MT is discussed in Section 6.7.4.

6.2.5. Sustainable Management Criteria for Groundwater Levels

The general approach to defining sustainability criteria (minimum thresholds and measurable objectives) for groundwater levels has involved selection of representative monitoring wells (Key Wells), review of groundwater level data, and review of supply well location/construction information to gage potential undesirable effects on wells. Specifically, this has included evaluating historical low levels in Key Wells. This approach is founded on the idea that undesirable results were not reported when groundwater elevations were at their minimum values and therefore returning to those minima should not cause undesirable results in the future.

6.2.5.1. Selection of Key Wells

The approach includes selection of existing monitored wells within the Basin that are or represent active supply wells. Sustainability criteria would be defined for each of these Key Wells and each would be monitored for groundwater levels with respect to MTs and MOs. The Key Wells (**Figure 6-1**) have been identified by reviewing groundwater level hydrographs from all currently monitored wells and selecting wells that have a long, reliable, and recent record of groundwater level monitoring, that represent local or regional trends, and that together provide a broad geographic distribution for the Principal Aquifer, the Secondary Aquifer, and the Basin as a whole. The distribution of these wells also has been reviewed with respect to maps showing density of wells across the Basin (e.g., **Figures 2-5** through **2-8**). These wells are mostly production wells, which is not optimal for monitoring; on the other hand, they are generally representative of production wells.

Groundwater level data and hydrographs of each Key Well have been reviewed to identify the all-time lowest groundwater elevation at each Key Well. As discussed in Groundwater Conditions Section 4.1.3, historical minima in many wells were recorded with the most recent drought, which implies that most currently active wells in the Basin would have experienced those historical minima.

The identified historical low at each Key Wells (i.e., historical maximum depth to water) represents the first approximation of a minimum threshold, with the realization that the final selection of the MT for a Key Well could be adjusted upward to be more protective of nearby supply wells.

6.2.5.2. Evaluation of Existing Wells

Existing wells in the Basin were assessed in the development of water level sustainability criteria. The California Department of Water Resources (DWR) has developed a database of information relating to well locations, use, construction, yield, and other information. By way of background, information on local supply wells has been recorded on Water Well Drillers Reports and is available mostly as paper or scanned copies. DWR has identified 383 individual paper records for wells in the Basin. However, detailed information from most of these records has not been digitized.

Accurate data on the location and elevation of most wells is not available. Most of the wells identified by DWR within the Basin have only been located to the center of a Public Land Survey System (PLSS) section. As a result, precise locations relating to Basin aquifer units and Key Wells are unknown.

In addition, construction information on most wells has not been entered into databases where it can be analyzed readily, and the status of wells is not known. Currently, DWR only has digitized construction information for 53 domestic, agricultural, or other production wells within the Basin. The current status of these wells is unknown, and most are fairly old. Of the 53 domestic, agricultural, or other production wells in the Basin with construction records in the DWR database, only seven were constructed after January 1, 2000 and 41 of the 53 were constructed before 1990. As described in Water Budget Section 5, land use and groundwater production has changed significantly since the late 1980s. Additionally, the GSA agencies are the municipal water purveyors in the Basin and in this capacity they have assessed the presence of private domestic wells in the Basin; no existing active private domestic wells were identified through this assessment.

Given the age of the existing wells, they should have been present during the recent historical groundwater level minima in the Basin. In fact, DWR records indicate that only three wells have been constructed in the Basin since the end of the recent drought. One of these wells (Corona Well 32) is a municipal supply well and the other two are listed as landscape irrigation wells. Given the age of most of the wells in the Basin, the historical minima in Key Wells are deemed to be protective with regard to groundwater level declines. As discussed in Sections 6.2.1 and 6.2.2, groundwater level declines involve a continuum of potential impacts that range from those effects not noticed by the well owner to those that are noticed and reasonably handled by the well owner.

6.2.6. Minimum Thresholds

According to GSP Regulations Section 354.28(c)(1) the minimum threshold for chronic lowering of groundwater levels must be the groundwater elevation indicating a depletion of supply at a given location that may lead to undesirable results. MTs for chronic lowering of groundwater levels are to be supported by information on the rate of groundwater elevation decline based on historical trends, water year type, and projected water use in a basin. However, as documented in the Groundwater Conditions Section 4.1.3, groundwater levels are not chronically declining in the Basin. While groundwater levels decline in dry and critically-dry years, they have recovered in normal, above normal, and wet years. Groundwater levels in many Key Wells were at historical lows during the recent drought (thereby defining the respective MT) but all have since recovered.

Under current conditions, groundwater levels in Key Wells are above the MTs and no undesirable results are known to occur. Nonetheless, MTs have been developed because the potential exists for chronic lowering of groundwater levels.

Using recent and reliable information on the construction of existing supply wells, the MT levels shown in **Table 6-1** are protective of most supply wells, based on available information. The MTs are based on historical low groundwater levels or levels that are higher. Because of this, the MTs are not only protective of local wells but also would help minimize potential impacts on groundwater flow to or from other area, such as the neighboring basins.

Based on historical lows, the MTs account for historical groundwater level variations, and consideration has been given to supporting basin management flexibility, for example to avoid setting off false alarms or triggering costly, ineffective, or harmful management actions. However, MTs have not been adjusted downward at this time, although periods of record for some groundwater level hydrographs are short and may not include actual historical lows that could recur.

Table 6-1. Minimum Thresholds for Groundwater Levels

Local Well Name	Earliest Monitoring Date	Average Depth to Groundwater (ft bgs)	Pump Intake Depth (ft bgs)	Date of Static Maximum Depth to Groundwater	Maximum Static Depth to Groundwater (ft bgs)
Corona 7A	6/1/2002	156.84	230	1/1/2003	178
Corona 8	12/13/2012	112.6	No Pump	5/4/2014	129.5
Corona 8A	1/1/1998	119.69	192	10/1/2001	131
Corona 9A	7/1/2002	80.72	220	7/1/2002	159
Corona 11	7/18/1959	134.14	180	9/13/2017	158
Corona 11A	12/6/2017	143.48	221.2	5/31/2014	155.2
Corona 12A	3/1/1993	158.59	280.3	11/2/2005	164
Corona 13	2/1/1977	141.19	182	6/1/1989	174
Corona 14	2/1/1924	184.92	250	5/1/2009	239
Corona 15	8/13/1952	116.63	171.6	12/1/2004	134
Corona 16	12/13/2012	140.3	No Pump	7/2/2018	159.5
Corona 17A	6/1/2002	110.63	182	5/13/2006	125
Corona 19	4/1/1992	102.73	200	9/1/2003	124.5
Corona 22	4/1/2001	150.19	387	5/1/2004	153.3
Corona 25	4/1/2001	61.71	180	7/1/2003	161.5
Corona 26	5/1/2001	136.86	333	10/1/2004	122
Corona 27	3/1/2003	154.19	436.7	3/3/2020	211
Corona 28	3/1/2003	90.59	174	9/6/2016	95.2
Corona 29	3/18/2009	88.63	230	8/1/2018	88.2
Corona 30	8/28/2009	56.9	No Pump	4/24/2014	70.6
Corona 31	3/18/2009	95.13	217	8/7/2009	132.2
Corona 33	3/13/2019	58.8	255	2/4/2020	68.1
Corona 10th/Lincoln	11/17/2011	197.5	No Pump	9/21/2013	204

6.2.6.1. Minimum Thresholds and Criteria for Undesirable Results

Undesirable results are based on exceedances of MT levels and must be defined not only in terms of how they occur (see Section 6.2.2 Potential Causes of Undesirable Results), but also when and where. By definition, undesirable results are not just drought-related but chronic and are not just local but basin-wide.

The distinction between drought and chronic declines may not be clear when declines are occurring, particularly during drought when it is not known whether subsequent years will bring recovery. Moreover, effects of declining levels on individual well owners may be real problems, whether or not they represent basin-wide sustainability issues.

The groundwater level monitoring program in the Basin is currently primarily monthly, with some wells monitored quarterly. These data will be incorporated into annual GSP reporting as required by SGMA and discussed in Section 7 of this GSP. Accordingly, groundwater level monitoring and annual reporting provides an early warning system that allows response by the GSA and local groundwater users. From this perspective, two consecutive exceedances in each of two consecutive years is regarded as indicating when an undesirable result is occurring. The exceedances would be measured at a Key Well as part of the regular quarterly monitoring program. It should be noted that GSA responses do not have to wait for two years and may involve a staged response as in urban water shortage contingency plans.

To summarize for the Basin:

> The **Minimum Threshold** for defining undesirable results relative to chronic lowering of groundwater levels is defined at each Key Well by historical groundwater low levels. Undesirable results are indicated when two consecutive exceedances occur in each of two consecutive years, in sixty percent or more of the Key Wells.

6.2.6.2. Relationship of Minimum Threshold to Other Sustainability Indicators

The establishment of MTs also needs to consider potential effects on other sustainability indicators. These indicators are discussed later in this section; the following are brief discussions.

- **Groundwater Storage**. The MTs for groundwater levels are protective of groundwater storage. These MTs are defined in terms of historical groundwater low levels and groundwater storage is recovering following the recent historical lows; it is not being depleted. The major concern expressed in the Sustainability Goal is to have reliable storage for drought or shortage; the MTs for groundwater levels will maintain groundwater levels and thus storage, too.
- **Seawater Intrusion.** There is no possibility of seawater intrusion in the Basin. Accordingly, there is no seawater intrusion minimum threshold and no relationship with other minimum thresholds.
- **Subsidence.** Subsidence is closely linked to groundwater levels. It is unlikely that significant inelastic subsidence would occur if groundwater levels remain above

historical levels, which have been used to define groundwater level MTs. Accordingly, the minimum threshold for groundwater levels is consistent with and supportive of the objective to prevent subsidence undesirable results.

- **Water Quality.** General relationships are recognized, for example that contaminants may be mobilized by changing groundwater levels or flow patterns. Maintenance of groundwater levels above historical low levels and within historical ranges would minimize any effects on maintenance of water quality at or above minimum thresholds. The groundwater quality issues in the Basin are associated primarily with salt and nutrient loading and not likely to be affected by groundwater levels or flow within historical ranges.
- **Interconnected Surface Water.** The minimum thresholds for interconnected surface water are shallow groundwater levels in the southern portion of the Prado Wetlands. The storage reduction minimum threshold does not propose decreased groundwater elevations below historical levels, so groundwater levels are expected to remain within the historical range. This means that water table depths in the Prado Wetlands will remain within the historical range, which was adequate to maintain the vegetation in good health.

6.2.6.3. Effect of Minimum Threshold on Sustainability in Adjacent Areas

The Basin shares portions of its boundary with four other basins, the Bedford-Coldwater Basin to the south, the Riverside-Arlington Basin along the Arlington Gap to the east, the Chino Basin on the north, and Coastal Plain of Orange County Basin along the canyon between the Chino Hills and Santa Ana Mountains. Groundwater flows are generally north and west, from the Bedford-Coldwater Basin and from the Chino and Riverside-Arlington basins into the Basin. Bedrock is very shallow in the canyon connecting the Basin to the Coastal Plain of Orange County Basin, forcing groundwater into the Santa Ana River and Wardlow Wash, so little subsurface outflow occurs along this boundary. The groundwater level MTs would support maintenance of groundwater levels above their respective MTs throughout the Basin. This in turn will support maintenance of groundwater levels in all four neighboring basins.

6.2.6.4. Effect of Minimum Threshold on Beneficial Uses and Users

Groundwater is the major source of supply in the GSP Area and supplies wells for municipal, industrial, and other beneficial uses and users. The MTs are based on historical lows, which recognizes that groundwater has been and is being used reasonably for the range of beneficial uses even during drought, and with reasonable operation and maintenance by well owners. The MTs quantify undesirable results as involving two consecutive exceedances in each of two consecutive years, which provides early warning of declining groundwater levels.

6.2.6.5. Relationship of Minimum Threshold to Regulatory Standards

No federal, state or local standards exist for groundwater levels.

6.2.6.6. How Management Areas Can Operate without Causing Undesirable Results

Management areas have not been defined for the Basin so the establishment of MTs has been consistently conceived and applied to the entire Basin.

6.2.6.7. How the Minimum Threshold will be Monitored

Monitoring for the groundwater levels MT will be conducted as part of the ongoing groundwater level monitoring programs performed by the GSA agencies, data and analytical results will be presented in annual reports.

6.2.7. Measurable Objectives

MOs are defined herein as an operating range of groundwater levels, allowing reasonable fluctuations with changing hydrologic and surface water supply conditions and with conjunctive management of surface water and groundwater. The groundwater level MTs represent the bottom of the operating range and are protective of well owners and groundwater users. The top of the operating range is generally where the water table approaches the soil zone and ground surface, except where groundwater and surface water are interconnected or groundwater dependent ecosystems exist. Section 6.7 addresses these areas and potential undesirable results with Depletions of Interconnected Surface Water. With these important exceptions, the top of the operating range is below the soil zone, thereby minimizing potential agricultural drainage problems.

> The **Measurable Objective** is to maintain groundwater levels above the groundwater level MTs (as quantified above or the interconnected surface water MTs, whichever is higher at the relevant measurement event), and to maintain groundwater levels within the operating range as defined in this section.

Groundwater conditions with respect to chronic groundwater level declines are already sustainable. Therefore, no interim milestones are needed to achieve sustainability by 2042.

6.2.7.1. Discussion of Monitoring and Management Measures to be Implemented

Management actions to maintain groundwater levels have been ongoing and effective for decades. These actions (consistent with the Sustainability Goal objective to support integrated and cooperative water resource management) have included developing local surface water for percolation, acquiring imported water for direct use, providing recycled water for irrigation, and other conjunctive use operations. The GSA agencies also have education and outreach programs to promote water use efficiency and to reduce water demand.

Monitoring measures for water levels are discussed in Section 7.

6.3. REDUCTION OF GROUNDWATER STORAGE

Groundwater storage is the volume of water in the Basin; it provides a reserve for droughts or surface water supply shortages. The MT for reduction of groundwater storage is the volume of groundwater that can be withdrawn from a Basin without leading to undesirable results. Undesirable results would involve insufficient stored groundwater to sustain beneficial uses through drought or shortage. The storage criteria are closely linked to groundwater levels. The sustainability indicator for groundwater storage addresses the ability of the groundwater Basin to support existing and planned beneficial uses of groundwater, even during drought and surface water supply shortage.

The water budget has been calculated using the numerical model, as described in Water Budget Chapter 5. In brief, this has included analyses of the cumulative change in storage for the historical and current period, 1993 through 2017, and for simulated future conditions. The future water budget analyses have shown the dynamic effects of drought and changes in groundwater use and indicate that groundwater storage in the Basin can be sustainably managed relative to storage. The water budget inflow and outflows have been balanced over the long term under expected future conditions. Furthermore, as indicated in Section 6.2, none of the water supply wells have been reported as going dry in the Basin during the historical period of record. No private wells have been reported to have water shortages for the Basin in the DWR led *Household Water Supply Shortage Reporting System* (DWR 2021).

6.3.1. Description of Undesirable Results

Given that the Basin has not experienced any impacts to wells related to groundwater storage, the undesirable result associated would be an insufficient supply to support beneficial uses during droughts. Storage is related to groundwater levels. Thus, undesirable results associated with storage would likely be accompanied by one or more undesirable results associated with groundwater levels, including reduced well yields, subsidence, and depletion of interconnected surface water.

6.3.2. Potential Causes of Undesirable Results

For groundwater storage in the Basin, the basic cause of undesirable results would be an imbalance of the water budget, such that outflows exceed inflows resulting in reduction of groundwater storage that adversely affects beneficial uses in the Basin. This imbalance could be caused in turn by reduced surface water supplies and associated groundwater recharge. Such reduction could potentially include the following conditions: 1) increased pumping due to disruption of imported water, 2) reduced percolation from Temescal Wash, 3) reduced natural recharge due to increased impervious area (development), or 4) increased pumping due to reduced recycled/non potable discharge and use. Undesirable results also could occur because of changes in land use causing increased demand for groundwater; this would be most problematic if these land uses do not have access to water supplies other than groundwater.

6.3.3. Definition of Undesirable Results

Undesirable results are defined with the understanding that the objective of groundwater management is to provide reliable storage for water supply resilience during droughts and shortages. Accordingly, the definition of potential undesirable results for storage reduction includes consideration of how much storage has been used historically (i.e., operating storage) and how much stored groundwater reserve is needed to withstand droughts.

In thinking about conceptual operating storage or groundwater reserves, it is important to bear in mind that these are not the total amount of groundwater that could potentially be extracted from the Basin. Most wells are in the range of 50 to 700 feet deep.

The depth of the Basin ranges from near zero feet in some areas to more than 1,200 feet in others (see **Figure 3-11**). Groundwater wells used for water supply are generally located in the Channel Aquifer portions of the Basin (see **Figure 3-10**). Additional groundwater storage could be utilized, with the foremost assumption that withdrawals and reduction are followed by commensurate recharge and recovery. This could occur as part of enhanced conjunctive use programs.

6.3.4. Potential Effects on Beneficial Uses and Users

Groundwater is a source of water supply in the GSP Area and supplies wells for municipal, industrial, and other beneficial uses. Reduction of groundwater storage would reduce access to that supply with adverse effects on the community, economy, and environmental setting of the Basin. However, groundwater has been and is being used for the beneficial uses, even during drought.

6.3.5. Sustainable Management Criteria for Groundwater Storage

The general approach to defining sustainability criteria for groundwater storage has involved review of historical cumulative change in storage and expected future storage declines during droughts. Review of historical change in storage is revealing about how much storage has been used in the Basin, effectively defining an *operating storage*. Similarly, the approach focuses on the beneficial uses of the Basin and acknowledges much of the pumping occurs in larger municipal wells with dynamic operations. Sustainability criteria for groundwater levels also take into account historical ranges and the management of dynamic operation of municipal wells.

6.3.5.1. Description of Change in Storage: Historical and Future Conditions

Figure 5-10 shows the cumulative change in storage for historical conditions (1990 through 2017), the baseline future scenario, and the growth plus climate change future scenario as simulated by the numerical model. Starting from an assigned value of zero at the end of 1989, the storage change in each year is added to the cumulative total of the preceding years. Wet periods appear as upward trends or relative peaks in the cumulative total and droughts appear as downward trends or relative lows. Cumulative storage reached its minimum in 2016, corresponding with the 2014 to 2017 drought period. While the historical period shows a declining trend in storage over the period, the main causes of these declines, including severe dry climatic conditions and high pumping early in the simulation, are not expected to continue in the future.

Table 5-4 shows the average change in storage for the historical period (1993 through 2017), baseline, and the simulated future conditions (baseline and with future demand and supply assumptions).

The cumulative storage declined slightly in the historical period (1993 through 2017) due to increased groundwater pumping and reduced imported water, with an average loss of storage of 194 acre-feet per year (AFY) in the Temescal Basin. Simulated groundwater storage mostly recovered during the one to two years following droughts, but still showed a general decrease in groundwater storage due to increased groundwater production over the same time. Under the future baseline conditions, the average annual change in storage in the Basin is expected to be nearly balanced, with a very slight decrease of 65AFY resulting in stable storage conditions for the Basin over the period. While the overall change in storage is slightly negative, the annual change in storage shows that expected inflows and outflows are evenly balanced. In the future growth plus climate change scenario, the average annual change in storage is an increase of 34 AFY, very slightly larger than baseline conditions as urban growth increases municipal irrigation return flows. Adaptive management will be key to respond to changing conditions including unexpected decreases to natural inflows or unexpected increases in groundwater pumping.

Given the relative stability of storage in the most recent period (2008 to 2017), and future simulations showing expected increases in storage, the current groundwater management practices will likely continue to increase groundwater storage on average and recover from short term droughts on the order of one to five years.

6.3.6. Minimum Threshold

Undesirable results relative to groundwater storage have not occurred in the Basin and numerical modeling of future conditions indicate that groundwater storage can continue to be operated within historical limits. Nonetheless, the potential for reduction of groundwater storage exists (probably involving disruption of imported water supply) and thus this section considers minimum thresholds for storage. According to GSP Regulations, the minimum threshold for storage is to be defined as the maximum groundwater volume that can be withdrawn without leading to undesirable results.

However, GSP Regulations allow the use of the groundwater level sustainability criteria (MTs and MOs) as a proxy for groundwater storage, provided that the GSP demonstrates a correlation between groundwater levels and storage. Groundwater levels and storage are closely related. This is demonstrated by comparison of groundwater level and storage trends, which reveal the same patterns of historical response to drought and recovery. The relationship of levels and storage is embodied in the calibrated numerical model.

The rationale for using groundwater levels as a proxy metric for groundwater storage is that the groundwater level MTs and MOs are sufficiently protective to ensure prevention of significant and unreasonable results relating to storage. In brief, groundwater level MTs have been defined to protect supply wells (see Section 6.2.6) and are based on the following:

- A broad geographic distribution of Key Wells that are representative of Basin production wells
- MTs that are based on historical minimum groundwater levels, consistent with analyses of storage change

- Analysis of existing wells with construction information
- MTs are relatively shallow; as shown in **Table 6-1**, all MTs are relatively shallow in comparison to production well depths
- Groundwater level MTs include two consecutive exceedances in each of two years, providing early warning for storage changes, while also involving sixty percent or more of the Key Wells in the Basin, thus involving a broad area, consistent with storage change

As a practical matter, the availability of groundwater storage will be constrained by water levels (including groundwater level proxies for depletion of interconnected surface water) and given all the above, the MTs for groundwater levels are more than sufficiently protective of groundwater storage.

To summarize for the Basin:

> The **Minimum Threshold** for storage is fulfilled by the minimum threshold for groundwater levels. The **Minimum Threshold** for defining undesirable results relative to chronic lowering of groundwater levels is defined at each Key Well (two consecutive quarters in two years, providing early warning for storage changes, in 60 percent or more of the Key Wells).

The Sustainability Goal for the Basin includes an objective to provide reliable storage for water supply resilience during droughts and shortages. Use of groundwater levels as a proxy also fulfills that objective. No additional MT definition is needed.

6.3.6.1. Relationship of Minimum Threshold to Other Sustainability Indicators

- **Water Levels.** The minimum thresholds for groundwater levels are protective of the beneficial use of the Basin – municipal and industrial water supply; therefore, these levels are protective of and serve as a proxy for groundwater storage and the provision of reliable storage for drought and shortage.
- **Seawater Intrusion.** There is no possibility of seawater intrusion in the Basin. Accordingly, there is no minimum threshold and no relationship with other minimum thresholds.
- **Subsidence.** Subsidence is linked to groundwater levels. Because the storage reduction minimum threshold would not cause water levels to drop below their minimum thresholds, it would not interfere with the subsidence minimum threshold.
- **Water Quality.** Maintenance of groundwater storage within historical ranges would minimize any effects on water quality relative to water quality minimum thresholds. Groundwater quality issues in the Basin are associated primarily with salt and nutrient loading and not likely to be affected by groundwater storage within historical ranges.
- **Interconnected Surface Water.** The minimum thresholds for interconnected surface water are shallow groundwater levels in the southern portion of the Prado

Wetlands. The storage reduction minimum threshold does not propose decreased groundwater elevations below historical levels, so groundwater levels are expected to remain within the historical range. This means that water table depths in the Prado Wetlands will remain within the historical range, which was adequate to maintain the vegetation in good health.

6.3.6.2. Effect of Minimum Threshold on Sustainability in Adjacent Areas

As noted in Section 6.2.6.3, the Basin borders portions of the Bedford-Coldwater Basin to the south, the Riverside-Arlington Basin along the Arlington Gap to the east, the Chino Basin on the north, and Coastal Plain of Orange County Basin at the west where the Santa Ana River exists the Basin. The groundwater level MTs would support maintenance of groundwater levels above their respective MTs throughout the Basin. This in turn will support maintenance of groundwater levels and storage in all four neighboring basins.

6.3.6.3. Effect of Minimum Threshold on Beneficial Uses and Users

Beneficial uses and users of groundwater storage include maintenance of interconnected surface water and associated GDEs and municipal, industrial and other groundwater users. The MTs for groundwater levels are based on historical minima, which recognizes that groundwater has been and is being used reasonably for the range of beneficial uses even during droughts. The storage minimum threshold is consistent with the water level minimum threshold, which means that available storage will be adequate to supply beneficial uses as long as water levels remain above their minimum thresholds.

6.3.6.4. Relationship of Minimum Threshold to Regulatory Standards

Other than SGMA, no federal, state or local standards exist for reduction of groundwater storage.

6.3.6.5. How Management Areas Can Operate without Causing Undesirable Results

Management areas have not been defined for the Basin so the establishment of MTs has been consistently conceived and applied to the entire Basin.

6.3.6.6. How the Minimum Threshold will be Monitored

Monitoring for the groundwater levels MT, which is the proxy for storage, will be part of the GSA groundwater level monitoring program (see Chapter 7). Data and analytical results, including assessment of change in storage, will be presented in GSP Annual Reports.

6.3.7. Measurable Objectives

MOs would be defined as an operating range of groundwater storage, allowing changes in groundwater storage with varying hydrologic and surface water supply conditions and as with conjunctive management of surface water and groundwater. The groundwater level MTs provide a protective level that corresponds to the minimum threshold for storage, which would keep groundwater storage within the historical operating range. The Five-Year GSP Update could include consideration of using more of this storage locally as part of ongoing conjunctive use while also protecting shallow wells.

The **Measurable Objective** for storage is fulfilled by the MT for groundwater levels, which maintains groundwater levels above the historical maximum groundwater depths in each Key Well (as quantified in **Table 6-1**).

Groundwater conditions with respect to depletion of groundwater storage are already sustainable. Therefore, no interim milestones are needed to achieve sustainability by 2042.

6.3.7.1. Discussion of Monitoring and Management Measures to be Implemented

Monitoring and management actions to prevent chronic reduction of groundwater storage and to provide groundwater reserves for drought will be the same as those for maintenance of groundwater levels. No other specific management actions for storage have been identified and no specific implementation is warranted.

6.4. SEAWATER INTRUSION

Seawater intrusion does not occur in the Basin because of its inland location. According to the GSP Regulations, the GSP is not required to establish criteria for such undesirable results that are not likely to occur. Accordingly, the remaining discussion in this section does not address seawater intrusion.

6.5. LAND SUBSIDENCE

Subsidence has not been a known issue in the Basin and undesirable results have not been reported. Nonetheless, the potential has been recognized that subsidence could occur as a result of groundwater pumping and groundwater level declines, typically in areas underlain by thick layers of fine-grained alluvial sediments.

As described in Section 4.3, available information on vertical land displacement (subsidence) includes estimates from InSAR satellite data systems. InSAR data provides mapping of ground surface elevations across the Basin, presented at regular (typically monthly) intervals.

InSAR data are made available by DWR from the TRE Altamira InSAR Dataset with vertical displacement data beginning in June 2015 and in monthly intervals thereafter until September 2019. The accuracy of the InSAR ground surface elevation change estimates is reported to be ±16 millimeters (mm), or ±0.052 feet (Towill 2020). While these data do currently represent a relatively short period of record, the InSAR data do not show significant changes in ground surface elevation in the Basin. The Basin shows small rise and fall within the margin of error throughout. Given the short records of these datasets and small vertical displacements, these data have not been analyzed systematically to identify specific areas that might be subject to long-term subsidence. As datasets are updated, that may be warranted in the future.

Data are limited not only on groundwater-related subsidence, but also potentially associated pumping and groundwater levels. SGMA allows groundwater level data to be used as a proxy for subsidence; however, relationships between pumping, groundwater levels, and subsidence have not been determined to support that. Subsidence information from DWR InSAR data will be reviewed as it becomes available.

6.5.1. Description of Undesirable Results

Land subsidence is the differential lowering of the ground surface, which can damage structures, roadways, and hinder surface water drainage. Subsidence remains a potential risk and inelastic subsidence is irreversible. Potential undesirable results associated with land subsidence due to groundwater withdrawals include the following:

- Potential damage to building structures and foundations, including water facilities, due to variations in vertical displacement causing potential cracking, compromised structural integrity, safety concerns and even collapse.
- Potential differential subsidence affecting the gradient of surface drainage channels, locally reducing the capacity to convey floodwater and causing potential drainage problems and ponding.
- Potential differential subsidence affecting the grade or drainage of other infrastructure such as railroads, roads, and sewers.
- Potential subsidence around a production well, disrupting wellhead facilities or resulting in casing failure.
- Potential non-recoverable loss of groundwater storage as fine-grained layers collapse.

None of these undesirable results has been observed in the Basin. However, subsidence may be subtle and cumulative over time. Accordingly, the potential for future subsidence cannot be ruled out if regional groundwater levels were to decline below historical lows and minimum thresholds.

6.5.2. Potential Causes of Undesirable Results

As described in Section 4.3, changes in ground surface elevations may be caused by regional tectonism or by subsidence related to declines in groundwater elevations due to pumping. Regarding the former, the InSAR data shows a general rising trend in the western portion of the Basin suggesting possible regional tectonic rise. In contrast, inelastic subsidence associated with groundwater pumping and level declines would generally show a long-term downward trend, with greater subsidence occurring during times of groundwater level decline (e.g., drought) and a flattening trend with no recovery during times of rising groundwater levels and reduced pumping (e.g., wet years).

In brief, as groundwater levels decline in the subsurface, dewatering and compaction of predominantly fine-grained deposits (such as clay and silt) can cause the overlying ground surface to settle. Land subsidence due to groundwater withdrawals can be temporary (elastic) or permanent (inelastic). While elastic deformation is relatively minor, fully recoverable, and not an undesirable result, inelastic deformation involves a permanent compaction of clay layers that occurs when groundwater levels in a groundwater basin decline below historical lows. This causes not only subsidence of the ground surface, but also compaction of sediments and loss of storage capacity.

Given the above, the potential for problematic land subsidence is affected by the proportion, overall thickness, and configuration of fine-grained sediments (with greater proportions and thicknesses suggesting greater potential). Because of the variability of local sediments, subsidence also is likely to be geographically variable. Moreover, the potential for subsidence is affected by the history of groundwater level fluctuations, such that areas with previous groundwater level declines may have already experienced some compaction and subsidence.

The potential for subsidence is possible, especially in the deeper portions of the Basin where there is more pumping, but there is no indication that permanent inelastic subsidence has occurred.

6.5.3. Potential Effects on Beneficial Uses and Users

The lack of any reports of undesirable results is an indication of no noticeable effects. However, there is a general awareness in the Basin of subsidence problems in the Central Valley that cause the above listed effects. Nonetheless, some subsidence could have occurred because of historical groundwater level declines without being noticed and could have contributed to drainage or flooding problems, which are also affected by multiple and sometimes more noticeable factors including variable weather, changes in streams and drainage systems, land use changes in the watershed, erosion and sedimentation. Accordingly, continued tracking of subsidence is warranted.

6.5.4. Minimum Threshold

According to the GSP regulations Section 354.28(c)(5) the minimum threshold for land subsidence is defined as the rate and extent of subsidence that substantially interferes with surface land uses. This section first addresses the rate at which subsidence substantially interferes with surface land uses and then describes how available InSAR data can be used to measure rate and extent across the Basin.

> The M**inimum Threshold** for subsidence is defined as a cumulative decline equal to or greater than one foot since 2015, which represents current conditions and the SGMA start date. This corresponds to a rate of decline equal to or greater than 0.2 feet in any five-year period.

The 1-foot criterion is reasonable based on standards for flooding and drainage and on empirical data for well casing collapse:

- In the southwestern part of the Sacramento Valley, where documented cumulative subsidence has reached several feet, video surveys of 88 undamaged wells and 80 damaged wells showed that casing damage was uncommon in wells where subsidence was less than 1 foot (Borchers and Carpenter 2014).

- Ground floor elevations are recommended or required to be at least 1 foot above the Base Flood Elevation in some jurisdictions (see for example FEMA 2011 and City of Temecula 2020). Subsidence above 1 foot may cause some buildings to become flooded.
- The minimum freeboard along roadside ditches is often required to be 1 foot above the maximum anticipated water level (see for example San Diego County 2005). Greater subsidence may cause sewer and stormwater flows to flow in unintended directions.

Subsidence impacts can be relatively rapid and noticeable. However, in the Basin any subsidence in the future is likely to be gradually cumulative as would be its undesirable results. Accordingly, the 0.2 feet per 5-year rate of decline is an appropriate criterion, with the understanding that it will be re-evaluated in the 2027 GSP Update.

Based on available data and using the above criterion, significant and unreasonable subsidence has not occurred since 2015 in the Basin. Moreover, it is unlikely that the criterion will be exceeded in the future as groundwater pumping will be constrained with the MT set for groundwater levels and storage.

The extent of cumulative subsidence across the Basin will be monitored using the InSAR satellite-based data that DWR has been providing on the SGMA Data Portal website. The data consist of a closely spaced grid of elevation points and are characterized by considerable "noise," meaning that adjacent points often have very different readings at the scale of 1 to 2 inches. These data will be smoothed to provide results at a spatial scale at which subsidence would plausibly occur. These values for cumulative elevation change will then be compared annually with the minimum threshold criterion.

6.5.4.1. Relationship of Minimum Threshold to Other Sustainability Indicators

Subsidence is closely linked to groundwater levels. It is unlikely that significant inelastic subsidence would occur if groundwater levels remain above historical levels, which have been used to define groundwater level MOs. In addition, the operationally defined MT levels will prohibit significant pumping if water levels decline below historical lows. Accordingly, the minimum threshold for groundwater levels is consistent with and supportive of the objective to prevent subsidence undesirable results.

The subsidence MT would have little or no effect on other MTs. Specifically, subsidence MTs would not result in significant or unreasonable groundwater elevations, would not affect pumping and change in storage, would not affect groundwater quality, or result in undesirable effects on connected surface water.

6.5.4.2. Effect of Minimum Threshold on Sustainability in Adjacent Areas

As noted in Section 6.2.6.3, the Basin borders portions of the Bedford-Coldwater Basin to the south, the Riverside-Arlington Basin along the Arlington Gap to the east, the Chino Basin on the north, and Coastal Plain of Orange County Basin at the west where the Santa Ana River exists in the Basin. The groundwater level MTs would support maintenance of groundwater levels above their respective MTs throughout the Basin. This in turn will support maintenance of groundwater levels above historical minima and, thus, subsidence affecting other basins is not expected to occur.

6.5.4.3. Effect of Minimum Threshold on Beneficial Uses and Users

Subsidence problems have not been reported in the Basin, but subsidence remains a potential undesirable result that may contribute incrementally to reduced drainage, increased flooding, or other undesirable results. The effects of establishing the numerical subsidence MT are beneficial because they support a greater chance of detecting subsidence, supporting management actions to maintain groundwater levels, and preventing significant subsidence.

6.5.4.4. Relationship of Minimum Threshold to Regulatory Standards

There are no federal, state or local standards specifically addressing subsidence. There are standards for flood depth, floodplain encroachment, freeboard in ditches and canals and slopes of gravity-flow plumbing pipes. These vary somewhat from jurisdiction to jurisdiction, but they are generally similar and were used as the basis for selecting the MT.

6.5.4.5. How Management Areas Can Operate without Causing Undesirable Results

Management areas have not been defined for the Basin so the establishment of MTs has been consistently conceived and applied to the entire Basin.

6.5.4.6. How the Minimum Threshold will be Monitored

The minimum threshold will be monitored using InSAR areal data. Cumulative subsidence will be monitored using the InSAR satellite-based geodetic data that DWR has been providing on the SGMA Data Portal website. The data are “raster” data sets consisting of a grid of elevation points spaced approximately 300 feet apart. The InSAR data will be evaluated to identify any occurrence and areal extent of subsidence. As data are provided over the next few years, this evaluation will involve review of temporal InSAR data to discern seasonal elastic fluctuations and potential inelastic declines. In addition, any areal extent will be examined; this may involve smoothing of elevation changes over the InSAR grid to summarize the results to a spatial scale at which subsidence would plausibly occur. The cell values for cumulative elevation change will then be compared with the minimum threshold criterion.

6.5.5. Measurable Objectives

The Sustainability Goal includes the objective to prevent subsidence. Accordingly, the MO is zero subsidence. Undesirable subsidence results have not occurred, and accordingly, no interim milestones are defined.

6.5.5.1. Representative Monitoring

It is assumed that the InSAR subsidence monitoring programs will continue for the foreseeable future and InSAR data will be available from the DWR website. The GSP monitoring program for subsidence will involve annual download of InSAR data with analysis for signs of cumulative inelastic subsidence.

6.5.5.2. Discussion of Management Actions to be Implemented

Management actions to prevent subsidence will be coordinated with actions relative to maintenance of groundwater levels. These actions involve maintaining groundwater levels above historical low water levels and will prevent significant inelastic subsidence. No other specific management actions for subsidence have been identified and no specific implementation is warranted.

6.6. DEGRADATION OF WATER QUALITY

Degraded water quality can impair water supply and affect human health and the environment. Impacts to drinking water supply wells can result in increased sampling and monitoring, increased treatment costs, use of bottled water, and the loss of wells. As described in Groundwater Conditions Sections 4.5 and 4.6, elevated concentrations in drinking water of some constituents, such as nitrate, can adversely affect human health. Impacts to agricultural supply can include reduced yields, the need to change irrigation methods/sources, and other economic effects. Discharge of degraded groundwater can harm ponds, wetlands, and associated ecosystems (e.g., eutrophication).

Consideration of the causes and circumstances of water quality conditions is important in the Basin because general mineral quality (e.g., TDS, etc.) is naturally poor throughout much of the Basin, has been poor for decades, and nonetheless has been used for beneficial purposes including irrigation, municipal, and domestic purposes. The main beneficial use in the Basin is municipal supply and Corona uses blending with imported water and treatment to meet federal, state, and local drinking water guidelines.

Sustainable management is about use and management of groundwater without causing undesirable results but does not necessarily include reversing natural undesirable conditions. According to SGMA (§10727.2(b)(4)), a GSP may—but is not required to—address undesirable results that occurred before and have not been corrected by the SGMA benchmark date of January 1, 2015.

Given all that, the sustainability goal—to protect groundwater quality—is not to reverse undesirable water quality conditions by 2042 but rather to prevent circumstances wherein future management activities might make water quality worse and insofar as possible to improve water quality in the long run. Implementation of management actions is recognized as needed now and, whether or not the results are perceptible in the short term, such actions will be helpful in the long term.

6.6.1. Potential Causes of Undesirable Results

The quality of groundwater in the Basin is characterized as somewhat mineralized, reflecting natural hydrogeologic processes (see Groundwater Conditions Section 4.4). Groundwater also has been affected by human activities including agricultural, rural, urban, and industrial land uses. While contaminant sources of groundwater quality degradation exist, these are effectively regulated as described in Groundwater Conditions Section 4.6 and regularly tracked as part of the GSA’s monitoring program.

As described in the Groundwater Conditions section, total dissolved solids (TDS) and nitrate are constituents of concern for the Basin. While there are elevated natural background TDS concentrations in groundwater, TDS also is an indicator of human impacts including infiltration of urban runoff, agricultural return flows, and wastewater disposal. Natural nitrate levels in groundwater are generally very low, and elevated concentrations are associated with agricultural activities, septic systems, landscape fertilization, and wastewater treatment facility discharges.

Other constituents have been documented (see Groundwater Conditions Section 4.8) but occurrences of these are either under regulation by RWQCB (e.g., perchlorate) or are naturally occurring with no recent exceedances of MCLs and limited potential for mobilization due to management actions (e.g., arsenic, chromium, iron, and manganese).

6.6.2. Description of Undesirable Results

The processes and criteria relied on to define Undesirable Results included review of available data and information summarized in the Plan Area and Groundwater Conditions sections and discussions with Temescal Basin stakeholders and local agency representatives.

Undesirable Results are defined in the GSP Regulations (§354.26) as occurring when significant and unreasonable effects for any of the sustainability indicators are caused by groundwater conditions occurring throughout the Basin. The GSA is not responsible for local problems or degradation caused by others. While the Basin includes regulated facilities with soil and groundwater contamination (see Groundwater Conditions Sections 4.4 and 4.7), these sites are under regulatory oversight by State agencies; the GSA does not have the mandate or authority to duplicate these programs. Nonetheless, the GSA plans to regularly cooperate with these agencies and check regulator files regularly as part of its water quality monitoring program. In addition, this GSP avoids management actions that would spread groundwater contamination through managed aquifer recharge, pumping, or other activities.

In fact, the GSA agencies have historically conducted management actions and programs (often in cooperation with other agencies) to improve groundwater quality. These activities have included treatment of groundwater and imported surface water for municipal use (which improves wastewater quality), wastewater treatment plant improvement and water recycling, and programs to reduce urban and agricultural salt and nutrient loading.

6.6.3. Potential Effects on Beneficial Uses and Users

Groundwater is a source of supply in the GSP Area and supports a range of beneficial uses: agricultural, municipal, rural, and environmental. Beneficial uses of water and respective water quality objectives are defined by the RWQCB in the Santa Ana Basin Water Quality Control Plan (Basin Plan). For TDS and nitrate, these are tabulated in the GSP Groundwater Conditions (Section 4.5 Key Constituents of Concern); this section indicates that water quality in the Basin is naturally mineralized and affected by human activities and has not been shown to change significantly. It is recognized that groundwater has been and is being used for the range of beneficial uses with reasonable accommodation by users. Blending and treatment of groundwater for municipal supply has been successful to provide drinking water to the Basin. This recognition does not preclude or ignore a desire by the community or intent of local agencies including the GSA to improve local groundwater quality.

6.6.4. Sustainable Management Criteria for Groundwater Quality

The definition of an Undesirable Result due to degraded water quality—TDS and nitrate concentrations—was evaluated in the context of regulatory objectives in the Basin.

GSP regulations require that the minimum threshold for degraded water quality be based on "the number of supply wells, a volume of water, or a location of an isocontour that exceeds concentrations of constituents determined by the agency to be of concern for the basin" (§354.28(4)). The number of supply wells are considered here for the minimum threshold. This is because the issues of concern in the Basin are focused on regional nitrate and salt loading, data are insufficient to define plumes or volumes of water, and the position of an isocontour is not applicable.

6.6.4.1. Temescal Water Quality Monitoring Program

The GSA agencies established a water quality monitoring program for the protection of beneficial uses, understanding of human and natural factors that affect water quality, and support for groundwater management decisions. The City of Corona (Corona) has been the primary agency implementing this program in the Basin and regularly monitors groundwater production wells as well as select dedicated monitoring wells. The network of wells historically has been focused on the Channel Aquifer where Corona pumps most of its water for municipal supply. The wells generally are sampled quarterly with lab analysis for general minerals, physical parameters, and selected constituents of concern. Accordingly, this data set can be used to detect a range of problems quickly, to track trends, allow geochemical investigation, and support focused management actions.

In addition, the GSA will regularly compile, reviews, and summarizes all available information on water quality in the Basin from the groundwater ambient monitoring program (GAMA) Groundwater Information System (SWRCB 2020b).

Limitations of this data set include the uneven and potentially shifting distribution of sampled wells across the Basin, lack of information on the vertical zone being sampled (well construction information), relatively less frequent sampling schedule and absence of historical record, variable data availability on specific constituents and parameters, and multiple sources of information from programs with differing objectives and procedures. These limitations present significant uncertainties to the GSA and stakeholders who are required to establish quantitative, measurable criteria and then comply with them, with real-world consequences.

6.6.5. Minimum Thresholds

Minimum Thresholds (MTs) are presented for nitrate and TDS using the best available information, namely data generated by the Water Quality Monitoring Program and compiled data. As summarized above, the limitations of this data set are recognized, and additional investigations and monitoring program improvements will be presented in this GSP for planned implementation. With adaptive management in mind, MTs may be revised to rely more on the GSA in the future as needed.

The MTs for nitrate and TDS quantify current conditions (2015 through 2019) based on available monitoring data. Water quality monitoring serves two useful purposes. First, it will eventually confirm whether concentrations begin leveling off as intended. Second, it can detect local sources of degradation that impact groundwater quality more strongly and rapidly than the slow, dispersed loading from agricultural activities. Early detection of local impacts can enable appropriate actions to halt further contamination before the impacts become severe or widespread.

6.6.5.1. Minimum Threshold for Nitrate (NO_3)

Table 6-2 summarizes current conditions for nitrate in reference to the maximum contaminant level (MCL) for nitrate as nitrate (NO_3) in drinking water, 45 mg/L, which also is the Basin Plan Objective for municipal use. Current conditions are expressed in terms of the percent of wells with concentrations over 45 mg/L. To compute the percent of wells, nitrate sampling results were compiled for each well over the period 2015 through 2019. For wells with one sample, the single value was used; for wells with two samples, the average value was used; and for wells with three or more values, the average value was used. Accordingly, each well was represented by one value. This was followed by computation of the percentage of wells with concentrations exceeding 45 mg/L.

This process of summarizing current conditions makes use of all available data. It also is recognized that the data are not representative of water supply conditions throughout the Basin because the geographic distribution of wells is uneven and information from shallow and deep wells are combined. Monitoring program improvements will be implemented as part of the GSP to improve the data set (see Section 6.6.6.2) and provide a more reasonable basis for sustainability criteria.

Table 6-2. Summary of Current Conditions for Nitrate (NO_3) and TDS

Water Quality Parameter	Minimum Threshold (MT)	Total Wells	Number of Wells Exceeding MT	Percent of Wells Exceeding MT
Nitrate as Nitrate (NO_3)	45 mg/L	24	12	50 percent
TDS	1,000 mg/L	23	6	26 percent

As documented in **Table 6-2**, there are wells in the Basin yielding water with nitrate concentrations exceeding the MCL. While recognizing the number of wells affected by high nitrate concentrations, there has been historical and ongoing groundwater use with reasonable accommodation by users and accordingly, these conditions are considered sustainable.

Despite the significant uncertainties, the following MT is presented as a starting point for maintenance and planned improvement of groundwater quality for the 2042 deadline for sustainability.

> The **Minimum Threshold** for nitrate is defined initially as the percentage of wells with concentrations exceeding the nitrate MCL (45 mg/L) based on current conditions (2015-2019).

Given the above definition, the MT for nitrate is expressed in **Table 6-2**. This MT refers to the numeric MCL and Basin Plan objective, honors the non-degradation policy, and quantifies current conditions based on available data. As described in the following section, Measurable Objectives, the approach is to implement management actions that will maintain or reduce nitrate concentrations in the future.

6.6.5.2. Minimum Threshold for Total Dissolved Solids

Table 6-2 summarizes current conditions for TDS with reference to the 1,000 mg/L secondary maximum contaminant level (SMCL). This value is far from ideal, but reflects the widespread conditions of elevated TDS concentrations in groundwater. The main beneficial use in the Basin is municipal supply and Corona uses blending with imported water and treatment to meet federal, state, and local drinking water guidelines.

As with nitrate, computation of the percent of wells in **Table 6-2** involved compilation of sampling results for each well over the period 2015 through 2019. For wells with one sample, the single value was used; for wells with two samples, the average was used; and for wells with multiple values, the average was used, such that each well was represented by one value. This was followed by computation of the percent of wells with concentrations exceeding 1,000 mg/L.

This process makes use of all available data. The data are not representative of water supply conditions throughout the Basin because the depths and geographic distribution of wells is uneven. Monitoring program improvements will be implemented as part of the GSP to improve the data set and provide a more reasonable basis for sustainability criteria.

Despite the uncertainties, the following MT is presented as a starting point for maintenance and planned improvement of groundwater quality for the 2042 deadline for sustainability.

> The **Minimum Threshold for TDS** is defined initially as the percentage of wells with concentrations exceeding the TDS value of 1,000 mg/L based on current conditions (2015-2019).

As with nitrate, this MT is presented with full recognition of data gaps and uncertainties, and with the commitment incorporated in this GSP to investigate nitrate and salt loading under current conditions and to expedite management actions for reduction of nitrate and salt loading.

Accordingly, the TDS MT is expressed in **Table 6-2**. This MT refers to the numeric Basin Plan objective, honors the non-degradation policy, and quantifies current conditions based on available data. Given historical and ongoing groundwater use, these conditions are considered sustainable. As described in the following section, Measurable Objectives, the approach is to implement management actions that will maintain or reduce nitrate concentrations in the future.

6.6.5.3. Relationship of Minimum Threshold to Other Sustainability Indicators

Three of the other sustainability indicators (groundwater level declines, storage depletion, subsidence) are directly linked to groundwater levels, while the sustainability indicator for connected surface water-groundwater dependent ecosystems is related to a rate or volume of surface water depletion, also linked to groundwater levels. The MTs for water quality are not known to be directly related to specific groundwater levels or fluctuations in groundwater levels. Nonetheless, general relationships are recognized, for example that contaminants may be mobilized by changing groundwater levels or flow patterns. Accordingly, the water quality MTs will help guide potential projects that alter groundwater levels or flow.

6.6.5.4. Effect of Minimum Threshold on Sustainability in Adjacent Areas

The Basin borders portions of the Bedford-Coldwater Basin to the south, the Riverside-Arlington Basin along the Arlington Gap to the east, the Chino Basin on the north, and Coastal Plain of Orange County Basin at the west where the Santa Ana River exists in the Basin. The MTs for the Basin represent current conditions; establishment of MTs and maintenance of such conditions, which reflect native conditions, would not affect the ability of the neighboring basins to achieve or maintain sustainability.

As consideration beyond the requirements of this section, some management actions to improve groundwater quality in the Basin (for example enhancing outflow of poor-quality groundwater) could potentially have adverse impacts downstream. However, potential impacts of management actions and projects will be addressed through the California Environmental Quality Act (CEQA). Overall improvement of the Basin groundwater quality through other management actions (e.g., increased CVP percolation with maintenance of outflow) would be beneficial.

6.6.5.5. Effect of Minimum Threshold on Beneficial Uses and Users

The establishment of the MTs reflects the current condition of the Basin relative to nitrate and TDS concentrations, insofar as available data and monitoring allow us to know. Establishing the MTs represents no change and recognizes that groundwater has been and is being used reasonably for the range of beneficial uses. The MTs represent a quantified starting point for protection of groundwater quality and for projects and management actions to improve groundwater quality, consistent with a best management practices approach.

6.6.5.6. Relationship of Minimum Threshold to Regulatory Standards

The MTs have been established with direct reference to regulatory standards, most notably the Maximum Contaminant Levels, drinking water standards set by the State of California, while recognizing that current nitrate and TDS concentrations in many wells do not meet regulatory standards. It should be noted all water delivered to users in the Basin met all drinking water standards, as achieved through blending and treatment.

6.6.5.7. How Management Areas Can Operate without Causing Undesirable Results

Management areas have not been defined for the Basin so the establishment of MTs has been consistently conceived and applied to the entire Basin.

6.6.5.8. How the Minimum Threshold will be Monitored

The GSP is using the best available information, namely data from the GSA's Water Quality Monitoring Program and available data from GAMA. The GSA's Water Quality Monitoring Program, along with its regular sampling schedule, historical records, and data on specific constituents and parameters will be the primary basis for MT tracking with reference to GSP 5-year updates.

6.6.6. Measurable Objectives

The sustainability goal is to protect groundwater quality, with general objectives of maintaining groundwater quality, preventing circumstances where future management activities might make water quality worse, and improving groundwater quality in the long run. In setting Measurable Objectives (MOs), a key issue is legacy loading, where the amount of historical loading is not known nor is the rate at which it is moving down to affect deep pumping zones. Because of the uncertainties associated with legacy loading, the use of water quality monitoring to track or verify sustainability needs to be tempered with a broad margin of operational flexibility. This margin should acknowledge the possibility (and even likelihood) that monitoring could indicate undesirable results—those stemming from past practices—while present reductions in loading are not yet perceptible.

6.6.6.1. Description of Measurable Objectives

Measurable Objectives are defined in this GSP using the same metrics and monitoring data as used to define Minimum Thresholds and are established to maintain or improve groundwater quality. Given the significant uncertainties presented by legacy loading and by data limitations, a reasonable margin of safety includes the possibility of "negative" monitoring results while positive progress is being made.

> The **Measurable Objective for nitrate** is defined as maintaining or reducing the percentage of wells with average concentrations exceeding the nitrate MCL (45 mg/L) based on conditions documented in GSP 5-year updates.
>
> The **Measurable Objective for TDS** is defined as maintaining or reducing the percentage of wells with average concentrations exceeding the TDS value of 1,000 mg/L based on conditions documented in the GSP 5-year updates.

Measurable Objectives will be evaluated in increments of five years and the numeric values will be presented with comparison to the Current Conditions. This comparison will be discussed in the context of actual progress in implementing measures to improve monitoring and management.

6.6.6.2. Discussion of Monitoring and Management Measures to be Implemented

The strategy of this GSP is to identify and implement monitoring and management measures to reduce nitrate and salt loading. Monitoring and management actions already undertaken are summarized in Plan Area Section 2 and would be continued, most notably including the following:

- Corona water treatment that continues to use imported water and thereby improve wastewater quality.
- Corona wastewater treatment improvements (nitrate reduction) and water recycling.

Additional **management measures** include the following:

- Development of a stormwater recharge program including cooperation with local agencies to prepare a Storm Water Resource Plan, with identification of opportunities to increase recharge using local storm runoff.
- Analysis of Basin outflows relative to salt management.
- Enhanced outreach to Temescal Basin stakeholders (including disadvantaged communities) on groundwater quality issues.

6.6.6.3. Description of Reasonable Pathway

Implementation of this GSP will include regular updates on a five-year basis. This will include evaluation of Measurable Objectives with comparison to Current Conditions (2015-2019). Because groundwater quality conditions are considered sustainable, interim milestones toward sustainability are not relevant. These comparisons will be discussed in the context of actual progress in implementing measures to improve monitoring and management.

A first step along the pathway will be analysis of the triennial data set used to establish criteria. A subset of the wells will be selected considering factors such as: uniform geographic representation, availability of well depth information, and continuity from one triennial period to the next. This first step will be completed during the first five years of GSP implementation.

The Management Actions and Implementation Plan sections of this GSP are intended to provide additional detail on the scope, scheduling, and estimated costs of the measures to be implemented.

6.7. DEPLETIONS OF INTERCONNECTED SURFACE WATER

This section builds and extends the discussion of interconnection of surface water and groundwater presented in in Section 4. That section provided information on surface water-groundwater connections (both seasonally and with wet years and drought), identification of potential groundwater dependent ecosystems (GDEs), distribution of riparian vegetation, and assessment of animal species that rely on groundwater-supported streamflow. Briefly, the analysis found that the only location within the Basin where pumping might affect surface flow or vegetation is along the southern edge of Prado Wetlands. Small patches of riparian vegetation in canyons where tributary streams enter the west side of the Basin are supplied by groundwater discharging from bedrock uplands and are not affected by pumping in the Basin. No isolated springs or seeps are located in the Basin.

6.7.1. Description of Undesirable Results

If a stream is hydraulically connected to groundwater, pumping from nearby wells can reduce the amount of stream flow by intercepting groundwater that would have discharged into the stream or by inducing seepage from the stream. Undesirable results associated with stream flow depletion include reduced quality and quantity of aquatic and riparian habitats and reduced water supply to downstream users. Areas of interconnected surface water can also contain riparian vegetation that relies on shallow groundwater as an important source of water. Conceptually, adverse impacts for stream and riparian habitat can result from decreased rainfall, decreased stream flow, and lowered groundwater levels. These variables are highly correlated in time: droughts include rainfall reductions, decreased stream flows, and lowered groundwater levels at a time when habitat impacts are usually the most severe. Furthermore, droughts and wet periods are a natural feature of California’s climate and are associated with waxing and waning of habitat conditions.

6.7.2. Potential Causes of Undesirable Results

Depletion of interconnected surface water by groundwater pumping can impact a variety of beneficial uses of surface water. A systematic evaluation of each potential impact is warranted, including impacts on downstream water users, and plants and animals that rely on flow or shallow water table conditions along streams.

6.7.2.1. Surface Water Users

There are no known diverters of surface water from Temescal Wash in the Basin. However, the Wash is tributary to the Santa Ana River, which is a source of supply to Orange County Water District downstream of Prado Dam. Pursuant to a 1968 agreement with Western Municipal Water District (WMWD), the Corona is required to discharge 1,625 acre-feet (AF) of water from Temescal Wash into the Prado Wetlands. That amount is equivalent to a continuous flow of 2.25 cubic feet per second (cfs) and has always been met by discharges of recycled water from Water Reclamation Facility 1 (WRF-1) to the lined reach of Temescal Wash upstream of the wetlands.

Groundwater discharge into the Prado Wetlands is apparently not viewed as a significant source of supply to downstream surface water users, based on active efforts over the past two decades to eliminate groundwater discharge into the wetlands from the Chino Basin. The Regional Water Quality Control Board mandated that the Chino Basin be operated to achieve “hydraulic control”, which means eliminating groundwater discharge into the Wetlands (WEI 2019). The objective is to prevent saline groundwater in the area from seeping into the Santa Ana River. Beginning in 2000 and increasing in stages since then, the Chino Desalter Wells now pump approximately 30,000 AFY of groundwater, most of which would otherwise discharge into the Prado Wetlands. This decrease in groundwater inflow has been offset by increases in surface water inflow, primarily discharges of reclaimed water from treatment plants along the Santa Ana River and its tributaries.

The expectation that flow requirements of Prado Wetlands and downstream water users will be met by surface inflows to the Wetlands rather than groundwater inflow is echoed in the Upper Santa Ana River Habitat Conservation Plan (SARHCP, ICF 2020). The plan notes that simulations using a regional groundwater model project about 5 feet of groundwater decline in the Prado Wetland area by 2030. However, no mitigation measures or management actions related to groundwater are included in the plan.

Groundwater discharge from the Basin into the Prado Wetlands is not expected to decrease in the future because groundwater levels are not expected to decrease. This assertion stems from the lack of long-term declines in water levels since at least 2005 (see **Figure 4-23**) and the selection of minimum historical water levels as the minimum thresholds for water levels in this GSP (see Section 6.2.6). However, the preceding discussion indicates that an increase in groundwater pumping resulting in slightly lowered groundwater levels and reduced groundwater discharge into Prado Wetlands would not cause an undesirable result for downstream water users.

6.7.2.2. Animals Dependent on Groundwater

The primary animal species that depend on groundwater in the Basin are birds that inhabit riparian vegetation in the Prado Wetlands, including several listed species. The nexus between groundwater and those species is via the extent and health of riparian vegetation, discussed below.

6.7.2.3. Riparian Vegetation

The beneficial use of interconnected surface water with the greatest potential to be impacted by groundwater pumping is riparian vegetation along the southern edge of the Prado Wetlands, where the Basin groundwater discharges into the Wetlands. As described above (Section 6.7.2.1 Surface Water Users), the Wetlands are presently sustained almost entirely by surface water inflow rather than groundwater discharge. Although substantial or long-term decreases in groundwater discharge from the Basin into the Prado Wetlands are not expected, they would tend to cause vegetation die-back along the southern fringe of the Wetlands by lowering the water table to a depth beyond the reach of vegetation roots.

6.7.3. Definition of Undesirable Results

The Sustainability Goal includes an objective to support beneficial uses in the Basin, and specifically those related to interconnected surface water. Consistent with that objective, undesirable results of excessive depletion of surface water are:

> Riparian vegetation die-back or mortality during droughts of a magnitude that disrupts ecological functions or causes substantial reductions in populations of riparian-associated species.

6.7.4. Potential Effects on Beneficial Uses and Users

The analysis presented in this section demonstrates that groundwater conditions are currently sustainable with respect to interconnected surface water and GDEs. There are no users of surface water in the Basin, and the needs of Santa Ana River users downstream of the Basin appear to be met by surface inflows to the Prado Wetlands and past Prado Dam. Although lowering of the water table in the Prado Wetlands could stress or kill riparian vegetation, the extent and health of riparian vegetation do not appear to be correlated with groundwater levels in water supply wells in the Basin (see Section 4.10.4).

6.7.5. Sustainable Management Criteria for Interconnected Surface Water

SGMA requires that the minimum threshold for depletions of interconnected surface water shall be the rate or volume of surface water depletions caused by groundwater use that has adverse impacts on beneficial uses of the surface water and may lead to undesirable results (§354.28(c)(6)). However, GSP Regulations allow GSAs to use groundwater elevation as a proxy metric for any of the sustainability indicators when setting minimum thresholds and measurable objectives (23 CCR § 354.28(d) and 23 CCR § 354.30(d)).

It would be difficult to define a minimum threshold in terms of flow depletion in this Basin because phreatophytic riparian vegetation in the Prado Wetlands is more dependent on surface inflows from outside the Basin (that is, from the Santa Ana River) than from groundwater discharge within the Basin. Also, groundwater does not need to discharge at the land surface to support vegetation; it only needs to rise up to the root zone. Thus, it is reasonable to define the minimum threshold in terms of water levels instead of flow.

6.7.6. Minimum Threshold

Given the above, the minimum threshold is defined here by groundwater levels. As noted previously, wells in the groundwater level monitoring program are production wells with relatively deep screens that have not been sited and designed for tracking surface water-groundwater interactions or water table depths in areas of riparian vegetation. The lack of such shallow monitoring wells is a data gap and a source of uncertainty. Hence, the minimum threshold described here is initial. Nonetheless, it is intended to be protective of GDEs until the monitoring program can be refined to better represent water-table depths along the southern edge of the Prado Wetlands.

Therefore, in the Basin:

> The **Minimum Threshold** for depletion of interconnected surface water is the amount of depletion that occurs when the depth to the water along the southern edge of the Prado Wetlands is greater than 15 feet for a period exceeding one year.

This threshold corresponds approximately to the maximum depth to water measured in shallow monitoring wells in the northern part of the Prado Wetlands.

Undesirable results are considered to commence if the water-table depth along the southern edge of the Prado Wetlands declines below the MT and the decline correlates with declining water levels in production wells in the Basin.

6.7.6.1. Relationship of Minimum Threshold to Other Sustainability Indicators

- **Groundwater Levels.** The water level MTs are set to equal the minimum historical water levels in existing monitored wells, all of which are over 1 mile from the Wetlands. The now-destroyed Butterfield Park Well was much closer to the Wetlands than the other monitored wells, and its water levels indicated that groundwater elevations and depths to water decreased continuously from the production wells in the center of the Basin to the Prado Wetlands. Assuming hydraulic connection between those two locations, the water level MT should prevent the water table at the edge of the Wetlands from declining below the historical minimum. Water levels in shallow monitoring wells in the northern part of the Prado Wetlands either did not decline much during the 2013 to 2015 drought or declined slightly to reach their lowest historical levels. There did not appear to be widespread die-back of vegetation in the Prado Wetlands during the 2013 to 2015 drought. Historical aerial photos confirmed a substantial reduction in riparian tree/shrub canopy coverage along the lowermost reach of Temescal Wash, where it enters the Prado Wetlands (a roughly 8,300-foot reach from North Lincoln Avenue to below West Rincon Avenue) (McMichael 2021). However, the decrease in vegetation appeared to start around 2009 (before the drought) and has been attributed to decreased base flow in Temescal Wash (McMichael 2021). The period of record for the Butterfield Park Well is only 2011 through 2017, so it is not possible to correlate the change in vegetation with groundwater levels over the entire period of interest. However, the MT for interconnected surface water is consistent with the water-level MT in that they both avoid water levels lower than historical minimum levels, which in most wells occurred during the 2013 to 2015 drought. Thus, the two MTs are consistent, and managing for one would not impact managing for the other.

- **Groundwater Storage.** The minimum threshold for interconnected surface water would similarly be consistent with the minimum threshold for groundwater storage near GDE reaches, because the latter is functionally the same as the minimum threshold for water levels.
- **Seawater Intrusion.** Seawater intrusion would not occur in the Basin due to its inland location. No minimum threshold was defined and there is no consistency issue.
- **Land Subsidence.** Significant land subsidence is only likely to occur with groundwater levels below historical minimum levels. The levels specified as minimum thresholds for interconnected surface water are thought to be within the historical range and thus unlikely to cause subsidence.
- **Water Quality.** Water quality issues in the Basin are primarily associated with dispersed loading of nitrate and salinity and long-term increases in ambient concentrations of those constituents. Those processes are generally independent of groundwater levels.

6.7.6.2. Effect of Minimum Threshold on Sustainability of Adjacent Areas

The Basin is separated from the Bedford-Coldwater Basin by a reach of Temescal Wash that flows over bedrock. Changes in groundwater-surface water interactions in the Basin would not propagate upstream to the Bedford-Coldwater Basin. The hydraulic connection between the Basin and the Arlington Basin is small and far from the Prado Wetlands. Water levels at the edge of the Wetlands would not affect flow across that boundary. The Chino Basin abuts the Basin beneath the Prado Wetlands. The Chino Basin does not rely on northward flow of groundwater from the Basin. On the contrary, basin operation in the Chino Basin seeks to minimize southward groundwater flow. The adjacent area with the greatest potential to be affected is Orange County downstream of Prado Dam. However, those areas are not heavily reliant on groundwater outflow from the Basin (see Section 6.7.2.1 Surface Water Users), and the minimum threshold for interconnected surface water would ensure that outflow does not drop below the historical minimum in any case.

6.7.6.3. Effect of Minimum Threshold on Beneficial Uses

Surface diversions are not a source of supply in the Basin; all water uses are supported by imported water or groundwater. With respect to groundwater, this GSP does not propose decreased groundwater elevations below historical levels, so groundwater levels are expected to remain within the historical range. This means that water table depths in the Prado Wetlands will remain within the historical range, which was adequate to maintain the vegetation in good health.

Riparian vegetation along Wardlow Wash would not be adversely affected if groundwater levels dropped to the groundwater elevation MT or the interconnected surface water MT because Wardlow Wash is far from the location of intensive pumping in the Basin (the Channel Aquifer) and on the opposite side of one or more faults that appear to sustain high groundwater levels along Wardlow Wash.

6.7.6.4. Relationship of Minimum Threshold to Regulatory Standards

Other than SGMA, there are no local, state, or federal regulations that specifically address stream flow depletion by groundwater pumping. The California and federal Endangered Species Acts protect species listed as threatened or endangered, including least Bell's vireo and Southwestern Willow Flycatcher. The minimum threshold for depletion of surface water is designed to prevent groundwater conditions from impacting those species beyond the level of impact that has historically occurred.

6.7.6.5. How the Minimum Threshold Will Be Monitored

There presently are no shallow monitoring wells in the southern part of the Prado Wetlands; all of them are in the northern part. This is a data gap that will be filled during the first 5-year implementation period of this GSP. In the meantime, if water levels in the Basin unexpectedly drop below their MT elevations, the levels will be evaluated in conjunction with shallow-well water levels in the northern part of the Wetlands to estimate whether the depth to water near the southern edge of the Wetlands might be increasing to more than 15 feet.

6.7.7. Measurable Objective

The Measurable Objective for interconnected surface water is a depth to the water table along the southern edge of the Prado Wetlands that is less than the MT of 15 feet. Groundwater conditions with respect to interconnected surface water and most GDE parameters are currently sustainable. Therefore, no interim milestones are needed to achieve sustainability at this time.

6.7.8. Data Gaps

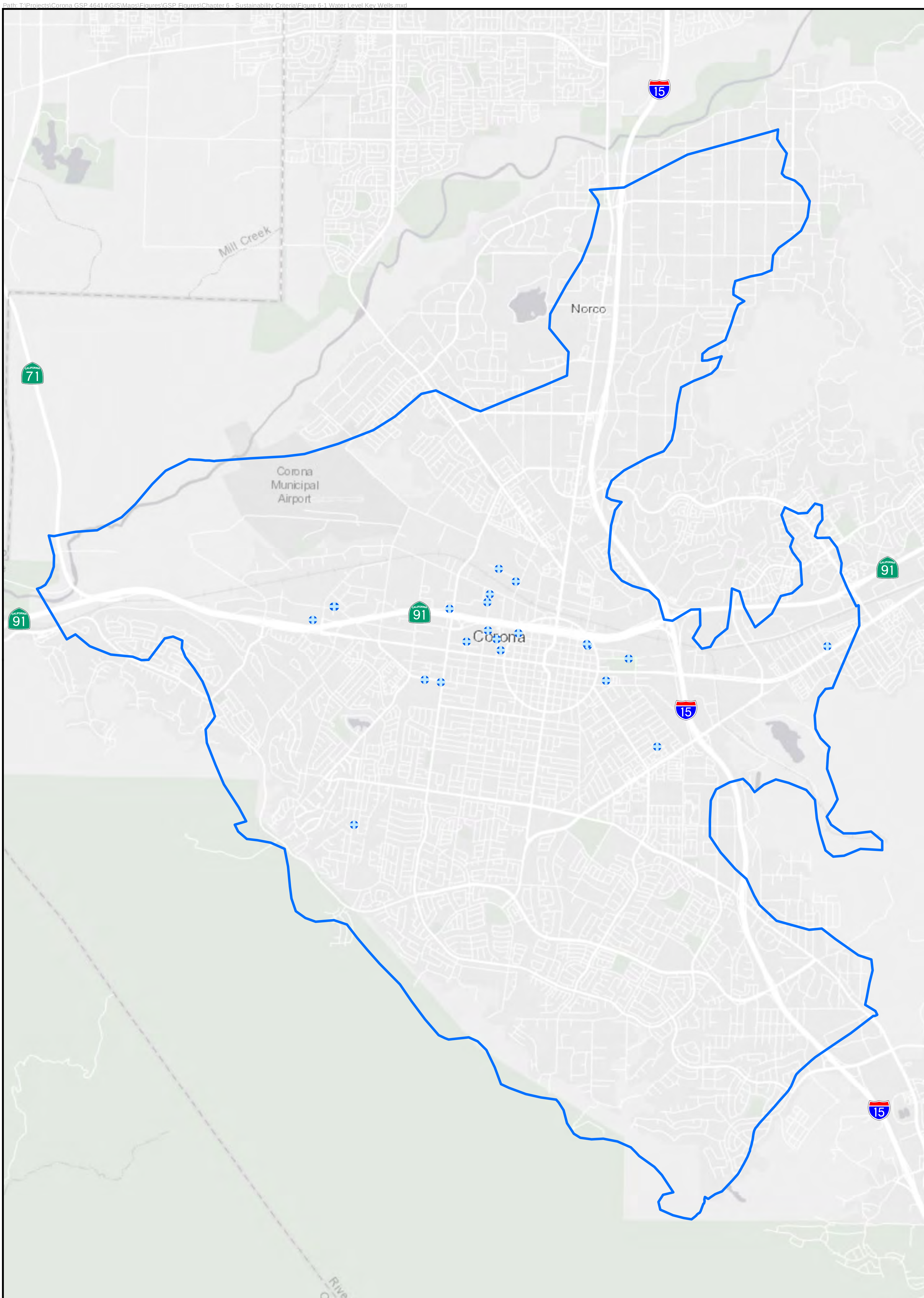
The primary data gap for interconnected surface water is the lack of shallow wells to monitor water table depth along the southern edge of the Prado Wetlands. Orange County Water District (OCWD) recently installed several shallow monitoring wells in the southern Prado Wetlands and has plans to install more in the near future. Water levels from these OWCD wells and additional wells that will be installed by the GSA (see Chapter 8) will be incorporated into the GSAs monitoring program as they become available, which will fill this data gap.

6.7.8.1. Discussion of Monitoring and Management Measures to be Implemented

The primary management action that will be implemented during the first 5-year implementation period will be to install two to four shallow piezometers along the southern edge of the Prado Wetlands, between the wetlands and the major production wells in Corona. These would consist of 2-inch polyvinyl chloride (PVC) casings and screens extending below the water level at the time of drilling to capture seasonal and long-term fluctuations in shallow groundwater levels. Reference point elevations at the well heads will be surveyed so that water levels can be tied to sea level.

Basin pumping and water levels are not expected to adversely impact riparian vegetation in the Prado Wetlands. In the unlikely event that such an impact does occur, Corona has various potential options available that could be temporarily implemented to minimize or mitigate impacts during droughts. These include reducing total pumping, shifting pumping to wells farther from the Wetlands, or temporarily increasing reclaimed water discharges down Temescal Wash to the Wetlands. Corona will select the most effective response based on the circumstances of the impact.

Path: T:\Projects\Corona GSP 46414\GIS\Maps\Figures\GSP Figures\Chapter 6 - Sustainability Criteria\Figure 6-1 Water Level Key Wells.mxd



Sustainability Criteria Key Well

Temescal Basin

N

0 0.5 1

Miles

Figure 6-1
Water Level
Key Wells

TODD GROUNDWATER

7. MONITORING NETWORK

The overall objective of the monitoring network for this Groundwater Sustainability Plan (GSP) is to yield representative information about water conditions in the Temescal Subbasin (Basin) as necessary to guide and evaluate GSP implementation. Specifically, monitoring network objectives are to:

- Build on the existing monitoring network data to represent the entire Basin,
- Reduce uncertainty and provide better data to guide management actions, document the water budget, and better understand how the surface water/groundwater system works,
- Monitor groundwater conditions relative to sustainability criteria, and
- Identify and track potential impacts on groundwater users/uses and better communicate the state of the Basin.

With the intent to provide sufficient data for demonstrating short-term, seasonal, and long-term trends in groundwater and related surface conditions, this GSP builds on existing monitoring programs (summarized in Chapter 2, Plan Area) that provide historical information and a context for monitoring. Data gaps are addressed in terms of information needed for understanding the basin setting, evaluation of the efficacy of GSP implementation, and the ability to assess whether the Basin is being sustainably managed.

This GSP section describes the monitoring network as enhanced to fulfill Sustainable Groundwater Management Act (SGMA) requirements and explains how it will be implemented. This includes description of the monitoring protocols for data collection, the development and maintenance of Temescal Groundwater Sustainability Agency (GSA) data management system (DMS), and the regular assessment and improvement of the monitoring program.

7.1. DESCRIPTION OF MONITORING NETWORK

The monitoring network for GSP implementation has been established to document groundwater and related surface conditions as relevant to the sustainability indicators: groundwater levels, storage, land subsidence, water quality, and interconnected surface water[6.] The components of the monitoring network are presented in **Table 7-1**.

[6] Seawater intrusion is noted, but no risk of seawater intrusion exists in this inland basin.

Table 7.1 - Temescal GSP Monitoring Program Summary

Monitored Variable	Type of Measurement	Locations	Data Interval	Data Collection Agency	Database Storage Agency	Notes
Groundwater levels						
Temescal Basin	Depth to water, feet	37 monitored wells (see Table 7-2)	Continuous to Annual	City of Corona	Temescal GSA	Data from all sources compiled into unified groundwater elevation database
Groundwater storage						
Rainfall	Rain gauge, daily total, inches	Lake Elsinore, Santiago Peak, and Riverside	Daily and Monthly	NOAA, Orange County, and UC Riverside CIMIS	Temescal GSA	Download from web annually for annual water budget and model update
Rainfall (Interpolated)	Interoplated spatially from point data	Basin-wide		PRISM Climate Group	Temescal GSA	Rainfall gauges are not within the basin, and PRISM data helps interpolate in regions with climatic variation
Reference ET (ET_0)	Daily ETo, inches	Lake Elsinore and Riverside	Daily	NOAA, UC Riverside CIMIS	DWR	Download from web
Stream flow	Daily average flow, cfs	Two active USGS gages near Temescal	Daily	USGS	USGS	Download from web
Wastewater pond water budgets	WRF effluent discharge, evaporation, percolation, AF	Corona	Monthly	City of Corona	Temescal GSA	
Wastewater/ Recycled Water percolation	WRF/RW percolation volume, AF	Corona	Monthly	City of Corona	Temescal GSA	
Recycled water use	Recycled water delivery, AF	Basin-wide	Monthly	City of Corona	Temescal GSA	Recycled water use is a relatively small but increasing supply
Imported Water	Volume imported water AF	Imported to Temescal	Monthly	City of Corona	Temescal GSA	
Crop patterns	Map of farmland use by category	Basin-wide	Annual	DWR	DWR	Field scale annual agricultural land use mapping data from remote sensing
Land Use Maps	Maps of Land Use	Basin-wide		DWR (2014) and Riverside County (1993 and 2000)	DWR and Riverside County	DWR data is statewide
Municipal Water Use	Metered water use by sector	Corona, Home Gardens and Norco	Monthly	City of Corona, Norco	Temescal GSA	Annual data reported in Annual Report: CVP, groundwater, recycled water use (AFY)
Groundwater pumping						
Community Water Systems	Estimated	Basin-wide	Annual	DDW		
Groundwater Production	Annual Volume, AFY	Basin-wide	Annual	City of Corona	Western Municipal Water District as Watermaster and Temescal GSA	
Rural domestic, commercial, industrial	Estimated	Basin-wide	Annual	City of Corona	Western Municipal Water District as Watermaster and Temescal GSA	Annual estimates provided in water budget updates of Annual Report
Subsidence						
Subsidence	InSAR satellite mapping of ground displacement	Basin-wide	Annual change	DWR (InSAR)	DWR SGMA Data Portal	Download annually, smooth InSAR raster data sets (see Section 4.2.3.1), compare cumulative elevation change since 2015 against Minimum Threshold criterion.
Groundwater quality						
Groundwater Quality	Major and minor ions and contaminants	27 currently monitored wells	Quarterly/ Semi-annual	City of Corona , DDW, RWQCB	Temescal GSA	Wells with water qualtiy data may be added or removed over time
Interconnected Surface Water and GDEs						
Groundwater Depth to Water	Depth to water, feet	Multiple monitored wells outside the Basin, three new wells will be installed in the future	Annual	City of Corona	Temescal GSA	Groundwater in the Prado Management Area is shallow enough to support riprarian vegetation. Water levels in wells within the Prado area will be used.

7.1.1. Chronic Lowering of Groundwater Levels

As described in Plan Area Section 2, there are wells in the Basin with elevation data that are monitored by the City of Corona (Corona) and other agencies. The wells in the groundwater level monitoring program are shown on **Figure 7-1** and listed in **Table 7-2**. The distribution of existing monitoring wells is uneven, with most monitoring wells clustered in the Channel Aquifer. All of the wells in the GSP monitoring network listed in **Table 7-2** will continue to be monitored by the GSA.

Data for GSP implementation collected by Corona, with support from the other GSA members, will be compiled into the DMS developed as part of the GSP. Benefits of these efforts will accrue over the next few years and will support review and update of the monitoring program in the 2027 GSP evaluation and update.

7.1.1.1. Spatial and Vertical Coverage

Well density has been a consideration in identifying new dedicated monitoring well sites and adding existing wells to the monitoring program. California Department of Water Resources (DWR) guidance (DWR 2016d) generally recommends a monitoring well density of 4 wells per 100 mi^2, which would equate to 1.48 wells for the 37 mi^2 Basin. The Temescal Basin monitoring program is consistent with this guidance. Many of the active wells are clustered in the Channel Aquifer, the principal aquifer. This is appropriate because most of the pumping for beneficial uses occurs in the Channel Aquifer and monitoring is needed to assess the sustainability management criteria.

Data on vertical groundwater gradients generally are lacking, as discussed in the Hydrogeologic Conceptual Model, Chapter 3. Vertical gradients also have not been distinguished because most monitoring data is from public supply wells, which generally have long screen zones and have not been designed to assess or monitor vertical gradients either locally or Basin-wide.

7.1.1.2. Monitoring Frequency

SGMA and the California Statewide Groundwater Elevation Monitoring (CASGEM) program require collection of static groundwater elevation measurements at least two times per year to represent seasonal low and seasonal high groundwater conditions (DWR 2010). Currently, the water level wells in the monitoring network are monitored at least quarterly, and most are monitored either monthly or continuously.

7.1.2. Reduction of Groundwater in Storage

As described in GSP Section 6.3, groundwater level Minimum Thresholds (MTs) are used as a proxy metric for groundwater in storage. Accordingly, the monitoring of groundwater levels described above in Section 7.1.1 also pertains to tracking sustainability for groundwater in storage.

In addition, GSP Regulations require annual evaluation and reporting of change in groundwater in storage.

Table 7-2. Wells in the Temescal Groundwater Sustainability Agency Monitoring Network

Local Well Name	X Coordinate (feet State Plane CA Zone 6, NAD 83)	Y Coordinate (feet State Plane CA Zone 6, NAD 83)	Production or Monitoring Well	Water Level Monitoring Well (Yes/No)	Water Level Key Well (Yes/No)	Water Quality Monitoring Well (Yes/No)
Corona 6	6164825.949	2263859.333	Monitoring	Yes	No	No
Corona 7	6164856.185	2263922.413	Production	Yes	No	Yes
Corona 7A	6164825.605	2263909.491	Production	Yes	Yes	Yes
Corona 8	6163919.615	2265638.126	Monitoring	Yes	Yes	No
Corona 8A	6163885.958	2265713.322	Production	Yes	Yes	Yes
Corona 9A	6159626.551	2265408.669	Production	Yes	Yes	Yes
Corona 11	6151398.941	2267565.162	Monitoring	Yes	Yes	No
Corona 11A	6151465.535	2267567.378	Production	Yes	Yes	Yes
Corona 12A	6150373.592	2266916.031	Production	Yes	Yes	Yes
Corona 13	6167356.423	2260664.289	Production	Yes	Yes	Yes
Corona 14	6155892.961	2263969.337	Production	Yes	Yes	Yes
Corona 15	6157114.482	2267464.919	Production	Yes	Yes	Yes
Corona 16	6151422.875	2267564.036	Monitoring	Yes	Yes	No
Corona 17A	6165945.52	2265005.116	Production	Yes	Yes	Yes
Corona 19	6160509.305	2266247.265	Production	Yes	Yes	Yes
Corona 22	6157958.891	2265844.063	Production	Yes	Yes	Yes
Corona 25	6159434.755	2265962.111	Production	Yes	Yes	Yes
Corona 26	6160385.783	2268810.243	Production	Yes	Yes	Yes
Corona 27	6152402.182	2256818.413	Production	Yes	Yes	Yes
Corona 28	6158978.97	2267786.881	Production	Yes	Yes	Yes
Corona 29	6159105.364	2268178.328	Production	Yes	Yes	Yes
Corona 30	6159542.311	2269428.52	Monitoring	Yes	Yes	No
Corona 31	6159001.737	2266396.339	Production	Yes	Yes	Yes
Corona 32	6175760.31	2265603.84	Monitoring	Yes	No	Yes
Corona 33	6175779.012	2265597.015	Production	Yes	Yes	No
Corona 10th/Lincoln	6156682.367	2263845.603	Monitoring	Yes	Yes	No

For the GSP, the numerical groundwater model has been used to quantify the water budget and change in storage (see Water Budget, Chapter 5) using available information from the Monitoring Well Network. The numerical model (described in GSP **Appendix J**) fulfills data and reporting standards described in SGMA Section 352.4.

As described in Plan Area Section 2.4 and summarized in **Table 7-1**, the Temescal GSA monitoring program provides information needed to update the water budget and assess annual change in groundwater storage. This program compiles and reviews information on climate (rainfall and evapotranspiration), stream flow, imported water deliveries, wastewater percolation and water recycling, and groundwater pumping (municipal, industrial, and other). Groundwater in storage will be assessed annually using the numerical model, which will be recalibrated during each five-year GSP update.

7.1.2.1. Spatial Coverage

Evaluation of change in groundwater in storage involves several of the monitored variables listed in **Table 7-1**; monitoring locations are described in the table. **Table 7-1** indicates locations of climate stations and stream gage locations.

7.1.2.2. Surface Water Monitoring

Temescal Wash is the main drainage in the Basin, originating at Lake Elsinore, 17 miles upstream of Basin. It passes from south to north through the Bedford-Coldwater Subbasin and then through the Basin before discharging into the Prado Management Area. There are two stream gages on Temescal Wash, one below Lee Lake at the upstream end of the Bedford-Coldwater Subbasin (Temescal Wash at Corona Lake; USGS 11071900) and one at Main Street downstream of the water reclamation facility in Corona (Temescal Creek above Main Street at Corona; USGS 11072100). These stream gages are operated and maintained by the United States Geological Survey (USGS 2020a).

7.1.2.3. Monitoring Frequency

Table 7-1 describes the data interval for the monitored variables that contribute to evaluation of groundwater in storage. Groundwater in storage will be assessed annually using the numerical model, which will be recalibrated during each five-year GSP update.

7.1.3. Seawater Intrusion

There is no monitoring for seawater intrusion and no gaging of tidal influence. The Basin is located over 20 miles inland from the Pacific Ocean, and its lowest elevations are around 1,000 feet above sea level. No risk of seawater intrusion exists in the Basin given its location and therefore no monitoring is needed.

7.1.4. Subsidence

The monitoring program will review Interferometric Synthetic Aperture Radar (InSAR) satellite-based data to identify and evaluate land subsidence in the Basin (see **Table 7-1**). These data will be used to monitor rate and extent of ground surface elevation change as applicable and with reference to the MT and Measurable Objective (MO), which are described in Sustainability Criteria Section 6.5. These data represent measurements of ground surface displacement and thus are directly applicable to scientific assessment of potential subsidence.

7.1.4.1. Spatial Coverage

The InSAR data provide adequate coverage of the Temescal Basin. As described in Groundwater Conditions Section 4.3 and Sustainability Criteria Section 6.5. InSAR data are available for the entire Basin (and beyond), as shown with recent InSAR information from DWR on **Figure 4-13**. InSAR data will be cross-checked, and in conjunction with local groundwater level and pumping data, will be used to assess relationships between levels, pumping, and subsidence data.

7.1.4.2. Monitoring Frequency

Assuming continued data availability, the monitoring program will involve annual download of InSAR data with analysis for any signs (rate and extent) of cumulative inelastic subsidence. To date there have been no reports or other indications of subsidence in the Basin. While data will be reviewed annually, at this time detailed analysis relative to the Minimum Threshold and Measurable Objective is planned as part of the five-year GSP update. The reporting will be consistent with GSP Regulations.

7.1.5. Degraded Water Quality

In addition to the general monitoring objectives listed above, specific objectives for the GSP water quality monitoring program include the following:

- Collect groundwater quality data from the principal aquifer to identify and track trends of any water quality degradation,
- Map the movement of degraded water quality,
- Define the three-dimensional extent of any existing degraded water quality impact,
- Assess groundwater quality impacts to beneficial uses and users, and
- Evaluate whether management activities are contributing to water quality degradation.

Figure 7-2 shows the location of the existing wells that are sampled for water quality. The existing water quality monitoring programs for the Basin are described in Plan Area Section 2.4 Groundwater Conditions Section 4, and Sustainability Criteria Section 6.6. To summarize, the Temescal Basin monitoring program relies on annual or semi-annual measurements from Corona wells, the Santa Ana Regional Water Quality Control Board (RWQCB), and State Water Resources Control Board Division of Drinking Water (SWRCB-DDW). Corona currently monitors wells periodically for general minerals, physical parameters, and selected constituents of concern. These wells are shown on **Figure 7-2** and listed in **Table 7-2**. As described in Groundwater Conditions Section 4 and discussed in depth in Section 6.6, a broad suite of inorganic constituents is sampled and analyzed and known regulated contamination sites are tracked. Total dissolved solids (TDS) and nitrate have been identified as the key constituents of concern for which sustainability criteria have been defined.

7.1.5.1. Spatial and Vertical Coverage

The current monitoring network in the Basin is focused in the Channel Aquifer and is limited in other areas of the Basin. **Figure 7-2** shows the spatial distribution of wells currently monitored. As with the groundwater level monitoring program, existing wells monitored by the GSA for groundwater quality will be evaluated relative to SGMA Section 352.4 requirements for well information. Also similar to the groundwater level monitoring program, the focus of monitoring is the Channel Aquifer as this is the primary source for municipal drinking water, a critical beneficial use of the Basin.

Vertical coverage is discussed in Groundwater Conditions Section 4.8, which indicates that the water quality monitoring programs in the Basin do not reveal vertical differences in water quality. Otherwise, vertical differences in water quality are uncertain; this reflects the fact that most monitored wells are pumping wells with long screens.

As stated in Section 6.6, the GSA will continue to improve and expanded the monitoring program to address spatial and vertical coverage.

7.1.6. Depletion of Interconnected Surface Water

The minimum threshold defined for depletion of interconnected surface water is defined by groundwater levels monitored near the Prado Management Area. At this time, wells in the groundwater level monitoring program are production wells with relatively deep screens that have not been sited and designed for tracking surface water-groundwater interactions. The lack of shallow monitoring wells has been identified as a data gap.

Improvement of the surface water-groundwater monitoring program includes addition of three dedicated shallow monitoring wells, implemented as part of the projects and management actions outlined in this GSP.

Benefits of the new wells will accrue over the next few years and support characterization of the spatial and temporal exchanges between surface water and groundwater, plus identification of thresholds for undesirable results relating to riparian vegetation, which will be evaluated as part of the 2027 GSP evaluation and update.

7.1.6.1. Spatial and Vertical Coverage

As noted above, the existing monitoring network does not provide adequate coverage for monitoring interconnected surface water. New shallow monitoring wells will be installed to fill this data gap, as described in Chapter 8.

7.1.6.2. Temporal Coverage and Monitoring Frequency

Groundwater level monitoring in the new shallow monitoring wells will be implemented as part of the overall groundwater level monitoring program as described in Section 7.1.1. Once sited and installed, the periods of record for new dedicated shallow wells will be established. Groundwater level data will be reviewed annually (for each annual report). Detailed analyses of the relationships among deep and shallow groundwater level data, stream flow, and riparian conditions will be provided in the 2027 GSP evaluation and update (or sooner if extreme drought conditions and riparian mortality occur; see GSP Section 6.7).

7.2. PROTOCOLS FOR DATA COLLECTION AND MONITORING

This section focuses on groundwater level monitoring (including regional and surface water-oriented) and groundwater quality sampling by the GSA. Other data (e.g., climate, streamflow, municipal pumping, subsidence) are compiled by other agencies.

This section describes general procedures for documenting wells in the monitoring program and for collecting consistent high-quality groundwater elevation and groundwater quality data. In general, the methods for establishing location coordinates (and reference point elevations for elevation monitoring) follow the data and reporting standards described in the GSP Regulations (Section 352.4) and the guidelines presented in USGS Groundwater Technical Procedures (Cunningham and Schalk 2011 and USGS 2021). These procedures are summarized below.

7.2.1. Field Methods for Monitoring Well Data

Background data for each monitoring well is required for its inclusion in the monitoring program. These data are generally available for wells in the network described in **Table 7-2** and shown on **Figures 7-1**. As part of GSP implementation, location and elevation data will be acquired where missing, revised if conditions at a monitored well change, and added when new wells are brought into the program. The methods for acquiring these data follow:

- Location coordinates will be surveyed with a survey grade global positioning system (GPS) device. The coordinates will be in Latitude/Longitude decimal degrees and reference the North American Datum of 1983 (NAD83).
- Reference point elevations will also be surveyed with a survey grade GPS with elevation accuracy of approximately 0.5 feet.
    - During surveying, the elevations of the reference point and ground surface near the well will be measured to the nearest 0.5 foot.
    - All elevation measurements will reference North American Vertical Datum of 1988 (NAVD88).

7.2.2. Field Methods for Groundwater Elevation Monitoring

Reference points and ground surface elevations will be documented as described above prior to groundwater elevation monitoring in the field. Field methods for collection of depth-to-water measurements are described below:

1. Measurements in all wells will be collected within a three-day window whenever possible.
2. Active production wells should be turned off prior to collecting a depth to water measurement.
3. The standard period of time that a well needs to be off before a static measurement is taken is 48 hours.
4. To verify that the wells are ready for measurement, agency staff (from Corona, the City of Norco [Norco], and Home Gardens County Water District [HGCWD]) will coordinate with well operators and/or owners as necessary.

5. Coordination with well operators/owners should occur approximately four days prior to the expected measurement date.
6. Depth to groundwater measurements collected by either electric sounding tape (Solinst or Powers type sounders) or by steel tape methods. Depth-to-water measurement methods are described in DWR's *Groundwater Elevation Monitoring Guidelines* (DWR 2010). Depth to groundwater will be measured and reported in feet to at least 0.1 foot.

7.2.3. Field Methods for Groundwater Quality Monitoring

Groundwater sampling is conducted by trained professionals from the GSA. Sampling follows standard monitoring well sampling guidelines such as those presented in the National Field Manual for the Collection of Water-Quality Data (USGS 2021).

Generally, the wells have been pumped prior to sample collection, or are purged. Purging is conducted until field instruments indicate that water quality parameters (pH, oxidation-reduction potential (ORP), specific conductance, and temperature) have stabilized and turbidity measurements are below five Nephelometric Turbidity Unit (NTUs). The pumping or purging demonstrate that the sample collected is representative of formation water and not stagnant water in the well casing or well filter pack. For groundwater, field temperature and conductivity are recorded while the well is being purged to ensure that physical parameters have stabilized before collecting a sample.

All groundwater samples are collected in laboratory-supplied, pre-labeled containers and include prescribed preservatives.

All field measurements are recorded in a field logbook or worksheets and the sample containers are labeled correctly and recorded on the chain-of-custody form. The applicable chain-of-custody sections are completed and forwarded with the samples to the laboratory. Upon receipt of the samples at the laboratory, laboratory personnel complete the chain-of-custody.

Quality assurance and quality control (QA/QC) assessment of field sampling includes use of field blanks. Field blanks identify sample contamination that is associated with the field environment and sample handling. These samples are prepared in the field by filling the appropriate sample containers with the distilled water used for cleaning and decontamination of all field equipment. One field blank per sampling event is collected.

Samples are sent to a State-certified laboratory that has a documented analytical QA/QC program including procedures to reduce variability and errors, identify and correct measurement problems, and provide a statistical measure of data quality. The laboratory conducts all QA/QC procedures in accordance with its QA/QC program. All QA/QC data are reported in the laboratory analytical report, including: the method, equipment, and analytical detection limits, the recovery rates, an explanation for any recovery rate that is less than 80 percent, the results of equipment and method blanks, the results of spiked and surrogate samples, the frequency of quality control analysis, and the name of the person(s) performing the analyses. Sample results are reported unadjusted for blank results or spike recovery.

7.3. REPRESENTATIVE MONITORING

To allow quantification and tracking of sustainability criteria, representative monitoring sites, or wells, have been identified for 1) regional groundwater level monitoring and 2) monitoring shallow groundwater conditions where surface water-groundwater connection is likely and tied to groundwater dependent ecosystems (GDEs). These Key Wells are shown on **Figure 7-1** and listed in **Table 7-2**. These have been designated by the GSA as the point at which sustainability indicators are monitored. Information on the quantitative values for minimum thresholds, measurable objectives, and interim milestones is included in Sustainability Criteria Section 6.

As discussed in Sustainability Criteria Section 6.3, change in groundwater in storage is closely related to groundwater levels, which can serve as a proxy for monitoring change in storage. Moreover, groundwater level MTs and MOs are sufficiently protective to ensure prevention of significant and unreasonable results relating to storage. Accordingly, continued monitoring of wells for groundwater levels also serve to track sustainability for storage.

As discussed in Section 6.5, the definition of undesirable results and the quantification of the MT and MO for subsidence are based on InSAR information on vertical displacement of the ground surface; these spatial and temporal data are publicly available from DWR.

Section 6.4 discusses seawater intrusion, which is not possible in this inland basin.

Section 6.6 describes undesirable results and defines sustainability criteria for water quality. MTs and MOs are quantified in terms of the percentage of wells with concentrations exceeding the local and state goals for nitrate and TDS based on current conditions. The GSP water quality monitoring wells shown on **Figure 7-2** and listed in **Table 7-2** are sampled regularly to identify water quality problems and to track water quality trends.

7.4. DATA MANAGEMENT SYSTEM (DMS)

The GSA has been collecting and compiling groundwater data including water levels, water quality, and water use for the GSP. Before the creation of the GSA, the individual agencies of (Corona, Norco, and HGCWD) monitored water levels and water quality independently. These data are compiled in relational databases, which consists of Access databases and ESRI geodatabases that have the capabilities for queries to quickly check and summarize data. As part of the GSP, the DMS has been modified to be practicable, usable, and intuitive for the purpose of GSP preparation and implementation. **Appendix L** details the final DMS. The databases include easy to update tables and other datasets that assist in comparison of real time conditions and sustainability goals.

7.5. ASSESSMENT AND IMPROVEMENT OF MONITORING NETWORK

The GSA has actively engaged in assessment and improvement of its monitoring network. This process has been intensified as part of the GSP, given the need to identify data gaps and to assess uncertainty in setting and tracking sustainability criteria. Monitoring improvements are a major part of GSP implementation and will be reviewed and updated for each five-year GSP evaluation.

7.5.1. Identification and Description of Data Gaps

Data gaps are identified in **Table 7-3** according to major monitored variable and described in terms of insufficient number of monitoring sites and utilization of monitoring sites that are unreliable (including those that do not satisfy minimum standards). Data gaps also are described in terms of the location and reason for data gaps in the monitoring network, and local issues and circumstances that limit or prevent monitoring. Data gaps listed in **Table 7-3** do not include gaps in understanding, which build on the monitoring network but also require investigation and analysis. These planned studies are described as Management Actions in GSP Chapter 8.

Table 7-3. Identification and Description of Data Gaps

Monitored Variable	Insufficient Sites	Local Issues
Regional groundwater levels	No	The water level network has historically relied largely on production wells.
Stream flow	No	There are gages on the major streams in the Basin.
Groundwater extraction	No	Most pumping is reported, there may be unreported pumping but it is assumed to be de minimis.
Groundwater quality	No	Water quality sampling in the Basin is typically tied to regulatory requirements, the GSA will perform regular monitoring of the well network and collect water quality data from all available sources.
Shallow groundwater levels	Yes	No shallow dedicated groundwater monitoring wells are currently in the Basin. Long well screens in monitoring wells limit vertical groundwater quality characterization. New shallow monitoring wells are included as a project in Chapter 8.

7.5.2. Description of Steps to Fill Data Gaps

Monitoring data gaps have been identified for surface water and shallow groundwater level measurements.

Additional shallow groundwater level monitoring is required to better monitor interconnected surface water and GDEs in the Basin. Corona will locate and install three new shallow water level monitoring wells/piezometers adjacent to Prado Management Area, as described in Chapter 8, Projects and Management Actions.

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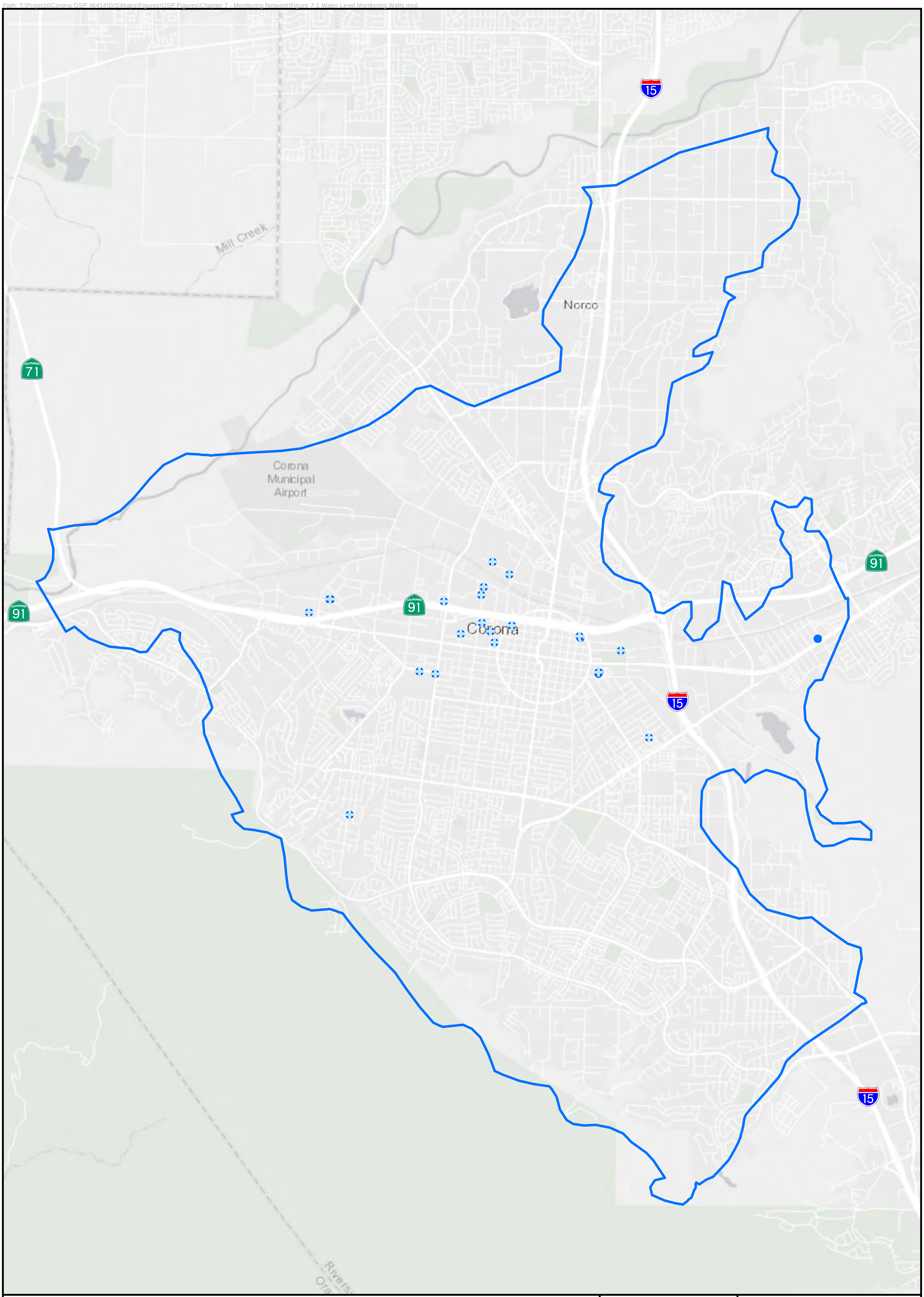

- Water Level Monitoring Well
- Sustainability Criteria Key Well
- Temescal Basin

N

0 0.5 1
Miles

Figure 7-1
Groundwater Level Monitoring Wells

TODD GROUNDWATER

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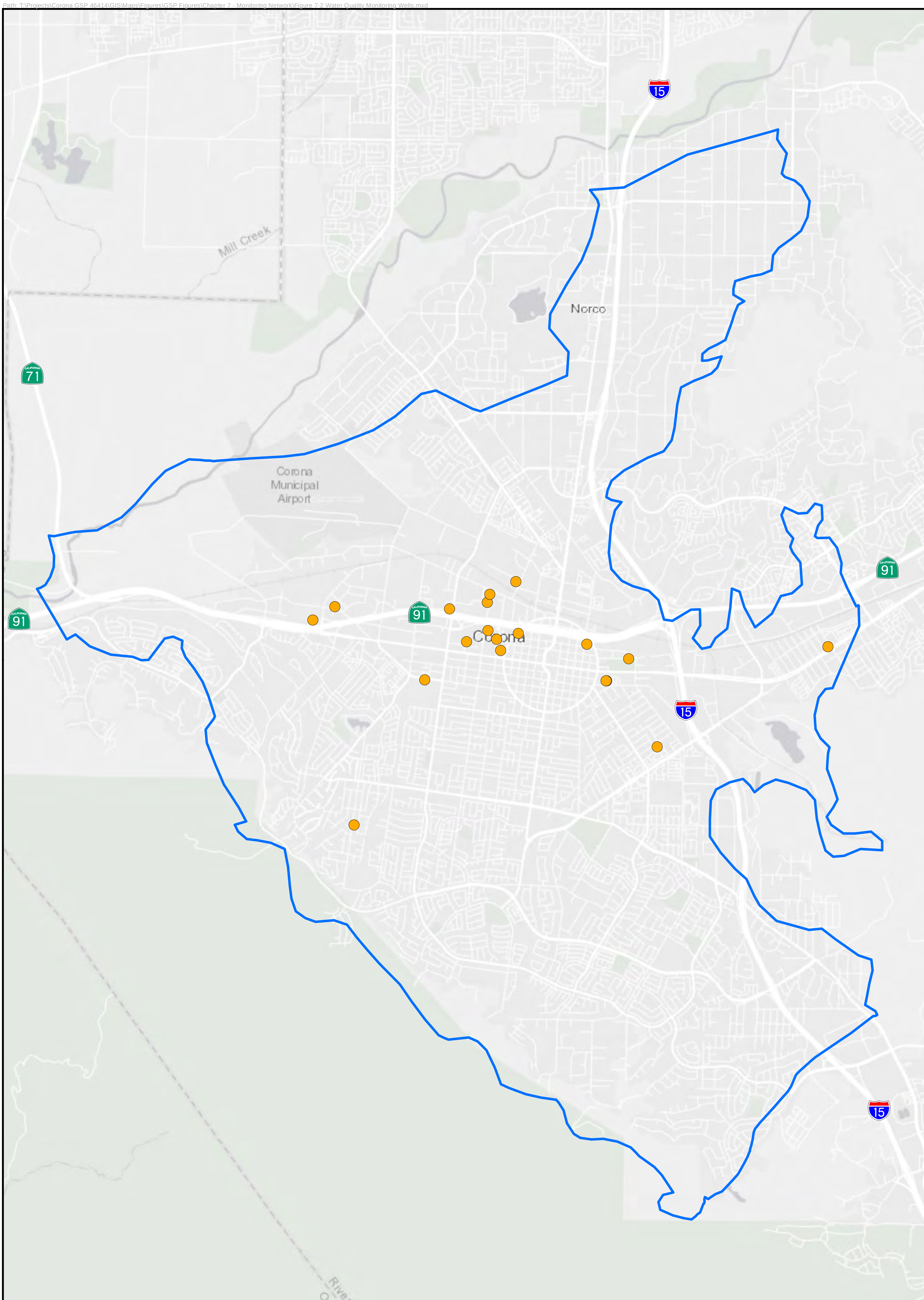


Water Quality Monitoring Well

Temescal Basin

N

0 0.5 1

Miles

Figure 7-2
Water Quality
Monitoring Wells

TODD GROUNDWATER

8. PROJECTS AND MANAGEMENT ACTIONS

This chapter of the Groundwater Sustainability Plan (GSP) includes projects and management actions aimed at achieving sustainability goals and responding to changing conditions in the Temescal Subbasin (Basin). The projects and management actions are divided into three groups:

- Group 1 - Existing or established projects and management actions
- Group 2 - Projects and management actions that have been or are under development
- Group 3 - Conceptual projects and management actions that can be considered in the future if any Group 2 projects fail to be implemented or additional intervention is required to achieve basin sustainability goals.

A summary of the projects and management actions in each of the groups is presented in **Table 8-1**. Additional discussion of each project is included in the sections that follow.

Table 8 1. Summary of Projects and Management Actions

Description	Agency	Category	Status	Anticipated Timeframe
Group 1 - Existing or established projects and management actions				
Groundwater Treatment	City of Corona	Project	Ongoing	Implemented
WRF Percolation Ponds	City of Corona	Project	Ongoing	Implemented
Water Level QA/QC	City of Corona	Project	Ongoing	Implemented
Water Shortage Contingency Plans	Cities of Corona and Norco	Management Action	Ongoing	Implemented
Water Conservation Programs	Cities of Corona and Norco	Management Action	Ongoing	Implemented
Western Municipal Water District - IRWMP	10 local cities/agencies including the GSA	Management Action	Ongoing	Implemented
Western Riverside County Regional Wastewater Authority (WRCRWA)	GSA, Jurupa Community Services District, and WMWD	Project	Ongoing coordination	Pending coordination with WRCRWA and partner agencies
Santa Ana Watershed Involvement	GSA, Santa Ana Watershed Project Authority (SAWPA), and Santa Ana River Dischargers Association (SARDA) members	Management Action	Ongoing	Implemented
Group 2 – Projects and management actions have been developed or are under development				
Interconnected Surface Water Monitoring Wells Implementation	GSA	Project	In planning	Well implementation within the first year of GSP adoption
Potable Reuse Feasibility Study	GSA	Project	Not started	Study initiation within the second year of GSP adoption
Mountain Runoff Capture Investigation	GSA and RCFCWCD	Project	Not started	Study initiation within five years of GSP adoption
Group 3 – Conceptual future projects and management actions				
Future Groundwater Treatment	GSA	Project	Not started	No current anticipated timeline
Stormwater Capture, Treatment and Recharge	GSA	Project	Not started	No current anticipated timeline
Santa Ana River Wastewater Discharge Coordination for Shallow Groundwater Conditions	GSA, SAWPA, and SARDA members	Management Action	Not started	No current anticipated timeline

8.1. GROUP 1 PROJECTS

Group 1 projects and management actions are considered existing or established commitments by the City of Corona (Corona), other agencies within the Temescal Groundwater Sustainability Agency (GSA), and/or affiliated agencies. Group 1 projects are either already in operation or are currently being implemented with anticipated near-term operation.

8.1.1. Groundwater Treatment

Corona relies on groundwater from the Temescal and Bedford-Coldwater Basins for up to 50 percent of its potable water supply. **Table 8-2** shows Corona's current and projected annual groundwater extraction volumes from these basins. As shown in the table, the Temescal Basin is responsible for most of Corona's current and future groundwater supply.

Table 8-2. Existing and Projected Corona Groundwater Extraction Volumes (AFY)

Basin	2020	2025	2030	2035	2040	2045
Bedford-Coldwater	0	2,112	2,112	2,112	2,112	2,112
Temescal	16,239	13,000	13,000	13,000	13,000	13,000

Data Source: 2020 Urban Water Management Plan (Michael Baker 2021)

Approximately half of the groundwater pumped in Corona is treated at the Temescal Desalter Facility, a city-owned, reverse osmosis (RO) facility. This facility reduces nitrates, per- and polyfluoroalkyl substances (PFAS), 1,2,3-Trichloropropane (TCP), perchlorates, and total suspended and dissolved solids (TSS and TDS) from water pumped from the Temescal Basin. In addition, ammonium hydroxide and sodium hypochlorite is added to the treated groundwater to act as a disinfectant and mitigate the formation of disinfection byproducts (DBPs) (Michael Baker 2021). The Temescal Desalter produces 10 million gallons per day (mgd) on average.

Corona maintains five continuously monitored blending facilities that blend the treated groundwater with both surface water and non-Desalter treated, locally produced groundwater. A portion of the groundwater utilized at the blend station that has not been treated by the Desalter is treated with sodium hypochlorite and ammonium hydroxide. This blend reduces the elevated amounts of fluoride, nitrate, and perchlorates found in the groundwater to a safe, consumable level.

The City of Norco (Norco) and Home Gardens County Water District (HGCWD) have service areas that overlie the Basin. The two entities do not currently pump groundwater from the Basin; however, should they utilize it for future supply they would likely require implementation of similar treatment.

8.1.2. Water Reclamation Facility (WRF) Percolation Ponds

Wastewater is treated at three Corona-owned and operated Water Reclamation Facilities (WRF-1, WRF-2 and WRF-3). The average annual production of treated wastewater (effluent) from these sources is approximately 11.35 mgd, or 12,700 acre-feet per year (AFY). Supply is anticipated to increase incrementally due to population growth by an additional 0.88 mgd through 2040 (about 7.8 percent).

WRF effluent is allocated to three end uses: 1) discharge to the Santa Ana River Watershed (SWRCB 2021), 2) reuse via the reclaimed water distribution system, and 3) discharge to offsite percolation ponds. WRF-1 and WRF-2 both contribute effluent to all of these end uses while WRF-3 only contributes effluent to the reclaimed water system. The three offsite percolation ponds overlie the Basin and allow for recharge. One of the ponds is located along Lincoln Avenue and the other two at the end of Rincon Street near Cota Street. **Table 8-3** shows the total annual effluent sent to the percolation ponds in the last five years.

Table 8-3. WRF Annual Percolation Pond Contributions (AFY)

Facility	2016	2017	2018	2019	2020
WRF-1	1,364	5,273	4,493	5,026	4,987
WRF-2	734	1,207	1,306	1,462	1,774

Data Source: 2020 Urban Water Management Plan (Michael Baker 2021)

8.1.3. Water Level Quality Assurance and Quality Control (QA/QC)

Corona is conducting water level quality assurance and quality control (QA/QC) activities to maintain and increase the integrity and reliability of ongoing groundwater elevation data collection. Static and pumping water level depths are collected, by Corona water operators, once a month from each groundwater well location identified in Chapter 7, Monitoring Network.

The current QA/QC process practiced by Corona involves the following activities:

- The data is entered into Corona’s database at the end of the water operator’s shift.
- The data is also written on a whiteboard in the Drinking Water staff crew room.

Corona is updating their QA/QC policies to ensure manual entry errors are minimized by creating “Alert” pop up boxes in their database.

- The minimum, maximum, average, and standard deviation static and pumping water level depths are calculated for each monitored well.
- The “Alert” pop up will appear if the data entered is greater than the upper limit or less than the lower limit for any monitoring event.
    - The upper limit for each well will be the standard deviation times two plus the average.
    - The lower limit will be the average minus two times the standard deviation.

- The Alert pop up still allows the operator to enter the data but makes them aware that the data being entered is outside the range of the historical measurements.
- It will be up to the water operator to recheck the data being entered, and either confirm or correct the measurement.
- A report including the most recent static and pumping water levels for each monitored well will be created once a month, and this report will be reviewed by operators and management to identify data collection errors and/or trends in water levels.

8.1.4. Water Shortage Contingency Plans

Corona's 2020 Urban Water Management Plan (UWMP) estimated the available supply from imported water, groundwater, and reclaimed water at a total of 50,000 AFY. Using this baseline supply, a water shortage contingency plan (WSCP) was developed. The WSCP has six shortage stages based on available supply and associated deficit. Each stage has associated response actions to ensure appropriate reductions in water use (Michael Baker 2021). **Table 8-4** shows each of the stages and associated supply. Note that the Ordinance 2962 Water Conservation Stage column will be discussed further in Section 8.1.5. Detailed information on response actions for a given stage can be found in the 2020 UWMP and is discussed further in Section 8.1.5.

Table 8-4. WSCP Shortage Level Determination

WSCP Stage	Ordinance 2962 Water Conservation Stage	Condition	Available Supply (AFY)	Deficit (AFY)
0	1	No Shortage	50,000	None
1	1	10 percent Shortage	45,000	None
2	1	20 percent Shortage	40,000	None
3	2	30 percent Shortage	35,000	5,000
4	3	40 percent Shortage	30,000	10,000
5	4	50 percent Shortage	25,000	15,000
6	5	> 50 percent Shortage	< 25,000	> 15,000

Data Source: 2020 Urban Water Management Plan (Michael Baker 2021)

Norco has developed their own respective WSCP based on the six stages and respective percent shortage condition as well (Norco 2021).

8.1.5. Water Conservation Program

In 2009, Corona implemented Ordinance No. 2962, amending the Corona Municipal Code to provide framework for water conservation and drought response measures. The Ordinance defines five stages of water conservation, corresponding water consumption objectives (10 percent to 40 percent or greater), and associated conservation and drought response measures. **Table 8-4**, above, shows the five stages and associated storage condition and available supply. The following is a summary of the shortage response actions to be taken at each water conservation stage (per Ordinance No. 2962), more detailed information can be found in the 2020 UWMP (Michael Baker 2021).

- **Stage 1:** No water shortage, or “normal water supply”, applies when Corona is able to fully meet all customer water demands. Normal water efficiency programs will be in effect during this time.
- **Stage 2:** Water customers shall reduce consumption by 10 to 15 percent. Examples of water reduction measures include irrigation limitations and residential car washing and drainage restrictions.
- **Stage 3:** Water customers shall reduce consumption by 16 to 20 percent. This includes all restrictions in Stages 1 and 2 and adds additional restrictions, such as limiting new construction water meters and prohibiting ornamental fountains or similar structures.
- **Stage 4:** Water customers shall reduce consumption by 21 to 40 percent. This includes all restrictions in Stages 1, 2, and 3 and adds additional restrictions, such as prohibiting the issuance of new construction water meters and prohibiting issuance of new building permits.
- **Stage 5:** Water customers shall reduce consumption by at least 41 percent. This includes all restrictions in Stages 1, 2, 3, and 4 and adds additional restrictions, such as prohibiting all outdoor watering, except for recycled water use for fruit tree irrigation.

Norco has developed their own respective conservation plan based more directly on the WSCP stages discussed in the prior section (Norco 2021).

8.1.6. Participation in Integrated Regional Water Management Plans (IRWMP)

The Western Municipal Water District (WMWD) Integrated Regional Water Management Plan (IRWMP) was prepared in 2008 (KJ 2008). The purpose of the plan was to address long range water quantity, quality, and environmental planning needs within the WMWD service area. The IRWMP was prepared in cooperation with the ten cities/water districts receiving water from WMWD, including the cities of Corona and Norco. The creation of the IRWMP provided a coordinated water management strategy to make sure water resources are being used responsibly throughout the region.

More recently, in 2018, the Santa Ana River Watershed Project Authority (SAWPA) developed the One Water One Watershed (OWOW) Plan Update to serve as the IRWMP for the Santa Ana River Watershed (SAWPA 2018). The OWOW Plan was initially developed in 2010 and has been subsequently updated in 2014 and 2019. The OWOW Plan was prepared with engagement from over 4,000 stakeholders. Including 120 water agencies and 63 incorporated cities within the watershed. All three GSA members were involved in the planning process.

The goals of the 2019 OWOW Plan are to achieve resilient water supply, improve water quality, preserve natural spaces, improve data integration and tracking, diminish environmental injustices, and educate visitors within the Santa Ana River Watershed.

8.1.7. Western Riverside County Regional Wastewater Authority (WRCRWA)

The Western Riverside County Regional Wastewater Authority (WRCRWA) is a joint powers authority (JPA) consisting of the cities of Norco and Corona, Jurupa Community Services District, Home Gardens Sanitary District, and WMWD. The WRCRWA Plant has a 14 mgd capacity and will soon produce recycled water for local irrigation use.

As JPA partners, Corona and Norco will be entitled to up to 2 and 2.7 mgd respectively of recycled water allocated for use in their service areas, reducing local pumping from the Temescal Basin.

8.1.8. Santa Ana Watershed Involvement

SAWPA is a JPA formed to develop and maintain regional plans and projects that will protect the Santa Ana River Basin and associated water resources. Corona participates in the task forces and working groups within the watershed noted in **Table 8-5**.

Table 8-5. City of Corona Santa Ana Watershed Task Forces/Groups

Name	Brief Description
SAWPA – Emerging Constituents Task Force	In 2007, a workgroup was formed among the water recharging agencies and publicly owned treatment works (POTWs) to address a characterization program for emerging constituents. SAWPA was requested to administer the development of a 2-phase approach.
SARDA – Santa Ana River Discharge Agencies	Working group of Santa Ana River (SAR) discharge agencies jointly implementing the annual mercury monitoring in the SAR.
SAWPA – Basin Monitoring Task Force	As an outgrowth of the Nitrogen/TDS Task Force, the agencies responsible for implementing the Basin Plan Amendments formed the Basin Monitoring Task Force, and SAWPA was identified to administer/facilitate that effort.
SAWPA – Imported Water Recharge Workgroup	The purpose of this Workgroup is to undertake tasks defined in a Cooperative Agreement among the water recharging agencies to assure that the water quality (Nitrogen and TDS) in groundwater is protected. These tasks include regular reporting on the amount and quality of water recharged, the ambient water quality in each groundwater management zone, and 20-year groundwater flow and quality model projections for each groundwater management zone that is recharged. All reports are provided to the Regional Water Quality Control Board.

In addition, Corona discharges treated wastewater from one of their three water reclamation plants (WRF-1) to Temescal Wash within the Santa Ana River Watershed. Corona discharged an average of approximately 2,000 AFY to the watershed from WRF-1 (Michael Baker 2021). The discharged water serves a dual purpose of maintaining riparian habitat as well as recharging the Basin via percolation.

8.2. GROUP 2 PROJECTS

Group 2 projects will be implemented to meet Basin sustainability goals, in conjunction with Group 1 projects.

8.2.1. Shallow Monitoring Well Installation

A total of three shallow monitoring wells will be drilled in the Prado Management Area. The wells will be approximately 40 to 60 feet in depth and 2-inches in diameter. **Figure 8-1** shows the proposed, approximate locations of these monitoring wells.

The approximate locations have been identified based on existing groundwater conditions, land access, and the ongoing construction of the new Prado Dike. Areas north of the Prado Dike will potentially be inundated in the future, and future monitoring wells need to be located outside the area of inundation. The locations shown on **Figure 8-1** are above 545-feet mean sea level (msl) elevation. The existing spillway elevation of the Prado Dam is 543-feet msl, so these monitoring well locations should be above the future area of inundation.

8.2.1.1. Measurable Objective Expected to Benefit from Project or Management Action

The project will allow for continuous monitoring at representative sites in the Prado Management Area. This will allow Corona to track groundwater levels in the southern part of the Management Area along with the rest of the Basin. Groundwater levels in these wells will be incorporated into the interconnected surface water sustainable management criteria in the 5-year GSP update. Once established, the sustainable management criteria for these wells will help guide future management actions required by upstream Santa Ana River Watershed partners.

8.2.1.2. Circumstances for Implementation

Corona has already initiated the planning process to install these monitoring wells. It is anticipated that these can be implemented with existing on-call contracts.

8.2.1.3. Public Noticing

The public will be notified per California Environmental Quality Act (CEQA)requirements.

8.2.1.4. Permitting and regulatory process

Wells will be drilled on private or City of Corona property. The project will comply with all CEQA, Riverside County, and discharge permitting requirements. Corona will coordinate with the Santa Ana Regional Water Quality Control Board (RWQCB) to plan for discharging any and all water in accordance with RWQCB general permits.

8.2.1.5. Project Timetable

The monitoring wells will be installed within two years of GSP implementation.

8.2.1.6. Plan for Project Implementation

Three monitoring wells will be drilled in areas in the Prado Management Area. The wells will be approximately 40 to 60 feet deep and will be 2-inches in diameter with polyvinyl chloride (PVC) casings and screens, bentonite seals, and cement sanitary seals. The well drilling process will be completed with existing Corona on-call contracts.

8.2.1.7. Expected Benefits

The installation of three monitoring wells will allow Corona to track groundwater levels in the Prado Management Area and identify timing and triggers for future management actions, if needed.

8.2.1.8. Legal Authority

By California state law, water districts and land use jurisdictions have the authority to take action to ensure sufficient water supply is available for present or future beneficial use within their service areas.

8.2.1.9. Estimated Costs and Funding Plan

Costs are anticipated to be $40,000 to $50,000 in total for the installation of the three wells. The project will be financed from existing Corona budgets.

8.2.1.10. Management of Project

The project will be managed by the City of Corona Department of Water and Power with support from other staff and outside technical experts, as necessary.

8.2.1.11. Relationship to Additional GSP Elements

The addition of three new monitoring wells in the Basin will identify future management actions required by upstream Santa Ana River Watershed partners. This is discussed in further detail in Group 3.

8.2.2. Potable Reuse Feasibility Study

As noted in the Group 1 project section, the WRCRWA facility is near-future reclaimed water supply source for Corona. Corona will conduct a potable reuse feasibility study to evaluate various potable reuse strategies and opportunities for optimizing use of reclaimed water supply in conjunction with existing reclaimed water supply from WRF-1, 2, and 3. This study would likely involve looking at specific end uses, water supply benefits, regulatory requirements, treatment requirements, infrastructure requirements, and associated costs.

8.2.2.1. Measurable Objective Expected to Benefit from Project or Management Action

Corona is exploring future options to optimize use of recycled water in the Basin in order to reduce groundwater dependence.

8.2.2.2. Circumstances for Implementation

Corona is currently exploring a wide range of options to increase their water supply portfolio.

8.2.2.3. Public Noticing

Public noticing is not required for this project. Should potable reuse projects be recommended for the region, Corona may choose to adopt a comprehensive outreach and education program to solicit public input.

8.2.2.4. Permitting and regulatory process

Permits are not required for this project. This study will evaluate potential potable reuse projects and will consider potential regulatory requirements for implementation.

8.2.2.5. Project Timetable

The study is anticipated to be one year in duration, initiating approximately two years after adoption of the GSP.

8.2.2.6. Plan for Project Implementation

Corona would need to develop a study scope, issue a project solicitation, and hire a technical consultant to perform the evaluation.

8.2.2.7. Expected Benefits

This study will evaluate and recommend future potable reuse projects to be implemented in the region.

8.2.2.8. Legal Authority

Legal authority is not required to perform a feasibility study.

8.2.2.9. Estimated Costs and Funding Plan

The study is anticipated to cost between $150,000 to $200,000 and will likely be funded through City of Corona sources. Grant funding is available through the State Water Resources Control Board (SWRCB) and the United States Bureau of Reclamation (USBR) should Corona choose to pursue alternate means of funding.

8.2.2.10. Management of Project

The project will be managed by the City of Corona Department of Water and Power with support from other staff and outside technical experts, as necessary.

8.2.2.11. Relationship to Additional GSP Elements

Because this project is a feasibility study, it is not anticipated to have any impact on other GSP projects or management actions described in this chapter. Future potable reuse projects recommended as a result of this study will reduce groundwater dependence in the region.

8.2.3. Mountain Runoff Capture Feasibility Study

Riverside County Flood Control and Water Conservation District (RCFCWCD) operates major flood control facilities such as dams, flood basins, levees, open channels, and major (36-inch or larger) underground storm drains in a 2,700 square mile service area in the western portion of Riverside County. Rainwater runoff from the Santa Ana Mountains flows into RCFCWCD flood basins during storm events to mitigate downstream flood damage. A Mountain Runoff Capture Feasibility Study would explore options for operational changes that would provide the dual benefit of flood control and groundwater recharge.

8.2.3.1. Measurable Objective Expected to Benefit from Project or Management Action

Although this study would yield no direct measurable objectives, future recommended projects would help to raise groundwater levels in the Basin and reduce the threat of land subsidence.

8.2.3.2. Circumstances for Implementation

Corona is currently exploring options to increase groundwater recharge. An initial study would be conducted to establish a basis for inter-agency coordination between RCFCWCD and Corona on the subsequent feasibility study.

8.2.3.3. Public Noticing

Public noticing is not required for this project. Should implementation projects be recommended for the region, Corona may choose to adopt a comprehensive outreach and education program to solicit public input.

8.2.3.4. Permitting and regulatory process

Permits are not required for this project. This study will evaluate potential runoff capture projects and will consider potential regulatory requirements for implementation.

8.2.3.5. Project Timetable

The initial study would be undertaken within the first five years of GSP adoption and be approximately three months in duration. After appropriate inter-agency coordination, the subsequent feasibility study is anticipated to be approximately six months in duration.

8.2.3.6. Plan for Project Implementation

RCFCWCD owns and operates this infrastructure. Interagency discussion should be conducted during the initial study to coordinate on development of the feasibility study.

8.2.3.7. Expected Benefits

This study will evaluate and recommend operational changes to the RCFCWCD flood basins that would enable the system to be used for both flood control and groundwater recharge to the Basin.

8.2.3.8. Legal Authority

Legal authority is not required to perform a feasibility study.

8.2.3.9. Estimated Costs and Funding Plan

The study is anticipated to cost approximately $75,000. Corona could explore potential funding sources through the California Department of Water Resources (DWR).

8.2.3.10. Management of Project

The project will be managed by the City of Corona Department of Water and Power with support from other staff and outside technical experts, as necessary.

8.2.3.11. Relationship to Additional GSP Elements

Because this project is a feasibility study, it is not anticipated to have any impact on other GSP projects or management actions described in this chapter. Future projects implemented as a result of this study will reduce groundwater dependence in the region.

8.3. GROUP 3 PROJECTS

Group 3 projects are conceptual activities that can be considered in the future if any Group 2 projects fail to be implemented or additional intervention is required to achieve basin sustainability goals. These projects are not planned for near-term implementation and have been developed to a lesser degree than Group 2 projects but will be evaluated further, as needed, should a given Group 3 project be deemed critical for Basin sustainability.

8.3.1. Groundwater Treatment

A study conducted in 2016 focused on the detection of PFAS in Corona wells as well as potential treatment options (Carollo 2017). Subsequently, Corona initiated an ongoing PFAS study likely to be complete in mid to late 2021.

Corona has future interests in advanced groundwater treatment to treat for previously detected PFAS as well as addressing TDS, nitrate, and TCP. Groundwater treated to remove these contaminants could potentially be recharged back into the Basin, improving water quality.

8.3.2. Stormwater Capture, Treatment, and Recharge

Harvesting of urban stormwater has a potential benefit of reducing the loss of water from the Basin. There are a number of different approaches to stormwater capture and use including:

- Onsite rain barrels to promote reuse and reduce generation of urban runoff
- Larger scale capture in stormwater vaults/cisterns and reuse
- Capture and infiltration approaches including infiltration basins, bioretention, and permeable pavement
- Dry wells for capture and recharge
- Diversion to WRFs for treatment and reuse.

Corona has conducted a preliminary investigation on capture of stormwater from a lined channel on Oak Avenue and transfer to the existing percolation ponds (Todd 2011).

It is anticipated that a future study would explore potential sources of urban runoff, estimated yield, mechanisms for augmenting or offsetting water supplies, treatment needs, capital costs, and operation and maintenance (O&M) costs. An initial investigation would establish the basis for further exploration of the feasibility of specific stormwater capture approaches and projects.

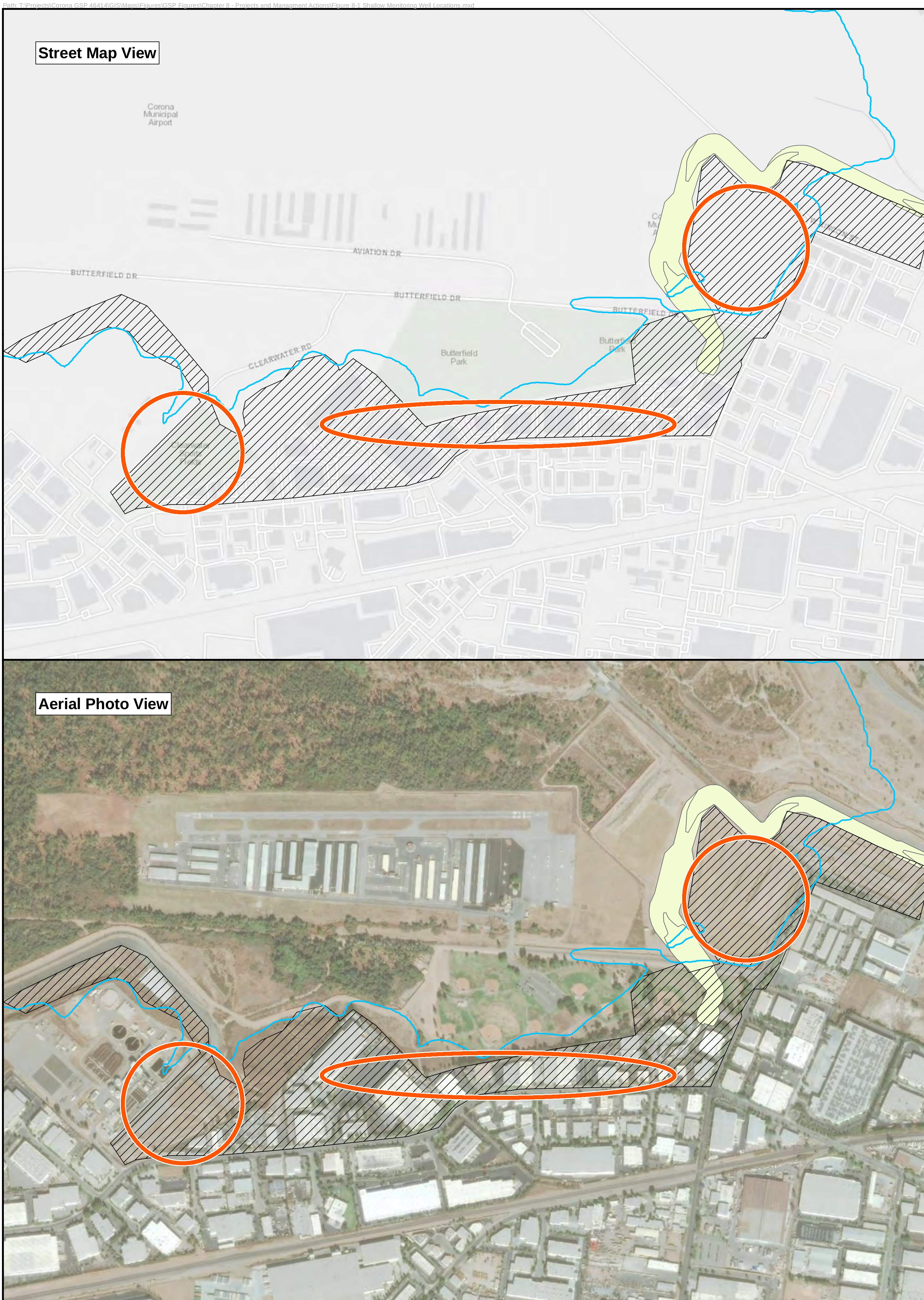
8.3.3. Santa Ana River Wastewater Discharge Coordination for Shallow Groundwater Conditions

This project would be implemented contingent on the outcome of the Prado Management Area monitoring well installation, a previously discussed Group 2 project. The Prado Management Area is currently maintained by wastewater discharge from upstream parties. If monitoring well data indicates that groundwater elevations are falling, it is likely due to reduction of wastewater discharge flow.

The project approach would be two-fold and encompass the following:

1. Evaluation and examination of current wastewater discharges into the Prado Management Area from contributing parties including SAWPA member agencies (Eastern Municipal Water District, Inland Empire Utilities Agency, Orange County Water District, San Bernardino Valley Municipal Water District, and Western Municipal Water District).
2. Coordinate with partners to identify solutions to falling groundwater water levels in the Prado Management Area.

Path: T:\Projects\Corona GSP 46414\GIS\Maps\Figures\GSP Figures\Chapter 8 - Projects and Managment Actions\Figure 8-1 Shallow Monitoring Well Locations.mxd



Approximate 545 foot Ground Surface Elevation Contour
Recommended Shallow Monitoring Well General Search Area
Focused Shallow Well Search Area
Planned Prado Dike

N

0 800
Feet

Figure 8-1
Potential
Shallow Monitoring
Well Locations

TODD GROUNDWATER

9. IMPLEMENTATION PLAN

While the Temescal Subbasin (Basin) is considered to be sustainably managed, this status is by no means taken for granted. Potential effects of growth and climate change have been evaluated by means of modeling simulations, but effects are likely to be cumulative, and thereby present challenges to sustainability. Accordingly, additional projects and actions must be continued or implemented to satisfy the Sustainability Goal to the foreseeable planning horizon. Implementation of the Groundwater Sustainability Plan (GSP) by the Temescal Groundwater Sustainability Agency (GSA) will begin following adoption of the plan by the GSA in 2022 and continue through 2042. The GSP will be implemented to sustainably manage groundwater in the Basin under the authority of the GSA and its member agencies the City of Corona (Corona), the City of Norco (Norco), and the Home Gardens County Water District (HGCWD) as provided by the Sustainable Groundwater Management Act (SGMA).

After submittal of the GSP to the California Department of Water Resources (DWR) and during the DWR review period, the GSA will begin implementing the projects and management actions described in Chapter 8 and will communicate with stakeholders throughout implementation.

9.1. PLAN IMPLEMENTATION RESOURCES AND RESPONSIBILITIES

Resources to implement the GSP will be derived from funds and personnel from the GSA parties (Corona, Norco, and HGCWD) and qualified firms contracted to perform specific specialized services.

Personnel from the three GSA parties will be responsible for collection of information from their respective facilities or within their area of influence in the Basin. This will include depth to groundwater measurements, collection of groundwater quality samples, groundwater extractions, use of surface water supplies, and total water use. This information will be maintained by each GSA party for inclusion in annual reports, GSP updates, and storage in the Data Management System (DMS).

Annual GSP reporting, specialized activities included in projects and/or management actions, and periodic GSP updates will be contracted by the GSA to specific specialized firms with relevant experience and expertise. Individual parties within the GSA may be responsible for developing requests for proposals (RFPs), contracting, and managing these activities with contractors and/or consultants.

9.2. ANNUAL REPORTING

The GSA is required to submit annual reports to DWR by April 1st of each year following adoption of the GSP. The first annual report will be due April 1, 2022. Each annual report will include the following components for the preceding water year as described in GSP Regulations:

- General information – Executive summary, location map.

- Detailed description and graphical representation of the following components of the Basin:
    - Groundwater elevation data from monitoring wells within the monitoring network.
    - Groundwater extraction data for the preceding water year.
    - Surface water supply used or available for use.
    - Total water use.
    - Change in groundwater storage.
- Description of progress towards implementing the GSP – implementation of projects or management actions since the previous annual report.

The first annual report will be prepared to include data and information from the end of the period included in this GSP (end of water year 2018) through to the end of water year 2021. The costs associated with producing annual reports will be incorporated into the Corona annual budget.

9.3. NEW INFORMATION AND CHANGES

The GSP has been developed based on the best available information. However, it is recognized that during implementation of the GSP, new information on groundwater conditions, changes in land use or climate, and or changes in the regulatory environment can be expected. Changes in GSP administration may also be appropriate based on experience. When these changes occur, the GSA will react with appropriate changes in GSP administration, data collection, and/or groundwater management methods. If the changes are significant, stakeholders and the GSA will be kept informed of these changes via the Corona GSP website and emails to stakeholders.

9.4. PERIODIC EVALUATIONS

The GSA will evaluate the GSP at least every five years and provide an assessment to DWR as required by GSP Regulations. This will include an update on the progress of achieving sustainability goals in the Basin and assessment of the following:

- Current groundwater conditions for each sustainability indicator applicable to the Basin relative to measurable objectives and minimum thresholds.
- The implementation of any projects or management actions and their effect on groundwater conditions.
- Revisions to the basin setting, management areas, or the identification of undesirable results and the setting of minimum thresholds and measurable objectives resulting from significant changes, new information, or changes in water use.
- The monitoring network within the Basin, including any data gaps and areas of the Basin that are represented by data that does not satisfy the requirements of SGMA requirements.
- Significant new information that has been made available since GSP adoption, amendment, or last assessment.

- Relevant actions taken by the GSA, including a summary of regulations or ordinances related to the GSP.
- Any enforcement or legal actions taken by the GSA to continue the sustainability goals of the Basin.
- Completed or proposed GSP amendments.

The cost of the periodic updates is dependent on the complexity of changes occurring in the Basin since adoption of the GSP but are estimated to be $250,000 per update (2021 dollars).

9.5. PROJECTS AND MANAGEMENT ACTIONS

Projects and management actions are described in Chapter 8, each in terms of technical description, feasibility and implementation, benefits, costs and financing, and timeline. The Projects and Management Actions are listed below in the same order as presented in Chapter 8.

Group 1 - Existing or established projects and management actions

- Groundwater Treatment
- Water Reclamation Facility (WRF) Percolation Ponds
- Water Level Quality Assurance and Quality Control (QA/QC)
- Water Shortage Contingency Plans (WSCPs)
- Water Conservation Programs
- Western Municipal Water District Integrated Regional Water Management Plan (IRWMP)
- Western Riverside County Regional Wastewater Authority (WRCRWA)
- Santa Ana Watershed Involvement

Group 2 – Projects and management actions that have been or are under development

- Interconnected Surface Water Monitoring Wells Implementation
- Potable Reuse Feasibility Study
- Mountain Runoff Capture Investigation

Group 3 – Conceptual future projects and management actions

- Future Groundwater Treatment
- Stormwater Capture, Treatment and Recharge
- Santa Ana River Wastewater Discharge Coordination for Shallow Groundwater Conditions

The projects and management actions described here work together toward the sustainability goal and objectives, namely: to provide a reliable and efficient groundwater supply, to provide reliable storage, to protect groundwater quality, to support beneficial uses of interconnected surface waters, and to support integrated and cooperative water resource management.

9.6. SCHEDULE FOR IMPLEMENTATION

Table 9-1 is an estimated timeline for implementation. The timeline columns include the individual years 2021 through 2025, which are followed by five-year intervals to 2040 to 2045. With implementation officially starting in 2022, the last interval includes the 2042 deadline for the 20-year implementation to achieve the sustainability goal.

The projects and management actions, and GSP Administration, Monitoring, and Reporting are listed in rows and as warranted. As shown, most projects and management actions have been ongoing. Some will be initiated following GSP adoption and continued during implementation.

Table 9 1. Estimated Timeline for Projects and Management Actions

Description	GSP Implementation Period								
	2021	2022	2023	2024	2025	2026-2030	2031-2035	2036-2040	2041-2045
Group 1 - Existing or established projects and management actions									
Groundwater Treatment									
WRF Percolation Ponds									
Water Level QA/QC									
Water Shortage Contingency Plans									
Water Conservation Programs									
Western Municipal Water District - IRWMP									
Western Riverside County Regional Wastewater Authority (WRCRWA)									
Santa Ana Watershed Involvement									
Group 2 – Projects and management actions that have been or are under development									
Interconnected Surface Water Monitoring Wells Implementation									
Potable Reuse Feasibility Study									
Mountain Runoff Capture Investigation									
Group 3 – Conceptual future projects and management actions									
Future Groundwater Treatment	(to be determined)								
Stormwater Capture, Treatment and Recharge	(to be determined)								
Coordination with Upstream Santa Ana River Partners	(to be determined)								
GSP Administration, Monitoring, and Reporting									
GSP Administration									
Ongoing Monitoring									
Annual Reporting									
Periodic GSP Evaluation and Updates									

9.7. GSP IMPLEMENTATION COSTS

Implementation costs include costs to continue monitoring as described in Chapter 7, implement management actions and projects as described in Chapter 8, and complete annual reports and periodic GSP evaluation and updates as required by SGMA. As summarized in **Table 9-2**, total annual costs (2021 dollars) are estimated at $100,000 per year for GSP administration and annual reporting. Costs for previously implemented existing ongoing Group 1 management actions and project and monitoring activities are not included in this total. Estimated single occurrence costs for activities anticipated to occur in the first 5 years of GSP implementation and the first periodic GSP evaluation and update total $515,000 to $575,000 (2021 dollars). Costs for conceptual future Group 3 projects and management actions are not included in this total.

Table 9-2. GSP Implementation Cost Estimates

Management Actions, Projects, and GSP Administration	Estimated Costs
GSP Administration and Annual Reporting	$100,000/year
Total Estimated Annual Implementation Costs	**$100,000/year**
Interconnected Surface Water Monitoring Wells Implementation	$40,000 to $50,000
Potable Reuse Feasibility Study	$150,000 to $200,000
Mountain Runoff Capture Investigation	$75,000
First Periodic Evaluation and GSP Update (2027)	$250,000
Total Estimated One-Occurrence Costs (First 5 years)	**$515,000 to $575,000**
Future Groundwater Treatment	To be decided
Stormwater Capture, Treatment and Recharge	To be decided
Coordination with Upstream Santa Ana River Partners	To be decided

9.7.1. Funding Methods

The funding method for operating expenses and GSP implementation costs is by contributions by GSA member agencies (Corona, Norco, and HGCWD). This is the same mechanism utilized to fund development of the GSP (with significant supplemental contribution though California Proposition 1 Grant funding). Corona will be responsible for most of the ongoing implementation costs, which are within budget projections for the next several years.

Sources of funding have and will continue to vary according to the project or management action (see Chapter 8). Funding for planning and implementation of some projects and management actions may be achieved with local, state, and federal sources. The local agencies track opportunities for outside financing (grants or loans) from state water programs and federal infrastructure funding. For local financing, the agencies update their financial plans and rates as needed.

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APPENDIX A

Memorandum of Understanding forming the Temescal Groundwater Sustainability Agency

MEMORANDUM OF UNDERSTANDING
(TEMESCAL SUB-BASIN GROUNDWATER SUSTAINABILITY AGENCY)

1. PARTIES AND DATE.

This Memorandum of Understanding ("**MOU**") is made and entered into by and between the City of Corona, a municipal corporation organized under the laws of the State of California with its principal place of business at 400 South Vicentia Avenue, Corona, California 92882 ("**Corona**"), the City of Norco, a municipal corporation organized under the laws of the State of California with its principal place of business at 2870 Clark Avenue, Norco, California 92860 ("**Norco**") and the Home Gardens County Water District, a county water district with its principal place of business at 3832 Grant Street, Corona, CA 92879 ("**HGCWD**"). Corona, Norco and HGCWD are sometimes individually referred to as "Party" and collectively as "Parties" in this MOU.

2. RECITALS.

2.1 Adoption of SGMA. On September 16, 2014, Governor Jerry Brown signed into law Senate Bills 1168 and 1319 and Assembly Bill 1739, known collectively as the Sustainable Groundwater Management Act ("**SGMA**").

2.2 Purpose of SGMA. The purpose of SGMA is to create a comprehensive management system in the State of California by creating a structure to manage groundwater at the local level, while providing authority to the State to oversee and regulate, if necessary, the local groundwater management system.

2.3 Groundwater Management Plans. SGMA empowers local agencies to adopt groundwater management plans that are tailored to the resources and needs of their communities to provide a buffer against drought and contribute to reliable water supply for the future.

2.4 Groundwater Sustainability Agencies. Water Code Section 10723.6 authorizes a combination of local agencies overlying a groundwater basin to elect to become a Groundwater Sustainability Agency ("**GSA**") by using a memorandum of understanding or other legal agreement.

2.5 Corona's Authority. Corona is a local agency qualified to become a GSA because Corona manages water, has a water supply, and has land use responsibilities over a portion of the Temescal Sub-Basin of the Upper Santa Ana Valley Groundwater Basin (DWR Basin Number 8-2.09) ("**Sub-Basin**"), which is a DWR-designated medium priority basin.

2.6 Norco's Authority. Norco is also a local agency qualified to become a GSA because Norco manages water, has a water supply, and has land use responsibilities over a portion of the Sub-Basin.