APPENDIX 6e

2022 State of the Basin Report

2022 State of the Basin Report
June 2023

PREPARED FOR

Chino Basin Watermaster

PREPARED BY

West Yost
Water. Engineered.

2022 State of the Basin Report
June 2023

Prepared for

Chino Basin Watermaster

Project No.941-80-22-13

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LIST OF ACRONYMS AND ABBREVIATIONS

1,1,1-TCA	1,1,1-trichloroethane
1,2,3-TCP	1,2,3-trichloropropane
AFFF	Aqueous Film Forming Foam
AFY	Acre Feet Per Year
ASR	Aquifer Storage and Recovery
Basin Plan	Water Quality Control Plan for the Santa Ana River Basin
CAO	Cleanup and Abatement Order
CIM	California Institution for Men
CBDC	Chino Basin Data Collection
CCL	Contaminant Candidate List
CCR	California Code of Regulations
CCWF	Chino Creek Well Field
CCWRF	Carbon Canyon Water Reclamation Facility
CCX	Chino Creek Extensometer Facility
CDA	Chino Basin Desalter Authority
CDFM	Cumulative Department from Mean
County	The County of San Bernardino Department of Airports
DDW	California State Water Resources Control Board Division of Drinking Water
DLR	Detection Limit for Reporting
DTSC	Department of Toxic Substances Control
DWR	The California Department of Water Resources
DYYP	Dry Year Yield Program
EDM	Electronic Distance Measurement
EPA	US- Environmental Protection Agency
ET	Evapotranspiration
ET_o	Potential Evapotranspiration
FY	Fiscal Year
GE	General Electric
GLMC	Ground Level Monitoring Committee
GMZ	Groundwater Management Zone
HAL	Health Advisory Level
HCMP	Hydraulic Control Monitoring Program
HFPO-DA	Hexafluoropropylene Oxide Dimer Acid
HQ	Hazard Quotient
IEUA	Inland Empire Utilities Agency
IMP	Interim Monitoring Program
InSAR	Interferometry Synthetic Aperture Radar
IRAP	Interim Remedial Action Plan
JCSD	Jurupa Community Services District
MCLs	Maximum Contaminant Levels
Metropolitan	Metropolitan Water District
MGD	Million Gallons Per Day
MGL	Milligrams per Liter
MS4	Municipal Separate Storm Sewer System Facilities
MVWD	The Monte Vista Water District
MZs	Management Zones
NAWQA	National Water Quality Assessment Program
NDMA	N-nitrosodimethylamine
NLs	Notification Levels
NPL	National Priorities List Site
OBMP	Optimum Basin Management Program
OEHHA	The California Office of Environmental Health Hazard Assessment
OIA	Ontario International Airport
PBHSP	Prado Basin Habitat Sustainability Program
PCE	Tetrachloroethene
PE	Program Elements
PFAS	Polyfluoroalkyl Substances
PFBS	Perfluorobutane Sulfonate
PFHxS	Perfluorohexane Sulfonate
PFNA	Perflorononanoic Acid
PFOA	Perfluorooctanoic Acid
PFOS	Perfluorooctane Sulfonic Acid
PGH	Public Health Goal
PPM	Parts Per Million
PX	Pomona Extensometer Facility
QA/QC	Quality Assurance/Quality Control
Regional Board	Santa Ana Regional Water Quality Control Board
R	Recurrence Interval
RL	Response Level
RMPU	Recharge Master Plan Update
ROD	Record of Decision
SARWC	Santa Ana River Water Company
SB	Senate Bill
State Water Board	State Water Resources Control Board
SWP	State Water Project
TCE	Trichloroethylene
TDS	Total Dissolved Solids
TOC	Total Organic Carbon
UCMR	Unregulated Chemicals Monitoring Rule
UCR	University of California Riverside
USGS	United States Geological Survey
UGL	Micrograms per Liter
VOCs	Volatile Organic Chemicals
Watermaster	Chino Basin Watermaster
WEI	Wildermuth Environmental
WHO	World Health Organization
WY	Water Year

INTRODUCTION

The 2000 Chino Basin Optimum Basin Management Program (OBMP) was developed pursuant to the Judgment (*Chino Basin Municipal Water District v. City of Chino, et al.*) and a ruling by the Court on February 19, 1998 (Wildermuth Environmental [WEI], 1999). The OBMP is the master planning document for the Chino Basin Watermaster's (Watermaster) basin management activities that provide for the enhanced yield of the Chino Basin and seek to provide reliable, high-quality, water supplies for the development that is expected to occur within the Basin. The OBMP Implementation Plan is the court-approved governing document for achieving the goals defined in the OBMP. The OBMP Implementation Plan includes the following Program Elements (PE):

PE 1. Develop and Implement a Comprehensive Monitoring Program

PE 2. Develop and Implement a Comprehensive Recharge Program

PE 3. Develop and Implement a Water Supply Plan for the Impaired Areas of the Basin

PE 4. Develop and Implement a Comprehensive Groundwater Management Plan for Management Zone 1

PE 5. Develop and Implement a Regional Supplemental Water Program

PE 6. Develop and Implement Cooperative Programs with the Santa Ana Regional Water Quality Control Board (Regional Board) and Other Agencies to Improve Basin Management

PE 7. Develop and Implement a Salt Management Program

PE 8. Develop and Implement a Groundwater Storage Management Program

PE 9. Develop and Implement Conjunctive Use Programs

In 2020, the OBMP was updated to address the management in the Basin for the next 20 years. (WEI, 2020a) The updated 2020 OBMP retains the initial nine Program Elements of the 2000 OBMP while addressing evolving water management issues.

A fundamental component in the implementation of each of the OBMP PEs is the monitoring performed in accordance with *PE 1*, which includes the monitoring of basin hydrology, pumping, recharge, groundwater levels, groundwater quality, and ground-level movement. Monitoring is performed by basin pumpers, Watermaster staff, and other cooperating entities. Watermaster staff collects and compiles the monitoring data into relational databases to support data analysis and reporting.

As a reporting mechanism and pursuant to the OBMP Phase 1 Report, the Peace Agreement and the associated OBMP Implementation Plan, and the November 15, 2001 Court Order, Watermaster staff prepares a *State of the Basin Report* every two years. In October 2002, Watermaster completed the *Initial State of the Basin Report* (WEI, 2002). The baseline for this report was on or about July 1, 2000—the point in time that represents the adoption of the Peace Agreement and the start of OBMP implementation. Subsequent *State of the Basin Reports* (WEI, 2005a; 2007a; 2009a; 2011c; 2013a; 2015b; 2017a; West Yost, 2021) were used to:

- Describe the then-current state of the Basin with respect to hydrology, production, recharge, groundwater levels, groundwater quality, and ground-level movement; and
- Demonstrate the progress made since July 1, 2000 related to activities, such as: production meter installation, desalter planning and engineering, recharge assessments, recharge master planning, hydraulic control, expansion of monitoring programs for groundwater levels and quality, and the monitoring and management of land subsidence.

This 2022 *State of the Basin Report* is an atlas-style document. It consists of detailed exhibits that characterize current Basin conditions related to hydrology, groundwater production and recharge, groundwater levels, groundwater quality, and ground-level monitoring at of the end of fiscal year (FY) 2021/22. In many of these exhibits, data are characterized as they relate to the Management Zones (MZs) defined in the OBMP. Exhibit 1-1 is a location map of the Chino Basin and the OBMP MZs. Exhibit 1-2 shows the water service area boundaries for the major municipal producers in the Chino Basin related to the OBMP MZs.

The exhibits in this report are grouped into the following sections:

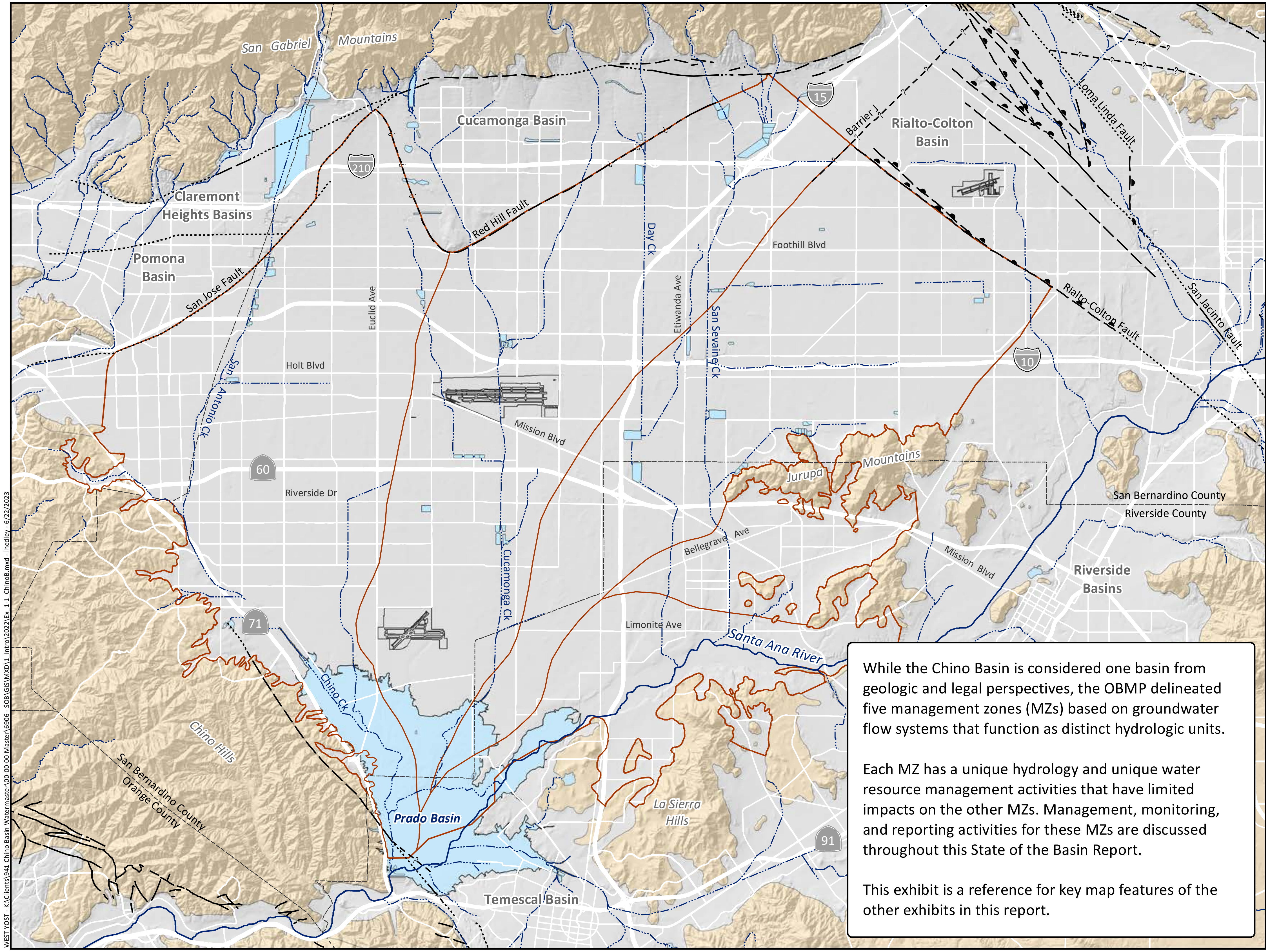
Hydrologic Conditions: This section contains exhibits that characterize the state of the Chino Basin as it relates to land use, hydrology, and climate (e.g. precipitation, temperature, and evaporation). This information provides a context for understanding the other changes in the Basin that are managed through the OBMP.

Basin Production and Recharge: This section contains exhibits that characterize groundwater production and recharge over time and space, including progress towards the expansion of the Chino Basin Desalters and the Chino Basin Groundwater Recharge Program. This information is useful in understanding historical changes in groundwater levels and quality.

Groundwater Levels: This section contains exhibits that characterize groundwater flow patterns and the change in groundwater elevations since 2000. It includes groundwater-elevation maps for spring 2000, spring 2020, and spring 2022, and groundwater-elevation change maps for 2000 to 2022 and 2020 to 2022. This section also includes characterizations of the time history of groundwater levels throughout the Chino Basin and correlates the change in groundwater levels to observed precipitation, recharge, and pumping patterns.

Groundwater Quality: This section contains exhibits that characterize the groundwater quality across the Chino Basin. The constituents characterized include total dissolved solids (TDS), nitrate, and other constituents of concern. This characterization includes maps of the spatial distribution of constituent concentrations, updated delineations of known point-source contaminant plumes across the Basin, and time-series charts that characterize TDS and nitrate concentration trends in the OBMP MZs since 1972.

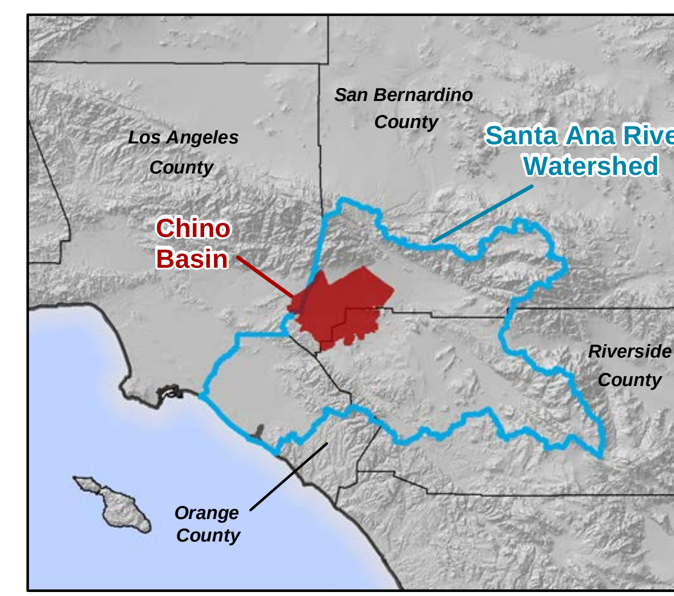
Ground-Level Monitoring: This section contains exhibits that characterize the history of land subsidence and ground fissuring and the current state of ground-level movement in the Chino Basin as understood through Watermaster's ground-level monitoring program. This characterization includes an assessment of ground-level movement in each of the five Areas of Subsidence Concern.



While the Chino Basin is considered one basin from geologic and legal perspectives, the OBMP delineated five management zones (MZs) based on groundwater flow systems that function as distinct hydrologic units.

Each MZ has a unique hydrology and unique water resource management activities that have limited impacts on the other MZs. Management, monitoring, and reporting activities for these MZs are discussed throughout this State of the Basin Report.

This exhibit is a reference for key map features of the other exhibits in this report.



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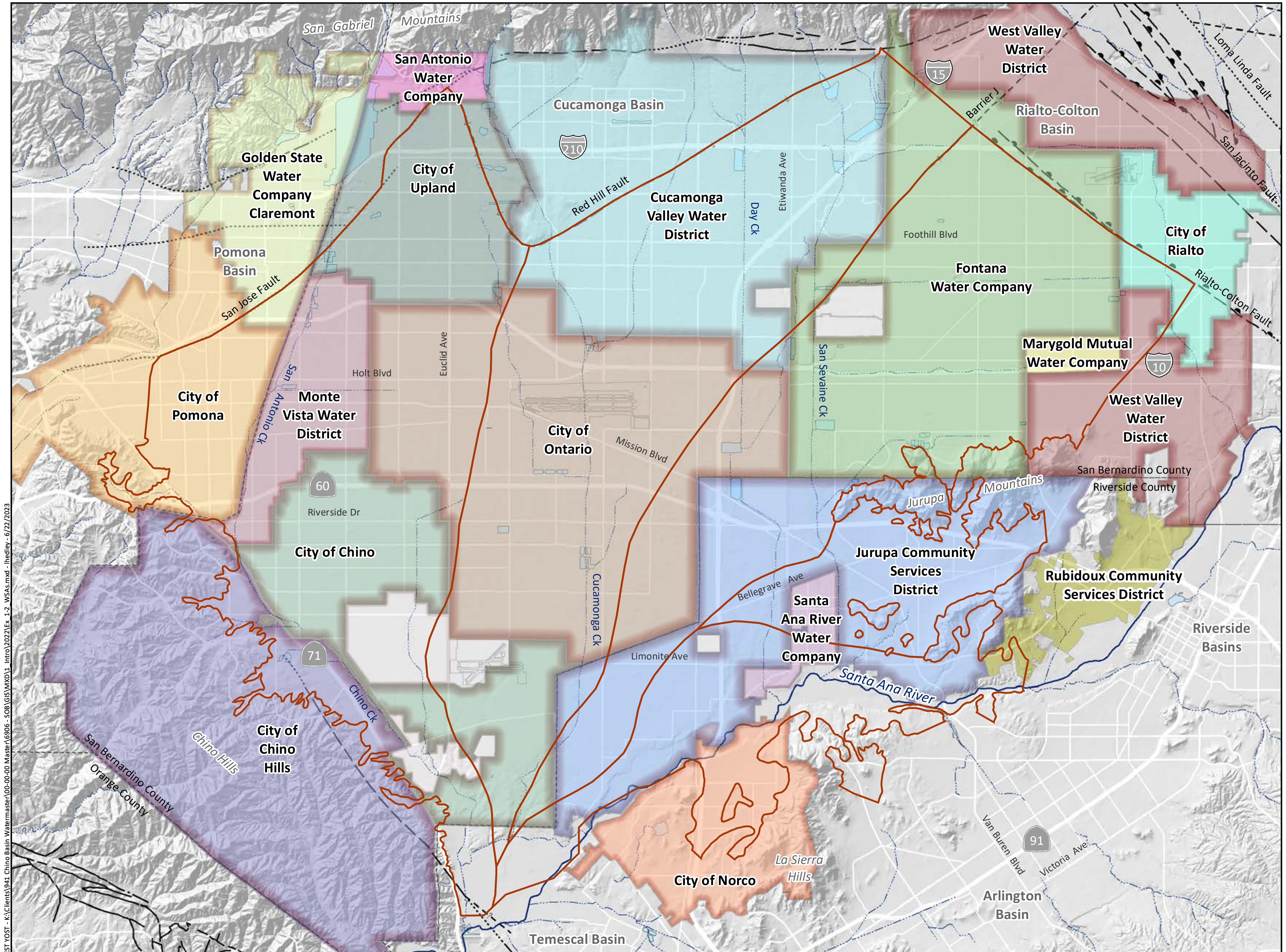
2022 State of the Basin Report
Introduction

Chino Basin Groundwater Basin
Key Map Features

Exhibit 1-1



Service Area Boundaries of Major Water Purveyors (various colors)

Other key map features are described in the legend of Exhibit 1-1.

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Water Service Areas

Exhibit 1-2

HYDROLOGIC CONDITIONS

This section contains seven exhibits that illustrate important hydrologic concepts to aid in understanding contemporary water management issues in the Chino Basin.

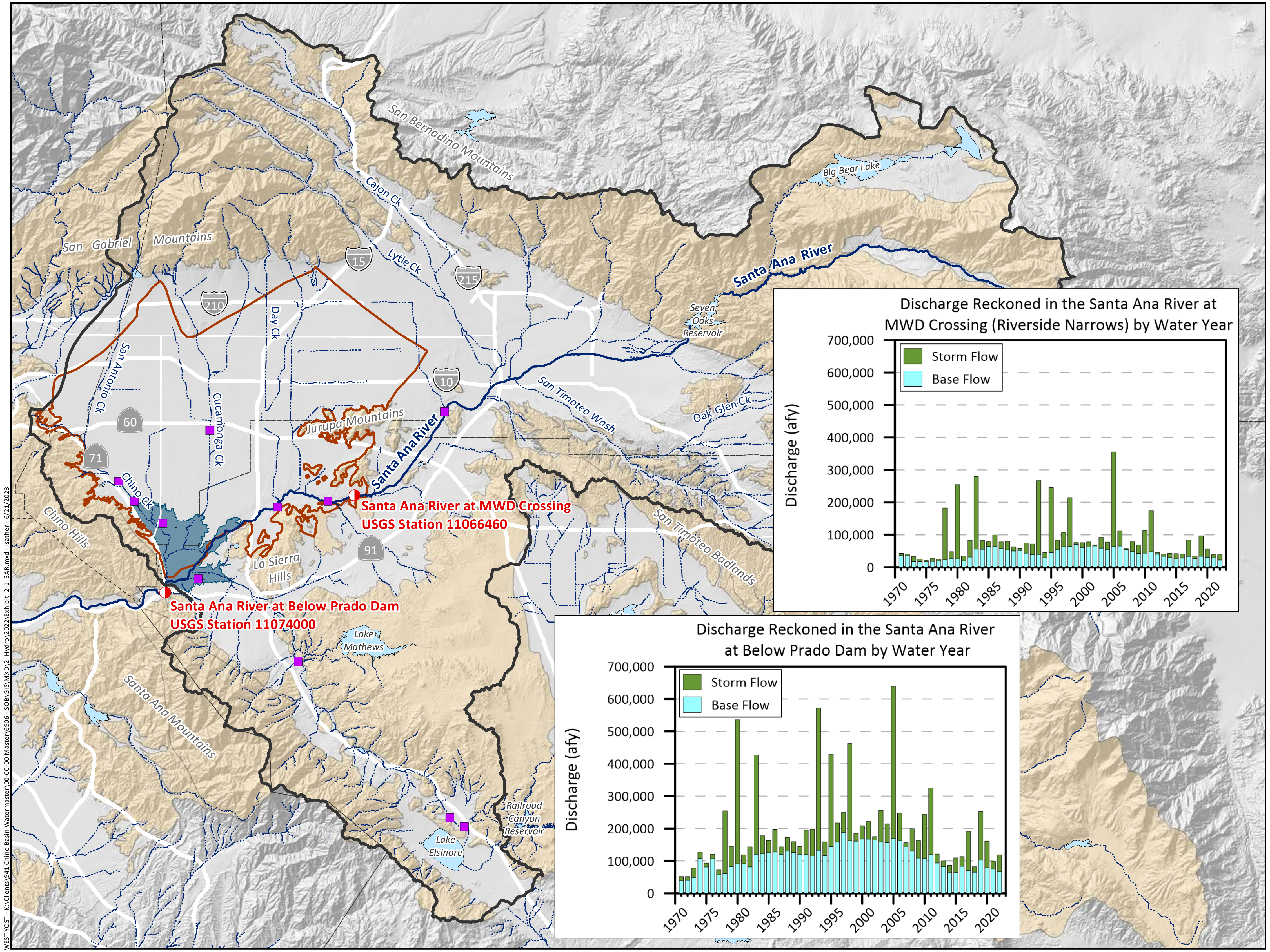
Significant hydrologic investigations have been completed in the Chino Basin that have: led to the construction of new recharge facilities increasing the amount of stormwater recharge and the supplemental water recharge capacity (WEI, 2013b); produced estimates of annual net recharge and Safe Yield (WEI, 2015e; WEI, 2020b); developed the relationship of desalter production and reoperation to Santa Ana River recharge (WEI, 2015e); and built the relationship of managed storage to annual net recharge and Safe Yield (WEI, 2019c; West Yost, 2023b). The information presented herein was mostly drawn from these investigations. Apart from Exhibit 2-1, each exhibit contains text that describes and interprets the charts presented.

Exhibit 2-1 shows the location of the Chino Basin within the Upper Santa Ana River Watershed and the locations of two key stream-gaging stations in the Chino Basin. Daily discharge data measured at the United States Geological Survey (USGS) gaging stations on the *Santa Ana River at MWD Crossing* (USGS Station 11066460) and at the *Santa Ana River at Below Prado Dam* (USGS Station 11074000) can be used to characterize the discharge of the Santa Ana River as it enters and exits the Chino Basin. The relationship of groundwater management activities in the Chino Basin and the streambed infiltration of Santa Ana River discharge was characterized in the original Chino Basin OBMP and its update in 2020. Santa Ana River discharge is composed of storm flow and base flow. Storm flow is discharge that is the direct result of runoff from precipitation. Base flow is the difference between the total measured discharge and storm flow; it consists of discharge from wastewater treatment plants and rising groundwater. Exhibit 2-1 shows the locations of the USGS gaging stations and wastewater treatment plant discharges. Base flow is a significant source of recharge to the Chino Basin.

Exhibit 2-1 also shows the annual discharge hydrographs in water year (WY) for the *Santa Ana River at MWD Crossing* and *at Below Prado Dam*. The annual discharge values have been divided into storm and base flows. The base flow time-series tends to increase over time, following the conversion of land uses to urban and industrial, until the onset of the great recession in 2008. These land use conversions increased base flow because the improved land uses were sewered, and the resulting wastewater discharged to the Santa Ana River. After WY 2007/08, the base flow decline was caused by decreased water use due to recession and drought and the Inland Empire Utilities Agency's (IEUA) increased use of recycled water for direct and indirect uses, thereby reducing wastewater discharges to the Santa Ana River.

The Santa Ana River base flow entering the Chino Basin at the *MWD Crossing* (Riverside Narrows) reached a maximum of 71,000 acre-feet per year (afy) in WY 1998/99 and has been generally decreasing since then. Starting in WY 2007/08, the base flow at the *MWD Crossing* has been less than 50,000 afy, with an average of 34,500 afy. The decrease in base flow at the *MWD Crossing* after WY 2007/08 is due, in part, to decreases in wastewater discharge to the Santa Ana River upstream of the *MWD Crossing* and declining groundwater levels in the groundwater basins underlying the Santa Ana River upstream of the *MWD Crossing*.

The base flow leaving the Chino Basin at Prado Dam is about two times the base flow entering the Chino Basin due to the combined wastewater treatment plant discharges of the Cities of Corona and Riverside, the IEUA, and the West Riverside County Wastewater Reclamation Authority. The base flow at Prado Dam reached a maximum of 188,000 afy in WY 1996/97 and has been generally decreasing since. Starting in WY 2008/09, the base flow at Prado Dam has been less than 120,000 afy with an average of 87,500 afy. The decrease in base flow exiting the Chino Basin is due to: the decrease in base flow entering the Chino Basin at the Riverside Narrows; decreases in wastewater discharges due to water conservation and recycled water reuse; and increased streambed infiltration caused by increased groundwater production in the southern Chino Basin.



USGS Stream-gaging Station

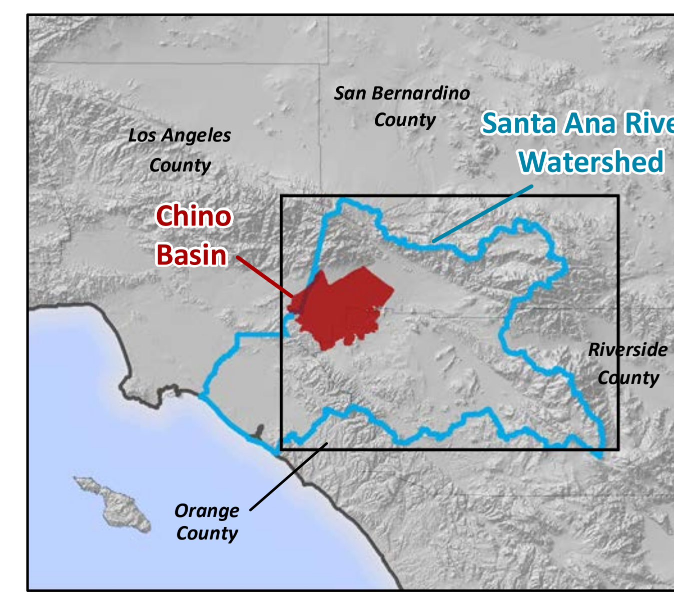
Wastewater Treatment Plant Discharge Locations

Santa Ana River Watershed Tributary to Prado

Lakes and Reservoirs

Prado Flood Control Basin

Other key map features are described in the legend of Exhibit 1-1.



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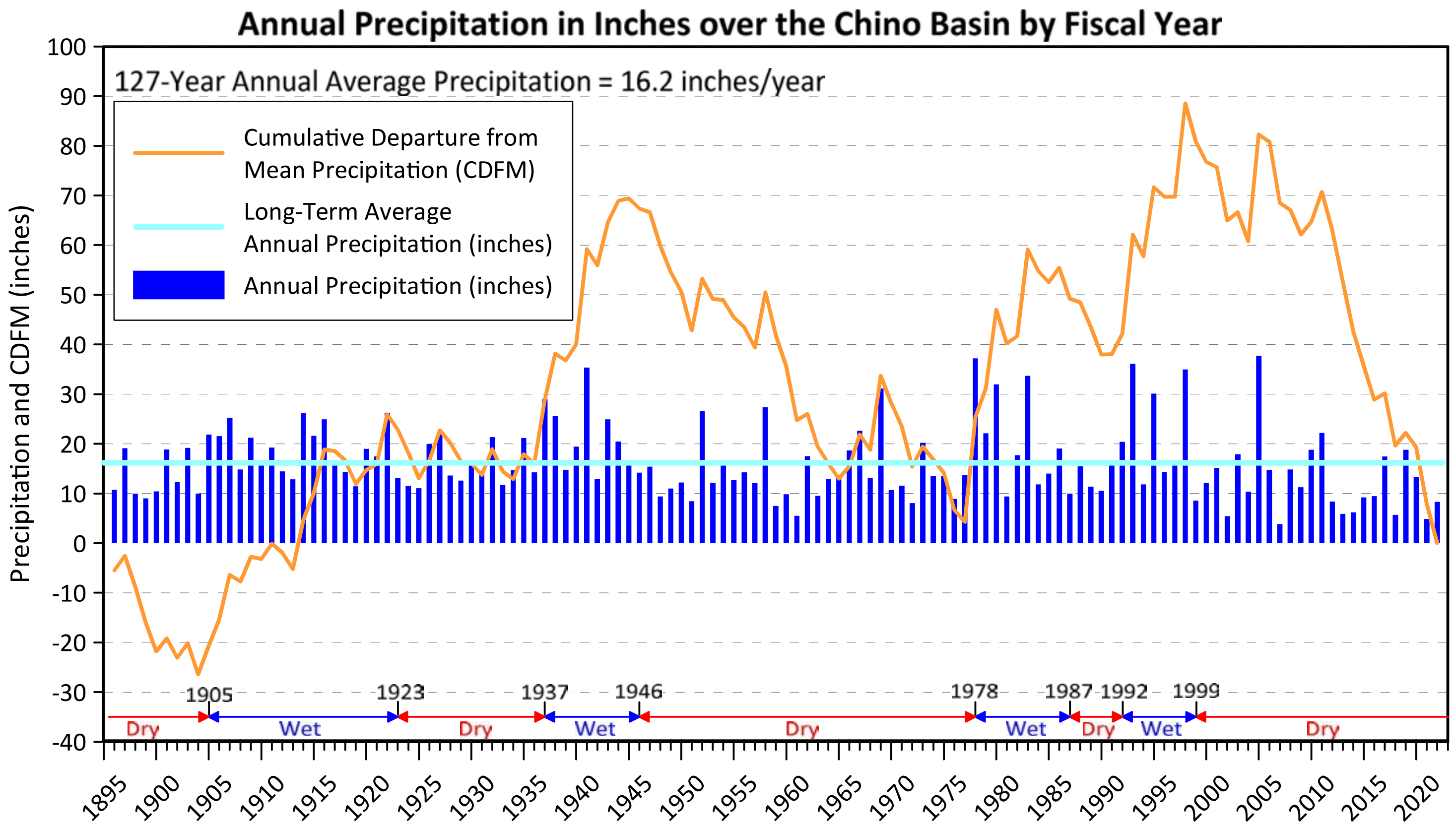
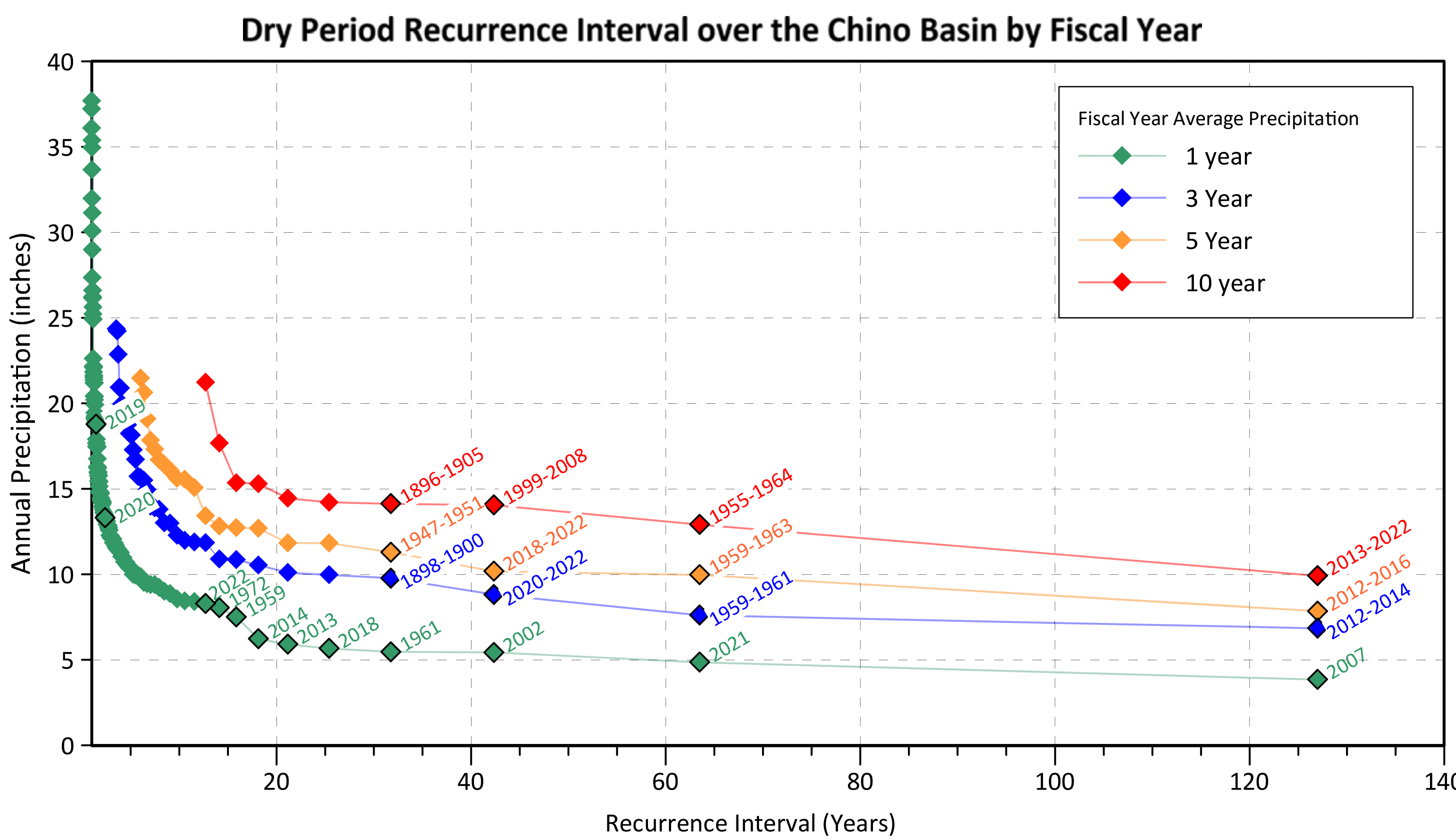
Hydrologic Conditions

Santa Ana River Discharge in the Chino Basin

Exhibit 2-1

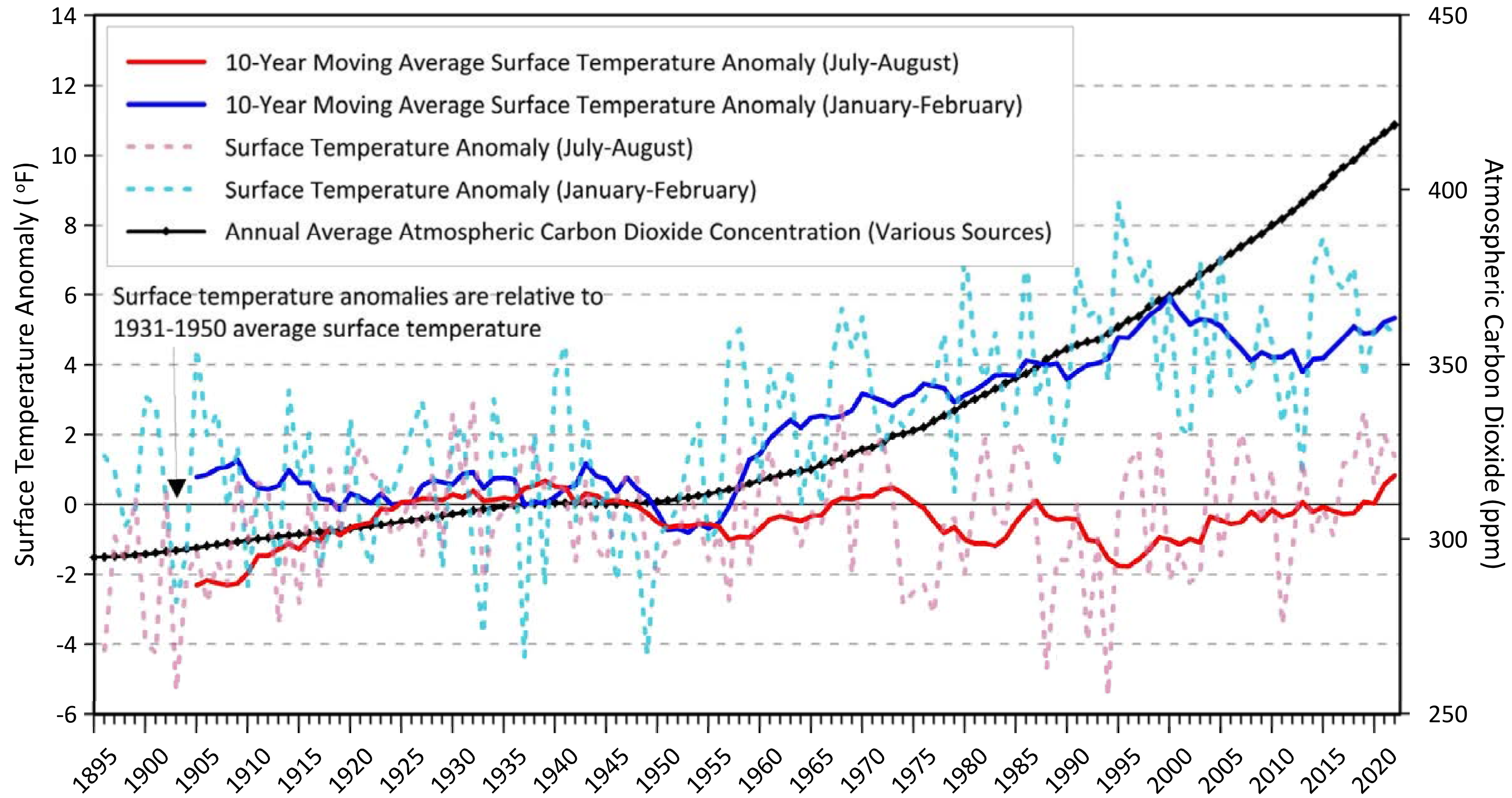




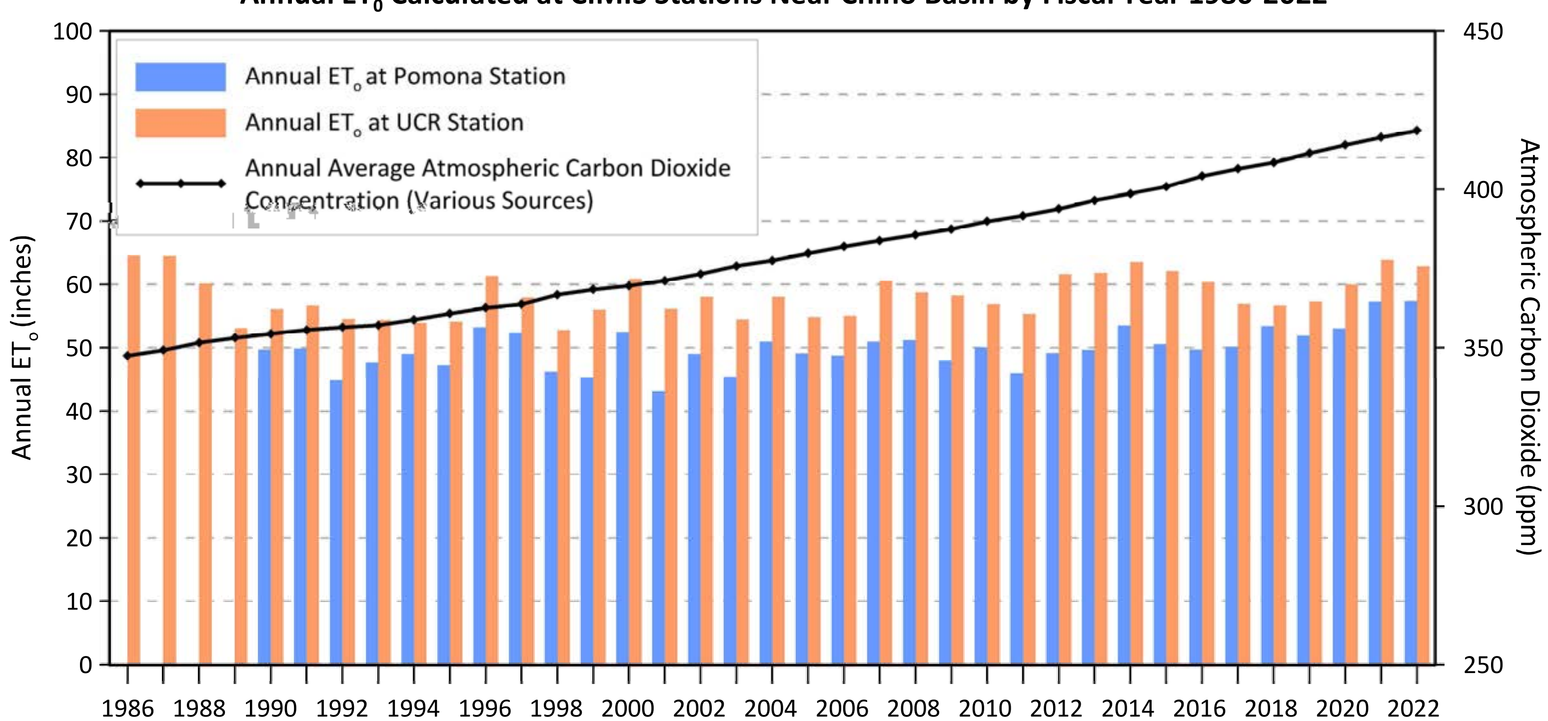
Precipitation is a major source of groundwater recharge for the Chino Basin through the deep infiltration of precipitation and stormwater recharge in streams and recharge facilities. The chart on the upper left shows the long-term annual precipitation time-series. These annual precipitation estimates are based on an areal average over the Chino Basin, created from gridded monthly precipitation estimates (800 by 800-meter grid) prepared by the PRISM Climate Group, and covers the period July 1895 through June 2022. The annual precipitation estimates cover the Fiscal Year (FY) (July through June). The chart contains a horizontal line indicating the 127-year average annual precipitation of 16.2 inches, and the cumulative departure from mean (CDFM) precipitation. The CDFM plot is a useful way to characterize the occurrence and magnitude of wet and dry periods: positive sloping segments (trending upward from left to right) indicate wet periods, and negative sloping segments (trending downward from left to right) indicate dry periods. The wet and dry periods are labeled at the bottom of the chart. On average, the ratio of dry years to wet years is about three to two. That is, for every ten years, about six years will experience below average precipitation and four years will experience greater than average precipitation. That said, July 1945 through June 1977 was a 32-year dry period, punctuated by seven years of above average precipitation: a dry-to-wet year ratio of about four to one. The period July 1998 through June 2022 was a 24-year dry period punctuated with six wet years: a dry-to-wet year ratio of three to one. Dry periods tend to be long and very dry and wet periods tend to relatively short and very wet (see for example July 1936 through June 1945, July 1977 through June 1986 and July 1991 through June 1998). The 30-year standard deviation of annual precipitation in the Chino Basin has approximately doubled over the last century, indicating that the variability of annual precipitation is increasing.

The chart on the lower left is an annual dry-period frequency duration plot that shows the recurrence interval of dry periods of various durations for the 127-year period of 1896 through 2022. The recurrence interval (*R*) is calculated as, $R = T/m$, where T is the length of record in years and m is the rank number of the event when the events are arrayed in order of magnitude. For $T = 127$ years, the extreme event would have a recurrence interval of 127 years ($T = 127$, $m = 1$), the second event – 63.5 years ($T = 127$, $m = 2$), the third – 42.3 years ($T = 127$, $m = 3$), etc. An event having recurrence interval, R, signifies that over a time period of n years, where $n \gg R$, such an event would be expected to happen n/R times. For example, 2012 through 2014, the driest three-year period in the historical record, has a recurrence interval of 127 years, meaning that based on the historical data, a three-year period with less than or equal to 6.8 inches of average annual rainfall would be expected to happen eight times in 1,000 years ($n = 1000$, $R = 127$). The chart shows that seven of the ten driest years on record occurred in the 1999 through 2022 dry period; and the driest consecutive three, five and 10-year periods have all occurred during the OBMP implementation period (since 1999). The driest 10-year period on record is the 10-year period from 2013 through 2022.

January-February and July-August Surface Temperature Anomalies over the Chino Basin 1896-2022



Annual ET_0 Calculated at CIMIS Stations Near Chino Basin by Fiscal Year 1986-2022



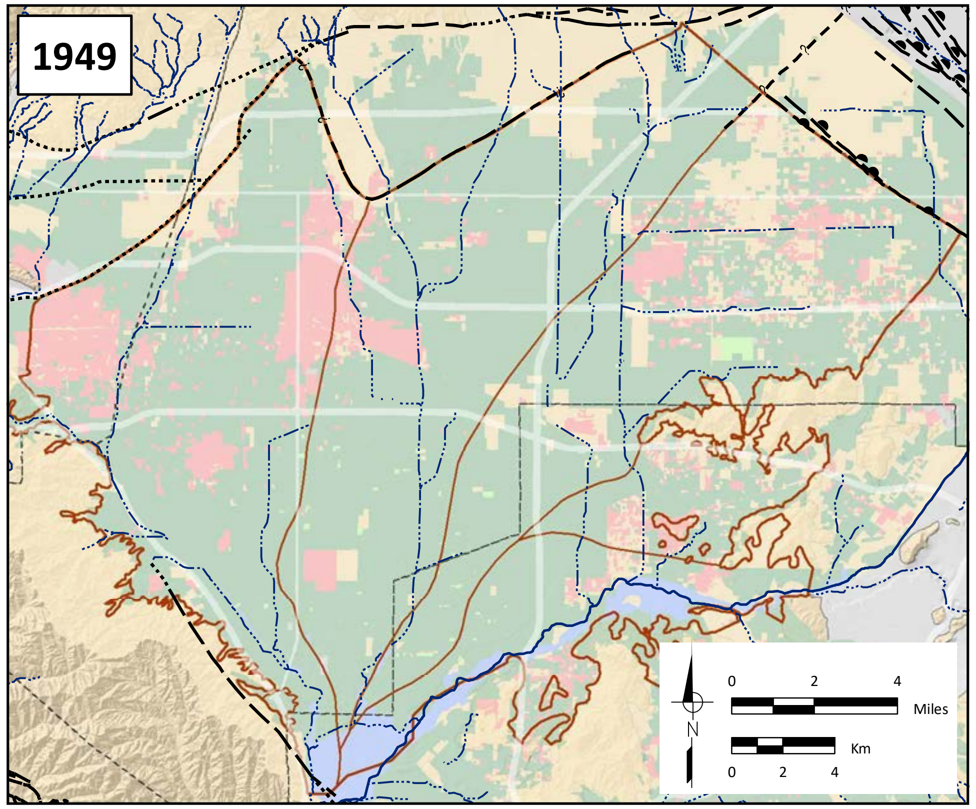
The chart on the upper left shows the time history of annual surface temperatures and 10-year average surface temperature anomalies for January-February and July-August. The average 10-year surface temperature anomaly is computed as the difference between the running 10-year average surface temperature and the 20-year average surface temperature for the 1931 through 1950 period. The January-February period represents winter and the coldest time of the year, and the July-August period represents summer and the hottest time of the year. This chart also shows the estimated atmospheric carbon dioxide concentration. The 1931 to 1950 baseline period corresponds to a period of relatively stable atmospheric carbon dioxide concentration of about 320 parts per million (ppm). After 1950, the atmospheric carbon dioxide concentration rate increases at an increasing rate through 2022. The surface temperature anomaly is a useful way to characterize surface temperature trends.

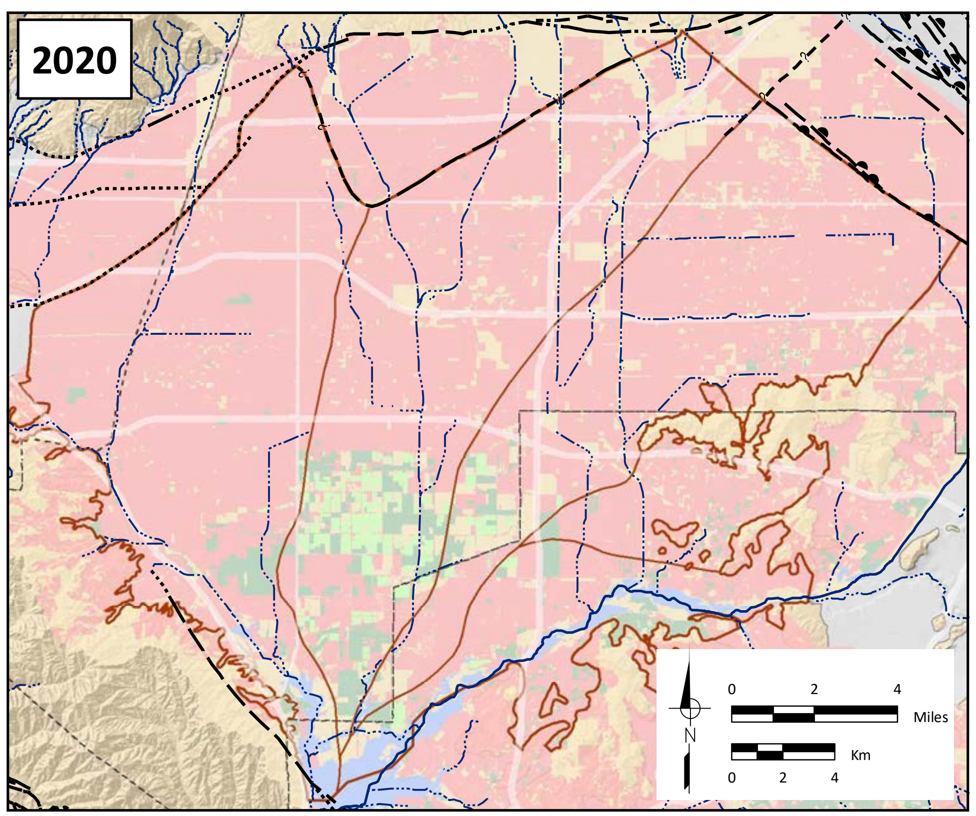
The data used to generate this chart is based on observed daily maximum and minimum temperatures converted to monthly statistics and interpolated by the PRISM Climate Group to produce gridded monthly maximum and minimum temperature estimates. The complete record of atmospheric carbon dioxide concentrations is assembled from multiple sources: prior to 1959, the annual values shown were estimated from an analysis of the Law Dome DE08 and DE08-2 ice cores in Antarctica (D.M. Etheridge, et al., 1998); values after 1959 were directly measured at the Mauna Loa Observatory in Hawaii (NOAA, 2023).

The 10-year moving average of the surface temperature anomaly for the July-August period varies between -2.3 and +0.8 degrees Fahrenheit and has neither an increasing or decreasing trend throughout the period. The 10-year moving average of the surface temperature anomaly for the January-February period varies between -0.8 and +6 degrees Fahrenheit and has an increasing trend since 1950. In 2022, the 10-year moving average of the surface temperature anomaly for the January-February period is +5.3 degrees Fahrenheit compared to the 1931 to 1950 baseline period, which equates to an increase of around three-fourths of a degree per decade since 1950. The increase in the winter temperatures during this period appears to correlate with the increase in atmospheric carbon dioxide concentration.

The significance of the increasing winter temperature to Chino Basin groundwater management is two-fold: a decrease in the occurrence of snowfall and increase in precipitation, and a slight increase in winter-time evapotranspiration (ET). The reduction in snowfall, coupled with an increase in precipitation, will increase the surface water discharge associated with individual precipitation events, cause more frequent exceedances of the recharge capacity of existing recharge facilities, and subsequently reduce the amount of stormwater recharged in the Basin relative to precipitation in the past.

The chart on the lower left shows the annual potential ET (ET_o) as computed at the California Irrigation Management Information System for stations in the Cities of Pomona and Riverside (University of California Riverside [UCR]). The reported ET_0 values are computed from measurements of solar radiation, temperature, humidity, and wind speed. It is unclear from these time- series data that ET_0 is changing in response to increases in atmospheric carbon dioxide concentration. The trends in ET0, if they become more apparent, will need to be included in future hydrologic evaluations of the Chino Basin.

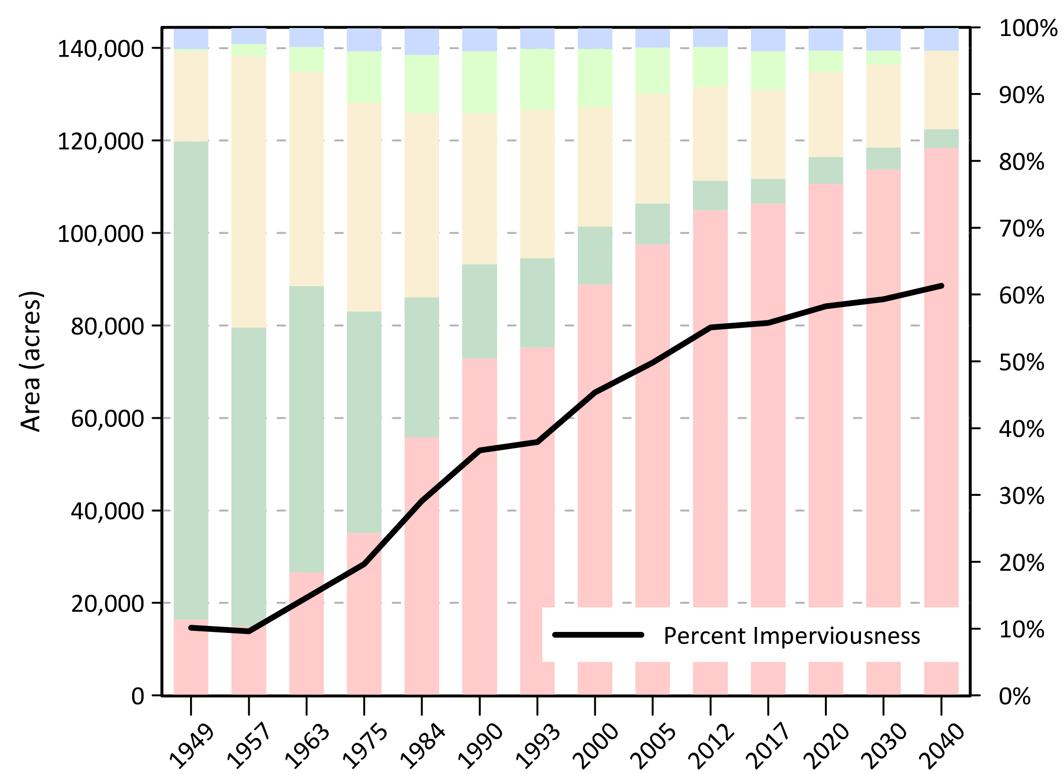




General Land Use Categories

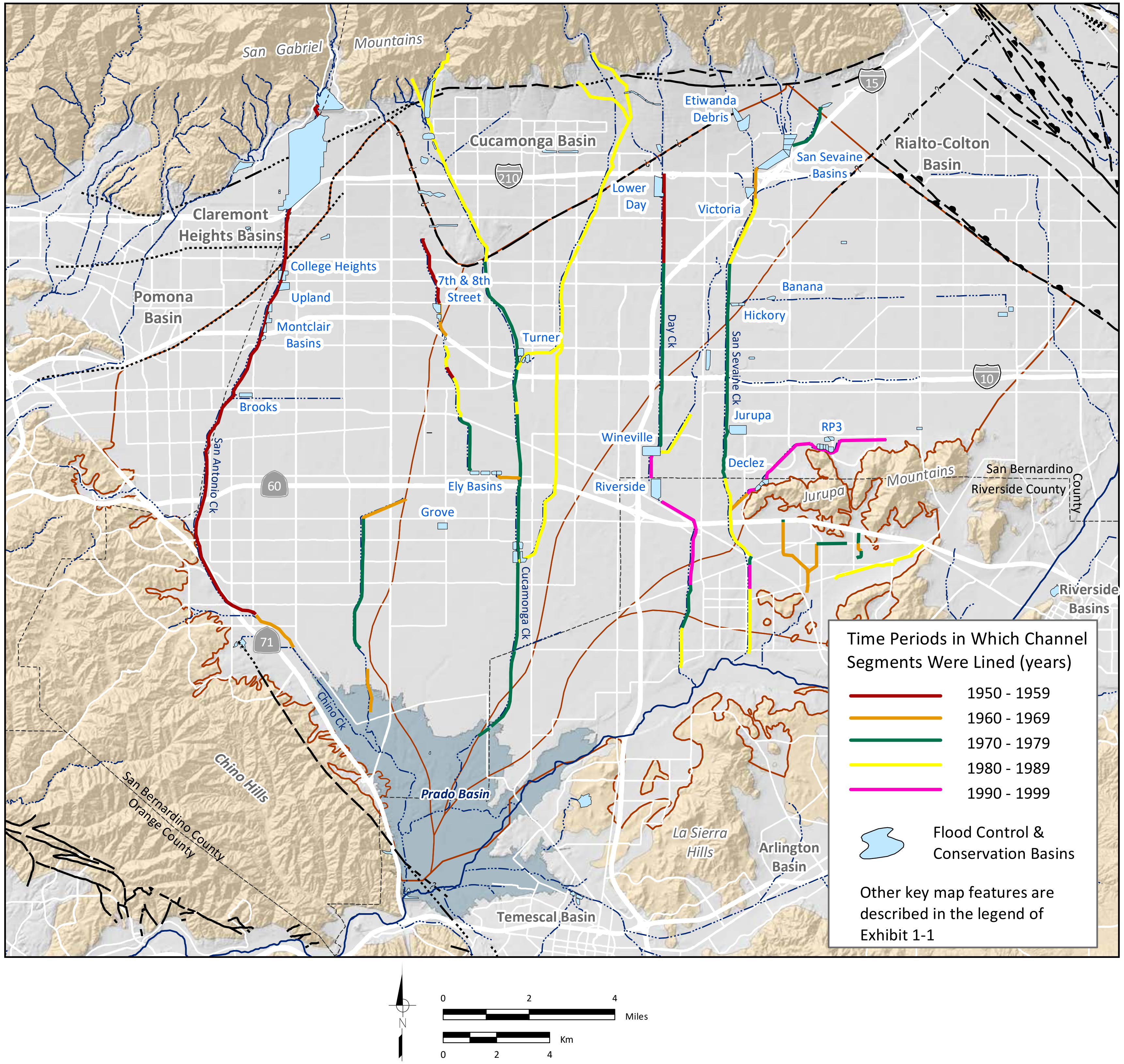
- Agriculture
- Dairy
- Urban
- Vacant
- Riparian Vegetation

Historical and Projected Distribution of Land Use in the Chino Basin

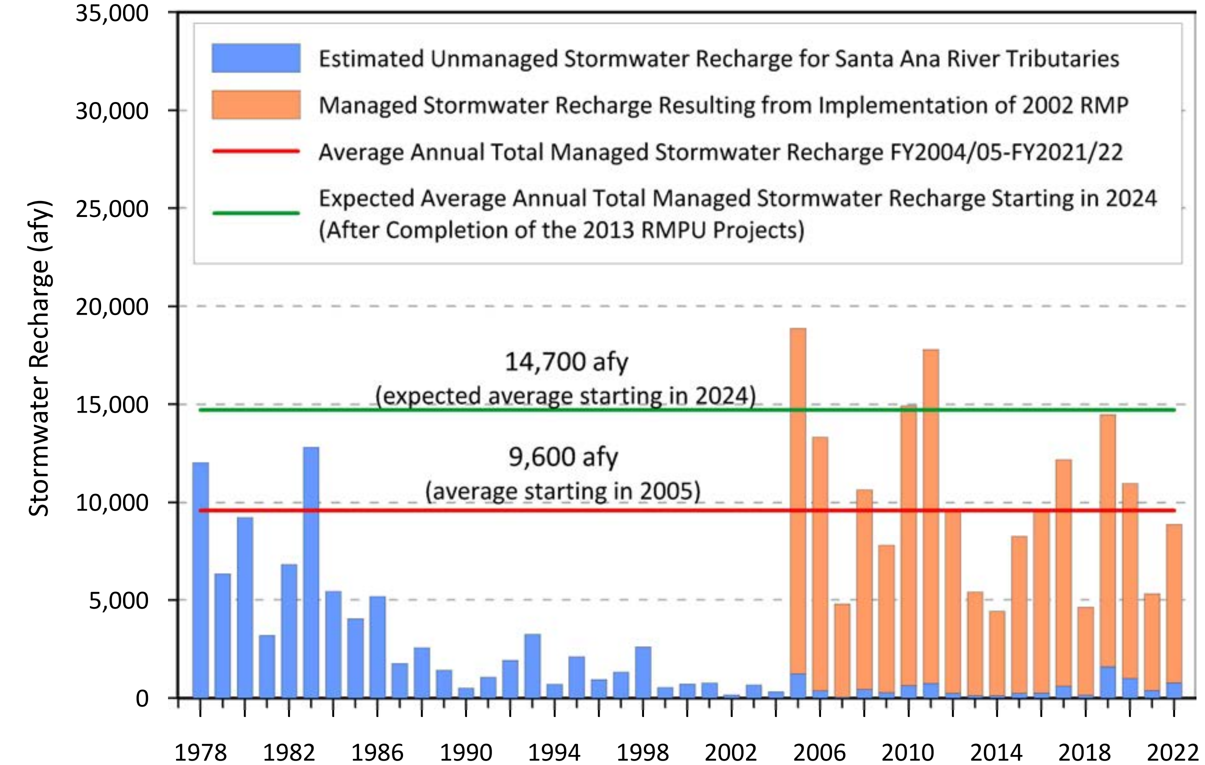


The watershed surface that is tributary to and overlies the Chino Basin and the water management practices over this surface, have changed dramatically over the last 80 years. The land use, water management, and drainage conditions that are tributary to and overlie the Basin at a specific time are referred to collectively as the cultural conditions of the Basin. The types of land uses that overlie a groundwater basin have a profound impact on recharge. The land use transition from natural to agricultural uses, and subsequently to developed urban uses, changes the amount of recharge to the Chino Basin. Furthermore, irrigation practices change over time in response to agricultural economics (e.g., demand for various agricultural products, commodity prices, production costs), regulatory requirements, technology, and the availability and cost of water. Urbanization increases the amount of imperviousness and decreases the irrigable and permeable areas that allow irrigation return flows and precipitation to infiltrate through the soil. And, urbanization increases the amount of stormwater produced on the land surface. Drainage changes associated with the transition from natural and agricultural uses to urban uses reduce the recharge of stormwater. Urbanization of the Chino Basin has included the lining many of channels and streams with concrete to move stormwater efficiently through the watershed to the Santa Ana River to reduce flood risk.

Historically, when land use has converted from natural and agricultural uses to urban uses, imperviousness has increased from near 0 to between 60 and almost 100 percent, depending on the specific land use. The maps on the left illustrate general land use types in the Chino Basin for 1949 and 2020. These data were obtained from the Department of Water Resources, San Bernardino County, and the Southern California Association of Governments. Also included is a chart that shows the estimated total imperviousness associated with the land uses. This latter chart is based on land use mapping for the years shown on the x-axis and projected land use from the land use control agencies. The land use was predominantly in an agricultural and undeveloped state until 1984: urban uses accounted for about 10 percent from 1933 through 1957, grew to about 25 percent in 1975, and reached about 60 percent in 2000. The total imperviousness of the Chino Basin is estimated to have increased from 18 percent in 1975 to about 58 percent in 2020 and is projected to reach about 60 percent by 2030. These land use changes contributed to a reduction of the deep infiltration of precipitation and applied water over the last 80 years. The model-estimated deep infiltration of precipitation and applied water decreased from about 125,000 afy over the period of 1980 through 1989 to 80,000 afy over the period of 2010 through 2018 (WEI, 2020b).



Estimated Unmanaged Stormwater Recharge for the Santa Ana River Tributaries in the Chino Basin and Managed Stormwater Recharge in Recharge Basins Resulting from Recharge Master Plans by Fiscal Year



Drainage improvements were incorporated into the urban landscape in the Chino Basin to convey stormwater rapidly, safely, and efficiently from the land surface through urban developments, and to discharge stormwater away from urbanized areas. Until the late 1990s, there was little or no thought as to the value of the stormwater that discharged out of the Chino Basin. The map to the left shows the stream systems that start in the San Gabriel Mountains and flow from the north to the south, crossing the Cucamonga, Chino, Claremont Heights, and Pomona Basins. From about 1957 to the present, the drainage areas overlying the valley floor have been almost completely converted to urban uses, and almost all the streams have been converted from unlined to concrete-lined channels.

The above chart illustrates the estimated unmanaged stormwater recharge in the Chino Basin (blue bars) for the Santa Ana River tributaries that flow south over the Chino Basin for the period of FY 1977/78 through 2021/22. The lining of these channels has almost eliminated unmanaged stormwater recharge in the Chino and Cucamonga Basins after 1984. The orange bars indicate the estimated managed stormwater recharged in recharge basins reported by the IEUA starting in 2005, due to the construction of stormwater recharge improvements from the 2002 Recharge Master Plan (RMP) that was implemented as part of the OBMP. The 2002 RMP projects have replaced some of the recharge lost due to channel lining. The red line indicates the average managed stormwater recharged in recharge basins (9,600 afy) from FY 2004/05 to 2021/22. Note that FY 2004/05 to 2021/22 contains the driest 10-year period (2013 through 2022) in the historical record (see Exhibit 2-2). The green line indicates the expected average managed stormwater recharge of 14,700 afy after the completion of the projects identified in the 2013 Amendment to the 2010 Recharge Master Plan Update (2013 RMPU), which is expected to be completed in 2024.

Earth's water is moved, stored, and exchanged between the atmosphere, land surface, and subsurface according to the hydrologic cycle. As water evaporates and rises from the ocean, the water vapor cools, condenses, and ultimately returns to the Earth's surface as precipitation (rain or snow). As the precipitation falls on the land surface, some water may infiltrate into the ground to become groundwater, some water may run off and contribute to streamflow, some may evaporate, and some may be used by plants and transpired back into the atmosphere to continue the hydrologic cycle (Healy, R.W. et al., 2007).

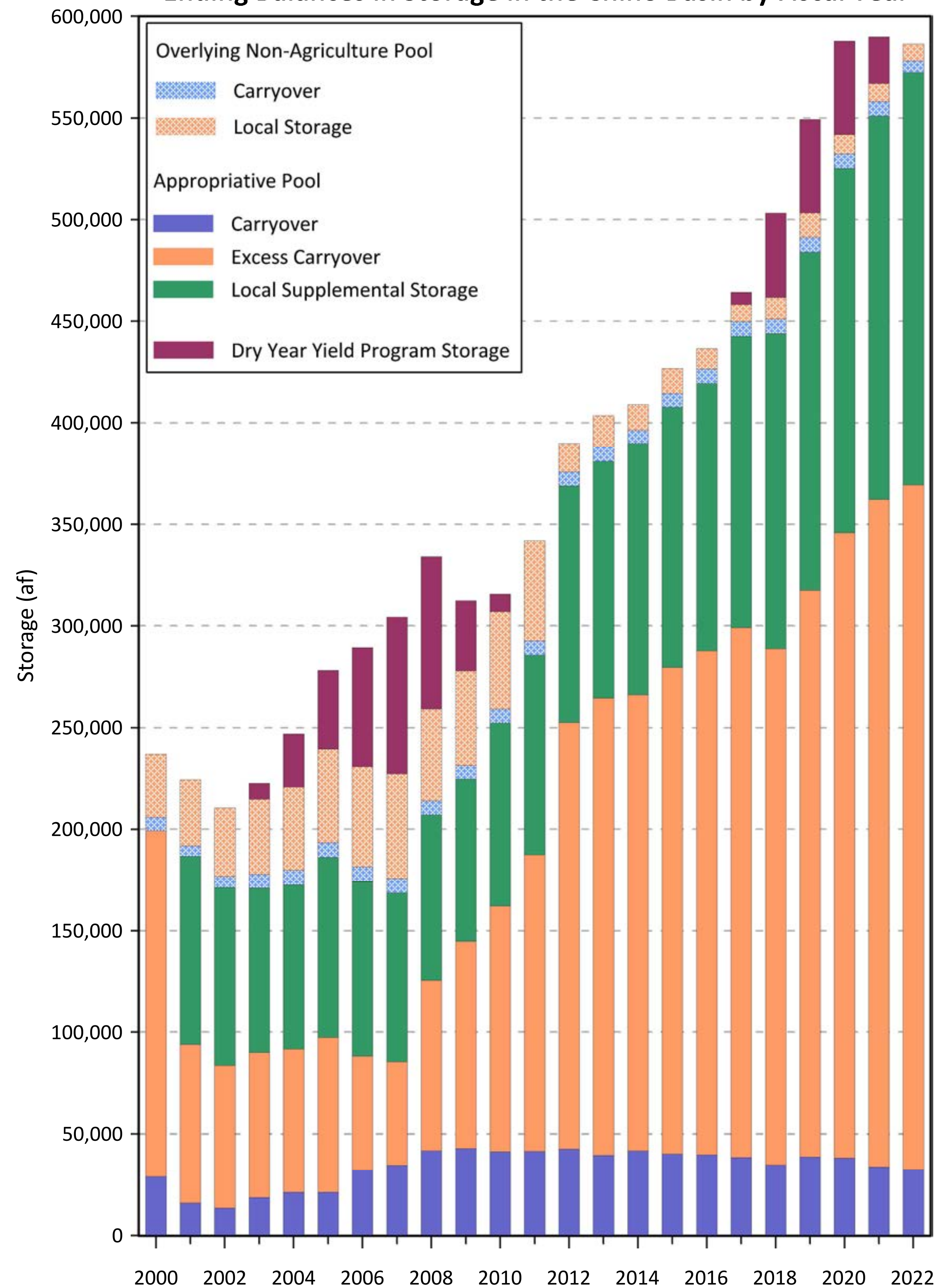
A water budget accounts for the storage and movement of water between the four physical systems of the hydrologic cycle: the atmospheric system, the land surface system, the river and stream system, and the groundwater system. A water budget is a foundational tool used to tabulate water inflows (recharge) and outflows (discharge). It is an accounting of the total groundwater and surface water entering and leaving a basin or a user-defined area. The difference between inflows and outflows is the change in the amount of water stored.

Below is a tabular presentation of the Chino Basin water budget for the OBMP implementation period of FY 1999/00 through FY 2021/22, based on recent modeling efforts for the 2020 Safe Yield Recalculation (WEI, 2020b; West Yost, In Press). The water budget below shows the recharge and discharge components and estimated change in storage on an annual time step. The recharge components include subsurface inflows from adjacent mountain blocks and groundwater basins, streambed infiltration, managed aquifer recharge, and the deep infiltration of precipitation and applied water. The discharge components include groundwater pumping, ET from riparian vegetation, groundwater discharge to streams, and subsurface outflow to adjacent groundwater basins. The change in storage is equal to the total recharge minus total discharge. The net recharge is equal to: Rnet = Pumping + Δ Storage – Rsw, where: Rnet is net recharge, Δ Storage is the change in storage, and Rsw is supplemental water recharge.

The net recharge is used with other information to estimate the Chino Basin Safe Yield. The average net recharge for the period of FY 1999/00 through FY 2009/10 was about 135,000 afy, and the net recharge for the period of FY 2010/11 through FY 2019/20 was about 126,000 afy. For perspective, recall that the period of 2010 through 2022 contains the driest 10-year period (2013 through 2022) in the historical record (see Exhibit 2-2) and thus the estimated net recharge during this period is not representative of the long-term average net recharge.

Fiscal Year	Recharge										Discharge							Change in Storage = Recharge minus Discharge	Net Recharge
	Subsurface Boundary Inflow from:			Streambed Infiltration from:		Water Recharged in Basins or ASR Wells from:			Deep Infiltration of Precipitation and Applied Water	Subtotal Recharge	Pumping:			Evapo-transpiration of Riparian Vegetation	Groundwater Discharge to Streams	Subsurface Discharge to Temescal Basin	Subtotal Discharge		
	Chino/Puente Hills, Six Basins, Cucamonga Basin, Rialto Basin and Spadra	Bloomington Divide	Temescal Basin	Santa Ana River Tributaries	Santa Ana River	Stormwater	Recycled Water	Imported Water			Chino Basin Desalter Authority	Overlying Non-Agricultural and Appropriative Pools	Overlying Agricultural Pool						
FY 1999/00	24,011	14,451	5,261	499	27,081	1,985	507	997	109,843	184,635	523	133,086	46,538	18,938	23,315	2,403	224,803	-40,168	138,476
FY 2000/01	23,503	14,556	6,177	598	25,419	3,162	500	6,538	107,823	188,276	9,470	120,396	41,429	18,717	26,464	3,045	219,521	-31,245	133,011
FY 2001/02	22,461	15,177	6,801	230	25,922	1,148	505	6,493	102,792	181,528	10,173	129,760	38,650	18,472	26,544	3,236	226,835	-45,307	126,279
FY 2002/03	21,413	15,747	6,511	859	28,672	6,284	185	6,548	102,305	188,524	10,322	123,471	36,507	18,157	26,630	3,579	218,665	-30,141	133,425
FY 2003/04	21,662	16,088	6,288	536	27,465	3,357	49	7,607	99,010	182,062	10,480	128,548	36,809	18,069	27,669	4,294	225,869	-43,807	124,374
FY 2004/05	23,194	14,346	5,465	5,917	30,922	17,648	158	12,259	99,647	209,556	10,595	112,943	34,503	17,178	29,844	4,744	209,807	-251	145,373
FY 2005/06	23,735	14,568	4,738	1,806	30,439	12,940	1,303	34,567	99,823	223,920	19,819	113,553	30,812	17,561	24,576	2,847	209,168	14,752	143,065
FY 2006/07	23,168	15,150	4,023	79	29,276	4,745	2,993	32,960	96,008	208,402	28,529	123,695	29,919	18,276	21,441	2,754	224,614	-16,212	129,978
FY 2007/08	22,439	15,044	3,580	1,530	31,703	10,205	2,340	0	93,275	180,116	30,116	127,696	26,280	18,358	20,003	2,406	224,859	-44,744	137,009
FY 2008/09	22,413	15,271	3,217	839	33,318	7,512	2,684	0	91,489	176,741	28,456	137,345	23,386	18,561	18,475	2,521	228,744	-52,003	134,500
FY 2009/10	21,267	15,584	3,342	1,939	35,285	14,273	7,210	5,000	88,512	192,412	28,964	108,983	22,038	18,686	18,067	2,780	199,519	-7,107	140,669
FY 2010/11	22,132	15,960	3,561	3,358	36,213	17,052	8,065	9,465	88,763	204,568	28,941	94,413	18,042	18,739	18,765	3,004	181,905	22,663	146,530
FY 2011/12	22,262	15,577	3,911	463	34,463	9,271	8,634	22,560	84,009	201,151	28,230	108,501	22,412	19,282	15,649	2,514	196,588	4,563	132,512
FY 2012/13	21,703	15,144	3,791	243	33,536	5,271	10,479	0	80,130	170,298	27,380	111,748	24,074	17,348	13,871	2,275	196,696	-26,398	126,325
FY 2013/14	21,132	15,067	3,812	241	34,301	4,299	13,593	795	78,395	171,636	29,626	118,849	22,131	17,426	13,348	2,441	203,821	-32,186	124,032
FY 2014/15	19,582	15,230	3,759	421	34,907	8,001	10,840	0	75,817	168,555	30,022	104,317	17,552	17,580	13,585	2,542	185,598	-17,042	124,009
FY 2015/16	17,833	15,716	3,765	476	36,134	9,236	13,222	0	73,547	169,928	28,191	101,301	16,908	17,824	14,147	2,708	181,079	-11,150	122,027
FY 2016/17	18,839	15,967	3,843	1,920	35,805	11,575	13,934	13,150	72,874	187,907	28,284	98,960	16,191	17,869	15,261	2,314	178,879	9,028	125,379
FY 2017/18	18,396	15,711	4,467	2,165	32,664	4,494	13,212	35,621	69,532	196,261	30,088	93,904	16,776	18,147	13,914	2,161	174,989	21,272	113,206
FY 2018/19	21,433	15,538	4,650	602	35,678	12,861	11,145	7,401	68,255	177,564	31,233	84,771	15,478	18,125	14,680	2,476	166,762	10,802	123,737
FY 2019/20	21,466	15,538	6,190	602	34,092	9,967	12,953	20,154	70,121	191,083	35,630	96,486	15,722	18,219	16,146	2,163	184,365	6,718	121,448
FY 2020/21	21,482	15,538	6,800	602	33,486	4,911	15,728	2,382	70,852	171,781	40,156	106,123	14,927	18,265	16,740	1,907	198,118	-26,337	116,760
FY 2021/22	21,415	15,538	6,679	601	33,483	8,108	15,042	1,742	72,733	175,341	40,566	108,239	14,072	18,348	16,998	1,707	199,931	-24,590	121,503
Statistics for the Peace Agreement Period, 2000 through 2022																			
Total	496,939	352,505	110,629	26,528	740,265	188,303	165,279	226,241	1,995,556	4,302,246	565,793	2,587,087	581,156	418,144	446,133	62,820	4,661,135	-358,889	2,983,627
Total (%)	12%	8%	3%	1%	17%	4%	4%	5%	46%	100%	12%	56%	12%	9%	10%	1%	100%	NA	NA
Average	21,606	15,326	4,810	1,153	32,185	8,187	7,186	9,837	86,763	187,054	24,600	112,482	25,268	18,180	19,397	2,731	202,658	-15,604	129,723
Maximum	24,011	16,088	6,801	5,917	36,213	17,648	15,728	35,621	109,843	223,920	40,566	137,345	46,538	19,282	29,844	4,744	228,744	22,663	146,530
Minimum	17,833	14,346	3,217	79	25,419	1,148	49	0	68,255	168,555	523	84,771	14,072	17,178	13,348	1,707	166,762	-52,003	113,206

Time History of Ending Balances in Storage in the Chino Basin by Fiscal Year



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The Overlying Non-Agricultural Pool and Appropriative Pool Parties individually engage in conjunctive-use activities by storing unpumped groundwater pumping rights, and subsequently recovering their stored water as their individual needs arise. The water stored by the Overlying Non-Agricultural Parties is classified as Carryover water (unpumped rights to the Safe Yield) and local storage (stored water other than carryover water). The water stored by the Appropriative Pool Parties includes Carryover, Excess Carryover, and local supplement water. Excess Carryover is unpumped Carryover water. Local supplemental water is imported water and recycled water stored by a Party. Managed storage collectively refers to all water stored by the Parties. The conjunctive-use activities of the Parties have caused managed storage to increase since 2000. The chart to the left and the table below show the time history of water held in managed storage at the end of each FY from July 1999 through June 2022. Account balances are from Watermaster Assessment Packages and do not account for the desalter replenishment obligation or the change in Safe Yield. The Parties, in aggregate, have continued to under-pump their pumping rights, causing managed storage to increase from about 237,000 acre-feet (af) in June 2000 to about 586,000 af in June 2022.

Metropolitan's Dry-Year Yield Program is the only active storage and recovery program in the Basin. In the Dry-Year Yield Program, up to 100,000 af of imported water can be stored in the Chino Basin during surplus years and extracted during years when the availability of imported water is limited. By the end of FY 2021/22, Metropolitan had zero af in its Dry-Year Yield Program Storage account.

Fiscal Year	Appropriative Pool				Overlying Non-Agricultural Pool			Total Managed Storage by Parties	Dry Year Yield Program Storage[5]	Total Managed Storage
	Carryover[1]	Excess Carryover (ECO)[2]	Local Supplemental Storage[3]	Subtotal	Carryover[1]	Local Storage[4]	Subtotal			
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8) = (7) + (4)	(9)	(10) = (9) + (8)
FY 1999/00[6]	28,911	170,342		199,253	6,541	31,031	37,572	236,825	0	236,825
FY 2000/01	15,940	77,907	92,813	186,660	5,301	32,330	37,631	224,291	0	224,291
FY 2001/02	13,521	70,103	87,801	171,425	5,285	33,727	39,012	210,437	0	210,437
FY 2002/03	18,656	71,329	81,180	171,165	6,743	36,850	43,593	214,758	7,738	222,496
FY 2003/04	21,204	70,503	80,963	172,670	7,177	40,881	48,058	220,728	26,300	247,028
FY 2004/05	21,289	76,080	88,849	186,218	7,227	45,888	53,115	239,333	38,754	278,087
FY 2005/06	32,062	56,062	86,170	174,294	7,227	49,178	56,405	230,699	58,653	289,352
FY 2006/07	34,552	50,895	83,184	168,631	7,084	51,476	58,560	227,191	77,116	304,307
FY 2007/08	41,626	83,962	81,520	207,108	6,819	45,248	52,067	259,175	74,877	334,052
FY 2008/09	42,795	101,908	79,890	224,593	6,672	46,600	53,272	277,865	34,494	312,359
FY 2009/10	41,263	120,897	90,133	252,293	6,934	47,732	54,666	306,959	8,543	315,502
FY 2010/11	41,412	146,074	98,080	285,566	6,959	49,343	56,302	341,868	0	341,868
FY 2011/12	42,614	209,981	116,138	368,733	6,914	13,993	20,907	389,640	0	389,640
FY 2012/13	39,413	225,068	116,378	380,859	7,073	15,473	22,546	403,405	0	403,405
FY 2013/14	41,708	224,496	123,484	389,688	6,478	12,812	19,290	408,978	0	408,978
FY 2014/15	40,092	239,517	127,994	407,603	6,823	12,225	19,048	426,651	0	426,651
FY 2015/16	39,733	248,013	131,522	419,267	7,195	9,949	17,144	436,411	0	436,411
FY 2016/17	38,340	260,682	143,552	442,575	7,226	8,292	15,519	458,093	6,315	464,408
FY 2017/18	34,582	254,221	155,018	443,821	7,198	10,775	17,973	461,795	41,380	503,175
FY 2018/19	38,605	279,033	166,406	484,044	7,227	12,004	19,231	503,275	45,969	549,243
FY 2019/20	38,095	307,757	179,292	525,144	7,227	9,474	16,701	541,845	45,961	587,806
FY 2020/21	33,766	328,371	188,836	550,973	7,227	8,746	15,974	566,946	22,929	589,875
FY 2021/22	32,385	336,964	202,964	572,313	5,703	8,294	13,997	586,310	0	586,310

1. The un-produced water in any year that may accrue to a member of the Non-Agricultural Pool or the Appropriative Pool and that is produced first each subsequent Fiscal Year or stored as Excess Carryover.
2. Carryover Water which in aggregate quantities exceeds a party's share of Safe Yield in the case of the Non-Agricultural Pool, or the assigned share of Operating Safe Yield in the case of the Appropriative Pool, in any year.
3. Water imported to Chino Basin from outside the Chino Basin Watershed and recycled water.
4. Water held in a storage account pursuant to a Local Storage Agreement between a party to the Judgement and Watermaster. "Local Storage Agreement" means a Groundwater Storage Agreement for Local Storage.
5. Ending balance in the Dry Year Yield Program storage account.
6. Prior to FY2000/01, Excess Carryover and Local Supplemental Storage were combined into one account.

BASIN PRODUCTION AND RECHARGE

The accurate accounting of groundwater production and artificial recharge is vital to the management of the Chino Basin. Several of the OBMP Program Elements have been developed to address these needs, primarily *OBMP PE 1 – Develop and Implement a Comprehensive Monitoring Program* and OBMP *PE 2 – Develop and Implement Comprehensive Recharge Program.* Estimates of production and recharge are essential inputs to inform re-determinations of the Safe Yield of the Chino Basin, which are scheduled to occur every ten years. The exhibits in this section characterize the physical state of the Chino Basin with respect to groundwater production and artificial recharge.

Groundwater Production. Since its establishment in 1978, Watermaster has collected information to estimate total groundwater production from the Chino Basin. The Watermaster Rules and Regulations require groundwater producers that pump in excess of 10 afy to install and maintain meters on their well(s). Well owners that pump less than 10 afy are considered “minimal producers” and are not required to meter or report to Watermaster. When the OBMP was adopted, many of the Agricultural Pool wells did not have properly functioning meters installed, so Watermaster initiated a meter installation program for these wells as part of *OBMP PE 1*. Meters were installed at most agricultural wells by 2003. Watermaster staff visit and record production data from the meters at these wells on a quarterly basis. For the remaining unmetered Agricultural Pool wells, including minimal producer wells, Watermaster applies a “water duty” method to estimate their production on an annual basis. Members of the Appropriative Pool and Overlying Non-Agricultural Pool, record their own meter data and submit to Watermaster staff on a quarterly basis. All Chino Basin production data are checked for accuracy and stored in Watermaster’s relational database. Watermaster summarizes and reports the groundwater production data based on FY. Watermaster uses reported production to quantify and levy assessments pursuant to the Judgment. Exhibit 3-1 shows the locations of all active production wells, symbolized by Pool, in the Chino Basin during FY 2021/22.

Prior to the widespread metering of Agricultural Pool production wells, Agricultural Pool production estimates in Watermaster’s database are believed to have been consistently underreported. For the development of the 2013 Chino Basin Groundwater Model (WEI, 2015e), agricultural production prior to FY 2001/02 was estimated based on historical land use data and the applied water requirements for those land uses. Exhibit 3-2 shows two bar charts depicting the annual groundwater production by Pool for FY 1977/78 through 2021/22. Exhibit 3-2 shows the estimated production by Pool as recorded in Watermaster’s database, except Agricultural Pool production totals prior to FY 2001/02, which were replaced with the volumes estimated for the 2015 Safe Yield recalculation effort (WEI, 2015e).

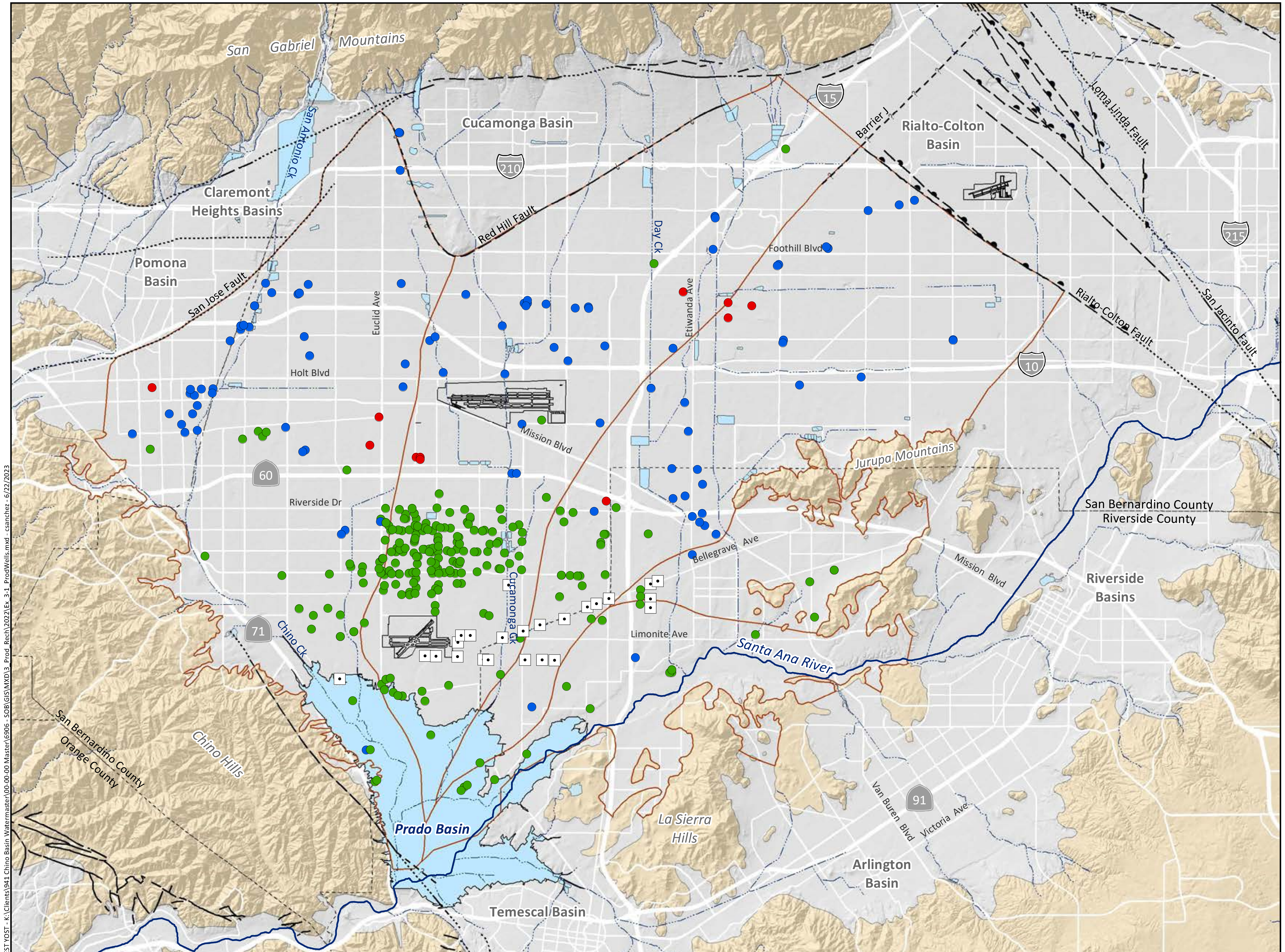
The spatial distribution of production has also shifted since 1978. Exhibit 3-3 is a series of maps that illustrate the location and magnitude of groundwater production of wells in the Chino Basin for FYs 1977/78 (Establishment of Watermaster), 1999/00 (commencement of the OBMP), and 2021/22 (current conditions).

The decline in agricultural production in the southern half of the Chino Basin has gradually been replaced by production at the wells for the Chino Desalters operated and owned by the CDA since FY 2000/01. The Chino Desalters wells and treatment facilities were developed as part of *OBMP PE 3 – Develop and Implement Water Supply Plan for the Impaired Areas of the Basin* and *PE 5 – Develop and Implement Regional Supplemental Water Program*. The Chino Desalters are meant to enhance water supply reliability and improve groundwater quality in the Chino Basin. Exhibit 3-4 is a map that displays the locations of the Chino Desalter wells and treatment facilities. This exhibit also summarizes the history of Chino Desalter production in the southern portion of the Chino Basin and its nexus to the OBMP goals.

Artificial Recharge. Watermaster also improves water supply reliability and water quality in the Chino Basin through the execution of *OBMP PE 2.* Increasing the recharge of stormwater and dry-weather runoff increases the sustainable yield of the Basin and improves the water quality of both the Chino Basin and the Santa Ana River, the latter being a regional benefit to other Santa Ana River Watershed parties and to Santa Ana River Watershed habitat. Additionally, supplemental water recharge is conducted to meet replenishment obligations, for storage and recovery programs, increase yield, and to meet Watermaster’s obligation to recharge 6,500 afy of supplemental water in MZ1 for the duration of the Peace Agreement (until June 30, 2030).

The comprehensive recharge program has been developed through a recharge master planning process that began in 1998 to increase the recharge of local and supplemental waters in the Chino Basin. Since the *Recharge Master Plan Phase II* report was developed in 2001 (WEI, 2001), Watermaster has partnered with the IEUA, San Bernardino County Flood Control District, and Chino Basin Water Conservation District to construct and/or improve recharge facilities in the Chino Basin, in accordance with the Recharge Master Plan and the 2003 Four-Party Agreement. The Peace Agreement requires the preparation of a recharge master plan update (RMPU) no more than every five years; the most recent approved recharge master plan update is the 2018 RMPU (WEI, 2018). A primary goal of the recharge master plan is to increase the capacity for and recharge of stormwater, imported water, and recycled water in the Chino Basin. Exhibit 3-5 shows the network of recharge facilities in the Chino Basin, a time history of the magnitude and types of groundwater recharge since FY 2004/05 (when the Chino Basin Recycled Water Groundwater Recharge Program was initiated), and a summary of the groundwater recharge programs and recharge master planning. Exhibit 3-6 characterizes the seasonal recharge of stormwater, recycled water, and imported water. Exhibit 3-7 shows estimated recharge capacities in the Chino Basin and a comparison of projected annual recharge and replenishment obligation to supplemental water recharge capacity.

Exhibit 3-8 shows the recycled water infrastructure, areas of recycled water reuse, and annual reuse from FY 1999/00 through FY 2021/22. Recycled water reuse has significantly increased since the OBMP implementation began in FY 1999/00.



Active Groundwater Production Wells in FY 2021/22 by Pumper

- Agricultural Pool (Pool 1 - 236 Wells)
- Overlying Non-Agricultural Pool (Pool 2 - 11 Wells)
- Appropriative Pool (Pool 3 - 97 Wells)
- CDA (Chino Desalter Wells - 24 wells)

Other key map features are described in the legend of Exhibit 1-1.

During FY 2021/22, 405 production wells were active in the Chino Basin. Total production was approximately 163,300 af and was divided as follows:

Agricultural Pool:
14,500 af, 9 percent of total production

Overlying Non-Agricultural Pool:
1,600 af, one percent of total production

Appropriative Pool (Less Chino Basin Desalters):
106,600 af, 65 percent of total production

Chino Desalters:
40,600 af, 25 percent of total production

Exhibits 3-2 and 3-3 characterize how production has changed over time across the Chino Basin

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Chino Basin Watermaster
2022 State of the Basin Report
Basin Production and Recharge

Active Production Wells in the Chino Basin
Fiscal Year 2021/22

Exhibit 3-1

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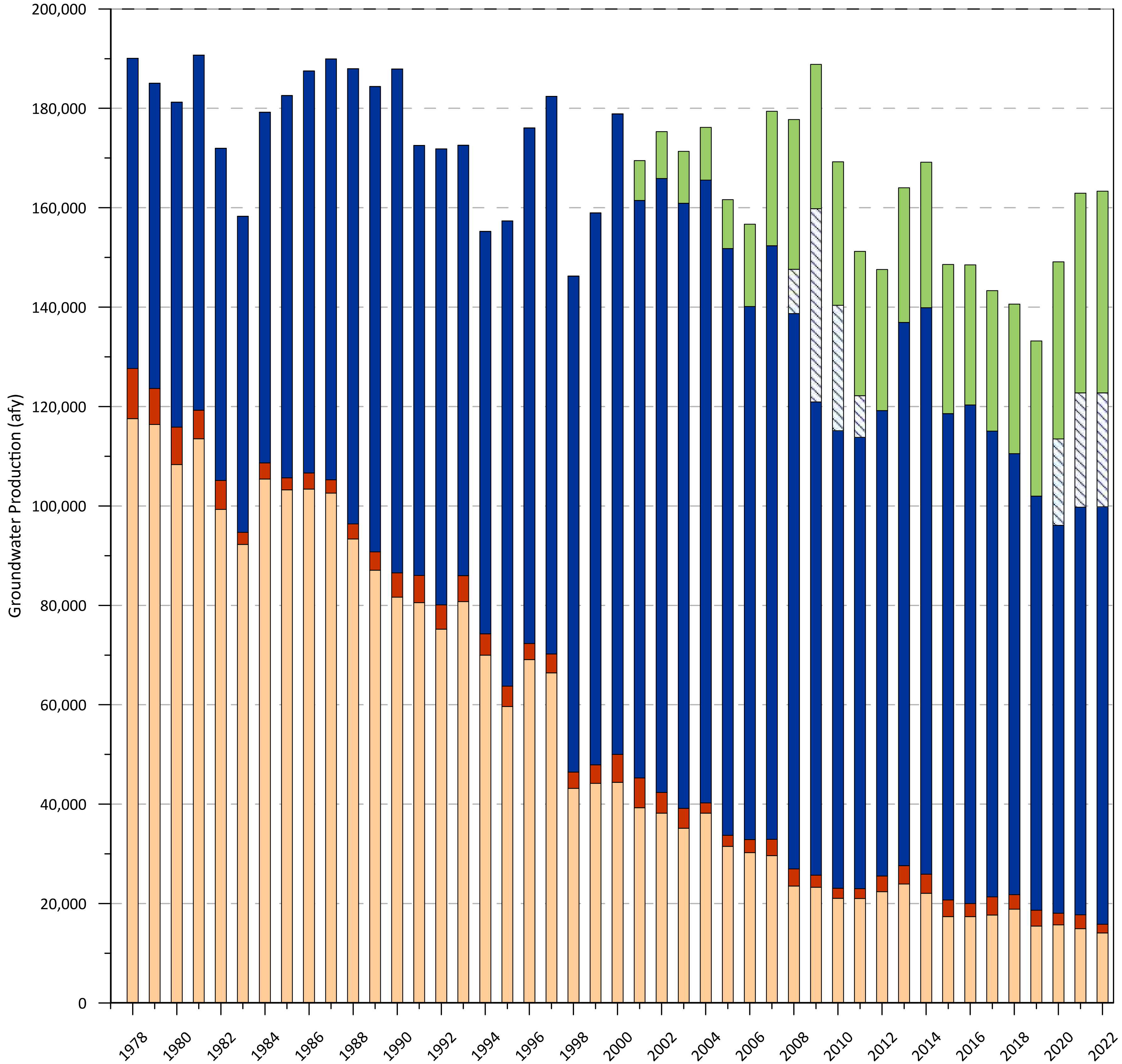

Exhibit 3-2 shows the estimated production by Pool as recorded in Watermaster's database, except for Agricultural Pool production totals prior to FY 2001/02, which were replaced with the volumes estimated for the 2015 Safe Yield recalculation effort (WEI, 2015e). Agricultural Pool production for the period of 1978 through 2001 was estimated for the Safe Yield recalculation effort (WEI, 2015e) based on published land use, water use, precipitation, and evapotranspiration data. The agricultural estimates were greater than the production reported by the Agricultural Pool Parties prior to 2002. For FY 1977/78, the estimated agricultural production was about 30,000 af greater than reported. The reported and model-estimated agricultural production estimates became aligned in the early 2000s. Since 2002, Agricultural Pool production estimates have been based on Watermaster records.

Total annual groundwater production in the Chino Basin has ranged from a maximum of about 191,000 afy during FY 1980/81 to a minimum of about 133,000 afy during FY 2018/19 and has averaged about 169,000 afy. Since FY 1977/78, Agricultural Pool production has decreased by about 73,700 af –from 55 percent of total production in FY 1977/78 to 9 percent in FY 2021/22. During the same period, Appropriative Pool production increased by about 85,000 af—from 39 percent of total production in FY 1977/78 to 90 percent as of FY 2021/22—inclusive of production at the Chino Basin Desalter Authority (CDA) wells. Production in the Overlying Non-Agricultural Pool declined from about six percent of total production in FY 1977/78 to one percent as of FY 2021/22.

The total groundwater production declined from 2012 to 2016 due to the drought conditions, state-mandated water conservation measures and a trend towards greater water conservation. Groundwater production has been increasing for the past three years. The primary driver of this increasing trend is the pumping for the DYYP by the Appropriative Pool over these last three years and there has been an increase in Chino Desalter pumping (see Exhibit 3-4).

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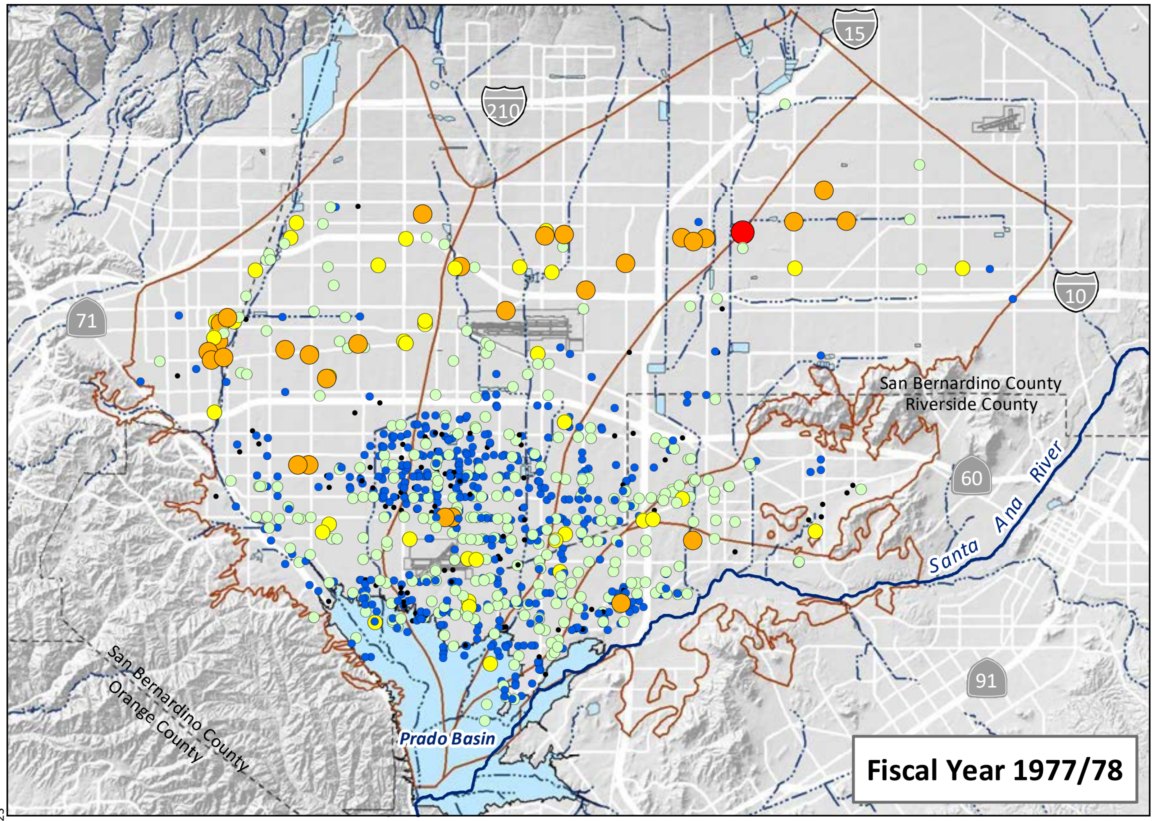
Agricultural Pool
Overlying Non-Agricultural Pool
Appropriative Pool
Appropriative Pool - Metropolitan Dry Year Yield Program
Chino Desalters (Appropriative Pool)

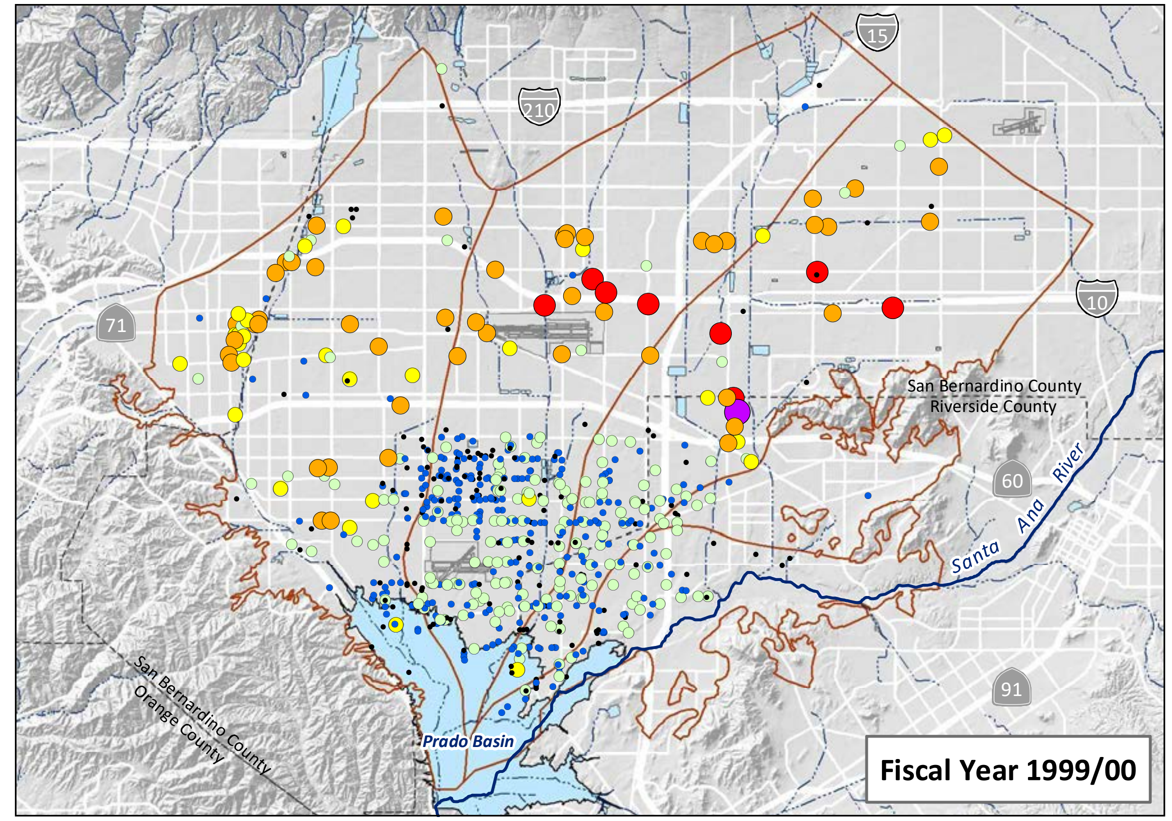
Prepared for:

Chino Basin Watermaster
2022 State of the Basin Report
Basin Production and Recharge

Groundwater Production by Pool in the Chino Basin
Fiscal Year 1977/78 to 2021/22

Exhibit 3-2

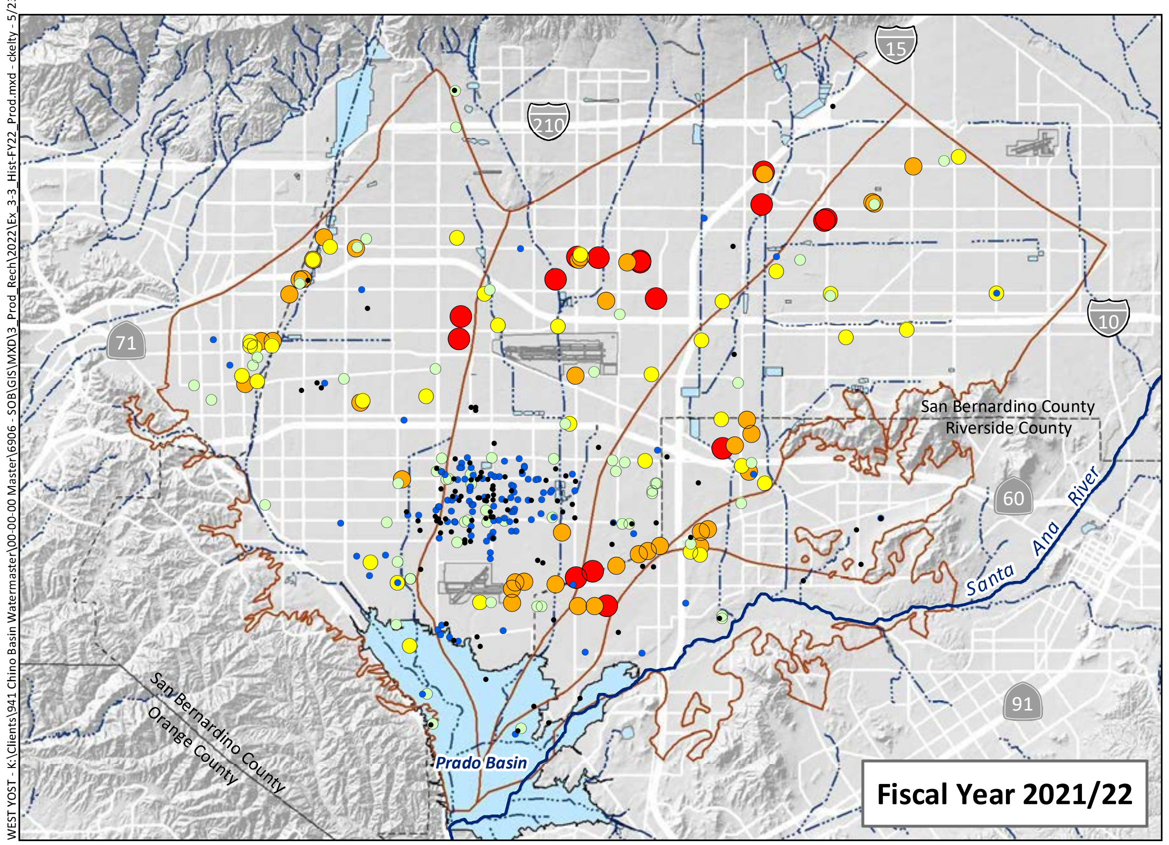




Groundwater Production (af)

- < 10
- 10 - 100
- 100 - 500
- 500 - 1,000
- 1,000 - 2,500
- 2,500 - 5,000
- > 5,000

Other key map features are described in the legend of Exhibit 1-1.

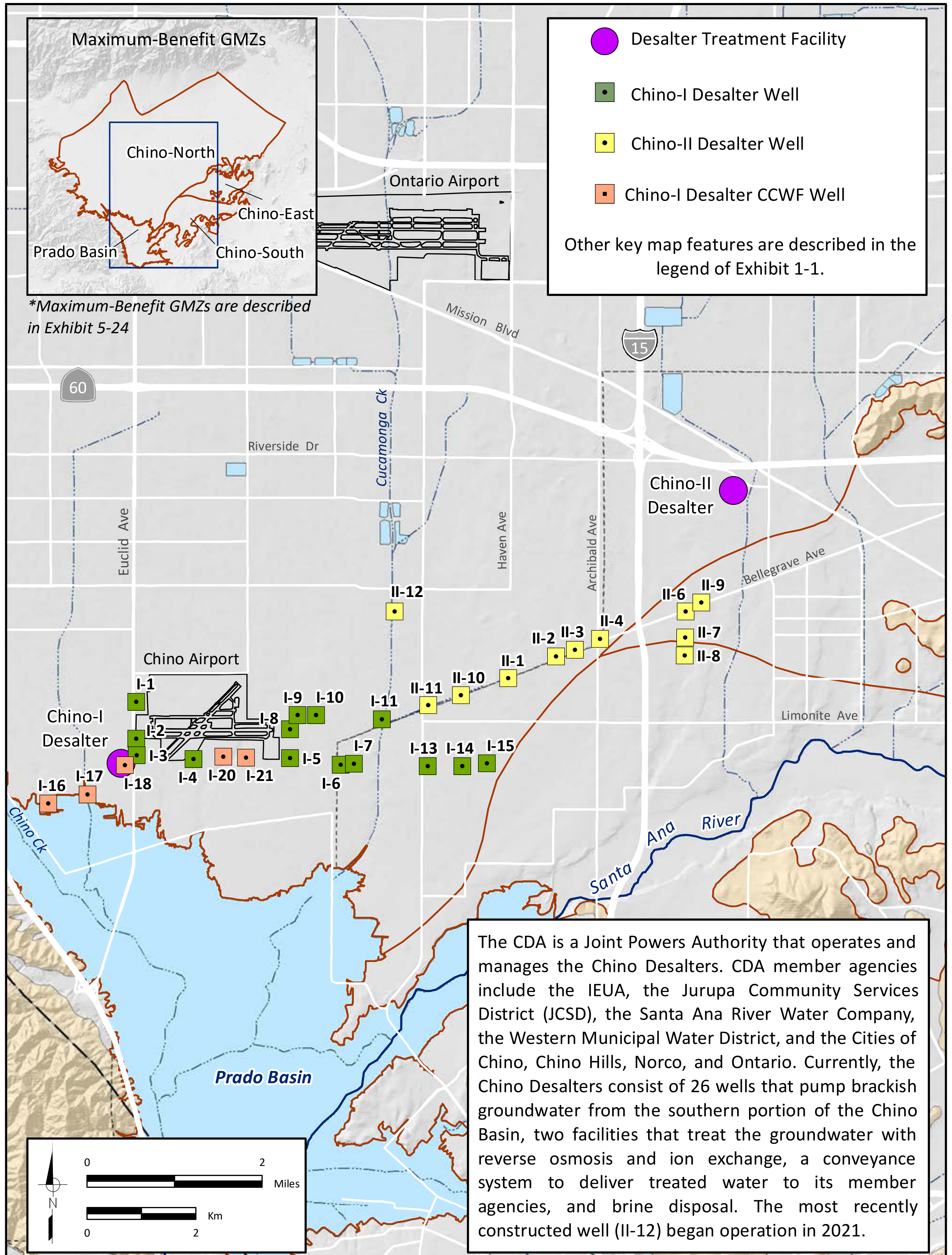


In FY 1977/78, production located south of Highway 60 in the Chino Basin was about 93,500 af and production located north of Highway 60 was about 65,300 af, accounting for 59 and 41 percent of total production, respectively. The agricultural production estimate for FY 1977/78 from the Safe Yield recalculation effort in 2015 was greater than the reported production and primarily occurred south of Highway 60.

Between FY 1977/78 and FY 1999/00, groundwater production shifted north, with groundwater production south of Highway 60 declining from 59 to 31 percent of total production. North of Highway 60, production increased from 41 to 69 percent of total production. This shift in production was a result of land use transitions: south of Highway 60, irrigated agricultural land had been largely replaced by dairies, which have lower water use requirements; and north of Highway 60, Appropriative Pool production increased concurrent with urbanization. In FY 1999/00, after the Chino Desalter wells were constructed and came online south of Highway 60 (see Exhibit 3-4), the spatial distribution of pumping began to shift again, south of Highway 60.

The number of wells producing greater than 1,000 afy began to increase from FY 1977/78 through the present period. This was due to the increase in urbanization, which tends to concentrate production over fewer wells, compared to agricultural production. The construction and operation of the Chino Desalter wells, most of which produce more than 1,000 afy, also contributed to this increase.

Pumper	FY 1977/78 Production		FY 1999/00 Production		FY 2021/22 Production	
	af	percentage	af	percentage	af	percentage
Agricultural	87,800	55	44,200	25	14,500	9
Overlying Non-Agricultural	10,100	6	5,600	3	1,600	1
Appropriative	62,400	39	128,900	72	106,600	65
Chino Desalters	0	0	0	0	40,600	25
Total	**160,300**	**100**	**178,700**	**100**	**163,300**	**100**



The CDA is a Joint Powers Authority that operates and manages the Chino Desalters. CDA member agencies include the IEUA, the Jurupa Community Services District (JCSD), the Santa Ana River Water Company, the Western Municipal Water District, and the Cities of Chino, Chino Hills, Norco, and Ontario. Currently, the Chino Desalters consist of 26 wells that pump brackish groundwater from the southern portion of the Chino Basin, two facilities that treat the groundwater with reverse osmosis and ion exchange, a conveyance system to deliver treated water to its member agencies, and brine disposal. The most recently constructed well (II-12) began operation in 2021.

The need for the Chino Desalters was described in the OBMP Phase 1 Report. Throughout the 20th century, land uses in the southern portion of the Chino Basin were primarily agricultural. Over time, groundwater quality degraded in this area, and it is not suitable for municipal use unless it is treated to reduce TDS, nitrate, and other contaminant concentrations. The OBMP recognized that urban land uses would ultimately replace agriculture and that if municipal pumping did not replace agricultural pumping, groundwater levels would rise and discharge to the Santa Ana River. The potential consequences would be the loss of Safe Yield in the Chino Basin and the degradation of the quality of the Santa Ana River—the latter of which could impair downstream beneficial uses in Orange County. Mitigating the lost yield and the subsequent degradation of water quality would come with high costs to the Chino Basin Parties.

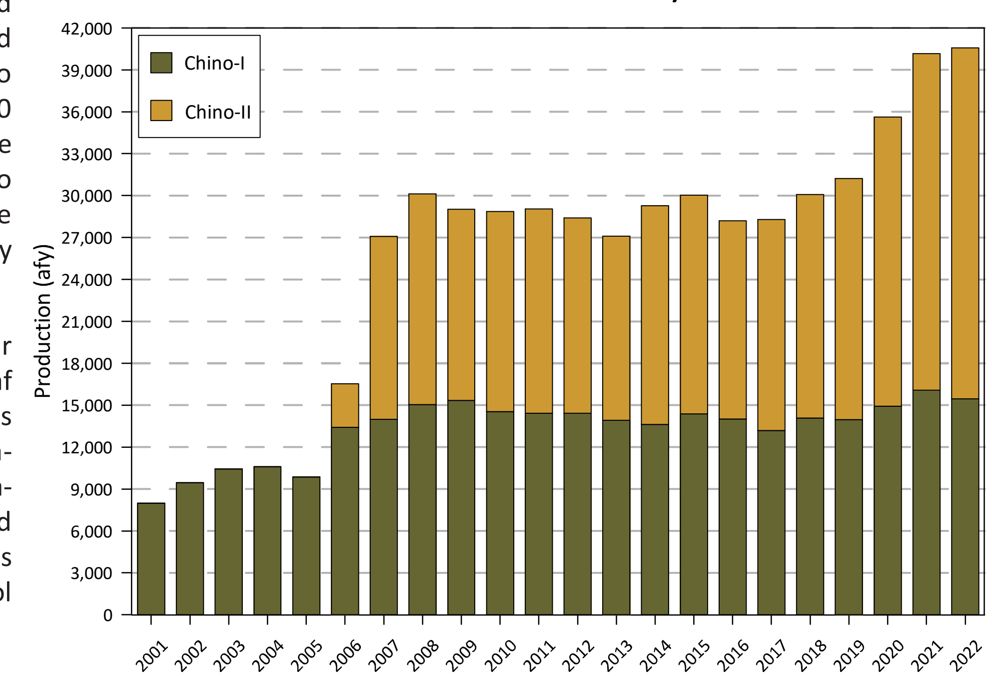
The Chino Desalters were designed to replace the expected decrease in agricultural production and accomplish the following objectives: meet emerging municipal demands in the Chino Basin, maintain or enhance Safe Yield, remove groundwater contaminants, and protect the beneficial uses of the Santa Ana River. Pursuant to the OBMP and the Peace Agreement, Watermaster's goal for desalter production was set at 40,000 afy.

The Chino Desalters also became a fundamental component of the maximum-benefit salt and nutrient management plan for the Chino Basin, which was written into the 2004 Water Quality Control Plan for the Santa Ana River Basin ([Basin Plan], California Regional Water Quality Control Board, Santa Ana Region [Regional Board], 2004)). The Basin Plan adopted maximum-benefit based water quality objectives in the Chino Basin, enabling the implementation of large-scale recycled-water reuse projects for direct reuse an indirect potable reuse in the Chino Basin. Watermaster and the IEUA made nine "maximum-benefit commitments," ensuring that beneficial uses in the Chino Basin will not be impaired by TDS and nitrate, and groundwater management in the Chino Basin will not contribute to the impairment of beneficial uses of the Santa Ana River. The operation of the Chino Desalters is necessary to attain "Hydraulic Control" in the southern portion of Chino Basin. Hydraulic Control is achieved by pumping at the Chino Desalter wells such that groundwater discharge from the Chino-North GMZ to the Santa Ana River is eliminated or reduced to de minimis levels. Hydraulic Control is necessary to maximize Safe Yield and to prevent degraded groundwater from discharging to the Santa Ana River. Four of the nine maximum-benefit commitments are related to the Chino Desalters and Hydraulic Control.

The Chino-I Desalter began operating in 2000 with a design capacity of 8 million gallons per day (mgd) (about 9,000 afy). In 2005, the Chino-I Desalter was expanded to 14 mgd (about 16,000 afy). The Chino-II Desalter began operating in June 2006 at a capacity of 15 mgd (about 17,000 afy). In 2012, the CDA completed construction of the Chino-I Desalter western Chino Creek Well Field (CCWF), and in early 2016, reached the level of production required to achieve Hydraulic Control with CCWF pumping. In 2015, the CDA completed the construction of two more wells (I-10 and I-11), and production at these wells started in mid-2018. In 2020, the CDA completed the construction of the last planned well (II-12) and pumping began in late 2021. In June 2020, the Chino Desalter wells reached the pumping capacity of 40,000 afy, thus, achieving the OBMP production goal to replace lost agricultural production. In FY 2021/22, the Chino Desalters pumped about 40,600 afy of groundwater. The chart herein shows annual groundwater production by the Chino Desalters.

Pursuant to the Peace II Agreement, Watermaster initiated additional controlled overdraft of 400,000 af through 2030, referred to as "Re-operation" which was allocated specifically to meet the replenishment obligation of the Chino Desalters (WEI, 2009b). An investigation conducted to evaluate the Peace II Agreement and desalter expansion concluded that Re-operation was required to ensure the attainment of Hydraulic Control (WEI, 2007c).

Chino Desalter Groundwater Production by Fiscal Year



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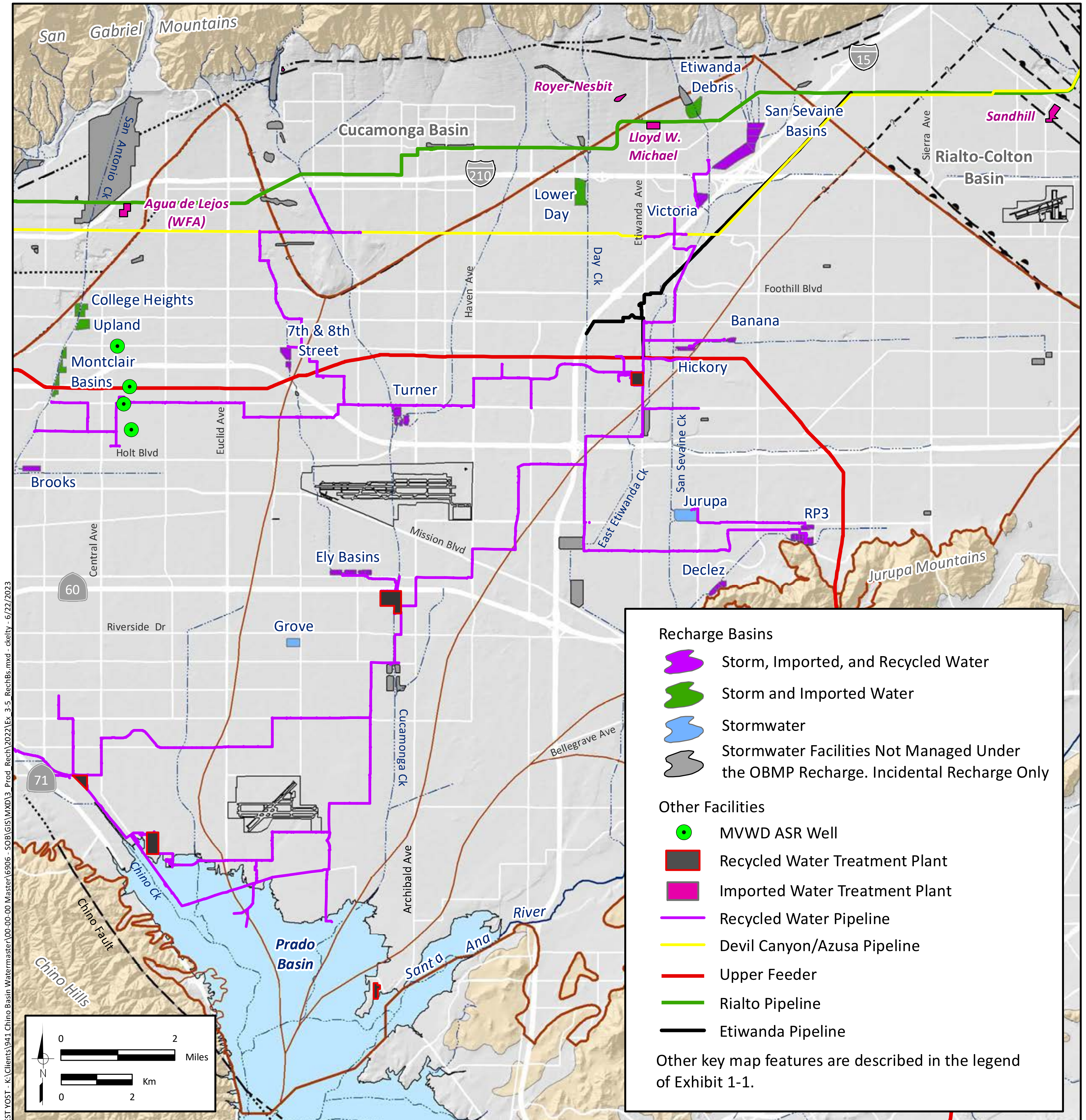
Chino Desalter Well Production

Exhibit 3-4



The recharge of recycled water, imported water, and storm water is an integral part of the OBMP Implementation Plan, and is necessary to maximize the use of the water resources of the Chino Basin. The IEUA, Watermaster, the Chino Basin Water Conservation District, and the San Bernardino County Flood Control District are partners in the planning and implementation of groundwater recharge projects in the Chino Basin. Existing recharge facilities are shown in the map to the left and include recharge basins, in-lieu recharge facilities, and Aquifer Storage and Recovery (ASR) wells. Not shown on the map are the municipal separate storm sewer system (MS4) facilities.

Recharge basins. Imported water, stormwater, dry-weather flow, and recycled water are recharged at 17 recharge basins. The IEUA and Watermaster have a permit from the Regional Board for recycled water recharge. Watermaster has permits from the State Water Resources Control Board (State Water Board) to divert stormwater and dry-weather flow to the basins for recharge and storage, and subsequently recover it for beneficial use.

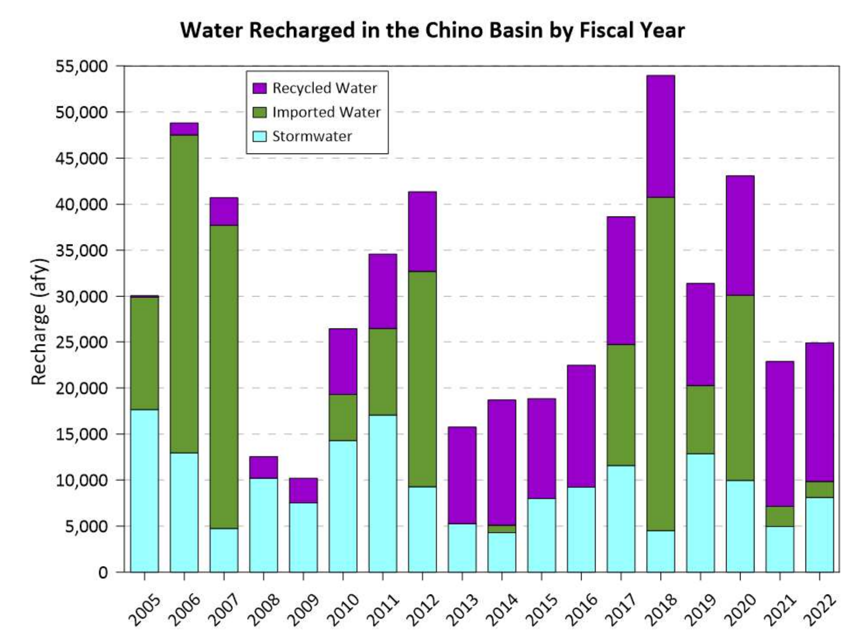
ASR wells. ASR wells are used to inject treated imported water into the Basin and to pump groundwater. The Monte Vista Water District (MVWD) owns and operates four ASR wells in the Chino Basin.

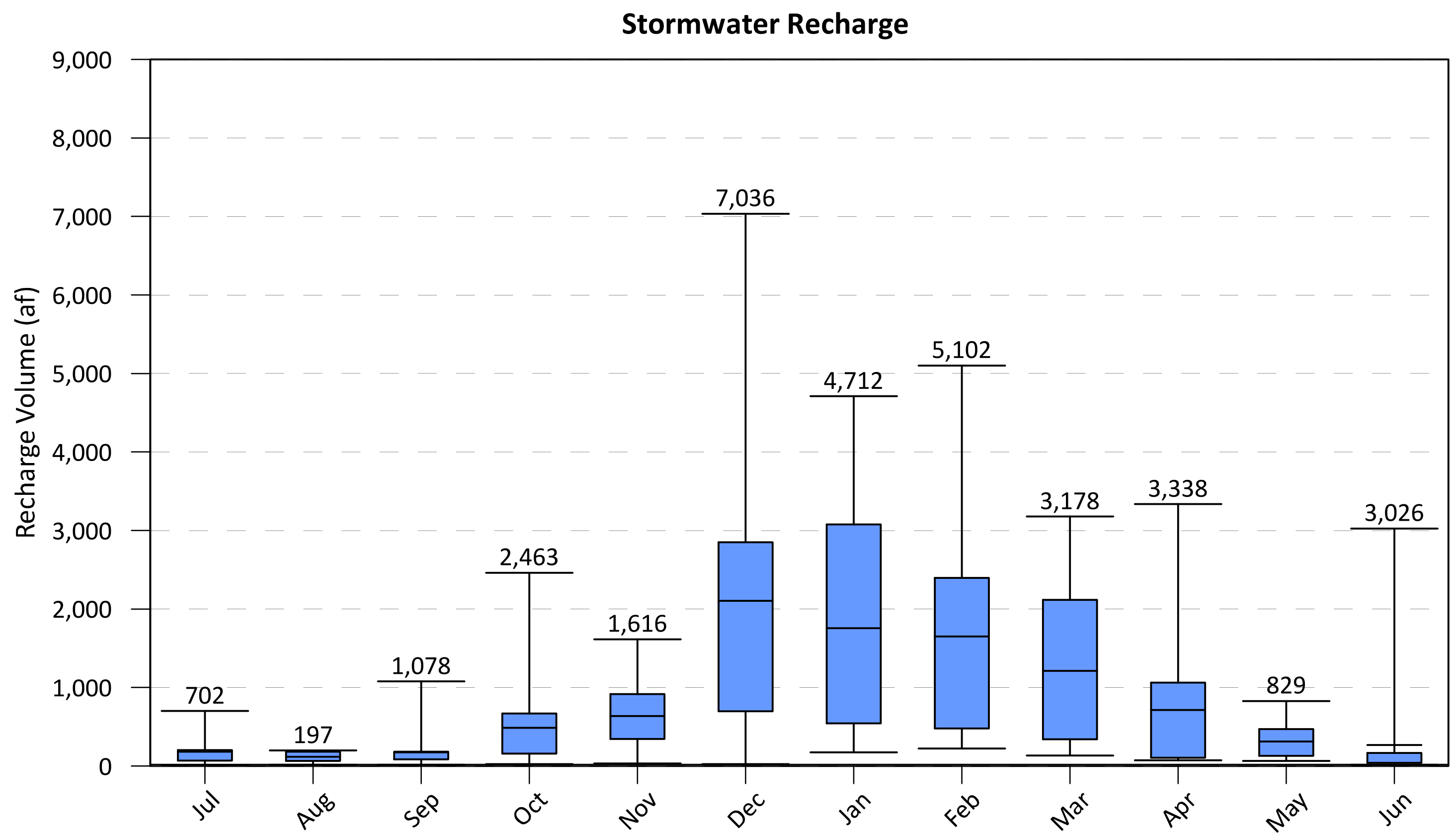
In-lieu recharge. In-lieu recharge can occur when a Party with pumping rights in the Chino Basin elects to use supplemental water directly in lieu of pumping some or all its rights for the specific purpose of recharging supplemental water.

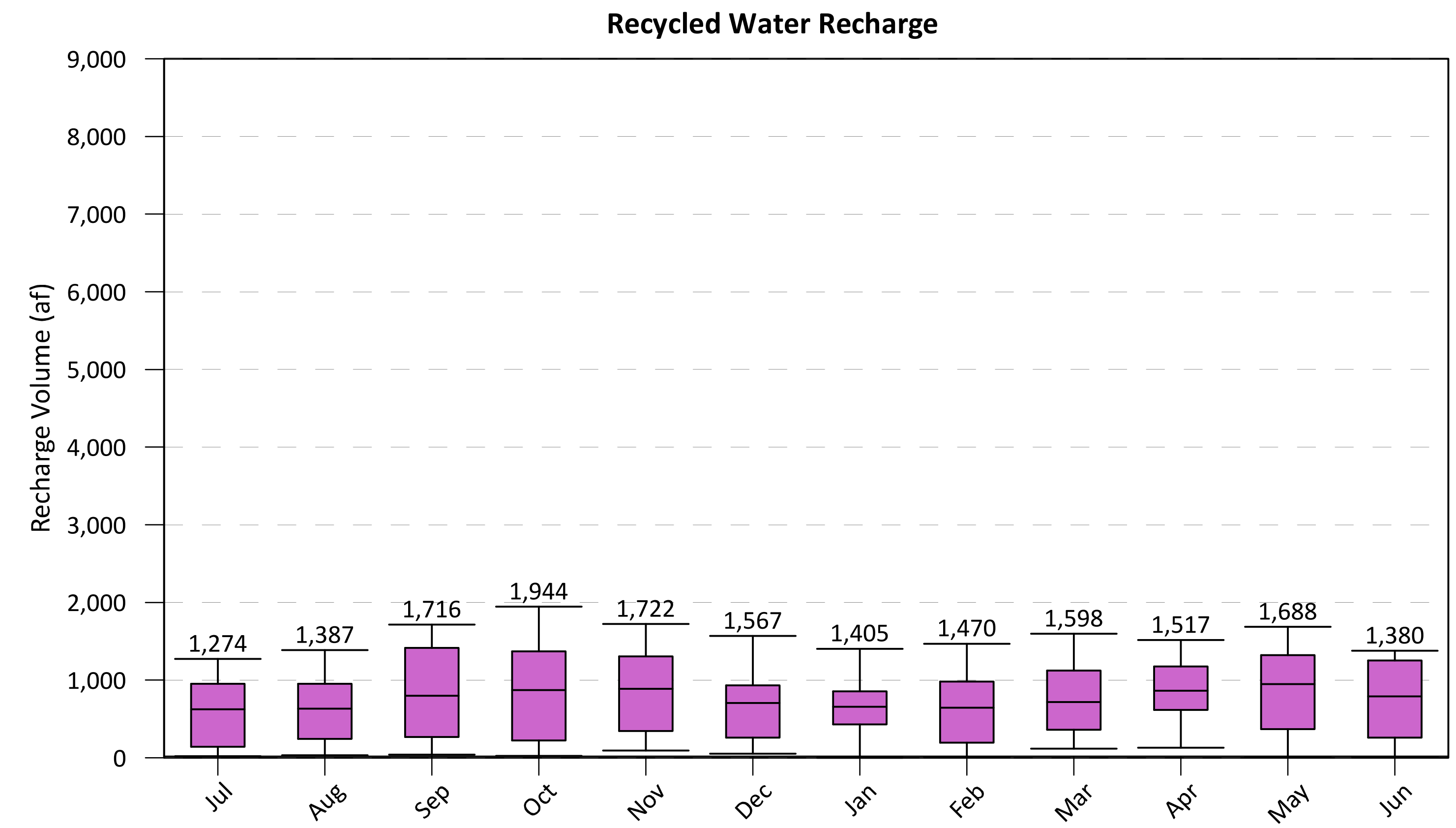
MS4 facilities. The 2013 RMPU implementation included a process to create and update a database of all known runoff management projects implemented through the MS4 permits in the Chino Basin. This was done to create the data necessary to evaluate the significance of new stormwater recharge created by MS4 projects. As of FY 2021/22, a total of 266 MS4 projects were identified as complying with the MS4 permit through infiltration features. These 266 projects have an aggregate drainage area of 3,836 acres.

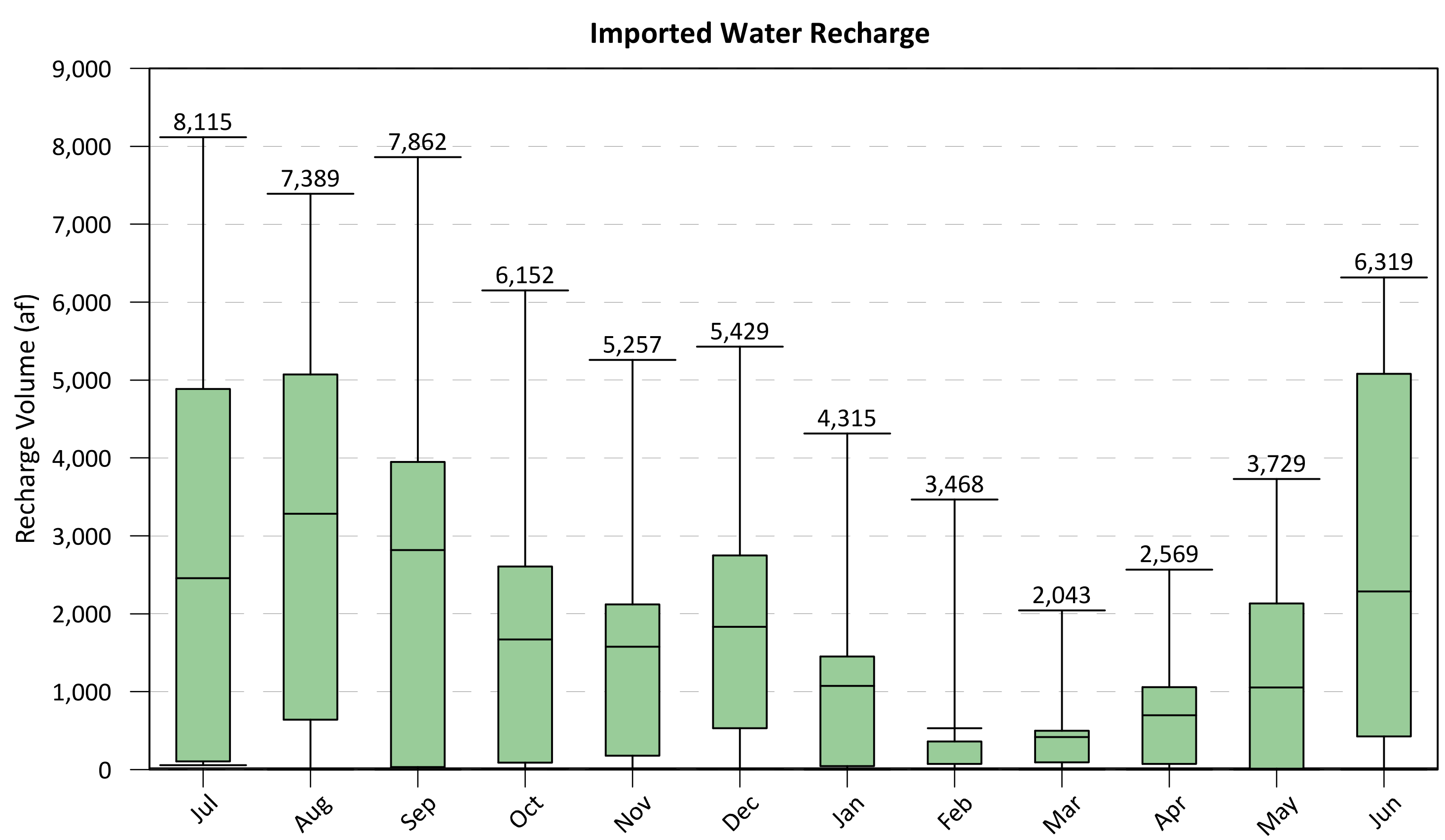
The chart below shows annual wet-water recharge at recharge basins and ASR wells by water type since the initiation of the recharge program in FY 2004/05 (dry-weather flow is included with stormwater). With OBMP implementation, recycled water has become a significant portion of annual recharge, totaling around 15,000 afy in FY 2021/22 and averaging about 13,600 afy over the past five years (40 percent of total recharge in the last five years). Recycled water recharge reduces the need for and dependence on imported water for replenishment.

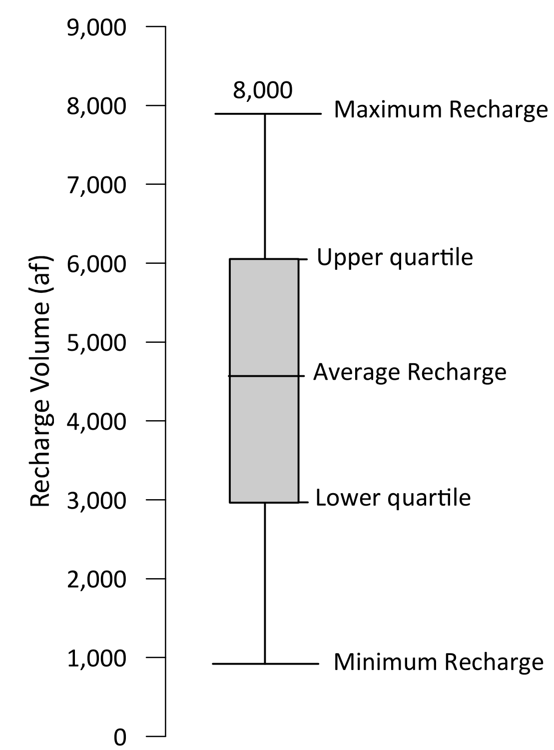
The annual magnitude of stormwater/dry-weather recharge at recharge basins fluctuates based on climate, and the annual magnitude of imported water recharge fluctuates based on the need for replenishment water, storage and recovery program operations (like DYYP), imported water availability, and other factors.











Recharge in the Chino Basin varies based on recharge water source and the seasonal changes in the availability of the water source. The distribution of monthly stormwater, recycled water, and imported water recharge volumes to the Chino Basin from FY 2004/05 through FY 2021/22 are plotted in the Box and Whisker Plots. There are three Box and Whisker Plots showing the minimum, lower quartile (the lower quartile represents the 25th percentile: 25 percent of the observed values are less than the lower quartile), average, upper quartile (the upper quartile represents the 75th percentile: 25 percent of the observed values are greater than the upper quartile), and maximum recharge volumes for each source.

The plots demonstrate that: stormwater recharge varies based on seasonal climate and precipitation with significant recharge occurring from December through March, when the average recharge volume is around 1,200 to 2,100 af; imported water recharge varies based on the need to supplement stormwater recharge with significant recharge occurring from June to September when the average recharge volume is around 2,300 to 3,300 af; recycled water recharge remains fairly consistent from month to month where the average recharge volume is around 700 af.

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Box and Whisker Diagram of Groundwater Recharge
Stormwater and Supplemental Water
Fiscal Year 2004/05 to Fiscal Year 2021/22

Exhibit 3-6

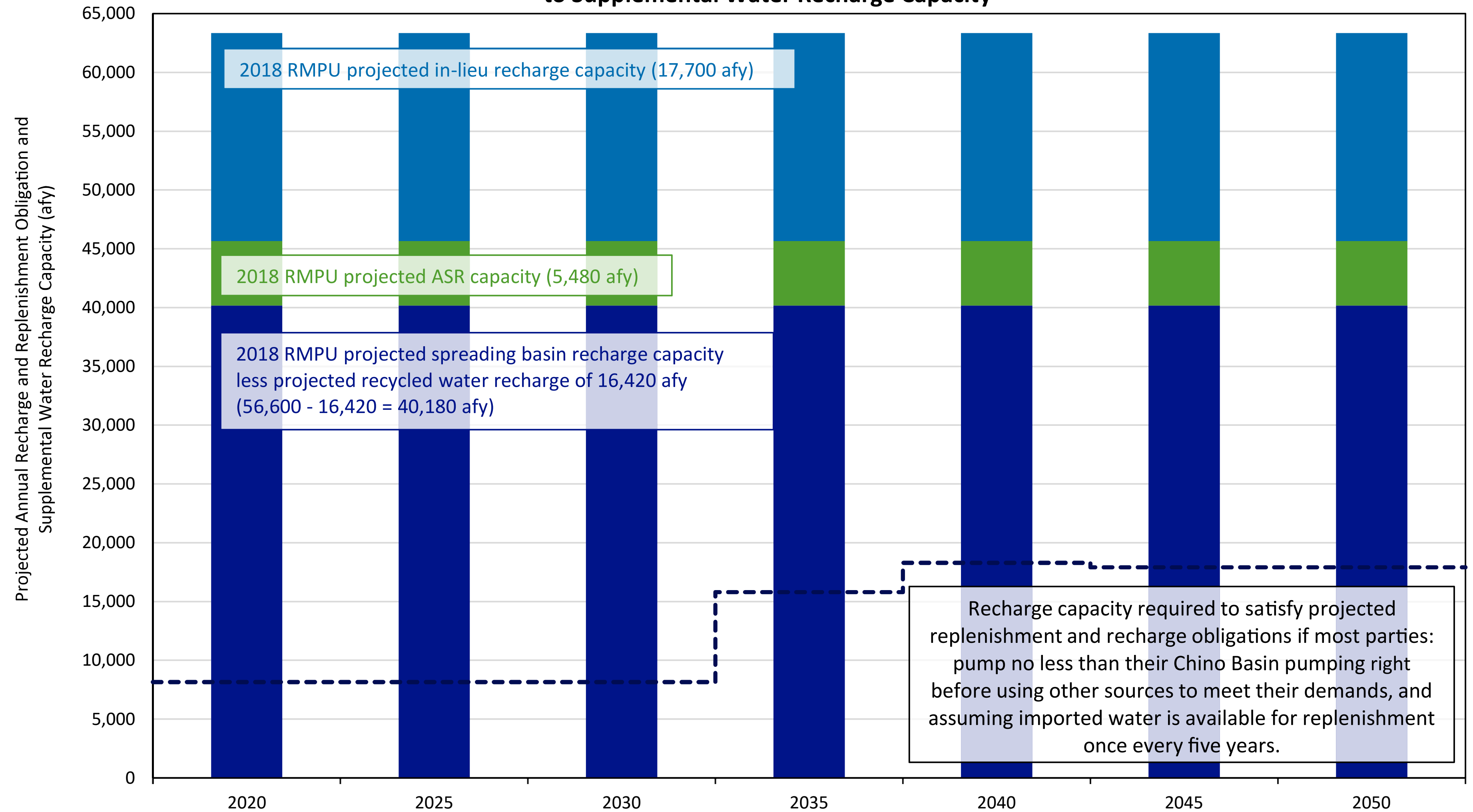
Estimated Annual Recharge Capacities in the Chino Basin (af)

Water Type	Recharge Type	Current Conditions	Current Conditions Plus Pending Recommended 2013 RMPU Projects
Stormwater	Average Stormwater Recharge in Spreading Basins	9,950	14,700
	Average Expected Recharge of MS4 Projects	840	840
	Subtotal	*10,790*	*15,540*
Supplemental Water (Recycled and Imported Water)	Supplemental Water Recharge in Spreading Basins	56,600	56,600
	ASR Injection	5,480	5,480
	In-Lieu	13,700	13,700
	Subtotal	*75,780*	*75,780*
	Total	**86,570**	**91,320**

The table above summarizes the recharge capacity under existing conditions. Stormwater recharge varies by year, based on hydrologic conditions, and averaged about 9,950 afy during the period FY 2004/05 through FY 2021/22 (period of available historical data). The net new stormwater recharge from MS4 projects is estimated to average about 380 afy (WEI, 2018). Supplemental water (i.e., imported and recycled water) recharge in recharge basins occurs during non-storm periods. The recharge capacity available for supplemental water recharge to basins varies from year to year based on the amount of stormwater recharge. The supplemental water recharge capacity at basins is projected to average about 56,600 afy (WEI, 2018). The ASR and in-lieu recharge capacities are estimated to be about 5,480 afy and 13,700 afy, respectively (WEI, 2018).

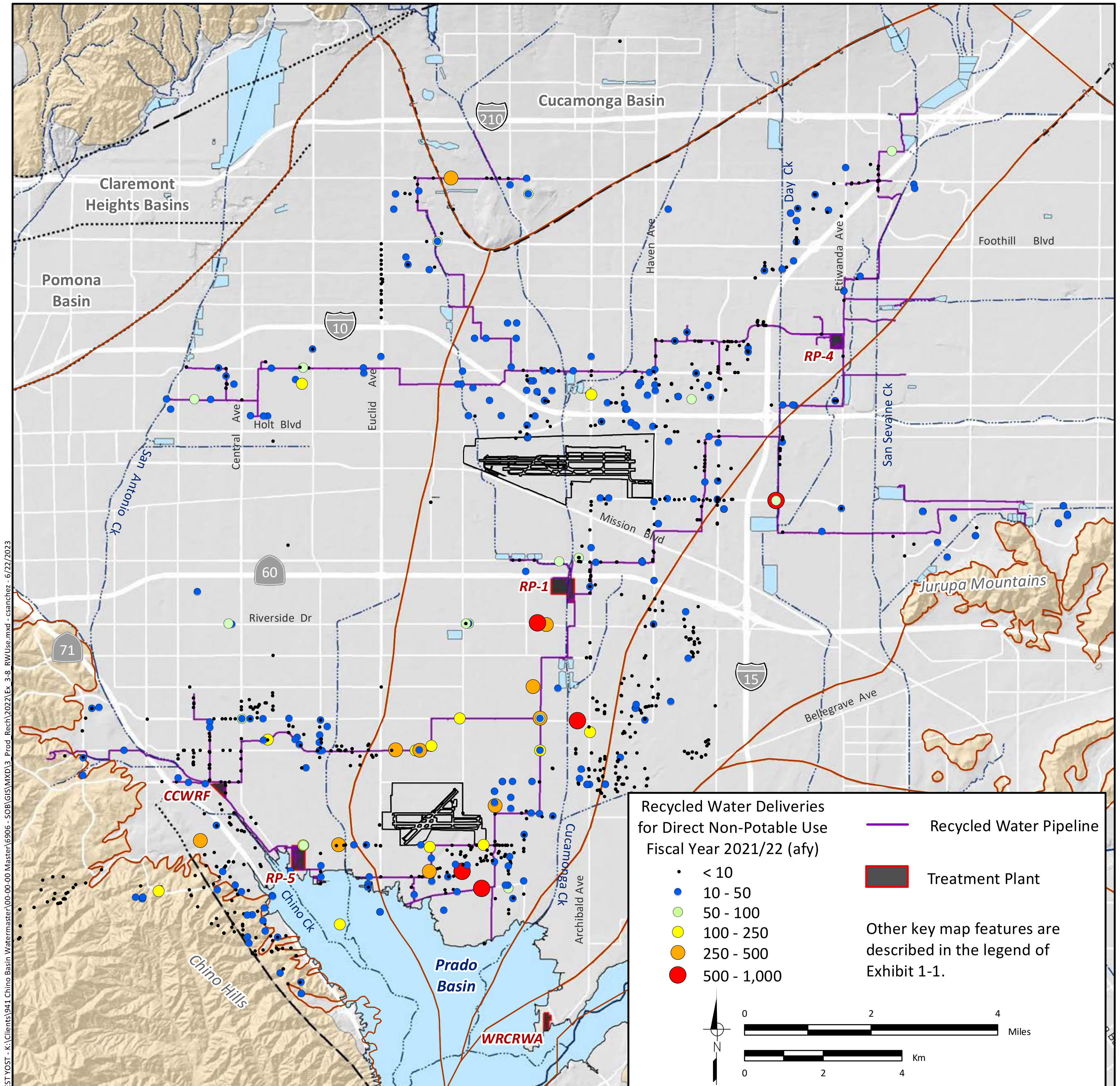
The initial OBMP recharge master plan was developed in 2002; its current version is the 2018 Recharge Master Plan Update (2018 RMPU) (WEI, 2018). No capital projects were selected as part of the 2018 RMPU process. However, the five projects selected for implementation in the 2013 RMPU are currently being implemented and involve improvements to existing recharge facilities and the construction of new facilities that, in aggregate, will increase the recharge of stormwater and dry-weather flow by 4,900 afy and increase recycled water recharge capacity by 7,100 afy. Pursuant to the Peace II Agreement, Watermaster and the IEUA update their recharge master plan on a five-year frequency with the next plan scheduled to be completed in October 2023.

Comparison of Projected Annual Recharge and Replenishment Obligation to Supplemental Water Recharge Capacity



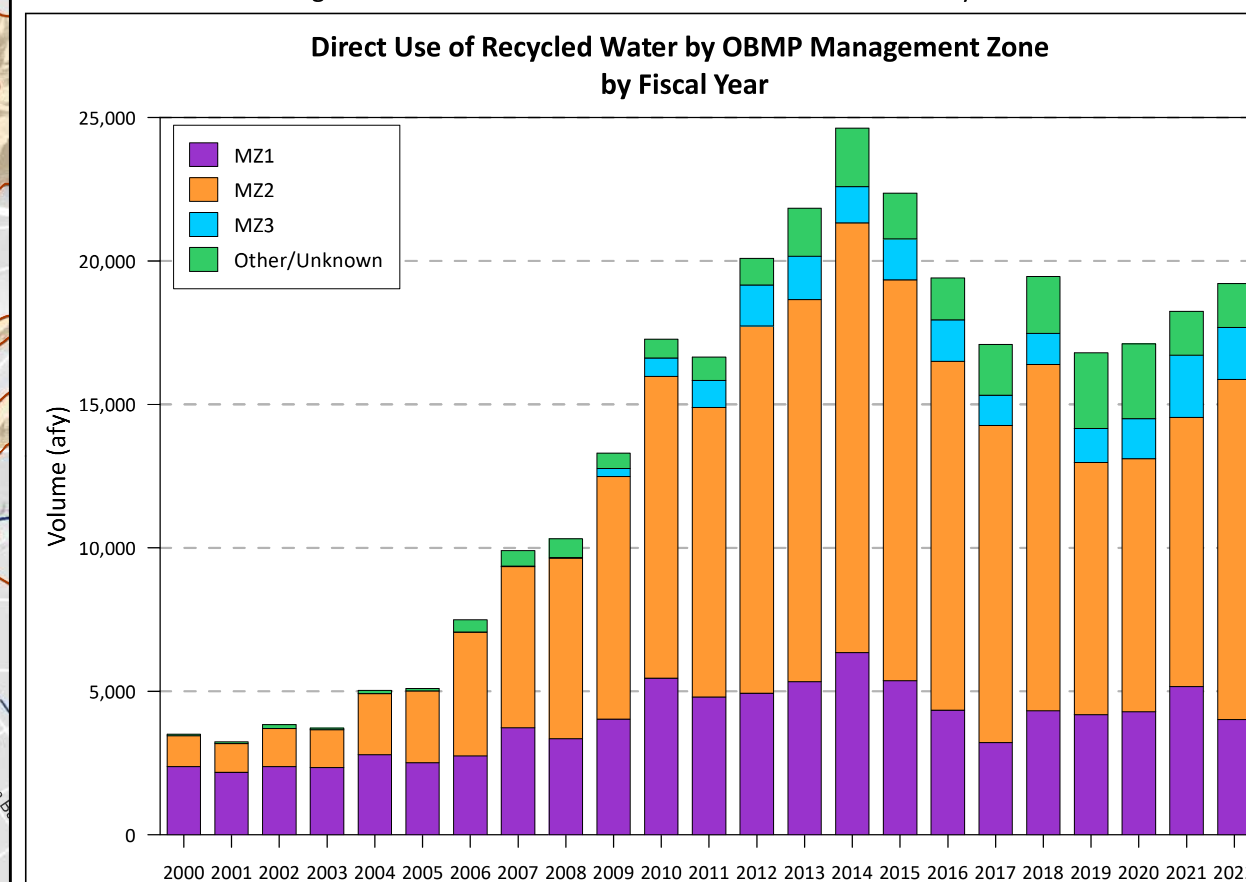
Future supplemental water recharge capacity requirements are estimated by assessing projections of the availability of supplemental water for recharge and replenishment obligation. Recycled water is assumed 100-percent reliable, and therefore the recharge capacity requirement to recharge recycled water is assumed equal to its projected supply. The imported water supply from Metropolitan, which is sourced entirely from the State Water Project (SWP) water, is assumed to be 20 percent reliable (i.e., once every five years). The chart above shows: the projected recharge capacity available at recharge basins less that used for recycled water recharge, in-lieu recharge capacity, and ASR recharge capacity as a stacked bar chart—the total supplemental capacity being the sum of these recharge capacities. The chart also shows the time history of the supplemental water recharge capacity required to recharge imported water from Metropolitan.

As the chart above shows, Watermaster and the IEUA are projected to have enough recharge capacity available to meet all of their recharge and replenishment obligations through 2050.



Increasing recycled water reuse is an integral part of the OBMP's goal to enhance water supplies. The direct use of recycled water increases the availability of native and imported waters for higher-priority beneficial uses. The 2004 Basin Plan incorporated the maximum-benefit based salt and nutrient management program for the Chino Basin, as an innovative regulatory construct that enabled an aggressive expansion of recycled water reuse in the Chino Basin. The IEUA owns and operates four treatment facilities: Regional Plant No. 1 (RP-1), Regional Plant No. 4 (RP-4), Regional Plant No. 5 (RP-5), and the Carbon Canyon Water Reclamation Facility (CCWRF). And, the IEUA has progressively built infrastructure to deliver recycled water to all of its member agencies throughout much of the Chino Basin. The map to the left shows the existing recycled water pipelines and areas of recycled water reuse by volumes during FY 2021/22.

This graph below characterizes the direct use of recycled water in the Chino Basin from FY 1999/00 through FY 2021/22. Recycled water from the IEUA's facilities is reused directly for: irrigation of crops, animal pastures, freeway landscape, parks, schools, golf courses, commercial laundry, car washes outdoor cleaning, construction, toilet plumbing, and industrial processes. Prior to 1997, there was minimal reuse of recycled water. Recycled water reuse started in 1997 after the completion of the conveyance facilities from the CCWRF to the Cities of Chino and Chino Hills. The direct use of recycled water has increased significantly since OBMP implementation began from about 3,500 afy in FY 1999/00 to a maximum of about 24,600 afy in FY 2013/14. Recycled water reuse was 19,200 afy in FY 2021/22. The decline in direct reuse of recycled water since FY 2013/14 is a result of the reduced water use during the drought and state-mandated water conservation programs, reducing the amount of recycled water reused and wastewater generated from households that can be treated for recycled water reuse.



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Recycled Deliveries for Direct Use

Exhibit 3-8

GROUNDWATER LEVELS

The exhibits in this section show the physical state of the Chino Basin for groundwater levels during the implementation of the Judgment and the OBMP. The groundwater-level data used to generate these exhibits were collected and compiled as part of Watermaster's groundwater-level monitoring program.

Prior to OBMP implementation, there was no formal groundwater-level monitoring program in the Chino Basin. Problems with historical groundwater-level monitoring included an inadequate areal distribution of wells that were monitored, short time histories, questionable data quality, and insufficient resources to develop and conduct a comprehensive program. The OBMP defined a new, comprehensive, basin-wide groundwater-level monitoring program pursuant to OBMP *PE 1 – Develop and Implement a Comprehensive Monitoring Program* to support the activities in other Program Elements, such as OBMP *PE 4 – Develop and Implement a Comprehensive Groundwater Management Plan for Management Zone 1*. The monitoring program has been refined over time to increase efficiency and to satisfy the evolving needs of Watermaster and the IEUA, such as new regulatory requirements.

Currently, the groundwater-level monitoring program supports many Watermaster functions, such as the periodic reassessment of Safe Yield, the monitoring and management of land subsidence, and the assessment of Hydraulic Control. The data are also used to update and re-calibrate Watermaster's groundwater-flow model, to understand directions of groundwater flow, to estimate storage changes, to interpret groundwater-quality data, to identify areas of the Basin where recharge and discharge are not in balance, and to monitor changes in groundwater levels in the Prado Basin where riparian vegetation is consumptively using shallow groundwater.

Exhibit 4-1 shows the locations and measurement frequencies of all wells currently in Watermaster's groundwater-level monitoring program. The groundwater-level data collected at key wells in the monitoring program were used to create groundwater-elevation contour maps for the shallow aquifer-system in the Chino Basin for spring 2000 (Exhibit 4-2), spring 2020 (Exhibit 4-3), and spring 2022 (Exhibit 4-4). These contour maps indicate the direction of groundwater flow, which is perpendicular to the contours from high elevations to low elevations. Rasters of groundwater elevation were subtracted from each other to show how groundwater levels have changed during OBMP implementation. Exhibit 4-5 shows the change from spring 2000 to spring 2022—the total 22-year period of OBMP implementation. Exhibit 4-6 shows the change from spring 2020 to spring 2022—the two-year period since the last State of the Basin analysis. The changes in groundwater levels are illustrative of changes in groundwater storage.

Exhibits 4-7 and 4-8 address the state of Hydraulic Control in the southern portion of Chino Basin in 2000 and 2022, respectively. Achieving "Hydraulic Control" is an important objective of Watermaster, the IEUA, and the Regional Board. Hydraulic Control is achieved when groundwater discharge from the Chino-North GMZ to Prado Basin is eliminated or reduced to *de minimis* levels. *De minimis* discharge is defined as less than 1,000 afy. The Regional Board made achieving Hydraulic Control a commitment for Watermaster and the IEUA in the Basin Plan (Regional Board, 2004) in exchange for relaxed groundwater-quality objectives in Chino-North GMZ. These objectives, called "maximum-benefit" objectives, allow for the implementation of recycled-water reuse in the Chino Basin for both direct use and recharge while simultaneously assuring the protection of the beneficial uses of the Chino Basin and the Santa Ana River. Achieving Hydraulic Control also maintains the yield of the Chino Basin by lowering groundwater levels in its southern portion, which controls outflow as rising groundwater to the Santa Ana River, and enhances streambed recharge of the Santa Ana River to the Chino Basin. These exhibits include a brief interpretation of the state of Hydraulic Control. For an in-depth discussion of Hydraulic Control, see *Chino Basin Maximum Benefit Monitoring Program 2022 Annual Report* (West Yost, 2023a).

Exhibit 4-9 shows the location of selected wells across the Chino Basin that have long time-histories of water level measurements. The time-histories describe long-term trends in groundwater levels in the GMZs. The wells were selected based on geographic location within the GMZ, well-screen interval, and the length, density, and quality of the water-level records. Exhibits 4-10 through 4-14 are water-level time-series charts for these wells grouped by GMZ for the period of 1978 to 2022. These exhibits compare the behavior of groundwater levels to trends in precipitation, groundwater production, and recharge, which reveal cause-and-effect relationships.

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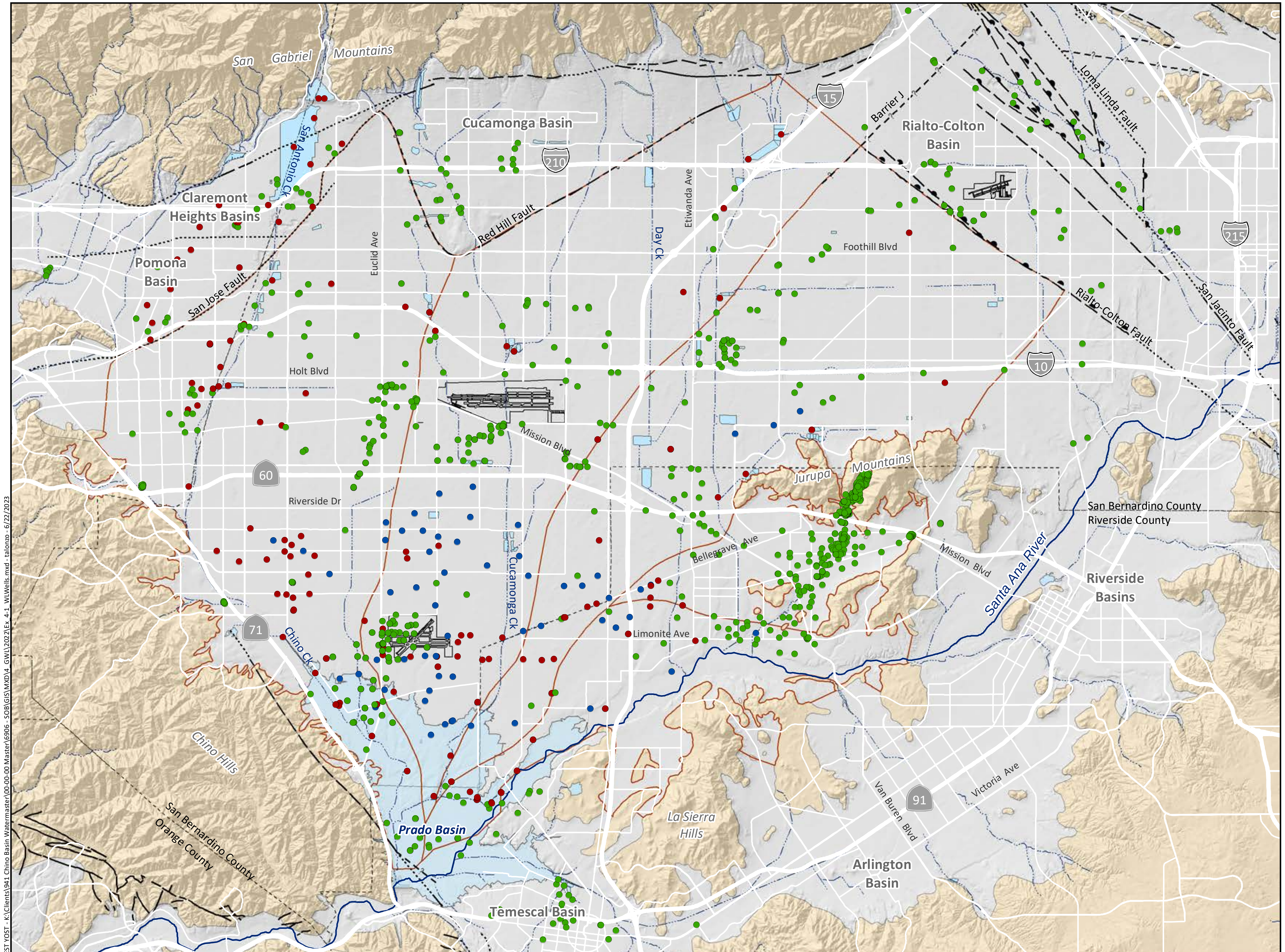

Basin-Wide Groundwater-Level Monitoring Program
Wells symbolized by Measurement Frequency

- Monthly Measurement by Watermaster Staff (59 wells)
- Measurement by Transducer - Every 15 Minutes (169 wells)
- Measurement by Owner at Various Frequencies (1,130 wells)

Other key map features are described in the legend of Exhibit 1-1.

To support OBMP implementation, Watermaster conducts a comprehensive groundwater-level monitoring program. In FY 2021/22, about 1,360 wells comprised Watermaster's groundwater-level monitoring program. At about 1,130 of these wells, well owners measure water levels and provide the data to Watermaster. These well owners include municipal water agencies, private water companies, the California Department of Toxic Substance Control (DTSC), the County of San Bernardino, and various private consulting firms. The remaining 200 wells are private or dedicated monitoring wells that are mostly located in the southern portion of the Basin. Watermaster staff measures water levels at these wells once a month or with pressure transducers that record water levels once every 15 minutes. These wells were preferentially selected to support Watermaster's monitoring programs for Hydraulic Control, Prado Basin habitat sustainability, land subsidence, and others. All groundwater-level data are collected, compiled, and checked by Watermaster staff, and uploaded to a centralized relational database that can be accessed online through HydroDaVE^{SM}.

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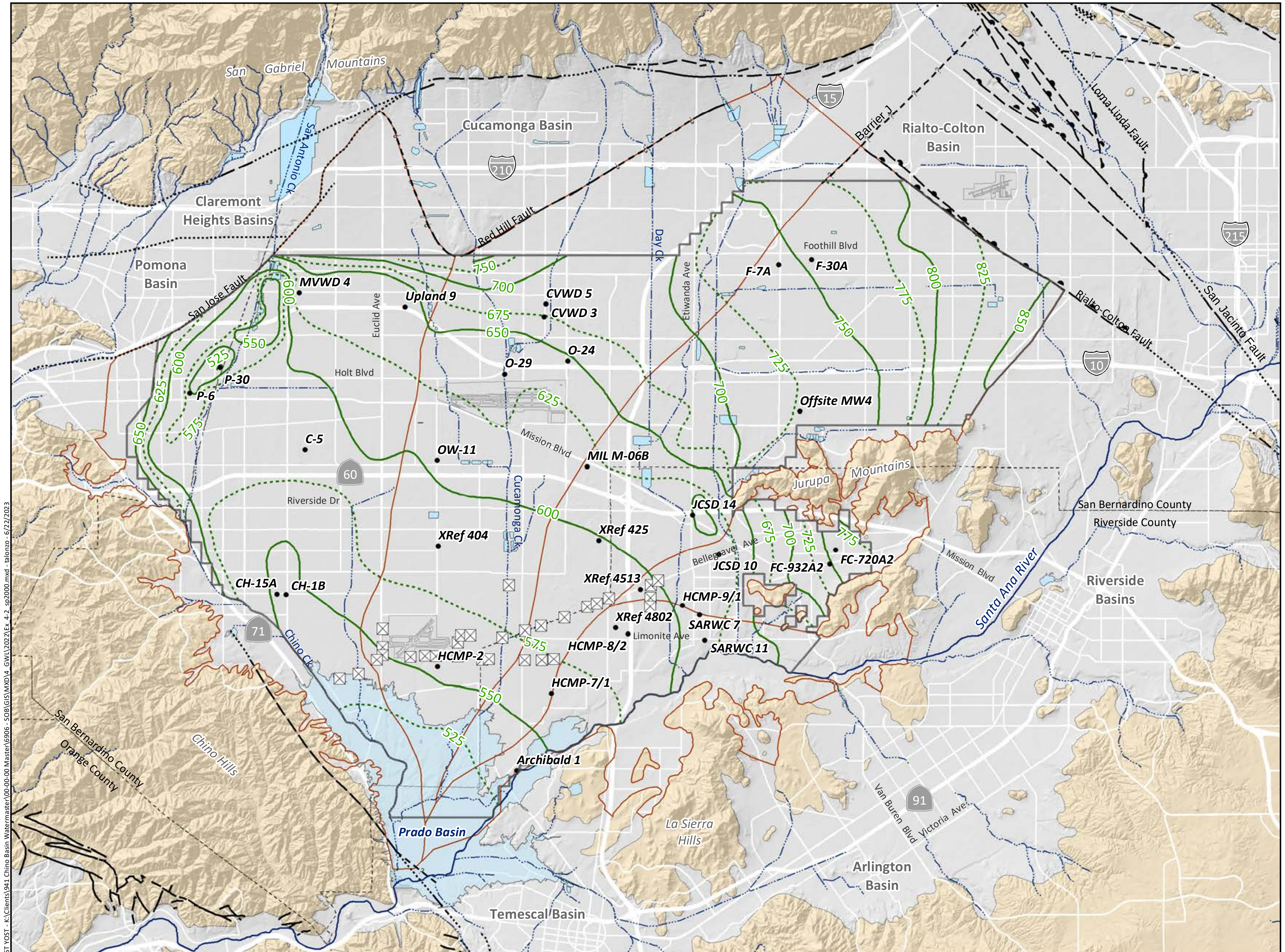
Groundwater-Level Monitoring Network
Well Location and Measurement Frequency
During Fiscal Year 2021/22

Exhibit 4-1



800 / 775 Groundwater-Elevation Contours (feet above mean sea-level)

Boundary of Contoured Area (contours are not shown outside of this boundary due to lack of groundwater-level data)

Well With a Groundwater-Level Time History Plotted in Exhibits 4-10 through 4-14

Chino Desalter Well

Other key map features are described in the legend of Exhibit 1-1.

This map displays contours of equal groundwater elevation across the Chino Basin during the spring of 2000—just prior to OBMP implementation. Two distinct aquifer- systems exist in Chino Basin: a shallow, unconfined to semi-confined aquifer- system and a deeper, confined aquifer- system. The groundwater elevations shown on this map (and Exhibits 4-3, 4-4, 4-7, and 4-8) were drawn based on measured groundwater levels within the shallow aquifer- system.

Groundwater flows from higher to lower elevations, with flow direction perpendicular to the contours. The groundwater-elevation contours on this map indicate that in 2000 groundwater was flowing in a south-southwest direction from the primary areas of recharge in the northern parts of the Basin toward the Prado Basin in the south. There were notable pumping depressions in the groundwater-level surface that interrupted the general flow patterns in the northern portion of MZ1 (Montclair and Pomona areas) and directly west of the Jurupa Mountains (near the JCSD's main well field). Pumping at the Chino Desalter wells had not yet begun in the spring

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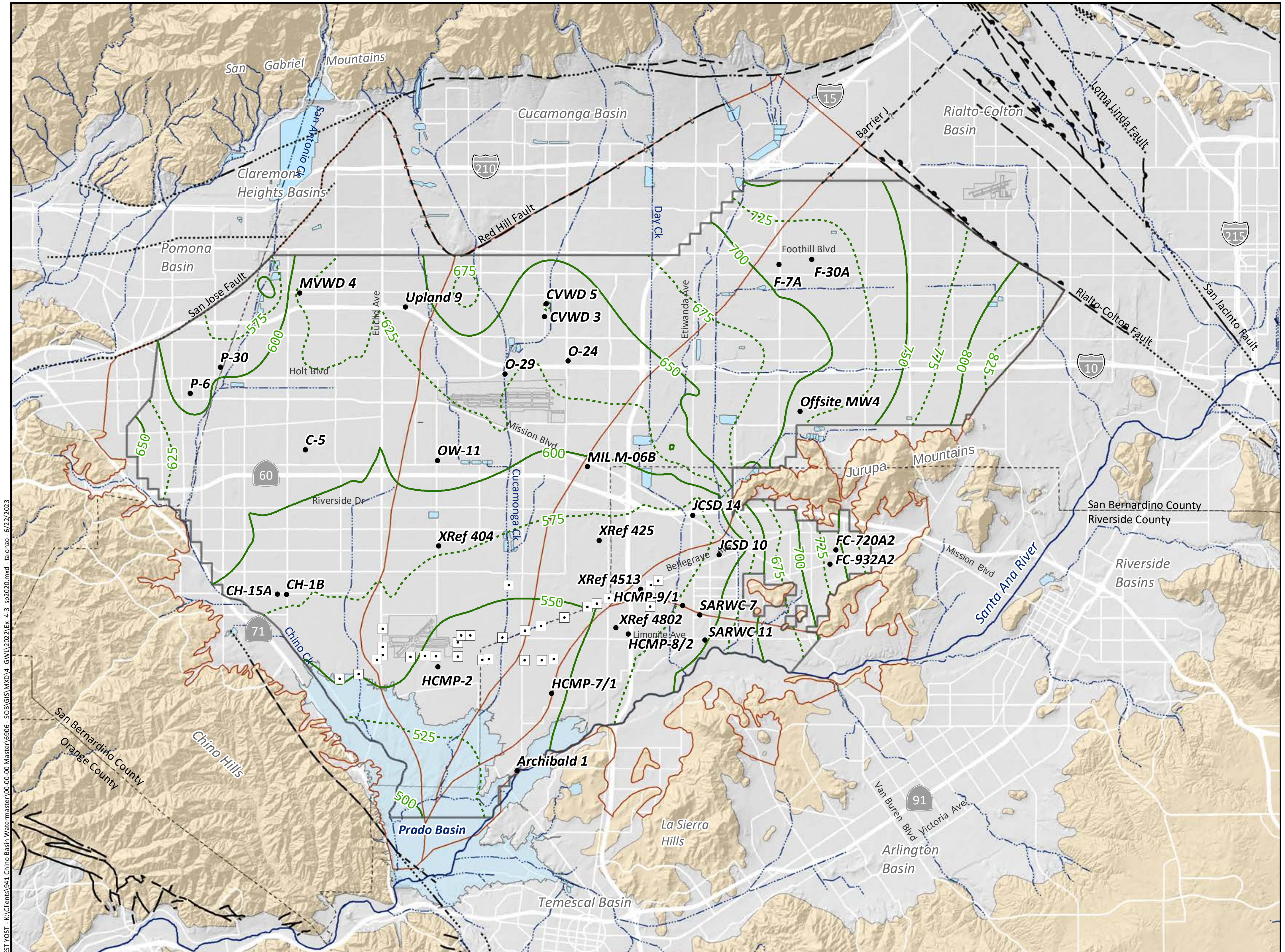
Groundwater-Elevation Contours for Spring 2000
Shallow Aquifer System

Exhibit 4-2



Groundwater-Elevation Contours (feet above mean sea-level)

Boundary of Contoured Area (contours are not shown outside of this boundary due to lack of groundwater-level data)

Well With a Groundwater-Level Time History Plotted on Exhibits 4-10 through 4-14

Chino Desalter Well

Other key map features are described in the legend of Exhibit 1-1.

This map displays contours of equal groundwater elevation across the Chino Basin during the spring of 2020, showing the effects of about 20 years of OBMP implementation. There was a large increase in the data available for this contouring effort—nearly twice as many wells were monitored in 2020 as were monitored in 2000. As with Exhibit 4-2, the groundwater elevation contours indicate that groundwater was flowing in a south-southwest direction from the primary areas of recharge in the northern parts of the Basin toward the Prado Basin in the south. There is a discernible depression in groundwater levels around the eastern portion of the Chino Desalter well field, which demonstrates that Hydraulic Control is achieved in this area. This depression has merged with the pumping depression around the JCSD well field to the east and has increased the hydraulic gradient from the Santa Ana River toward the desalter well field. As was the case in 2000, there continued to be a notable pumping depression in the groundwater-level surface in the northern portion of MZ1 (Montclair and Pomona areas).

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0 2 4 Miles
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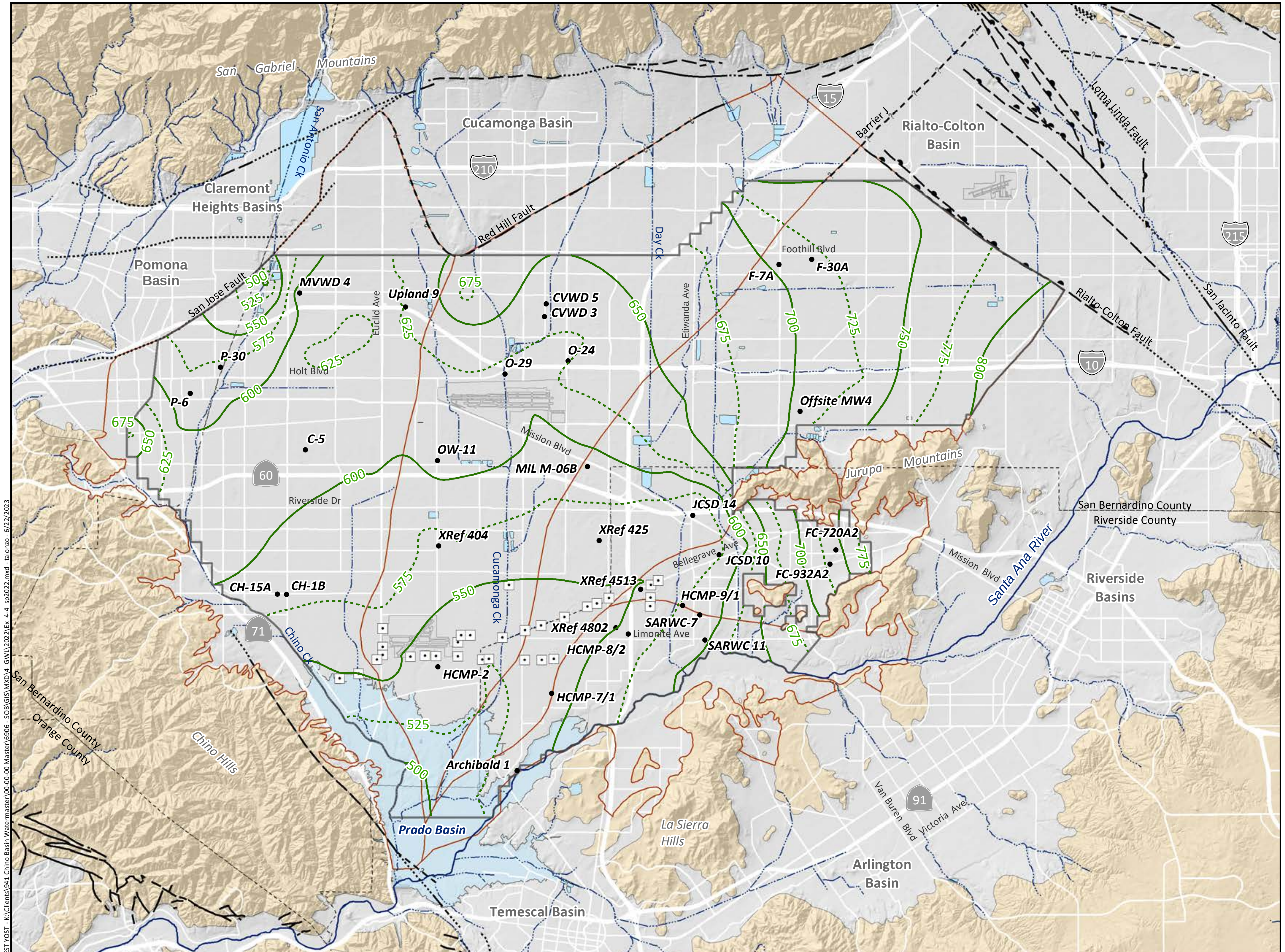
Groundwater-Elevation Contours for Spring 2020
Shallow Aquifer System

Exhibit 4-3



800 775 Groundwater-Elevation Contours (feet above mean sea-level)

Boundary of Contoured Area (contours are not shown outside of this boundary due to lack of groundwater-level data)

Well With a Groundwater-Level Time History Plotted on Exhibits 4-10 through 4-14

Chino Desalter Well

Other key map features are described in the legend of Exhibit 1-1.

This map displays contours of equal groundwater elevation across the Chino Basin during the spring of 2022, showing the effects of about 22 years of OBMP implementation. The contours are generally consistent with the groundwater-elevation contours for spring 2020, indicating regional groundwater flow in a south-southwest direction from the primary areas of recharge in the northern parts of the Basin toward the Prado Basin in the south. There continued to be a discernible depression in groundwater levels around the eastern portion of the Chino Basin Desalter well field, which demonstrates the achievement of Hydraulic Control in this area. This depression merged with the pumping depression around the JCSD well field to the east and increased the hydraulic gradient from the Santa Ana River toward the Chino Desalter well field. As was the case in 2000 and 2020, there continues to be a notable pumping depression in the groundwater-level surface in the northern portion of MZ1 (Montclair and Pomona areas).

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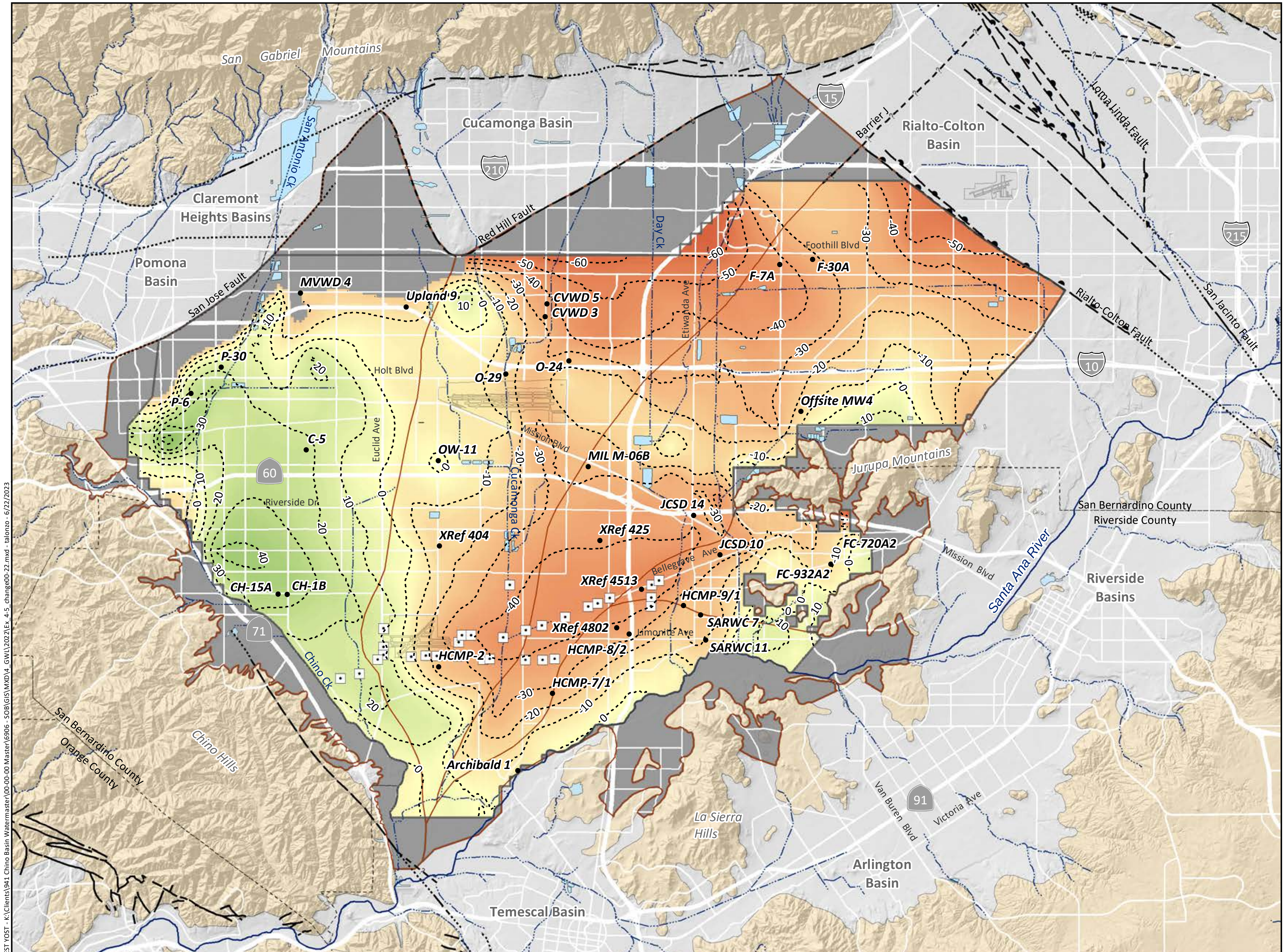
Groundwater Levels

Groundwater-Elevation Contours for Spring 2022
Shallow Aquifer System

Exhibit 4-4



Contour of Groundwater-Level Change (ft) Spring 2000 to Spring 2022

Groundwater-Level Change Spring 2000 to Spring 2022

+100ft — Increase

-100ft — Decrease

Area Not Included in the Change Calculation Due to a Lack of Groundwater-level Data

Well With a Groundwater-Level Time History Plotted on Exhibits 4-10 through 4-14

Chino Desalter Well

Other key map features are described in the legend of Exhibit 1-1.

This map shows the change in groundwater elevation during the 22-year period of OBMP implementation: spring 2000 to spring 2022. This map was created by subtracting a rasterized grid created from the groundwater elevations for spring 2000 (Exhibit 4-2) from a rasterized grid created from the groundwater elevations for spring 2022 (Exhibit 4-4).

Groundwater levels have increased in the western portion of the Basin. Groundwater levels have decreased in the central and eastern portions of the Basin and around the eastern portion of the Chino Desalter well field in the south. The changes in groundwater elevation shown here are consistent with projections from Watermaster's groundwater modeling efforts (WEI, 2003a; 2007c; 2014a; 2015; 2020) that simulated changes in the groundwater levels and flow patterns from the production and recharge strategies described in the Judgment, OBMP, Peace Agreement, and Peace II Agreement. These strategies include: desalter production in the southern portion of the Basin; controlled overdraft through Basin Re-operation to achieve Hydraulic Control; subsidence management in MZ1; mandatory recharge of Supplemental Water in MZ1 to improve the balance of recharge and discharge; and facilities improvements to enhance the recharge of storm, recycled, and imported waters.

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0 2 4 Miles

0 2 4 Km

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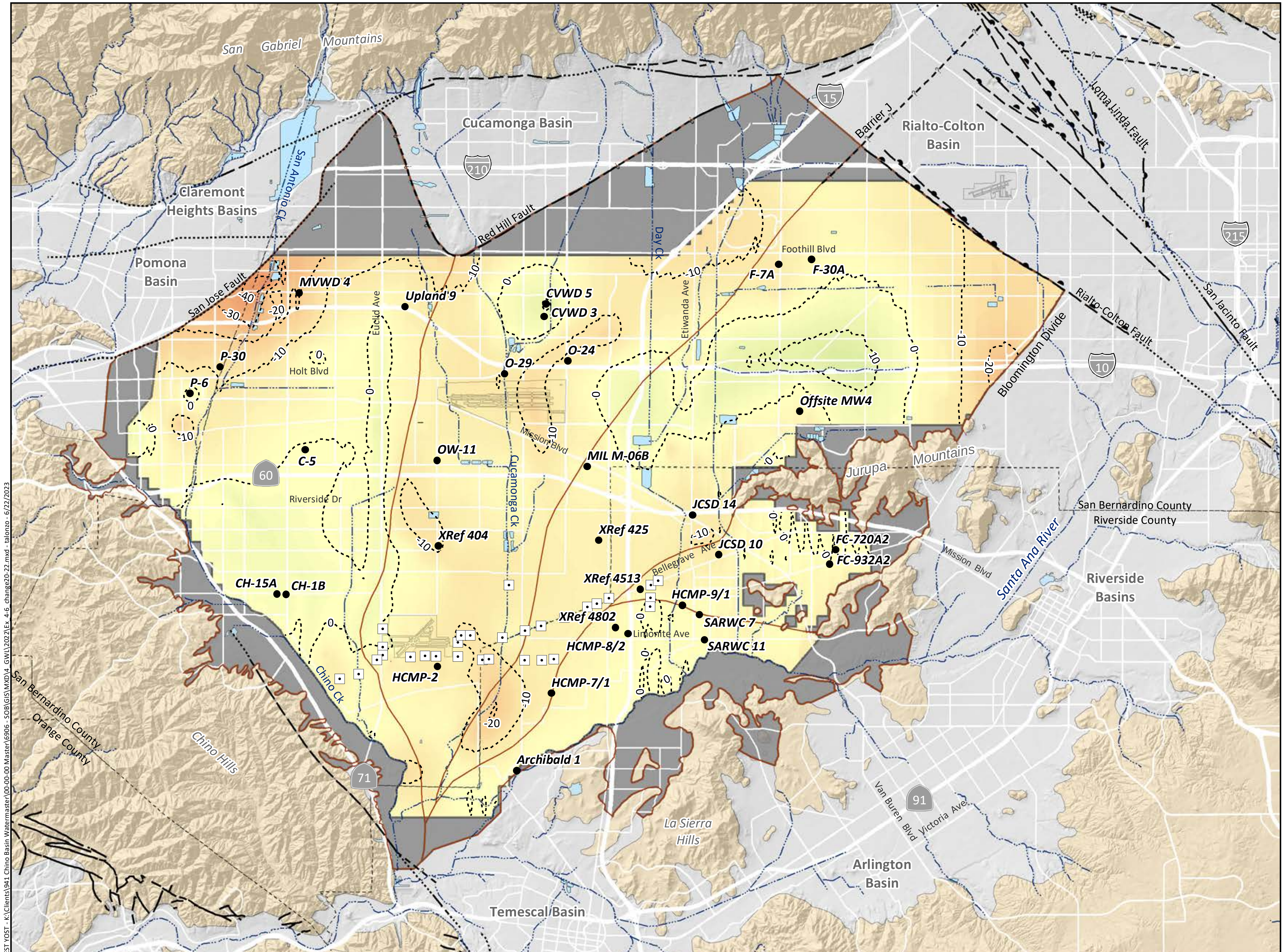
Groundwater-Level Change from Spring 2000 to Spring 2022
Shallow Aquifer System

Exhibit 4-5



Contour of Groundwater-Level Change (ft) Spring 2020 to Spring 2022

Groundwater-Level Change Spring 2020 to Spring 2022

+100ft — Increase

-100ft — Decrease

Area Not Included in the Change Calculation Due to a Lack of Groundwater-Level Data

Well With a Groundwater-Level Time History Plotted on Exhibits 4-10 through 4-14

Chino Desalter Well

Other key map features are described in the legend of Exhibit 1-1.

This map shows the change in groundwater elevation for the two-year period since the last State of the Basin Report: spring 2020 to spring 2022. It was created by subtracting a rasterized grid created from the groundwater elevations for spring 2020 (Exhibit 4 3) from a rasterized grid created from the groundwater elevations for spring 2022 (Exhibit 4-4). Groundwater levels have changed by less than 20 feet across most of the Basin during this two-year period. Groundwater levels have decreased in the northeastern corner of the Basin along the Bloomington Divide, which could indicate decreased groundwater inflow from the Bloomington Divide. Groundwater levels have also decreased in northwestern and central portions of the Basin—consistent with local changes in pumping from 2020 to 2022.

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0 2 4 Miles
0 2 4 Km

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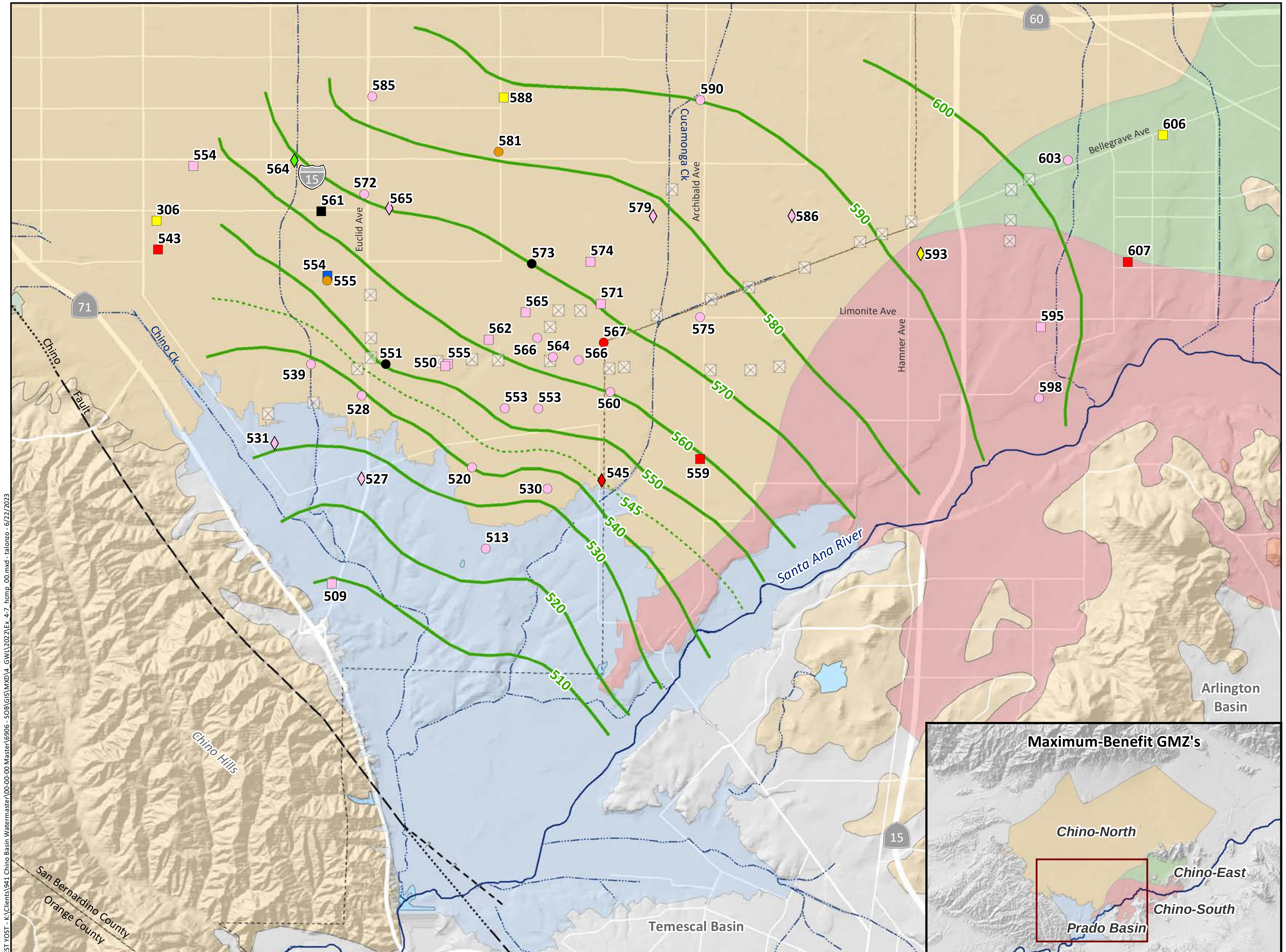
Groundwater-Level Change from Spring 2020 to Spring 2022
Shallow Aquifer System

Exhibit 4-6



800 / 775 Groundwater-Elevation Contours (feet above mean sea-level)

Well With Groundwater Elevation Used to Prepare Groundwater Elevation Contours - Symbolized by Qualifier Code and Aquifer Layer (Labeled by Groundwater Elevation)

Qualifier code

- Estimated Static
- Static
- Dynamic
- Recovering

Aquifer Layer Where Well Casing is Perforated

- Layer 1
- Layer 2
- Layer 3
- Layers 1 & 2
- Layers 1 , 2 & 3
- Unknown Well Construction

Future Location of Chino Desalter Well

Other key map features are described in the legend of Exhibit 1-1.

Hydraulic Control is a commitment of the Watermaster and the IEUA to the Regional Board that allows for the reuse and recharge of recycled water in the Chino Basin. Hydraulic Control is defined as eliminating groundwater discharge from the Chino-North GMZ to the Prado Basin MZ or controlling the discharge to *de minimis* levels of less than 1,000 afy. Hydraulic Control is to be achieved and maintained by controlling groundwater levels via pumping at the Chino Desalter wells.

This map illustrates groundwater elevation and flow directions in the southern Chino Basin prior to the commencement of pumping at the Chino Desalter wells in Spring 2000. The groundwater-elevation contours depict regional groundwater flow from the northeast to the southwest under a hydraulic gradient that steepens slightly south of the current location of the Chino-I Desalter well field. This map is consistent with the conceptual model of the Chino Basin, wherein groundwater flows from areas of recharge in the north/northeast toward areas of discharge in the south near the Prado Basin and the Santa Ana River. Pumping at the Chino-I Desalter well field began in late spring to early summer 2000, so its effects on groundwater levels are not apparent in this map.

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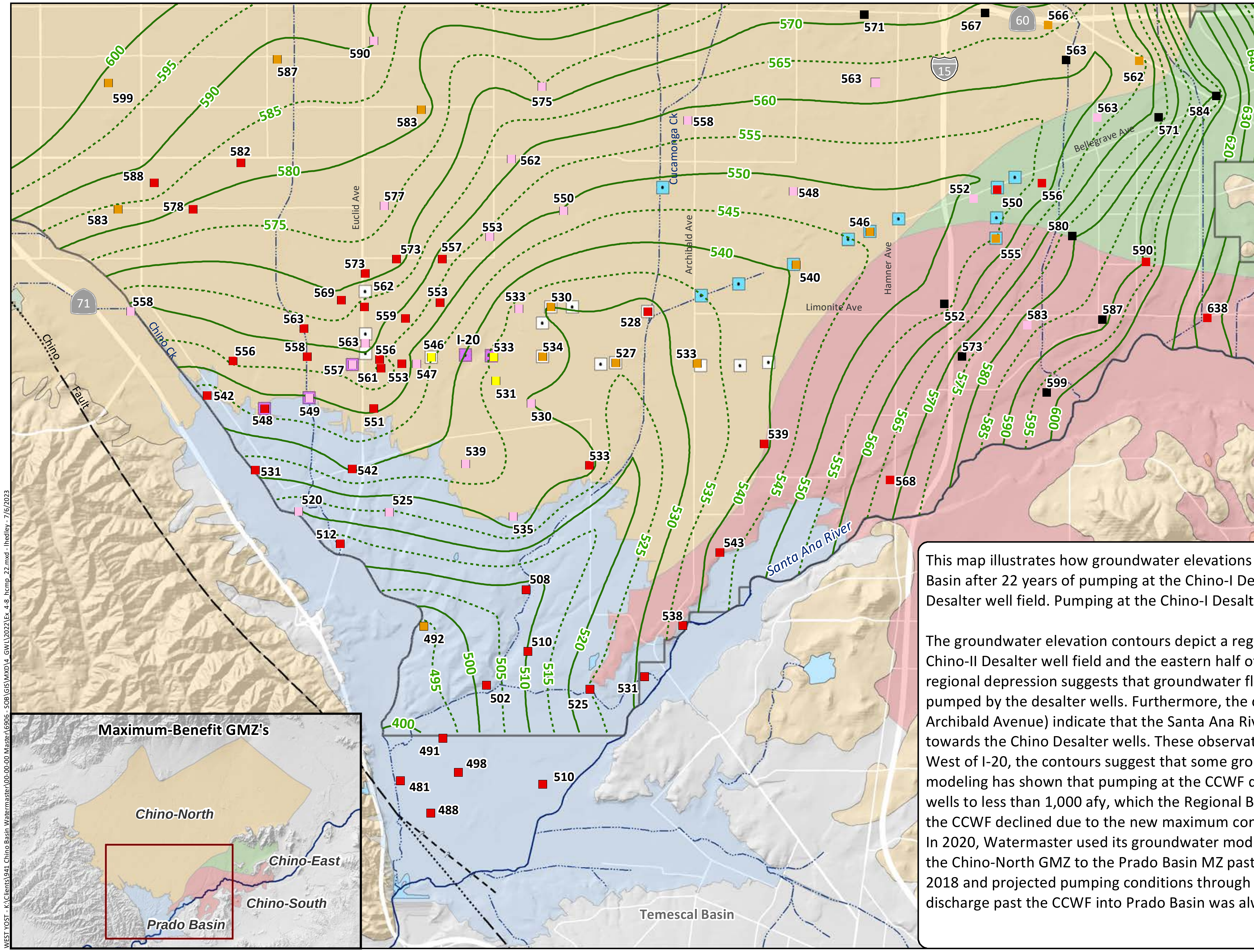
State of Hydraulic Control in Spring 2000
Shallow Aquifer System

Exhibit 4-7



Groundwater-Elevation Contours (feet above mean sea-level)

Boundary of Contoured Area (contours are not shown outside of this boundary due to lack of groundwater-level data)

Well With Groundwater Elevation Used to Prepare Groundwater Elevation Contours - Symbolized by Aquifer Layer Where Well Casing is Perforated (Labeled by Groundwater Elevation)

- Layer 1
- Layer 2
- Layers 1 & 2
- Layers 1 & 2 & 3
- Unknown Well Construction

Chino Desalter Wells

- Chino-I Desalter Well
- Chino-II Desalter Well
- Chino-I Desalter CCWF Well

Numbers next to well indicate groundwater elevation

Other key map features are described in the legend of Exhibit 1-1.

This map illustrates how groundwater elevations and flow directions have changed in the southern Chino Basin after 22 years of pumping at the Chino-I Desalter well field and 16 years of pumping at the Chino-II Desalter well field. Pumping at the Chino-I Desalter western CCWF began in 2014.

The groundwater elevation contours depict a regional depression in groundwater levels surrounding the Chino-II Desalter well field and the eastern half of the Chino-I Desalter well field (east of well I-20). This regional depression suggests that groundwater flowing south in the Chino-North GMZ is being captured and pumped by the desalter wells. Furthermore, the contours southeast of the Chino Desalter well field (east of Archibald Avenue) indicate that the Santa Ana River is recharging the Chino Basin and flowing northwest towards the Chino Desalter wells. These observations indicate that Hydraulic Control is achieved east of I-20. West of I-20, the contours suggest that some groundwater flows past the desalter wells. Groundwater modeling has shown that pumping at the CCWF decreases the volume of groundwater flow past the desalter wells to less than 1,000 afy, which the Regional Board defines as *de minimis* discharge. In 2017, pumping at the CCWF declined due to the new maximum contaminant level (MCL) for 1,2,3-trichloropropane (1,2,3-TCP). In 2020, Watermaster used its groundwater model to determine the volume of groundwater discharge from the Chino-North GMZ to the Prado Basin MZ past the CCWF for both historical pumping conditions through 2018 and projected pumping conditions through 2050. The model analysis indicated that the groundwater discharge past the CCWF into Prado Basin was always less than the *de minimis* level of 1,000 afy.

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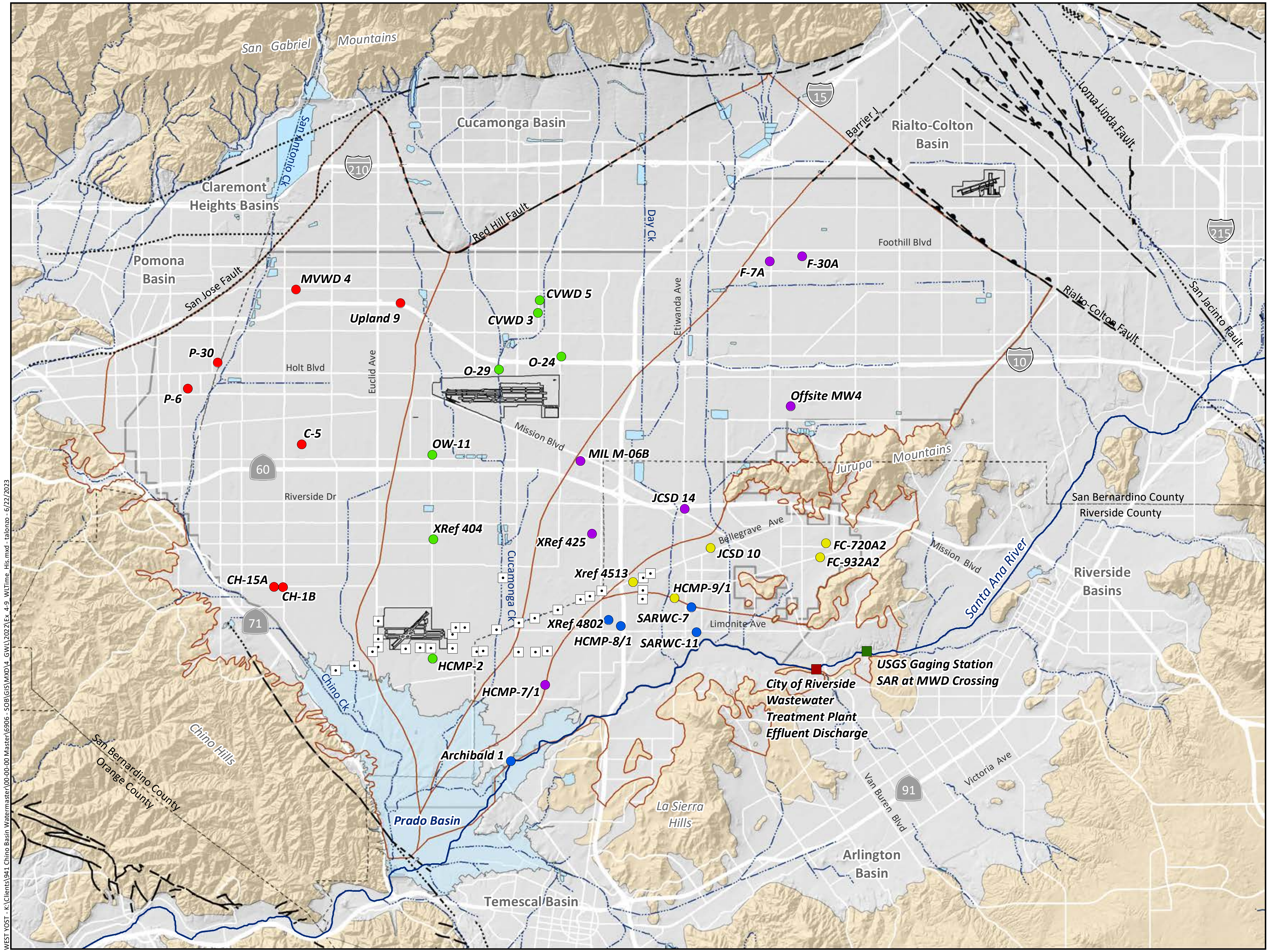
Groundwater Levels

State of Hydraulic Control in Spring 2022
Shallow Aquifer System

Exhibit 4-8



Wells With a Groundwater-Level Time History Plotted on Exhibit 4-10 through Exhibit 4-14

- Wells in MZ1
- Wells in MZ2
- Wells in MZ3
- Wells in MZ4
- Wells in MZ5

- Chino Desalter Well

Surface Water Sites With Discharge Time History Plotted on Exhibit 4-14

- Wastewater Discharge Location
- USGS Gaging Station

Other key map features are described in the legend of Exhibit 1-1.

The wells shown on this map have long groundwater-level time histories that are representative of the groundwater-level trends in their respective GMZs. Subsequent exhibits display time-series charts of groundwater-level data from these wells by GMZ with respect to precipitation, production, and artificial recharge, which are stresses that cause changes in groundwater levels. Precipitation trends on the charts are displayed as a CDFM precipitation curve using PRISM data from 1896 to 2022. An upward slope on the CDFM curve indicates wet years or periods. A downward slope indicates dry years or periods. See Section 2 of this report for more information on precipitation trends.

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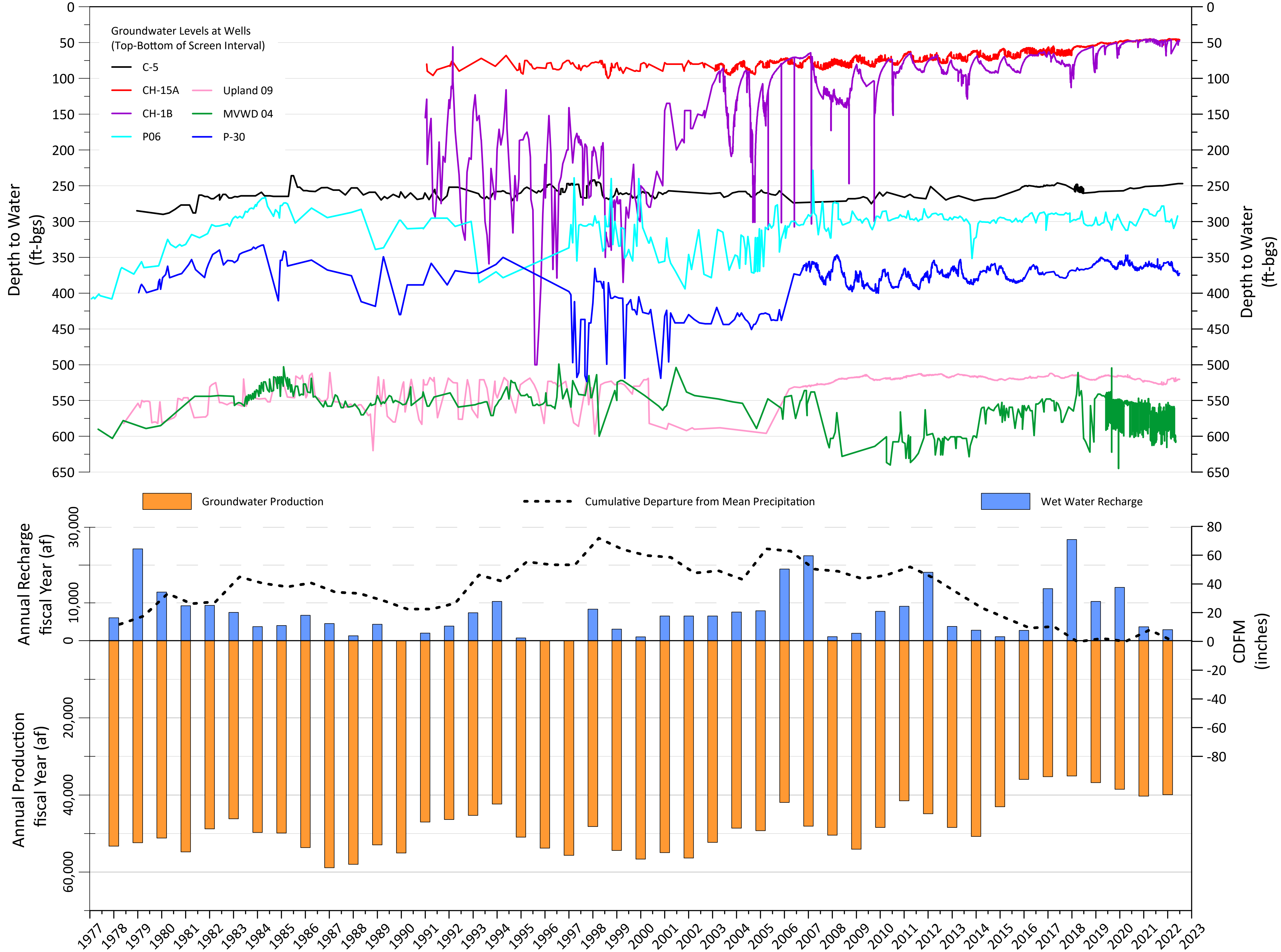
Wells Used to Characterize Long-Term Trends in Groundwater Levels Versus Precipitation, Production, and Recharge

Exhibit 4-9



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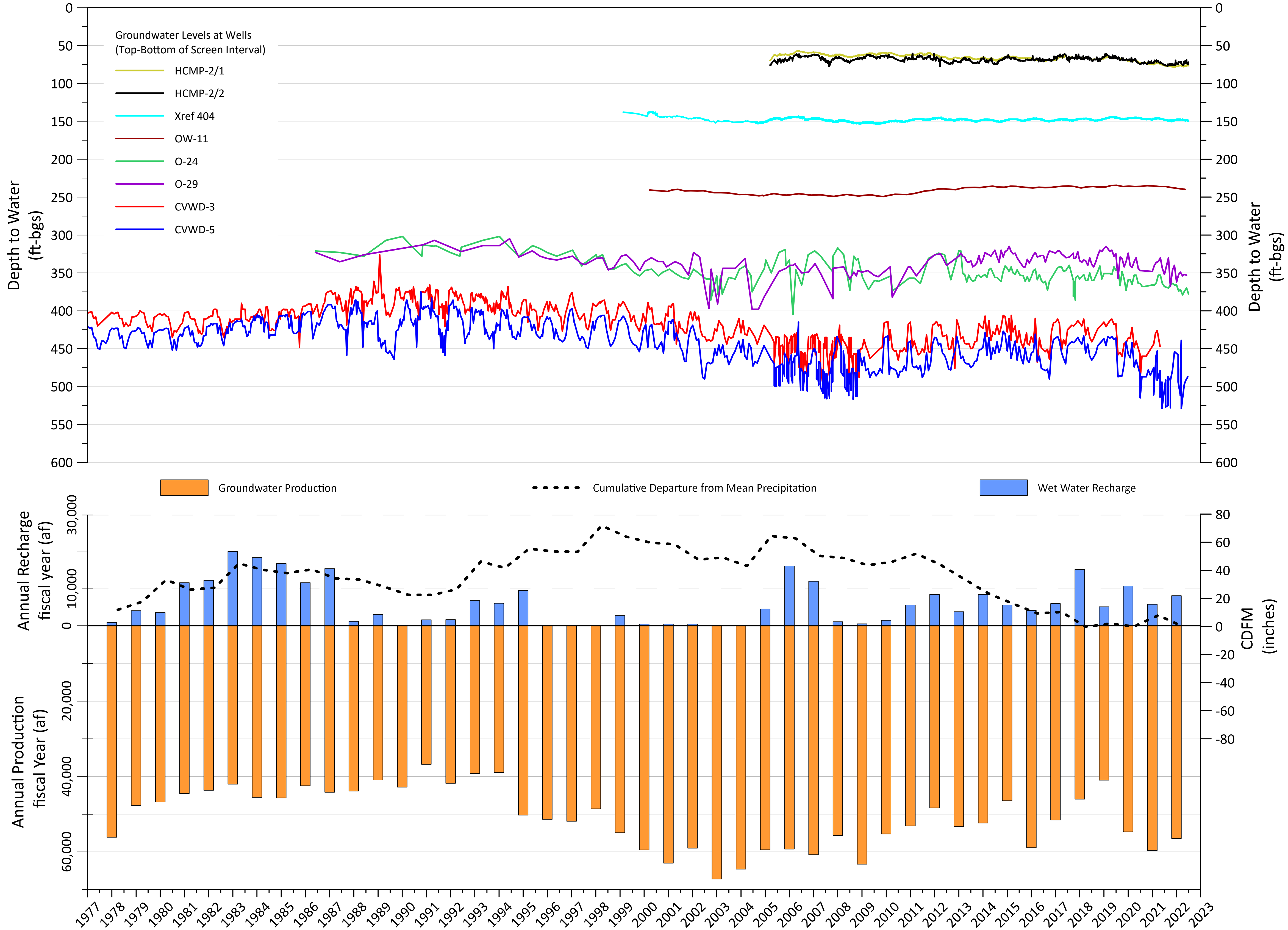
Water levels at MVWD-4 and Upland-9 are representative of groundwater-level trends in the northern portion of MZ1. Water levels at wells P-06, P-30 and C-5 are representative of groundwater-level trends in the central portion of MZ1. In these areas, water levels appear to be controlled by local pumping and recharge stresses, such as the "put and take" cycles associated with Metropolitan's Dry-Year Yield storage program in Chino Basin, the mandatory recharge of Supplemental Water in MZ1 to improve the balance of recharge and discharge, and facilities improvements to enhance the recharge of storm, recycled, and imported waters. Generally, groundwater levels are higher in 2022 compared to the beginning of OBMP implementation in 2000.

Water levels at well CH-1B are representative of groundwater-level trends in the deep, confined aquifer-system in the southern portion of MZ1. Water levels at this well are influenced by pumping from nearby wells that are also screened within the deep aquifer-system. During the 1990s, water levels at this well declined by up to 200 feet due to increased pumping from the deep aquifer-system in this area. From 2000 to 2007, water levels at this well increased primarily due to decreased pumping from the deep aquifer-system associated with poor groundwater quality and the management of land subsidence (WEI, 2007b). From 2007 to 2018, water levels at this well remained relatively stable, fluctuating annually by about +/- 30 feet due to seasonal production patterns from the deep aquifer-system. From 2018 to 2022, water levels at this well increased by about 20 feet, primary due to decreased pumping in this area.

Water levels at well CH-15A are representative of groundwater-level trends in the shallow, unconfined aquifer-system in the southern portion of MZ1. Historically, water levels in CH-15A were stable, fluctuating between 80 to 90 ft-bgs in response to nearby pumping. Since 2000, water levels have risen by about 30 feet, which is partly due to the increasing availability of recycled water for direct uses, resulting in decreased local pumping.



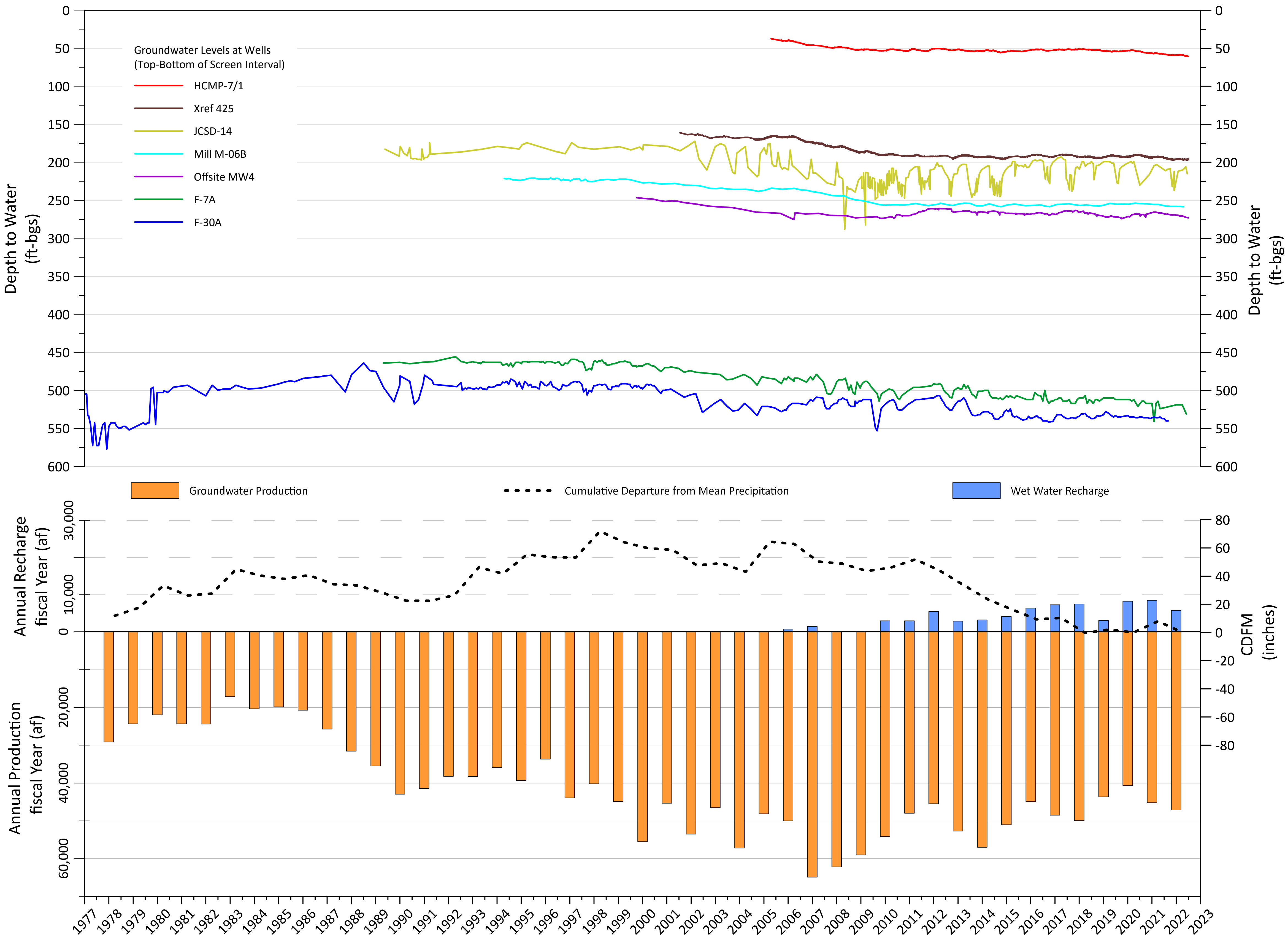
Water levels at wells CVWD-3, CVWD-5, O-29 and O-24 are representative of groundwater-level trends in the north-central portion of MZ2. Water levels increased from 1978 to about 1990, likely due to a combination of the 1978 to 1983 wet period, decreased production following the execution of the Judgment, and the initiation of the artificial recharge of imported water in the San Sevaine and Etiwanda Basins. From 1990 to 2010, water levels progressively declined by about 75 feet due to increased production in the region. From 2010 to 2014, water levels increased by about 30 feet, likely due to decreased production and increased artificial recharge. From 2014 to 2019 water levels remained relatively stable, indicating a general balance of recharge and discharge during this period. From 2019-2022, water levels have decreased primarily due to increased pumping in the area.

Water level data at wells OW-11 and XRef 404 are representative of trends in the central portion of MZ2. Well OW-11 is located adjacent to the Ely Basins, and well XRef 404 is located in the region south of all recharge basins in MZ2 and north of the Chino Desalter wells. From 2000 to 2004, water levels at both wells decreased by about 10 feet, likely due to a dry period, increases in production in MZ2, and very little artificial recharge. From 2005 to 2020, water levels increased by up to 15 feet, likely due to decreased production and increased artificial recharge. Currently, groundwater levels are exhibiting a slight downward trend, likely due to increased pumping in MZ2.

Water levels at wells HCMP-2/1 (shallow aquifer) and HCMP-2/2 (deep aquifer) are representative of groundwater-level trends in the southern portion of MZ2, just south of the Chino Desalter wells. One of the objectives of the desalter well field is to lower groundwater levels to achieve Hydraulic Control of the Chino Basin (see Exhibits 4-7 and 4-8 for further explanation of Hydraulic Control). The Chino-I Desalter well field began pumping in late 2000. Since these wells were constructed in 2005, groundwater levels in this area have declined by about ten feet.

Time-Series Chart of Groundwater Levels Versus Precipitation, Production, and Recharge
MZ2 - 1978 to 2022

Exhibit 4-11



Water levels at wells F-30A and F-7A are representative of groundwater-level trends in the northeastern portions of MZ3. From 2000 to 2020, water levels declined in this area by approximately 35-50 feet due to a dry climatic period and increased pumping in MZ3.

Water levels at wells Offsite MW4, Mill M-6B, JCSD-14, and XRef 425 are representative of groundwater-level trends in the central portion of MZ3. From 2000 to 2010, groundwater levels in this area progressively declined by about 30 feet due to a dry period and increased pumping in MZ3. From 2010 to 2022, groundwater levels stabilized or increased by up to 10 feet, likely due to reduced production and increases in artificial recharge.

Water levels at well HCMP-7/1 are representative of groundwater-level trends in the southernmost portion of MZ3—just south of the Chino-II Desalter well field and just north of the Santa Ana River. Since 2005, water levels at this well have declined by about 20 feet, mainly due to the onset of pumping at the Chino-II Desalter well field.

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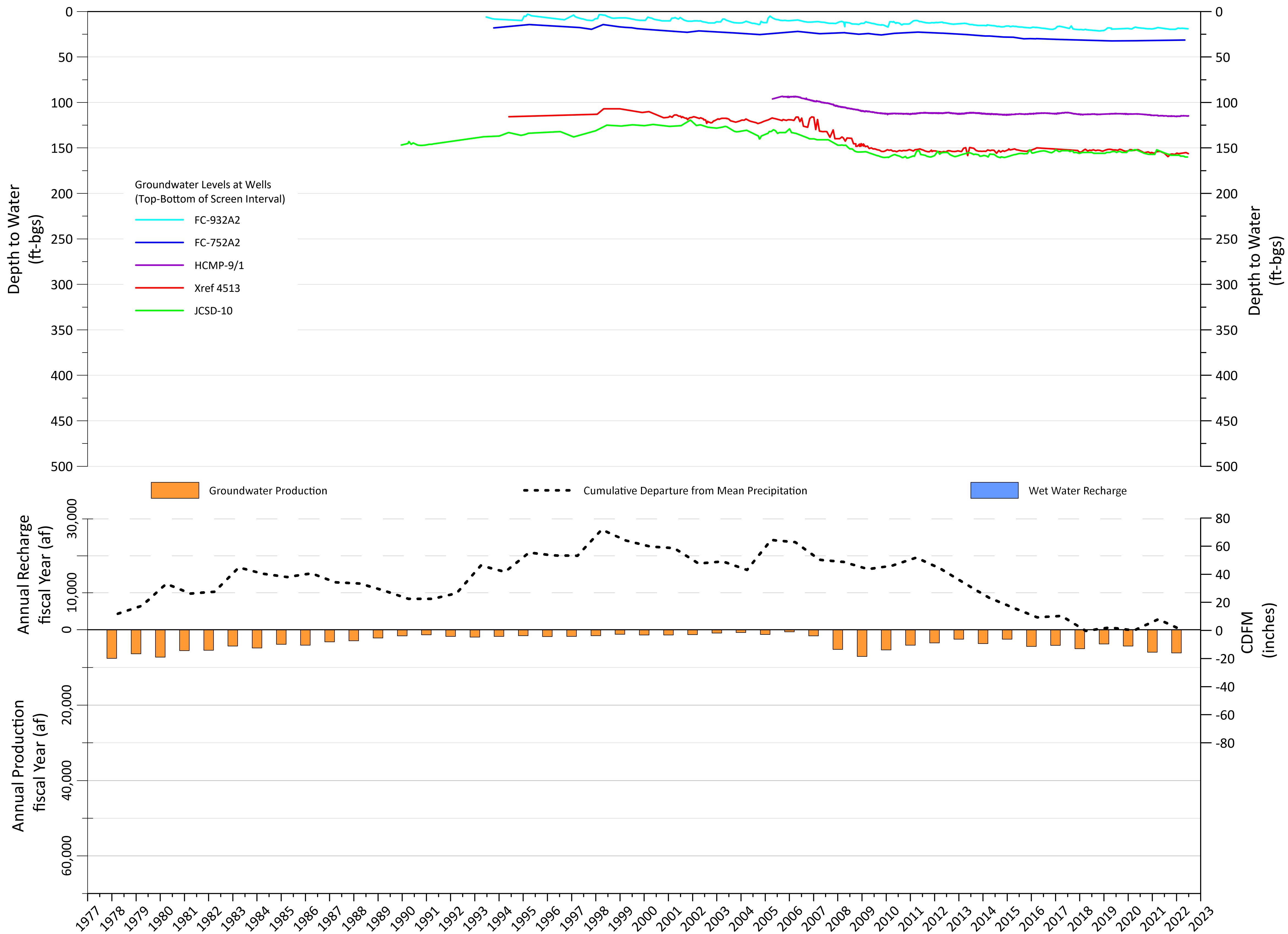
Time-Series Chart of Groundwater Levels Versus Precipitation, Production, and Recharge
MZ3 - 1978 to 2022

Exhibit 4-12



Water levels at wells JCSD-10, XRef 4513, and HCMP-9/1 are representative of groundwater-level trends in the western portion of MZ4 in the vicinity of the JCSD and Chino-II Desalter well fields. Water levels at JCSD-10 and XRef 4513 began to decrease around 2000 and notably accelerated in decline around 2006 when pumping at Chino-II Desalter wells in commenced in MZ3 and MZ4. From 2000 to 2010, water levels declined by about 35 feet at these wells. Water levels at HCMP-9/1 show a similar decrease during this time, declining by about 20 feet from the well's construction in 2005 to 2010. The decline of groundwater levels in this portion of the Basin was necessary to achieve Hydraulic Control of the Chino Basin (see Exhibits 4-7 and 4-8 for further explanation of Hydraulic Control); however groundwater level decline in this area is a concern of the JCSD with regard to production sustainability at its wells. Hydraulic Control was achieved in this area by 2010, and from 2010 to 2022 groundwater levels stabilized.

Water levels at wells FC-720A2 and FC-932A2 are representative of groundwater-level trends in the eastern portion of MZ4. From 2000 to 2018, the water levels at these wells declined by about 10 feet, likely in response to the dry period. From 2018 to 2022 water levels at these wells were relatively stable.

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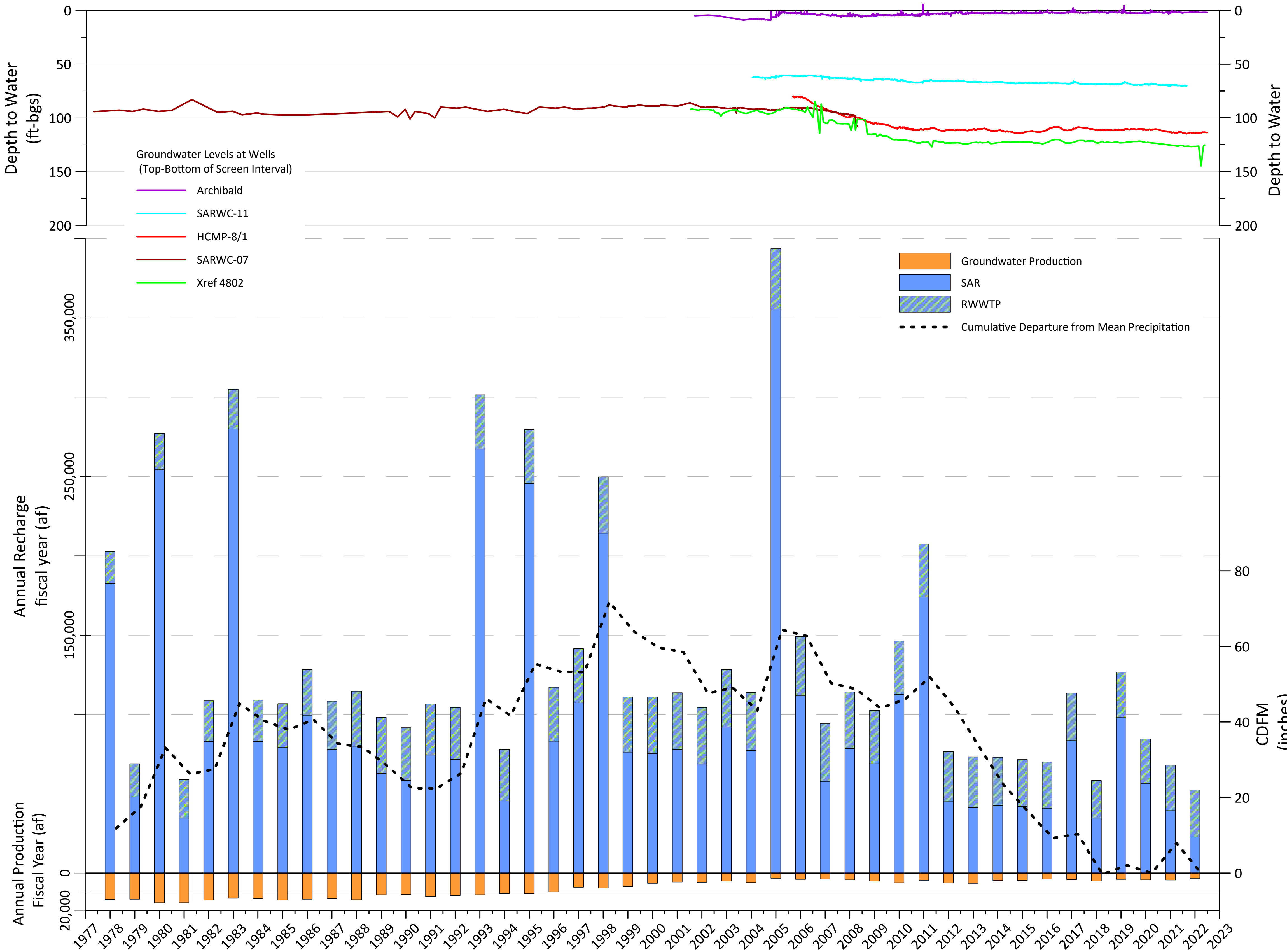
Time-Series Chart of Groundwater Levels Versus Precipitation, Production, and Recharge
MZ4 - 1978 to 2022

Exhibit 4-13



MZ5 is a groundwater flow system that parallels the Santa Ana River. The discharge of the Santa Ana River shown on this chart is the total flow measured at USGS gage SAR at MWD Crossing and the total effluent discharged to the Santa Ana River from the City of Riverside's wastewater treatment plant. A portion of this Santa Ana River discharge can recharge the Chino Basin in MZ5.

Water levels at wells XRef 4802, SARWC-7, SARWC-11, and HCMP-8/2 are representative of groundwater levels in the eastern portion of MZ5, where the Santa Ana River is recharging the Chino Basin. From 2005 to 2022, water levels at these wells declined by about 8 to 35 feet. This decline of groundwater levels coincided with increased pumping at the Chino Desalter well field nearby in MZ3 and MZ4, which has helped to achieve Hydraulic Control in this portion of the Chino Basin. This decline of groundwater levels also suggests that Santa Ana River recharge to the Chino Basin in this area has increased.

Water levels at the Archibald-1 well are representative of groundwater levels in the southwestern portion of MZ5, where groundwater is very near the ground surface were it can rise to become flow in the Santa Ana River. Water levels at this near-river well have remained relatively stable since monitoring began in 2000.

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Time-Series Chart of Groundwater Levels Versus Precipitation, Production, and Recharge
MZ5 - 1978 to 2022

Exhibit 4-14

GROUNDWATER QUALITY

The exhibits in this section show the physical state of the Chino Basin with respect to groundwater quality, using data from the Chino Basin groundwater-quality monitoring programs.

Prior to OBMP implementation, historical groundwater-quality data were obtained from the California Department of Water Resources (DWR) and supplemented with data from some producers in the Appropriative Pool and from the State of California Department of Public Health (now the California State Water Resources Control Board Division of Drinking Water [DDW]). As part of the implementation of OBMP *PE 1 – Develop and Implement a Comprehensive Monitoring Program*, Watermaster began conducting a more robust water-quality monitoring program to support the activities in other Program Elements, such as OBMP *PE 6 – Develop and Implement Cooperative Programs with the Regional Board and Other Agencies to Improve Basin Management* and OBMP *PE 7 – Develop and Implement Salt Management Program*.

In 1999, Watermaster initiated a comprehensive monitoring program to perform systematic sampling of private wells south of Highway 60 in the Chino Basin. By 2001, Watermaster had sampled all known wells at least once to develop a robust baseline dataset. Since that time, Watermaster has continued its sampling and data collection efforts and is constantly evaluating and revising the monitoring programs as wells are abandoned or destroyed due to urban development. The details of the groundwater monitoring program as of FY 2021/22 are described below.

Chino Basin Data Collection (CBDC). Watermaster routinely and proactively collects groundwater-quality data from well owners that perform sampling at their own wells, such as municipal producers and government agencies. Groundwater-quality data are also obtained from special studies and monitoring that takes place under the orders of the Regional Board, the DTSC, the USGS, and others. These data are collected from well owners and monitoring entities twice per year. In FY 2021/22, data from over 500 wells were compiled as part of the CBDC program.

Watermaster Field Groundwater-Quality Monitoring Programs. Watermaster continues to sample privately owned wells and its own monitoring wells on a routine basis.

Private Wells. Watermaster collects groundwater-quality samples at about 80 private wells, located predominantly in the southern portion of the Basin. The wells are sampled at various frequencies based on their proximity to known point-source contamination plumes. Seventy-two wells are sampled on a triennial basis and eight wells near contaminant plumes are sampled on an annual basis.

Watermaster Monitoring Wells. Watermaster collects groundwater-quality samples at 22 multi-nested monitoring sites located throughout the southern Chino Basin. There is a total of 53 well casings at these sites. These include nine Hydraulic Control Monitoring Program (HCMP) monitoring well sites constructed to support the demonstration of Hydraulic Control, nine monitoring well sites constructed to support the Prado Basin Habitat Sustainability Program (PBHSP), and four sites that fill spatial data gaps near contamination plumes in MZ3). Each nested well site contains up to four wells in the borehole. The HCMP and MZ3 wells are sampled annually. The PBHSP wells are sampled every three years.

Other wells. Watermaster collects samples from four near-river wells quarterly. The data are used to characterize the interaction of the Santa Ana River and groundwater in this area. These shallow monitoring wells along the Santa Ana River consist of two former USGS National Water Quality Assessment Program (NAWQA) wells (Archibald 1 and Archibald 2) and two Santa Ana River Water Company (SARWC) wells (Well 9 and Well 11).

All groundwater-quality data are checked for quality assurance and quality control (QA/QC) by Watermaster staff and uploaded to a centralized database management system that can be accessed online through HydroDaVE^{SM}. The data are used (1) to comply with two of Watermaster and IEUA's maximum benefit salinity management commitments: the triennial ambient water quality re-computation and the analysis of Hydraulic Control; (2) to prepare Watermaster's biennial State of the Basin report (this report); (3) to support ground-water modeling; (4) to characterize non-point source contamination and plumes associated with point-source discharges; (5) to characterize long-term trends in water quality; and (6) to periodically perform special studies.

Groundwater-quality data representing the five-year period from July 2017 to June 2022 were analyzed synoptically and temporally to characterize current water quality conditions in the Chino Basin. This analysis does not represent a programmatic investigation of potential sources of chemical constituents in the Chino Basin. Exhibit 5-1 shows the wells with data over this five-year period.

Groundwater quality is characterized with respect to constituents where groundwater exceeds primary or secondary California MCLs or notification levels (NLs). Wells with constituent concentrations greater than a primary MCL represent areas of concern, and the spatial distribution of these wells indicates areas in the Basin where groundwater may be impaired from a beneficial use standpoint. Exhibit 5-2 characterizes the number of wells in the Basin that exceed primary or secondary MCLs or NLs. Exhibits 5-3 through 5-16 show the areal distribution of concentrations for the constituents of potential concern described in Exhibit 5-2.

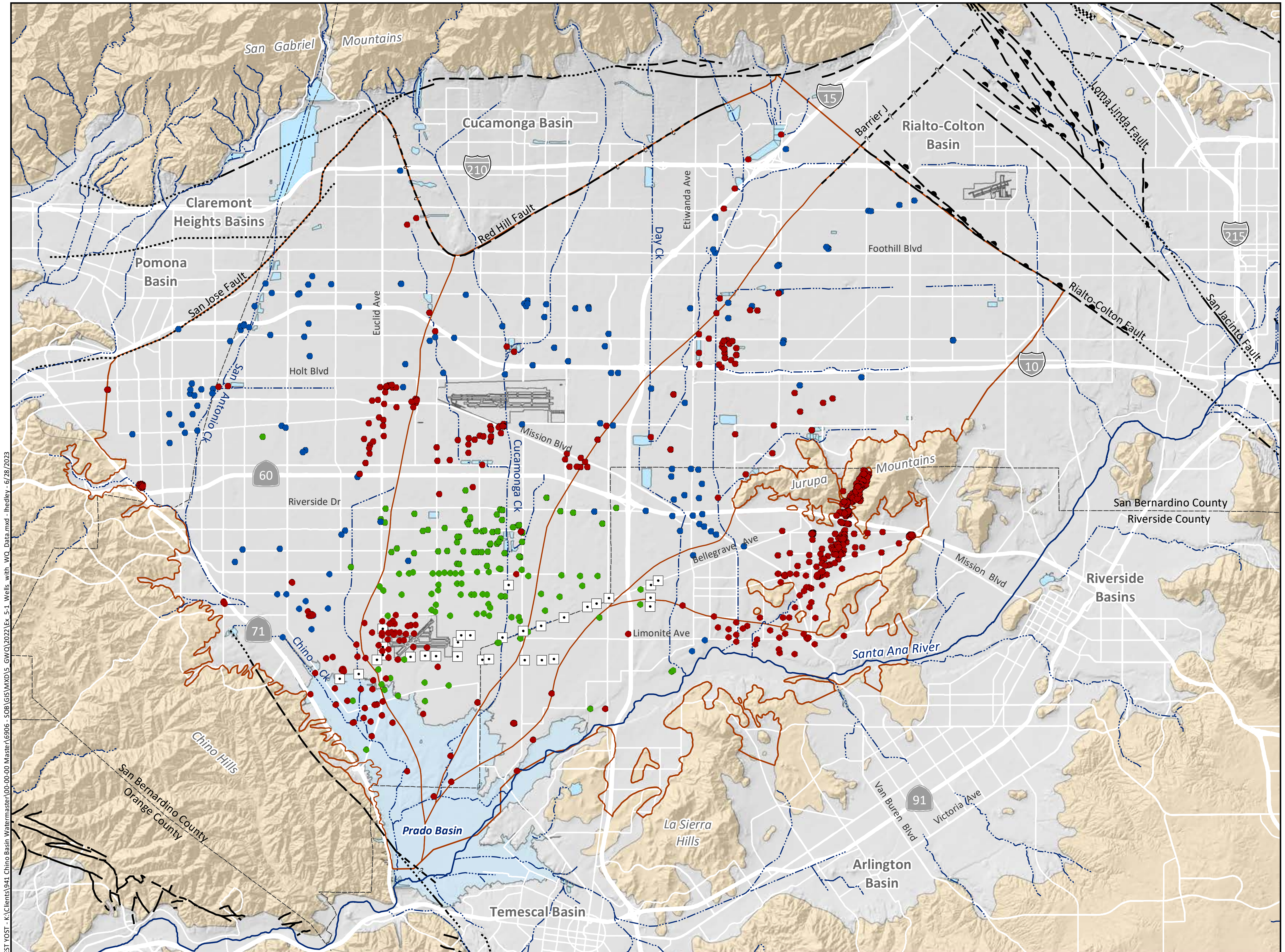
Several of the constituents in Exhibits 5-3 through 5-16 are associated with known point-source contaminant discharges to groundwater. Understanding point-sources of concern is critical to the overall management of groundwater quality to ensure that Chino Basin groundwater remains a sustainable resource. Watermaster closely monitors information, decisions, cleanup activities, and monitoring data pertaining to point-source contamination within the Chino Basin. The following is a list of the regulatory and voluntary groundwater quality contamination monitoring efforts in the Chino Basin that are tracked by Watermaster, the locations of which are shown in Exhibit 5-17.

- Alumax Aluminum Recycling Facility
  Constituents of Concern: TDS, sulfate, nitrate, chloride
  Order: RWQCB Cleanup and Abatement Order 99-38
- Alger Manufacturing Co.
  Constituents of Concern: volatile organic chemicals (VOCs)
  Order: Voluntary Cleanup and Monitoring
- Chino Airport
  Constituents of Concern: VOCs and 1,2,3-TCP
  Order: Regional Board Cleanup and Abatement Orders 90-134, R8-2008-0064, and R8-2017- 0011
- California Institution for Men (No Further Action status, as of 2/17/2009)
  Constituents of Concern: VOCs
  Order: Voluntary Cleanup and Monitoring
- General Electric Flatiron Facility
  Constituents of Concern: VOCs and hexavalent chromium
  Order: Voluntary Cleanup and Monitoring
- General Electric Test Cell Facility
  Constituents of Concern: VOCs
  Order: Voluntary Cleanup and Monitoring
- Former Kaiser Steel Mill
  Constituents of Concern: TDS, total organic carbon (TOC), VOCs
  Order: RWQCB Order No. 91-40 Closed. Kaiser granted capacity in the Chino II Desalter to remediate.
- Former Kaiser Steel Mill. CCG Property
  Constituents of Concern: chromium, hexavalent chromium, other metals, VOCs
  Order: DTSC Consent Order 00/01-001
- Milliken Sanitary Landfill
  Constituents of Concern: VOCs
  Order: RWQCB Order No. 81-003
- Upland Sanitary Landfill
  Constituents of Concern: VOCs
  Order RWQCB Order No 98-99-07
- South Archibald Plume
  Constituents of Concern: VOCs
  Order: Stipulated Settlement and Cleanup and Abatement Order No. R8-2016-0016 to a group of eight responsible parties
- Stringfellow NPL Site
  Constituents of Concern: VOCs, perchlorate, N-nitrosodimethylamine (NDMA), trace metals
  Order: The Stringfellow Site is the subject of US Environmental Protection Agency (EPA) Records of Decision (RODs): EPA/ROD/R09-84/007, EPA/ROD/R09-83/005, EPA/ROD/R09-87/016, and EPA/ROD/R09-90/048.

Every two years, Watermaster uses the data collected as part of its monitoring programs and other information to delineate the extent of contaminant plumes comprised of VOCs. Exhibits 5-17 and 5-18 show the current delineation and chemical differentiation of the VOC plumes. Exhibits 5-19 through 5-22 show more detailed information about the Chino Airport, South Archibald, GE Flatiron, and GE Test Cell plumes, the monitoring and remediation activities for which are tracked and reported on by Watermaster on a semiannual or annual basis.

Exhibit 5-23 shows all known point-sources of potential contamination in the Chino Basin as of 2022, based on the State Water Board's GeoTracker and EnviroStor websites. GeoTracker is the State Water Board's online data-management system for the compliance data collected from point-source discharge sites with confirmed or potential impacts to groundwater. This includes locations where there have been unauthorized discharges of waste to land or unauthorized releases of hazardous substances from underground storage tanks. EnviroStor is the DTSC's online data-management system for permitted hazardous waste facilities. In 2014, Watermaster performed a comprehensive review of the GeoTracker and EnviroStor databases to identify sites in the Chino Basin that may have an impact on groundwater quality but have not been previously tracked by Watermaster. Watermaster reviews the GeoTracker and EnviroStor databases annually to track the status of previously identified sites, identify new sites with potential or confirmed impacts to groundwater, and add new data to Watermaster's database.

The remaining exhibits in this section characterize long-term trends in groundwater quality in the Basin with respect to TDS and nitrate concentrations. The management of TDS and nitrate concentrations is essential to Watermaster's maximum-benefit salt and nutrient management plan. In 2002, Watermaster proposed that the Regional Board adopt alternative maximum-benefit water-quality objectives for the Chino-North Management Zone that were higher than the antidegradation water-quality objectives for MZ1, MZ2, and MZ3. The proposed objectives were approved by the Regional Board and incorporated into the Basin Plan in 2004 (Regional Board, 2004). The maximum-benefit objectives enabled Watermaster and the IEUA to implement recycled water recharge and reuse throughout the Chino Basin. The application of the maximum-benefit objectives is contingent upon the implementation of specific projects and programs known as the "Chino Basin maximum-benefit commitments." The commitments include requirements for basin-wide monitoring of groundwater quality and the triennial re-computation of ambient TDS and nitrate. The commitments also require the development of plans and schedules for water-quality improvement programs when current ambient TDS exceeds the maximum-benefit objective or when recycled water used for recharge and irrigation exceeds the discharge limitations listed in the IEUA's recycled water discharge and reuse permits. Exhibits 5-24 through 5-26 show trends in the ambient water quality determinations for TDS and nitrate. Exhibits 5-27 through 5-34 show TDS and nitrate concentration time histories from 1973 to 2022 for selected wells. These time histories illustrate groundwater-quality variations and trends within each GMZ compared to the GMZ TDS and nitrate objectives.



Wells with Groundwater-Quality Monitoring Data

Between July 2017 and June 2022

- Monitoring (902 wells)
- Municipal (136 wells)
- Private (131 wells)
- Chino Desalter Well (30 wells)

Other key map features are described in the legend of Exhibit 1-1.

Watermaster's current water-quality monitoring program relies on municipal producers, government agencies, and others to supply groundwater-quality data on a cooperative basis. Watermaster supplements these data through its own sampling and analysis of private wells and monitoring wells in the area, generally south of Highway 60. All groundwater-quality data are collected and checked for QA/QC by Watermaster staff and uploaded to a centralized data management system that can be accessed online through HydroDaVESM. For the July 2017 to June 2022 period, water-quality data were available for a total of 1,199 wells within the Chino Basin. Of those, 613 wells were sampled in FY 2021/22.

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Wells with Groundwater Quality Data
July 2017 - June 2022

Exhibit 5-1

All Chino Basin groundwater-quality data for the five-year period of July 2017 through June 2022 were analyzed for exceedances of primary or secondary MCLs and NLs. Primary MCLs are enforceable drinking water standards set by the California DDW to protect the public from potential negative health effects associated with contaminants. Secondary MCLs are drinking water standards set by the California DDW based on undesirable aesthetic, cosmetic, or technical effects caused by a respective contaminant. NLs are set by the California DDW as a health advisory level for unregulated contaminants with the potential for negative health impacts. Contaminants with an NL may eventually become regulated with an MCL after a formal regulatory review. HydroDaVE[SM] was used to create an exceedance report for wells in the Chino Basin. The tables shown here list the number of wells in the Chino Basin with sample results that exceeded California primary/secondary MCLs or NLs during the reporting period.

Contaminant with a Primary MCL					
Contaminant	California MCL	Number of Wells with Exceedance	Contaminant	California MCL	Number of Wells with Exceedance
1,1,2-Trichloroethane	5 µgl	1	Ethylbenzene	300 µgl	32
1,1-Dichloroethene (1,1-DCE)	5 µgl	16	Fluoride	2 mgl	37
1,2,3-Trichloropropane	0.5 µgl	138	Gross Alpha	15 pCi/L	16
1,2,4-Trichlorobenzene	5 µgl	23	Heptachlor	0.01 µgl	9
1,2-Dibromo-3-chloropropane	0.2 µgl	3	Heptachlor Epoxide	0.01 µgl	6
1,2-Dichlorobenzene	600 µgl	40	Hexachlorobenzene	1 µgl	3
1,2-Dichloroethane	0.005 µgl	40	Hexachlorocyclopentadiene	50 µgl	4
1,4-Dichlorobenzene	5 µgl	107	Lead	0.015 mgl	12
Aluminum*	1 mgl	25	Mercury	0.002 mgl	2
Antimony	6 µgl	2	Methyl Tert-Butyl Ether (MTBE)*	13 µgl	18
Arsenic	0.01 mgl	25	Nickel	0.1 mgl	55
Barium	1 mgl	2	Nitrate-Nitrogen	10 mgl	348
Benzene	1 µgl	75	Nitrite-Nitrogen	1 mgl	8
Benzo(a)pyrene	0.2 µgl	3	Pentachlorophenol	1 µgl	6
Beryllium	0.004 mgl	6	Perchlorate	6 µgl	360
Cadmium	0.005 mgl	45	Selenium	0.05 mgl	4
Carbon Tetrachloride	0.5 µgl	23	Tetrachloroethene (PCE)	5 µgl	107
Chlorine	4 mgl	44	Thallium	2 µgl	11
Chlorobenzene	70 µgl	61	Toluene	150 µgl	26
Chromium	50 µgl	146	Total Xylene	1750 µgl	17
Chromium (VI)	10 µgl	93	Trichloroethylene (TCE)	5 µgl	312
cis-1,2-Dichloroethene (cis-1,2-DCE)	6 µgl	49	Trihalomethanes	80 µgl	4
Copper*	1.3 mgl	19	Uranium	20 pCi/L	2
Di(2-ethylhexyl)phthalate	4 µgl	41	Vinyl Chloride	0.5 µgl	4
Dichloromethane (Freon 30)	5 µgl	93			

mgl = milligrams per liter µgl = micrograms per liter ngl = nanograms per liter

*Contaminant has both a primary and secondary MCL

**PFOA and PFOS also have a proposed U.S. EPA Primary MCL of 4 ngl. PFBS and PFHxS also have a proposed U.S. EPA Primary MCL of a Hazard Index of 1.0 along with PFNA and GenX Chemicals. See Exhibits 5-12, 5-13, and 5-14.

Contaminant with a Secondary MCL		
Contaminant	California MCL	Number of Wells with Exceedance
Aluminum*	0.2 mgl	38
Chloride	500 mgl	10
Color	15 color units	14
Copper*	1 mgl	22
Iron	0.3 mgl	59
Manganese	0.05 mgl	39
Methyl Tert-Butyl Ether (MTBE)*	5 µgl	25
Odor	3 TON	3
Specific Conductance	1600 µS/cm	83
Sulfate	250 mgl	75
TDS	1000 mgl	79
Turbidity	5 NTU	42
Zinc	5 mgl	23

Contaminant with a California NL		
Contaminant	California NL	Number of Wells with Exceedance
1,2,4-Trimethylbenzene	330 µgl	14
1,3,5-Trimethylbenzene	330 µgl	11
1,4-Dioxane	1 µgl	65
Manganese	500 µgl	17
Methyl Isobutyl Ketone	120 µgl	8
n-Butylbenzene	260 µgl	2
N-Nitrosodimethylamine (NDMA)	0.01 µgl	52
N-Nitrosodipropylamine (NDPA)	0.01 µgl	3
n-Propylbenzene	260 µgl	8
Naphthalene	17 µgl	31
Perfluorohexanesulfonic acid (PFHxS)**	3 ngl	96
Perfluorooctanoic acid (PFOA)**	5.1 ngl	46
Perfluorooctanesulfonic acid (PFOS)**	6.5 ngl	39
Sec-Butylbenzene	260 µgl	1
Tert-Butyl Alcohol	120 µgl	45
Vanadium	50 µgl	8

Exhibits 5-3 through 5-16 are maps of the Chino and Cucamonga Basins depicting the spatial distribution of wells with exceedances for contaminants of potential concern. The contaminants of potential concern are defined as follows:

- Contaminants associated with salt and nutrient management planning (i.e. TDS and nitrate).
- Contaminants where a primary MCL was exceeded in 50 or more wells from July 2017 to June 2022 and where 10 percent or more of the wells with exceedances are not directly tied to a single contamination plume with a known point-source of contamination (i.e. the Stringfellow NPL Site, Milliken Landfill, etc.). These constituents include 1,2,3-TCP, benzene, total chromium, hexavalent chromium, perchlorate, tetrachloroethene (PCE), and trichloroethylene (TCE).
- Contaminants which the California DDW and/or federal EPA considers a candidate for the development of an MCL or is in the process of developing an MCL. These include perfluorooctanoic acid (PFOA), perfluorooctane sulfonic acid (PFOS), perfluorobutane sulfonate (PFBS), perfluorohexane sulfonate (PFHxS), perflorononanoic acid (PFNA), hexafluoropropylene oxide dimer acid (HFPO-DA, commonly known as "GenX Chemicals"), 1,4-dioxane, and manganese.

In each exhibit, the water-quality standard is defined in the legend, and each well is symbolized by the maximum concentration value measured during the reporting period. The following class interval convention is applied to each exhibit based on the subject water-quality standard:

Symbol	Class Interval
	Not Detected above the reporting limit (ND)
	< 0.5x WQS
	0.5x WQS to WQS
	> WQS to 2x WQS
	> 2x WQS to 4x WQS
	> 4x WQS

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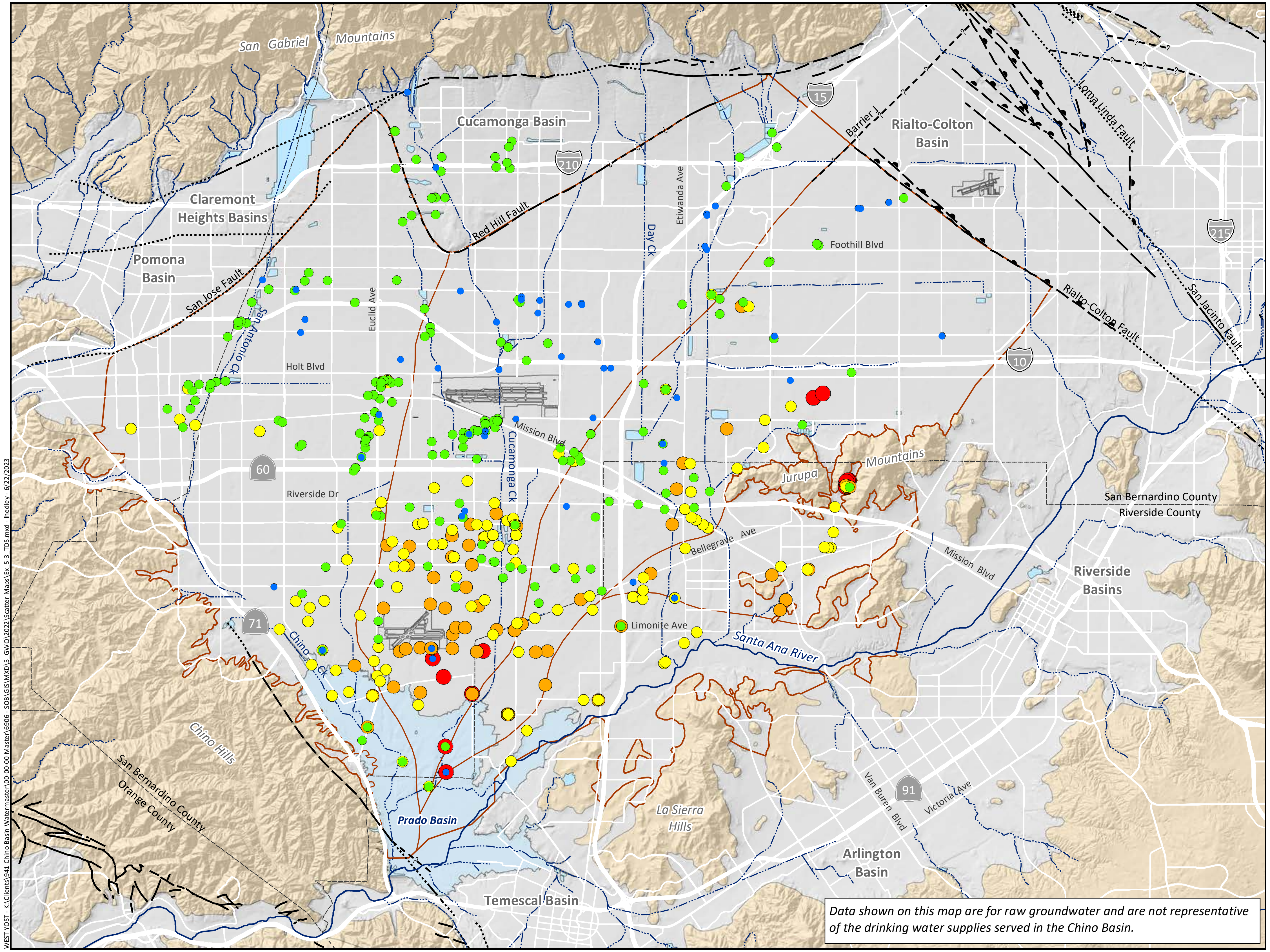

TDS (mgl)

- < 125
- 125 - 250
- 250 - 500
- 500 - 1,000
- 1,000 - 2,000
- > 2,000

California Secondary MCL = 500 mgl

Other key map features are described in the legend of Exhibit 1-1.

TDS is a measure of all dissolved substances in water (salinity), which includes organic matter and ions such as chloride, sodium, nitrate, calcium, potassium, magnesium, bicarbonate, and sulfate. Common sources of salinity in groundwater can include agricultural, municipal, and industrial wastewaters; applied water for irrigation (urban and agricultural); or natural sources. TDS has a secondary California recommended MCL of 500 milligrams per liter (mgl). From 2017 to 2022, TDS was measured at 450 wells in the Chino Basin. Of these, 214 (48 percent) have five-year maximum values that exceed the MCL. The highest five-year maximum TDS concentrations are located near the Jurupa Mountains within the Stringfellow NPL site and can be up to 20,000 mgl. Exclusive of these concentrations, the five-year maximum concentrations across the Basin range from 108 to 9,300 mgl, with average and median values of 644 and 530 mgl, respectively. The wells with the highest TDS concentrations in this range are predominantly located south of Highway 60 in the area of historic and current agricultural land uses, including irrigated agriculture and dairies. Agricultural and dairy land uses impact TDS concentrations through the use of fertilizer on crops, the concentrating effects of the consumptive use of applied water for irrigation, and the disposal of dairy waste via land application and discharge to ponds.

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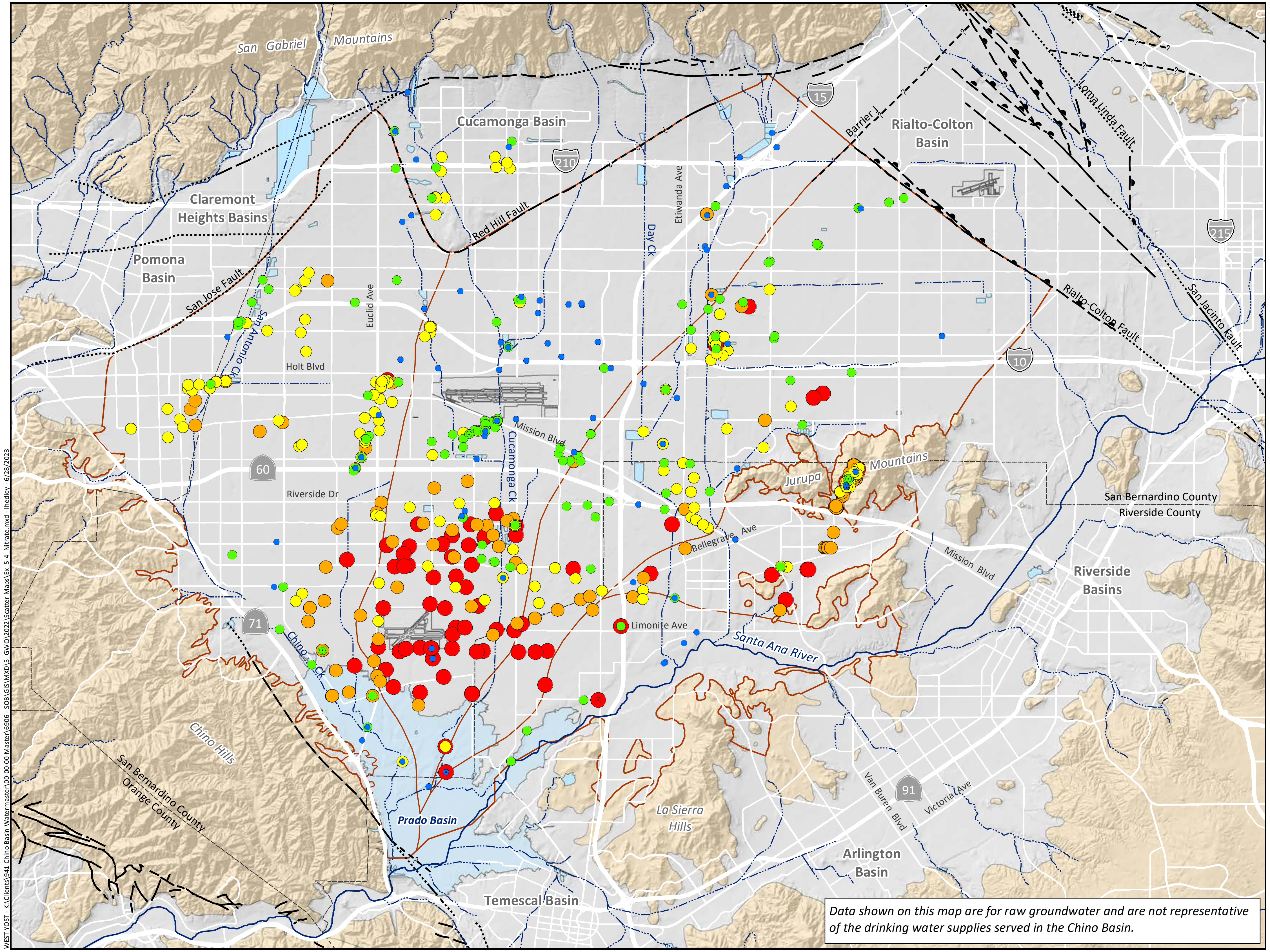
Total Dissolved Solids (TDS) in Groundwater
Maximum Concentration (July 2017 to June 2022)

Exhibit 5-3



Nitrate-N (mgl)

- ND
- < 5
- 5 - 10
- 10 - 20
- 20 - 40
- > 40

California Primary MCL = 10 mgl

Other key map features are described in the legend of Exhibit 1-1.

Nitrate is a common contaminant in groundwater. It forms naturally through nitrification (overall conversion of ammonia to nitrate) and is synthesized in the industrial manufacturing of fertilizers. The California primary MCL for nitrate (expressed as nitrogen) in drinking water is 10 mgl. From 2017 to 2022, nitrate was measured at 547 wells in the Chino Basin with 540 (99 percent) of the wells having detectable concentrations ranging from 0.044 to 280 mgl, with average and median concentrations of 15.7 and 8.7 mgl, respectively; 352 wells (64 percent) have a five-year maximum concentration value that exceeds the MCL. The wells with the highest nitrate concentrations are predominantly located south of Highway 60, where historical agricultural land uses progressively converted from irrigated agricultural to dairies. Agricultural and dairy land uses impact nitrate concentrations through the use of fertilizer on crops and the disposal of dairy waste via land application and discharge to ponds. In this area south of Highway 60, sample results frequently exceed the MCL and often exceed 40 mgl (four times the MCL).

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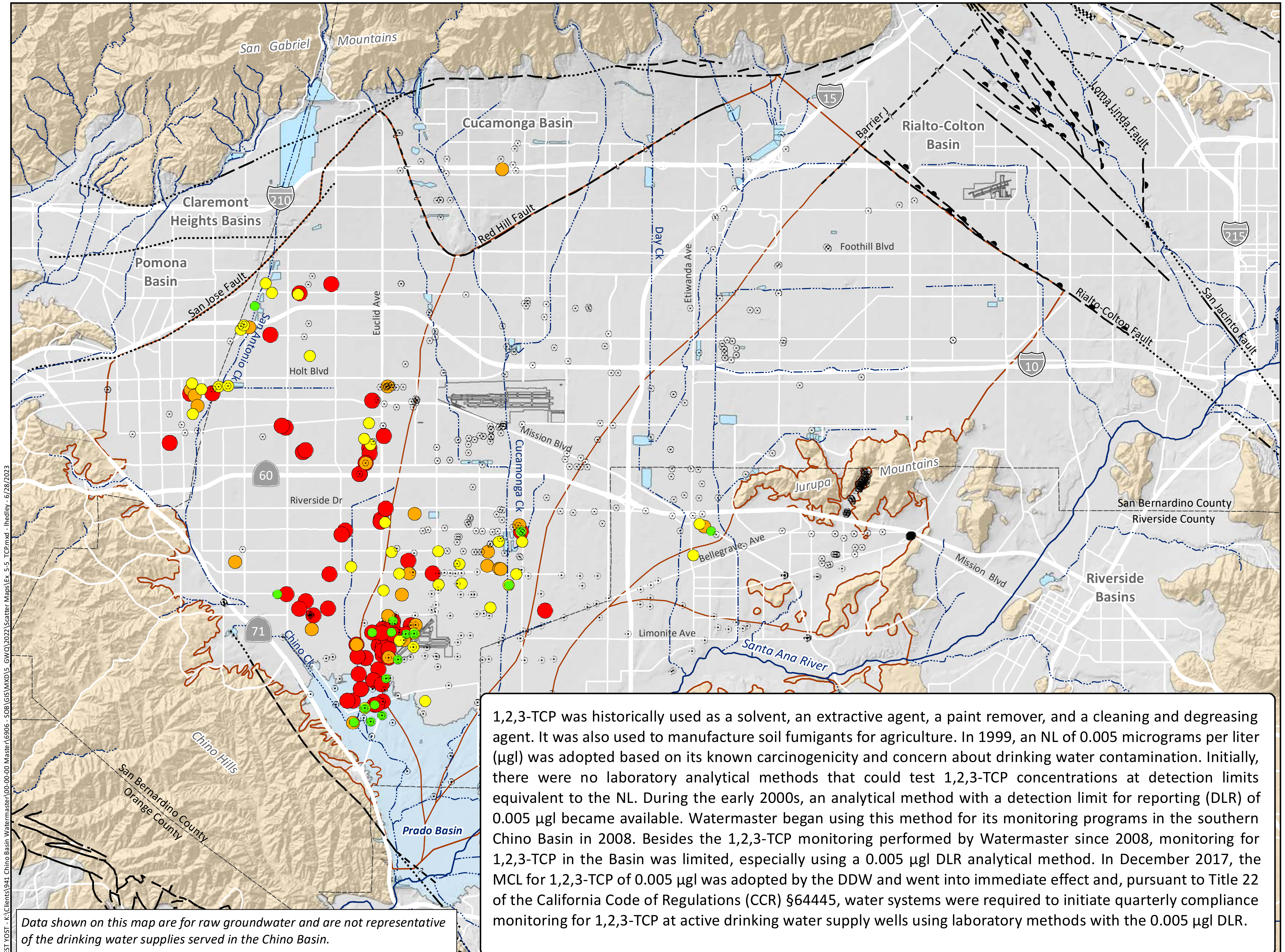
Nitrate (as Nitrogen) in Groundwater
Maximum Concentration (July 2017 to June 2022)

Exhibit 5-4



1,2,3-TCP was historically used as a solvent, an extractive agent, a paint remover, and a cleaning and degreasing agent. It was also used to manufacture soil fumigants for agriculture. In 1999, an NL of 0.005 micrograms per liter (µgl) was adopted based on its known carcinogenicity and concern about drinking water contamination. Initially, there were no laboratory analytical methods that could test 1,2,3-TCP concentrations at detection limits equivalent to the NL. During the early 2000s, an analytical method with a detection limit for reporting (DLR) of 0.005 µgl became available. Watermaster began using this method for its monitoring programs in the southern Chino Basin in 2008. Besides the 1,2,3-TCP monitoring performed by Watermaster since 2008, monitoring for 1,2,3-TCP in the Basin was limited, especially using a 0.005 µgl DLR analytical method. In December 2017, the MCL for 1,2,3-TCP of 0.005 µgl was adopted by the DDW and went into immediate effect and, pursuant to Title 22 of the California Code of Regulations (CCR) §64445, water systems were required to initiate quarterly compliance monitoring for 1,2,3-TCP at active drinking water supply wells using laboratory methods with the 0.005 µgl DLR.

1,2,3-TCP (µgl)

- ND
- < 0.0025
- 0.0025 - 0.005
- 0.005 - 0.01
- 0.01 - 0.02
- > 0.02

California Primary MCL = 0.005 µgl

Other key map features are described in the legend of Exhibit 1-1.

From 2017 to 2022, 714 wells in the Chino Basin were sampled for 1,2,3-TCP. Of these wells, 159 wells (22 percent) had detectable concentrations, ranging from .0013 to 21 µgl, with average and median concentrations of 0.46 and 0.02 µgl, respectively. 139 wells (19 percent) had concentrations exceeding the MCL.

1,2,3-TCP concentrations detected in groundwater above the MCL are mostly in wells in the western Chino Basin. Some of the wells are associated with the Chino Airport plume, Pomona Plume, and the GE Flatiron plume. The 1,2,3-TCP concentrations at these point-source plumes are one to two orders of magnitude greater than the concentrations measured at the other wells in the western Chino Basin. The detections of 1,2,3-TCP at these other wells are likely the result of the historical application of soil fumigants to crops.

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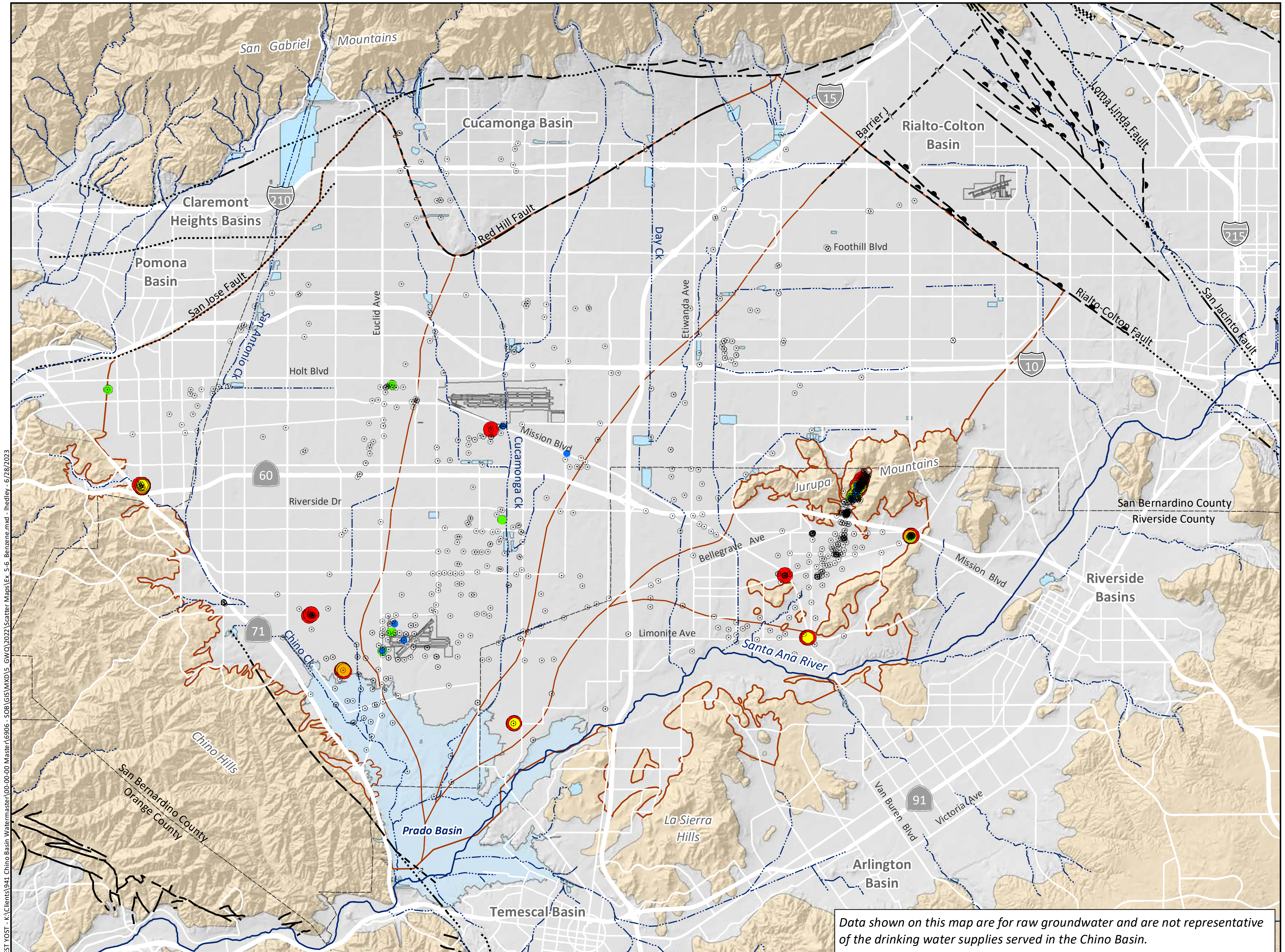
1,2,3-Trichloropropane (1,2,3-TCP) in Groundwater
Maximum Concentration (July 2017 to June 2022)

Exhibit 5-5



Benzene (µgl)

- ND
- < 0.5
- 0.5 - 1
- 1 - 2
- 2 - 4
- > 4

California Primary MCL = 1 µgl

Other key map features are described in the legend of Exhibit 1-1.

Benzene is a regulated drinking water contaminant in California with a primary MCL of 1 µgl. It is a colorless, highly flammable liquid that evaporates quickly into air and dissolves slightly in water. It is found in crude oil and gasoline, but also occurs naturally in volcanic gasses and smoke resulting from forest fires. Benzene in unleaded gasoline is typically only around 1 percent of the total volume and was originally used as a replacement for lead as a gasoline additive. It is most likely to be released to groundwater from leaking underground fuel storage tanks, fuel spills, and leaks at refineries. Benzene is a known carcinogen. From 2017 to 2022, 1,089 wells in the Chino Basin were sampled for benzene with 99 (9 percent) having detectable concentrations; 75 wells (7 percent) have a five-year maximum concentration exceeding the MCL. The five-year maximum detected concentrations range from 0.08 to 20,000 µgl, with average and median concentrations of 936 µgl and 5.4 µgl, respectively. Wells with detectable levels of benzene in the Chino Basin occur predominantly in monitoring wells at point-source contaminant sites associated with leaking underground fuel storage tanks.

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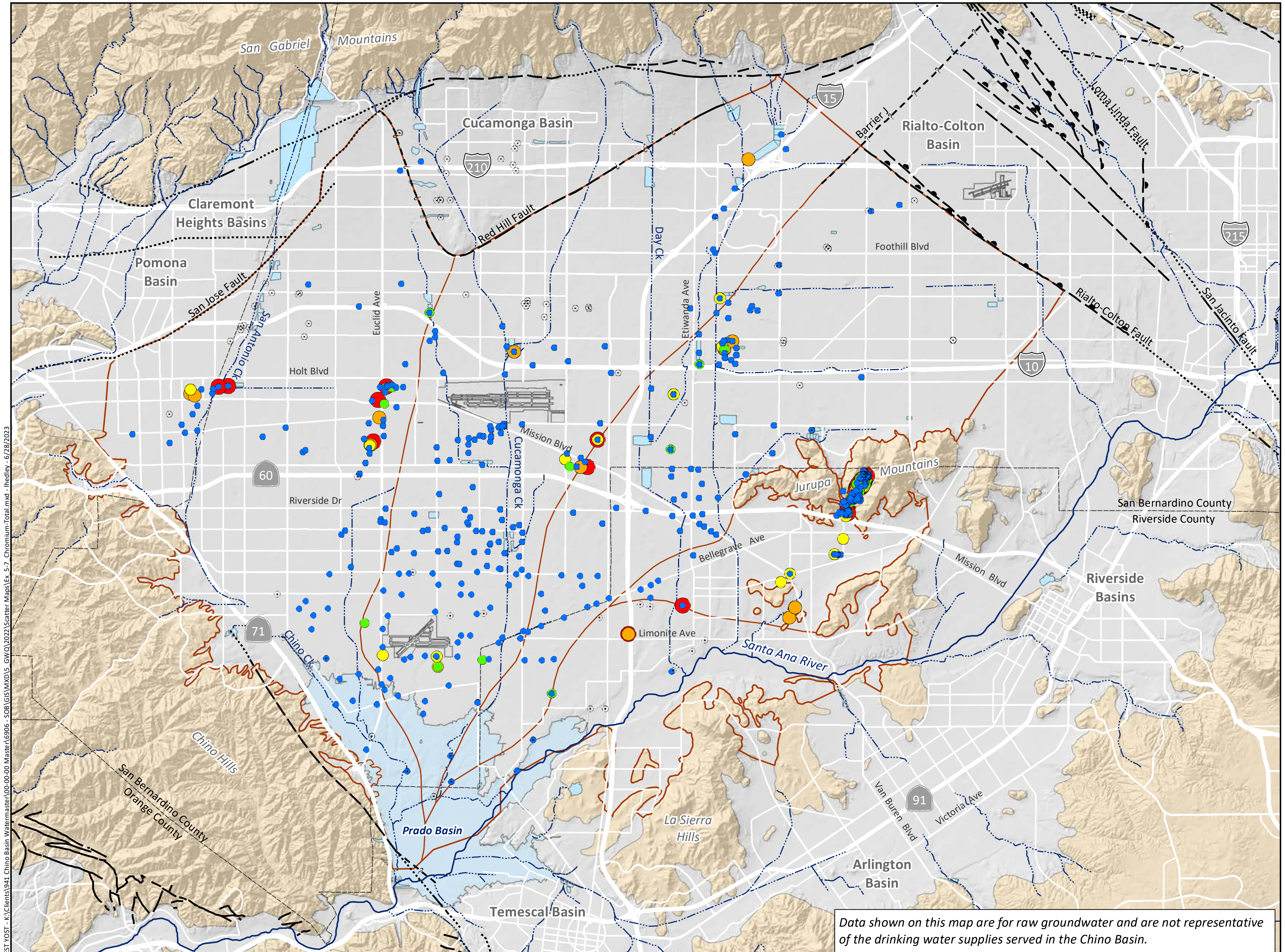
Benzene in Groundwater
Maximum Concentration (July 2017 to June 2022)

Exhibit 5-6



Total Chromium (µgl)

- ND
- < 25
- 25 - 50
- 50 - 100
- 100 - 200
- > 200

California Primary MCL = 50 µgl

Other key map features are described in the legend of Exhibit 1-1.

Total chromium is a regulated drinking water contaminant in California with a primary MCL of 50 µgl. Total chromium in groundwater consists of trivalent and hexavalent chromium, deriving from both natural and anthropogenic sources. Examples of anthropogenic sources include dye, paint pigments, and chrome plating liquid wastes. Most chromium in the environment exists in the generally insoluble trivalent form ; however, under oxidizing conditions, more soluble hexavalent chromium may form. Although trivalent chromium is considered a micronutrient , hexavalent chromium is a known carcinogen. From 2017 to 2022, total chromium was measured at 718 wells in the Chino Basin with 651 (91 percent) of the wells having detectable concentrations ranging from 0.003 to 720,000 µgl, with average and median concentrations of 6,710 and 6.57 µgl, respectively; 146 wells (20 percent) have a five-year maximum concentration value that exceeds the MCL. Wells with higher concentrations of total chromium occur predominantly in monitoring wells associated with known point-source contamination sites for the former Kaiser Steel Mill CCG property, GE Flatiron, and Stringfellow NPL site. The Stringfellow NPL site is the only area where there are concentrations of total chromium greater than 4,730 µgl.

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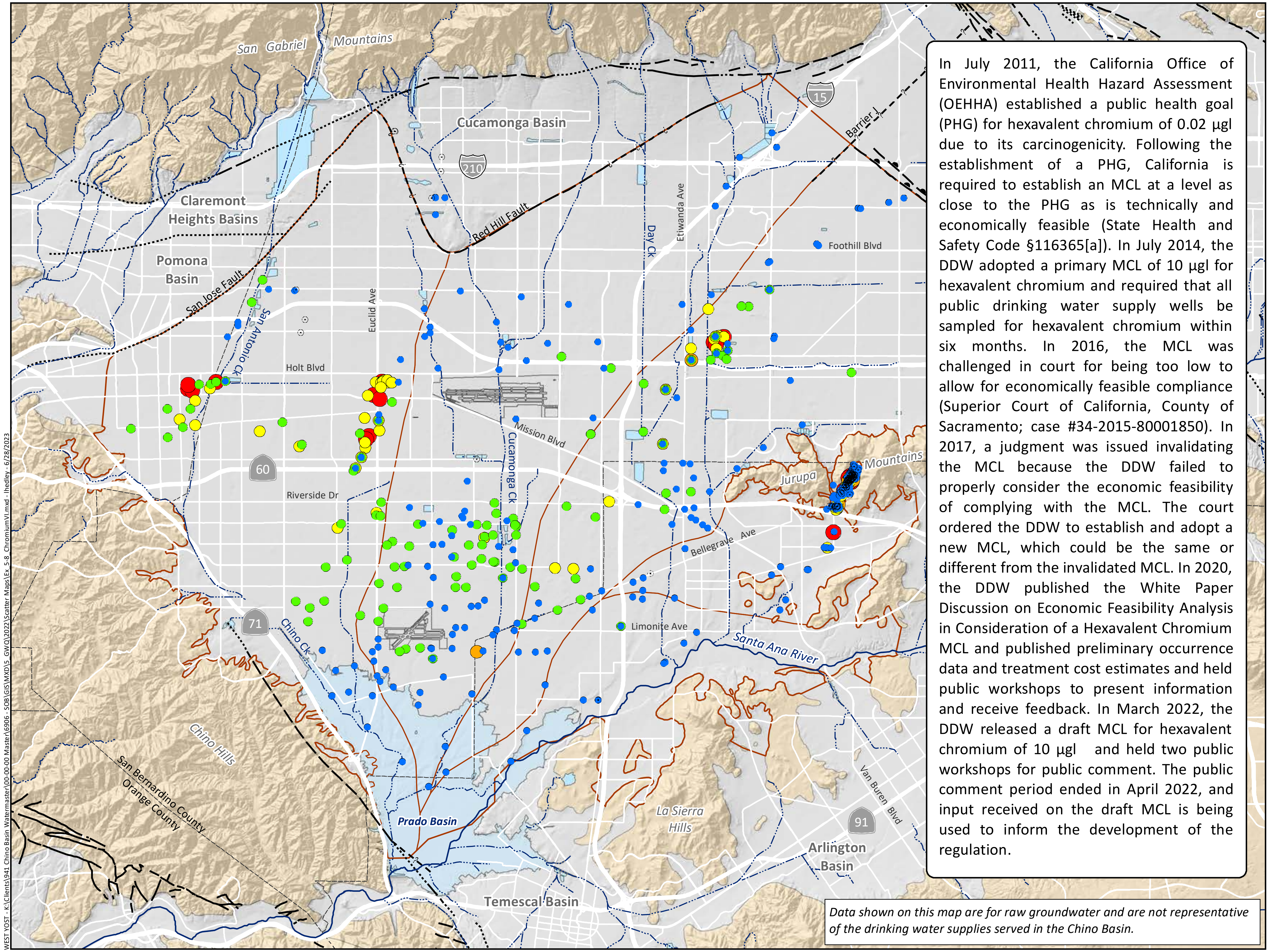
Total Chromium in Groundwater
Maximum Concentration (July 2017 to June 2022)

Exhibit 5-7



In July 2011, the California Office of Environmental Health Hazard Assessment (OEHHA) established a public health goal (PHG) for hexavalent chromium of 0.02 µgl due to its carcinogenicity. Following the establishment of a PHG, California is required to establish an MCL at a level as close to the PHG as is technically and economically feasible (State Health and Safety Code §116365[a]). In July 2014, the DDW adopted a primary MCL of 10 µgl for hexavalent chromium and required that all public drinking water supply wells be sampled for hexavalent chromium within six months. In 2016, the MCL was challenged in court for being too low to allow for economically feasible compliance (Superior Court of California, County of Sacramento; case #34-2015-80001850). In 2017, a judgment was issued invalidating the MCL because the DDW failed to properly consider the economic feasibility of complying with the MCL. The court ordered the DDW to establish and adopt a new MCL, which could be the same or different from the invalidated MCL. In 2020, the DDW published the White Paper Discussion on Economic Feasibility Analysis in Consideration of a Hexavalent Chromium MCL and published preliminary occurrence data and treatment cost estimates and held public workshops to present information and receive feedback. In March 2022, the DDW released a draft MCL for hexavalent chromium of 10 µgl and held two public workshops for public comment. The public comment period ended in April 2022, and input received on the draft MCL is being used to inform the development of the regulation.

Data shown on this map are for raw groundwater and are not representative of the drinking water supplies served in the Chino Basin.

Hexavalent Chromium (µgl)

- ND
- < 5
- 5 - 10
- 10 - 20
- 20 - 40
- > 40

2014 California Primary MCL (Invalidatd in 2016) = 10 µgl
2022 California DRAFT Primary MCL = 10 ugl

Other key map features are described in the legend of Exhibit 1-1.

From 2017 to 2022, hexavalent chromium was measured at 663 wells in the Chino Basin with 584 (88 percent) of the wells having detectable concentrations ranging from 0.01 to 5,100 µgl, with average and median concentrations of 38 and 4.3 µgl, respectively; 92 wells (14 percent) have a five-year maximum concentration value that exceeds the draft MCL of 10 µgl. Wells with higher concentrations of hexavalent chromium occur predominantly in monitoring wells associated with known point-source contamination sites for the former Kaiser Steel Mill CCG property, GE Flatiron, and Stringfellow NPL site, and in the Pomona Plume area. The highest concentrations of hexavalent chromium (>250 µgl) are at wells associated with the GE Flatiron and Stringfellow NPL sites.

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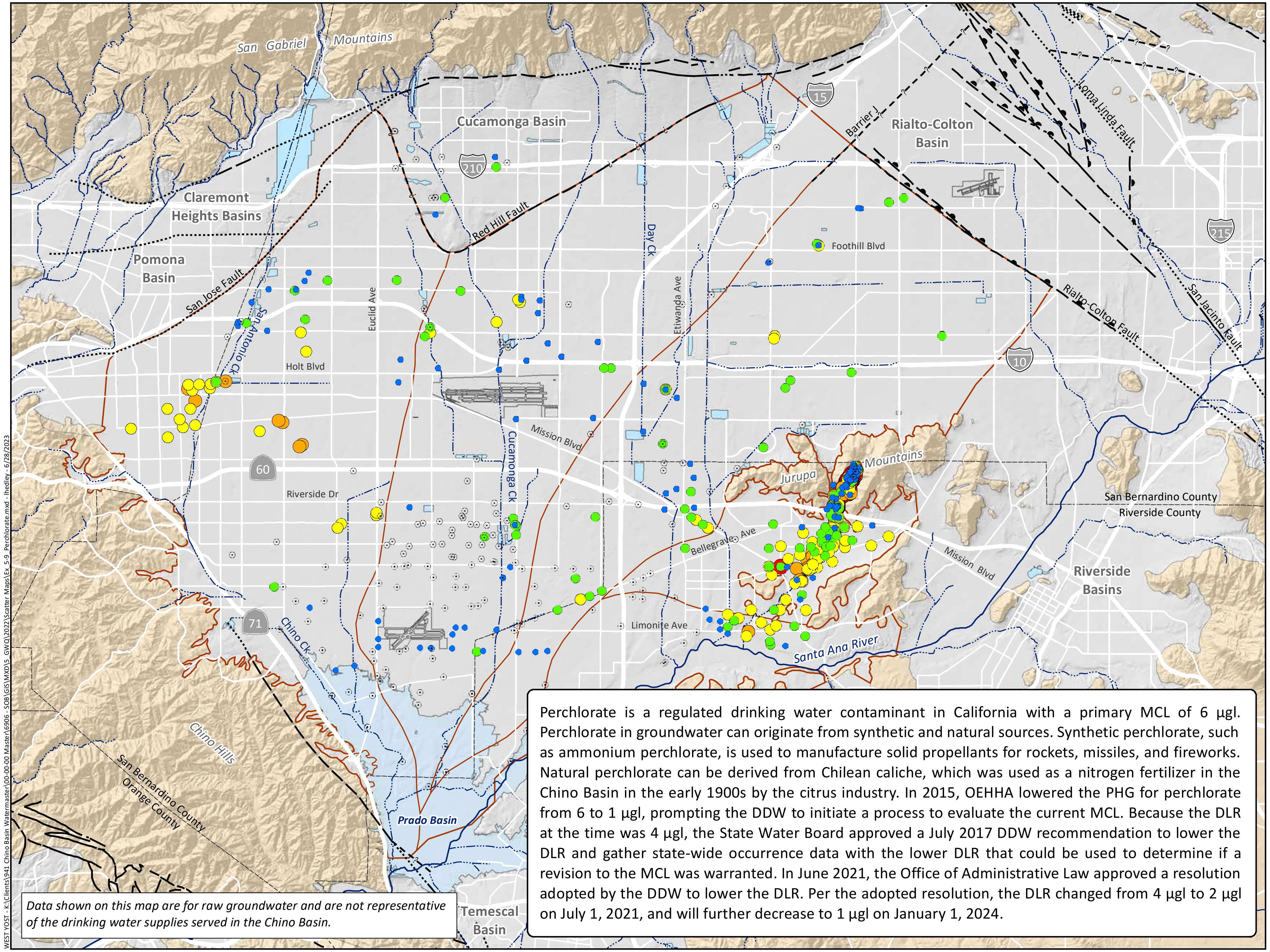
Hexavalent Chromium in Groundwater
Maximum Concentration (July 2017 to June 2022)

Exhibit 5-8



Data shown on this map are for raw groundwater and are not representative of the drinking water supplies served in the Chino Basin.

Perchlorate is a regulated drinking water contaminant in California with a primary MCL of 6 µgl. Perchlorate in groundwater can originate from synthetic and natural sources. Synthetic perchlorate, such as ammonium perchlorate, is used to manufacture solid propellants for rockets, missiles, and fireworks. Natural perchlorate can be derived from Chilean caliche, which was used as a nitrogen fertilizer in the Chino Basin in the early 1900s by the citrus industry. In 2015, OEHHA lowered the PHG for perchlorate from 6 to 1 µgl, prompting the DDW to initiate a process to evaluate the current MCL. Because the DLR at the time was 4 µgl, the State Water Board approved a July 2017 DDW recommendation to lower the DLR and gather state-wide occurrence data with the lower DLR that could be used to determine if a revision to the MCL was warranted. In June 2021, the Office of Administrative Law approved a resolution adopted by the DDW to lower the DLR. Per the adopted resolution, the DLR changed from 4 µgl to 2 µgl on July 1, 2021, and will further decrease to 1 µgl on January 1, 2024.

Perchlorate (µgl)

- ND
- < 3
- 3 - 6
- 6 - 12
- 12 - 24
- > 24

California Primary MCL = 6 µgl

Other key map features are described in the legend of Exhibit 1-1.

From 2017 to 2022, perchlorate was measured at 763 wells in the Chino Basin with 585 (77 percent) of the wells having detectable concentrations ranging from 0.5 to 10,000 µgl, with average and median concentrations of 32.7 and 5.3 µgl, respectively; 354 (46 percent) have a five-year maximum concentration value that exceeds the MCL. All of the wells with concentrations of perchlorate over 23 µgl are monitoring wells associated with the Stringfellow NPL site, where a perchlorate plume of mostly synthetic nature extends from the Jurupa Mountains downgradient to Limonite Avenue. A perchlorate isotope investigation performed by Watermaster in 2006 confirmed that most of the perchlorate in the west and central portions of the Chino Basin was derived from Chilean nitrogen fertilizer.

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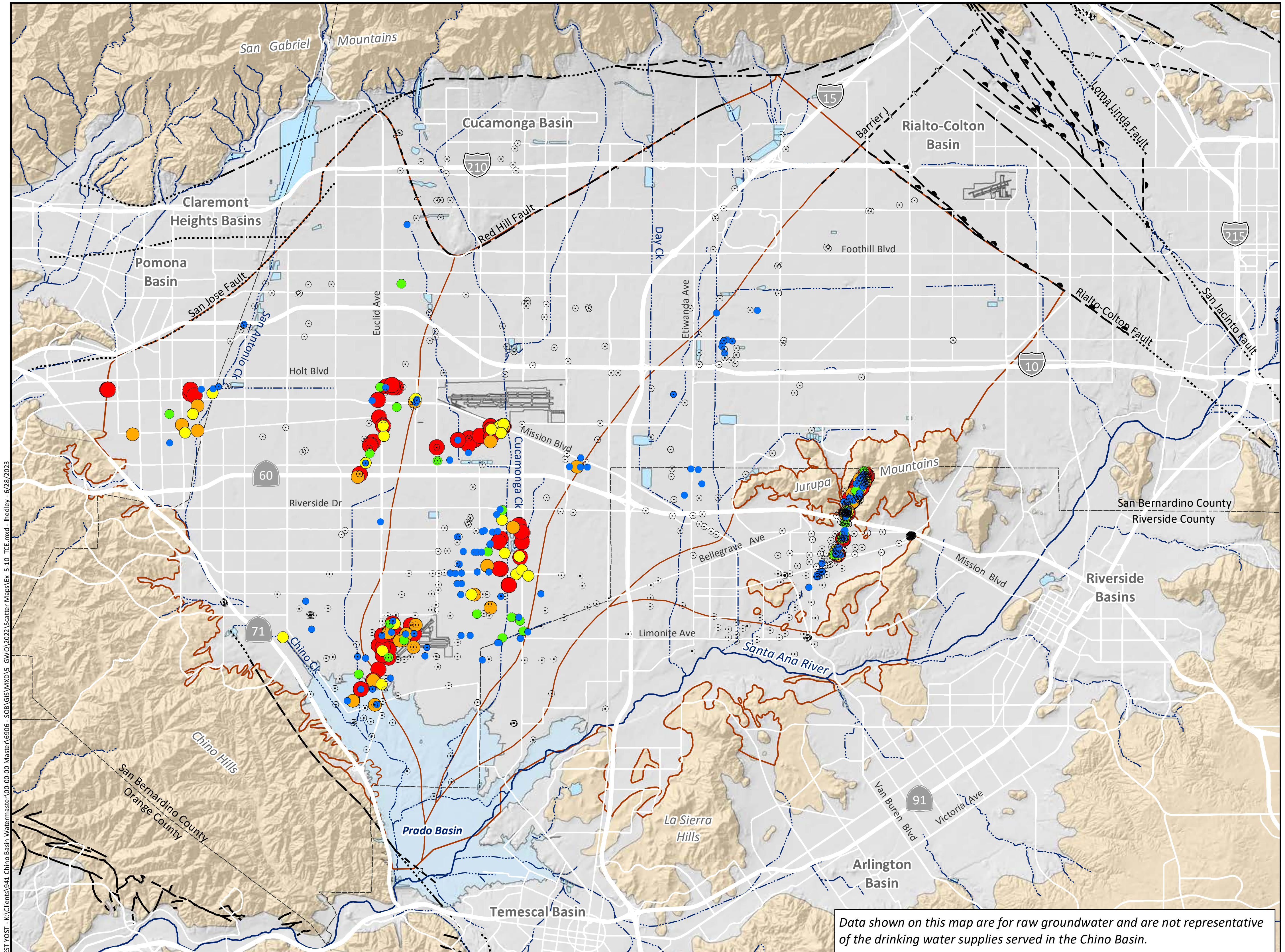
Perchlorate in Groundwater
Maximum Concentration (July 2017 to June 2022)

Exhibit 5-9



TCE (µgl)

- ND
- < 2.5
- 2.5 - 5
- 5 - 10
- 10 - 20
- > 20

California Primary MCL = 5 µgl

Other key map features are described in the legend of Exhibit 1-1.

TCE is a regulated drinking water contaminant in California with a primary MCL of 5 µgl. TCE, along with PCE, is an industrial solvent that has been widely used as a metal degreaser in the aviation, automotive, and other metal working industries for almost a century. The largest sources of TCE in groundwater are releases from chemical waste sites, dry cleaners, improper disposal practices, and leaking storage tanks and pipelines. From 2017 to 2022, 1,042 wells in Chino Basin were sampled for TCE, with 492 wells (47 percent) having detectable concentrations ranging from 0.5 to 280,000 µgl, with average and median concentrations of 1,004 µgl and 7 µgl, respectively; 492 wells (47 percent) have concentrations exceeding the MCL. Wells with concentrations of TCE above the MCL occur predominantly in monitoring wells associated with the following VOC contaminant plumes: GE Flatiron, GE Test Cell, South Archibald plume, Chino Airport, Pomona, and Stringfellow NPL site. Monitoring wells at the Stringfellow NPL site are the only wells that have concentrations of TCE greater than 33,000 µgl.

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0 2 4 Miles

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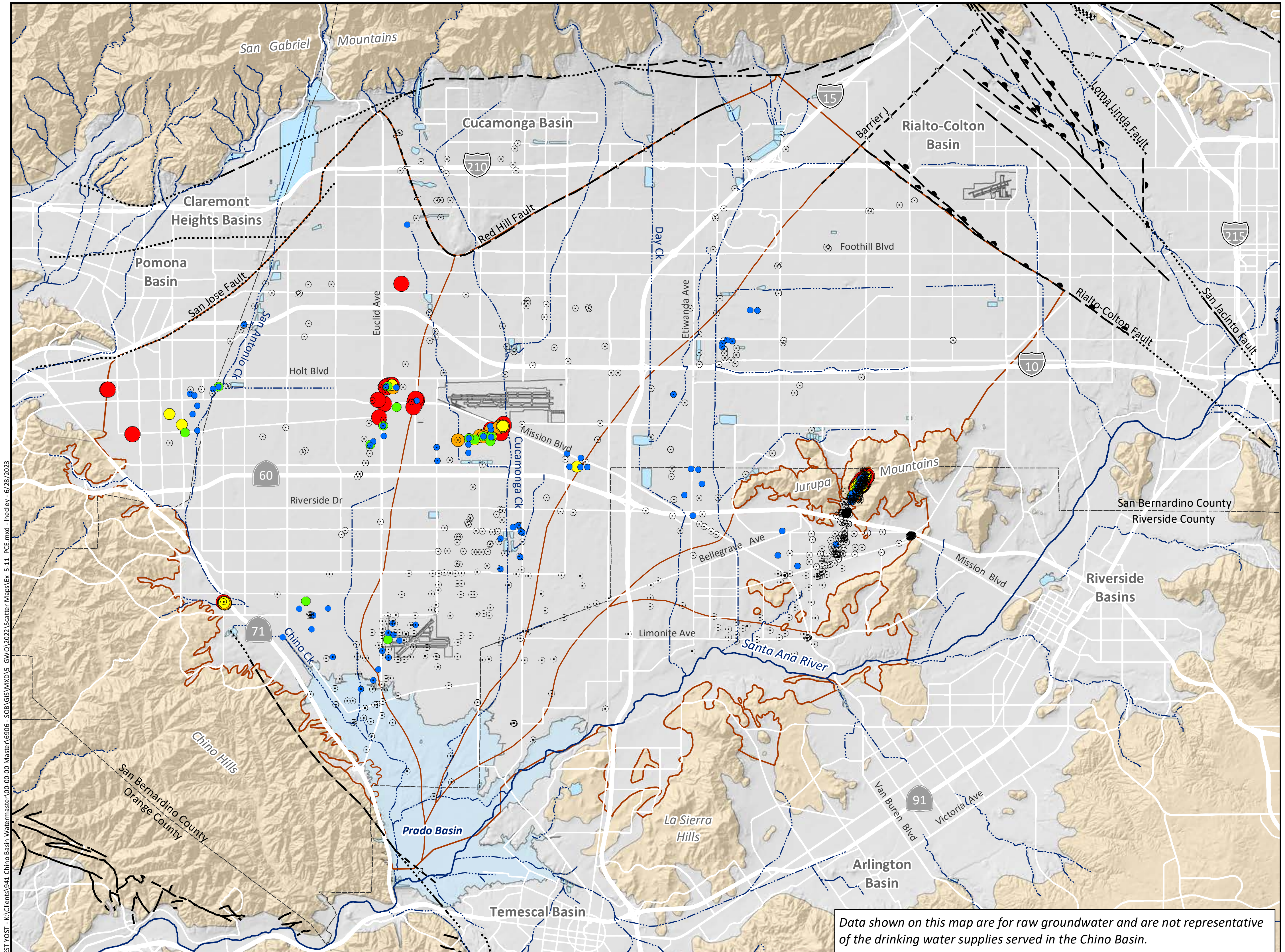
Trichloroethene (TCE) in Groundwater
Maximum Concentration (July 2017 to June 2022)

Exhibit 5-10



PCE (µgl)

- ND
- < 2.5
- 2.5 - 5
- 5 - 10
- 10 - 20
- > 20

California Primary MCL = 5 µgl

Other key map features are described in the legend of Exhibit 1-1.

PCE is a regulated drinking water contaminant in California with a primary MCL of 5 µgl. Like TCE, PCE is an industrial solvent that has been widely used as a metal degreaser in the aviation, automotive, and other metal working industries. PCE is also commonly used in the dry-cleaning industry and in the production of CFC-113 (Freon-113) and other fluorocarbons. Due to poor handling and disposal practices, PCE has entered the environment through evaporation, leaks, and improper disposal. From 2017 to 2022, 1,029 wells in the Chino Basin were sampled for PCE, with 229 (22 percent) having detectable concentrations ranging from 0.5 to 14,000 µgl, with average and median concentrations of 94 µgl and 4.9 µgl, respectively; 105 wells (10 percent) have concentrations exceeding the MCL. Wells with concentrations of PCE above the MCL occur predominantly in monitoring wells associated with the following VOC contaminant plumes: GE Flatiron, GE Test Cell, former Alger Manufacturing, and the Stringfellow NPL site. Only three wells have maximum concentrations greater than 5,800 µgl and are all located at the Stringfellow NPL.

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0 2 4 Miles

0 2 4 Km

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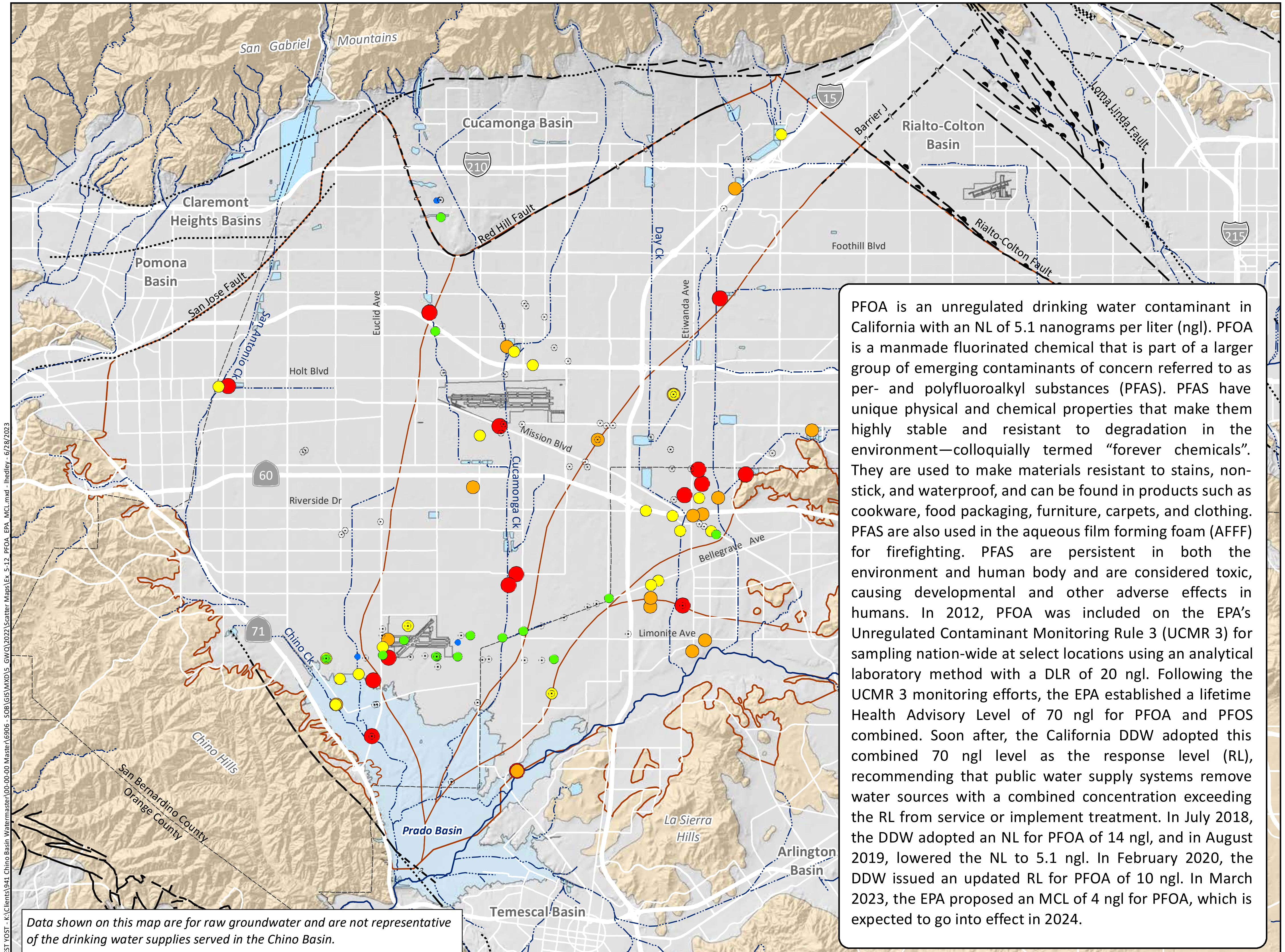
2022 State of the Basin Report
Groundwater Quality

Tetrachloroethene (PCE) in Groundwater
Maximum Concentration (July 2017 to June 2022)

Exhibit 5-11



PFOA is an unregulated drinking water contaminant in California with an NL of 5.1 nanograms per liter (ngl). PFOA is a manmade fluorinated chemical that is part of a larger group of emerging contaminants of concern referred to as per- and polyfluoroalkyl substances (PFAS). PFAS have unique physical and chemical properties that make them highly stable and resistant to degradation in the environment—colloquially termed "forever chemicals". They are used to make materials resistant to stains, non-stick, and waterproof, and can be found in products such as cookware, food packaging, furniture, carpets, and clothing. PFAS are also used in the aqueous film forming foam (AFFF) for firefighting. PFAS are persistent in both the environment and human body and are considered toxic, causing developmental and other adverse effects in humans. In 2012, PFOA was included on the EPA's Unregulated Contaminant Monitoring Rule 3 (UCMR 3) for sampling nation-wide at select locations using an analytical laboratory method with a DLR of 20 ngl. Following the UCMR 3 monitoring efforts, the EPA established a lifetime Health Advisory Level of 70 ngl for PFOA and PFOS combined. Soon after, the California DDW adopted this combined 70 ngl level as the response level (RL), recommending that public water supply systems remove water sources with a combined concentration exceeding the RL from service or implement treatment. In July 2018, the DDW adopted an NL for PFOA of 14 ngl, and in August 2019, lowered the NL to 5.1 ngl. In February 2020, the DDW issued an updated RL for PFOA of 10 ngl. In March 2023, the EPA proposed an MCL of 4 ngl for PFOA, which is expected to go into effect in 2024.

PFOA (ngl)

- ND
- < 2
- 2 - 4
- 4 - 8
- 8 - 16
- > 16

Proposed EPA MCL = 4 ngl
California NL = 5.1 ngl

Other key map features are described in the legend of Exhibit 1-1.

Monitoring for PFOA and other PFAS compounds in the Chino Basin began in 2019, in part due to the State Water Board issuing orders to monitor for PFAS compounds, including PFOA at selected public supply wells throughout the state. The sample results collected during and after 2019 provide a good characterization of the occurrence of PFOA because laboratory analytical methods with a DLR below the NL were developed and utilized. From 2017 to 2022, PFOA was measured at 137 wells in the Chino Basin with 67 (49 percent) of the wells having detectable concentrations ranging from 1.7 to 48 ngl, with average and median concentrations of 7.5 and 5 ngl, respectively. Of the 137 wells where PFOA was measured, 47 wells (34 percent) have a five-year maximum concentration above the NL of 5.1 and 53 wells (39 percent) have a five-year maximum concentration value that exceeds the proposed EPA MCL of 4 ngl. Wells with detectable levels of PFOA are distributed across the Chino Basin at variable concentrations.

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0 2 4 Miles
0 2 4 Km

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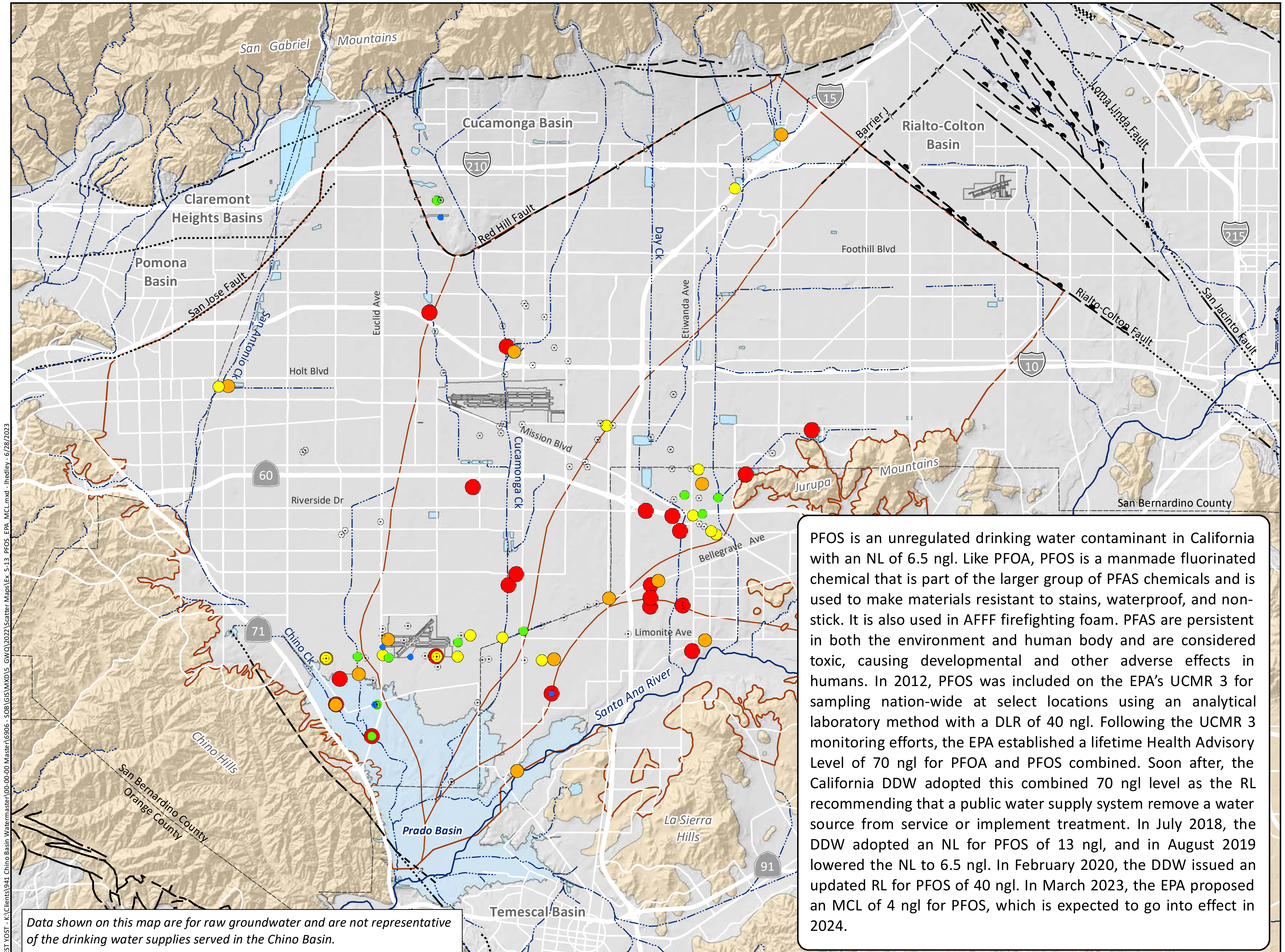
Groundwater Quality

Perfluorooctanoic Acid (PFOA) in Groundwater
Maximum Concentration (July 2017 to June 2022)

Exhibit 5-12



PFOS is an unregulated drinking water contaminant in California with an NL of 6.5 ngl. Like PFOA, PFOS is a manmade fluorinated chemical that is part of the larger group of PFAS chemicals and is used to make materials resistant to stains, waterproof, and non-stick. It is also used in AFFF firefighting foam. PFAS are persistent in both the environment and human body and are considered toxic, causing developmental and other adverse effects in humans. In 2012, PFOS was included on the EPA's UCMR 3 for sampling nation-wide at select locations using an analytical laboratory method with a DLR of 40 ngl. Following the UCMR 3 monitoring efforts, the EPA established a lifetime Health Advisory Level of 70 ngl for PFOA and PFOS combined. Soon after, the California DDW adopted this combined 70 ngl level as the RL recommending that a public water supply system remove a water source from service or implement treatment. In July 2018, the DDW adopted an NL for PFOS of 13 ngl, and in August 2019 lowered the NL to 6.5 ngl. In February 2020, the DDW issued an updated RL for PFOS of 40 ngl. In March 2023, the EPA proposed an MCL of 4 ngl for PFOS, which is expected to go into effect in 2024.

Data shown on this map are for raw groundwater and are not representative of the drinking water supplies served in the Chino Basin.

PFOS (ngl)

- ND
- < 2
- 2 - 4
- 4 - 8
- 8 - 16
- > 16

Proposed EPA MCL = 4 ngl
California NL = 6.5 ngl

Other key map features are described in the legend of Exhibit 1-1.

The monitoring for PFOS and other PFAS compounds in the Chino Basin began in 2019, in part due to the orders issued by the State Water Board to monitor for PFAS compounds, including PFOS at selected public supply wells throughout the state. The sample results collected during or after 2019 provide a good characterization of the occurrence of PFOS, because laboratory analytical methods with a DLR lower than the NL were developed and utilized. From 2017 to 2022, PFOS was measured at 137 wells in the Chino Basin with 62 wells (45 percent) of the wells having detectable concentrations ranging from 1.7 to 210 ngl, with average and median concentrations of 14 and 6.7 ngl, respectively; 39 wells (28 percent) have a five-year maximum concentration value that exceeds the NL and 49 wells (36 percent) have a five-year maximum concentration value that exceeds the proposed EPA MCL. Wells with detectable levels of PFOS are distributed across the Basin at variable concentrations.

0 2 4 Miles
0 2 4 Km

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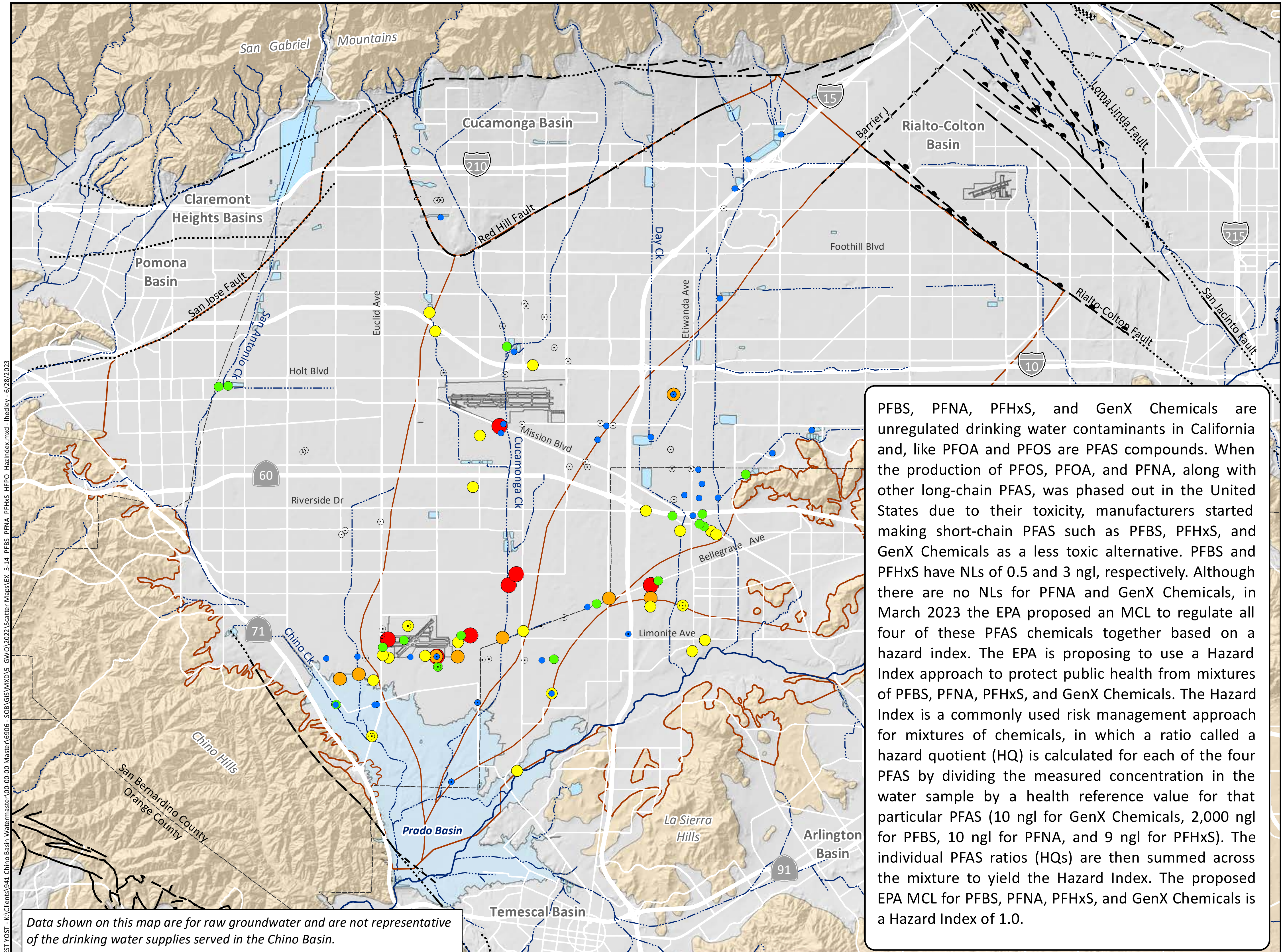
Perfluorooctane Sulfonic Acid (PFOS) in Groundwater
Maximum Concentration (July 2017 to June 2022)

Exhibit 5-13



Data shown on this map are for raw groundwater and are not representative of the drinking water supplies served in the Chino Basin.

PFBS, PFNA, PFHxS, and GenX Chemicals are unregulated drinking water contaminants in California and, like PFOA and PFOS are PFAS compounds. When the production of PFOS, PFOA, and PFNA, along with other long-chain PFAS, was phased out in the United States due to their toxicity, manufacturers started making short-chain PFAS such as PFBS, PFHxS, and GenX Chemicals as a less toxic alternative. PFBS and PFHxS have NLs of 0.5 and 3 ngl, respectively. Although there are no NLs for PFNA and GenX Chemicals, in March 2023 the EPA proposed an MCL to regulate all four of these PFAS chemicals together based on a hazard index. The EPA is proposing to use a Hazard Index approach to protect public health from mixtures of PFBS, PFNA, PFHxS, and GenX Chemicals. The Hazard Index is a commonly used risk management approach for mixtures of chemicals, in which a ratio called a hazard quotient (HQ) is calculated for each of the four PFAS by dividing the measured concentration in the water sample by a health reference value for that particular PFAS (10 ngl for GenX Chemicals, 2,000 ngl for PFBS, 10 ngl for PFNA, and 9 ngl for PFHxS). The individual PFAS ratios (HQs) are then summed across the mixture to yield the Hazard Index. The proposed EPA MCL for PFBS, PFNA, PFHxS, and GenX Chemicals is a Hazard Index of 1.0.

PFBS, PFHxS, PFNA, and GenX Chemicals
Hazard Index

- 0
- < 0.5
- 0.5 - 1
- 1 - 2
- 2 - 4
- > 4

Proposed EPA MCL
Hazard Index = 1.0

Other key map features are described in the legend of Exhibit 1-1.

From 2017 to 2022, PFBS, PFHxS, PFNA, and GenX Chemicals were measured at 137 wells in the Chino Basin with 93 wells (68 percent) of the wells having detectable concentrations of at least one of these chemicals. There were no detectable concentrations of GenX Chemicals. The maximum concentrations of PFBS, PFNA, and PFHxS are as follows: 200, 6.1, and 214 ngl, respectively. The minimum detectable concentrations of PFBS, PFNA, and PFHxS are as follows: 1.7, 1.7, and 1.9 ngl, respectively. The Hazard Index for wells with detectable concentrations of at least one of these PFAS ranged from 0.00085 to 23.88; 41 wells (30 percent) had a Hazard Index greater than the proposed MCL of 1.0.

0 2 4 Miles
0 2 4 Km

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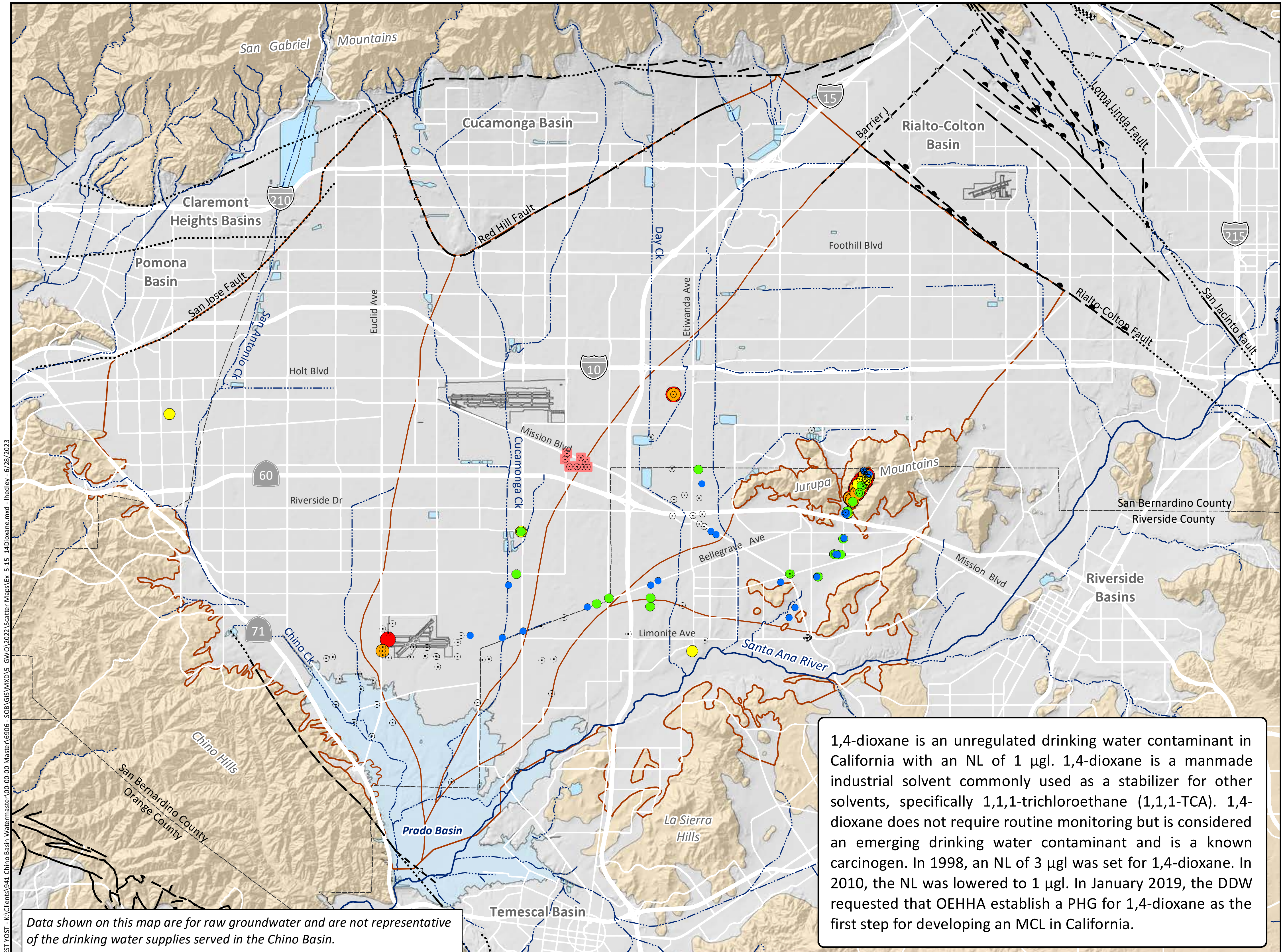
PFBS, PFNA, PFHxS, and GenX Chemicals in Groundwater
Maximum Hazard Index (July 2017 to June 2022)

Exhibit 5-14



1,4-dioxane is an unregulated drinking water contaminant in California with an NL of 1 µgl. 1,4-dioxane is a manmade industrial solvent commonly used as a stabilizer for other solvents, specifically 1,1,1-trichloroethane (1,1,1-TCA). 1,4-dioxane does not require routine monitoring but is considered an emerging drinking water contaminant and is a known carcinogen. In 1998, an NL of 3 µgl was set for 1,4-dioxane. In 2010, the NL was lowered to 1 µgl. In January 2019, the DDW requested that OEHHA establish a PHG for 1,4-dioxane as the first step for developing an MCL in California.

1,4-Dioxane (µgl)

- ND
- < 0.5
- 0.5 - 1
- 1 - 2
- 2 - 4
- > 4

California NL = 1 µgl

Used DLR greater than NL of 1 µgl

Other key map features are described in the legend of Exhibit 1-1.

The recommended DLR for laboratory analytical methods is 1 µgl, which is equivalent to the NL. However, there are some methods that can quantify concentrations lower than 1 µgl. 1,4-dioxane is not commonly monitored in the Chino Basin and when monitoring is performed, it is not always done using laboratory methods that have a DLR of 1 µgl or lower. From 2017-2022, 223 wells were sampled for 1,4-dioxane. This is about 20 percent of all the wells in the Chino Basin that are sampled for water-quality analyses. Of the 223 wells sampled for 1,4-dioxane, most were monitoring wells associated with the Stringfellow NPL site. 116 of the wells sampled (52 percent) had detected concentrations of 1,4-dioxane. The five-year maximum concentrations range from 0.07 to 260 µgl with an average and median concentrations of 14 µgl and 1.8 µgl. 66 wells (30 percent) have a five-year maximum concentration that exceeds the NL. About 80 percent of the actively sampled wells have either not been analyzed for 1,4-dioxane in the last five years or analyzed using laboratory methods with DLRs equivalent to or below the NL of 1 µgl. This includes most of the drinking water supply wells. Thus, there is paucity in the characterization of 1,4-dioxane in the Chino Basin and its occurrence is not well known as the DDW moves towards developing an MCL.

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0 2 4 Miles

0 2 4 Km

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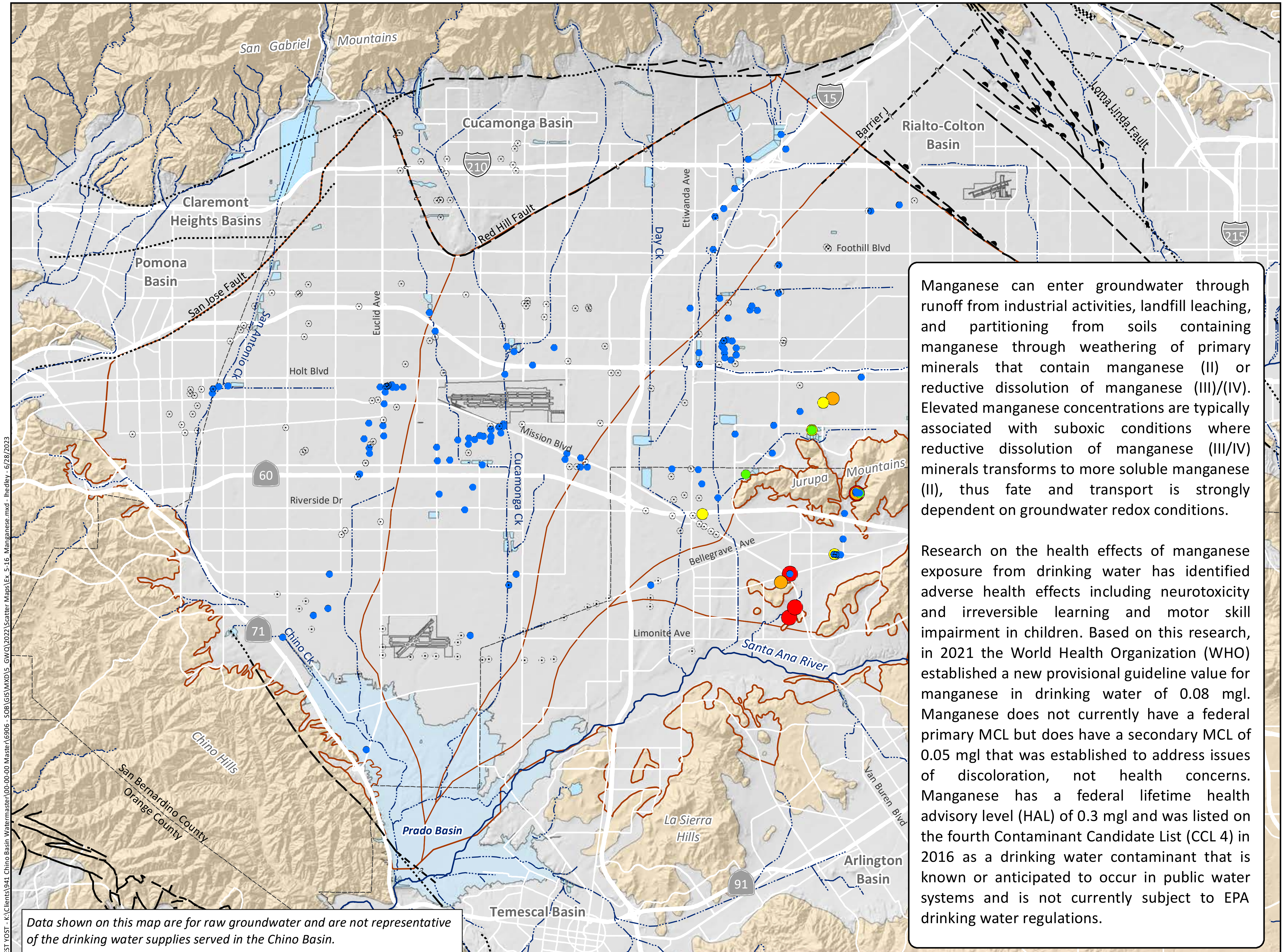
1,4-Dioxane in Groundwater
Maximum Concentration (July 2017 to June 2022)

Exhibit 5-15



Data shown on this map are for raw groundwater and are not representative of the drinking water supplies served in the Chino Basin.

Manganese can enter groundwater through runoff from industrial activities, landfill leaching, and partitioning from soils containing manganese through weathering of primary minerals that contain manganese (II) or reductive dissolution of manganese (III)/(IV). Elevated manganese concentrations are typically associated with suboxic conditions where reductive dissolution of manganese (III/IV) minerals transforms to more soluble manganese (II), thus fate and transport is strongly dependent on groundwater redox conditions.

Research on the health effects of manganese exposure from drinking water has identified adverse health effects including neurotoxicity and irreversible learning and motor skill impairment in children. Based on this research, in 2021 the World Health Organization (WHO) established a new provisional guideline value for manganese in drinking water of 0.08 mgl. Manganese does not currently have a federal primary MCL but does have a secondary MCL of 0.05 mgl that was established to address issues of discoloration, not health concerns. Manganese has a federal lifetime health advisory level (HAL) of 0.3 mgl and was listed on the fourth Contaminant Candidate List (CCL 4) in 2016 as a drinking water contaminant that is known or anticipated to occur in public water systems and is not currently subject to EPA drinking water regulations.

Manganese (mgl)

- ND
- < 0.25
- 0.25 - 0.5
- 0.5 - 1
- 1 - 2
- > 2

California NL = 0.5 mgl

Other key map features are described in the legend of Exhibit 1-1.

Manganese has a California secondary MCL of 0.05 mgl and an NL of 0.5 mgl. Recent legislation in California Senate Bill (SB) 1124 set a timeline and funding mechanisms to evaluate the need to develop a health-based drinking water limit for manganese. SB 1124 requires development of a revised NL for manganese by January 31, 2024 and a PHG by July 1, 2025. Development of a PHG will provide the scientific basis for determining a primary MCL for manganese in California.

From 2017 to 2022, 313 wells in the Chino Basin were sampled for manganese with 169 (54 percent) having detectable concentrations; 7 wells (2 percent) have a five-year maximum concentration exceeding the NL. The five-year maximum detected concentrations range from 0.00001 to 380 ugl, with average and median concentrations of 10 ugl and 0.01 µgl, respectively.

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0 2 4 Miles
0 2 4 Km

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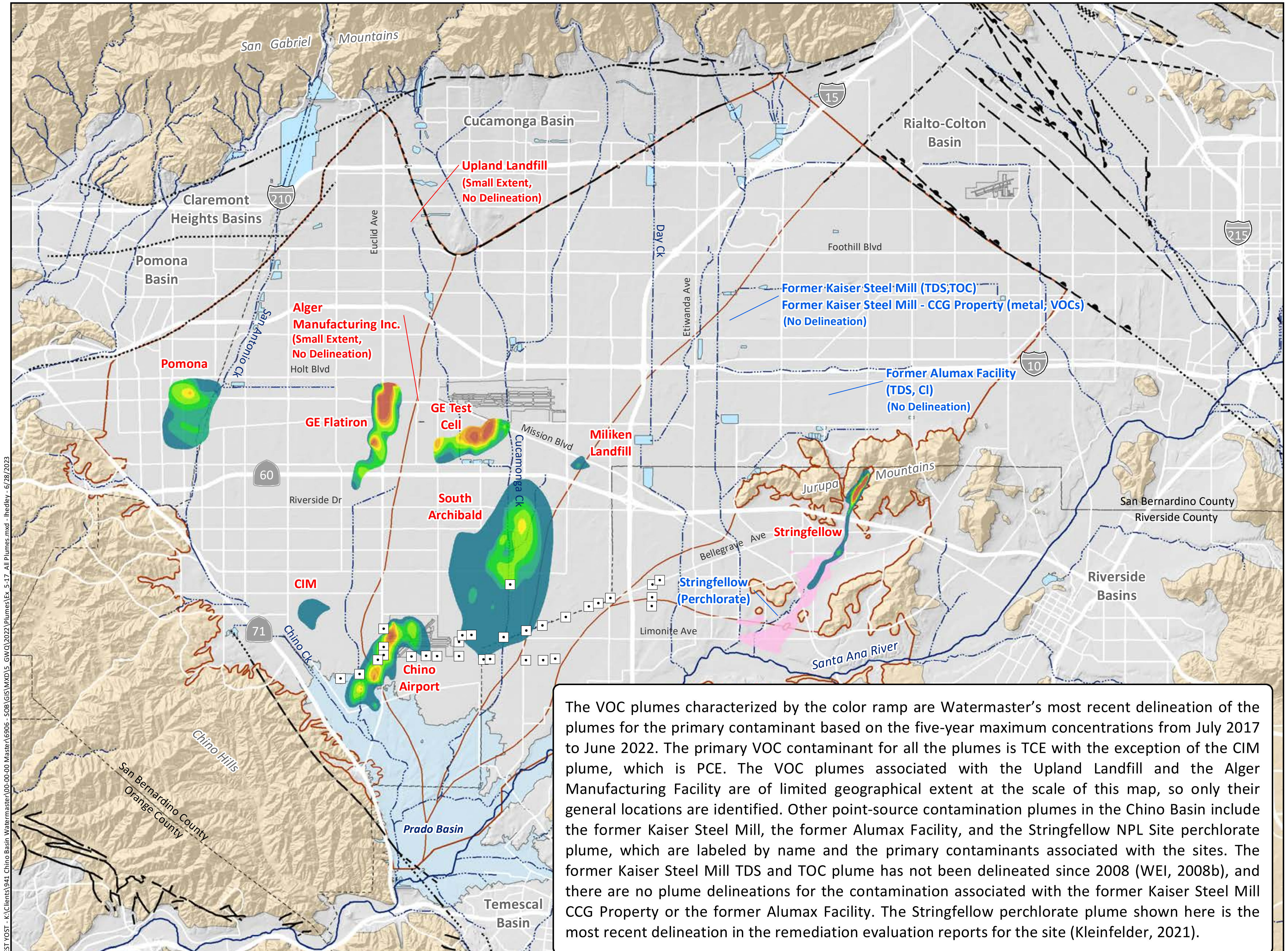
Manganese in Groundwater
Maximum Concentration (July 2017 to June 2022)

Exhibit 5-16



The VOC plumes characterized by the color ramp are Watermaster's most recent delineation of the plumes for the primary contaminant based on the five-year maximum concentrations from July 2017 to June 2022. The primary VOC contaminant for all the plumes is TCE with the exception of the CIM plume, which is PCE. The VOC plumes associated with the Upland Landfill and the Alger Manufacturing Facility are of limited geographical extent at the scale of this map, so only their general locations are identified. Other point-source contamination plumes in the Chino Basin include the former Kaiser Steel Mill, the former Alumax Facility, and the Stringfellow NPL Site perchlorate plume, which are labeled by name and the primary contaminants associated with the sites. The former Kaiser Steel Mill TDS and TOC plume has not been delineated since 2008 (WEI, 2008b), and there are no plume delineations for the contamination associated with the former Kaiser Steel Mill CCG Property or the former Alumax Facility. The Stringfellow perchlorate plume shown here is the most recent delineation in the remediation evaluation reports for the site (Kleinfelder, 2021).

VOC Concentration (µgl)

- > 0 to ≤ 5
- > 5 to ≤ 10
- > 10 to ≤ 20
- > 20 to ≤ 50
- > 50 to ≤ 100
- > 100 to ≤ 200
- > 200 to ≤ 500
- > 500

VOC Plumes Labeled in Red by Name

Other Plumes
Labled in Blue by Name and Dominant Contaminant

Chino Desalter Well

Other key map features are described in the legend of Exhibit 1-1.

The VOC plumes shown on this map are generalized illustrations of the estimated spatial extent of TCE or PCE, based on the maximum concentration measured at wells from July 2017 to June 2022. The estimated spatial distribution of VOC concentrations was generated by an ordinary kriging method performed using PyKrige, a kriging toolkit for Python. The experimental semivariograms were approximated using a spherical semivariogram whose parameters (range, sill and nugget) and anisotropy (ratio and angle) were chosen through trial and error, taking into account local groundwater flow directions predicted by the Chino Basin groundwater flow model. The plume extents were determined based on measured concentrations.

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0 2 4 Miles
0 2 4 Km

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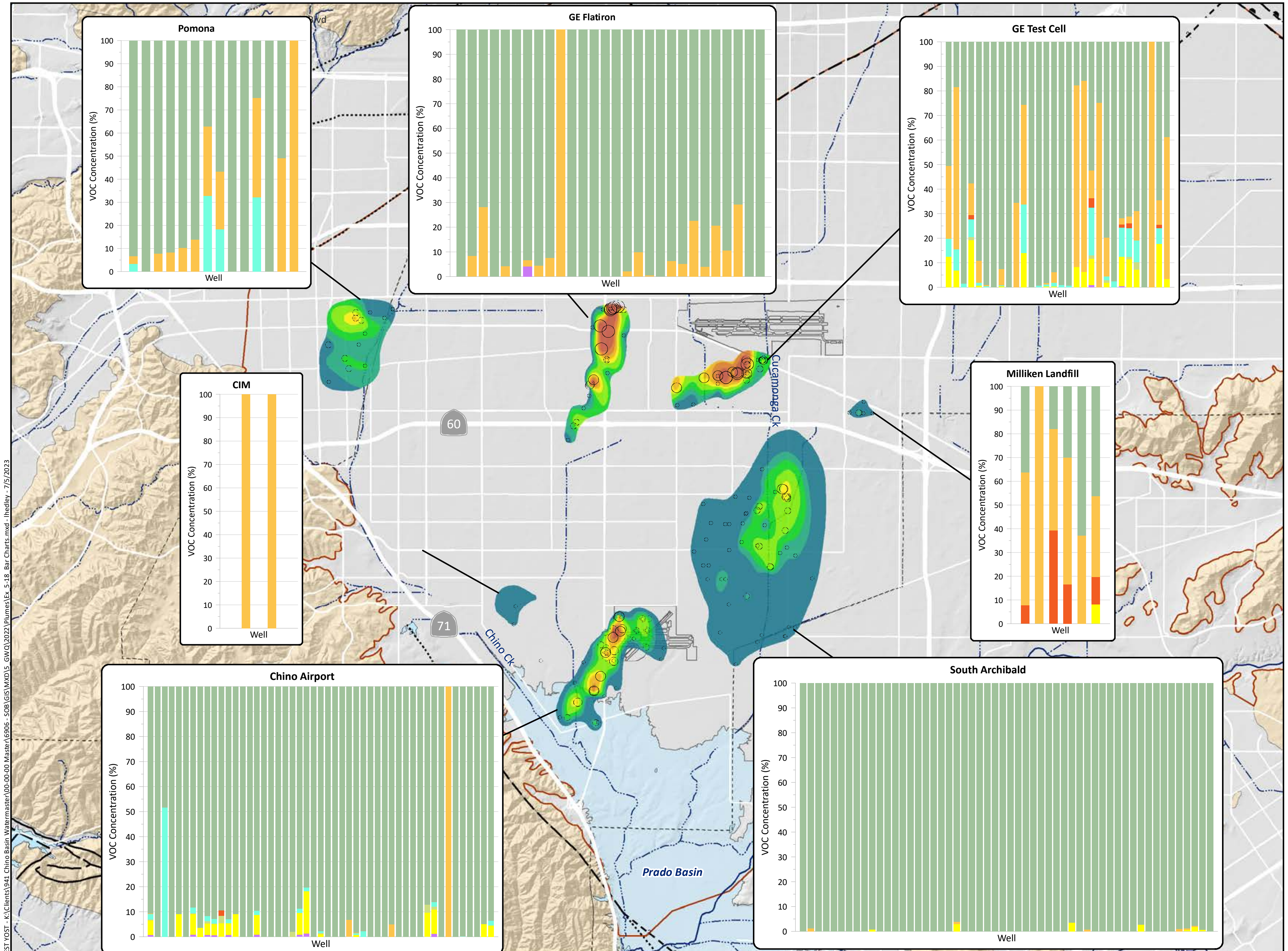
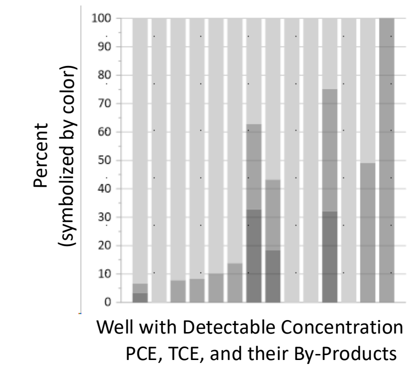
Delineation of Groundwater Contamination
Plumes and Point Sources of Concern

Exhibit 5-17



Percent of Detectable TCE, PCE, and their Degradation By-Products During the Last Sample Event



Trichloroethene (TCE)

Tetrachloroethene (PCE)

TCE and PCE Degradation By-Products

- 1,1,1-Trichloroethane
- cis-1,2-Dichloroethene
- 1,1-Dichloroethane
- trans-1,2-Dichloroethene
- 1,1-Dichloroethene
- Vinyl Chloride
- 1,2-Dichloroethane

Well Shown in Bar Chart (Symbolized by the Sum of TCE, PCE, and their Degradation By-Products) (µgl)

- 0.25 - 10
- 10 - 50
- 50 - 100
- 100 - 500
- > 500

Other key map features are described in the legend of Exhibit 1-1.

These composition bar charts show the relative percentages of VOCs measured at wells within each of the VOC plumes shown in Exhibit 5-17. The data used to create the charts are based on the results from the most recent sampling event over the five-year period of July 2017 to June 2022. The chemical differentiation of these plumes can be understood by comparing the proportions of TCE, PCE, and their breakdown by-products. For example, the Milliken Landfill plume and the GE Test Cell plume directly south of the Ontario Airport have significant percentages of both TCE and PCE, as well as the presence of breakdown products, whereas the South Archibald plume is predominantly comprised of TCE. This demonstrates that there is no intermingling of these plumes.

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0 2 4 Miles

0 2 4 Km

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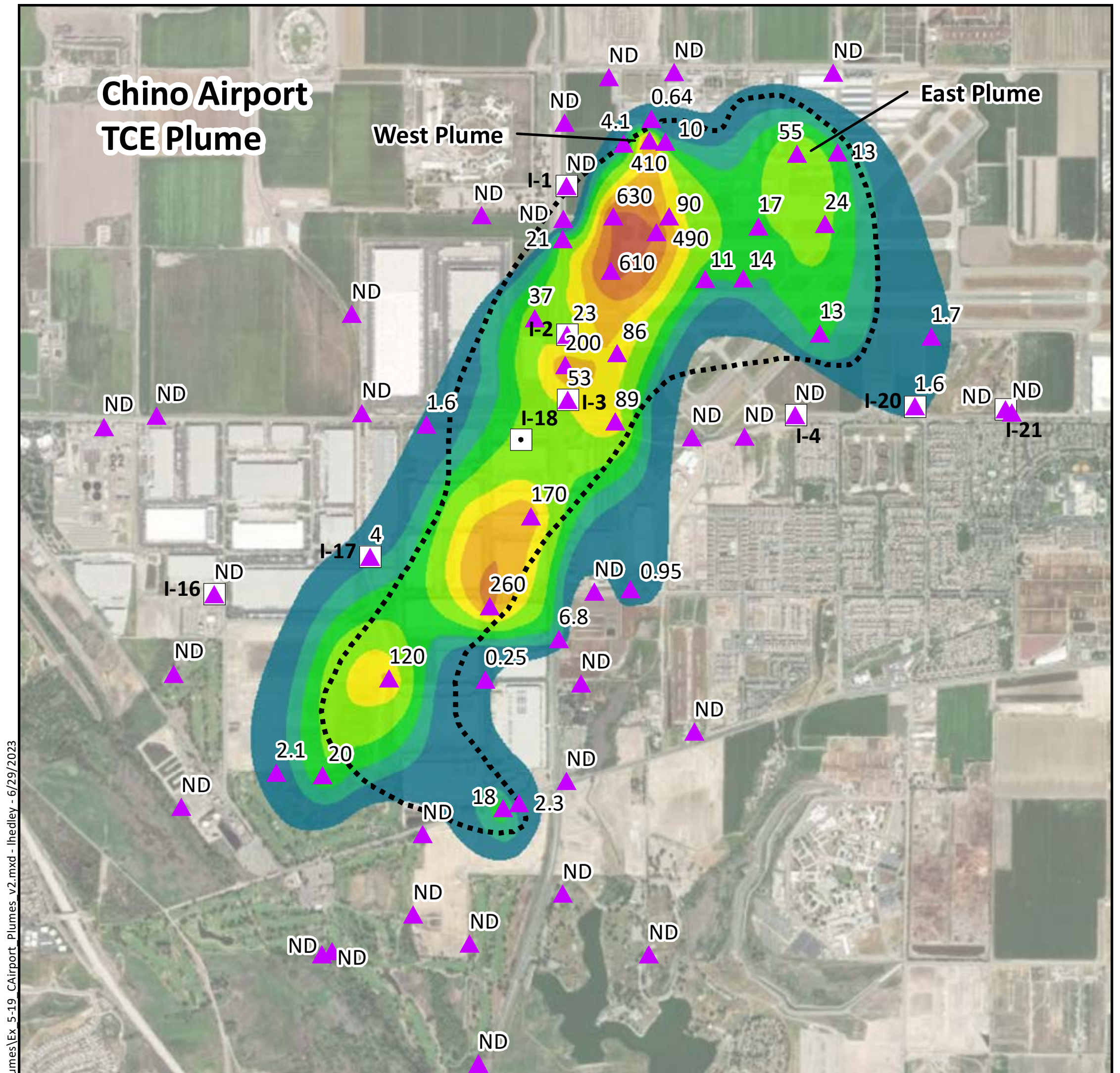
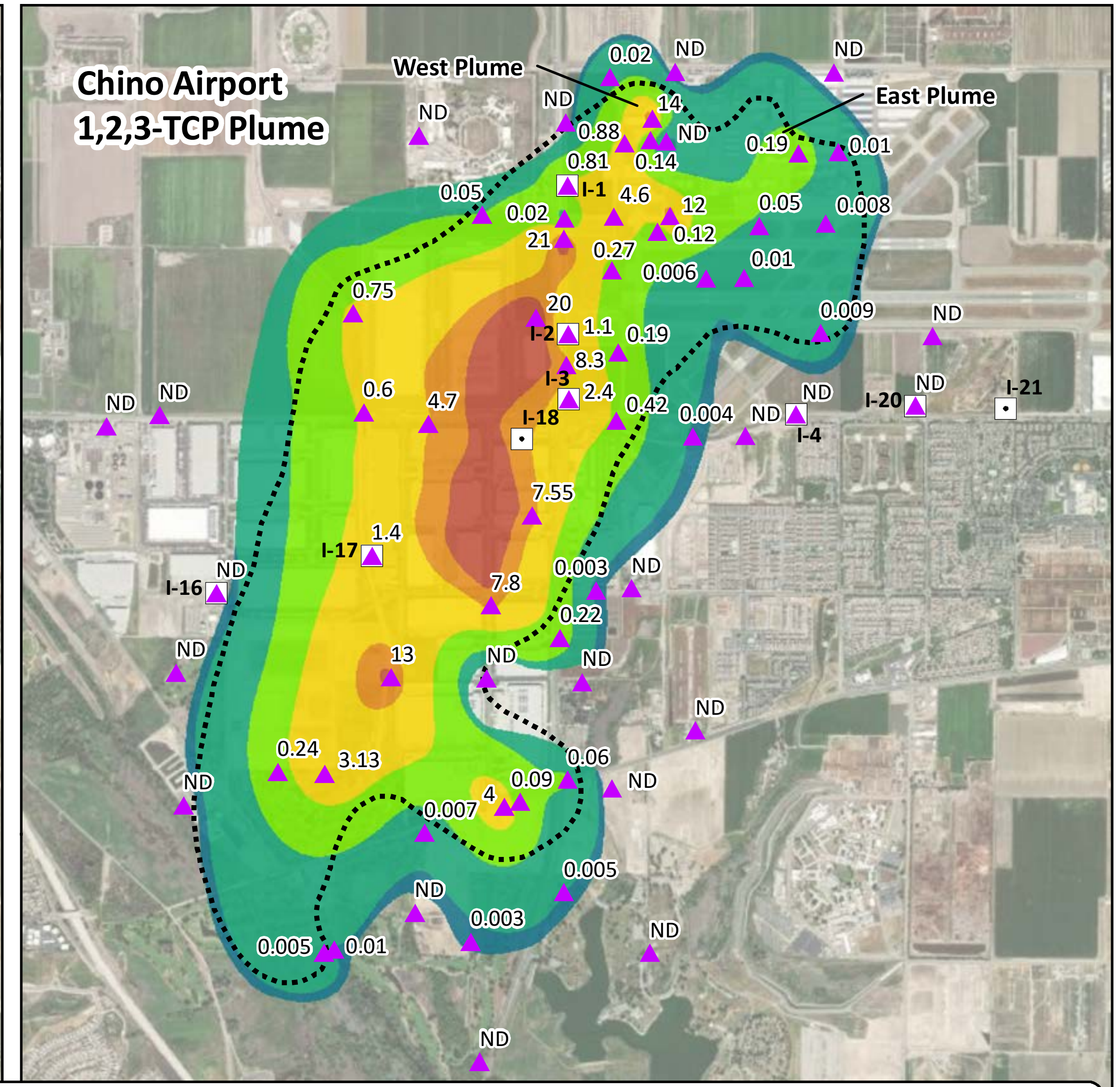
VOC Composition Charts
Wells Within and Adjacent to VOC Plumes

Exhibit 5-18





TCE Concentration (µgl)

- > 0 to ≤ 5
- > 5 to ≤ 10
- > 10 to ≤ 20
- > 20 to ≤ 50
- > 50 to ≤ 100
- > 100 to ≤ 200
- > 200 to ≤ 500
- > 500

TCE MCL = 5 µgl

1,2,3-TCP Concentration (µgl)

- > 0.0025 to ≤ 0.005
- > .005 to ≤ .05
- > .05 to ≤ .5
- > 0.5 to ≤ 5
- >5 to ≤10
- > 10

1,2,3-TCP MCL = 0.005 µgl

The VOC plumes shown in this exhibit are generalized illustrations of the estimated spatial extent of TCE and 1,2,3-TCP, based on the maximum concentration over the five-year period from July 2017 to June 2022. The estimated spatial distribution of the plume concentrations was generated using the same method as the plumes for Exhibit 5-17, using an ordinary kriging method performed using PyKrige, a Kriging toolkit for Python.

5 Wells Labeled by Maximum TCE or 1,2,3-TCP Concentration (µgl) for July 2017 to June 2022
ND = TCE or 1,2,3-TCP was Non-Detect

Chino Desalter Well

Approximate Extent of TCE (5 µgl) or 1,2,3-TCP (0.005 µgl) Plumes as Delineated by the County of San Bernardino in 2022

The Chino Airport TCE and 1,2,3-TCP plumes are located in the southwestern portion of the Chino Basin within the City of Chino. The County of San Bernardino Department of Airports (County) is identified as the responsible party for the Chino Airport plumes. The Regional Board has issued cleanup and abatement orders (CAOs) 90-134, R8-2008-0064, and R8-2017-0011, ordering the County to characterize the extent of the plumes on and offsite of the airport property, and prepare a feasibility study and remedial action plan. Since 2003, the County has constructed a total of 89 monitoring wells, 18 piezometers, and five extraction wells, and has conducted extensive investigations to characterize the soil and groundwater contamination on and offsite of airport property. The County submitted a final feasibility study for the Chino Airport in 2017 (Tetra Tech, 2017). In November 2020, a final interim remedial action plan (IRAP) was approved by the Regional Board and in July 2022, the County submitted a Remedial Action Work Plan to the Regional Board (Tetra Tech, 2020; 2022). The remedial action includes institutional controls, monitored natural attenuation, and a groundwater pump-and-treat system, which will consist of 22 wells located at ten extraction well sites both on and offsite. It will also incorporate the existing Chino Desalter wells I-16, I-17, I-18, and potentially I-20 and I-21. All extraction wells are expected to be complete by 2025 and will go into operation as they are constructed. Extracted groundwater will be treated for TCE and 1,2,3-TCP at a new granular activated carbon treatment system at the Chino-I Desalter facility.

Watermaster collects groundwater-quality samples from private wells in the plume area and at its HCMP-4 monitoring well. Additionally, the CDA collects groundwater-quality samples from the Chino Desalter wells. Watermaster uses data from the County, CDA, and its own sampling to perform an independent characterization of the areal extent and concentration of the TCE and 1,2,3-TCP plumes every two years for the State of the Basin Report. Watermaster's 2022 plume characterizations are based on the maximum concentrations measured at wells from July 2017 to June 2022.

TCE and 1,2,3-TCP are the primary contaminants associated with the Chino Airport plume. The County characterizes West and East plumes, originating from two different source areas at the Chino Airport. The West and East plumes are comingled, and TCE and 1,2,3-TCP concentrations are higher within the West plumes than the East plumes. The extent of the West plumes is also greater. Over time, the vertical and lateral extents of the plumes have changed in response to groundwater production at nearby wells and other hydrological factors, with the vertical extent of the plume increasing by almost 100 feet and the lateral extent of the plume moving in the southeast direction. The County prepared its most recent characterization of the TCE and 1,2,3-TCP plumes in 2022 (Tetra Tech, 2023), which are shown here compared to Watermaster's delineation of the plumes.

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0 0.5 1 Miles
0 0.5 1 Km

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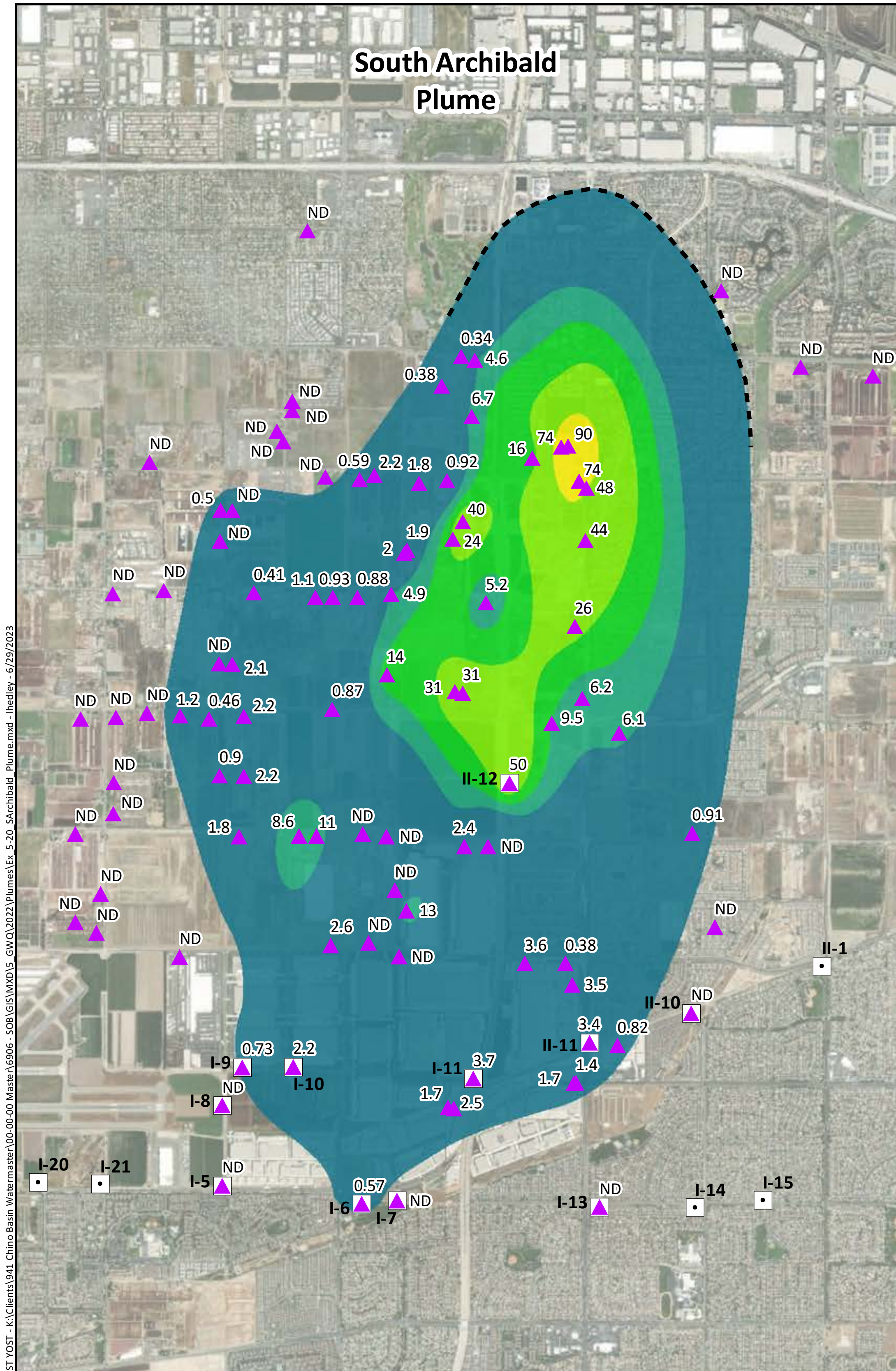
Chino Airport TCE and 1,2,3-TCP Plumes

Exhibit 5-19



The South Archibald TCE plume is located in the southern Chino Basin within the City of Ontario. In the mid-1980s, when Metropolitan sampled wells south of the Ontario International Airport (OIA) as part of the Chino Basin Storage Program, they found TCE in several private wells (Metropolitan et al., 1987). The Regional Board confirmed the presence of TCE with subsequent rounds of sampling and identified activities at OIA as likely sources of TCE. In 2005, the Regional Board issued Draft CAOs to six different parties who were tenants on the OIA property. On a voluntary basis, four of the six parties (Aerojet, Boeing, GE, and Lockheed Martin, collectively the ABGL Parties) worked together, along with the U.S. Department of Defense, to investigate the source of contamination. The investigation included collecting water-quality samples from private wells and taps at residences, as well as constructing and sampling four triple-nested monitoring wells. Alternative water supplies were provided at private residences in the area where groundwater was contaminated.

The Regional Board staff conducted research pertaining to the likely source of TCE contamination and identified discharges of wastewater to the RP-1 treatment plant and associated disposal areas as potential sources. The Regional Board identified several industries, including some previously identified tenants of the OIA property, that likely used TCE solvents in the past and discharged wastes to the Cities of Ontario and Upland sewage systems tributary to the RP-1 treatment plant and disposal areas. In 2012, the Regional Board issued an additional Draft CAO to the City of Ontario, City of Upland, and the IEUA as the previous and current operators of the RP-1 treatment plant and disposal area (collectively the RP-1 Parties). Under the Regional Board's oversight from 2007 to 2014, the ABGL Parties and the RP-1 Parties conducted sampling at private residential wells and taps approximately every two years.

In November 2015, the RP-1 Parties completed a draft feasibility study and remedial action plan, which identified a pump-and-treat system as the preferred groundwater remediation alternative. The system will rely on the use of existing Chino Desalter wells and treatment facilities, as well as three newly constructed wells and a dedicated pipeline to convey water to the Chino-II Desalter facility. The preferred domestic water supply alternative identified in the remedial action plan includes the installation of tank systems, where water is delivered from the City of Ontario potable supply, and the installation of a pipeline to connect some residences to the City of Ontario potable water system.

In September 2016, the Regional Board issued the Final Stipulated Settlement and CAO R8-2016-0016 (Stipulated CAO) collectively to the RP-1 Parties and the ABGL Parties (excluding Northrop Grumman). The Stipulated CAO was adopted by all Parties in November 2016, thus approving the preferred plume remediation and domestic water supply alternatives identified in the remedial action plan. The Parties also reached a settlement agreement that aligned with the Final CAO and authorized funding to modify the Chino Desalter facilities to use air stripping to treat TCE and other VOCs and to construct three new desalter wells (II-10, II-11, and II-12). Construction was completed and pumping began at CDA wells II-10 and II-11 in 2018 and at CDA well II-12 in August 2021. Additionally, a dedicated raw water pipeline was constructed to convey groundwater to the Chino-II Desalter facility for treatment.

TCE Concentration (µgl)

- > 0 to ≤ 5
- > 5 to ≤ 10
- > 10 to ≤ 20
- > 20 to ≤ 50
- > 50 to ≤ 100
- > 100 to ≤ 200
- > 200 to ≤ 500
- > 500

TCE MCL = 5 µgl

The VOC plume shown in this exhibit is a generalized illustration of the estimated spatial extent of TCE based on the maximum concentration over the five-year period from July 2017 to June 2022. The estimated spatial distribution of the plume concentrations was generated using the same method as the plumes for Exhibit 5-17, using an ordinary kriging method performed using PyKrige, a kriging toolkit for Python.

5 Wells Labeled by Maximum TCE Concentration (µgl) from July 2017 to June 2022

ND = TCE was Non-Detect

Chino Desalter Well

No data exist in the northern portion of the plume for the analysis period so the approximate location of the spatial extent and TCE concentrations in the northern portion is unknown

The Cities of Ontario and Upland are responsible for collecting annual groundwater samples and submitting an annual monitoring report to the Regional Board pursuant to the CAO. Additionally, pursuant to the Proposition 1 Grant agreement for funding the expansion of the Chino Desalter facilities, which included the construction of new monitoring wells (CDA II-MW-4 and II-MW-5), the CDA and the IEUA completed a monitoring and reporting plan, which requires quarterly and annual reporting of the data collected. Watermaster also routinely collects and analyzes samples from active private wells in and around the plume and uses the available data to delineate the TCE plume every two years. This 2022 plume characterization is based on the maximum TCE concentrations measured at wells from July 2017 to June 2022. Watermaster works closely with the Regional Board, the responsible parties, and other stakeholders in providing any available information to assist in the investigation and provides semi-annual updates to the Watermaster Board on the status of the investigation and remediation.

Prepared by:

WEST YOST
Water. Engineered.

0 0.5 1 Miles

0 0.5 1 Km

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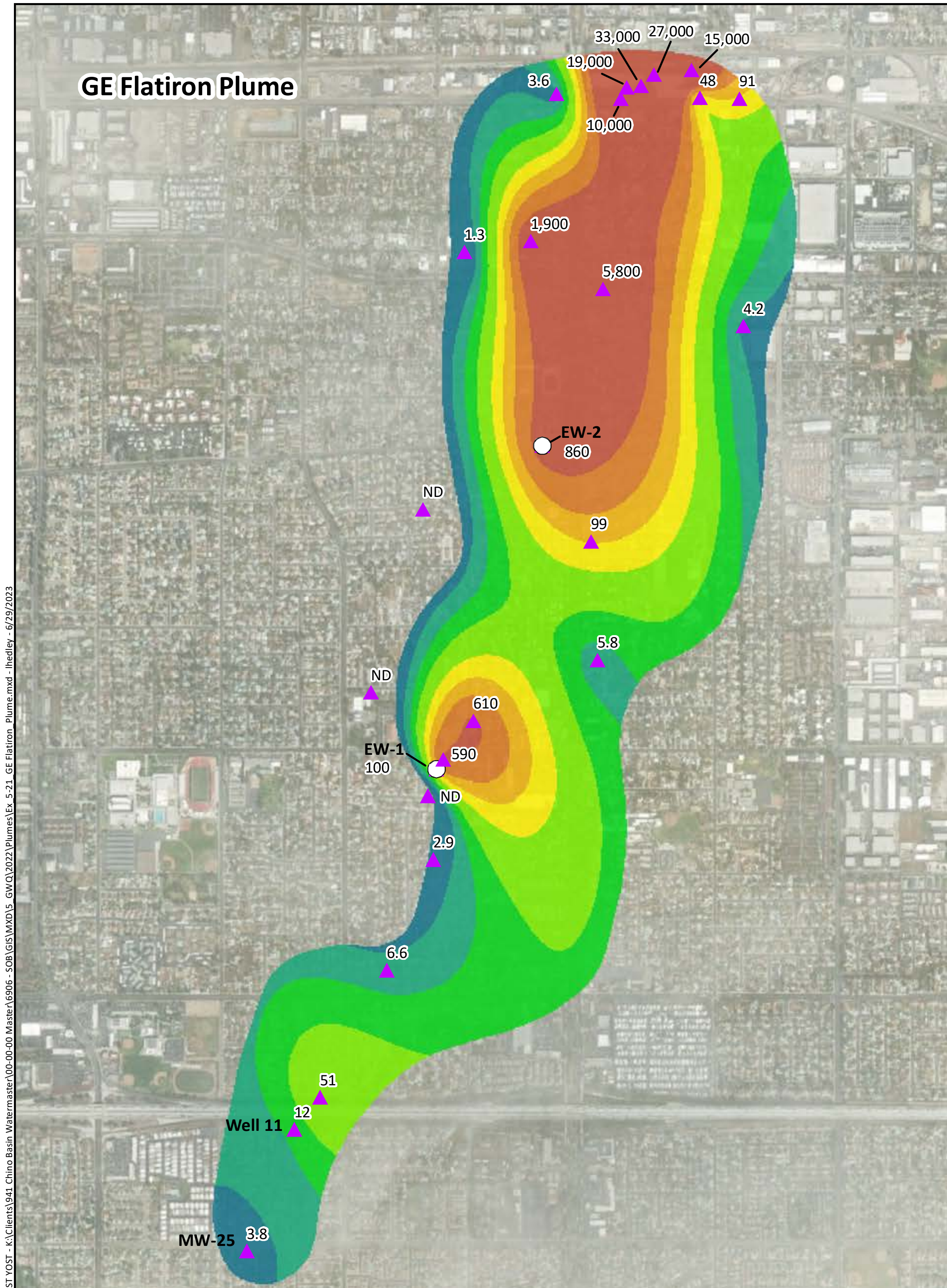
South Archibald TCE Plume

Exhibit 5-20



The GE Flatiron TCE plume is in the central Chino Basin within the City of Ontario. GE manufactured clothes irons at the Flatiron Facility from the early 1900s to 1982. In 1987, TCE and chromium were detected above drinking water standards at a municipal supply well downgradient from the site. A Phase I investigation performed by GE confirmed that the former facility was the source of contamination. The Regional Board issued Investigative Order No. 87-146 which required GE to further characterize on-site conditions and groundwater flow patterns. Following the onsite characterization, Phases II-V of the investigation required extensive sampling to define the extent of contaminants in groundwater both on and offsite. In the end, these investigations revealed a contaminant plume beneath and downgradient of the former Flatiron Facility. An interim remedial measure was proposed in 1993, which prescribed a pump-and-treat program using an ion exchange resin and liquid-phase granular activated carbon to remove TCE, chromium, and other VOCs in groundwater. In 1996, GE began operating the first extraction well (EW-01) at the leading edge of the plume. In 2002, GE began operation of an additional extraction well (EW-02) located in the center of the plume. Groundwater from the extraction wells was treated at GE Flatiron's groundwater treatment system and discharged to the Ely Basins. In 2005, the Ely Basins became fully dedicated to the recharge of stormwater, recycled water, and imported water for Watermaster and the IEUA's long-term recharge plan, and the treated effluent could no longer be discharged into the Ely Basins. As an alternative, three injection wells and conveyance pipelines were installed in July 2011.

In 2016 and 2017, under the Regional Board's direction, GE constructed two new monitoring well clusters downgradient of the known plume extent and just upgradient of a City of Chino supply well (Well 11). Monitoring at these new wells indicated that the plume extended another 0.5 miles downgradient from EW-01. Later in 2016 and 2017, GE constructed four new monitoring well clusters in the upgradient end of the plume. High concentrations of TCE, PCE, total chromium, and hexavalent chromium have been detected at several of these wells, and the highest concentration of TCE ever measured in the GE Flatiron plume (33,000 µgl) was at one of these wells in 2021. In July 2021 the City of Chino asked the Regional Board to investigate whether Well 11 is or will be impacted by the plume, as they were planning to put the well back in service. Sampling results showed concentrations of TCE above the MCL at Well 11. Per the Regional Board's request, GE submitted a work plan in August 2021 for a groundwater investigation downgradient of Well 11 and an engineering study for the installation of a new groundwater extraction well.

In 2022, GE installed an additional monitoring well cluster (MW-25) downgradient of Well 11. TCE and chromium were detected in several of the samples but were below the respective MCLs.

TCE Concentration (µgl)

- > 0 to ≤ 5
- > 5 to ≤ 10
- > 10 to ≤ 20
- > 20 to ≤ 50
- > 50 to ≤ 100
- > 100 to ≤ 200
- > 200 to ≤ 500
- > 500

TCE MCL = 5 µgl

The VOC plume shown in this exhibit is a generalized illustration of the estimated spatial extent of TCE based on the maximum concentration over the five-year period from July 2017 to June 2022. The estimated spatial distribution of the plume concentrations was generated using the same method as the plumes for Exhibit 5-17, using an ordinary kriging method performed using PyKrige, a kriging toolkit for Python.

5 Wells Labeled by Maximum TCE Concentration (µgl) from July 2017 to June 2022

ND = TCE was Non-Detect in Samples

GE Extraction Well

Currently, GE performs quarterly monitoring of groundwater levels and groundwater quality at 31 monitoring wells onsite and three piezometers, as well as monthly monitoring of groundwater quality at the two extraction wells. Watermaster routinely compiles the data from the GE monitoring wells and uses them to independently delineate the spatial extent of the TCE plume every two years. This 2022 plume characterization is based on the maximum TCE concentrations measured at wells from July 2017 to June 2022. Watermaster provides annual updates to the Watermaster Board on the status of the investigation and remediation of these wells.

Prepared by:

WEST YOST
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0 0.25 0.5 Miles

0 0.25 0.5 Km

Prepared for:

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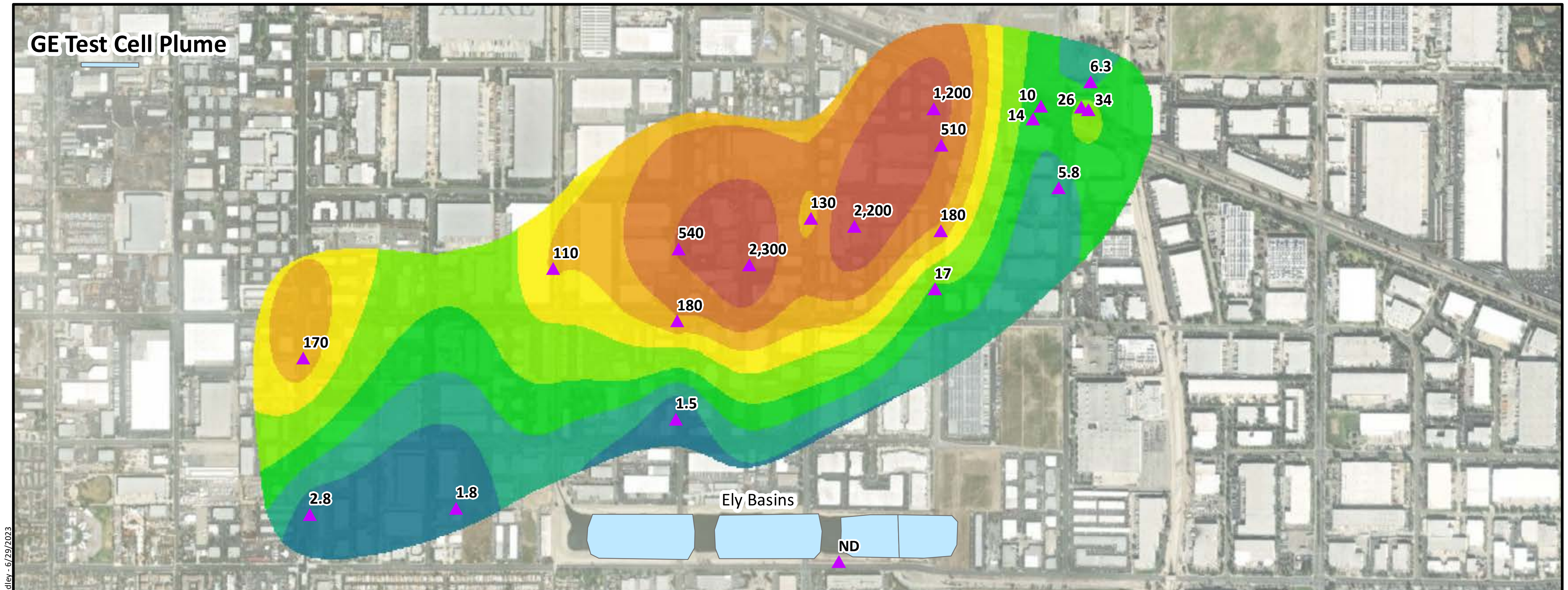
General Electric Flatiron TCE Plume

Exhibit 5-21



TCE Concentration (µgl)

- > 0 to ≤ 5
- > 5 to ≤ 10
- > 10 to ≤ 20
- > 20 to ≤ 50
- > 50 to ≤ 100
- > 100 to ≤ 200
- > 200 to ≤ 500
- > 500

TCE MCL = 5 µgl

The VOC plume shown in this exhibit is a generalized illustration of the estimated spatial extent of TCE based on the maximum concentration over the five-year period from July 2017 to June 2022. The estimated spatial distribution of the plume concentrations was generated using the same method as the plumes for Exhibit 5-17, using an ordinary kriging method performed using PyKrige, a kriging toolkit for Python.

5 Wells Labeled by Maximum TCE Concentration (µgl) from July 2017 to June 2022

ND = TCE was Non-Detect in Samples

The GE Test Cell plume is located in the central Chino Basin within the City of Ontario, south of the OIA. From 1956 to 2010, the GE Test Cell facility was predominately used to test and maintain commercial and military aircraft engines. Solvents used at the facility included TCE, PCE, 1,1,1-TCA, methyl ethyl ketone, and isopropyl alcohol. From 1956 to 1974, wastewater with residual solvents was diverted to below-ground separators where it was recycled. Beginning in 1974, wastewater was disposed of directly to the separators via onsite dry wells. In 2006, GE stopped discharging wastewater underground, instead storing it in above-ground storage tanks to transport offsite for treatment and disposal. The Test Cell facility ceased operation in 2011, and the site is currently vacant.

In 1988, following the discovery of VOCs in the soil near the disposal sites, GE and the DTSC signed Consent Order 88/89-009 to initiate the investigation of soil, surface water, and groundwater contamination. From 1991-1995, GE installed 11 monitoring wells on and offsite and noted the presence of VOCs in groundwater beneath the facility with the possibility of offsite migration. A remedial action plan was prepared in 1994 and identified a soil vapor extraction treatment system to reduce VOCs to levels that would not impact groundwater. The system began operation in 1996. Between 1996 and the early 2000s, GE constructed eight multi-depth well clusters that provided information on the vertical distribution of VOCs, indicating that TCE concentrations were highest in the intermediate and deep interval zones offsite. In 2003, GE submitted a groundwater feasibility study to the Regional Board and in 2006 they submitted a draft remedial action plan (RAP) that identified two groundwater remedial alternatives: (1) extraction and treatment of groundwater for areas that have VOC concentrations approximately ten times the MCL, and (2) monitored natural attenuation of groundwater for areas that have VOC concentrations less than ten times the MCL. In 2010, GE replaced the RAP with a new RAP for only monitored natural attenuation. The new RAP was approved with the condition that GE would install additional monitoring wells. In May 2019, the Regional Board requested GE prepare a Conceptual Site Model to aid in determining whether monitored natural attenuation was suitable as the only remedial action. The findings in the 2019 Conceptual Site Model showed: TCE concentrations have decreased one to two orders of magnitude near the source area and have remained below the MCL in the most downgradient wells; the groundwater plume is predicted to remain stable in the future; the plume has shifted slightly to the north, likely due to recharge at the Ely Basins; and that increases in TCE concentrations found at monitoring wells in the central portion of the plume indicate that TCE contamination is likely due to an offsite source. In 2022, GE submitted three work plans: (1) to investigate and delineate the vertical and lateral extent of the plume on either side of the Ely Basins and at the plume front, (2) for the feasibility, design, and installation of a plume migration control system at the core of the plume, and (3) to perform an investigation west and northwest of the site for other potential contributing sources of TCE.

Currently, GE performs quarterly monitoring of groundwater levels and groundwater quality at 35 onsite and offsite monitoring wells and four piezometers located adjacent to the Ely Basins to support the ongoing evaluation of monitored natural attenuation as the remedial action. Watermaster routinely compiles the data from the GE monitoring wells and uses them to independently delineate the spatial extent of the TCE plume every two years. Watermaster's 2022 plume characterization is based on the maximum TCE concentrations measured at wells from July 2017 to June 2022. Watermaster also prepares annual report updates on the status of the investigation and remediation of the wells.

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0 0.25 0.5 Miles

0 0.25 0.5 Km

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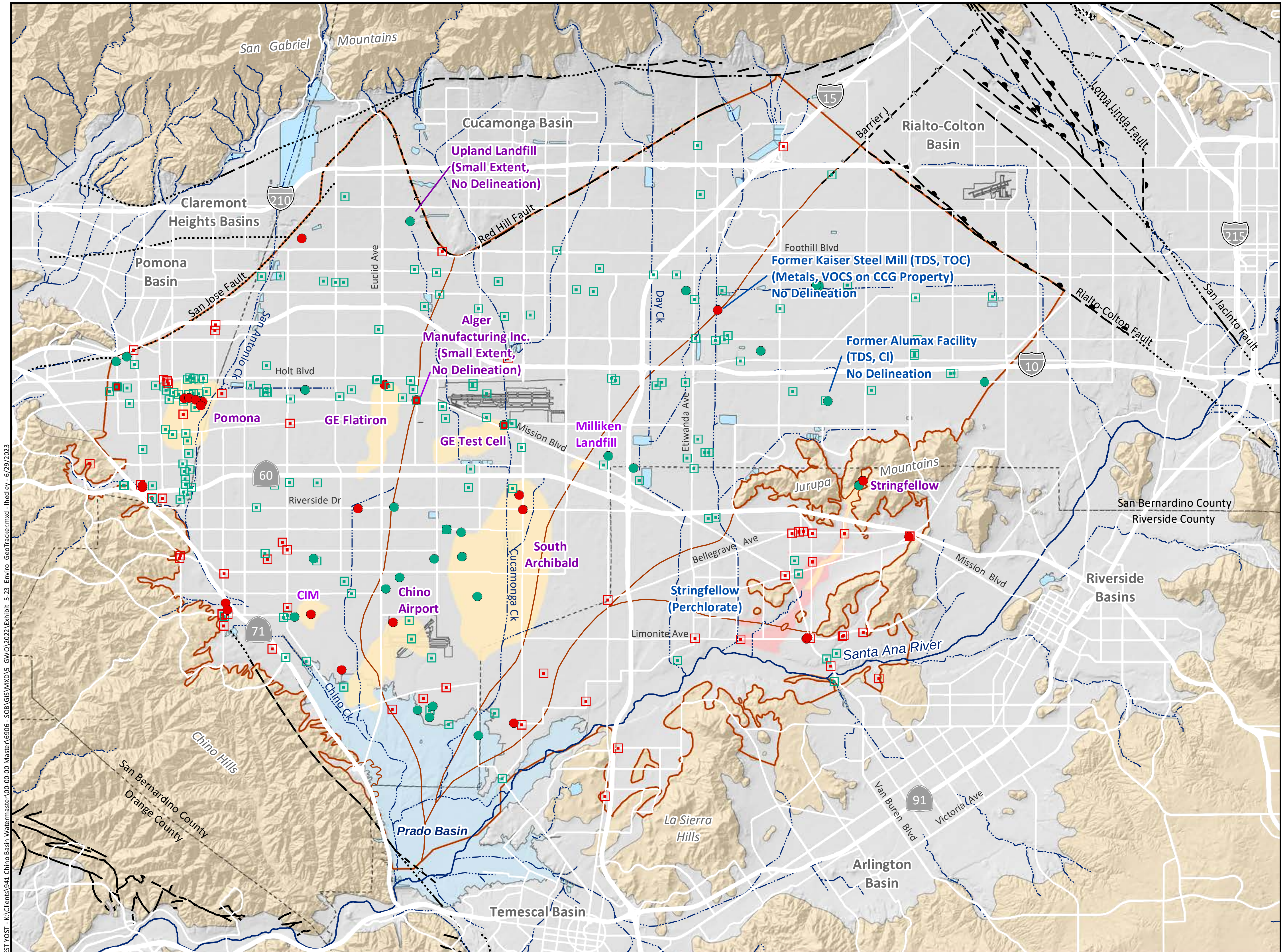
General Electric Test Cell TCE Plume

Exhibit 5-22



GeoTracker and EnviroStor Sites

Site Status (Symbol)

Open Case

Closed Case

Contaminated Media (Color)

Groundwater (potential or confirmed)

No Media Established, but Potentail Impacts to Groundwater Quality Identified

VOC Plumes Labeled in Purple by Name

VOC Plumes Delineated in 2022

Other Plumes Labeled in Blue by Name and Dominant Contaminants

Other Plumes

Plumes that are too small to be shown on this map, or are not delineated, are labeled with a line indicating the general location of the point-source site

Other key map features are described in the legend of Exhibit 1-1.

Watermaster performs a review of the GeoTracker and EnviroStor databases to identify all sites in the Chino Basin that have the potential to impact groundwater quality. As of 2022, a total of 896 sites with contaminated media were identified in the Chino Basin. The sites are categorized by site status (open or closed case) and the contaminated media (groundwater, soil, air, or not identified). Of the 896 sites, 290 were identified as having the potential to impact groundwater quality. Since 2020, nine new sites have been identified with the potential to impact groundwater quality. Sixty-two of the 290 sites with the potential to impact groundwater quality are open cases, and 228 are closed cases. Watermaster downloads all newly available monitoring data for the open sites on average twice per year. For more information about GeoTracker, see:

www.geotracker.waterboards.ca.gov

www.envirostor.dtsc.ca.gov

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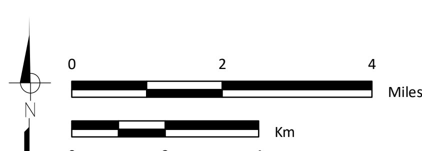

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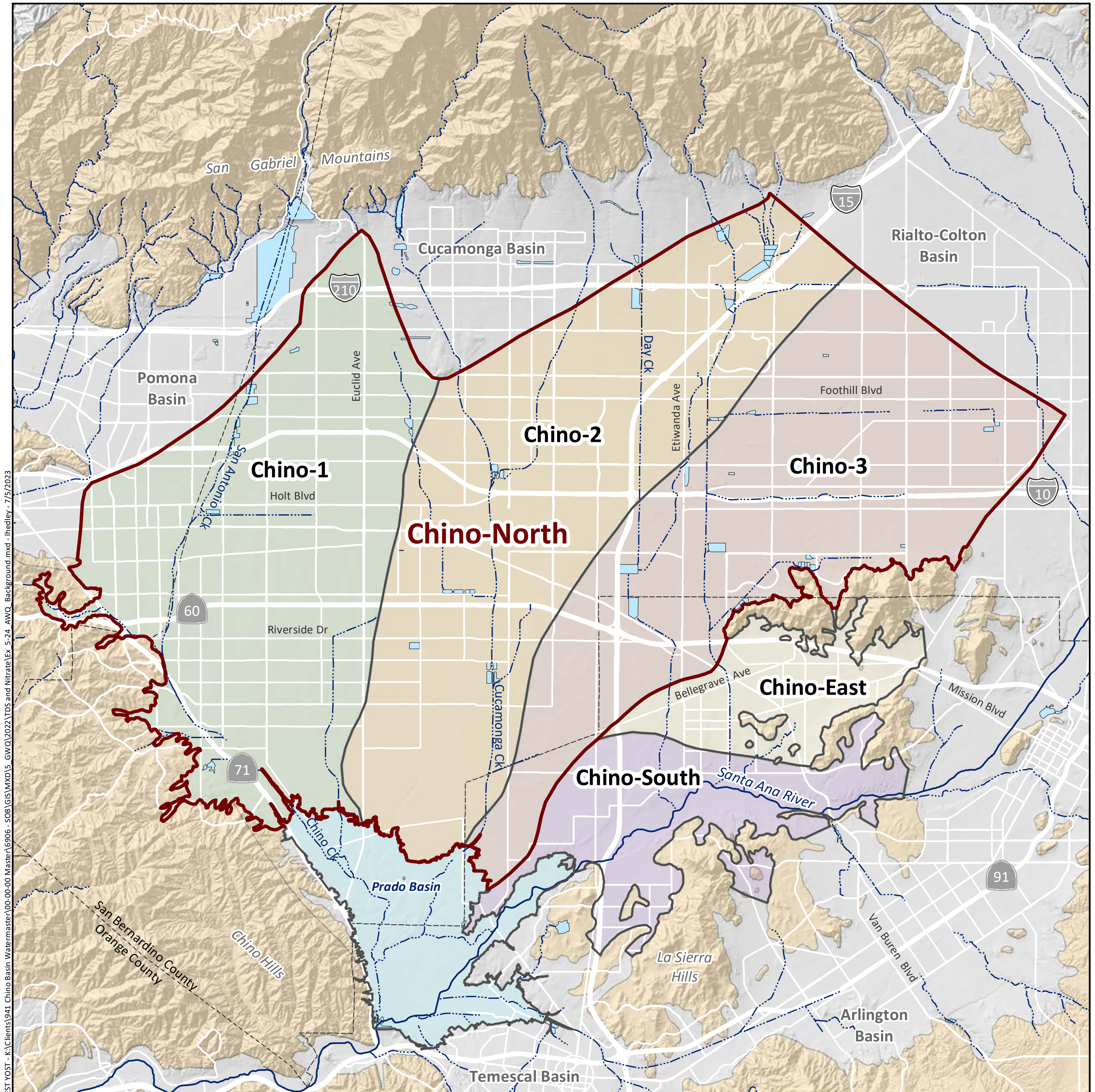
Groundwater Quality

GeoTracker and EnviroStor
Sites in the Chino Basin
With the Potential to Impact Groundwater Quality

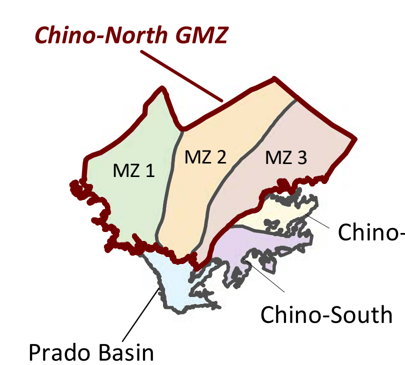
Exhibit 5-23



Pursuant to the Basin Plan, the Regional Board periodically re-computes the current TDS and nitrate concentrations (ambient TDS and nitrate) of GMZs in the Santa Ana Watershed based on TDS and nitrate concentration data for a "current" 20 year period (i.e., the 2018 ambient water quality was computed using the groundwater-quality data from 1999 through 2018). The Regional Board utilizes the ambient water-quality recomputations to determine if assimilative capacity for TDS and nitrate exists in the Basin and to assess if the recycled water discharge limitations are protective of the water-quality objectives for TDS and nitrate defined in the Basin Plan for each GMZ. If the ambient TDS or nitrate concentrations are greater than the Basin Plan objectives, then there is no assimilative capacity and recycled water activities are restricted in the GMZ unless the discharger implements a Regional Board-approved mitigation program.

The ambient TDS concentrations for the Chino-1, Chino-2, and Chino-3 GMZs are all greater than the anti-degradation TDS objectives, which range from 250 to 280 mgl. Under the Basin Plan these concentrations require mitigation for recycled water reuse and recharge in excess of the antidegradation objectives. To address this issue and continue recycled water activities without having to do significant mitigation, Watermaster and the IEUA collaborated with the Regional Board to establish alternative, less-stringent, "maximum-benefit" TDS and nitrate objectives for the Chino-North GMZ (combined Chino-1, Chino-2, and Chino-3). The maximum-benefit objectives were established based on the demonstrations that beneficial uses of the Basin would continue to be protected and water quality consistent with the maximum-benefit to the people of California would be maintained with the implementation of specific projects and programs by Watermaster and the IEUA, termed the "Chino Basin maximum-benefit commitments". Because the maximum-benefit objectives are greater than the individual anti-degradation objectives for each GMZ, they create assimilative capacity in the Chino-North GMZ where all the groundwater recharge activities that are part of the OBMP occur. The maximum-benefit objectives are also part of the comprehensive salt and nutrient management program for the Chino Basin, developed pursuant to PE 7 of the OBMP. The maximum-benefit salt and nutrient management program is a critical basin management strategy and regulatory compliance plan that enables Watermaster to implement comprehensive groundwater recharge program and utilize recycled water in the Chino Basin.

Antidegradation GMZs
and Chino-North Maximum-Benefit GMZ



Other key map features are described in the legend of Exhibit 1-1.

This exhibit includes a map of maximum-benefit Chino-North GMZ and the antidegradation GMZs. The following Exhibits 5-25 and 5-26 show the time history of the TDS and nitrate ambient water-quality determinations for the GMZs of the Chino Basin, compared to the maximum-benefit and antidegradation objectives.

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0 2 4 Miles
0 2 4 Km

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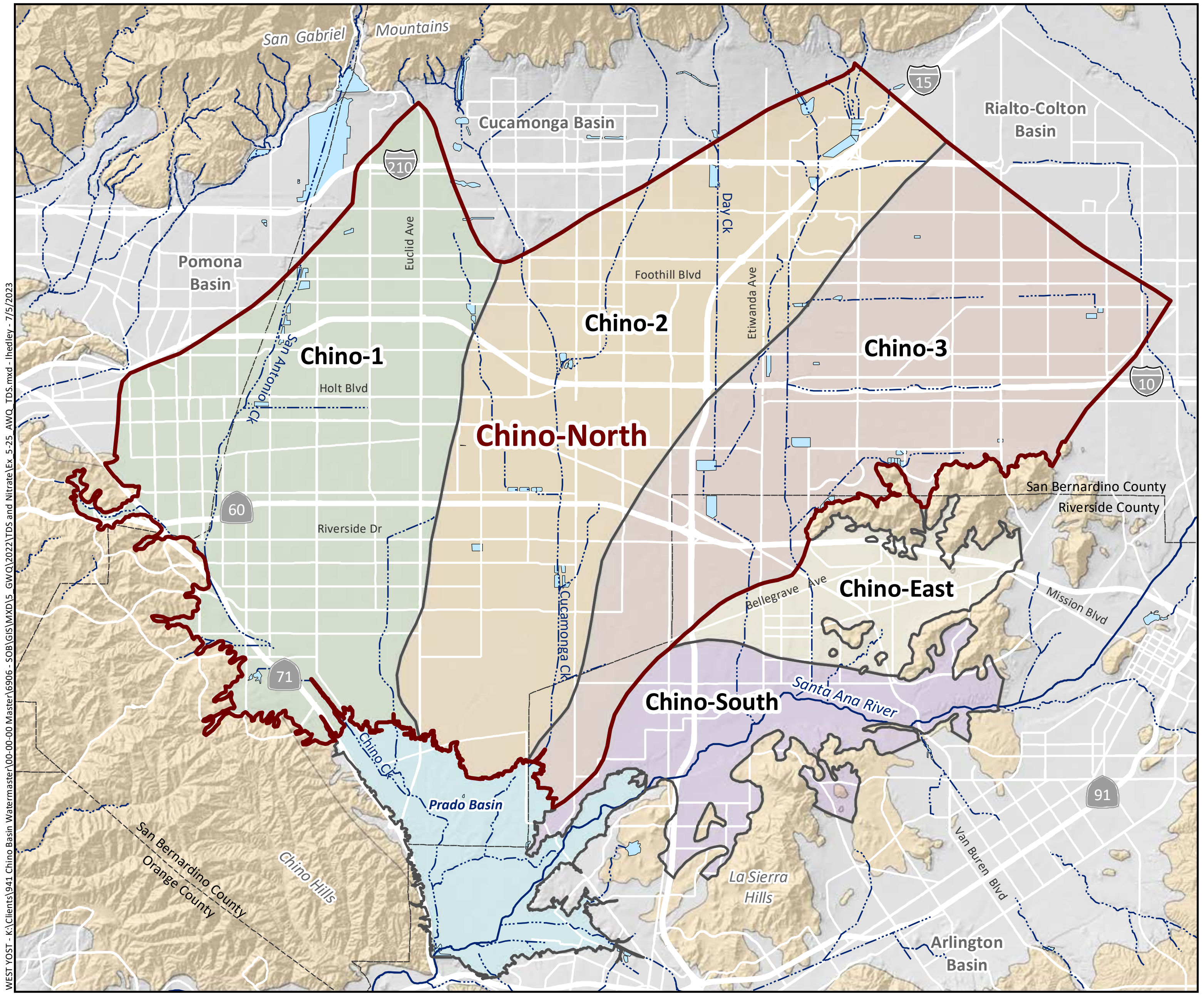
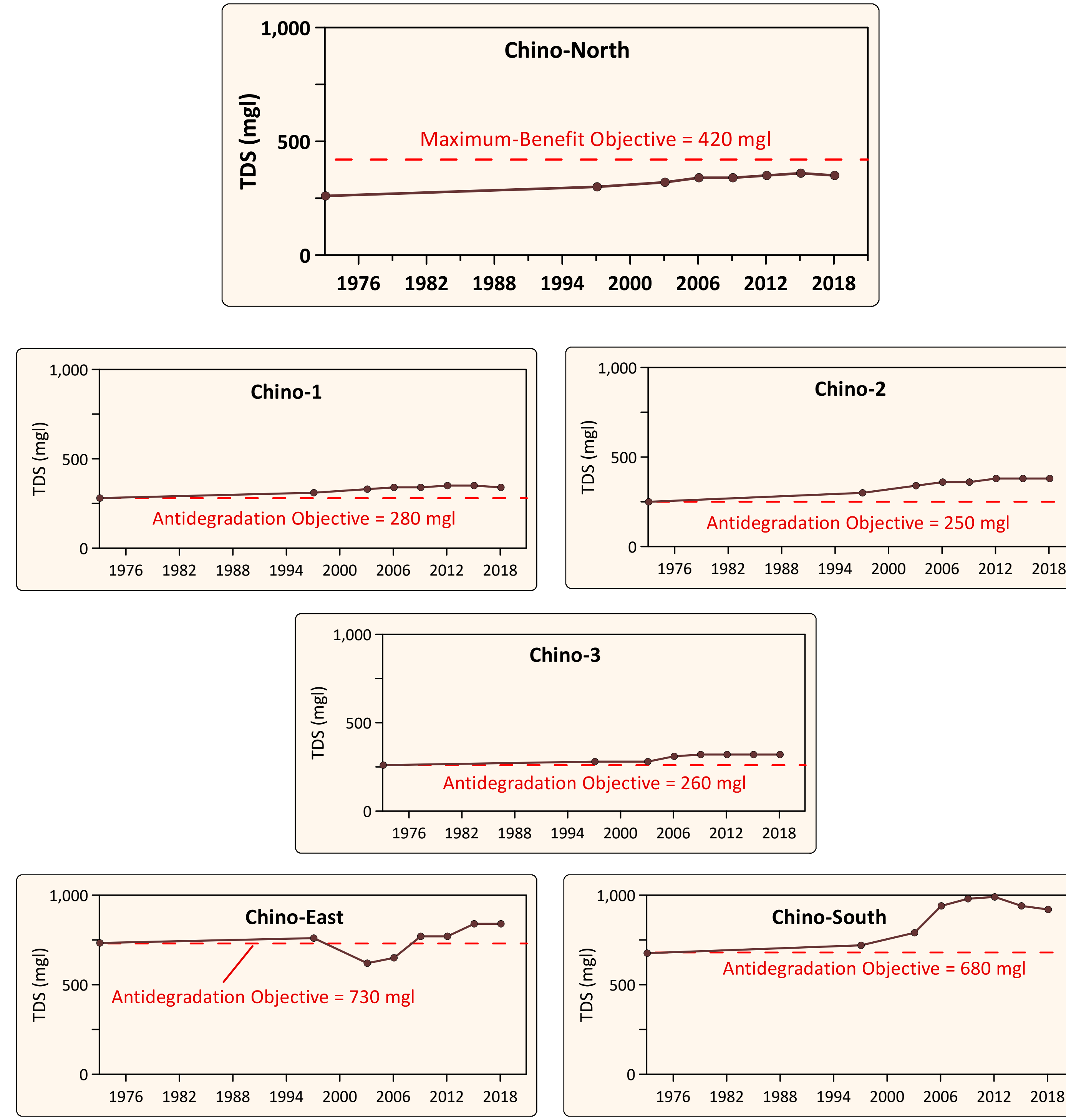
Ambient Water Quality and Maximum-Benefit and Antidegradation Objectives for Chino Basin Groundwater Managment Zones

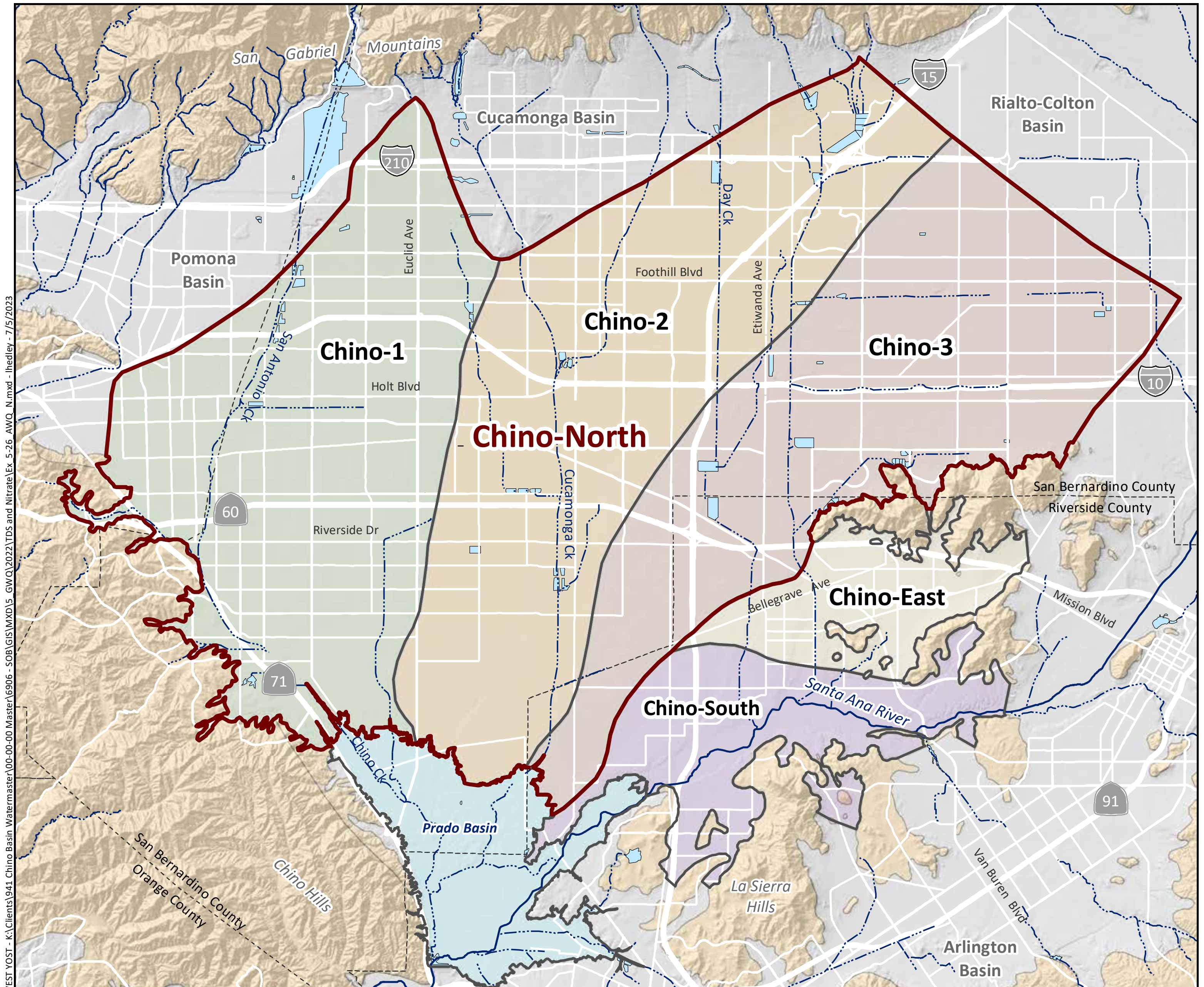
Exhibit 5-24



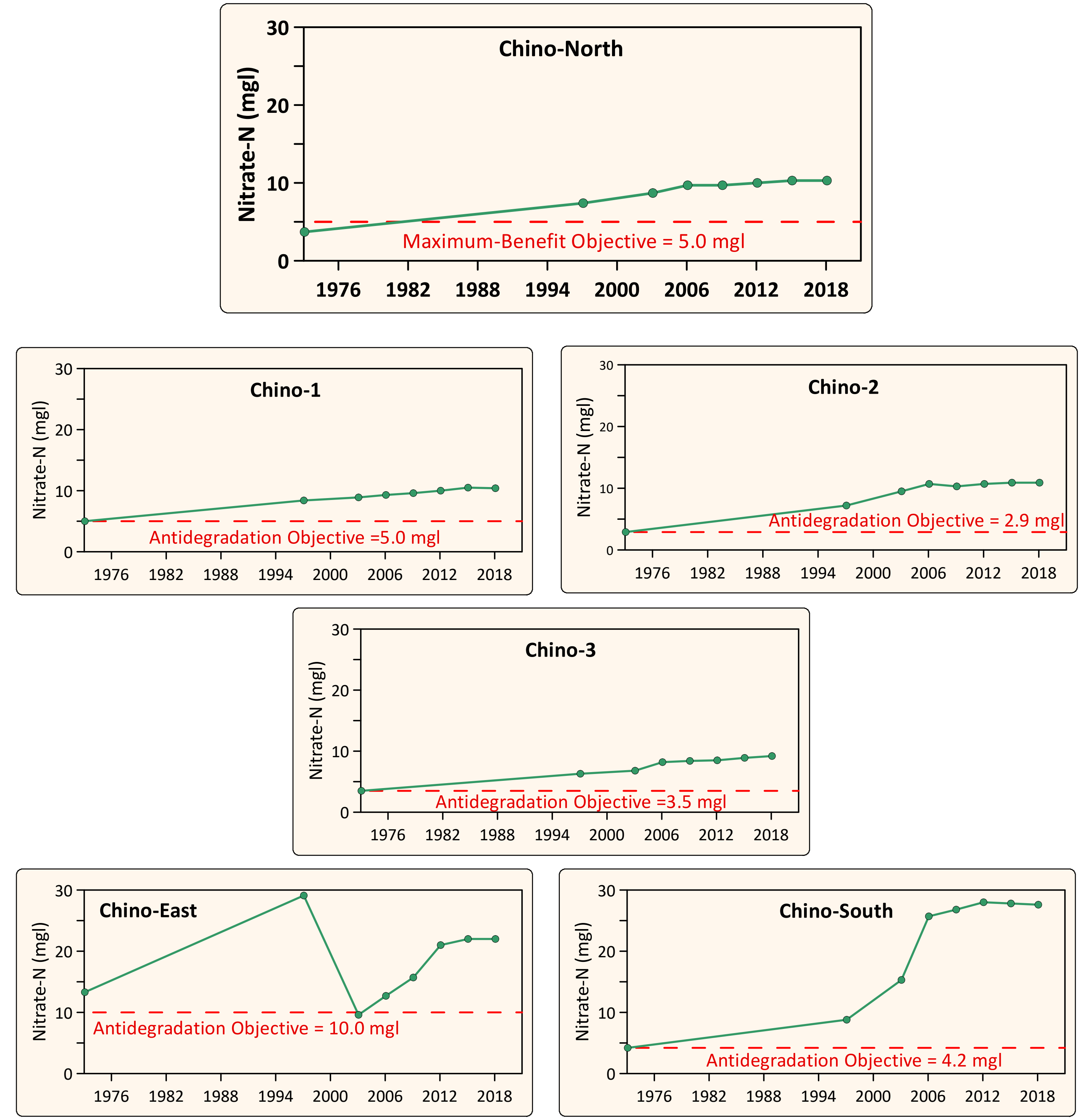
Time-Series of TDS AWQ Determinations for Maximum-Benefit and Antidegradation GMZs Compared to TDS Objectives



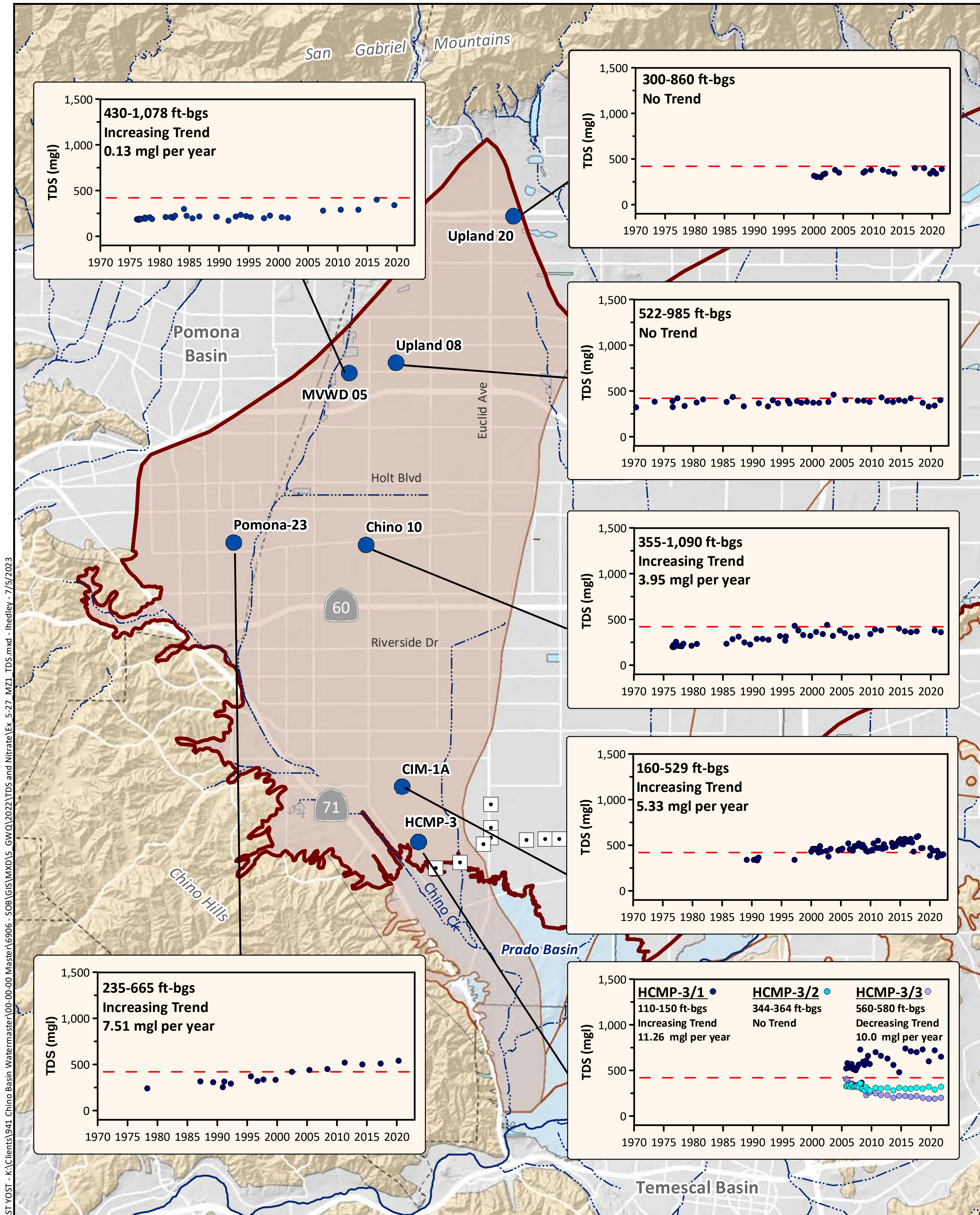
The ambient water-quality determinations were computed for eight, 20-year periods: 1954-1973, 1978-1997, 1984-2003, 1987-2006, 1990-2009, 1993-2012 (WEI, 2000; 2005b; 2008a; 2011b; and 2014), 1996-2015 (DBS&A, 2017), and 1999-2018 (WSC, 2020). This exhibit includes time-series charts of all ambient TDS determinations from 1973 to 2018 compared to the TDS objectives for the Chino Basin maximum-benefit and antidegradation GMZs. The Chino-North ambient TDS concentrations have always been below the maximum-benefit TDS objective. The current (2018) ambient TDS concentration is 350 mgl, which means there is 70 mgl of assimilative capacity for TDS in the Chino-North GMZ. The Chino-East and Chino-South ambient TDS concentrations exceed the antidegradation TDS objectives; however, since there is no recycled water reuse and recharge by Watermaster and the IEUA in these GMZs, there is no regulatory challenges or mitigation required.



Time-Series of Nitrate AWQ Determinations for Maximum-Benefit and Antidegradation GMZs Compared to Nitrate Objectives



This exhibit includes time-series charts of all ambient nitrate determinations from 1973 to 2018 compared to the nitrate objectives for the Chino Basin maximum-benefit and antidegradation GMZs. The Chino-North ambient nitrate concentrations have mostly been above the maximum-benefit nitrate objective, and the current (2018) ambient is 10.3 mgl, hence there is no assimilative capacity for nitrate in Chino-North GMZ, which has been the case since the adoption of the maximum-benefit objectives in 2004. Pursuant to the maximum-benefit salt and nutrient management plan, Watermaster and the IEUA implement a comprehensive recharge program for recycled, storm, and imported waters where the combined volume-weighted nitrate concentration is less than or equal to the maximum-benefit nitrate objective of 5.0 mgl. The Chino-East and Chino-South ambient nitrate concentrations exceed the antidegradation nitrate objectives; however, since there is no recycled water reuse and recharge by Watermaster and the IEUA in these GMZs, there is no regulatory challenges or mitigation required.



It is expected that TDS concentrations in the Chino Basin will increase over time, increase in magnitude from north to south, and be greatest in the shallow layer of the aquifer in areas where the primary loading source occurs at the ground surface (e.g. areas with outdoor water use). The anticipated trends are based on the following:

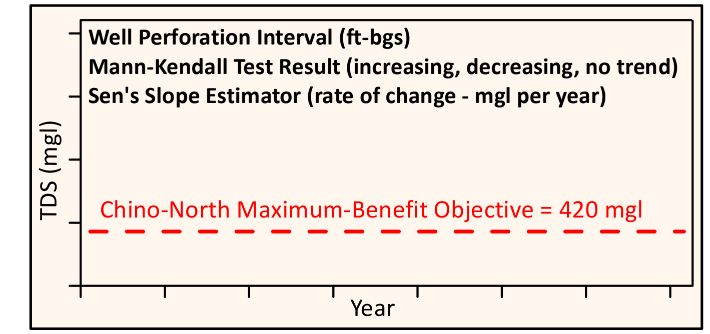
- The Chino Basin is operated as a closed basin, meaning that salts will accumulate in the Basin over time. The only export of salt is through the CDA's brine line and wastewater discharged to the Santa Ana River.
- Low-TDS source waters (e.g. mountain front recharge and storm and supplemental waters) are being recharged in the forebay areas to the north and at recharge basins that are primarily located north of Highway 60 (refer to Sections 2 and 3 of this report).
- The direction of groundwater-flow is generally from north to south (as shown in Section 4 of this report).
- The land use types with the greatest impact on TDS concentrations (irrigated agriculture and dairies) have been concentrated to the south of Highway 60.

Other factors that contribute to localized TDS concentrations and trends include: proximity to production wells, recharge sources, point-source discharges, and underlying aquifer properties.

For the period of record, the data show that TDS concentration trends throughout the Chino Basin are consistent with expected trends, specifically:

- TDS concentrations at wells located north of Highway 60 in MZ1, MZ2, and MZ3 have generally stayed the same, or increased slightly, and are less than or about equal to the maximum-benefit objective for Chino-North of 420 mgl.
- TDS concentrations at wells located south of Highway 60 in MZ1, MZ2, and MZ3 have generally increased and are about equal to or greater than the maximum-benefit objective for Chino-North of 420 mgl.
- TDS concentrations at wells located in MZ4 and MZ5 are both below and above the anti-degradation objectives of 730 and 680 mgl for Chino-East and Chino-South, respectively.
- TDS concentrations at wells with shallow well perforations (e.g. less than 200 ft-bgs) are higher than at wells with deep well perforations. Note that the wells with data to the north of Highway 60 are primarily deep municipal production wells.

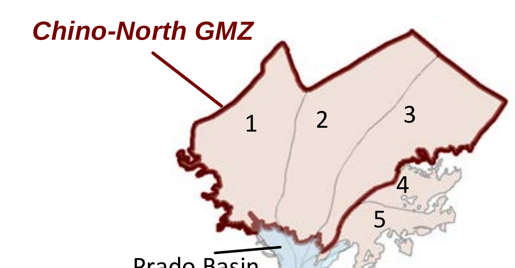
TDS Concentration



Two statistical trend tests were computed on the TDS concentration data. The Mann-Kendall test indicates whether data are increasing, decreasing, or do not have a statistically quantifiable trend (no trend). The Sen's Slope estimator is a non-parametric determination of the rate of change in concentration over time. All calculations were computed using Python. Both statistics were interpreted using a confidence level of 95%.

Exhibits 5-27 through 5-30 show time-history plots of TDS concentrations measured at selected wells in each of the OBMP MZs compared to the TDS objectives defined in the Basin Plan for the Chino-North, Chino-South, and Chino-East GMZs. Data are shown for the 51-year period of 1970 through 2022. The wells and time-histories included in these exhibits were selected based on location, geographical distribution, length of data record, depth of well perforations, and the representativeness of TDS concentrations in the area. Noted on each time-series chart are the results of two statistical trend analyses, indicating the trend in the data (increasing, decreasing, no statistical trend) and the rate of change (mgl per year).

OBMP MZs and Chino-North Maximum Benefit GMZ



Note: Prado Basin Management Zone has a surface water objective only.

Prepared by:

WEST YOST
Water. Engineered.

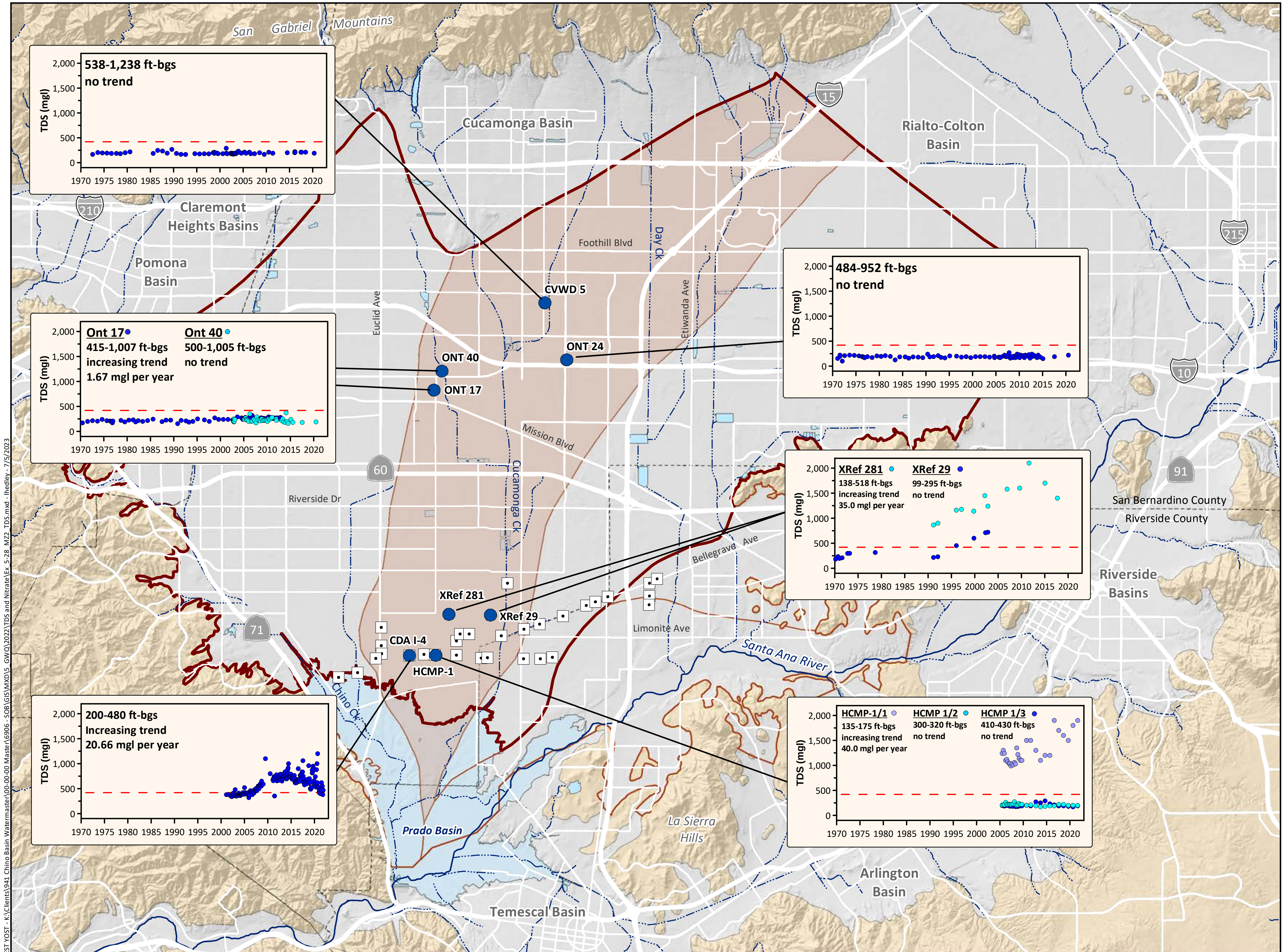
0 2 4 Miles
0 2 4 Km

Prepared for:

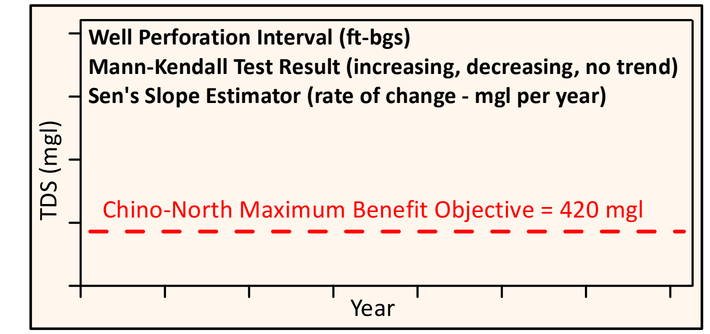
Chino Basin Watermaster
2022 State of the Basin Report
Groundwater Quality

Chino Basin Management Zone 1
Trends in TDS Concentrations

Exhibit 5-27



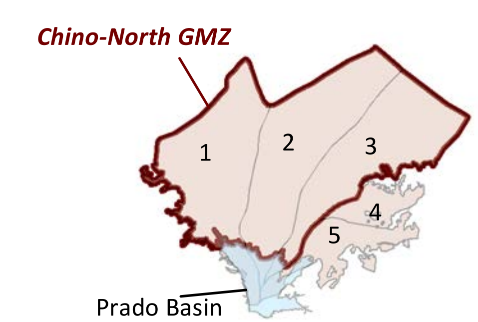
TDS Concentration



Two statistical trend tests were computed on the TDS concentration data. The Mann-Kendall test indicates whether data are increasing, decreasing, or do not have a statistically quantifiable trend (no trend). The Sen's Slope estimator is a non-parametric determination of the rate of change in concentration over time. All calculations were computed using Python. Both statistics were interpreted using a confidence level of 95%.

Other key map features are described in the legend of Exhibit 1-1.

OBMP MZs and Chino-North Maximum-Benefit GMZ



Note: Prado Basin Management Zone has a surface water objective only.

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Chino Basin Watermaster
2022 State of the Basin Report
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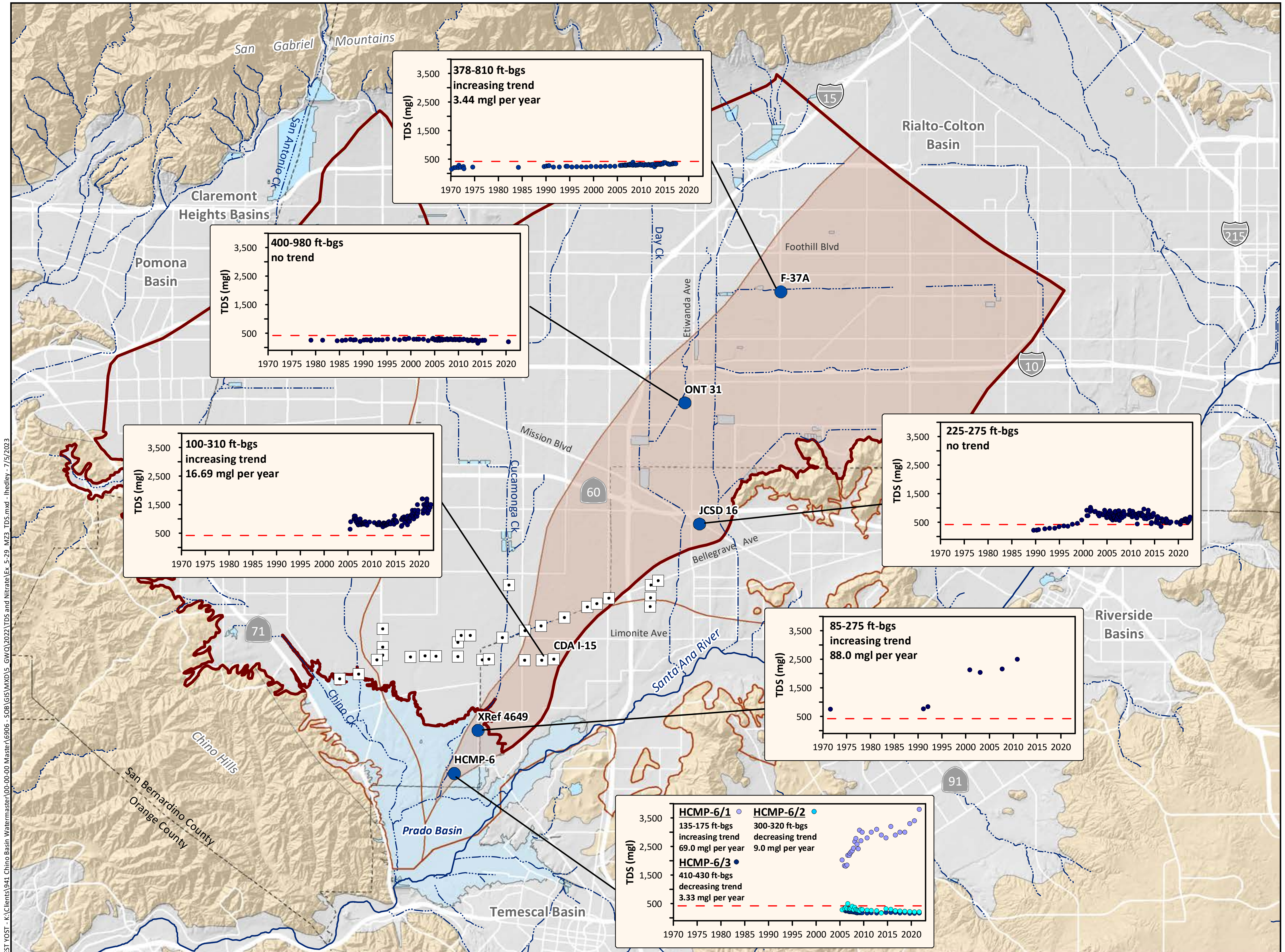
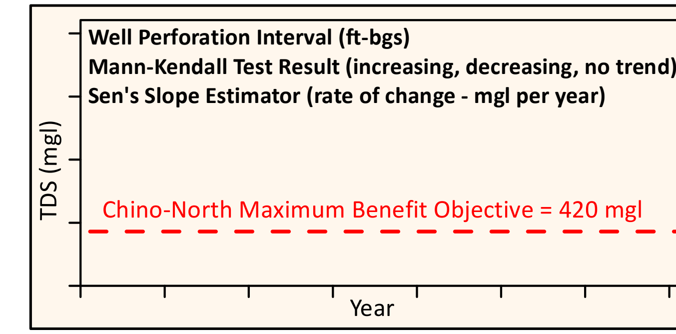
Chino Basin Management Zone 2
Trends in TDS Concentrations

Exhibit 5-28



TDS Concentration



Two statistical trend tests were computed on the TDS concentration data. The Mann-Kendall test indicates whether data are increasing, decreasing, or do not have a statistically quantifiable trend (no trend). The Sen's Slope estimator is a non-parametric determination of the rate of change in concentration over time. All calculations were computed using Python. Both statistics were interpreted using a confidence level of 95%.

Other key map features are described in the legend of Exhibit 1-1.

OBMP MZs and Chino-North Maximum-Benefit GMZ

Note: Prado Basin Management Zone has a surface water objective only.

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WEST YOST
Water. Engineered.

0 2 4 Miles
0 2 4 Km

Prepared for:

Chino Basin Watermaster
2022 State of the Basin Report
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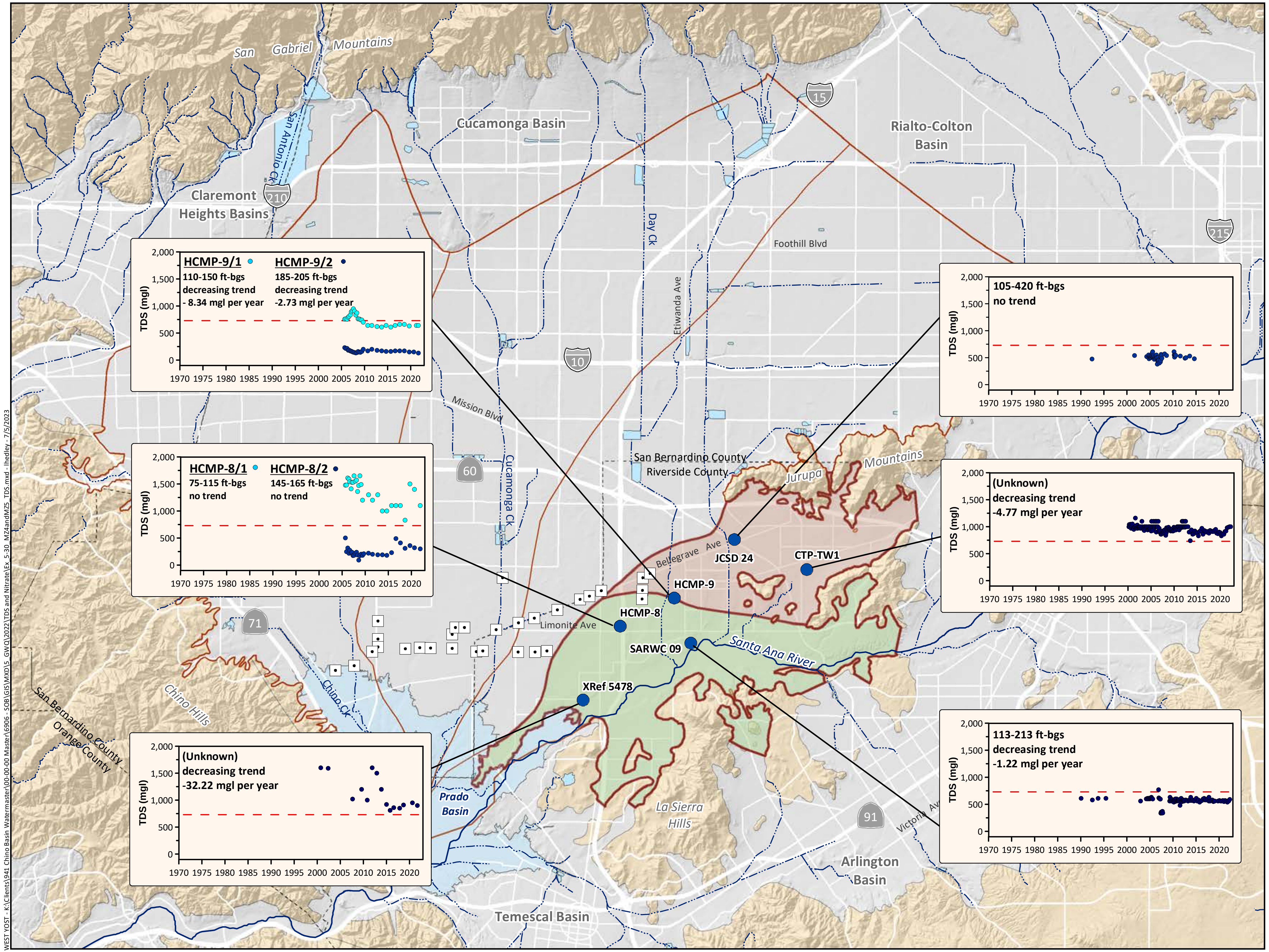
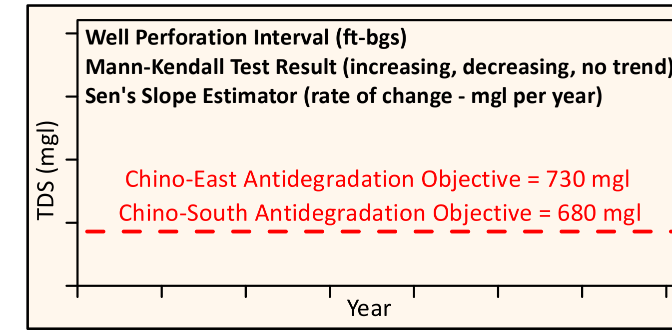
Chino Basin Management Zone 3
Trends in TDS Concentrations

Exhibit 5-29



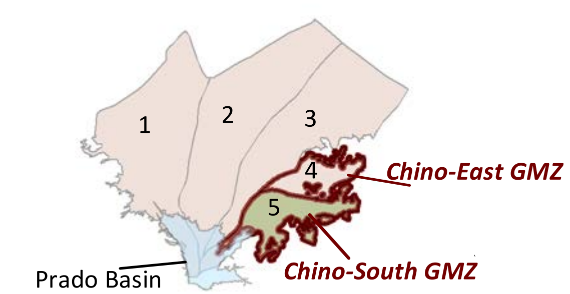
TDS Concentration



Two statistical trend tests were computed on the TDS concentration data. The Mann-Kendall test indicates whether data are increasing, decreasing, or do not have a statistically quantifiable trend (no trend). The Sen's Slope estimator is a non-parametric determination of the rate of change in concentration over time. All calculations were computed using Python. Both statistics were interpreted using a confidence level of 95%.

Other key map features are described in the legend of Exhibit 1-1.

OBMP MZs and Chino-East and Chino-South Antidegradation GMZs



Note: Prado Basin Management Zone has a surface water objective only.

Prepared by:

WEST YOST
Water. Engineered.

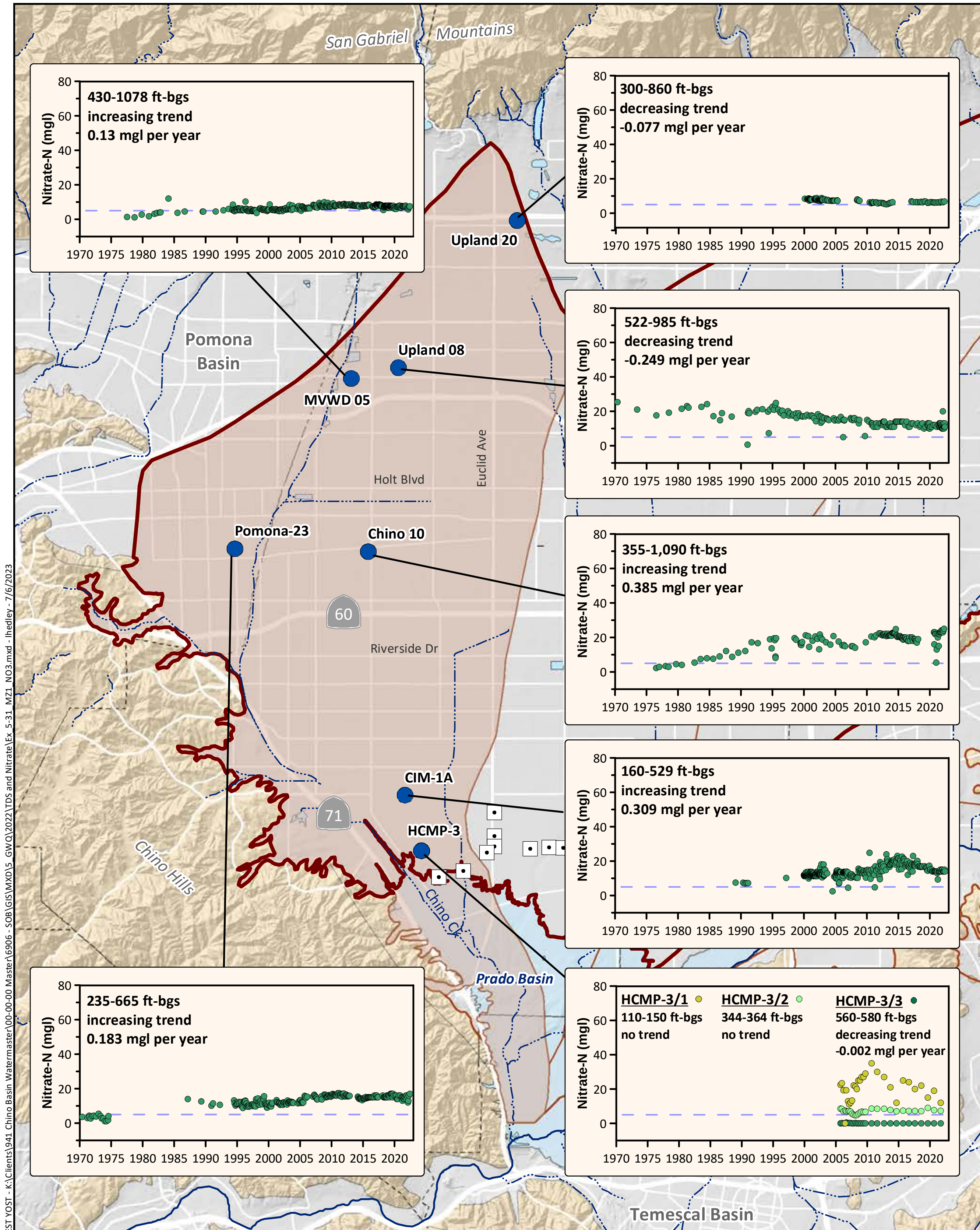
0 2 4 Miles
0 2 4 Km

Prepared for:

Chino Basin Watermaster
2022 State of the Basin Report
Groundwater Quality

Chino Basin Management Zone 4 and Zone 5 Trends in TDS Concentrations

Exhibit 5-30



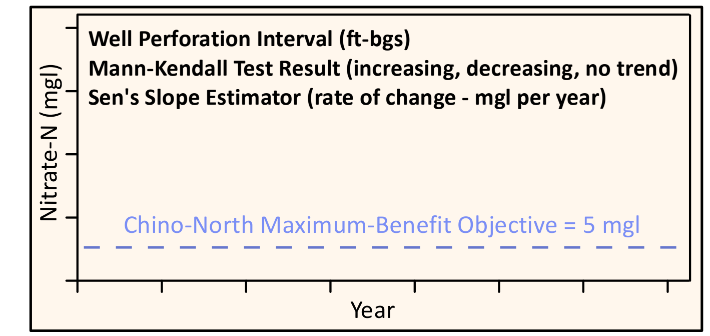
It is expected that nitrate concentrations in the Chino Basin will increase over time, increase in magnitude from north to south, and be greatest in the shallow layer of the aquifer in areas where the primary loading source occurs at the ground surface (e.g. areas with outdoor water use). One exception to the generally increasing trend occurs in the northwestern area of the Chino Basin where decreasing trends in nitrate are observed in some areas that previously had high concentrations. The anticipated trends are based on the following:

- The Chino Basin is operated as a closed basin, meaning that salts will accumulate in the basin over time. The only export of salt is through the CDA's brine line and wastewater discharged to the Santa Ana River.
- The low-nitrogen sources of recharge (e.g. mountain front recharge and storm water) are recharging the basin in the fore-bay areas to the north and at recharge basins that are primarily located north of Highway 60 (refer to Sections 2 and 3 of this report).
- The direction of groundwater-flow is generally from north to south
- The current land use types with the greatest impact on nitrate concentrations (irrigated agriculture and dairies) are concentrated south of Highway 60.
- Historically, the northwest areas of the Chino Basin contained agricultural land use types, particularly irrigated citrus that relied heavily on fertilizers. As the agricultural land uses converted to urban uses, the high-nitrate loading at the ground surface has been replaced with lower-nitrate returns from outdoor water use, low-nitrate boundary inflows, and storm water recharge.

For the period of record, the data show that the nitrate concentration trends throughout the Chino Basin are consistent with expected trends, specifically:

- Nitrate concentrations at wells located north of Highway 60 in MZ1, MZ2, and MZ3 are both above and below the maximum-benefit objective of 5 mgl for Chino-North and most of the wells are showing an increasing trend.
- Nitrate concentrations at wells located south of Highway 60 in MZ1, MZ2, and MZ3 are above the maximum-benefit objective for Chino-North of 5 mgl.
- Nitrate concentrations at wells located in MZ4 and MZ5 are typically above the anti-degradation objectives for Chino-East and Chino-South of 10 and 5 mgl, respectively.
- Nitrate concentrations at wells with shallow well perforations (e.g. less than 200 ft-bgs) are higher than those at wells with deep well perforations. Note that the wells with data to the north of Highway 60 are primarily deep municipal production wells.

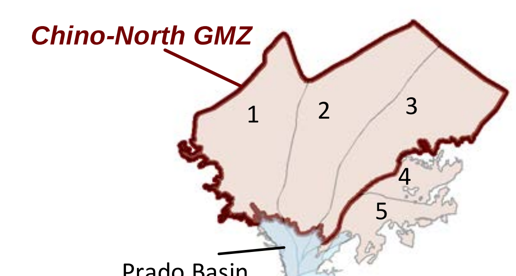
Nitrate-N Concentration



Two statistical trend tests were computed on the TDS concentration data. The Mann-Kendall test indicates whether data are increasing, decreasing, or do not have a statistically quantifiable trend (no trend). The Sen's Slope estimator is a non-parametric determination of the rate of change in concentration over time. All calculations were computed using Python. Both statistics were interpreted using a confidence level of 95%.

Exhibits 5-31 through 5-34 show time-history plots of nitrate concentrations measured at selected wells in each of the OBMP MZs. Data are shown for the 51-year period of 1972 through 2022. The wells and time-histories included in these exhibits were selected based on location, geographical distribution, length of data record, depth of well perforations, and the representativeness of nitrate concentrations in the area. Noted on each time-series chart are the results of two statistical trend tests, indicating the trend in the data (increasing, decreasing, no statistical trend) and the rate of change.

OBMP MZs and Chino-North Maximum-Benefit GMZ



Note: Prado Basin Management Zone has a surface water objective only.

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0 2 4 Miles
0 2 4 Km

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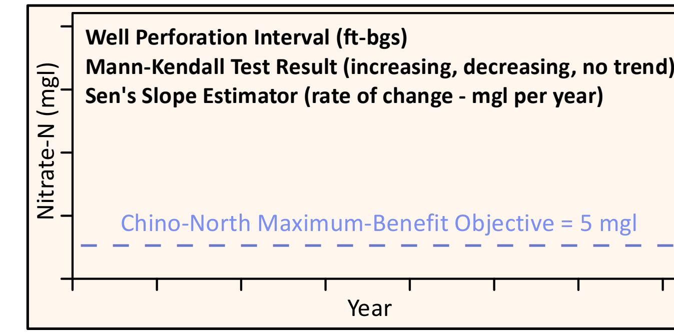
Chino Basin Management Zone 1
Trends in Nitrate Concentrations

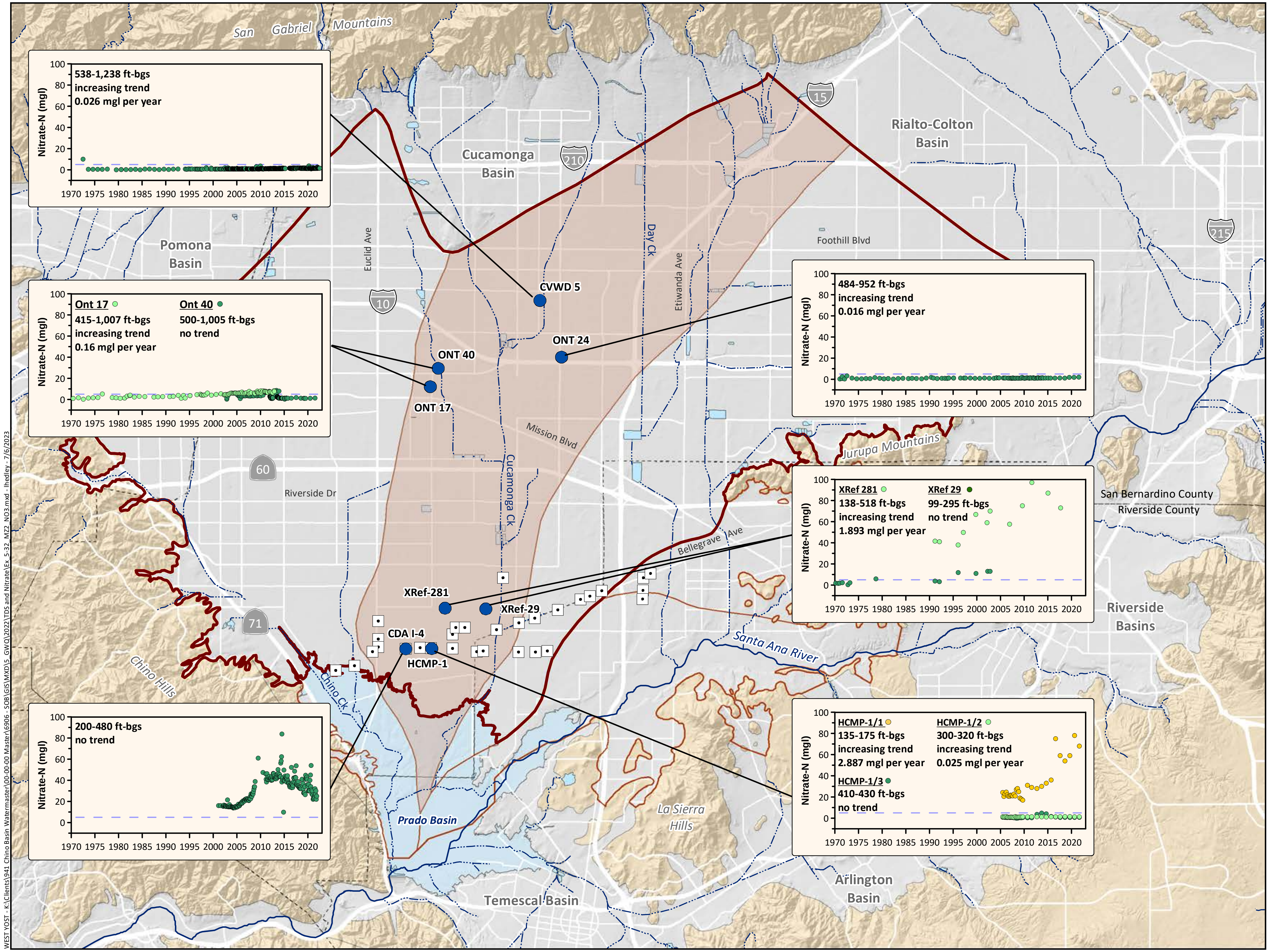
Exhibit 5-31

Nitrate-N Concentration



Two statistical trend tests were computed on the TDS concentration data. The Mann-Kendall test indicates whether data are increasing, decreasing, or do not have a statistically quantifiable trend (no trend). The Sen's Slope estimator is a non-parametric determination of the rate of change in concentration over time. All calculations were computed using Python. Both statistics were interpreted using a confidence level of 95%.

Other key map features are described in the legend of Exhibit 1-1.



OBMP MZs and Chino-North Maximum-Benefit GMZ

Note: Prado Basin Management Zone has a surface water objective only.

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0 2 4 Miles
0 2 4 Km

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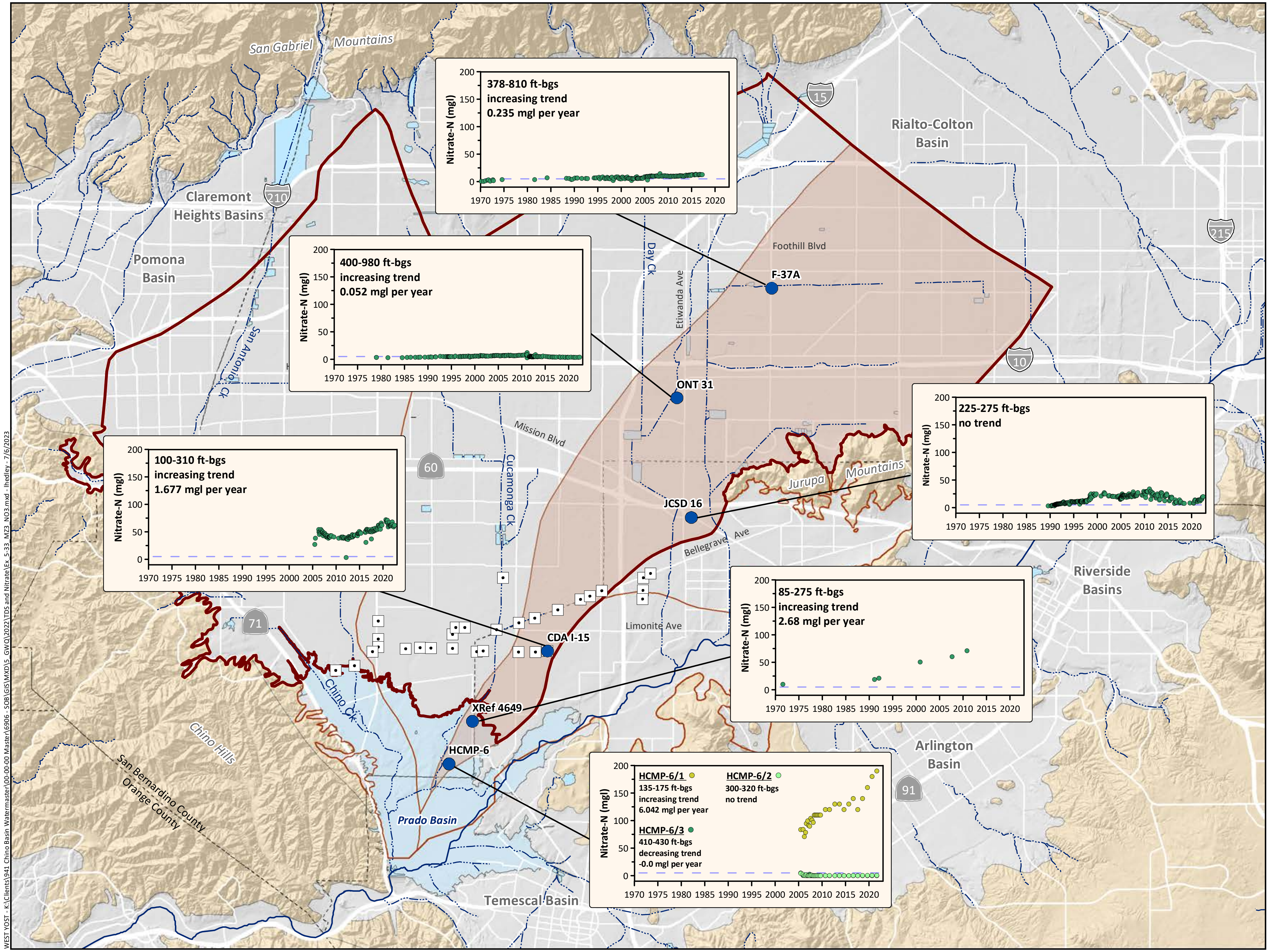
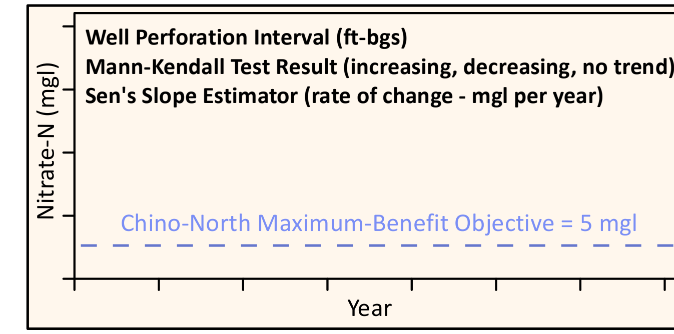
Chino Basin Management Zone 2
Trends in Nitrate Concentrations

Exhibit 5-32



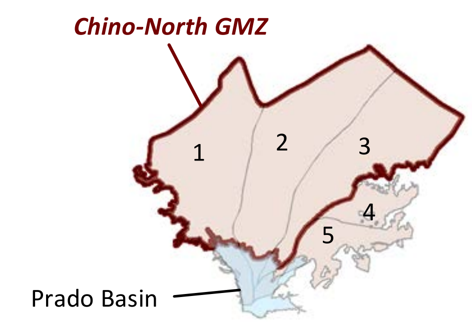
Nitrate-N Concentration



Two statistical trend tests were computed on the TDS concentration data. The Mann-Kendall test indicates whether data are increasing, decreasing, or do not have a statistically quantifiable trend (no trend). The Sen's Slope estimator is a non-parametric determination of the rate of change in concentration over time. All calculations were computed using Python. Both statistics were interpreted using a confidence level of 95%.

Other key map features are described in the legend of Exhibit 1-1.

OBMP MZs and Chino-North Maximum-Benefit GMZ



Note: Prado Basin Management Zone has a surface water objective only.

Prepared by:

WEST YOST Water. Engineered.

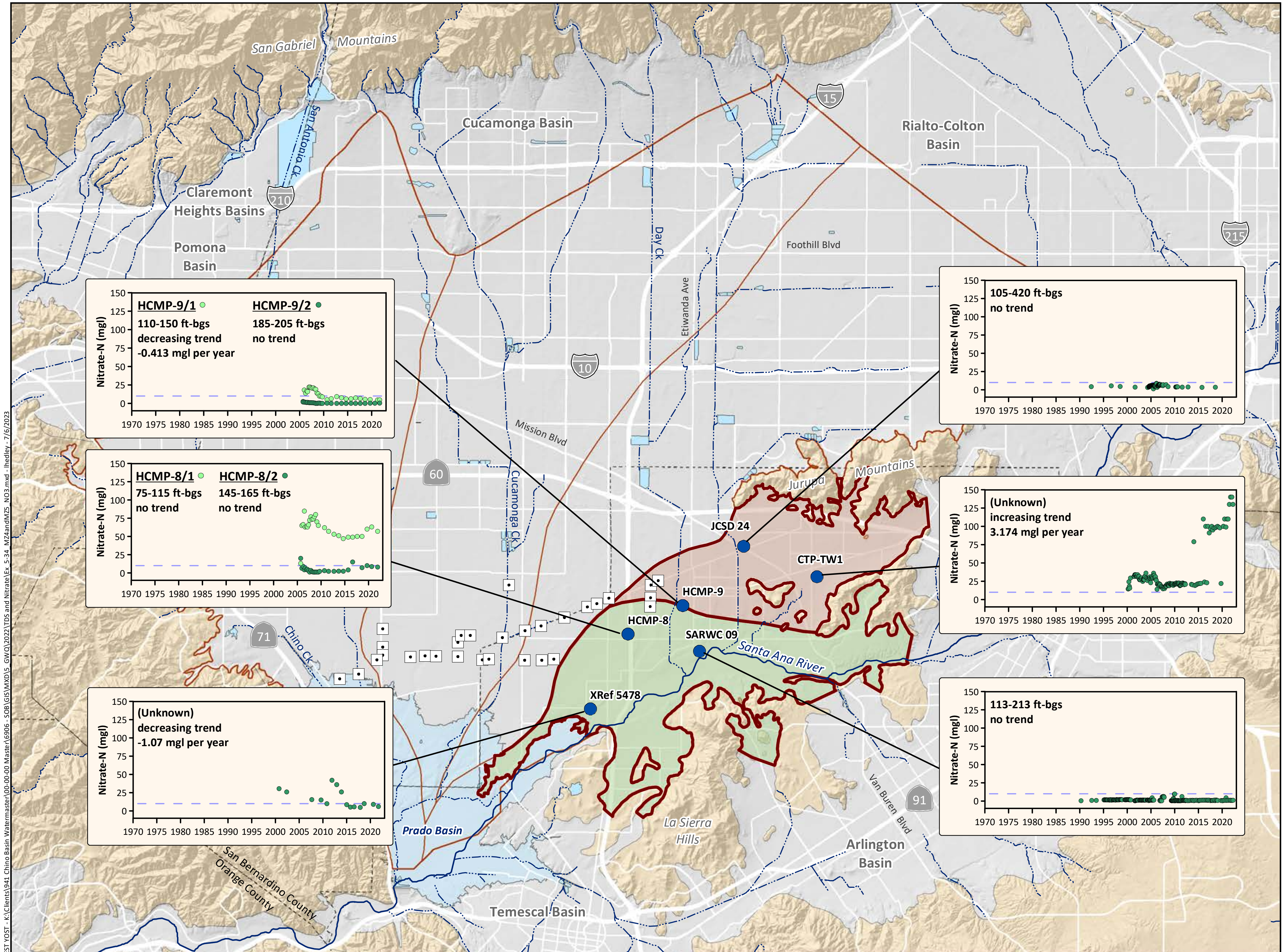
Miles 0 2 4
Km 0 2 4

Prepared for:

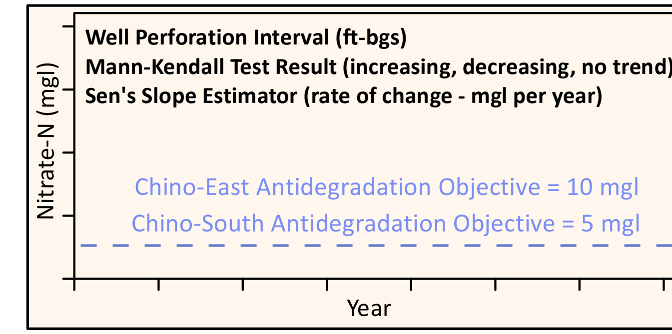
Chino Basin Watermaster
2022 State of the Basin Report
Groundwater Quality

Chino Basin Management Zone 3
Trends in Nitrate Concentrations

Exhibit 5-33



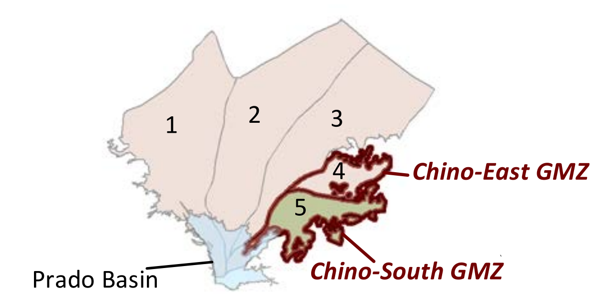
Nitrate-N Concentration



Two statistical trend tests were computed on the TDS concentration data. The Mann-Kendall test indicates whether data are increasing, decreasing, or do not have a statistically quantifiable trend (no trend). The Sen's Slope estimator is a non-parametric determination of the rate of change in concentration over time. All calculations were computed using Python. Both statistics were interpreted using a confidence level of 95%.

Other key map features are described in the legend of Exhibit 1-1.

OBMP MZs and Chino-East and Chino-South Antidegradation GMZs



Note: Prado Basin Management Zone has a surface water objective only.

Prepared by:

WEST YOST
Water. Engineered.

0 2 4 Miles
0 2 4 Km

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Chino Basin Watermaster
2022 State of the Basin Report
Groundwater Quality

Chino Basin Management Zone 4 and Zone 5
Trends in Nitrate Concentrations

Exhibit 5-34

GROUND-LEVEL MONITORING

This section characterizes the history of land subsidence and ground fissuring, and the current state of ground motion in the Chino Basin as understood through Watermaster's ground-level monitoring program. One of the earliest indications of land subsidence in the Chino Basin was the appearance of ground fissures in the City of Chino. These fissures appeared as early as 1973, but an accelerated occurrence of ground fissuring ensued after 1991 and resulted in damaged infrastructure. In 1999, the *OBMP Phase I Report* (WEI, 1999) identified a pumping-induced decline of hydraulic heads and subsequent aquifer system compaction as the most likely cause of land subsidence and ground fissuring in MZ1. OBMP *PE 1 – Develop and Implement a Comprehensive Monitoring Program* called for basin-wide analysis of ground motion via ground-level surveys and Interferometry Synthetic Aperture Radar (InSAR), and ongoing monitoring based on the analysis of the ground motion data. OBMP *PE 4 – Develop and Implement a Comprehensive Groundwater Management Plan for Management Zone 1* called for the development and implementation of an interim subsidence management plan for MZ1 that would:

- Minimize subsidence and fissuring in the short-term.
- Collect the information necessary to understand the extent, rate, and mechanisms of subsidence and fissuring.
- Formulate a long-term management plan to monitor and manage ground-level movement to abate future subsidence and fissuring, or reduce it to tolerable levels.

In 2000, the Implementation Plan for the Peace Agreement called for an aquifer-system and land-subsidence investigation in the southwestern portion of MZ1 to support the development of the long-term management plan (second and third bullets above). This investigation was titled the MZ1 Interim Monitoring Program (IMP). From 2001 to 2005, Watermaster developed, coordinated, and conducted the IMP under the guidance of the MZ1 Technical Committee, which was composed of representatives from all major producers in MZ1 and their technical consultants. The investigation methods, results, and conclusions are described in detail in the *MZ1 Summary Report* (WEI, 2006). The investigation provided enough information for Watermaster to develop Guidance Criteria for MZ1 that, if followed, would minimize the potential for subsidence and fissuring in the investigation area.

The Guidance Criteria also formed the basis for the *MZ1 Subsidence Management Plan* (MZ1 Plan; WEI, 2007b). The MZ1 Plan was developed by the MZ1 Technical Committee and approved by Watermaster in October 2007. In November 2007, the California Superior Court for the County of San Bernardino, which retains continuing jurisdiction over the Chino Basin adjudication, approved the MZ1 Plan and ordered its implementation. The MZ1 Plan called for the continued scope and frequency of monitoring implemented within the MZ1 Managed Area during the IMP, and expanded monitoring of the aquifer-system and ground motion into other areas of the Chino Basin where the IMP indicated concern for future subsidence and ground fissuring. These so-called "Areas of Subsidence Concern" include the Central MZ1, Northwest MZ1, the Northeast Area, and the Southeast Areas. Watermaster's ground-level monitoring program includes:

- *Hydraulic Heads*. Hydraulic heads are an important part of the ground-level monitoring program because piezometric changes are the mechanism for aquifer-system deformation and land subsidence. Watermaster conducts high-frequency, piezometric level monitoring at about 77 wells as part of its ground-level monitoring program. A pressure transducer data-logger is installed at each of these wells and records one water-level measurement every 15 minutes. Data loggers also record depth-specific hydraulic heads at the piezometers located at Watermaster's Ayala Park, Pomona (PX), and Chino Creek (CCX) Extensometer Facilities once every 15 minutes.
- *Aquifer-System Deformation*. The vertical deformation of the aquifer-system is measured and recorded with borehole extensometers. In 2003, Watermaster installed the Ayala Park extensometer in the MZ1 Managed Area to support the IMP. At this facility, two extensometers are completed to depths of 550 ft-bgs and 1,400 ft-bgs. In 2012, Watermaster installed the CCX in the Southeast Area to understand the effects of pumping at the western Chino-1 Desalter CCWF. The CCX also consists of two extensometers: one completed to a depth of 140 ft-bgs and the other to 610 ft-bgs. In 2019, Watermaster installed the PX in Northwest MZ1 to support the development of the *Subsidence Management Plan for Northwest MZ1*. At this facility, four extensometers were completed to 520 ft-bgs (PX1-1), 750 ft-bgs (PX1-2), 1,025 ft-bgs (PX2-3), and 1,290 ft-bgs (PX2-4). All three extensometer facilities record the vertical component of aquifer-system compression and expansion once every 15 minutes, synchronized with piezometric measurements, to understand the relationship between piezometric changes and aquifer-system deformation.
- *Vertical Ground Motion*. Watermaster monitors vertical ground motion via traditional leveling surveys at benchmark monuments and via remote-sensing techniques (InSAR) established during the IMP. Leveling surveys are typically conducted in the MZ1 Managed Area, Northwest MZ1, Northeast Area, and Southeast Area at least once every five years. Vertical ground motion data, based on InSAR, are collected about every two months and analyzed once per year.
- *Horizontal Ground-Surface Deformation*. Watermaster monitors horizontal ground-surface deformation across areas that are experiencing differential land subsidence to understand the potential threats and locations of ground fissuring. These data are obtained by electronic distance measurements (EDMs) between benchmark monuments in two areas: across the historical zone of ground fissuring in the MZ1 Managed Area and across the San Jose Fault Zone in Northwest MZ1. Past San Jose fault zone surveys (2013-2021) have demonstrated that the horizontal strain measured between benchmark pairs appears to behave elastically so future EDM surveys may be conducted less frequently than annual (e.g., once every five years).

Exhibits 6-1 through 6-3 illustrate the historical occurrence of vertical ground motion in the Chino Basin as interpreted from InSAR and leveling surveys. These maps demonstrate that land subsidence concerns are primarily confined to the west side of the Chino Basin.

The land subsidence that has occurred in the Chino Basin was mainly controlled by changes in hydraulic heads, which, in turn, were mainly controlled by pumping and recharge. Exhibits 6-4b through 6-8b show the relationships between groundwater pumping, recharge, recycled water reuse, hydraulic heads, and vertical ground motion in the MZ1 Managed Area and the other Areas of Subsidence Concern. These graphics can reveal cause-and-effect relationships and the current state and nature of vertical ground motion. For reference, Exhibits 6-4a through 6-8a illustrate vertical ground motion for each Area of Subsidence Concern as estimated by InSAR for the period March 2011 to March 2022 and display the locations of wells with long-term time-series of depth to groundwater, key benchmark locations with time-series of cumulative ground-surface-elevation displacement, and InSAR with time-series of cumulative vertical ground motion.

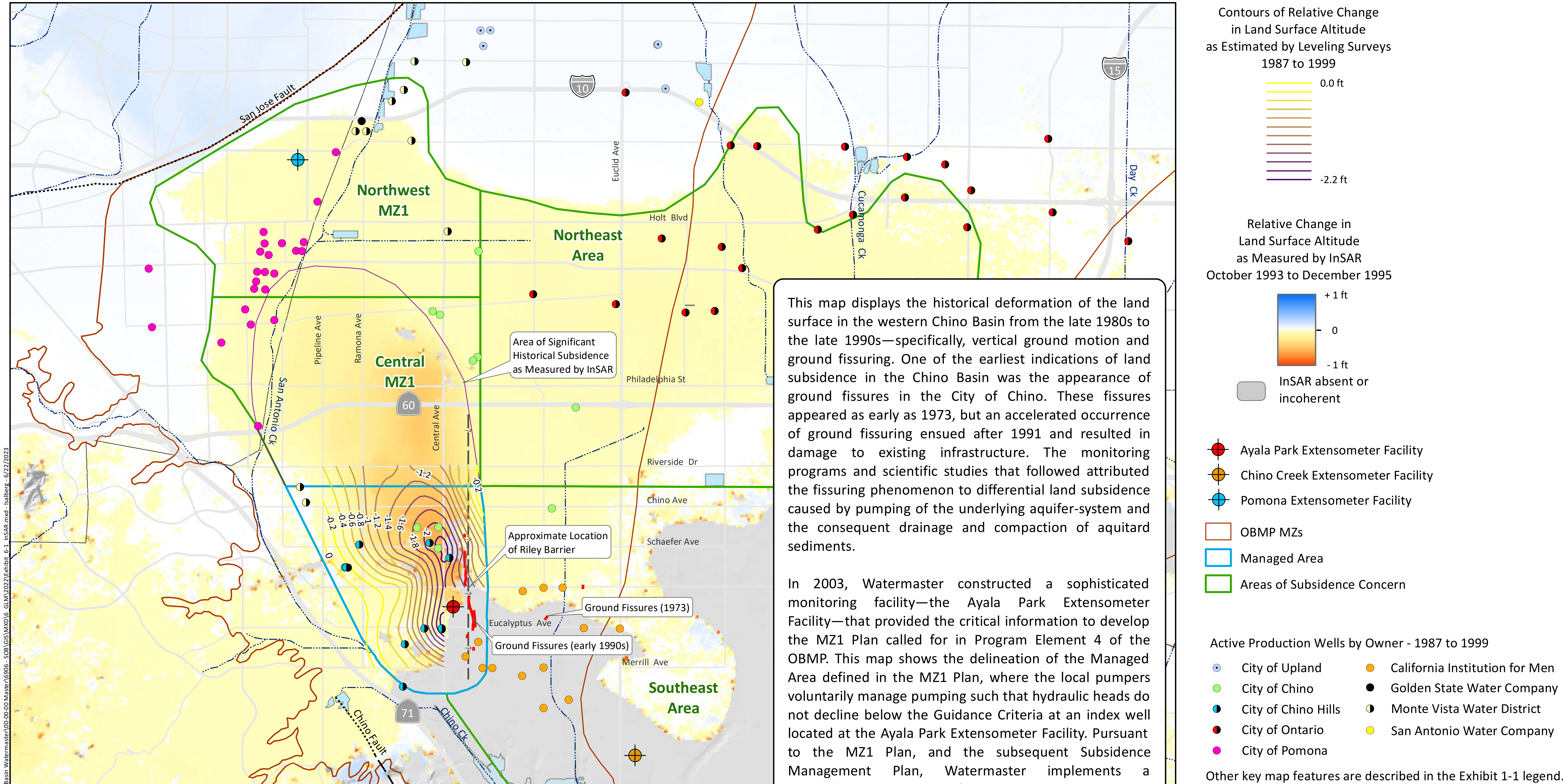
Watermaster convenes a Ground-Level Monitoring Committee (GLMC) annually to review and interpret data from the ground-level monitoring program. The GLMC prepares annual reports that include recommendations for changes to the monitoring program and/or the MZ1 Plan, if such changes are demonstrated to be necessary to achieve the objectives of the monitoring program.

Based on the data collected and analyzed for the ground-level monitoring program, the GLMC became increasingly concerned with the occurrence of persistent differential subsidence in Northwest MZ1. In 2014, the GLMC recommended that the MZ1 Plan be updated to include a subsidence management plan for Northwest MZ1 with the long-term objective of minimizing or abating the occurrence of the differential land subsidence. In 2015, Watermaster updated the MZ1 Plan to more accurately reflect Watermaster's current and future efforts to monitor and manage land subsidence, including the effort to develop a subsidence management plan for Northwest MZ1. The MZ1 Plan was renamed the *Chino Basin Subsidence Management Plan* (WEI, 2015c).

This new effort in Northwest MZ1 is an example of adaptive management of land subsidence, based on monitoring data, and includes the following activities:

- To better understand the extent, rate, and causes of the ongoing subsidence in Northwest MZ1, the GLMC and Watermaster have increased monitoring efforts to include the installation of benchmark monuments across Northwest MZ1, performing annual leveling surveys at the benchmarks, performing EDMs between benchmarks across the San Jose Fault, and expanding the high-frequency measurement of hydraulic heads at wells.

- Aquifer-system compaction may be occurring (or may have occurred historically) at specific depths within Northwest MZ1, caused by depth-specific piezometric changes. Depth-specific data, obtained from piezometers and extensometers, are critical to understanding how groundwater production and recharge affect hydraulic heads and the deformation of the aquifer-system. This understanding is needed to develop a subsidence management plan for Northwest MZ1. Depth-specific piezometric and aquifer-system deformation data is currently being collected at the PX facility and analyzed on a monthly basis in conjunction with pumping data from nearby production wells independently operated by MVWD and the City of Pomona.
- To characterize the potential for future subsidence in Northwest MZ1, two 1D compaction models were developed at Well MVWD-28 and the PX. The 1D models simulate the mechanical response of the aquifer-system to the projected future changes in hydraulic heads, which will be largely controlled by future pumping and recharge. The 1D modeling results will inform the development of the Subsidence Management Plan for Northwest MZ1.
- The initial Subsidence Management Plan for Northwest MZ1 is expected to be completed by the end of FY 2023/24.



This map displays the historical deformation of the land surface in the western Chino Basin from the late 1980s to the late 1990s—specifically, vertical ground motion and ground fissuring. One of the earliest indications of land subsidence in the Chino Basin was the appearance of ground fissures in the City of Chino. These fissures appeared as early as 1973, but an accelerated occurrence of ground fissuring ensued after 1991 and resulted in damage to existing infrastructure. The monitoring programs and scientific studies that followed attributed the fissuring phenomenon to differential land subsidence caused by pumping of the underlying aquifer-system and the consequent drainage and compaction of aquitard sediments.

In 2003, Watermaster constructed a sophisticated monitoring facility—the Ayala Park Extensometer Facility—that provided the critical information to develop the MZ1 Plan called for in Program Element 4 of the OBMP. This map shows the delineation of the Managed Area defined in the MZ1 Plan, where the local pumpers voluntarily manage pumping such that hydraulic heads do not decline below the Guidance Criteria at an index well located at the Ayala Park Extensometer Facility. Pursuant to the MZ1 Plan, and the subsequent Subsidence Management Plan, Watermaster implements a comprehensive program of monitoring and assessment, and updates the Plan, as necessary, to minimize or abate the future occurrence of land subsidence and ground fissuring.

Prepared by:

WEST YOST
Water. Engineered.

0 1 2 Miles
0 2 4 Km

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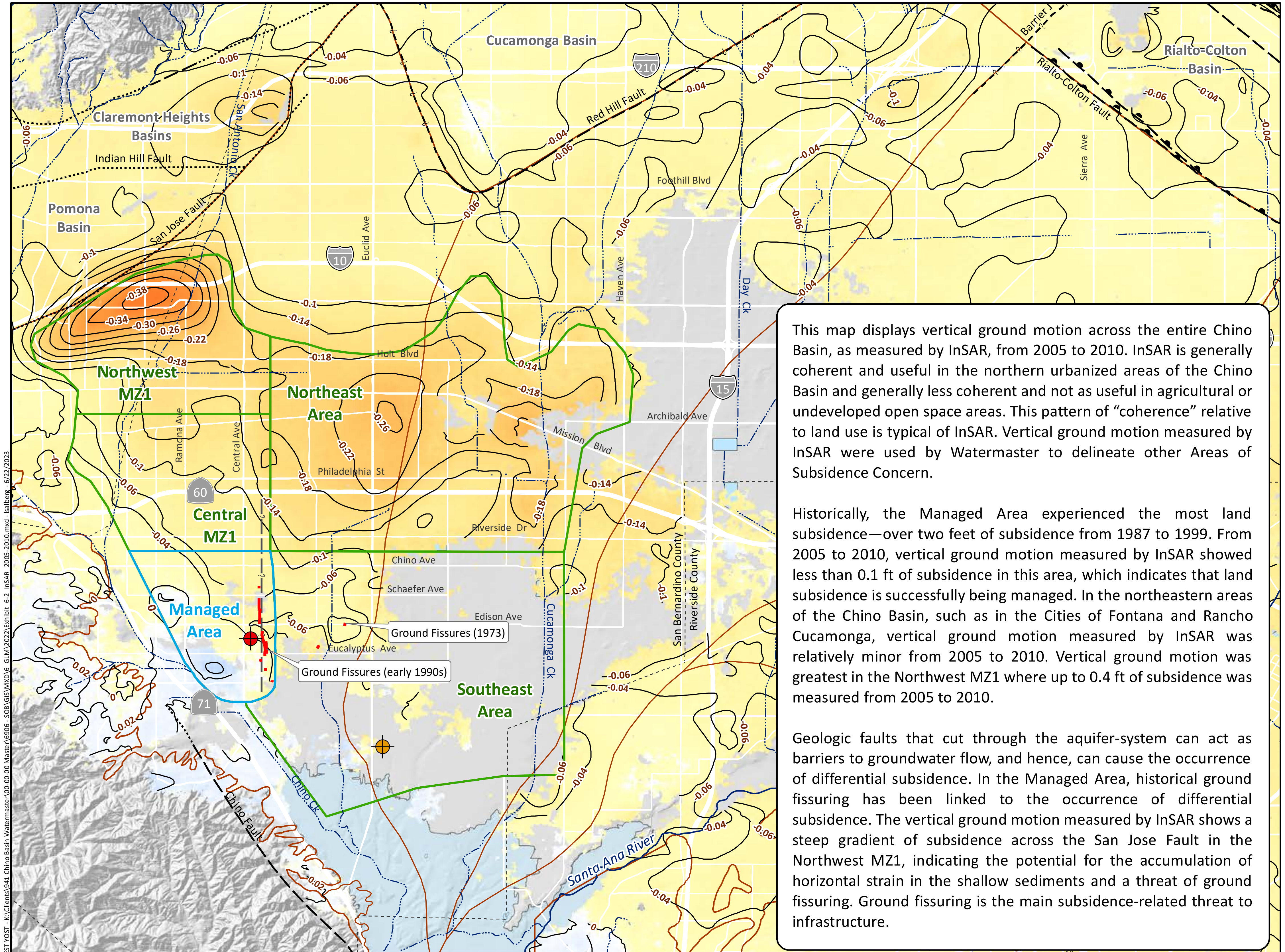
2022 State of the Basin Report
Ground-Level Monitoring

Historical Land Surface Deformation in Management Zone 1
Leveling Surveys (1987-1999) and InSAR (1993-1995)

Exhibit 6-1



This map displays vertical ground motion across the entire Chino Basin, as measured by InSAR, from 2005 to 2010. InSAR is generally coherent and useful in the northern urbanized areas of the Chino Basin and generally less coherent and not as useful in agricultural or undeveloped open space areas. This pattern of "coherence" relative to land use is typical of InSAR. Vertical ground motion measured by InSAR were used by Watermaster to delineate other Areas of Subsidence Concern.

Historically, the Managed Area experienced the most land subsidence—over two feet of subsidence from 1987 to 1999. From 2005 to 2010, vertical ground motion measured by InSAR showed less than 0.1 ft of subsidence in this area, which indicates that land subsidence is successfully being managed. In the northeastern areas of the Chino Basin, such as in the Cities of Fontana and Rancho Cucamonga, vertical ground motion measured by InSAR was relatively minor from 2005 to 2010. Vertical ground motion was greatest in the Northwest MZ1 where up to 0.4 ft of subsidence was measured from 2005 to 2010.

Geologic faults that cut through the aquifer-system can act as barriers to groundwater flow, and hence, can cause the occurrence of differential subsidence. In the Managed Area, historical ground fissuring has been linked to the occurrence of differential subsidence. The vertical ground motion measured by InSAR shows a steep gradient of subsidence across the San Jose Fault in the Northwest MZ1, indicating the potential for the accumulation of horizontal strain in the shallow sediments and a threat of ground fissuring. Ground fissuring is the main subsidence-related threat to infrastructure.

-0.04 Contour of Vertical Ground Motion (ft) June 2005 to September 2010

Relative Change in Land Surface Altitude as Measured by InSAR June 2005 to September 2010

+ 0.5 ft

0

- 0.5 ft

InSAR absent or incoherent

Ayala Park Extensometer Facility

Chino Creek Extensometer Facility (CCX)

OBMP MZs

Managed Area

Areas of Subsidence Concern

Other key map features are described in the Exhibit 1-1 legend.

WEST YOST - K:\Clients\941 Chino Basin Watermaster\00-00-00 Master\6906 - SOB\GIS\MXD\6_GLM\2022\Exhibit_6-2_InSAR_2005-2010.mxd - lsalberg - 6/22/2023

Prepared by:

WEST YOST Water. Engineered.

0 2 4 Miles

0 2 4 Km

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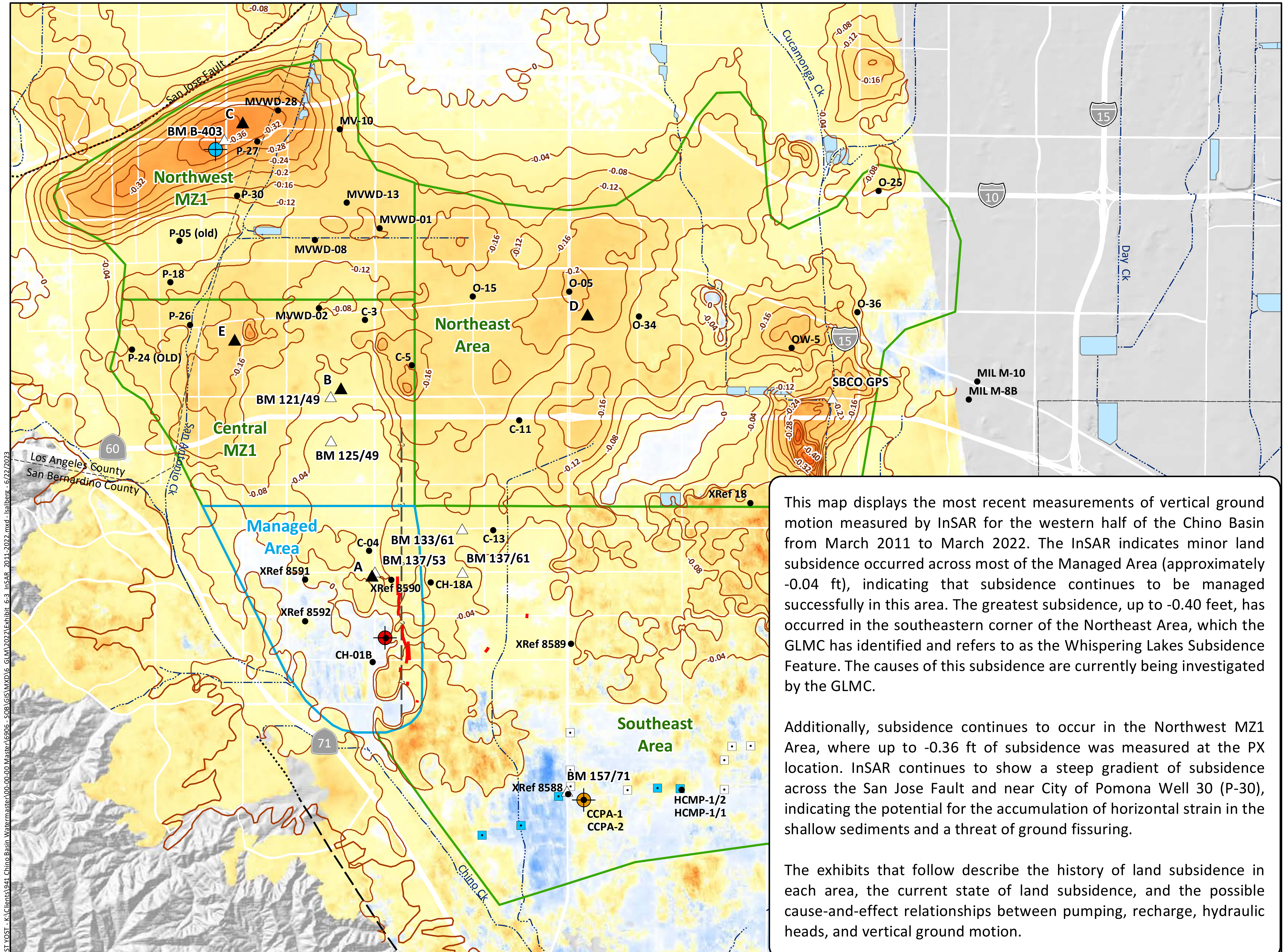
Chino Basin Watermaster
2022 State of the Basin Report
Ground-Level Monitoring

Vertical Ground-Motion as Measured by InSAR
2005 to 2010

Exhibit 6-2



This map displays the most recent measurements of vertical ground motion measured by InSAR for the western half of the Chino Basin from March 2011 to March 2022. The InSAR indicates minor land subsidence occurred across most of the Managed Area (approximately -0.04 ft), indicating that subsidence continues to be managed successfully in this area. The greatest subsidence, up to -0.40 feet, has occurred in the southeastern corner of the Northeast Area, which the GLMC has identified and refers to as the Whispering Lakes Subsidence Feature. The causes of this subsidence are currently being investigated by the GLMC.

Additionally, subsidence continues to occur in the Northwest MZ1 Area, where up to -0.36 ft of subsidence was measured at the PX location. InSAR continues to show a steep gradient of subsidence across the San Jose Fault and near City of Pomona Well 30 (P-30), indicating the potential for the accumulation of horizontal strain in the shallow sediments and a threat of ground fissuring.

The exhibits that follow describe the history of land subsidence in each area, the current state of land subsidence, and the possible cause-and-effect relationships between pumping, recharge, hydraulic heads, and vertical ground motion.

Contour of Vertical Ground Motion (ft)
March 2011 to March 2022

Relative Change in Land Surface Altitude
as Measured by InSAR
March 2011 to March 2022

+ 0.5 ft
0
- 0.5 ft

InSAR absent or incoherent

Well with a Piezometric Level Time History
Plotted on Exhibits 6-4b to 6-8b

InSAR Time-History Point
Plotted on Exhibits 6-4b to 6-8b

Ground-Level Survey Benchmark Time-History Point
Plotted on Exhibits 6-4b to 6-8b

Ayala Park Extensometer Facility

Chino Creek Extensometer Facility (CCX)

Pomona Extensometer Facility (PX)

Chino-I/Chino-II Desalter Well

Chino-1 Desalter CCWF

OBMP MZs

Managed Area

Areas of Subsidence Concern

Ground Fissure

Approximate Location of the Riley Barrier

Other key map features are described in the Exhibit 1-1 legend.

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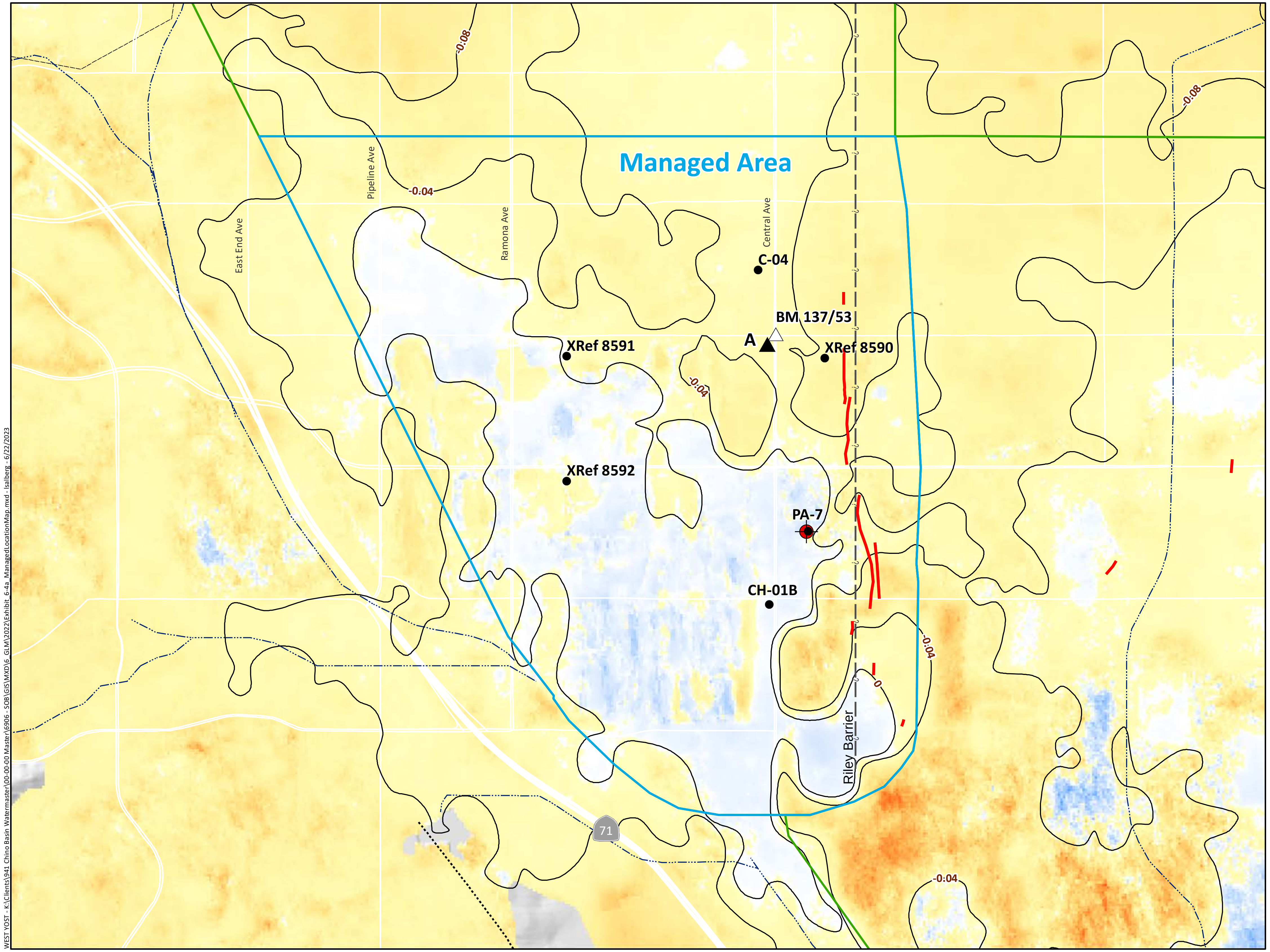
Chino Basin Watermaster
2022 State of the Basin Report
Ground-Level Monitoring

Vertical Ground-Motion as Measured by InSAR
2011 to 2022

Exhibit 6-3



Contour of Vertical Ground Motion (ft)
March 2011 to March 2022

Relative Change in Land Surface Altitude
as Measured by InSAR
March 2011 to March 2022

+ 0.5 ft
0
- 0.5 ft

InSAR absent or incoherent

Ayala Park Extensometer Facility

Well with a Piezometric Level Time History Plotted on Exhibit 6-4b

InSAR Time-History Point Plotted on Exhibit 6-4b

Benchmark Time-History Point Plotted on Exhibit 6-4b

Ground Fissure

Other key map features are described in the Exhibit 1-1 and 6-3 legend.

This map displays vertical ground motion as estimated by InSAR across the Managed Area for the period from March 2011 to March 2022. InSAR estimates of vertical ground motion range from zero ft to about -0.04 ft. The greatest area of downward ground motion occurred in the northern and southeastern portions of the Managed Area. The InSAR estimates of vertical ground motion are consistent with the Deep Extensometer record at Ayala Park from March 2011 to March 2022. Over this period, the Deep Extensometer recorded nearly 0.04 ft of aquifer-system deformation which is equivalent to the -0.04 ft of vertical ground motion estimated by InSAR at the Ayala Park Deep Extensometer Facility location.

Prepared by:

WEST YOST
Water. Engineered.

0 0.5 1 Miles
0 0.5 1 Km

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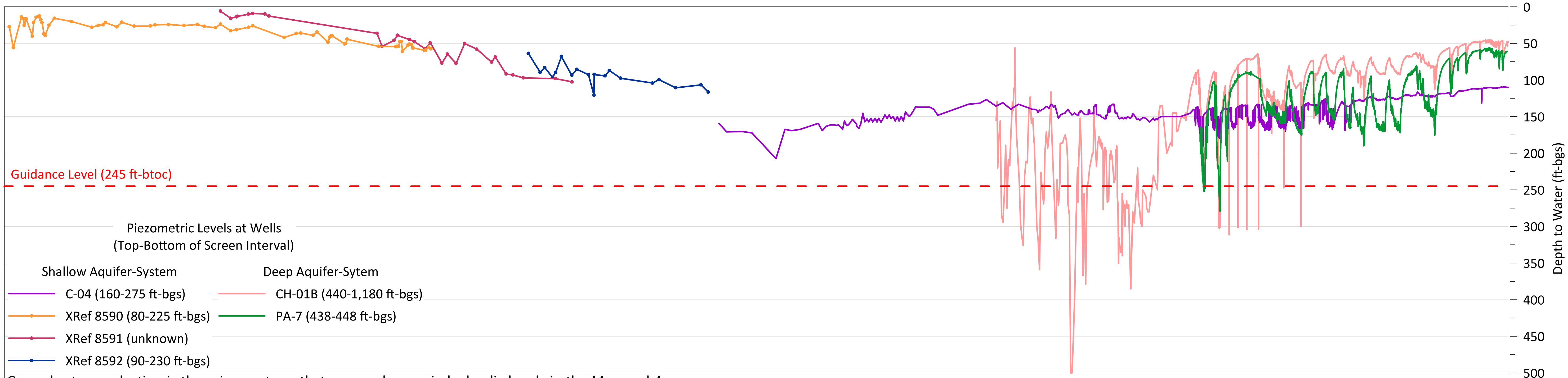
2022 State of the Basin Report
Ground-Level Monitoring

Vertical Ground-Motion across the Manged Area
2011 to 2022

Exhibit 6-4a



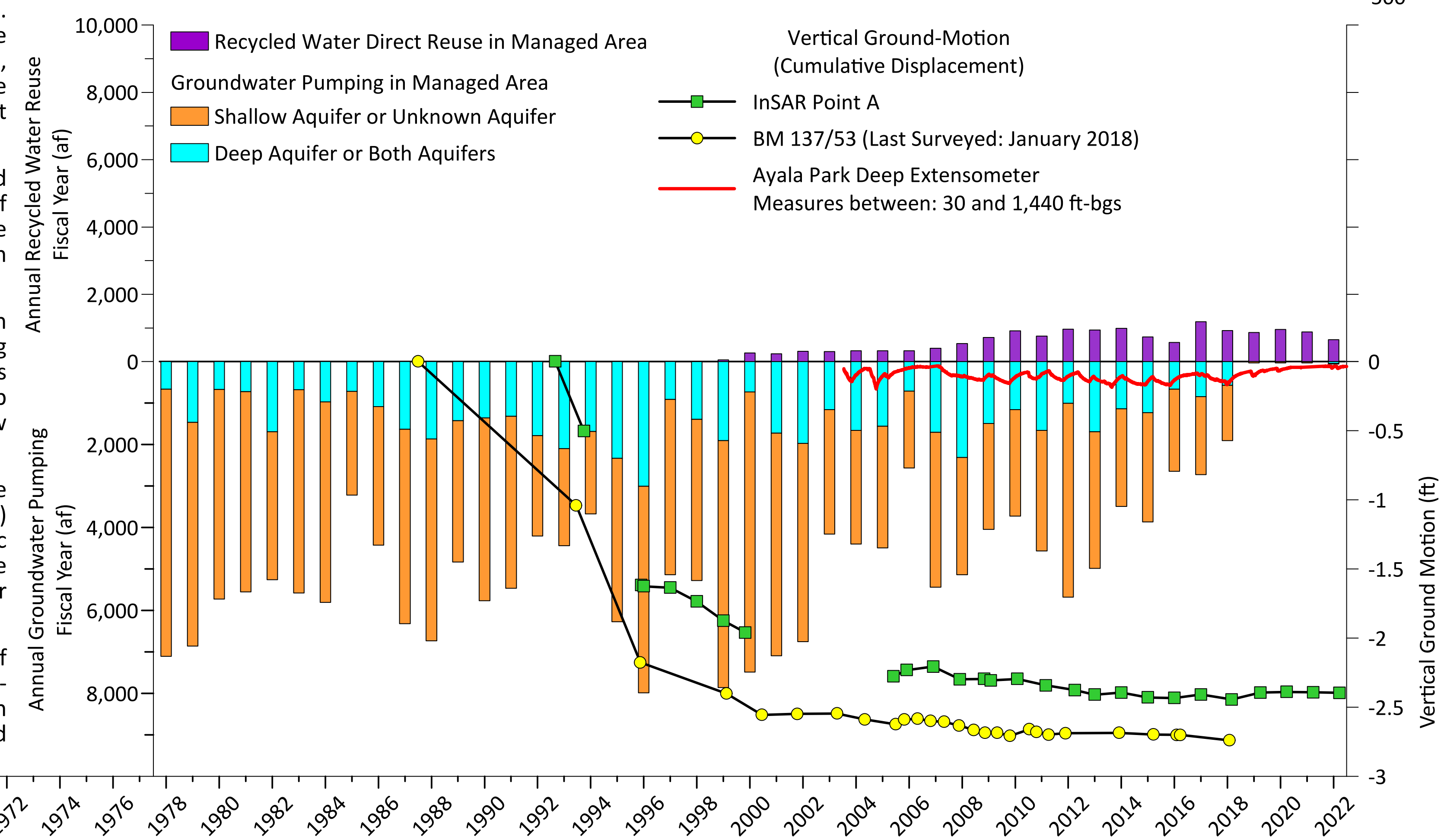
Groundwater production is the primary stress that causes changes in hydraulic heads in the Managed Area. Changes in hydraulic heads can cause deformation of the aquifer-system sediments, which, in turn, cause ground motion at the land surface. This time-series chart illustrates the history of vertical ground motion, groundwater production, and hydraulic heads at representative wells in the Managed Area. Also shown is the volume of direct use of recycled water in the Managed Area, which is an alternative water supply that can result in decreased groundwater production from the area.

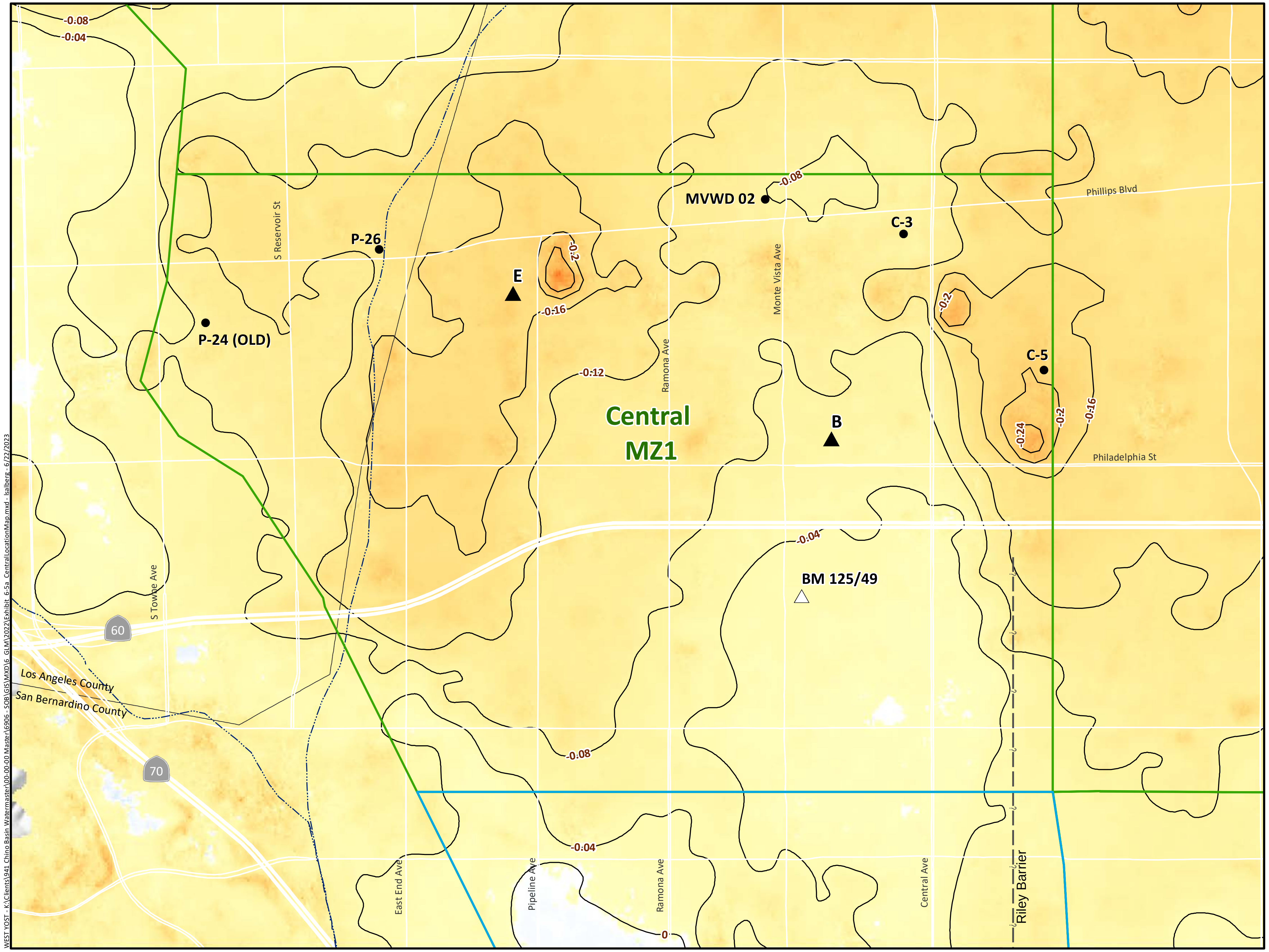
The vertical ground motion shown is based on measurements at the Ayala Park Deep Extensometer, InSAR, and a benchmark monument located at the corner of Schaefer Avenue and Central Avenue. About 2.5 feet of subsidence occurred in portions of the Managed Area from 1987 to 2000, and ground fissuring occurred in the early- to mid-1990s. Very little subsidence has occurred since 2000, and no additional ground fissuring has been observed.

Pumping of the deep aquifer-system is the main cause of changes in hydraulic head and vertical ground motion in the Managed Area. Other factors that influence hydraulic heads in the deep aquifer-system include pumping and recharge stresses in the shallow aquifer-system in the Managed Area and other portions of Chino Basin. As shown here, pumping of the deep, confined aquifer-system causes head declines at wells screened in the deep system (Wells CH-01B and PA-7) that are greater in magnitude than head declines from pumping of the shallow aquifer-system (e.g. Wells C-4, XRef 8590, and XRef 8592).

During controlled pumping tests performed in 2004 and 2005, the initiation of inelastic compaction within the deep aquifer-system was observed when hydraulic head declined below 250 feet below top of casing (ft-btoc) in the PA-7 piezometer at Ayala Park. Historical hydraulic head data show that from 1991 to 2001, hydraulic heads in the deep aquifer-system were consistently below 250 ft-btoc. To avoid inelastic compaction in the future, a “Guidance Level” of 245 ft-btoc in the PA 7 piezometer was established, and it’s the primary criteria for subsidence management in the Managed Area.

From 2005 through 2022, hydraulic heads at PA-7 did not decline below the Guidance Level, and very little, if any, inelastic compaction was recorded in the Managed Area. These observations demonstrate the effectiveness of the MZ1 Plan in the management of subsidence in the Managed Area. Note that recent increases in hydraulic heads in the Managed Area may also be related in part to the increase in the direct use of recycled water, beginning FY 1998/99, resulting in reduced groundwater pumping.





Contour of Vertical Ground Motion (ft)
March 2011 to March 2022

Relative Change in Land Surface Altitude
as Measured by InSAR
March 2011 to March 2022

+ 0.5 ft
0
- 0.5 ft

InSAR absent or incoherent

Well with a Piezometric Level Time History Plotted on Exhibit 6-5b

InSAR Time-History Point Plotted on Exhibit 6-5b

Benchmark Time-History Point Plotted on Exhibit 6-5b

Other key map features are described in the Exhibit 1-1 and 6-3 legend.

This map displays vertical ground motion as estimated by InSAR across Central MZ1 for the period March 2011 to March 2022. The InSAR indicates that generally vertical ground motion across most of Central MZ1 was minor and that the areas in the Central MZ1 that experienced the greatest magnitude of subsidence are located in the northern portion of the Central MZ1 where up to -0.24 feet of vertical ground motion has occurred.

Prepared by:

WEST YOST
Water. Engineered.

0 0.5 1 Miles
0 0.5 1 Km

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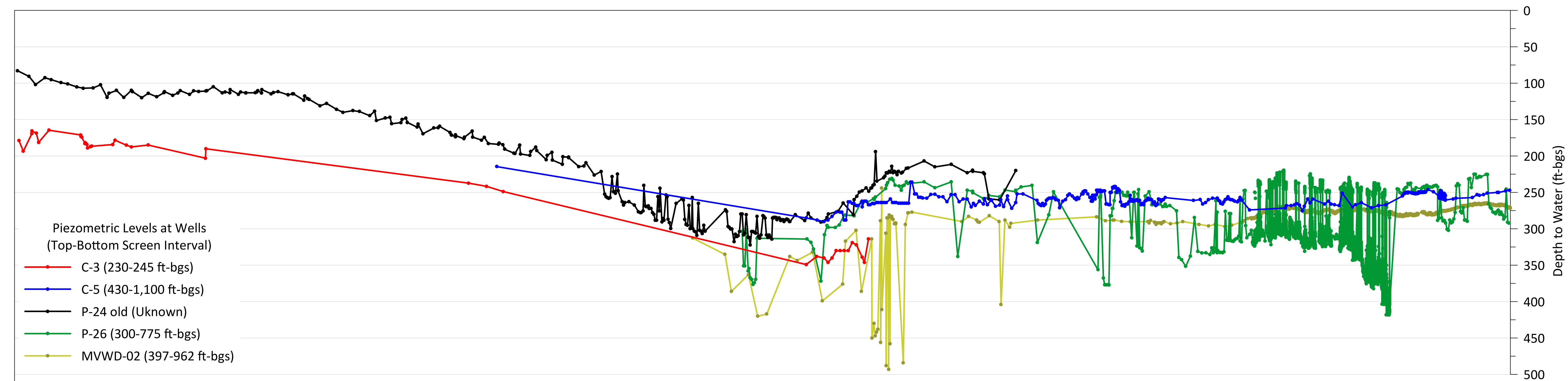
Ground-Level Monitoring

Vertical Ground-Motion across Central MZ1
2011 to 2022

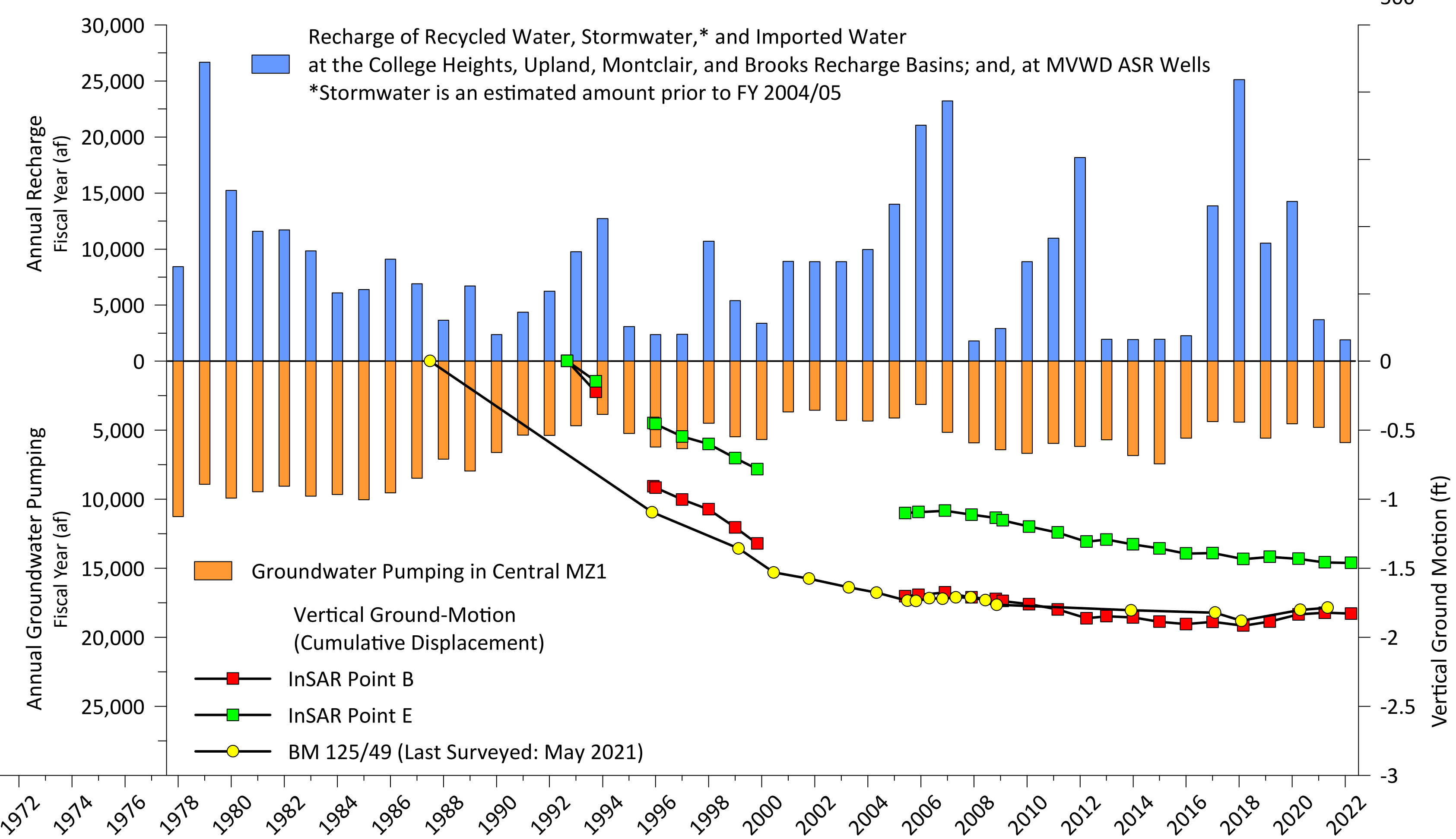
Exhibit 6-5a

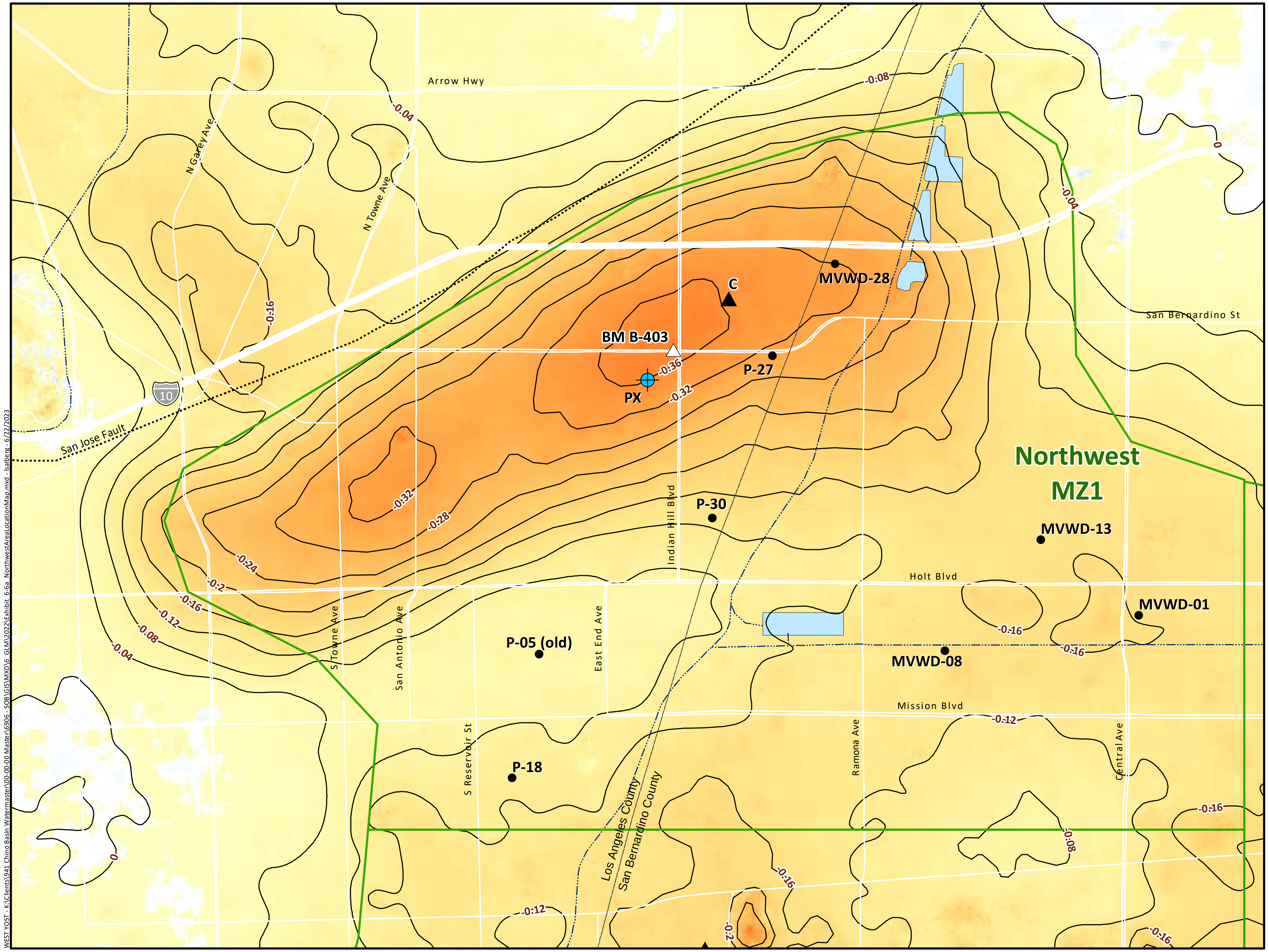


Groundwater production and supplemental-water recharge are the primary stresses that cause changes in hydraulic heads in the Central MZ1. Changes in hydraulic heads can cause deformation of the aquifer-system sediments, which in turn, cause ground motion at the land surface. This time-series chart illustrates the history of vertical ground motion, groundwater production, managed recharge, and hydraulic heads at representative wells in the Central MZ1.

Vertical ground motion shown here is based on InSAR and leveling surveys at benchmark monuments within Central MZ1. Single and multi-year gaps in the InSAR record in 1994 and between 2000 and 2005 are due to incongruent datasets collected from different radar satellites. Vertical ground motion during these gaps in the InSAR record was estimated based on the rate of vertical ground motion measured at nearby benchmarks, or the rate of vertical ground motion measured by InSAR, before and after the gaps.

Hydraulic head data are absent in the southern portion of Central MZ1. In the northern portion of Central MZ1, hydraulic heads declined by about 200 ft from 1930 to about 1978. From 1978 to 1986, hydraulic heads increased by about 80 ft and have remained relatively stable or have slightly increased from 1986 to 2022. The recent hydraulic heads in the northern portion of Central MZ1 are about 120 ft lower than the hydraulic heads in the 1930s. About 1.9 feet of subsidence occurred near Walnut and Monte Vista Avenue from 1988 to 2000, as measured by ground level surveys at BM 125/49. Since 2000, the rate of subsidence has slowed significantly—about -0.34 feet of subsidence occurred at a gradually declining rate from 2000 to 2022. Hydraulic heads remained relatively stable in this area from 2011 to 2022, which indicates that the downward vertical ground motion is, at least in part, permanent subsidence due to delayed aquitard drainage in response to the historical declines in hydraulic heads that occurred from 1930 to 1978.





Contour of Vertical Ground Motion (ft)
March 2011 to March 2022

Relative Change in Land Surface Altitude
as Measured by InSAR
March 2011 to March 2022

+ 0.5 ft
0
- 0.5 ft

InSAR absent or incoherent

Pomona Extensometer Facility (PX)

Well with a Piezometric Level Time History Plotted on Exhibit 6-6b

InSAR Time-History Point Plotted on Exhibit 6-6b

Benchmark Time-History Point Plotted on Exhibit 6-6b

Other key map features are described in the Exhibit 1-1 and 6-3 legend.

This map displays vertical ground motion as estimated by InSAR across the Northwest MZ1 for the period March 2011 to March 2022. The InSAR indicates a maximum of about -0.36 ft of subsidence occurred near the intersection of Indian Hill Boulevard and San Bernardino Avenue in the Northwest MZ1.

Also shown on this map is the location of the PX. The PX houses two dual-nested piezometers, each equipped with pressure transducer data loggers and cable extensometers. Depth-specific piezometric and aquifer-system deformation data are collected at the PX site at 15-minute intervals. These data are critical to understanding how groundwater production and recharge affect hydraulic heads and the deformation of the aquifer-system in Northwest MZ1.

1D compaction models have been developed at the PX site and at Well MVWD-28 (both shown on this map). The 1D compaction models are being used to develop the Subsidence Management Plan for Northwest MZ1, which may include recommendations for recharge, pumping, and hydraulic heads to minimize the future occurrence of subsidence in this area.

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0 0.5 1 Miles
0 0.5 1 Km

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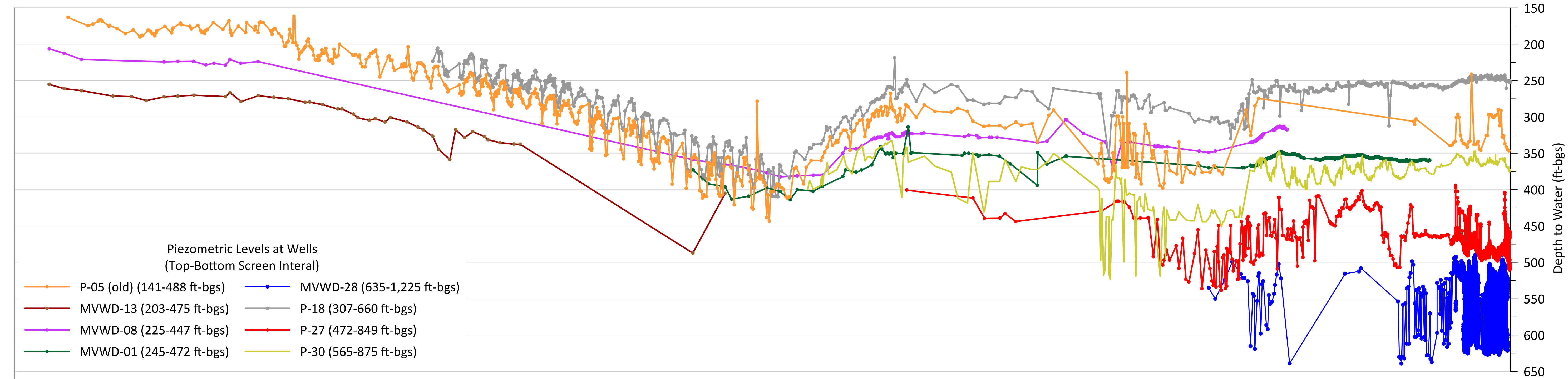
Ground-Level Monitoring

Vertical Ground-Motion across the Northwest MZ1 Area
2011 to 2022

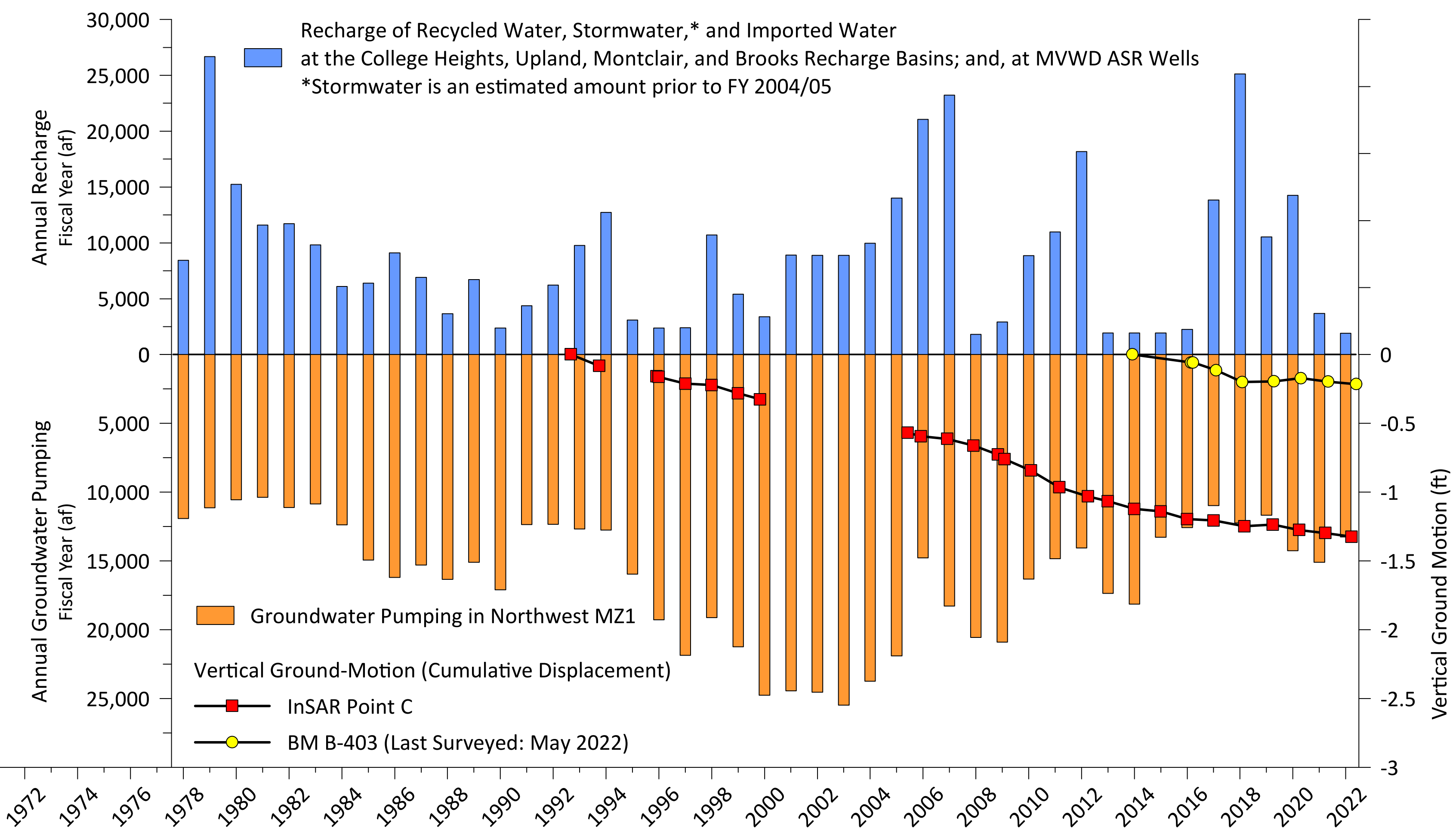
Exhibit 6-6a

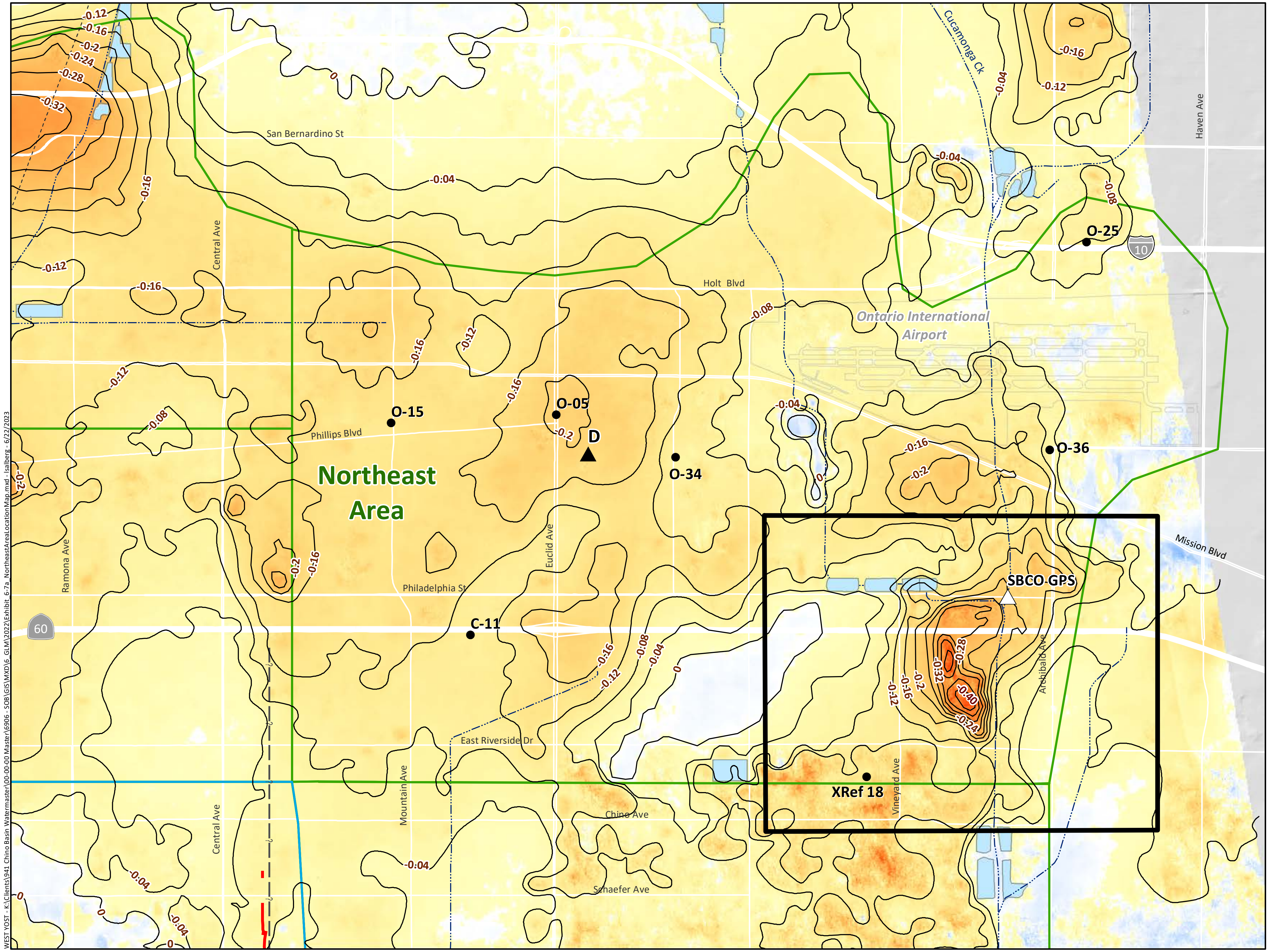


Groundwater production and supplemental water recharge are the primary stresses that cause changes in hydraulic heads in Northwest MZ1. Changes in hydraulic heads can cause deformation of the aquifer -system sediments, which in turn, cause vertical ground motion at the land surface. This time-series chart illustrates the history of vertical ground motion, groundwater production, managed recharge, and hydraulic heads at representative wells in Northwest MZ1.

Vertical ground motion shown here is based on InSAR and ground-level surveys at benchmark monuments within Northwest MZ1. Single and multi-year gaps in the InSAR record in 1994 and between 2000 and 2005 are due to incongruent datasets collected from different radar satellites. Vertical ground motion during the gaps in the InSAR record was estimated based on the rate of vertical ground motion measured by InSAR before and after the gaps. About 1.3 feet of subsidence has occurred in this area from 1992 through 2022. Of concern, is that the subsidence has occurred differentially across the San Jose Fault Zone—the same pattern of differential subsidence that occurred in the Managed Area.

Hydraulic heads in Northwest MZ1 have fluctuated since the 1930s. The fluctuation in hydraulic head began with a decline of about 200 ft from about 1930 to 1978. From 1978 to 1985, hydraulic heads increased by about 100 ft. From 1985 to 2022 hydraulic heads have remained relatively stable but still well below the levels of 1930. The observed continuous land subsidence that occurred from 1992 to 2022 cannot be explained entirely by the concurrent changes in hydraulic heads. A plausible explanation for the subsidence is that thick, slow-draining aquitards are compacting in response to the historical decline of hydraulic heads that occurred from 1930 to 1978. Results from the 1D compaction models have confirmed that the process of delayed drainage of aquitards within the deep aquifer-system is the main cause of the observed subsidence since 1992.





0 0.5 1 Miles

0 0.5 1 Km

Contour of Vertical Ground Motion (ft)
March 2011 to March 2022

Relative Change in Land Surface Altitude
as Measured by InSAR
March 2011 to March 2022

+ 0.5 ft
0
- 0.5 ft

InSAR absent or incoherent

Well with a Piezometric Level Time History Plotted on Exhibit 6-7b

InSAR Time-History Point Plotted on Exhibit 6-7b

Ground-Level Survey BenchmarkTime-History Point Plotted on Exhibit 6-7b

Whispering Lakes Subsidence Feature Study Area

Other key map features are described in the Exhibit 1-1 and 6-3 legend.

This map displays vertical ground motion as estimated by InSAR across the Northeast Area for the period March 2011 to March 2022. The InSAR indicates that an average of approximately -0.22 feet of vertical ground motion has occurred in the Northeast Area, except for an area between Vineyard Avenue and Archibald Avenue, where a maximum of about -0.40 feet of vertical ground motion has occurred. This area of concentrated land subsidence is referred to as the Whispering Lakes Subsidence Feature ("feature"). The western and eastern edges of the feature exhibit steep subsidence gradients or "differential subsidence," which is a threat for ground fissuring. The feature was only recently observed via InSAR due to the use of enhanced processing and interpolation techniques with the InSAR data. There was not enough information to describe the history of the feature or its cause(s) at the time of the recognition, so Watermaster performed a desktop investigation in 2022 to enhance the understanding of the feature. The results of the investigation led to the following recommendations for future actions: 1) further investigate the historical land use practices in the vicinity of the feature, 2) perform field studies of shallow soil consolidation, and 3) expand aquifer-system monitoring.

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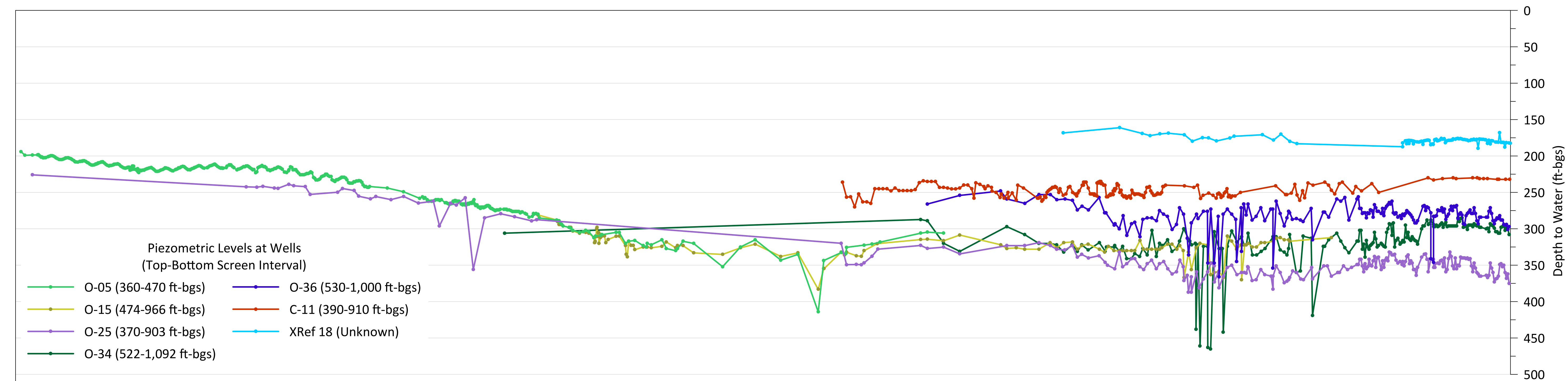
Ground-Level Monitoring

Vertical Ground-Motion across the Northeast Area
2011 to 2022

Exhibit 6-7a

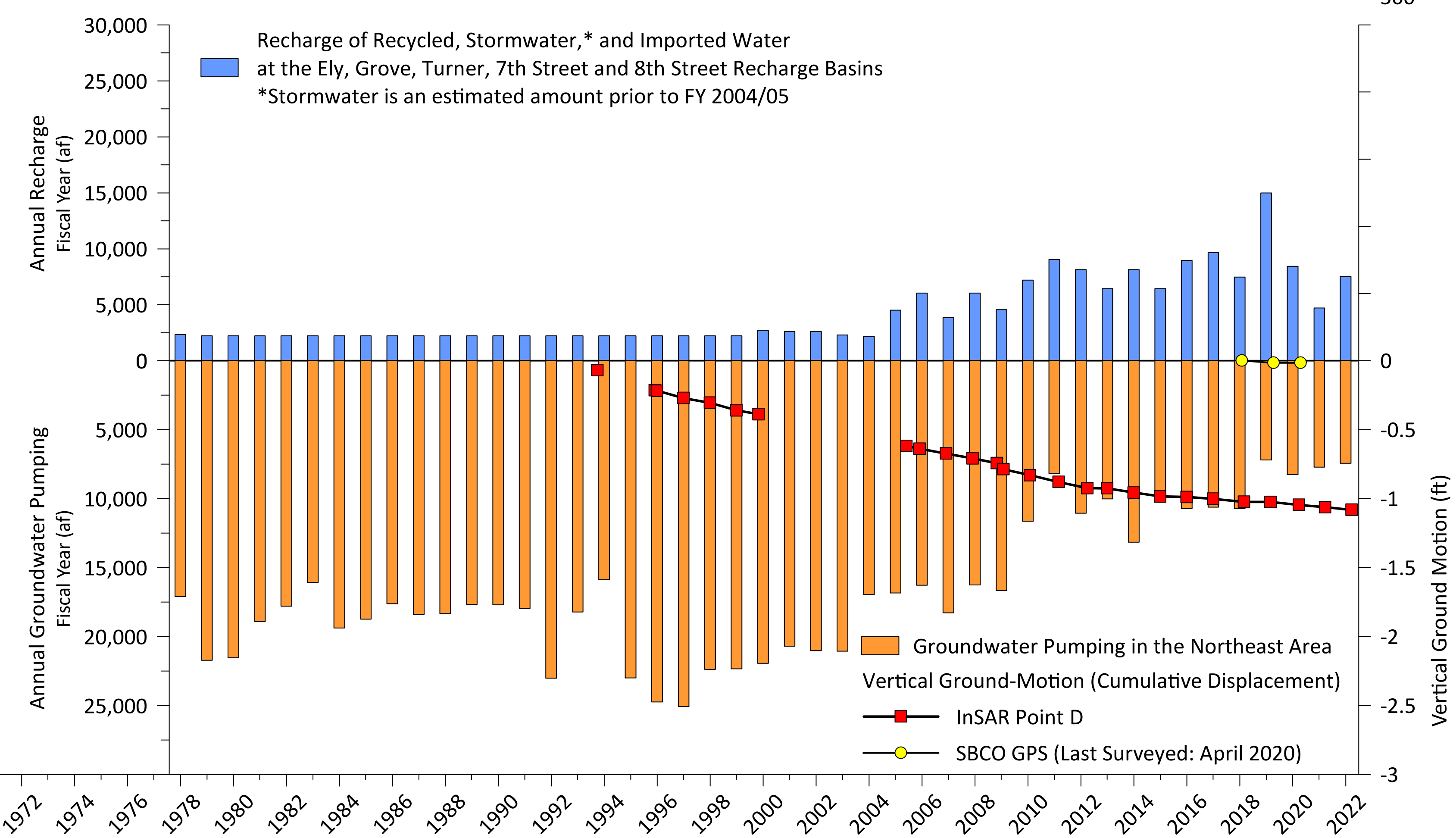


Groundwater production and supplemental-water recharge are the primary stresses that cause changes in hydraulic heads in the Northeast Area. Changes in hydraulic heads can cause deformation of the aquifer-system sediments, which in turn, cause vertical ground motion at the land surface. This time-series chart illustrates the history of vertical ground motion, groundwater production, managed recharge, and hydraulic heads at representative wells in the Northeast Area.

Vertical ground motion shown here is based on InSAR measurements within the Northeast Area. About 1.1 feet of subsidence has occurred in this area from 1992 through 2022. With the exception of the feature in the Whispering Lakes area between Vineyard and Archibald Avenues, subsidence has generally occurred gradually and over a broad area. Single and multi-year gaps in the InSAR record in 1994 and between 2000 and 2005 are due to incongruent datasets collected from different radar satellites. Vertical ground motion during the gaps in the InSAR record was estimated based on the rate of vertical ground motion measured by InSAR before and after the gaps.

Based on measured heads at wells throughout the Northeast Area, hydraulic heads continuously declined by about 125 feet from about 1930 to 1978. In the early 1980s, the pattern of continuous decline ceased, and hydraulic heads fluctuated between 25 and 175 feet in response to groundwater production and supplemental-water recharge. Since 2012, hydraulic heads have remained relatively stable, but still below the levels of 1930. The observed, continuous land subsidence that occurred from 1992 to 2022 cannot be explained entirely by the concurrent changes in hydraulic head. A plausible explanation for the subsidence across the Northeast Area is that thick, slowly-draining aquitards are compacting in response to the historical decline of hydraulic heads that occurred from 1930 to 1978.

The explanation for the differential subsidence occurring within the feature in the Whispering Lakes area is still under investigation by Watermaster. There are no wells with long-term head measurements within the observed extent of the feature.



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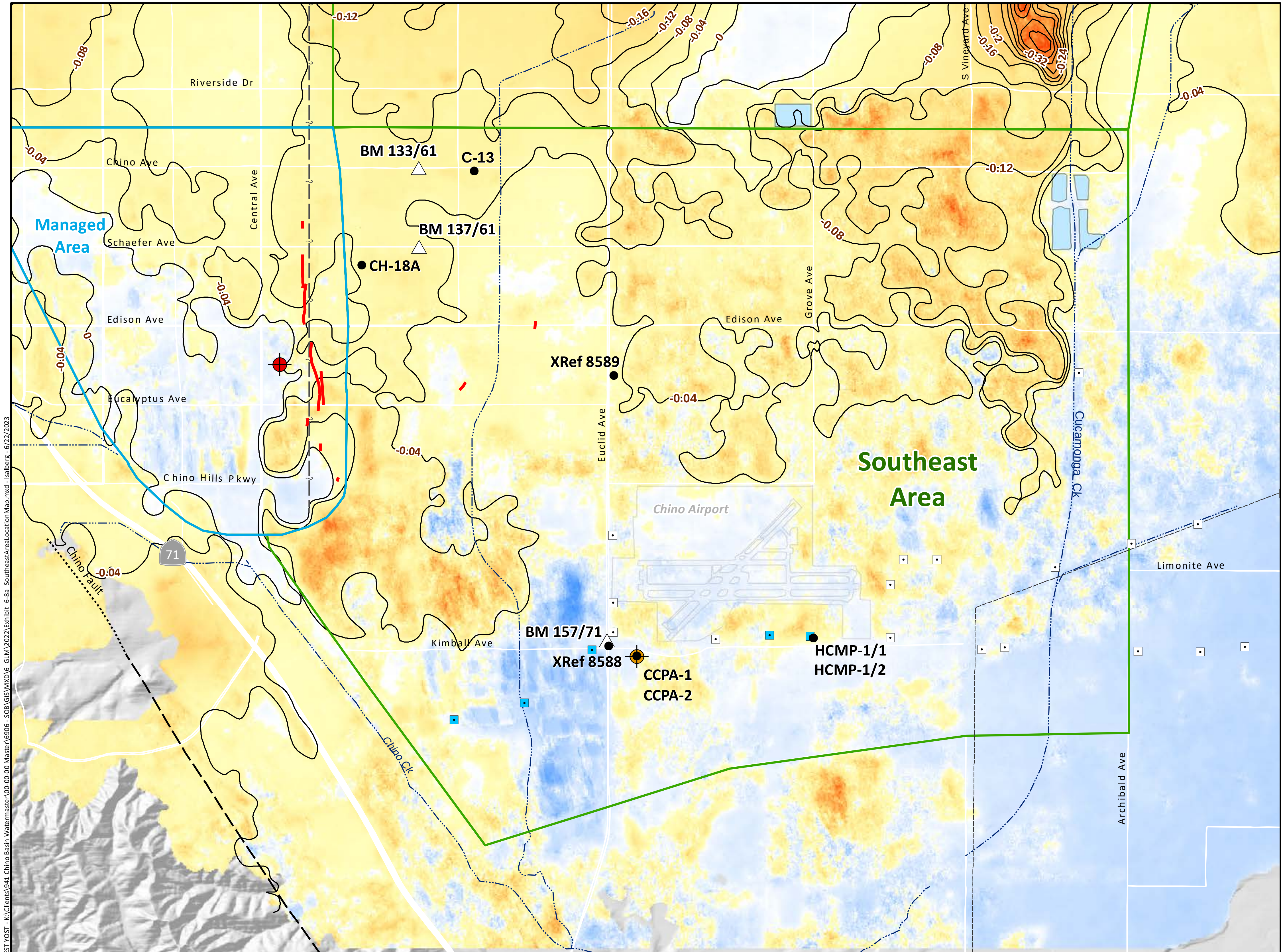
Ground-Level Monitoring

The History of Land Subsidence in the Northeast Area

Exhibit 6-7b



Contour of Vertical Ground Motion (ft)
March 2011 to March 2022

Relative Change in Land Surface Altitude
as Measured by InSAR
March 2011 to March 2022

+ 0.5 ft
0
- 0.5 ft

InSAR absent or incoherent

Ayala Park Extensometer Facility

Chino Creek Extensometer Facility (CCX)

Well with a Piezometric Level Time History
Plotted on Exhibit 6-8b

Benchmark Time-History Point Plotted on Exhibit 6-8b

Chino-I/Chino-II Desalter Well

Chino-1 Desalter CCWF

Other key map features are described in the Exhibit 1-1 and 6-3 legend.

This map displays vertical ground motion as estimated by InSAR across the Southeast Area for the period from March 2011 to March 2022. In general, the occurrence of subsidence has been relatively minor across the Southeast Area, and some areas have recently experienced upward vertical ground motion. In the northern portions of the Southeast Area, up to -0.12 feet of vertical ground motion occurred from 2011 to 2022, which most likely represents the delayed drainage and compaction of aquitards due to historical head declines that occurred prior to the Judgment.

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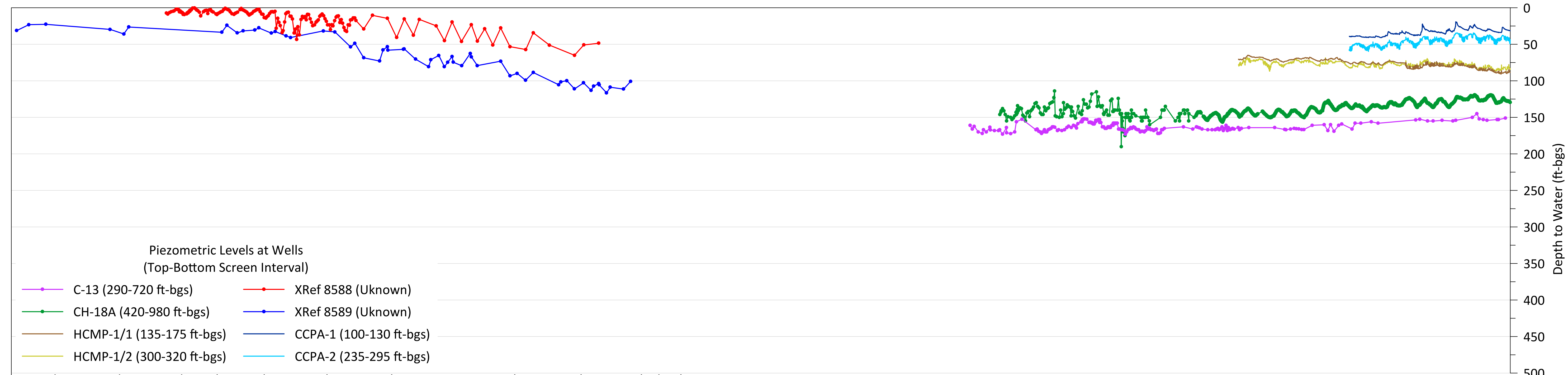
0 0.5 1 Miles
0 0.5 1 Km

Prepared for:

Chino Basin Watermaster
2022 State of the Basin Report
Ground-Level Monitoring

Vertical Ground-Motion across the Southeast Area
2011 to 2022

Exhibit 6-8a



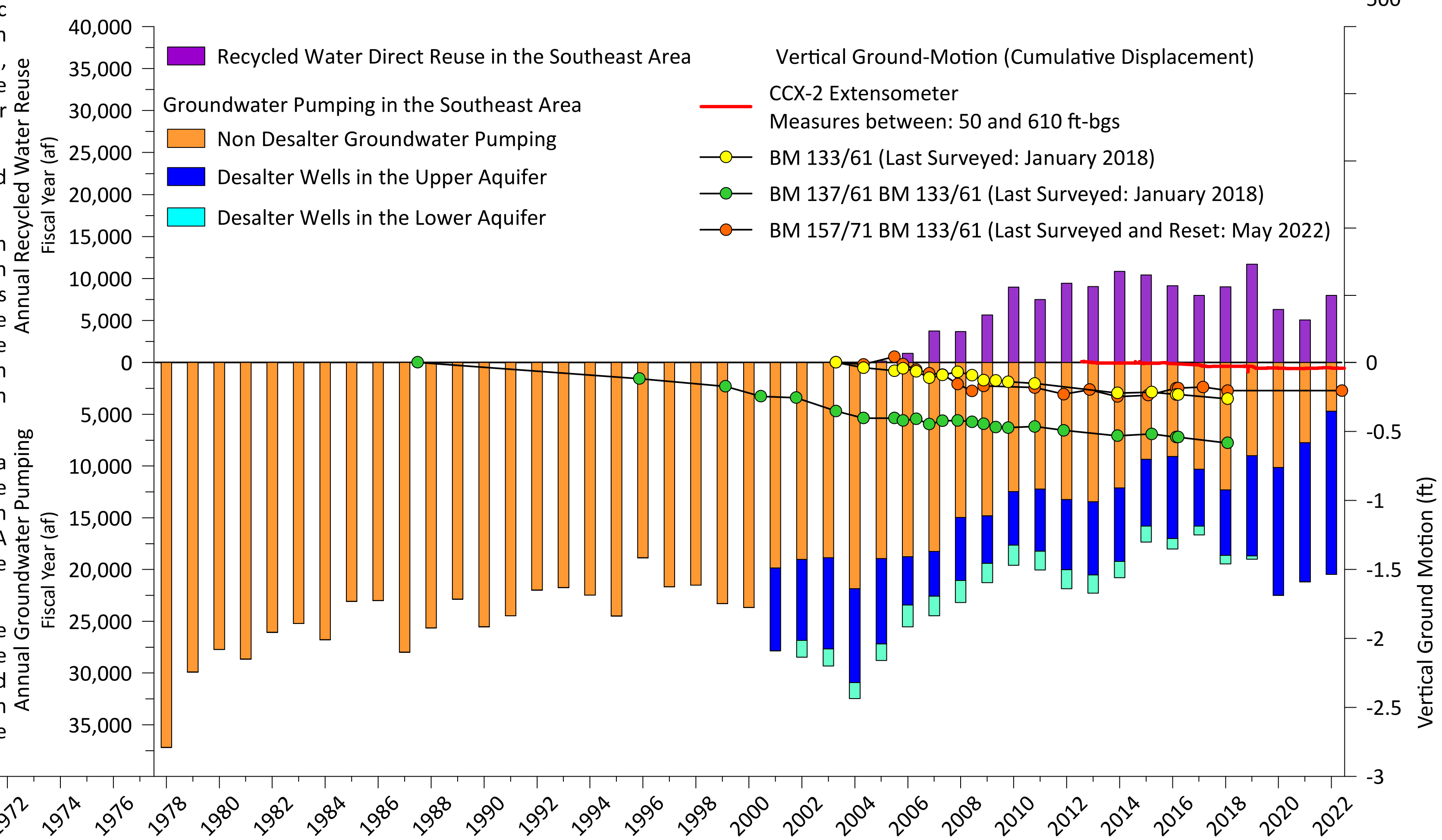
Groundwater production and supplemental-water recharge are the primary stresses that cause changes in hydraulic heads in the Southeast Area. Changes in hydraulic heads can cause deformation of the aquifer-system sediments, which in turn, cause ground motion at the land surface. This time-series chart illustrates the history of vertical ground motion, groundwater production, and hydraulic heads at representative wells in the Northeast Area. Also shown is the direct use of recycled water in the Southeast Area, which is an alternative water supply that can result in decreased groundwater production from the area.

The first ground fissures documented in the Chino Basin occurred in the Southeast Area in the early 1970s, but ground fissuring has not been observed in the area since.

From the 1940s to about 1968, hydraulic heads declined by up to about 75 feet in this area. There is a data gap from about 1968 to 1988; however, it is likely that hydraulic heads continued to decline from 1968 to 1978, as was the case in most portions of the Chino Basin during this period. In the western portion of the Southeast Area, hydraulic heads remained relatively stable from 1988 to 2010 and then gradually increased by about 10 to 20 feet from 2010 to 2022 (see wells CH 18A, C 13, CCPA 1, and CCPA 2). Recent increases in hydraulic heads in the area may be related in part to the increase in the direct use of recycled water. However, recent hydraulic heads have remained below the levels of 1930. In the eastern portion of the Southeast Area, hydraulic heads have been gradually declining by about 2 to 17 feet between 2005 and 2022 (see wells HCMP 1/1 and HCMP 1/2) likely in response to pumping at the Chino Desalter wells.

Vertical ground motion shown here is based on leveling surveys at benchmark monuments within the Southeast Area between 1987 and 2022. Maximum downward ground motion of about -0.12 feet as estimated by InSAR occurred in the northeastern portion of the area. The observed slow but continuous land subsidence from 1987 to 2022 – particularly in the northern portion of the Southeast Area – cannot be explained by the concurrent, relatively stable hydraulic heads. A plausible explanation for the subsidence in this area is that thick, slowly draining aquitards are compacting in response to the historical decline of hydraulic heads that occurred prior to 1990.

Watermaster installed the CCX facility within the Chino-I Desalter well field in July 2012 to characterize the occurrence and mechanisms of the subsidence near the Chino-I Desalter well field and recorded the effects of new pumping at the CCWF on hydraulic heads and land subsidence. Pumping at the CCWF wells commenced in 2014 but appears to have had little, if any, effect on hydraulic heads or aquifer system deformation at the CCX through March 2022. The CCX began collecting data in July 2012 and in general, shows that hydraulic heads vary seasonally, have gradually increased since 2012, and that a small amount of expansion of the aquifer system has been measured by the CCX extensometers.



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Ground-Level Monitoring

The History of Land Subsidence in the Southeast Area

Exhibit 6-8b

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