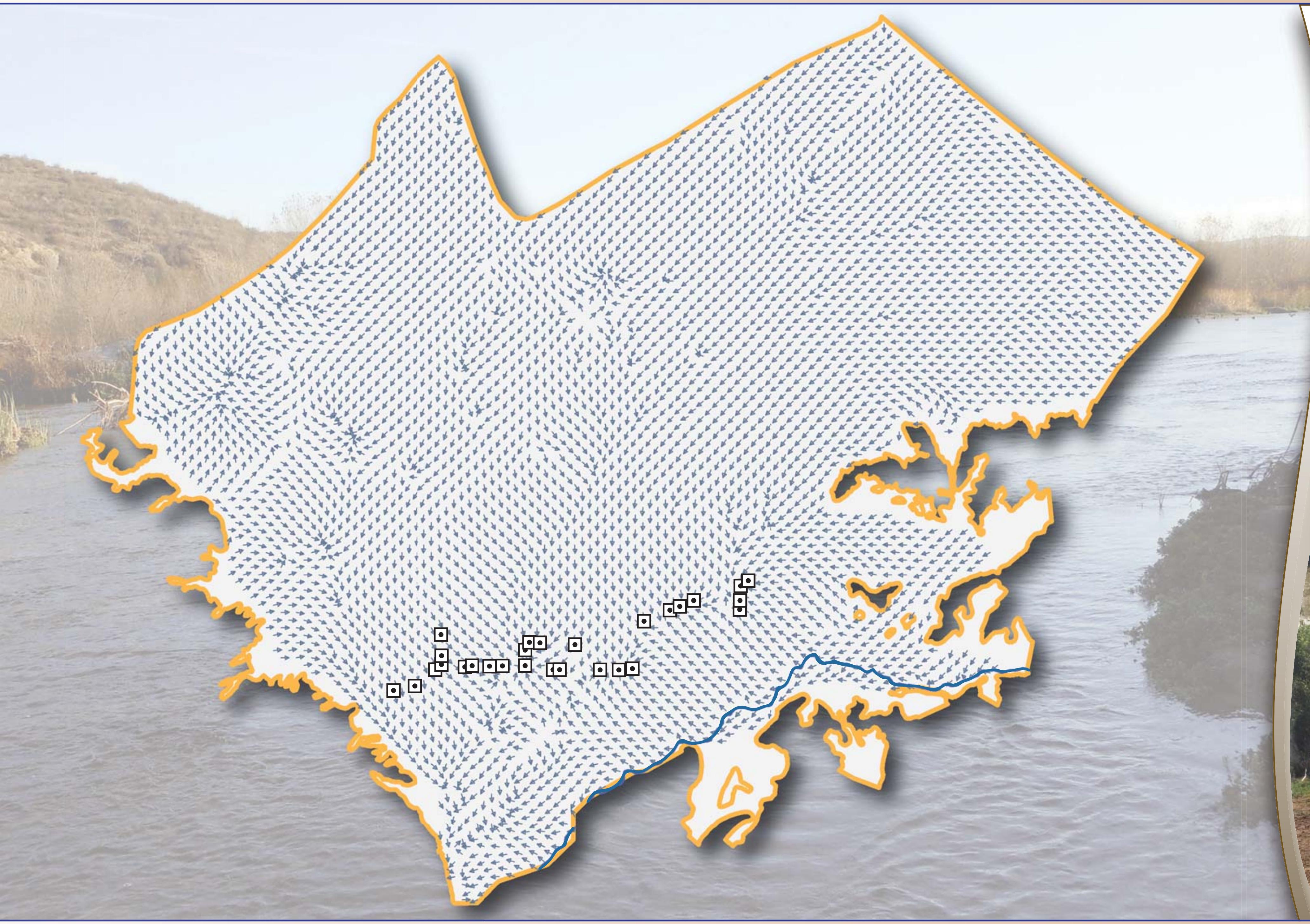
Chino Basin Optimum Basin Management Program
2014 State of the Basin Report



WEI
WILDERMUTH ENVIRONMENTAL, INC.

prepared for

Chino Basin Watermaster

June 2015

2014 State of the Basin Report

June 2015

Prepared for:

Chino Basin Watermaster
Partners in Basin Management

Prepared by:

WEI
Wildermuth Environmental, Inc.

Front cover left imagery: Map of the Chino Basin hydrologic boundary, Santa Ana River, Chino Basin Desalter wells, and model-projected groundwater-flow direction for 2015 Scenario 5A4. The background photo is the Santa Ana River near the USGS gaging station at MWD Crossing and the Riverside Narrows. Front cover right photo collage - clockwise from upper left: drilling of Prado Basin Habitat Sustainability Program monitoring well PB-9; Ely Basin 3 recharge facility; San Sevaine Basin 5 recharge facility; Chino-I Desalter treatment facility; Prado Basin Habitat Sustainability Program monitoring wells PB-7/1 and PB-7/2; and Turner Basin 1 recharge facility.

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Acronyms, Abbreviations, and Initialisms	
μg/L	micrograms per liter
1,1-DCE	1,1-dichloroethene
1,2,3-TCP	1,2,3-trichloropropane
1,2-DCA	1,2-dichloroethane
acre-ft	acre-feet
acre-ft/yr	acre-feet per year
AWQ	ambient water quality
Basin Plan	Water Quality Control Plan for the Santa Ana River Basin
BM	bench mark
CAO	Cleanup and Abatement Order
CBWM ID	Chino Basin Watermaster Well Identification
CCWF	Chino Creek Well Field
CDA	Chino Basin Desalter Authority
CDFM	cumulative departure from mean
CDPH	California Department of Public Health
CIM	California Institution for Men
cis-1,2-DCE	cis-1,2-dichloroethene
CVWD	Cucamonga Valley Water District
DDW	California State Board Division of Drinking Water
DLR	detection limit for reporting
DTSC	California Department of Toxic Substances Control
DWR	California Department of Water Resources
EPA	US Environmental Protection Agency
ft	feet
ft-bgs	feet below ground surface
ft-brp	feet below reference point (*e.g.* static surveyed measurement point)
FY	fiscal year
GE	General Electric
GIS	Geographic Information System
HCMP	Hydraulic Control Monitoring Program
IEUA	Inland Empire Utilities Agency

Acronyms, Abbreviations, and Initialisms	
InSAR	Synthetic Aperture Radar Interferometry
JCSD	Jurupa Community Services District
KM	kilometer
MCL	maximum contaminant level
mg/L	milligrams per liter
MSL	Milliken Sanitary Landfill
MVWD	Monte Vista Water District
MWDSC	Metropolitan Water District of Southern California
MZ	Management Zone
NO_3 - N	nitrate expressed as nitrogen
ND	non-detect
OBMP	Optimum Basin Management Program
OIA	Ontario International Airport
PBMZ	Prado Basin Management Zone
PCE	tetrachloroethene
PRISM	Parameter-Elevation Regressions on Independent Slope Model
PRP	potentially responsible party
POTW	Publicly Owned Treatment Works
RP	Regional Plant
RWQCB	Regional Water Quality Control Board
SARWC	Santa Ana River Water Company
SBCFCD	San Bernardino County Flood Control District
SOB	State of the Basin
SWP	State Water Project
TCE	trichloroethene
TDS	total dissolved solids
USGS	US Geological Survey
VOC	volatile organic compound
Watermaster	Chino Basin Watermaster
WEI	Wildermuth Environmental, Inc.
XRef	anonymous well reference ID

The 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 (WEI, 1999). The OBMP maps a strategy that provides for the enhanced yield of the Chino Basin and seeks to provide reliable, high-quality, water supplies for the development that is expected to occur within the Basin. An important element of the OBMP is the monitoring of the Chino Basin and the periodic analysis and reporting of these data.

Monitoring is performed in accordance with *OBMP Program Element 1 – Develop and Implement a Comprehensive Monitoring Program* which includes the monitoring of basin hydrology, pumping, recharge, groundwater levels, groundwater quality, and land subsidence. The monitoring is performed by basin pumpers, Chino Basin Watermaster (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 its associated 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, 2005; 2007; 2009a; 2011c; and 2013) were used to:

- describe the then-current state of the Basin with respect to production, recharge, groundwater levels, groundwater quality, land subsidence, and hydraulic control.
- demonstrate the progress made since July 1, 2000, when Watermaster commenced several OBMP-spawned investigations and initiatives related to groundwater levels and quality, land subsidence, recharge assessments, recharge master planning, hydraulic control, desalter planning and engineering, and production meter installation.

This 2014 *State of the Basin Report* is an atlas-style document. It consists of detailed exhibits that characterize groundwater production, groundwater levels, groundwater quality, ground-level monitoring, and recharge through fiscal year 2013/14. These exhibits are grouped into the following sections:

Introduction: This section describes the background and objectives of the *State of the Basin Report* and contains exhibits that show the Chino Basin Management Zones (MZ) and water service areas of the major water purveyors that overlie the Basin.

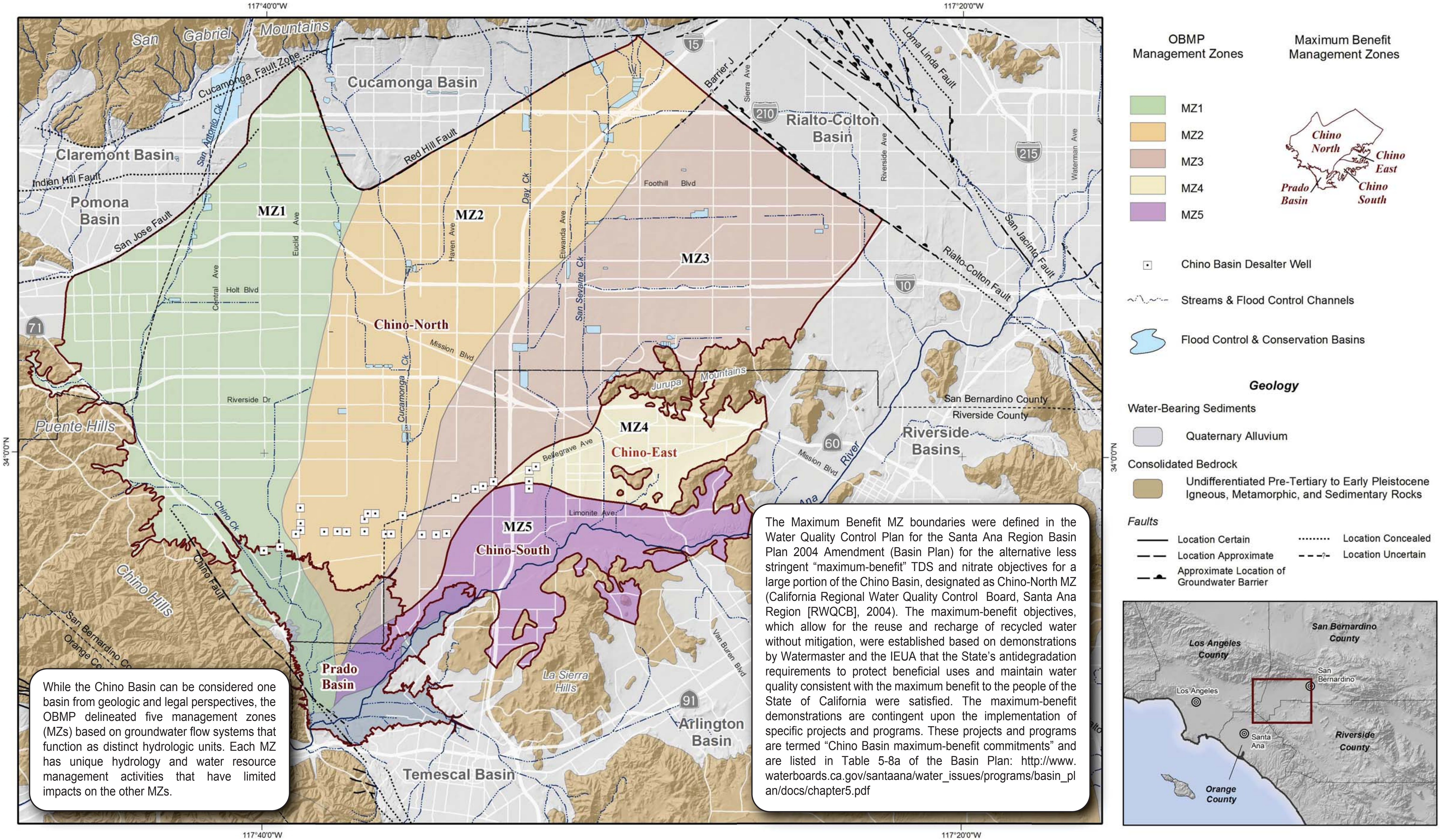
General Hydrologic Conditions: This section contains exhibits that characterize the hydrologic history of the Basin during the base period for the Judgment (1965-1974), the period of the Judgment (1978 to the present), and the period of the Peace Agreement (2000 to the present). This information is useful for characterizing other changes in Basin conditions, including groundwater levels, water quality, recharge and subsidence.

Basin Production and Recharge: This section contains exhibits that characterize groundwater production and recharge over time and space. This information is useful in understanding historical changes in groundwater levels and quality.

Groundwater Levels: This section contains exhibits that characterize groundwater flow patterns, the change in groundwater elevations since 2000. The section includes groundwater-elevation maps for spring 2000, spring 2012, and spring 2014; and groundwater-elevation change maps for 2000 to 2014 and 2012 to 2014. The section also includes exhibits that characterize 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 time-series charts of TDS and nitrate, maps of the spatial distribution of constituent concentrations, and a current map of the known point-source contaminants in groundwater as of 2014.

Ground-Level Monitoring: This section contains exhibits that characterize the history and current state of land subsidence, ground fissuring, and ground-level monitoring in the Chino Basin.



While the Chino Basin can be 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 unique hydrology and water resource management activities that have limited impacts on the other MZs.

The Maximum Benefit MZ boundaries were defined in the Water Quality Control Plan for the Santa Ana Region Basin Plan 2004 Amendment (Basin Plan) for the alternative less stringent "maximum-benefit" TDS and nitrate objectives for a large portion of the Chino Basin, designated as Chino-North MZ (California Regional Water Quality Control Board, Santa Ana Region [RWQCB], 2004). The maximum-benefit objectives, which allow for the reuse and recharge of recycled water without mitigation, were established based on demonstrations by Watermaster and the IEUA that the State's antidegradation requirements to protect beneficial uses and maintain water quality consistent with the maximum benefit to the people of the State of California were satisfied. The maximum-benefit demonstrations are contingent upon the implementation of specific projects and programs. These projects and programs are termed "Chino Basin maximum-benefit commitments" and are listed in Table 5-8a of the Basin Plan: http://www.waterboards.ca.gov/santaana/water_issues/programs/basin_plan/docs/chapter5.pdf

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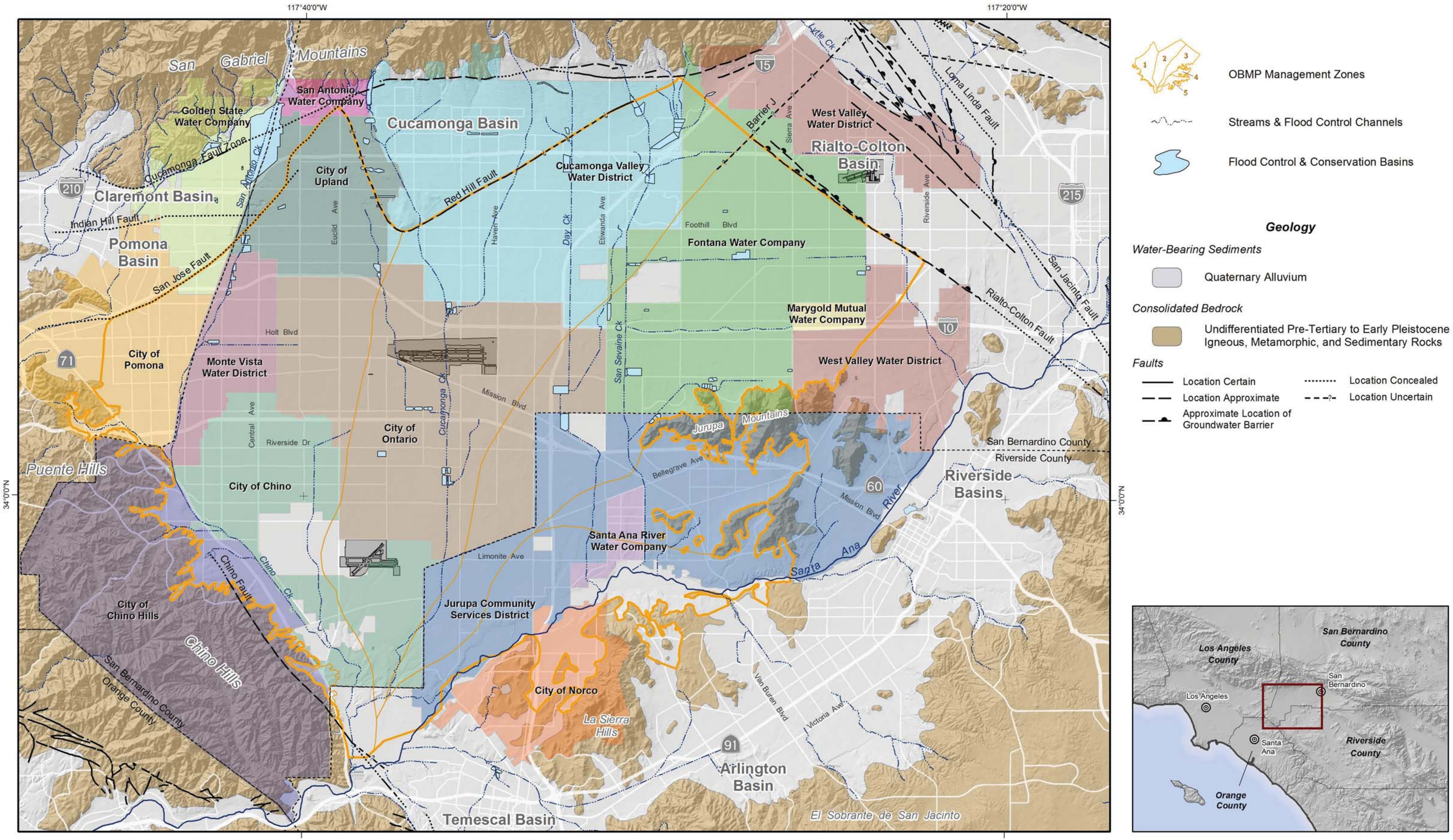
Document Name: Exhibit_1_ChinoGWbasins

2014 State of the Basin
Introduction

Chino Groundwater Basin

OBMP and Maximum Benefit Management Zones

Exhibit 1



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Date: 1/26/2015
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2014 State of the Basin
Introduction

Water Service Areas of the Major Appropriative Pool Parties of the Chino Basin Watermaster

Exhibit 2

The exhibits in this section characterize the hydrologic setting of the Chino Basin and its importance to water supply and groundwater management within the Basin.

The Chino Basin covers about 240 square miles and is located centrally within the Santa Ana River Watershed. Exhibit 3 shows the location of the Chino Basin within the context of the upper Santa Ana River Watershed. The Santa Ana River flows southwest through the Chino Basin from the Riverside Narrows to Prado Dam. Downstream of Prado Dam, the Santa Ana River flows through the Orange County Basin and out to the ocean. In total, the drainage area of the Santa Ana River Watershed at Prado Dam is about 1,490 square miles. The following streams are tributary to the Santa Ana River within the Chino Basin: San Sevaine Creek, Day Creek, Deer Creek, Cucamonga Creek, and San Antonio/Chino Creek. These tributaries generally flow from north to south. The time of concentration[1] to Prado Dam for the Santa Ana River is estimated to be between one to two days. By contrast the time of concentration to Prado Dam for tributaries of the Santa Ana River that flow from north to south in the Chino Basin is a few hours.

Exhibit 3 shows the locations of three San Bernardino County Flood Control District (SBCFCD) precipitation stations: the San Bernardino Hospital station, located centrally in the Santa Ana River Watershed tributary to the Chino Basin; an Ontario hybrid station (combined records of SBCFCD 1017 and 1075), located in the central Chino Basin; and the Montclair station, located in the northwestern portion of the Basin. Exhibit 3 also shows the U.S. Geological Survey's stream-gaging stations on the Santa Ana River at Riverside Narrows (*SAR at MWD Xing*) and below Prado Dam (*SAR at Below Prado Dam*).

Precipitation is a major source of recharge to the Chino Basin; thus, the magnitude and temporal pattern of this recharge can be understood by analyzing long-term precipitation records. In Exhibit 4, annual precipitation totals are plotted from the Ontario (1915 to 2014) and San Bernardino Hospital stations (1901 to 2014). Exhibit 4 characterizes long-term precipitation trends within and upstream of the Chino Basin. The mean annual precipitation totals at the Ontario and San Bernardino Hospital stations are 15.28 inches and 16.22 inches, respectfully. Exhibit 4 also includes a plot of the cumulative departure from mean precipitation (CDFM), which is used to characterize the occurrence and magnitude of the wet and dry periods. Positive sloping segments of the CDFM plot (trending upward to the right) indicate wet periods, and negative sloping segments of the CDFM plot (trending downward to the right) indicate dry periods. The longest dry period for the 1900 to 2014 record is from 1945 to 1976—a 32 year period.

The Safe Yield of the Chino Basin was computed using a base period of 1965 through 1974, a period of ten years. This base period had two years of above average precipitation, eight years of below average precipitation, and falls within the 1945 through 1976 dry period. The average annual precipitation for the base period was 14.64 inches, or 0.77 inches less than the long-term annual average. The post-Peace-Agreement period runs from July 2000 to present, a fourteen-year period. The post-Peace-Agreement period contains four years of above average precipitation and ten years below average precipitation. The average annual precipitation during the post-Peace-Agreement period is 13.71 inches, or 1.57 inches less than the long-term annual average, which is comparable to the 1945 through 1976 dry period. Precipitation during the base period in which the Safe Yield was initially estimated, and the post-Peace-Agreement period, is less than average; thus, the yield developed during these periods is likely less than the yield that would be developed from a longer, more hydrologically representative period.

Exhibit 5 shows the historical relationship between precipitation and storm water discharge in the Chino Basin and uses a double-mass curve analysis to illustrate the change in the precipitation-discharge relationship. A double-mass analysis is an arithmetic plot of the accumulated values of observations for two related variables that are paired in time and thought to be related. As long as the relationship between those two variables remains constant, the double-mass curve will appear as a straight line (constant slope). A change in slope indicates that the relationship has changed; the break in slope denotes the timing of that change.

Specifically, in Exhibit 5, the double-mass curve analysis was used to look at precipitation versus storm water discharge reckoned at Prado Dam (*SAR at Below Prado Dam*) and precipitation versus storm water discharge generated between Riverside Narrows and Prado Dam (storm water reckoned at *SAR at Below Prado Dam* minus storm water reckoned at *SAR at MWD Xing*). In each plot, the slope of the double-mass curve after water year 1976/77 is much steeper than prior years. The change in curvature suggests that a significant change occurred in the precipitation-discharge relationship: there is an increase in the magnitude of storm water discharge starting in the late 1970s. This increase in storm water discharge is due to land surface modifications caused by the conversion from agricultural to urban uses, the rapid post-1969 lining of stream channels in the Chino Basin and elsewhere in the upper Santa Ana Watershed, and other associated drainage system modifications. The hydrologic effects of land use changes and channel lining were apparently masked by the below average precipitation years that preceded the 1978 through 1983 wet period. These charts indicate that natural storm water recharge in the Chino Basin declined as the stream channels were lined and that the storm water available for diversion to recharge basins has increased significantly with urbanization. In fact, the average annual decrease in natural storm water recharge due to the lining of stream channels in the Chino Basin was recently estimated to be about 13,000 acre-ft/yr (WEI, 2014).

Exhibit 5 also shows what the relationship would be if no storm water were recharged for the Chino Basin Groundwater Recharge program, starting in fiscal year 2005. The plots of the relationship without storm water recharge to recharge basins show that the Chino Basin Groundwater Recharge Program has offset Chino Basin recharge losses due to the historical lining of the channels and urbanization and that there is potential to increase this recharge in the future.

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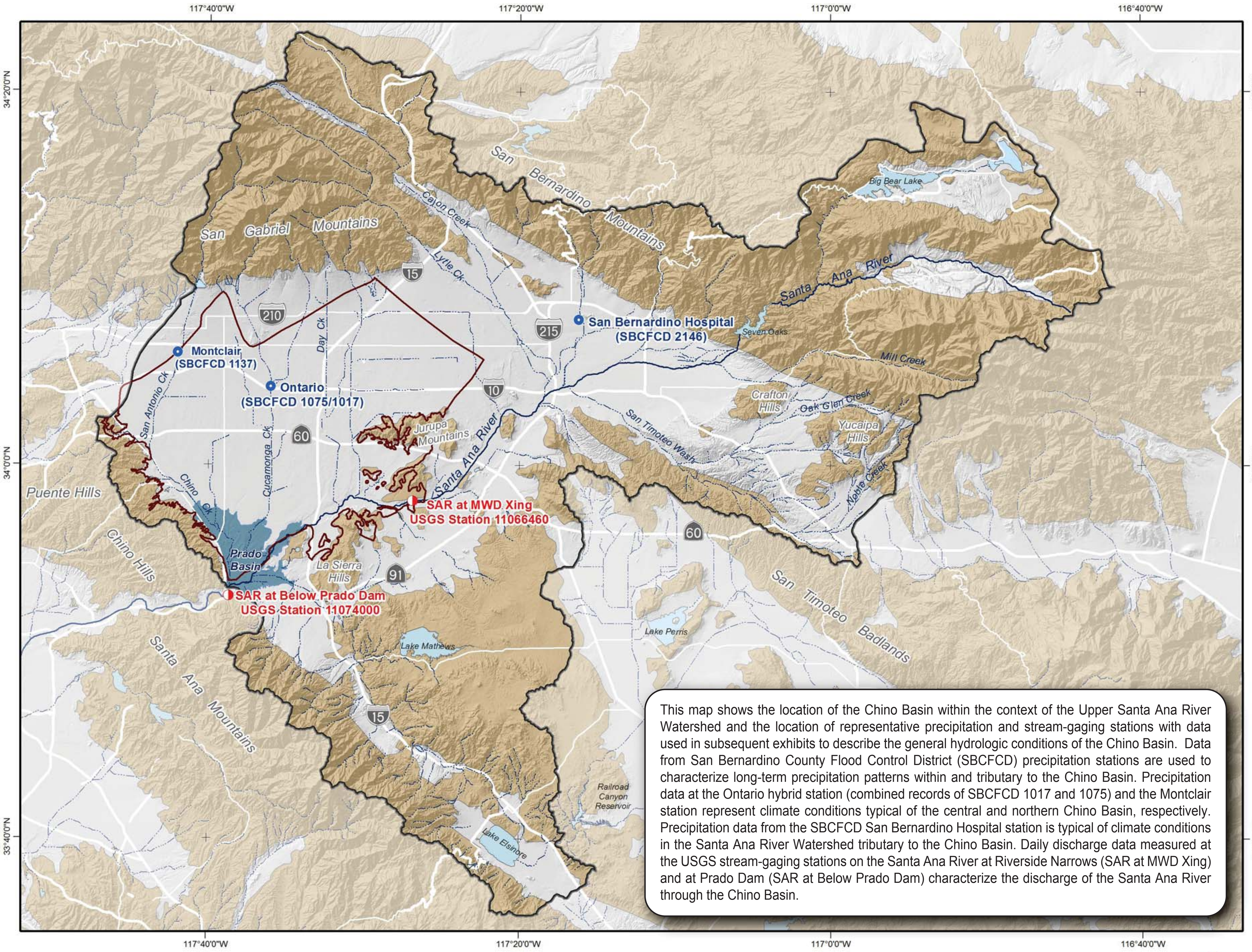
[1] The time of concentration is the time it takes for runoff from the most distant upstream part of the watershed to reach a specified point of interest.



This map shows the location of the Chino Basin within the context of the Upper Santa Ana River Watershed and the location of representative precipitation and stream-gaging stations with data used in subsequent exhibits to describe the general hydrologic conditions of the Chino Basin. Data from San Bernardino County Flood Control District (SBCFCD) precipitation stations are used to characterize long-term precipitation patterns within and tributary to the Chino Basin. Precipitation data at the Ontario hybrid station (combined records of SBCFCD 1017 and 1075) and the Montclair station represent climate conditions typical of the central and northern Chino Basin, respectively. Precipitation data from the SBCFCD San Bernardino Hospital station is typical of climate conditions in the Santa Ana River Watershed tributary to the Chino Basin. Daily discharge data measured at the USGS stream-gaging stations on the Santa Ana River at Riverside Narrows (SAR at MWD Xing) and at Prado Dam (SAR at Below Prado Dam) characterize the discharge of the Santa Ana River through the Chino Basin.

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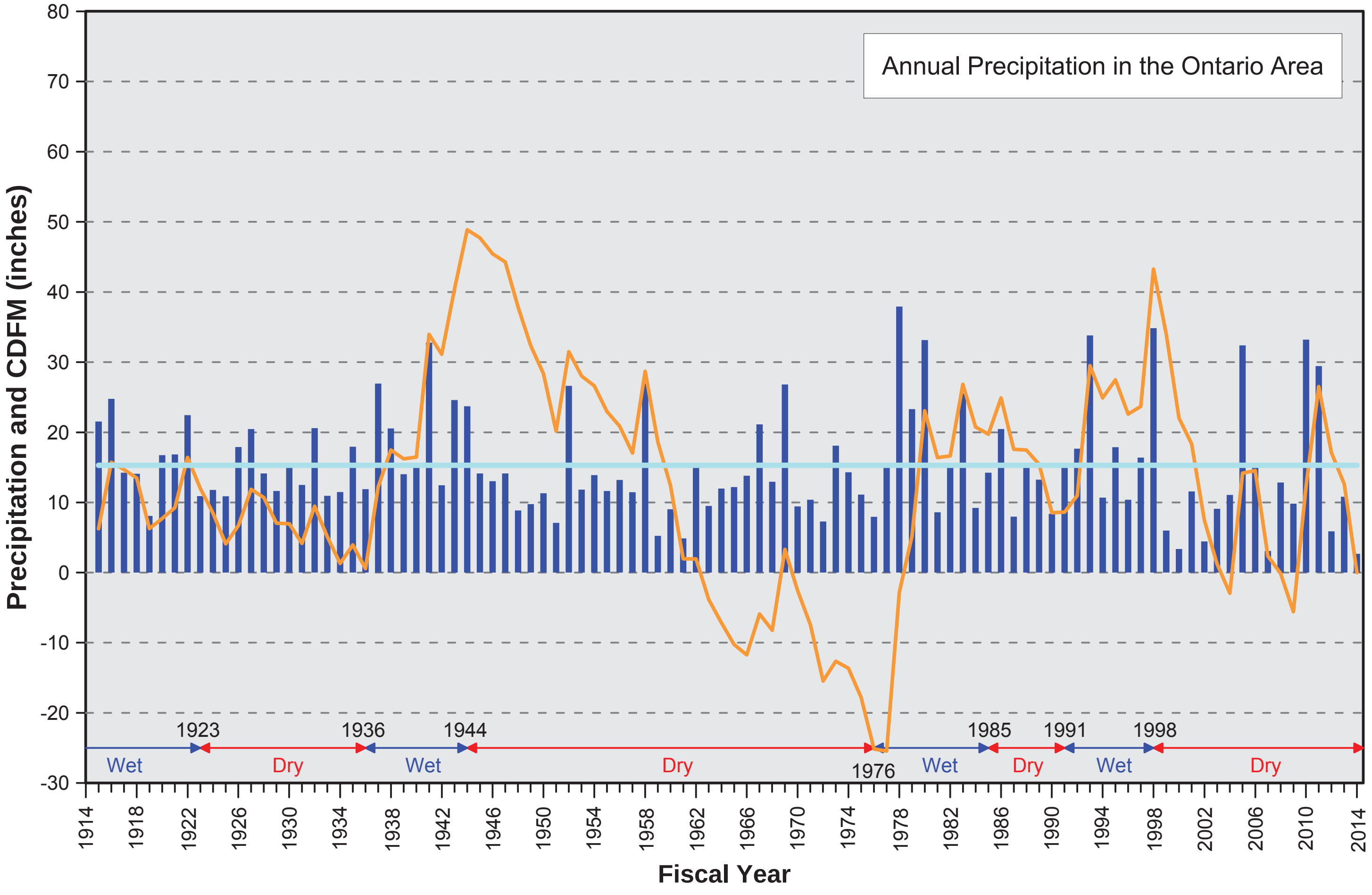
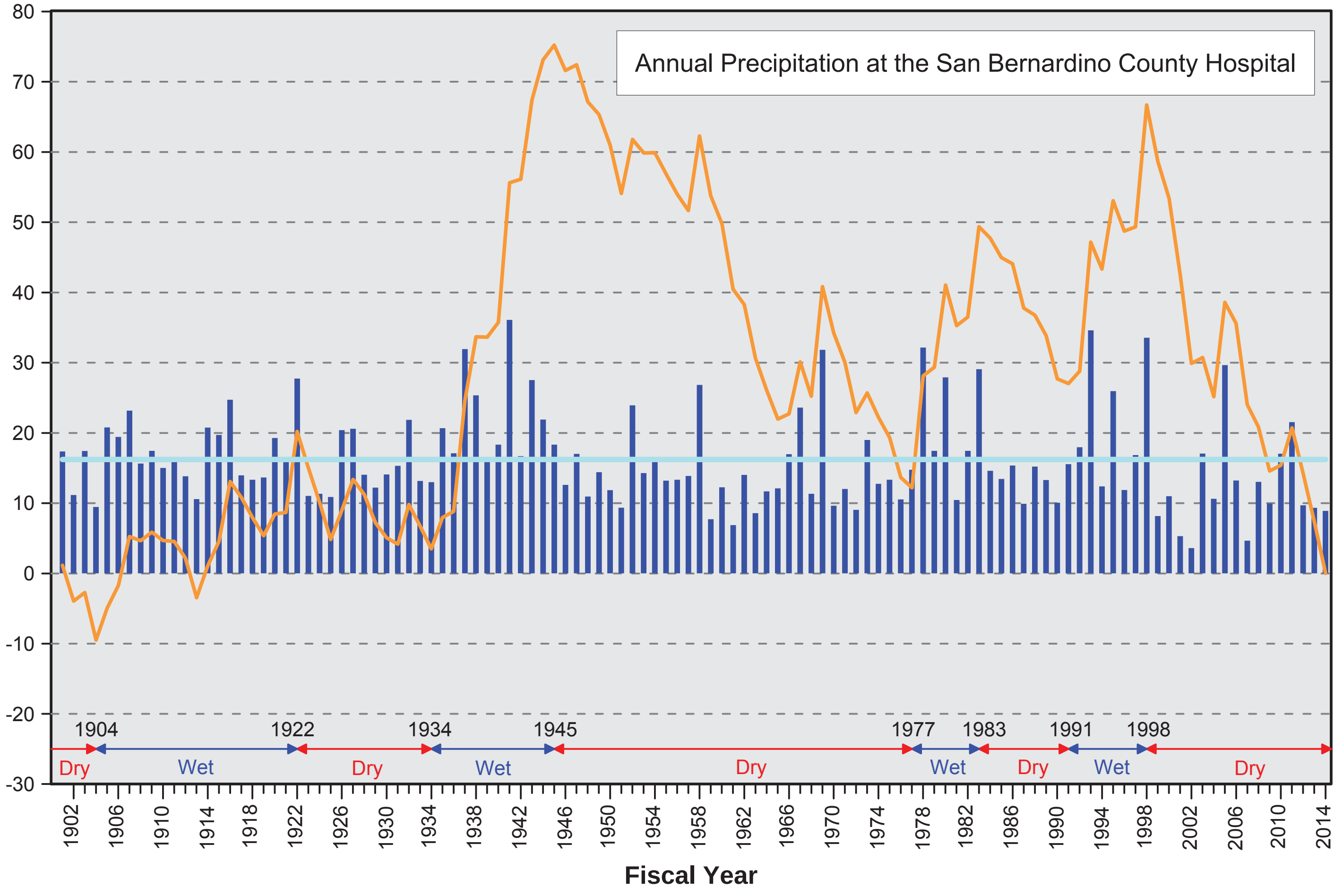
Document Name: Exhibit_3_SARWtrsd

2014 State of the Basin
General Hydrologic Conditions

Santa Ana River Watershed Tributary to Prado Dam

Exhibit 3





Annual Statistics of Long-Term Precipitation Records
(inches)

Statistics	Ontario Area*	San Bernardino Hospital
Period of Record (Fiscal Year)	1915 to 2014	1901 to 2014
Mean	15.28	16.22
Minimum	2.67	3.61
Maximum	37.92	36.10
Standard Deviation	7.72	6.69
Mean + 1 Standard Deviation	23.00	22.91
Coefficient of Variation	50%	41%

* Two precipitation stations in the Ontario Area (SBCFCD 1075 and 1017) were combined to create a long-term record. These two precipitation stations are in close proximity to each other and their overlapping records are highly correlated. Recent data is from SBCFCD Station 1017.

The Chino Basin has a semi-arid Mediterranean climate. Precipitation is a major source of groundwater recharge for the Basin; thus, the magnitude and temporal pattern of this recharge can be understood by analyzing long-term precipitation records. Shown here are the long-term precipitation records for the Ontario Area (located centrally within the Chino Basin) and the San Bernardino County Hospital (located within the Santa Ana River Watershed, upstream of the Chino Basin). These figures show the fiscal year annual precipitation totals, long-term average annual precipitation, and the cumulative departure from mean precipitation (CDFM). The CDFM plot is a useful way to characterize the occurrence and magnitude of wet and dry periods: positive sloping segments (trending upward to the right) indicate wet periods, and negative sloping segments (trending downward to the right) indicate dry periods. In the Ontario area, four series of wet-dry cycles are apparent: prior to 1914 through 1936, 1937 through 1976, 1977 through 1991, and 1992 through 2014. The record of the San Bernardino County Hospital station shows the same pattern of wet-dry cycles. The ratio of dry years to wet years is about three to two. That is, for every ten years, about six years will have below average precipitation and four years will have greater than average precipitation. That said, the 1945 through 1976 dry period is 32 years long. During this dry period, for the Ontario station, there were 27 dry years to 5 wet years, averaging about 2.31 inches per year below the average annual precipitation, and for the San Bernardino County Hospital station, there were 23 dry years to 9 wet years, averaging about 1.86 inches per year below the average annual precipitation.

The base period used to compute the Safe Yield of the Chino Basin in the 1978 Judgment was 1965 through 1974, a period of ten years. This base period had three years of above-average precipitation and seven years of below-average precipitation and falls within the 1945 through 1976 dry period. The average annual precipitation for the base period was 14.64 inches, or 0.64 inches less than the long-term annual average. The post-Peace-Agreement period is from July 2000 to present, a fourteen-year period. The post-Peace-Agreement period contains four above-average precipitation years: 2005, 2006, 2010, and 2011; the remaining years had below average precipitation. In the Chino Basin, the four driest years in the 100 period for which data are available at the Ontario station occurred since 1999 and include in order of the driest to less dry: 2014 (2.67 inches), 2007 (3.09 inches), 2000 (3.37 inches), and 2002 (4.43 inches). The average annual precipitation during the post-Peace Agreement period is 13.71 inches, or 1.57 inches less than the long-term annual average. One of the takeaways from these charts is that the recharge from precipitation during the base period, in which the Safe Yield was initially estimated, and the post-Peace-Agreement period should be less than average; thus, the yield developed during these periods is likely less than the yield that would be developed from a longer, more hydrologically-representative period.

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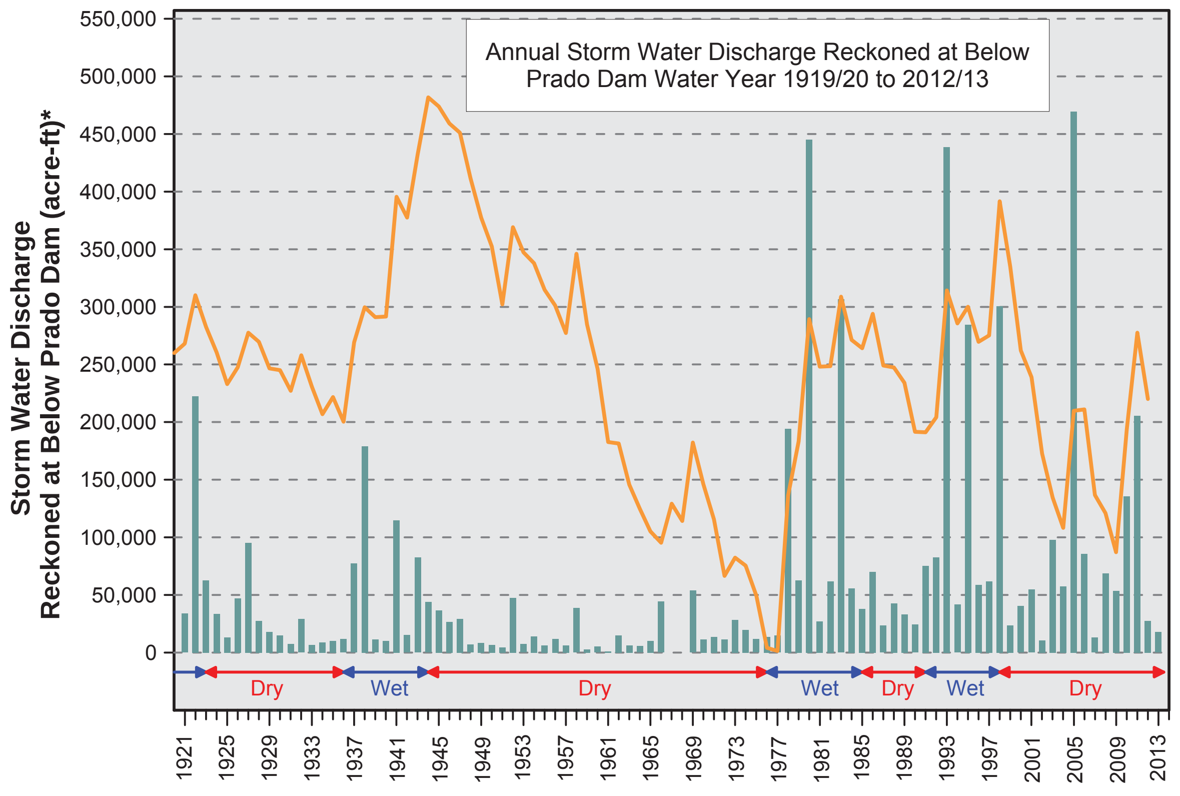
▬ Annual Precipitation (inches)
▬ Cumulative Departure from Mean Precipitation
▬ Long-Term Average Annual Precipitation (inches)

2014 State of the Basin
General Hydrologic Conditions

Long-Term Precipitation Within and Upstream of the Chino Basin

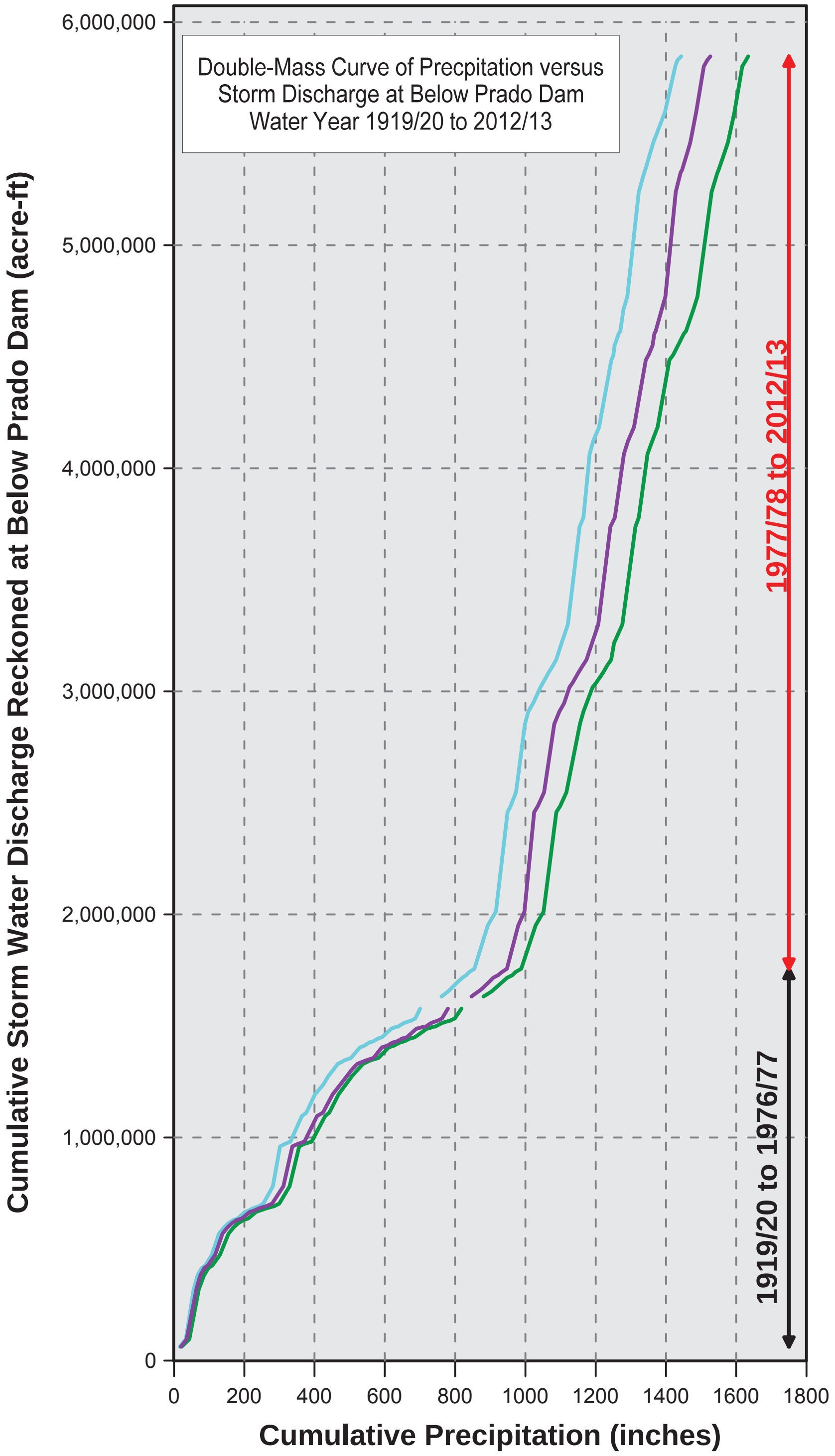
Exhibit 4

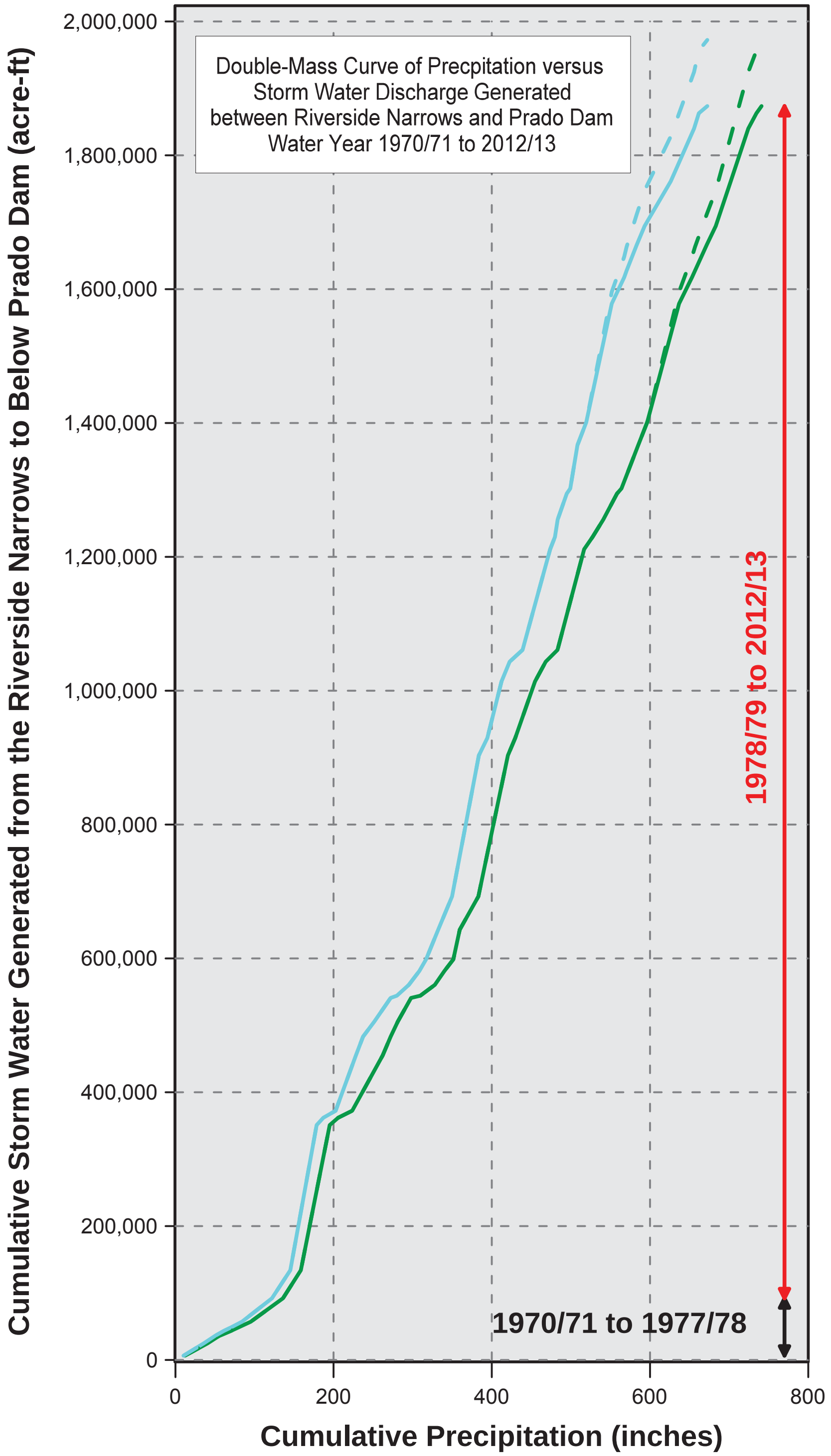


*Storm water discharge data at below Prado Dam is not available for 1967 and 1968.

As seen in the graph entitled Annual Storm Water Discharge Reckoned at Below Prado Dam, around water year 1976/1977, the relationship of precipitation to storm water discharge appears to change significantly such that there was more discharge per unit of precipitation produced after this time (compare the amount of storm water runoff for the 1936 to 1944 wet period with the 1977 to 1983 wet period).

A double-mass curve analysis can illustrate the change in the precipitation-runoff relationship. A double-mass curve analysis is an arithmetic plot of the accumulated values of observations for two related variables that are paired in time and thought to be related. As long as the relationship between those two variables remains constant, the double-mass curve will appear as a straight line (constant slope). A change in slope indicates that the relationship has changed; the break in slope denotes the timing of that change. Shown here are double-mass curves of precipitation at stations in and around the Chino Basin versus Santa Ana River storm water discharge reckoned at Below Prado Dam and Santa Ana River storm water discharge generated between Riverside Narrows and Prado Dam (storm water discharge reckoned at SAR at Below Prado Dam minus storm water discharge reckoned at SAR at MWD Xing). Note that in each plot, the slope of the double-mass curve after water year 1976/1977 is much steeper than prior years. The change in curvature suggests that a significant change occurred in the precipitation-discharge relationship: there is an increase in the magnitude of storm water discharge starting in the late 1970s. This increase in storm water discharge is due to land surface modifications caused by the conversion from agricultural to urban uses, the rapid post-1969 lining of stream channels in the Chino Basin and elsewhere in the upper Santa Ana Watershed, and other associated drainage system improvements. These charts indicate that natural storm water recharge in the Chino Basin declined as the channels were lined and that the storm water component of the Santa Ana River at Prado Dam has increased significantly with urbanization. The average annual decrease in storm water recharge due to the lining of stream channels in the Chino Basin was estimated to be about 13,000 acre-ft/yr (WEI, 2014).





Watermaster and the IEUA initiated the Chino Basin Groundwater Recharge Program in 2005 in part to increase storm water recharge in the Chino Basin. Shown above, are double-mass curves for the Ontario and Montclair precipitation stations versus the storm water discharge generated between Riverside Narrows and Prado Dam. Also shown are what these curves would have looked like had the Chino Basin Groundwater Recharge Program not been implemented (dashed lines starting in 2005). The shifting of the actual double-mass curves to the right caused by the recharge program is evidence that the recharge program has begun to offset recharge losses due to past channel lining and land use decisions and that there is additional opportunity to increase recharge in the future.

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—	Cumulative Departure from Mean Precipitation (Ontario Station)
▬	Storm Water at Prado Dam (acre-ft)
—	Cumulative Precipitation at San Bernardino County Hospital vs. Storm Water Flow
—	Cumulative Precipitation at Montclair vs. Storm Water Flow
- -	Cumulative Precipitation at Montclair vs. Storm Water Flow (Without Storm Water Recharge in the Chino Basin)
—	Cumulative Precipitation at Ontario vs. Storm Water Flow
- -	Cumulative Precipitation at Ontario vs. Storm Water Flow (Without Storm Water Recharge in the Chino Basin)

2014 State of the Basin
General Hydrologic Conditions

Relationship of Precipitation and Storm Water Discharge in the Chino Basin

Water Year 1919/20 to 2012/13

Exhibit 5

The exhibits in this section characterize the physical state of the Chino Basin with respect to groundwater production and artificial recharge. Future re-determinations of Safe Yield for the Chino Basin will be based largely on accurate estimations of groundwater production and artificial recharge.

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 produce in excess of 10 acre-feet per year (acre-ft/yr) to install and maintain meters on their well(s). Appropriative Pool, Overlying Non-Agricultural Pool, and Chino Basin Desalter well production estimates are based on flow-meter data that are provided by producers on a quarterly basis. Agricultural Pool estimates are based on flow-meter data collected by Watermaster staff on a quarterly basis. Minimal producer estimates are determined by Watermaster staff on an annual basis using water duty methods. All production data in the Chino Basin are entered into Watermaster's database. Watermaster summarizes and reports on groundwater production data over the fiscal year (FY) that begins on July 1. Exhibit 6 shows the locations of all active production wells in the Basin during FY 2013/2014.

Exhibit 7 depicts the annual groundwater production by Pool for FY 1977/1978 through 2013/2014. There are two bar charts in Exhibit 7: 7a shows the actual production by Pool as recorded in Watermasters' production database; 7b shows the actual production in Watermaster's database for the Appropriative Pool, Overlying Non-Agricultural Pool, and Chino Basin Desalter Authority (CDA), with the Agricultural Pool production amounts from the 2013 Chino Basin Groundwater Model. The pre-2002 modeled agricultural production was determined using historical land use data, and land use requirements. Prior to the implementation of the meter installation program during 2001 to 2003, the modeled historical agricultural production is regarded as more accurate than the estimates of Agricultural Pool production in Watermaster's database.

Total groundwater production in Chino Basin has ranged from a maximum of about 189,000 acre-ft during FY 2008/2009 to a low of about 123,000 acre-ft during FY 1982/1983, and has averaged about 154,000 acre-ft/yr. The spatial distribution of production has shifted since 1978. Agricultural Pool production, which has been mainly concentrated south of the 60 Freeway, dropped from about 55 percent of total production in FY 1977/1978 to 13 percent as of FY 2013/2014. During the same period, Appropriative Pool production increased from about 39 percent of total production in FY 1977/1978 to 84 percent as of FY 2013/2014 (for this characterization, this is the sum of production for the Appropriative Pool and the CDA). Increases in Appropriative Pool production have approximately kept pace with the decline in agricultural production. Production in the Overlying Non-Agricultural Pool declined from about six percent of total production in FY 1977/1978 to two percent as of FY 2013/2014.

Exhibits 8 through 10 are maps that illustrate the location and magnitude of groundwater production at wells in the Chino Basin for FYs 1977/1978 (Watermaster established), 1999/2000 (commencement of the OBMP), and 2013/2014 (current conditions). These figures indicate the following:

- There was a basin-wide increase in the number of wells producing over 1,000 acre-ft/yr between 1978 and 2014. This is consistent with (i) the land transition from agricultural to urban uses, (ii) the trend of increasing imported water costs, and (iii) the construction of the desalters.
- From FY 1977/1978 to 1999/2000, production south of the 60 Freeway deceased from 59 percent to 31 percent of total production in the Chino Basin, while production north of the 60 Freeway increased from 41 percent to 69 percent of total production. This shift in production patterns is due to a decline in irrigated agriculture and an increase in urbanization south of the 60 Freeway, and an increase in urbanization north of the 60 Freeway.
- From FY 1999/2000 to 2013/2014, production north of the 60 Freeway deceased from 69 percent to 66 percent of total production in the Chino Basin, while production at wells south of the 60 Freeway increased from 31 percent to 34 percent of total production. Since FY 1999/2000 the number of active agricultural wells in the southern portion of the Basin decreased by about 50 percent. The three percent increase in total groundwater production south of the 60 Freeway is due to the onset of Chino Basin Desalter well pumping, which progressively increased since start-up in 2000 and currently totals about 30,000 acre-ft/yr.

The Chino Basin Desalters were described in the OBMP Phase 1 Report (WEI, 1999) as facilities that would *"Enhance Basin Water Supplies"* and *"Protect and Enhance Water Quality."* Exhibit 11 is a map that displays the locations of the wells and desalter facilities, and summarizes the history of desalter production in the southern portion of the Chino Basin.

The objectives of the Chino Basin Groundwater Recharge Program are to enhance water supply reliability and improve groundwater quality throughout the Chino Basin by increasing the recharge of storm water, imported water, and recycled water. For further information on Watermaster's requirements for recharge, see Section 5.1 of the Peace Agreement, Article 8 of the Peace II Agreement, the 2010 Recharge Master Plan Update (WEI, 2010).

The Chino Basin Recycled Water Groundwater Recharge Program, which is implemented by IEUA and Watermaster, is subject to the following regulatory orders:

- California Regional Water Quality Control Board, Santa Ana Region, Order No. R8-2007-0039, Water Recycling Requirements for Inland Empire Utilities Agency and Chino Basin Watermaster, Chino Basin Recycled Groundwater Recharge Program, Phase I and Phase II Projects, San Bernardino County. June 29, 2007.
- California Regional Water Quality Control Board, Santa Ana Region. Order No. R8-2009-0057. Amending Order No. R8-2007-0039, October 30, 2009.
- California Regional Water Quality Control Board, Santa Ana Region. Revised Monitoring and Reporting Program No. R8-2007-0039 for the Inland Empire Utilities Agency and Chino Basin Watermaster, Chino Basin Recycled Groundwater Recharge Program, Phase I and Phase II Projects, San Bernardino County. October 27, 2010.

Exhibit 12 shows the locations of the recharge basins in Chino Basin symbolized by the types of waters that are recharged, including storm water, urban runoff, recycled water, and imported water. The volumes of recharge that occur at each basin are monitored and recorded by IEUA. Exhibit 13 lists the operable recharge facilities in the Chino Basin and summarizes annual recharge by type for the period of July 1, 2000 through June 30, 2014 (FY 2000/2001 to FY 2013/2014).[2] The following are the general trends in recharge:

- Storm water recharge at the recharge basins was not measured prior to FY 2004/2005. Since then, annual storm-water recharge has ranged from about 4,300 acre-ft to 17,600 acre-ft and has averaged about 10,300 acre-ft/yr.
- Since FY 2000/2001, annual imported-water recharge has ranged from 0 to 34,567 acre-ft and has averaged about 13,400 acre-ft/yr. The wide range in annual imported water recharged is reflective of the MWDSC Dry Year Yield (DYY) conjunctive use storage program in the Chino Basin. During FYs 2004/2005, 2005/2006, and 2006/2007, imported water recharge was well above average because the MWDSC was doing a "put" operation pursuant to the DYY storage program.
- During FYs 2007/2008, 2008/2009, 2009/2010, and 2010/2011, imported water recharge was well below average due to the lack of low-cost replenishment water supplied by MWDSC. In FY 2011/2012, about 23,500 acre-ft of imported water was recharged in Chino Basin. This large amount of imported water recharged during that year, is because of the availability of low-cost Tier 1 water from MWDSC at that time.
- Since FY 2000/2001, annual recycled-water recharge has ranged from 49 to 13,600 acre-ft. In FY 2005/2006, recycled water recharge increased from an average of about 300 acre-ft/yr to about 6,000 acre-ft/yr after the implementation of the Recycled Water Groundwater Recharge Program. After the expansion of the program in 2007, the amount of recycled-water recharge continued to increase annually and reached a historical high of 13,593 acre-ft/yr in FY 2013/2014.

Since the late 1990s, the reuse of recycled water has increased in the Chino Basin. Recycled water is utilized two ways: (i) direct non-potable uses such as irrigation and (ii) indirect potable reuse via groundwater recharge. Exhibits 12, 13, and 14 characterize the reuse of recycled water in the Chino Basin from FY 2000/2001 through FY 2013/2014. Since the OBMP Implementation the reuse of recycled water for the combined uses of direct non-potable uses and recharge has increased ten-fold from about 3,700 acre-ft/yr to 38,000 acre-ft/yr in FY 2013/2014, which is about 70 percent of the total effluent produced from the IEUA's treatment plants.

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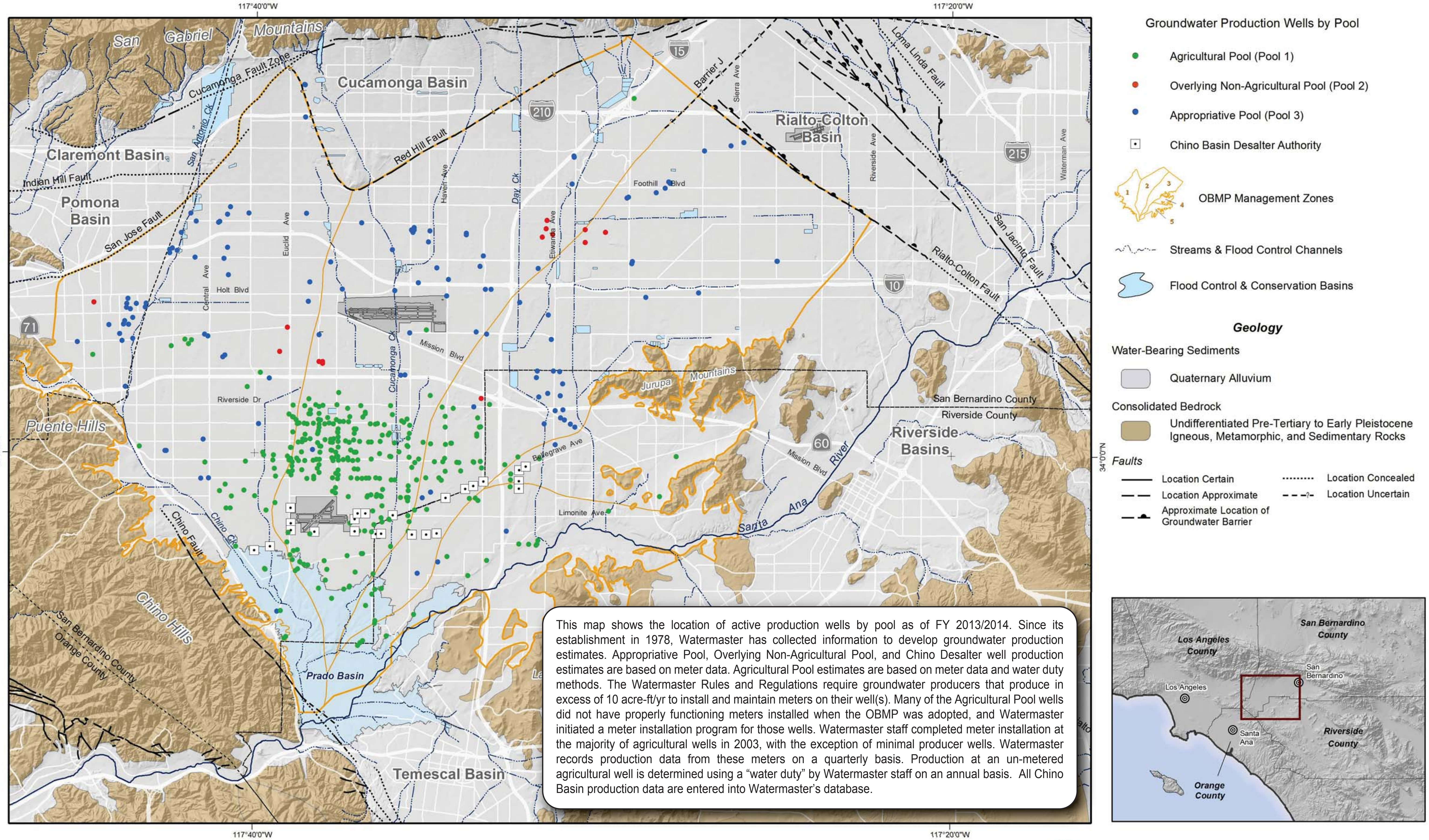
[2] The IEUA does not distinguish storm water from urban runoff in the recharge tabulations it submits to Watermaster.



This map shows the location of active production wells by pool as of FY 2013/2014. Since its establishment in 1978, Watermaster has collected information to develop groundwater production estimates. Appropriative Pool, Overlying Non-Agricultural Pool, and Chino Desalter well production estimates are based on meter data. Agricultural Pool estimates are based on meter data and water duty methods. The Watermaster Rules and Regulations require groundwater producers that produce in excess of 10 acre-ft/yr to install and maintain meters on their well(s). Many of the Agricultural Pool wells did not have properly functioning meters installed when the OBMP was adopted, and Watermaster initiated a meter installation program for those wells. Watermaster staff completed meter installation at the majority of agricultural wells in 2003, with the exception of minimal producer wells. Watermaster records production data from these meters on a quarterly basis. Production at an un-metered agricultural well is determined using a “water duty” by Watermaster staff on an annual basis. All Chino Basin production data are entered into Watermaster’s database.

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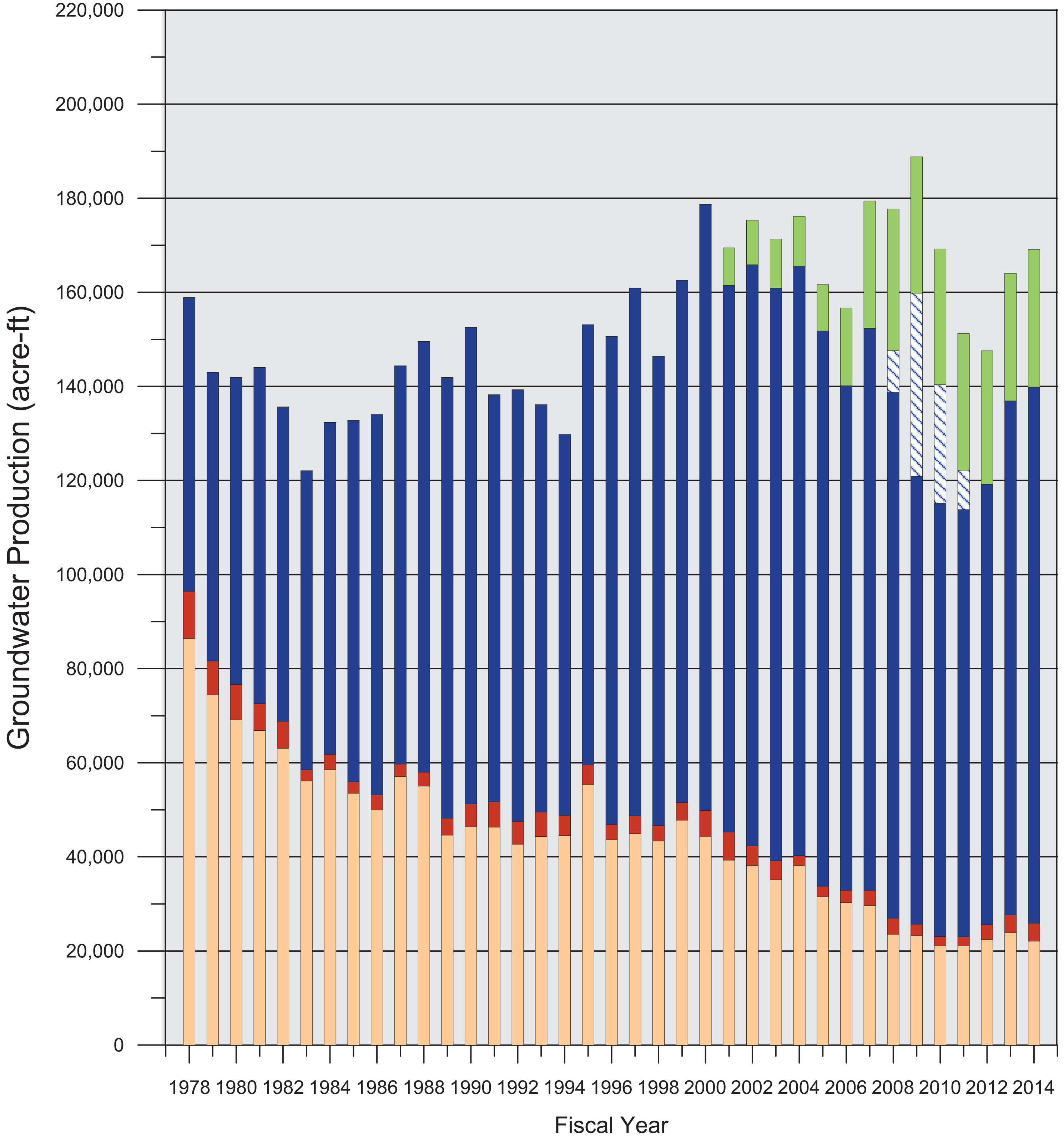
2014 State of the Basin
Basin Production and Recharge

Active Groundwater Production Wells

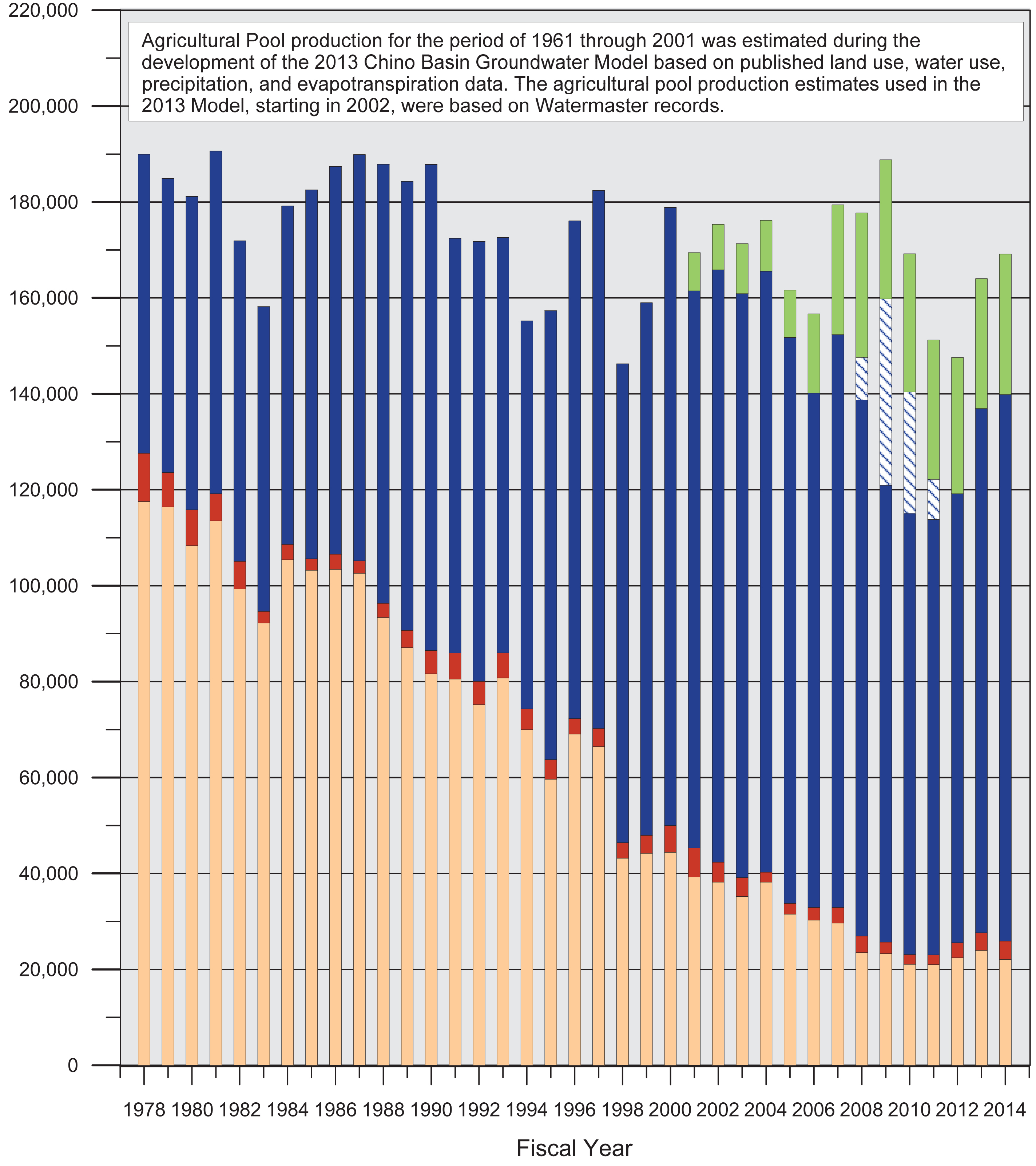
Fiscal Year 2013/2014

Exhibit 6

7a
Distribution of Groundwater Production in the Chino Basin Agricultural Pool Production Amounts from Watermaster Database



7b
Distribution of Groundwater Production in the Chino Basin with Agricultural Pool Production Amounts from the Chino Basin Model Prior to 2002


Agricultural Pool production for the period of 1961 through 2001 was estimated during the development of the 2013 Chino Basin Groundwater Model based on published land use, water use, precipitation, and evapotranspiration data. The agricultural pool production estimates used in the 2013 Model, starting in 2002, were based on Watermaster records.

🟧 Agricultural Pool
🟥 Overlying Non-Agricultural Pool
🟦 Appropriative Pool
▨ Appropriative Pool - MWDSC Dry Year Yield Program
🟩 Chino Basin Desalter Authority

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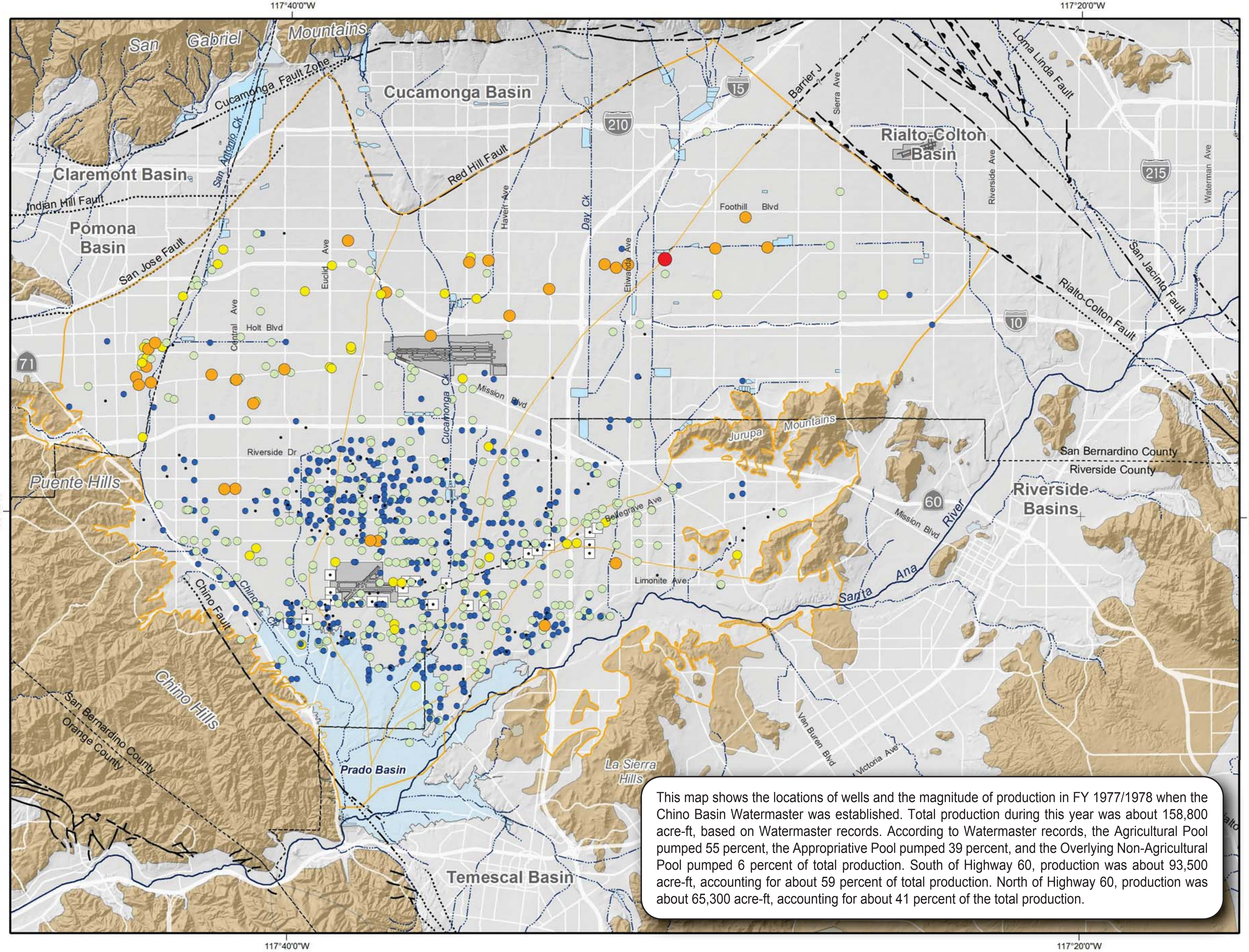
File: Exhibit_7_Production by Pool

2014 State of the Basin
Basin Production and Recharge

Distribution of Groundwater Production
Fiscal Year 1978 to 2014

Exhibit 7



This map shows the locations of wells and the magnitude of production in FY 1977/1978 when the Chino Basin Watermaster was established. Total production during this year was about 158,800 acre-ft, based on Watermaster records. According to Watermaster records, the Agricultural Pool pumped 55 percent, the Appropriative Pool pumped 39 percent, and the Overlying Non-Agricultural Pool pumped 6 percent of total production. South of Highway 60, production was about 93,500 acre-ft, accounting for about 59 percent of total production. North of Highway 60, production was about 65,300 acre-ft, accounting for about 41 percent of the total production.

Groundwater Production
Fiscal Year 1977/1978 (acre-ft)

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

OBMP Management Zones

⊡ Chino Basin Desalter Wells

Streams & Flood Control Channels

Flood Control & Conservation Basins

Geology

Water-Bearing Sediments

Quaternary Alluvium

Consolidated Bedrock

Undifferentiated Pre-Tertiary to Early Pleistocene Igneous, Metamorphic, and Sedimentary Rocks

Faults

Location Certain
Location Approximate
Approximate Location of Groundwater Barrier
Location Concealed
Location Uncertain

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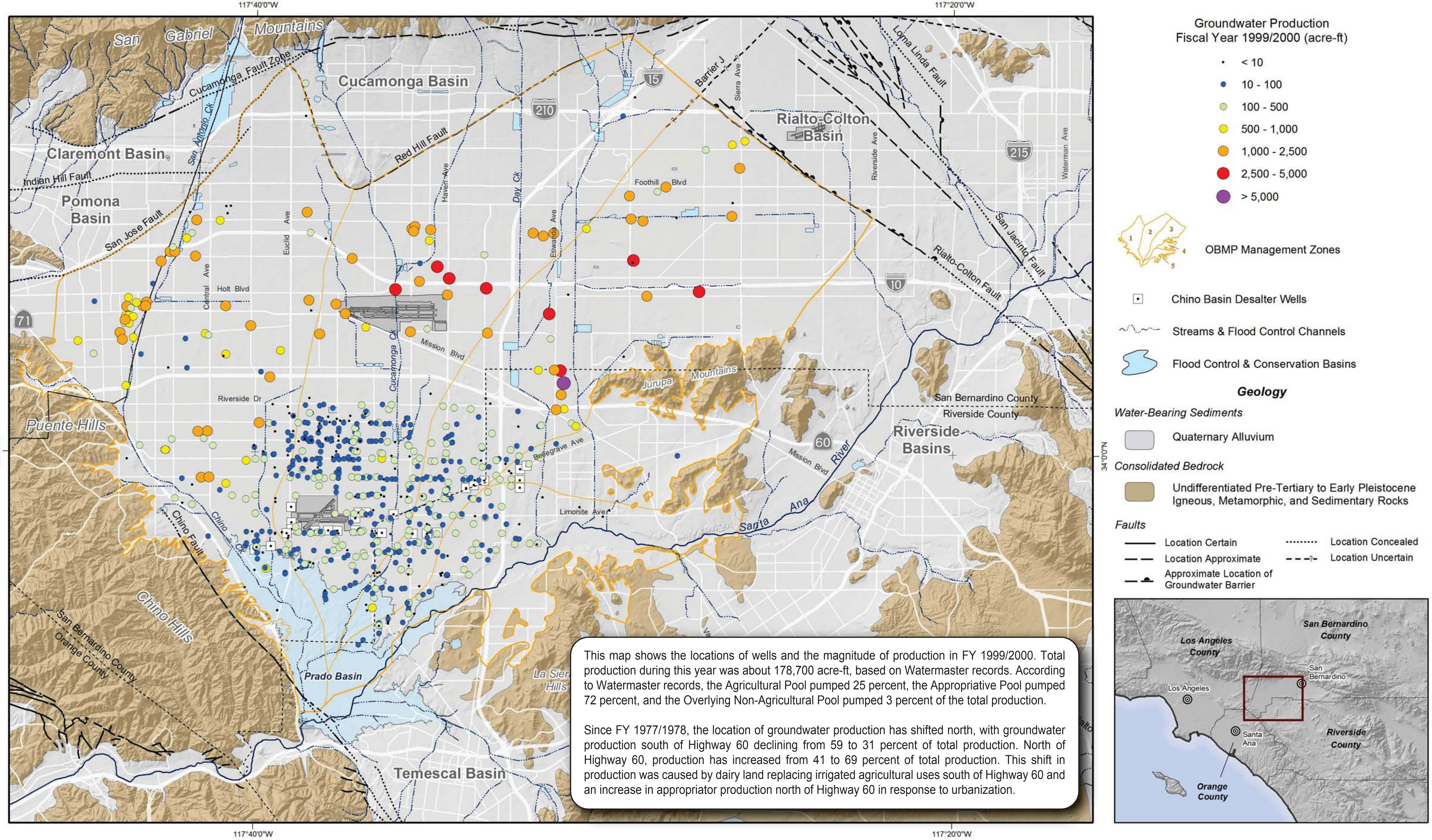
0 2 4 Miles
0 3 6 KM

2014 State of the Basin
Basin Production and Recharge

Groundwater Production by Well
Fiscal Year 1977/1978

Exhibit 8



This map shows the locations of wells and the magnitude of production in FY 1999/2000. Total production during this year was about 178,700 acre-ft, based on Watermaster records. According to Watermaster records, the Agricultural Pool pumped 25 percent, the Appropriative Pool pumped 72 percent, and the Overlying Non-Agricultural Pool pumped 3 percent of the total production.

Since FY 1977/1978, the location of groundwater production has shifted north, with groundwater production south of Highway 60 declining from 59 to 31 percent of total production. North of Highway 60, production has increased from 41 to 69 percent of total production. This shift in production was caused by dairy land replacing irrigated agricultural uses south of Highway 60 and an increase in appropriator production north of Highway 60 in response to urbanization.

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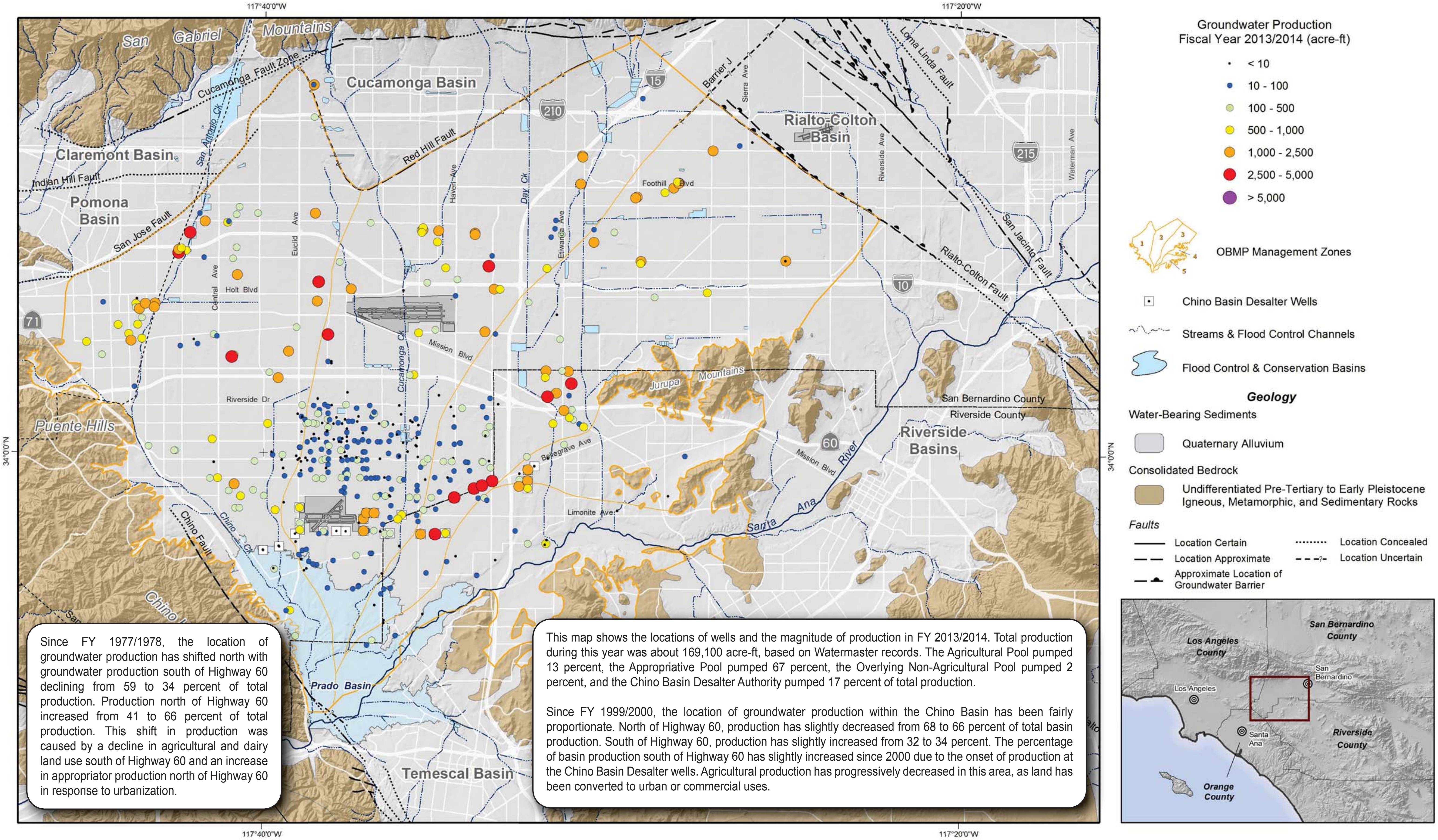
0 2 4 Miles

0 3 6 KM

2014 State of the Basin
Basin Production and Recharge

Groundwater Production by Well
Fiscal Year 1999/2000

Exhibit 9



Since FY 1977/1978, the location of groundwater production has shifted north with groundwater production south of Highway 60 declining from 59 to 34 percent of total production. Production north of Highway 60 increased from 41 to 66 percent of total production. This shift in production was caused by a decline in agricultural and dairy land use south of Highway 60 and an increase in appropriator production north of Highway 60 in response to urbanization.

This map shows the locations of wells and the magnitude of production in FY 2013/2014. Total production during this year was about 169,100 acre-ft, based on Watermaster records. The Agricultural Pool pumped 13 percent, the Appropriative Pool pumped 67 percent, the Overlying Non-Agricultural Pool pumped 2 percent, and the Chino Basin Desalter Authority pumped 17 percent of total production.

Since FY 1999/2000, the location of groundwater production within the Chino Basin has been fairly proportionate. North of Highway 60, production has slightly decreased from 68 to 66 percent of total basin production. South of Highway 60, production has slightly increased from 32 to 34 percent. The percentage of basin production south of Highway 60 has slightly increased since 2000 due to the onset of production at the Chino Basin Desalter wells. Agricultural production has progressively decreased in this area, as land has been converted to urban or commercial uses.

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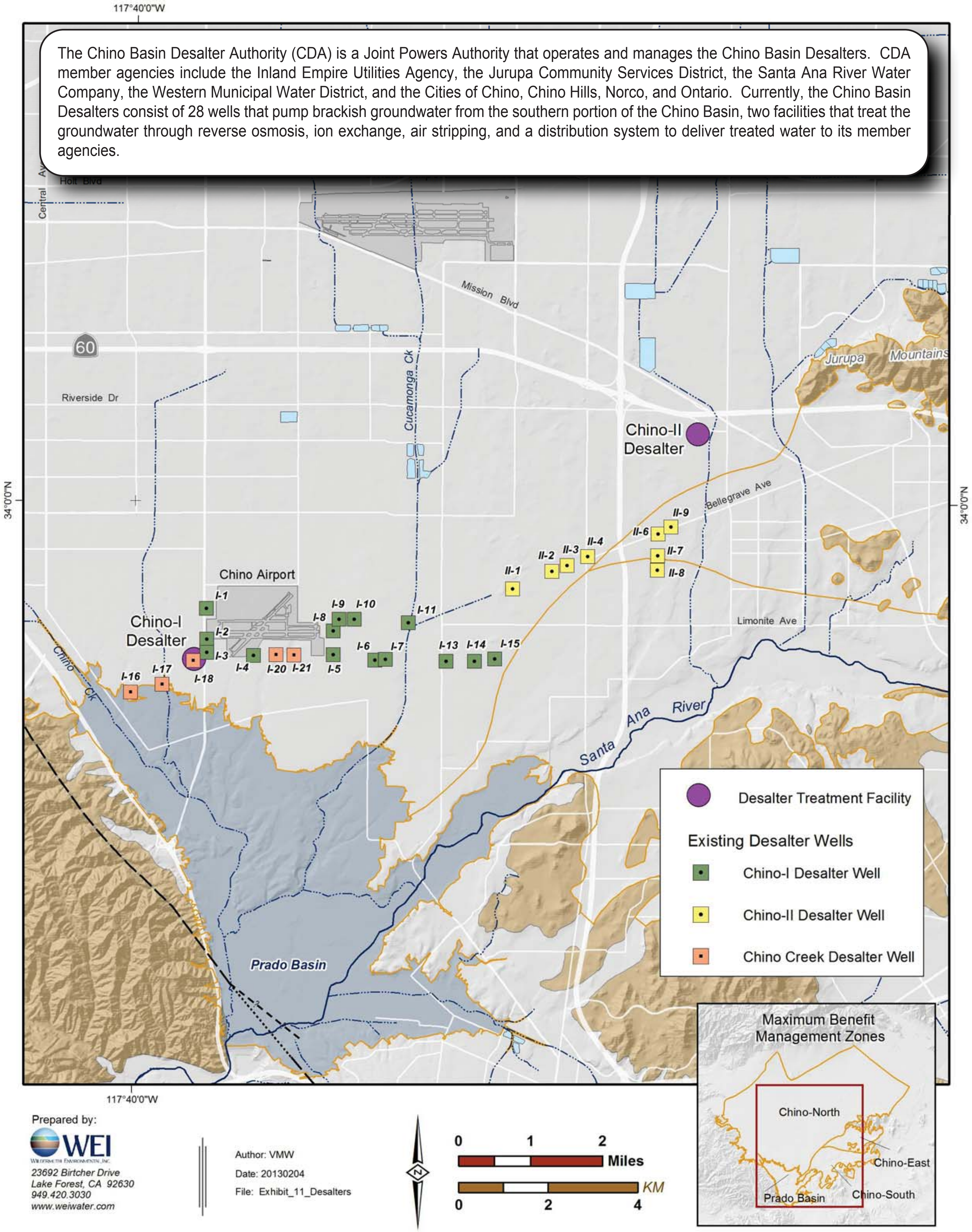
2014 State of the Basin
Basin Production and Recharge

Groundwater Production by Well

Fiscal Year 2013/2014

Exhibit 10

The Chino Basin Desalter Authority (CDA) is a Joint Powers Authority that operates and manages the Chino Basin Desalters. CDA member agencies include the Inland Empire Utilities Agency, the Jurupa Community Services District, the Santa Ana River Water Company, the Western Municipal Water District, and the Cities of Chino, Chino Hills, Norco, and Ontario. Currently, the Chino Basin Desalters consist of 28 wells that pump brackish groundwater from the southern portion of the Chino Basin, two facilities that treat the groundwater through reverse osmosis, ion exchange, air stripping, and a distribution system to deliver treated water to its member agencies.



The need for the Chino Basin Desalters was described the OBMP Phase 1 Report. During the 1900s, the land uses in southern portion of the Chino Basin were primarily agricultural. Over time, groundwater quality degraded in this area and currently 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 and their water demands would ultimately replace agriculture. If municipal pumping did not replace the decreased agricultural pumping, groundwater levels would rise and discharge to the Santa Ana River. The potential consequences of this occurrence would be (i) loss of Safe Yield in the Chino Basin and (ii) degradation of the quality of the Santa Ana River, which could impact the downstream beneficial uses of the River in Orange County. These consequences would come with high costs to the Chino Basin parties to mitigate the loss of Safe Yield and to comply with water-quality regulations.

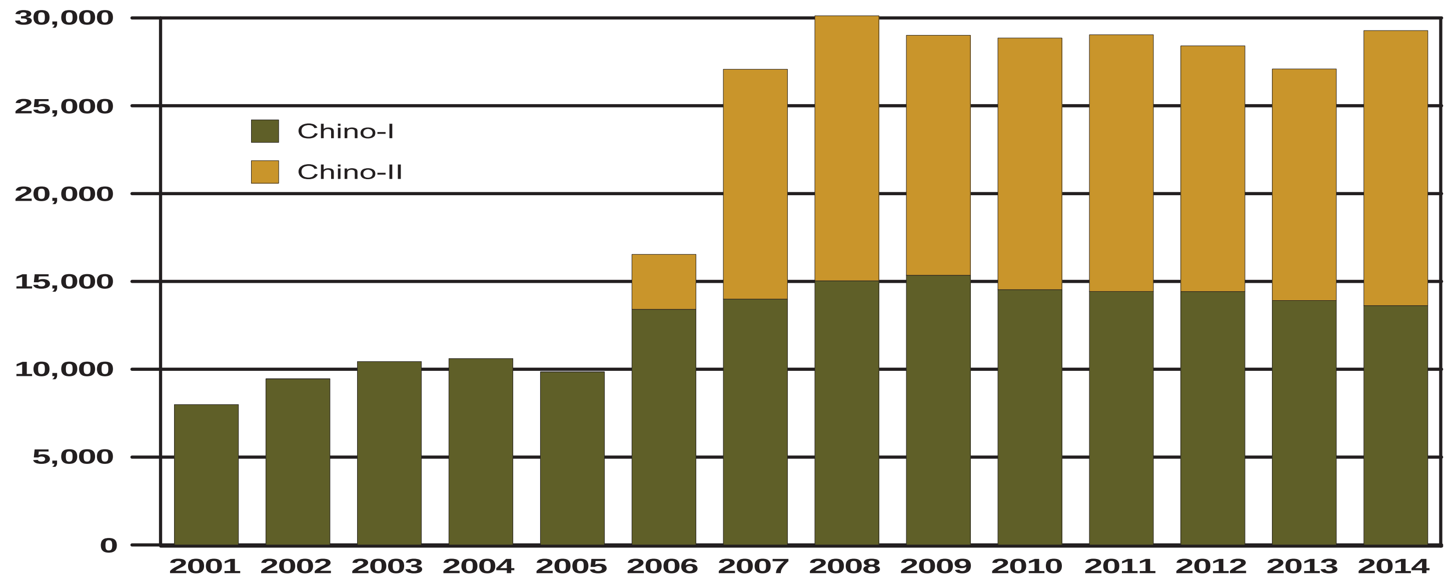
The Chino Basin Desalters were hence designed to replace the expected decrease in agricultural production and accomplish the following objectives: meet emerging municipal demands in the Chino Basin, maintain or enhance Safe Yield, remove groundwater contaminants, and protect the beneficial uses of the Santa Ana River. The first desalter facility and well field, the Chino-I Desalter, began operation in 2000 and had an original design capacity of 8 mgd (about 9,000 acre-ft/yr). In 2005, Chino-I was expanded to a capacity of 14 mgd (about 17,000 acre-ft/yr). The Chino-II Desalter began operating in June 2006 at a capacity of 15 mgd (about 16,000 acre-ft/yr). Currently, the Chino-I and Chino-II Desalters produce about 30,000 acre-ft/yr of groundwater. The chart below shows annual groundwater-production for the Chino Basin Desalters.

The Chino Basin Desalters are fundamental to achieving “Hydraulic Control” in the southern portion of Chino Basin. Hydraulic Control is achieved when groundwater discharge from the Chino-North Management Zone to Prado Basin is eliminated or reduced to de minimis levels. The RWQCB made Hydraulic Control a commitment for Watermaster and the IEUA in the Basin Plan, in exchange for relaxed groundwater-quality objectives in Chino-North. These so-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 beneficial uses of the Santa Ana River.

Pursuant to the Peace and Peace II Agreements, desalter production is to reach 40,000 acre-ft/yr. The CDA’s most recent expansion was the construction of five Chino Creek Well Field (CCWF) wells in 2012. Production at some of the CCWF wells began in late 2014, and production will commence at the other CCWF wells in 2015. An additional scheduled expansion of the Chino Basin Desalters consists of three additional wells for the Chino-II well field in the south-central portion of the Chino Basin. These wells are anticipated to begin production in 2016 and will facilitate the achievement of 40,000 acre-ft/yr of desalter production.

As described in the Peace II Agreement, through re-operation and pursuant to a Judgment Amendment, Watermaster will engage in the controlled overdraft of 400,000 acre-ft through 2030, allocated specifically to meet the replenishment obligation of the desalter well production (WEI, 2009b). Previous investigations have shown that re-operation is required to achieve Hydraulic Control (WEI, 2007). Re-operation water is divided into two tranches: the first tranche of 225,000 acre-ft is dedicated for the replenishment of groundwater produced by existing desalter wells; the second tranche of 175,000 acre-ft will be used at a rate of 10,000 acre-ft/yr through 2030 for the replenishment obligation of the current desalter expansion.

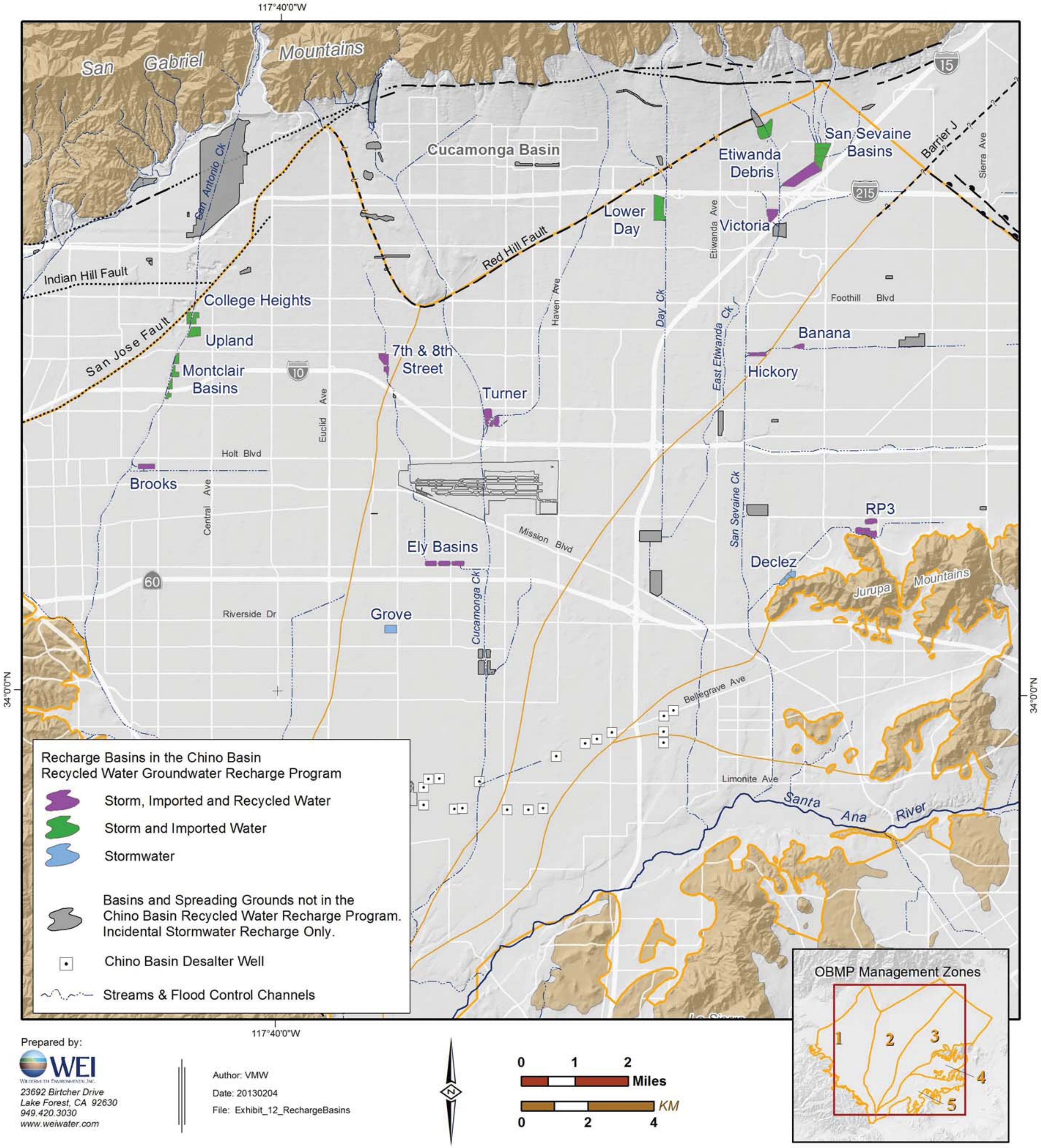
Groundwater Production for the Chino Desalters *(by fiscal year in acre-ft)*



Chino Basin Desalter Well Production

Fiscal Year 2013/2014

Exhibit 11

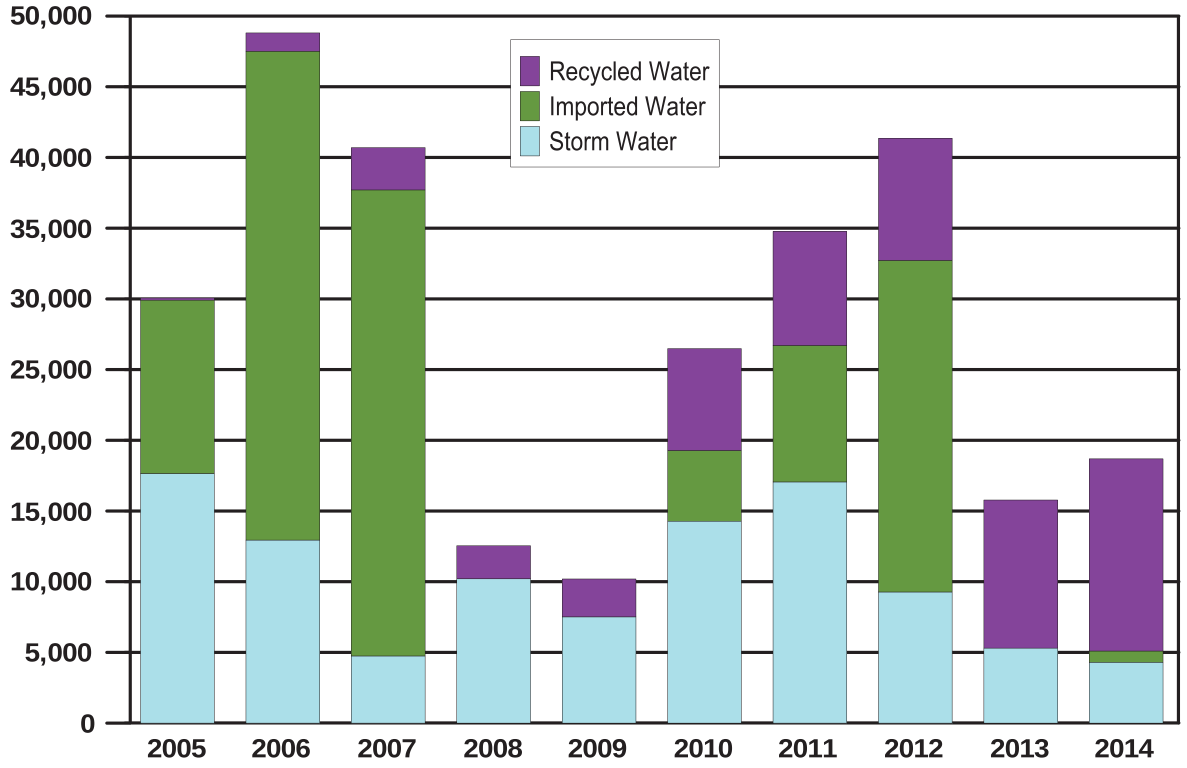


The IEUA and Watermaster are partners in the implementation of the Chino Basin Recycled Water Groundwater Recharge Program. This program is an integral part of the OBMP's objective to enhance water supply reliability and improve groundwater quality. Since the implementation of the Chino Basin Recycled Water Groundwater Recharge Program in FY 2004/2005, the recharge of storm water and recycled water has increased in the Chino Basin, relieving some dependence on imported water for direct use and replenishment. The operation of the Chino Basin Desalters and the increase in storm water recharge have provided mitigation for the expanded use of recycled water in the Chino Basin.

Four types of water are recharged for the Chino Basin Recycled Water Groundwater Recharge Program: imported water, storm water, urban runoff, and recycled water. The IEUA records the daily volumes of all types of water routed to all recharge basins for the program. Since about 2004, sensors have been installed at some of the recharge basins to monitor stage, and the data are used to calculate recharge volumes. The IEUA does not distinguish storm water from urban runoff in the recharge tabulations it submits to Watermaster. Watermaster maintains a centralized database of the recharge volumes. See Exhibit 13 for the fiscal year totals of recharged water by type and by recharge basin for FY 2000/2001 through 2013/2014.

The chart below shows annual recharge by water type since the initiation of the Chino Basin Recycled Water Groundwater Recharge Program in FY 2004/2005.

Water Recharged in the Chino Basin *(by fiscal year in acre-ft)*



Groundwater Recharge in the Chino Basin

2014 State of the Basin
Basin Production and Recharge

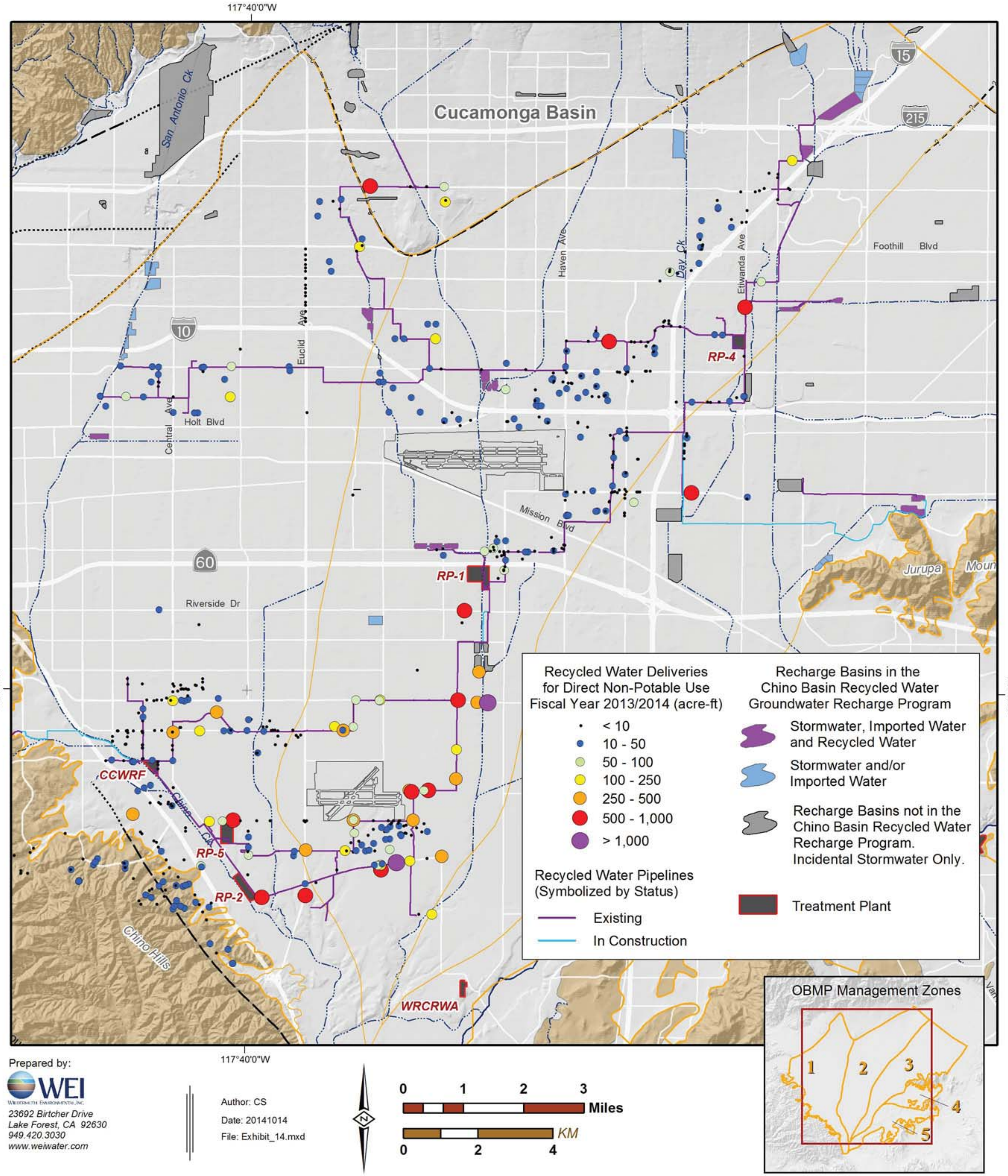
Exhibit 12

Exhibit 13
Summary of Annual Wet Water Recharge Records in the Chino Basin
(acre-ft)

Basin Name	FY 2000/2001				FY 2001/2002				FY 2002/2003				FY 2003/2004				FY 2004/2005				FY 2005/2006				FY 2006/2007			
	SW	IW	RW	Total	SW	IW	RW	Total	SW	IW	RW	Total	SW	IW	RW	Total	SW	IW	RW	Total	SW	IW	RW	Total	SW	IW	RW	Total
MVWD ASR Well	NM	0	0	0	NM	0	0	0	NM	0	0	0	NM	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
College Heights Basins	NM	0	0	0	NM	0	0	0	NM	0	0	0	NM	0	0	0	0	0	0	0	108	5,326	0	5,434	1	3,125	0	3,126
Upland Basin	NM	0	0	0	NM	0	0	0	NM	0	0	0	NM	0	0	0	989	0	0	989	214	5,985	0	6,199	195	7,068	0	7,263
Montclair Basins	NM	6,530	0	6,530	NM	6,500	0	6,500	NM	6,499	0	6,499	NM	3,558	0	3,558	3,350	7,887	0	11,237	1,296	5,579	0	6,875	355	10,681	0	11,036
Brooks Street Basin	NM	0	0	0	NM	0	0	0	NM	0	0	0	NM	0	0	0	1776	0	0	1,776	524	2,032	0	2,556	205	1,604	0	1,809
7th and 8th Street Basins	NM	0	0	0	NM	0	0	0	NM	0	0	0	NM	0	0	0	620	0	0	620	1,271	0	0	1,271	640	0	0	640
Ely Basins	NM	0	500	500	NM	0	505	505	NM	0	185	185	NM	0	49	49	2,010	0	158	2,168	1,531	0	188	1,719	631	0	466	1,097
Grove Basin	NM	0	0	0	NM	0	0	0	NM	0	0	0	NM	0	0	0	0	0	0	0	133	0	0	133	166	0	0	166
Turner Basins	NM	0	0	0	NM	0	0	0	NM	0	0	0	NM	0	0	0	1428	310	0	1,738	2,575	346	0	2,921	406	313	1,237	1,956
Lower Day Basin	NM	0	0	0	NM	0	0	0	NM	0	0	0	NM	0	0	0	2798	107	0	2,905	624	2,810	0	3,434	78	2,266	0	2,344
Etiwanda Debris Basins	NM	0	0	0	NM	0	0	0	NM	0	0	0	NM	2,812	0	2,812	0	2,137	0	2,137	20	2,488	0	2,508	0	1,160	0	1,160
Victoria Basin	NM	0	0	0	NM	0	0	0	NM	0	0	0	NM	0	0	0	0	0	0	0	330	0	0	330	260	0	0	260
San Sevaine	NM	0	0	0	NM	0	0	0	NM	0	0	0	NM	1,211	0	1,211	2,830	1,621	0	4,451	2,072	9,172	0	11,244	244	5,749	0	5,993
Hickory Basin	NM	0	0	0	NM	0	0	0	NM	0	0	0	NM	0	0	0	298	197	0	495	438	636	586	1,660	536	212	647	1,395
Banana Basin	NM	0	0	0	NM	0	0	0	NM	0	0	0	NM	0	0	0	425	0	0	425	300	193	529	1,022	226	783	643	1,653
RP-3 Basins	NM	0	0	0	NM	0	0	0	NM	0	0	0	NM	0	0	0	1,105	0	0	1,105	767	0	0	767	802	0	0	802
Declez Basin	NM	0	0	0	NM	0	0	0	NM	0	0	0	NM	0	0	0	19	0	0	19	737	0	0	737	0	0	0	0
Totals:	NM	6,530	500	7,030	NM	6,500	505	7,005	NM	6,499	185	6,684	NM	7,582	49	7,631	17,648	12,258	158	30,065	12,940	34,567	1,303	48,810	4,745	32,960	2,993	40,698

Basin Name	FY 2007/2008				FY 2008/2009				FY 2009/2010				FY 2010/2011				FY 2011/2012				FY 2012/2013				FY 2013/2014			
	SW	IW	RW	Total	SW	IW	RW	Total	SW	IW	RW	Total	SW	IW	RW	Total	SW	IW	RW	Total	SW	IW	RW	Total	SW	IW	RW	Total
MVWD ASR Well	0	0	0	0	0	0	0	0	0	0	0	0	0	186	0	186	0	889	0	889	0	0	0	0	0	0	0	0
College Heights Basins	172	0	0	172	0	0	0	0	65	382	0	447	593	559	0	1,152	4	578	0	582	0	0	0	0	0	4	0	4
Upland Basin	312	0	0	312	274	0	0	274	532	0	0	532	1,308	899	0	2,207	222	2,118	0	2,340	0	119	0	119	0	95	0	95
Montclair Basins	859	0	0	859	611	0	0	611	937	4,592	0	5,529	1,762	3,672	0	5,434	703	11,893	0	12,596	0	204	0	204	0	416	0	416
Brooks Street Basin	475	0	0	475	434	0	1,605	2,039	666	0	1,695	2,361	628	0	1,373	2,001	363	561	836	1,760	0	115	1,505	1,620	0	112	1,308	1,420
7th and 8th Street Basins	959	0	1,054	2,013	1,139	0	352	1,491	1,744	6	1,067	2,817	1,583	543	1,871	3,997	1047	572	641	2,260	0	751	2,261	3,012	5	441	1,423	1,869
Ely Basins	1,603	0	562	2,165	927	0	364	1,291	1,164	0	246	1,410	1,415	83	757	2,255	1096	885	393	2,374	0	568	1,378	1,946	0	548	3,298	3,846
Grove Basin	326	0	0	326	405	0	0	405	351	0	0	351	431	0	0	431	400	0	0	400	0	177	0	177	0	258	0	258
Turner Basins	1,542	0	0	1,542	1,200	0	171	1,371	2,220	0	397	2,617	2,308	0	53	2,361	1879	199	1,034	3,112	0	1,120	176	1,296	0	596	1,565	2,161
Lower Day Basin	303	0	0	303	168	0	0	168	540	3	0	543	703	894	0	1,597	158	1,439	0	1,597	0	106	0	106	28	114	0	142
Etiwanda Debris Basins	10	0	0	10	28	0	0	28	775	7	0	782	1,213	147	0	1,360	100	567	0	667	0	33	0	33	0	45	0	45
Victoria Basin	427	0	0	427	250	0	0	250	494	2	0	496	461	69	773	1,303	221	281	665	1,167	0	94	842	936	0	192	1,379	1,571
San Sevaine	749	0	0	749	225	0	0	225	993	0	0	993	1,049	1,707	396	3,152	436	1,228	513	2,177	0	147	575	722	0	162	274	436
Hickory Basin	949	0	567	1,516	199	0	46	245	700	7	856	1,563	371	10	776	1,157	258	515	783	1,556	0	199	874	1,073	13	171	1,920	2,104
Banana Basin	278	0	157	435	383	0	40	423	416	0	898	1,314	149	0	267	416	247	0	1,915	2,162	0	114	670	784	24	87	1,071	1,182
RP-3 Basins	511	0	0	511	613	0	106	719	1,902	1	2,051	3,954	2,201	882	1,799	4,882	1339	1,724	1,789	4,852	0	1,021	2,198	3,219	350	717	1,355	2,422
Declez Basin	730	0	0	730	656	0	0	656	774	0	0	774	877	0	0	877	798	0	65	863	0	530	0	530	374	341	0	715
Totals:	10,205	0	2,340	12,545	7,512	0	2,684	10,196	14,273	5,000	7,210	26,483	17,052	9,650	8,065	34,767	9,271	23,449	8,634	41,354	0	5,298	10,479	15,777	795	4,299	13,593	18,687

NM - Not measured
SW - Surface Water
IW - Imported Water
RW - Recycled Water
FY - Fiscal Year



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The direct use of recycled water in Chino Basin was identified in the OBMP to achieve Goal No. 1 – Enhance Basin Water Supplies. The 2004 Basin Plan Amendment (RWQCB, 2004) was the instrumental regulatory construct that allowed for the aggressive expansion of recycled-water reuse in the Chino Basin. The IEUA owns and operates the four treatment facilities in the Chino Basin that produce recycled water for reuse: 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).

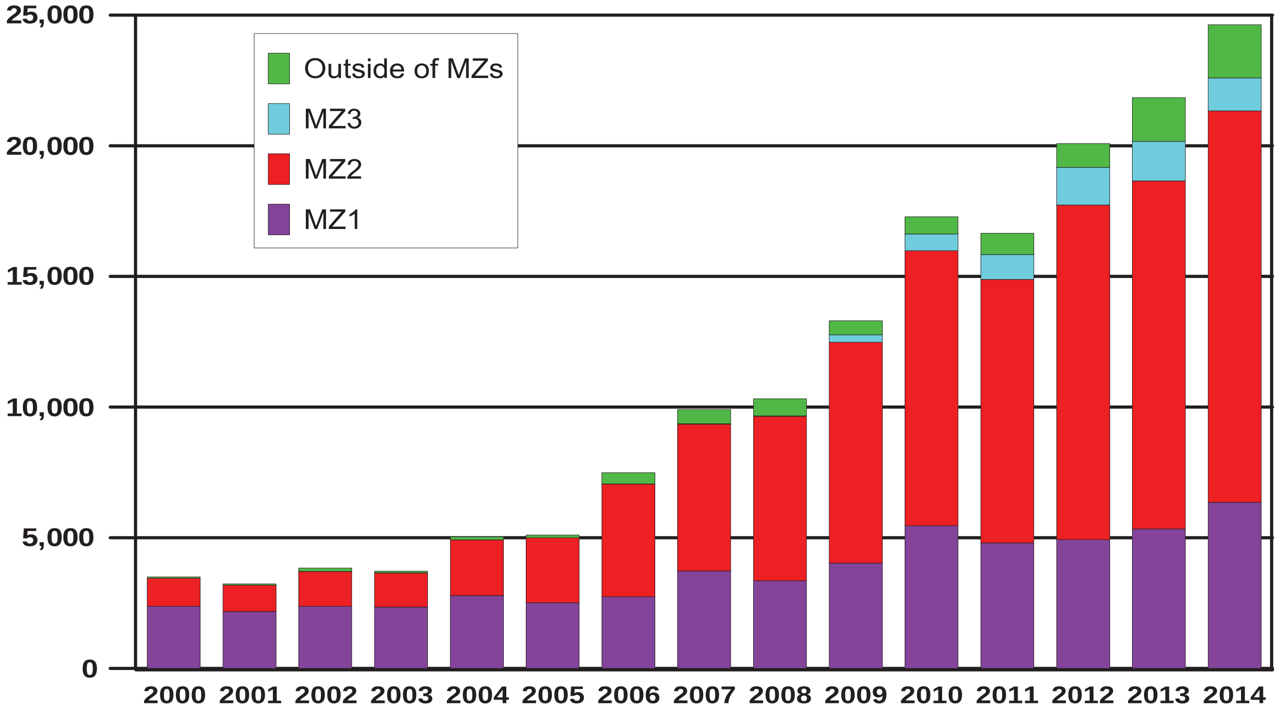
Recycled water is reused directly for non-potable uses, which include: irrigation of crops, animal pastures, freeway landscape, parks, schools, and golf courses; commercial laundry and car washes; outdoor cleaning and construction; toilet plumbing; and industrial processes. The direct use of recycled water began in 1997 after the completion of distribution pipelines from the CCWRF to the cities of Chino and Chino Hills. The direct use of recycled water in the Chino Basin has increased sevenfold since the OBMP implementation, from about 3,500 acre-ft in FY 1999/2000 to about 24,600 acre-ft in FY 2013/2014. The direct use of recycled water increases the availability of native and imported waters for higher-priority beneficial uses. The IEUA has progressively built infrastructure to deliver recycled water to all of its member agencies throughout much of the Chino Basin.

Recycled water also is used in the Chino Basin for indirect potable reuse via groundwater recharge. Currently, the recharge of recycled water can occur at the San Sevaine, Victoria, Banana, Hickory, Turner, 7th & 8th Street, Ely, RP-3, and Brooks Basins. This exhibit shows the locations of the recharge basins used to recharge recycled in the Chino Basin (also shown in Exhibit 12), and Exhibit 13 shows the amount of recycled water recharged by basin. In FY 2013/2014, about 13,600 acre-ft of recycled water was recharged.

Total recycled water reuse for direct use and recharge in the Chino Basin in FY 2013/2014 was about 38,000 acre-ft, which accounts for about 70 percent of the total effluent produced from the IEUA's treatment plants. This is the maximum annual amount of recycled water ever used in the Chino Basin to date. The IEUA is continuing its efforts to expand the recycled-water distribution system throughout the Chino Basin for direct non-potable uses and indirect potable reuse via recharge, further relieving demands on native and imported waters.

Direct Use of Recycled Water by OBMP Management Zone

(by fiscal year in acre-ft)



2014 State of the Basin

Basin Production and Recharge

Recycled Water Deliveries for Direct Use

Fiscal Year 2013/2014

Exhibit 14

The exhibits in this section show the physical state of the Chino Basin with respect to changes in groundwater levels since the Judgement and OBMP implementation. 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 Program Element 1 – Develop and Implement a Comprehensive Monitoring Program.* The monitoring program has been refined over time to satisfy the evolving needs of the Watermaster and IEUA, such as new regulatory requirements, and to increase efficiency.

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 water quality data, and to identify areas of the basin where recharge and discharge are not in balance.

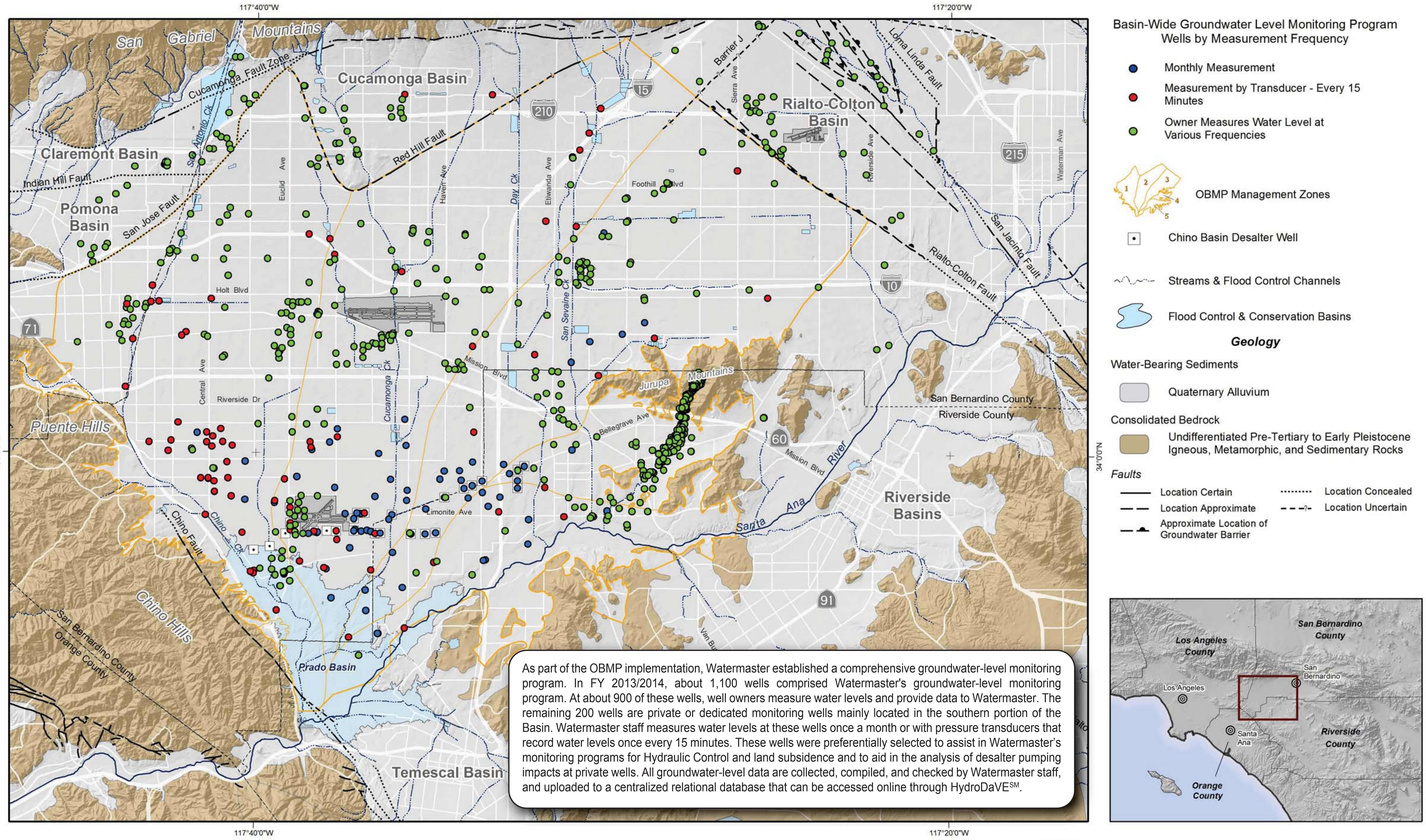
Exhibit 15 shows the locations and measurement frequencies of all wells currently in Watermaster's groundwater-level monitoring program. Water levels are measured at private wells and dedicated monitoring wells by Watermaster staff using manual methods once per month or with pressure transducers that record water levels once every 15 minutes. Water levels are also measured by well owners, including municipal water agencies, private water companies, the California Department of Toxic Substance Control (DTSC), the County of San Bernardino, and various private consulting firms. Typically, water levels are measured by well owners monthly, and Watermaster staff collects these data from the well owners quarterly. All water-level data are checked by Watermaster staff and uploaded to a centralized database management system that can be accessed online through HydroDaVE^{SM}.

The groundwater-level data were used to create groundwater-elevation contour maps for the shallow aquifer system in the Chino Basin for spring 2000 (Exhibit 16), spring 2012 (Exhibit 17), and spring 2014 (Exhibit 18). The contours were used to create 60x60-meter rasterized grids of the piezomtetric surface using an Ordinary Kriging method of interpolation with the ArcMap Geostatistical Analyst extension. The groundwater-elevation rasterized grid for spring 2012 and spring 2014 were subtracted to generate a map of water-level change over the two-year period since the last State of the Basin analysis (Exhibit 19). The groundwater-elevation rasterized grid from spring 2000 and spring 2014 were subtracted to generate a map of groundwater-level change over the 14-year period since the OBMP and Peace Agreement implementation (Exhibit 20).

Achieving "Hydraulic Control" in the southern portion of Chino Basin is an important objective of Watermaster, the IEUA, and the RWQCB. Hydraulic Control is achieved when groundwater discharge from the Chino-North groundwater management zone to Prado Basin is eliminated or reduced to de minimis levels. The RWQCB made achieving Hydraulic Control a commitment for the Watermaster and the IEUA in the Basin Plan (RWQCB, 2004) in exchange for relaxed groundwater-quality objectives in Chino-North. 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 enhances the yield of the Chino Basin by controlling groundwater levels in its southern portion, which has the effect of reducing outflow as rising groundwater and increasing streambed recharge in the Santa Ana River.

Groundwater-level data are used to assess the state of Hydraulic Control. Data are collected from a selected set of "key wells" and are mapped and analyzed annually. Exhibit 21 shows groundwater-elevation contours and data for the shallow aquifer system within the southern portion of the Chino Basin in spring 2000—prior to any significant pumping by the Chino-I Desalter wells. Exhibit 22 shows groundwater-elevation contours and data for the shallow aquifer system in spring 2014—approximately fourteen years after the commencement of Chino-I Desalter pumping and eight years after the commencement of Chino-II Desalter pumping. 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 2014 Annual Report* (WEI, 2015).

Exhibit 23 shows the location of selected wells across the Chino Basin that have long time-histories of water-levels. The time-histories describe long-term trends in groundwater levels in the different groundwater management zones of the Chino Basin. The wells were selected based on geographic location within the management zone, well-screen intervals, and the length, density, and quality of water-level records. Exhibits 24 through 28 are water-level time-series charts for these wells by management zone for the period of 1978 to 2014. These exhibits compare the behavior of water levels to climate, groundwater production, and recharge, revealing cause-and-effect relationships. To show the relationship between groundwater levels and climate, a cumulative departure from mean precipitation (CDFM) plot is provided. Positive sloping lines on the CDFM plot indicate wet years or wet periods, and negatively sloping lines indicate dry years or dry periods. For example, 1978 to 1983 was an extremely wet period, and it is represented by a positively sloping line. Bar charts of annual pumping and artificial recharge by management zone are shown to characterize the relationships between groundwater levels and pumping and/or artificial recharge.



As part of the OBMP implementation, Watermaster established a comprehensive groundwater-level monitoring program. In FY 2013/2014, about 1,100 wells comprised Watermaster's groundwater-level monitoring program. At about 900 of these wells, well owners measure water levels and provide data to Watermaster. The remaining 200 wells are private or dedicated monitoring wells mainly 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 assist in Watermaster's monitoring programs for Hydraulic Control and land subsidence and to aid in the analysis of desalter pumping impacts at private wells. 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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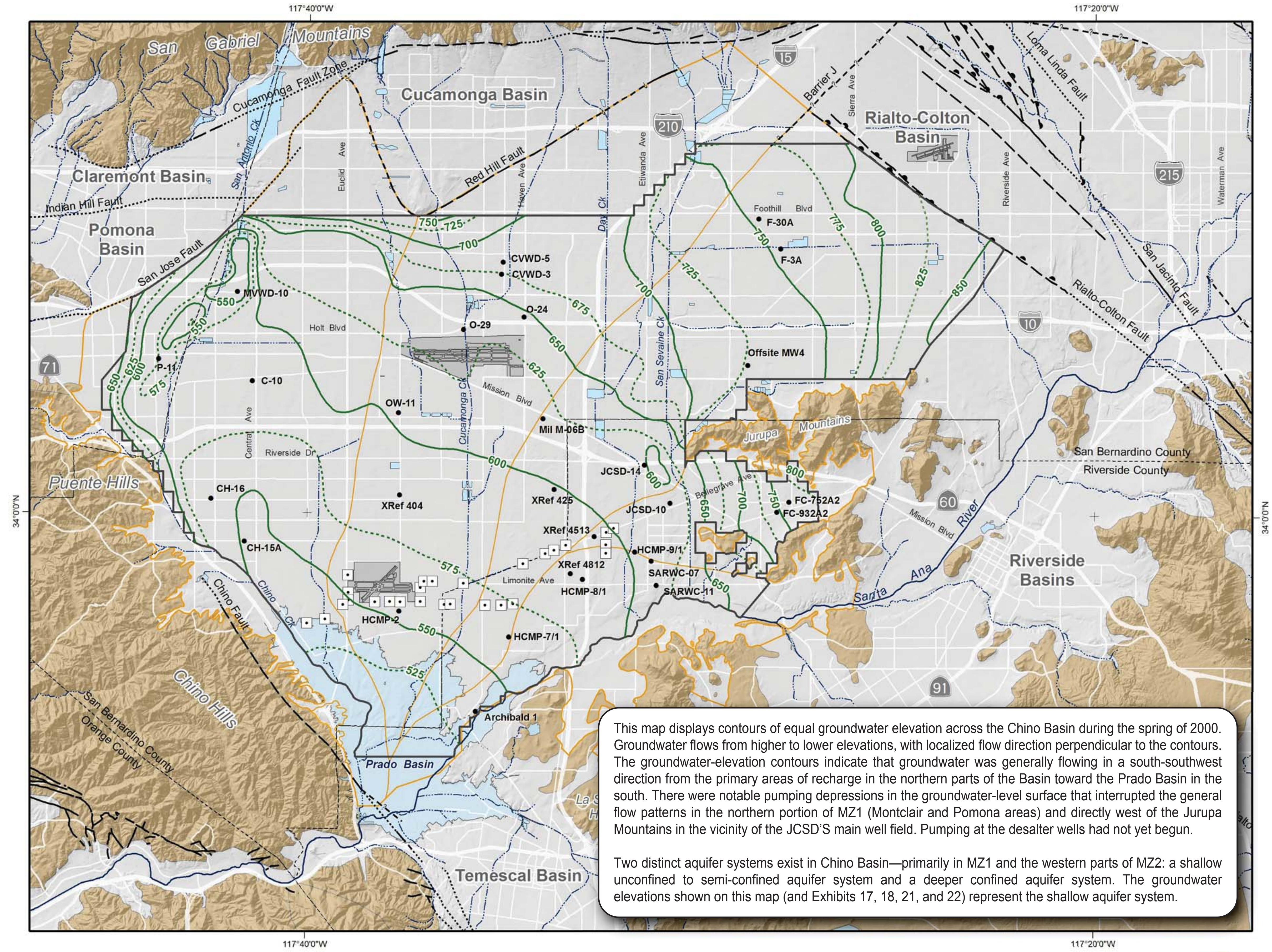
0 1 2 3 4 5 Miles
0 2 4 6 8 KM

2014 State of the Basin
Groundwater Levels

Groundwater Level Monitoring Network

Well Location and Measurement Frequency
During Fiscal Year 2013/2014

Exhibit 15



This map displays contours of equal groundwater elevation across the Chino Basin during the spring of 2000. Groundwater flows from higher to lower elevations, with localized flow direction perpendicular to the contours. The groundwater-elevation contours indicate that groundwater was generally 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 in the vicinity of the JCSD'S main well field. Pumping at the desalter wells had not yet begun.

Two distinct aquifer systems exist in Chino Basin—primarily in MZ1 and the western parts of MZ2: a shallow unconfined to semi-confined aquifer system and a deeper confined aquifer system. The groundwater elevations shown on this map (and Exhibits 17, 18, 21, and 22) represent the shallow aquifer system.

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

Boundry 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 24 through 28

OBMP Management Zones

⊡ Chino Basin Desalter Well

Streams & Flood Control Channels

Flood Control & Conservation Basins

Geology

Water-Bearing Sediments

Quaternary Alluvium

Consolidated Bedrock

Undifferentiated Pre-Tertiary to Early Pleistocene Igneous, Metamorphic, and Sedimentary Rocks

Faults

Location Certain	Location Concealed
Location Approximate	Location Uncertain
Approximate Location of Groundwater Barrier	

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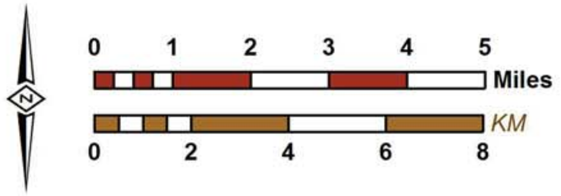
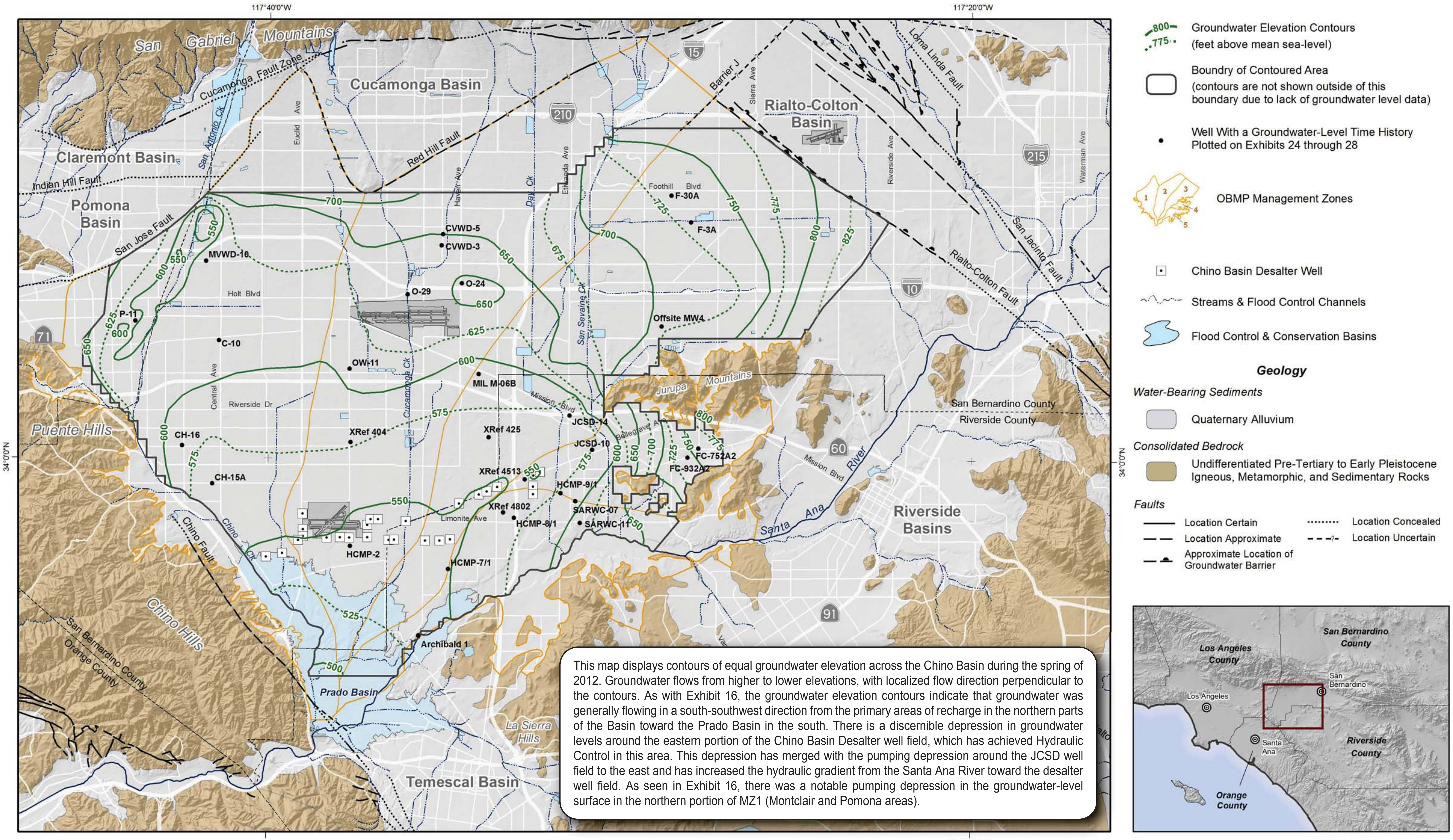


2014 State of the Basin
Groundwater Levels

Groundwater Elevation Contours in Spring 2000

Shallow Aquifer System

Exhibit 16



This map displays contours of equal groundwater elevation across the Chino Basin during the spring of 2012. Groundwater flows from higher to lower elevations, with localized flow direction perpendicular to the contours. As with Exhibit 16, the groundwater elevation contours indicate that groundwater was generally 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 Basin Desalter well field, which has achieved Hydraulic Control 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 seen in Exhibit 16, there was a notable pumping depression in the groundwater-level surface in the northern portion of MZ1 (Montclair and Pomona areas).

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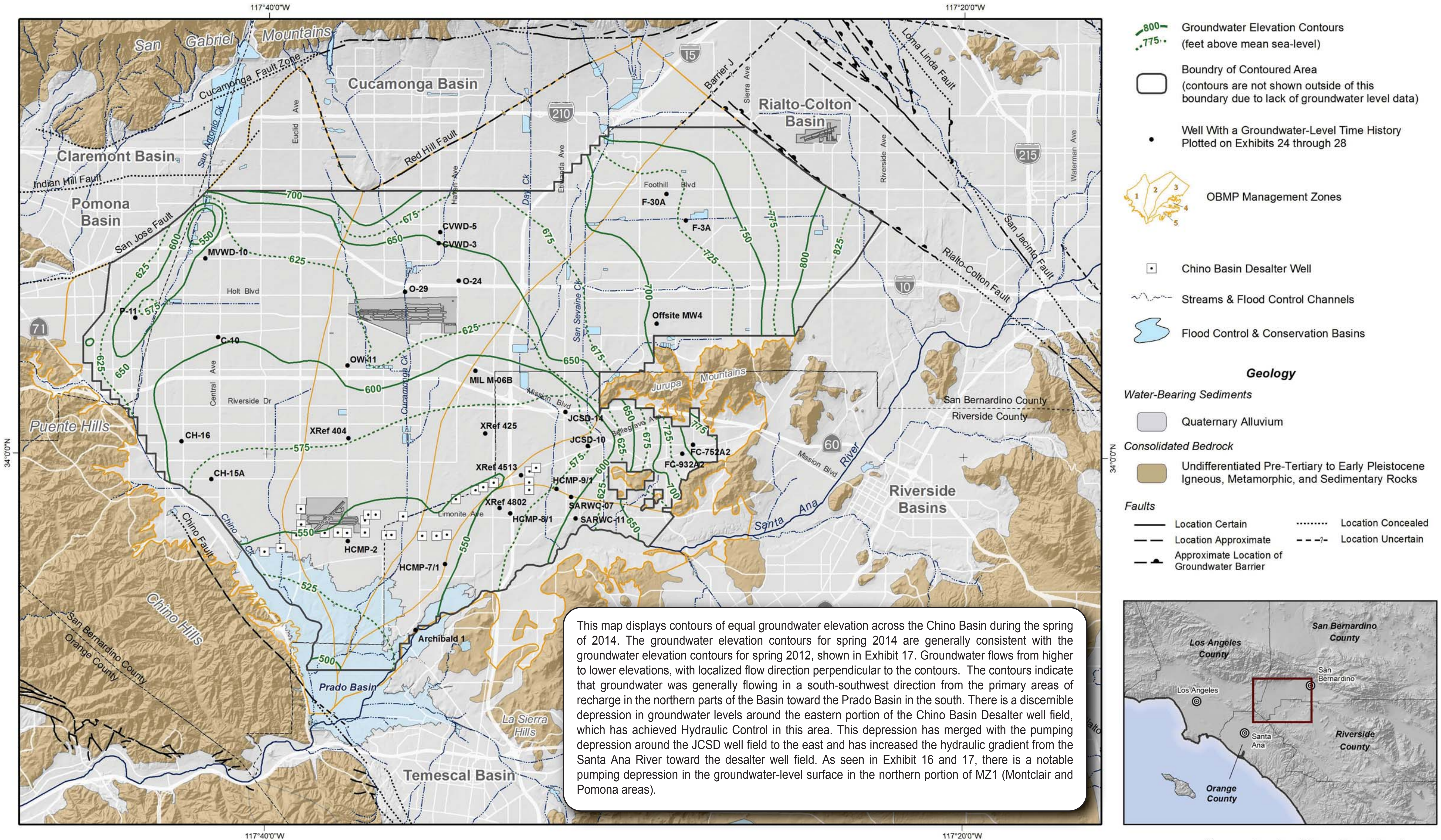
0 1 2 3 4 5 Miles
0 2 4 6 8 KM

2014 State of the Basin
Groundwater Levels

Groundwater Elevation Contours in Spring 2012

Shallow Aquifer System

Exhibit 17



This map displays contours of equal groundwater elevation across the Chino Basin during the spring of 2014. The groundwater elevation contours for spring 2014 are generally consistent with the groundwater elevation contours for spring 2012, shown in Exhibit 17. Groundwater flows from higher to lower elevations, with localized flow direction perpendicular to the contours. The contours indicate that groundwater was generally 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 Basin Desalter well field, which has achieved Hydraulic Control 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 seen in Exhibit 16 and 17, there is a notable pumping depression in the groundwater-level surface in the northern portion of MZ1 (Montclair and Pomona areas).

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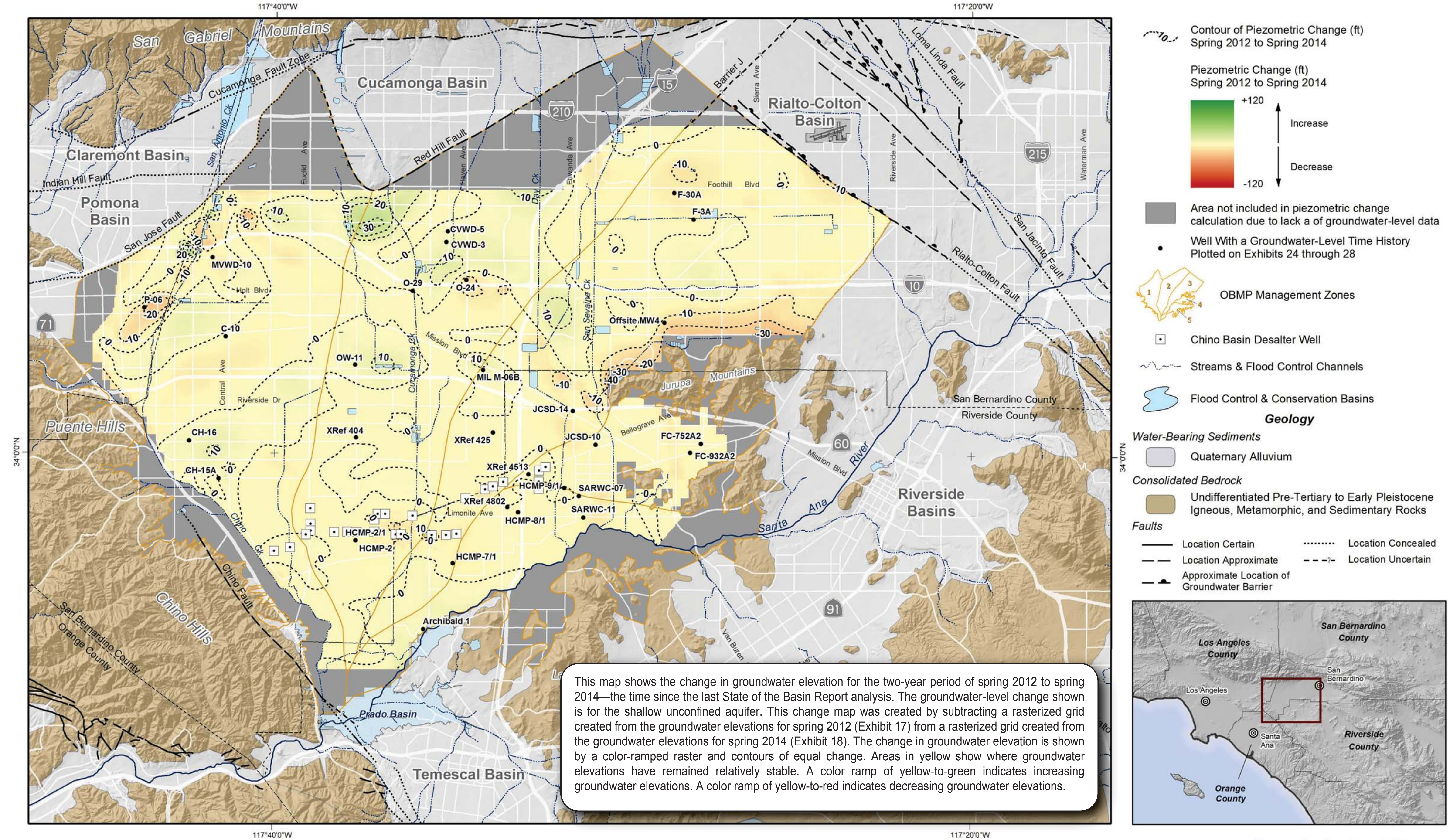
2014 State of the Basin
Groundwater Levels

Groundwater Elevation Contours in Spring 2014

Shallow Aquifer System

Exhibit 18



This map shows the change in groundwater elevation for the two-year period of spring 2012 to spring 2014—the time since the last State of the Basin Report analysis. The groundwater-level change shown is for the shallow unconfined aquifer. This change map was created by subtracting a rasterized grid created from the groundwater elevations for spring 2012 (Exhibit 17) from a rasterized grid created from the groundwater elevations for spring 2014 (Exhibit 18). The change in groundwater elevation is shown by a color-ramped raster and contours of equal change. Areas in yellow show where groundwater elevations have remained relatively stable. A color ramp of yellow-to-green indicates increasing groundwater elevations. A color ramp of yellow-to-red indicates decreasing groundwater elevations.

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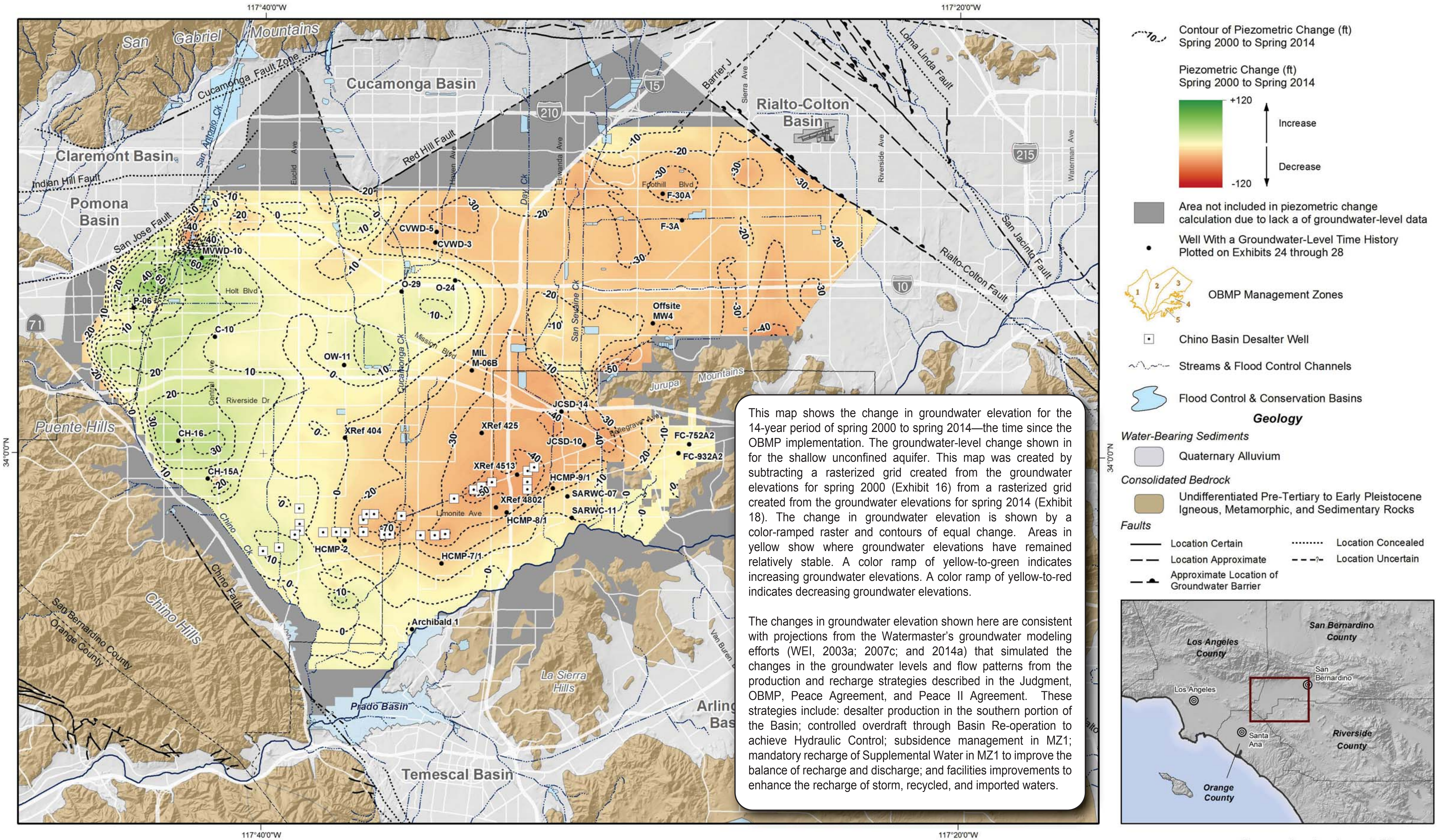
2014 State of the Basin
Groundwater Levels

Groundwater Level Change from Spring 2012 to Spring 2014

Shallow Aquifer System

Exhibit 19



This map shows the change in groundwater elevation for the 14-year period of spring 2000 to spring 2014—the time since the OBMP implementation. The groundwater-level change shown in for the shallow unconfined aquifer. This map was created by subtracting a rasterized grid created from the groundwater elevations for spring 2000 (Exhibit 16) from a rasterized grid created from the groundwater elevations for spring 2014 (Exhibit 18). The change in groundwater elevation is shown by a color-ramped raster and contours of equal change. Areas in yellow show where groundwater elevations have remained relatively stable. A color ramp of yellow-to-green indicates increasing groundwater elevations. A color ramp of yellow-to-red indicates decreasing groundwater elevations.

The changes in groundwater elevation shown here are consistent with projections from the Watermaster's groundwater modeling efforts (WEI, 2003a; 2007c; and 2014a) that simulated the 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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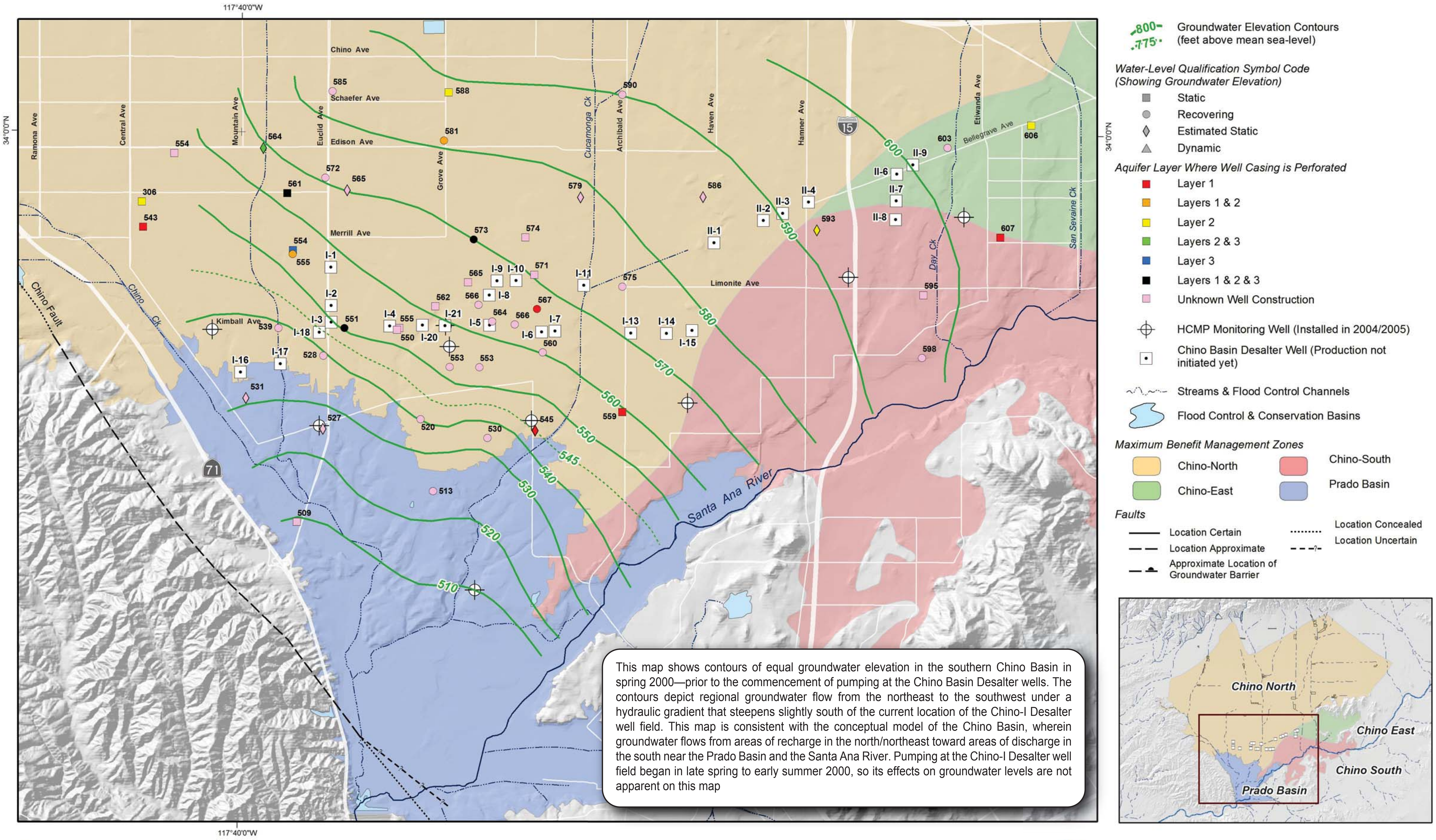
0	1	2	3	4	5	Miles
0	2	4	6	8		KM

2014 State of the Basin
Groundwater Levels

Groundwater Level Change from Spring 2000 to Spring 2014

Shallow Aquifer System

Exhibit 20



This map shows contours of equal groundwater elevation in the southern Chino Basin in spring 2000—prior to the commencement of pumping at the Chino Basin Desalter wells. The 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 on this map

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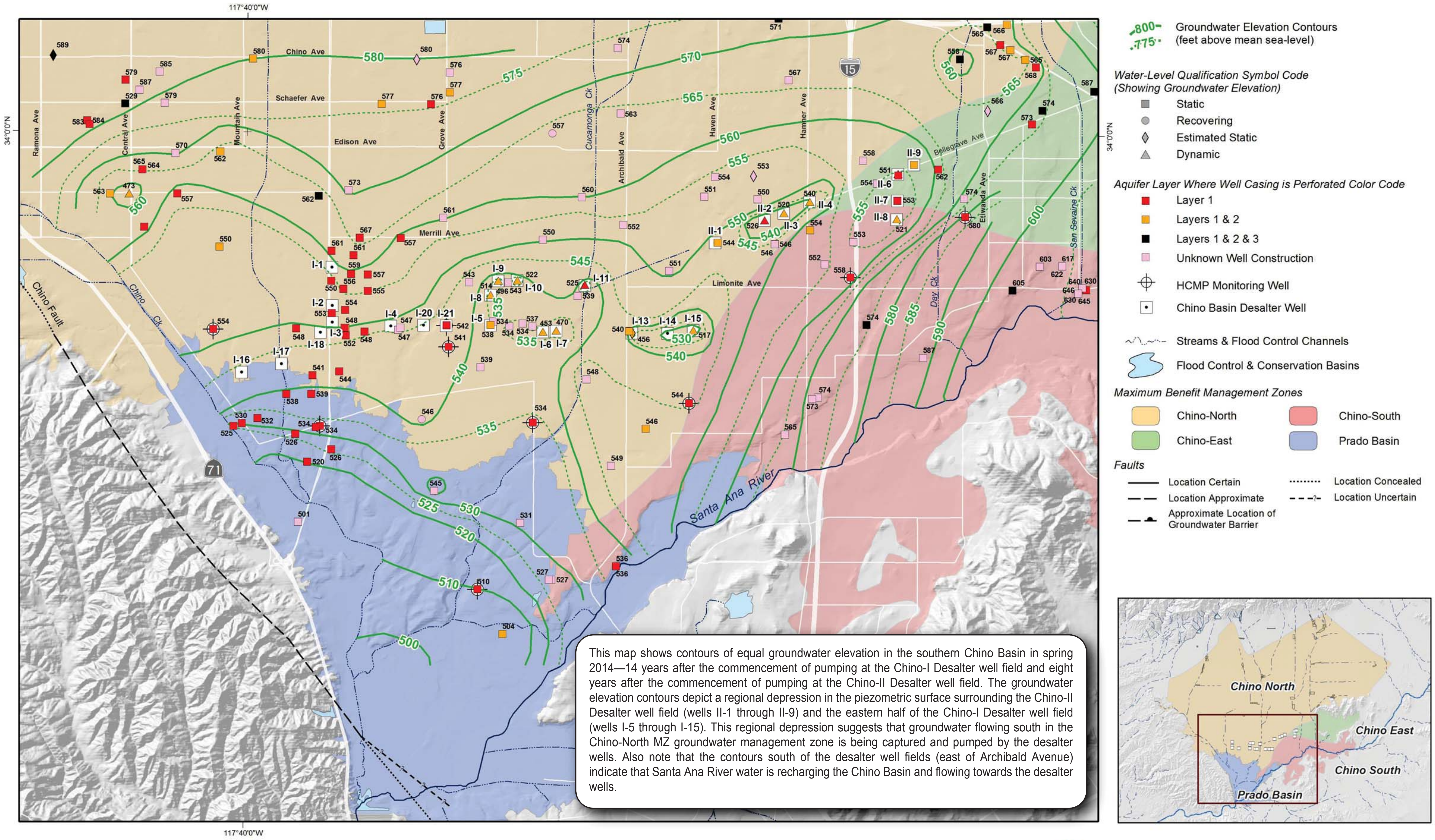
2014 State of the Basin
Groundwater Levels

State of Hydraulic Control in Spring 2000

Shallow Aquifer System

Exhibit 21



This map shows contours of equal groundwater elevation in the southern Chino Basin in spring 2014—14 years after the commencement of pumping at the Chino-I Desalter well field and eight years after the commencement of pumping at the Chino-II Desalter well field. The groundwater elevation contours depict a regional depression in the piezometric surface surrounding the Chino-II Desalter well field (wells II-1 through II-9) and the eastern half of the Chino-I Desalter well field (wells I-5 through I-15). This regional depression suggests that groundwater flowing south in the Chino-North MZ groundwater management zone is being captured and pumped by the desalter wells. Also note that the contours south of the desalter well fields (east of Archibald Avenue) indicate that Santa Ana River water is recharging the Chino Basin and flowing towards the desalter wells.

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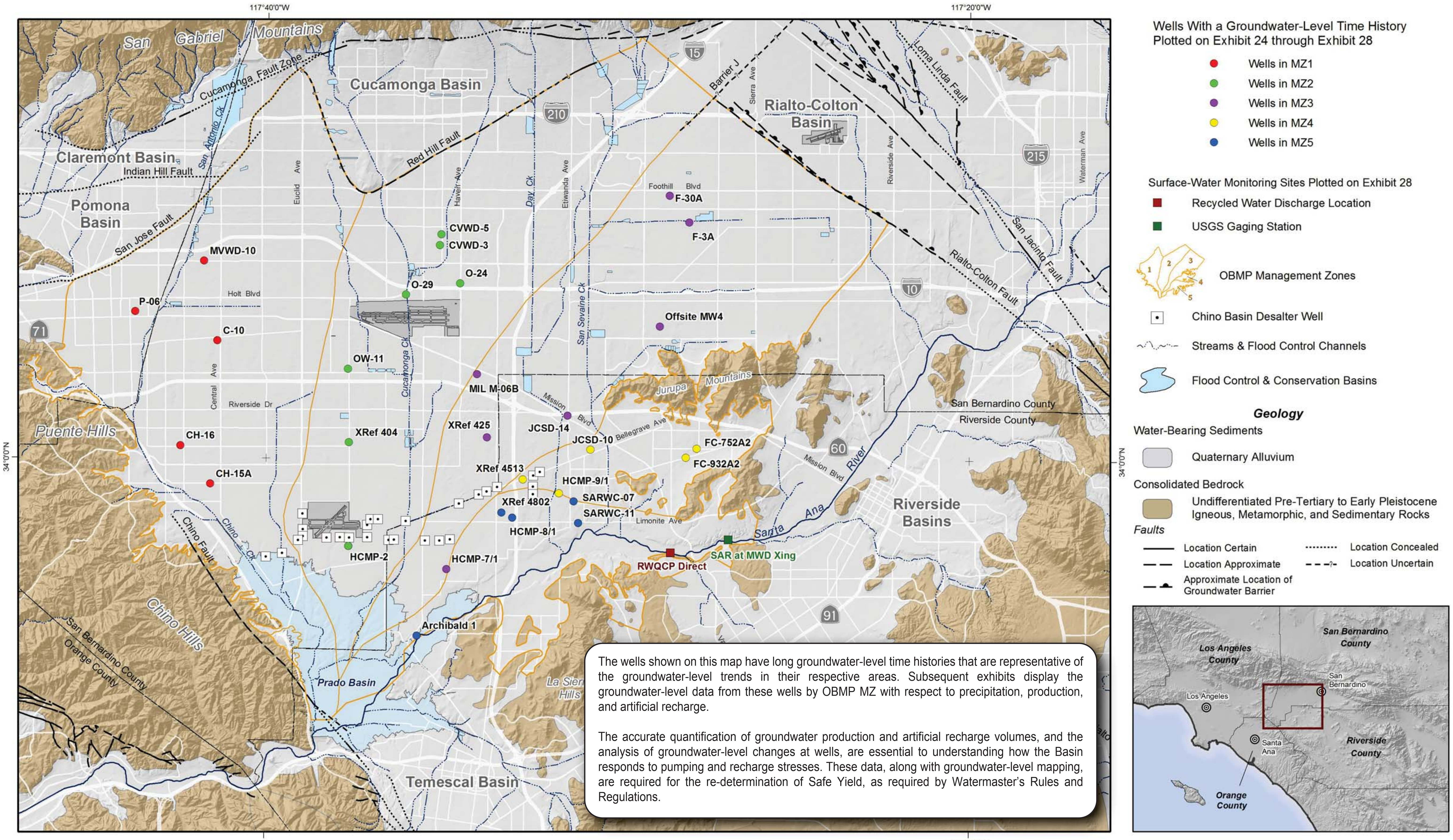
0 1 2 Miles
0 1 2 3 KM

2014 State of the Basin
Groundwater Levels

State of Hydraulic Control in Spring 2014

Shallow Aquifer System

Exhibit 22



The wells shown on this map have long groundwater-level time histories that are representative of the groundwater-level trends in their respective areas. Subsequent exhibits display the groundwater-level data from these wells by OBMP MZ with respect to precipitation, production, and artificial recharge.

The accurate quantification of groundwater production and artificial recharge volumes, and the analysis of groundwater-level changes at wells, are essential to understanding how the Basin responds to pumping and recharge stresses. These data, along with groundwater-level mapping, are required for the re-determination of Safe Yield, as required by Watermaster's Rules and Regulations.

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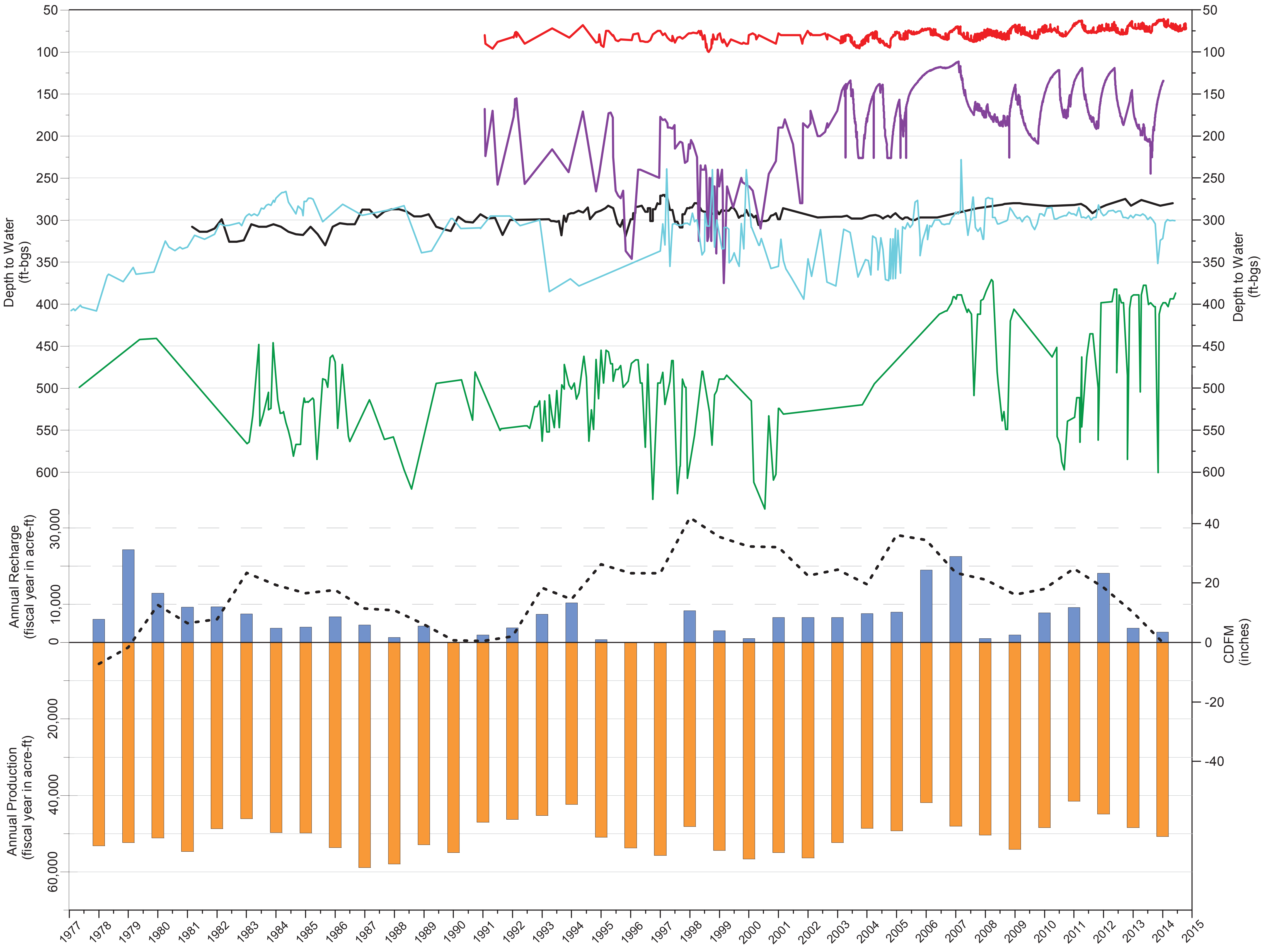
0 1 2 3 4 5 Miles
0 2 4 6 8 KM

2014 State of the Basin
Groundwater Levels

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

Exhibit 23



This time-series chart displays groundwater levels at wells, annual production, and annual artificial recharge to basins in MZ1 for the time period since the Judgment to FY 2013/2014. Climate is displayed as a CDFM precipitation plot using PRISM climate data from 1895 to 2014. Upward sloping lines on the CDFM curve indicate wet years or wet periods. Downward sloping lines indicate dry years or dry periods.

Water levels at wells MVWD-10, P-06, and C-10 are representative of groundwater-level trends in the central and northern portions of MZ1. From about 1995 to 2003, water levels generally declined in these areas due to increased production and relatively small volumes of wet-water recharge in MZ1. From about 2003 to 2014, water levels increased and then stabilized due to a decrease in production and an increase in artificial recharge. The changes in water levels in the central and northern portions of MZ1 since 2003 coincide with a dry period and the "put and take" cycle associated with Metropolitan Water District of Southern California's Dry-Year Yield storage program in Chino Basin.

Water levels at well CH-16 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 land subsidence (WEI, 2007b), and have remained relatively stable since.

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 have been stable, from 80 to 90 ft-bgs, and showed only small fluctuations in response to nearby pumping. Since 2000, water levels have risen by about 15 feet, which is primarily due to a decrease in local pumping.

Since 2000, groundwater levels in MZ1 have generally increased even though this was a relatively dry period. This groundwater-level recovery in MZ1 is due to decreased groundwater production and increased artificial recharge of supplemental water. The availability of recycled water during this period played an important role in both the decreased groundwater production and the increased artificial recharge in MZ1.

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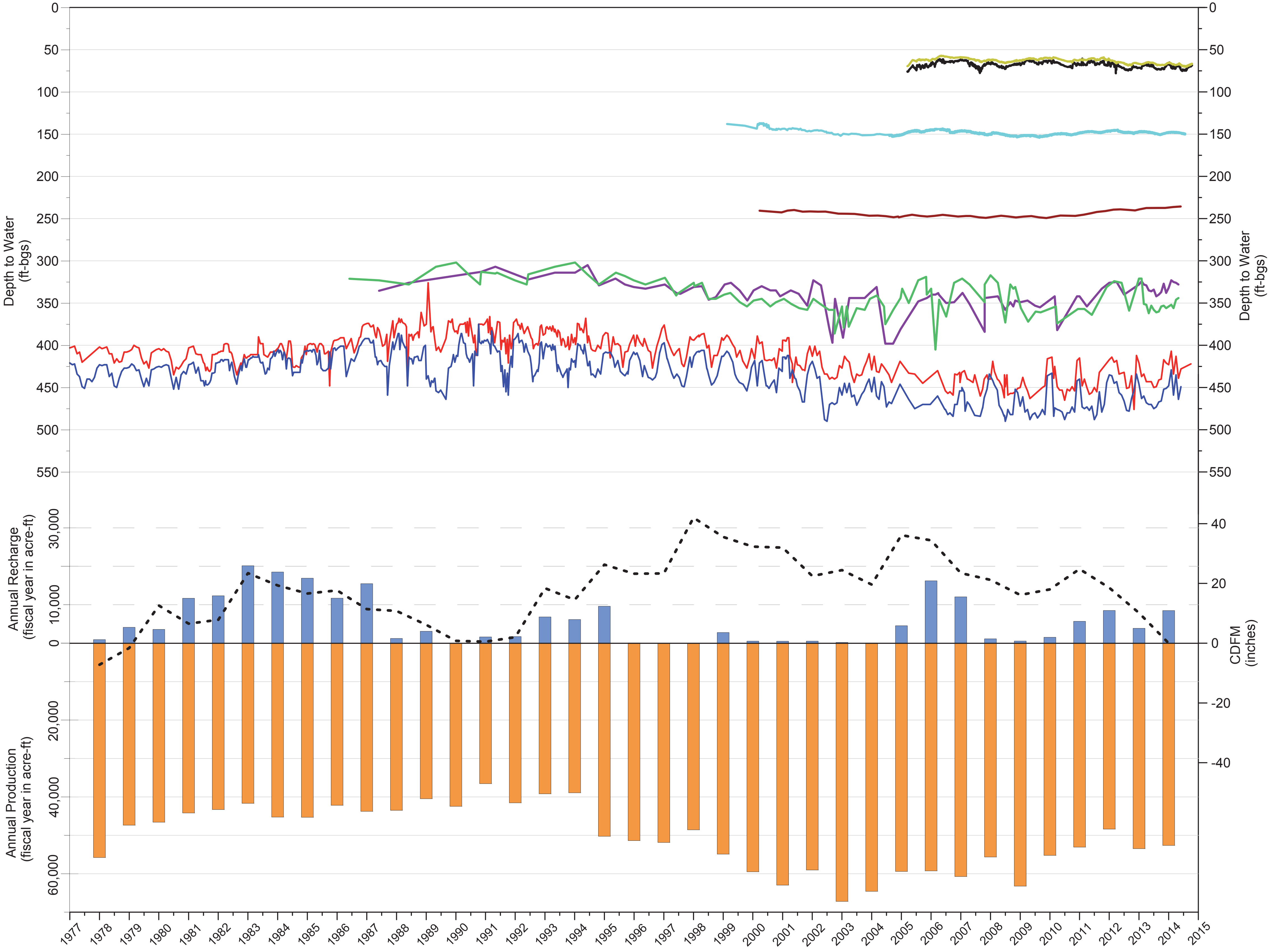
File: Exhibit_24.grf

2014 State of the Basin
Groundwater Levels

Time-Series Chart of Groundwater Levels, Production, Recharge, and Climate – MZ1
1978 to 2014

Exhibit 24



This time-series chart displays groundwater levels at wells, annual production, and annual artificial recharge in MZ2 for the time period since the Judgment to FY 2013/2014. Climate is displayed as a CDFM precipitation plot using PRISM climate data from 1895 to 2014. Upward sloping lines on the CDFM curve indicate wet years or wet periods. Downward sloping lines indicate dry years or dry periods.

Water levels at wells CVWD-3 and CVWD-5 are representative of groundwater-level trends in the northern portions 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 in this portion of MZ2 progressively declined by about 50 feet due to increased production in the region. From 2010 to 2014, water levels increased slightly, likely due to decreased production and increased recharge at the San Sevaine and Victoria basins.

Water levels at wells O-29 and O-24 are representative of groundwater-level trends in the upper-central portion of MZ2. The groundwater levels at O-29 and O-24 followed a similar pattern as groundwater levels at the wells in the northern portion of MZ2.

Water level data at wells OW-11 and XRef 404 (private well) are representative of trends in the lower-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 the all the recharge basins in MZ2 and north of the Chino Basin Desalter wells. From 2000 to 2004, water levels at both wells slightly decreased— this is likely due to a combination of a dry period, an increase in production in MZ2, and limited artificial recharge at this time in MZ2. From 2005 to 2014, water levels overall increased at OW-11 about ten feet— this can likely be related to increased recharge at the Ely Basins and other recharge basins in MZ2 for the Chino Basin Groundwater Recharge Program. From 2005 to 2014 water levels at XRef 404 fluctuated within about ten feet, and slightly decreased overall during 2012 to 2014.

Water levels at wells HCMP-2/1 (shallow aquifer) and HCMP-2/2 (deep aquifer) are representative of groundwater-level trends at the southern portion of MZ2, just south of the Chino-I Desalter wells. One of the objectives of the desalter well field is to cause the drawdown of groundwater levels in the southern portion of Chino Basin to achieve Hydraulic Control. See Exhibits 21 and 22 for further explanation of Hydraulic Control. The Chino-I Desalter well field began pumping in late 2000 and production steadily increased until 2008. From 2005 to 2011 there was no notable groundwater-level drawdown at the HCMP-2/1 and HCMP-2/2 monitoring wells since their construction in 2005. However from 2012 to 2014 water levels declined about five feet in both the shallow and deep aquifer monitoring wells of HCMP-2.

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Groundwater Levels at Wells (Perforated Interval Depth)

- CVWD-5 (538-1,238 ft-bgs)
- CVWD-3 (341-810 ft-bgs)
- O-29 (400-1,095 ft-bgs)
- O-24 (484-952 ft-bgs)
- OW-11 (323-333 ft-bgs)
- XRef 404 (274-354 ft-bgs)
- HCMP-2/2 (296-316 ft-bgs)
- HCMP-2/1 (124-164 ft-bgs)

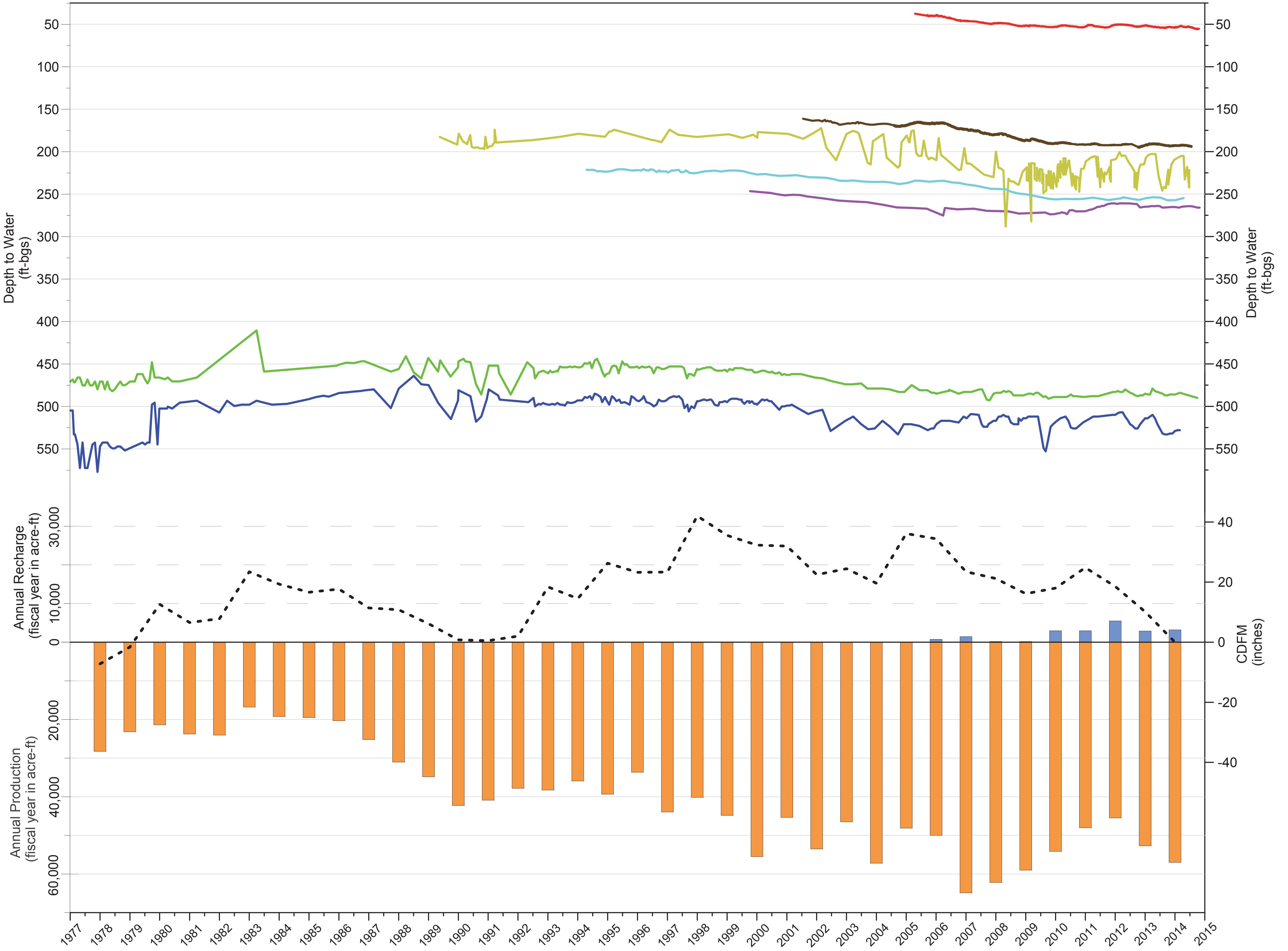
Production, Recharge, and Precipitation

- Recharge of Imported Water and Recycled Water at Basins in MZ2
- Groundwater Production from Wells in the MZ2
- CDFM Precipitation Plot - Data from PRISM 4-km grid for 1895-2014; Spatial Average for Chino Basin

2014 State of the Basin
Groundwater Levels

Time-Series Chart of Groundwater Levels, Production, Recharge, and Climate – MZ2
1978 to 2014

Exhibit 25



This time-series chart displays groundwater levels at wells, annual production, and annual artificial recharge to basins, in MZ3, for the time period since the Judgment to FY 2013/2014. Climate is displayed as a CDFM precipitation plot using PRISM climate data from 1895 to 2014. Upward sloping lines on the CDFM curve indicate wet years or wet periods. Downward sloping lines indicate dry years or dry periods.

Water levels at wells F-30A and F-3A are representative of groundwater-level trends in the northeastern portions of MZ3. Water levels were relatively stable from 1978 to about 1995. From 1995 to 2007, water levels declined by approximately 25-30 feet due to a dry climatic period and increased pumping in MZ3. Since 2007, water levels have remained relatively stable through about 2011, and slightly declined about ten feet during 2012 through 2014.

Water levels at wells Offsite MW4, Mill M-06B, JCSD-14, and XRef 425 (private well) are representative of groundwater-level trends in the central portion of MZ3. From about 1998 to 2010, water levels at these wells progressively declined by about 30 feet due to a dry climatic period and increased pumping in MZ3. From 2010 to 2014, water levels at Mill M-06B, JCSD-14, and XRef 425 have remained relatively stable. Water levels at Offsite MW4 increased by about 10 feet from 2010 to 2012, and have remained stable since. The water level increase seen at Offsite MW4 is likely due to improvements to, and the increase of, storm water and recycled water recharge at the RP3 recharge basins.

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. From 2005 to 2014, water levels at this well progressively declined by about 15 feet. This decline in groundwater levels is mainly due to pumping at the Chino-II Desalter and is necessary for Hydraulic Control to be achieved in this portion of the Chino Basin; and to enhance recharge of the Santa Ana River to the Chino Basin. See Exhibits 21 and 22 for further explanation of Hydraulic Control.

Since 2000, generally in MZ3 groundwater levels have decreased, annual production has increased, and annual recharge has increased. The period of 2000 to 2014 was relatively dry—as the CDFM precipitation plot indicates.

Prepared by:

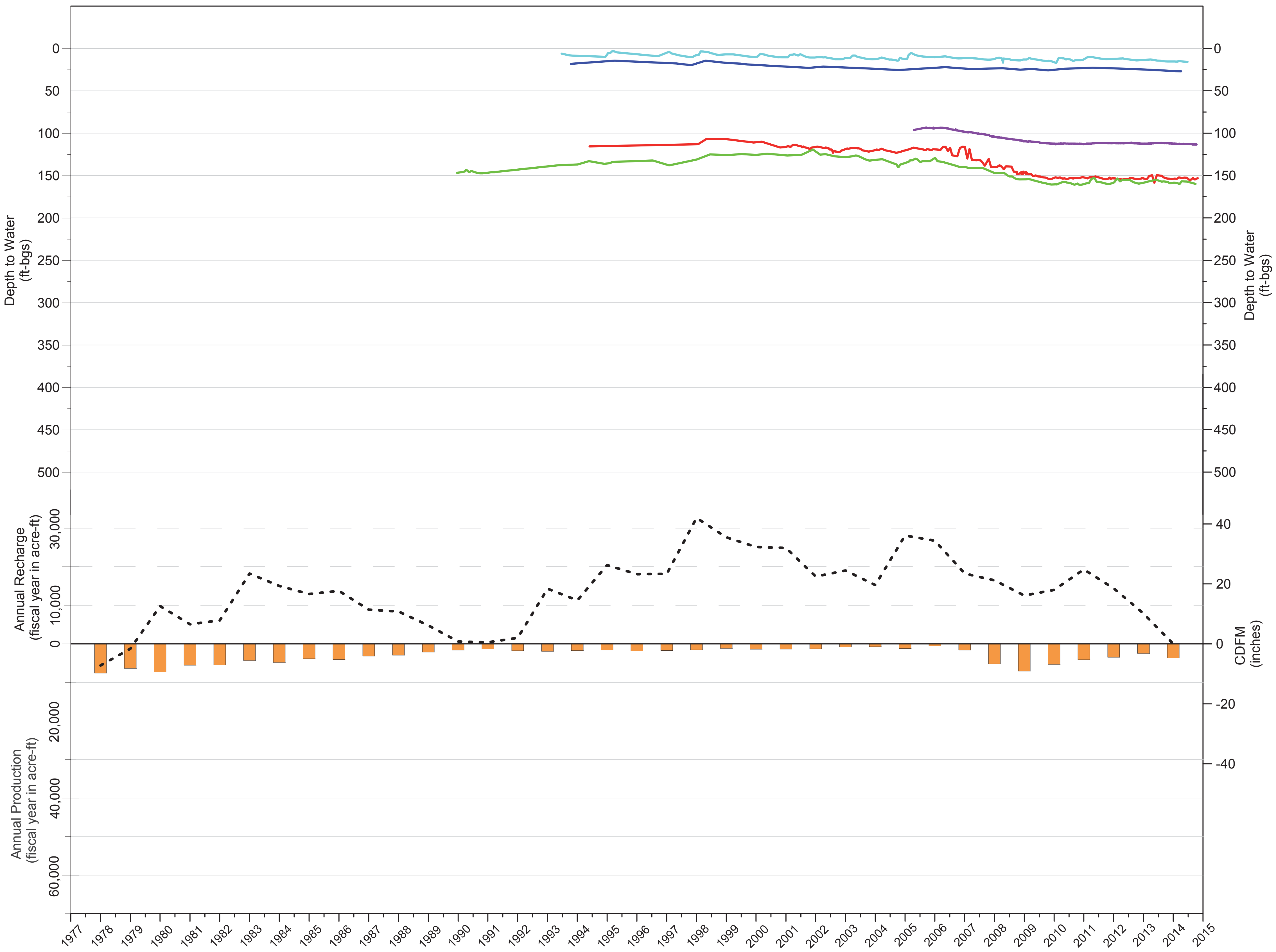
WEI
Wildermuth Environmental, Inc.

Author: NWS
Date: 06/09/2015
File: Exhibit_26.grf

2014 State of the Basin
Groundwater Levels

Time-Series Chart of Groundwater Levels, Production, Recharge, and Climate – MZ3
1978 to 2014

Exhibit 26



This time-series chart displays groundwater levels at wells, annual production, and annual artificial recharge to basins in MZ4 for the time period since the Judgment to FY 2013/2014. Climate is displayed as a CDFM precipitation plot using PRISM climate data from 1895 to 2014. Upward sloping lines on the CDFM curve indicate wet years or wet periods, and downward sloping lines indicate dry years or dry periods.

Water levels at wells JCSD-10, XRef 4513 (private well), and HCMP-9/1 are representative of groundwater-level trends in the western portion of MZ4—in the vicinity of the major well fields of the Jurupa Community Services District (JCSD) and the Chino-II Desalter. Water levels at JCSD-10 and XRef 4513 began to decrease around 2000 and show a notable acceleration in the decline of groundwater-levels around 2006 when pumping at Chino-II Desalter wells commenced. A similar decrease is seen in HCMP-9/1, where water levels decreased by about 20 feet since the well's construction in 2005. Overall in this portion of MZ4, water levels have decreased by about 35 feet since 2000 due to a dry climatic period and increased pumping. The decline of groundwater levels seen at the wells in the western portion of MZ4 is necessary for Hydraulic Control to be achieved in this portion of the Chino Basin. See Exhibits 21 and 22 for further explanation of Hydraulic Control. The decline of groundwater levels in this area is also a concern of the JCSD with regard to production sustainability at its wells.

Water levels at wells FC-752A2 and FC-932A2 are representative of groundwater-level trends in the eastern portion of MZ4. From 2000 to 2014, the water levels at these wells declined by about eight feet.

Since 2000 generally in MZ4, groundwater levels have decreased and annual production has increased. The period of 2000 to 2014 was a relatively dry period—as the CDFM precipitation plot indicates.

Prepared by:

WILDERMUTH ENVIRONMENTAL, INC.

Author: NWS
Date: 05/13/2015
File: Exhibit_27.grf

Groundwater Levels at Wells (Perforated Interval Depth)

— JCSD-10 (no perf data)
— XRef 4513 (no perf data)
— HCMP-9/1 (110-150 ft-bgs)
— FC-752A2 (no perf data)
— FC-932A2 (no perf data)

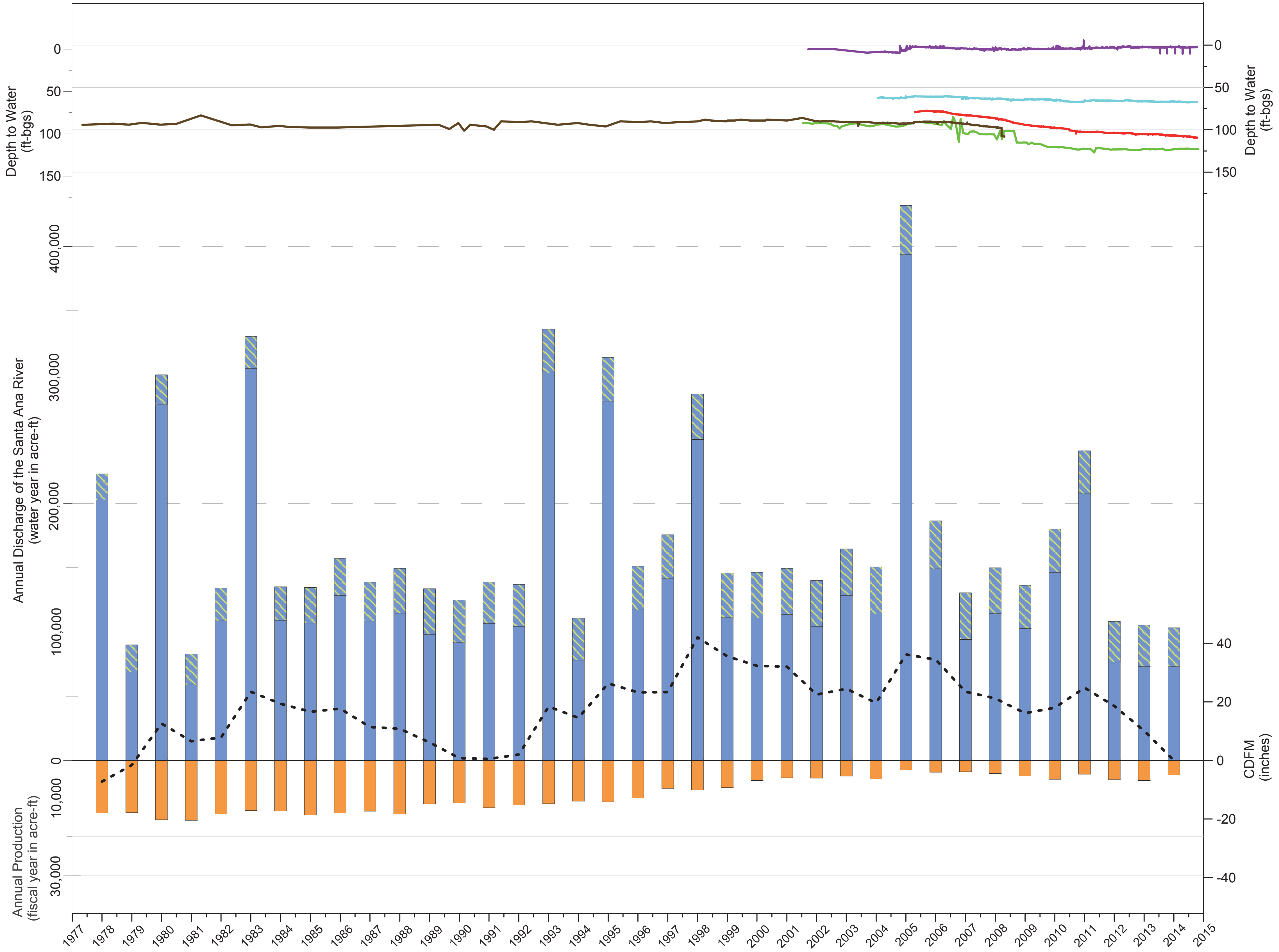
Production, Recharge, and Precipitation

🟦 Recharge of Imported Water and Recycled Water at Basins in MZ4
🟧 Groundwater Production from Wells in the MZ4
⋯ CDFM Precipitation Plot - Data from PRISM 4-km grid for 1895-2014; Spatial Average for Chino Basin

2014 State of the Basin
Groundwater Levels

Time-Series Chart of Groundwater Levels, Production, Recharge, and Climate – MZ4
1978 to 2014

Exhibit 27



This time-series chart displays groundwater levels and annual production at wells in MZ5 and annual discharge of the Santa Ana River through MZ5 for the time period since the Judgment to FY 2013/2014. Total discharge of the Santa Ana River through the MZ5 area is represented by the total flow measured by the USGS at the SAR at MWD Xing station and the total effluent discharged to the Santa Ana River from the City of Riverside's WWTP. Exhibit 23 shows the locations of the SAR at MWD Xing station and the City of Riverside's WWTP discharge location. MZ5 is a groundwater flow system that parallels the Santa Ana River. The discharge of the Santa Ana River shown in this chart represents the total potential volume of Santa Ana River water that can recharge the Chino Basin in MZ5. Climate is displayed as a CDFM precipitation plot using PRISM climate data from 1895 to 2014. Upward sloping lines on the CDFM curve indicate wet years or wet periods. Downward sloping lines indicate dry years or dry periods.

Water levels at wells XRef 4802 (private well), SARWC-07, SARWC-11, and HCMP-8/1 are representative of groundwater levels in the eastern portion of MZ5, where the Santa Ana River is recharging the Chino Basin. From 2005 to 2014, water levels at these wells progressively declined by about 5 to 30 feet. This decline of groundwater-levels is consistent with increased pumping at the Chino Basin Desalter well field and is a necessary occurrence to achieve Hydraulic Control in this portion of the Chino Basin. This decline of groundwater-levels also indicates that recharge of the Santa Ana River to the Chino Basin is being enhanced in this vicinity. See Exhibits 21 and 22 for further explanation of Hydraulic Control.

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 and could be rising to become flow in the Santa Ana River. Water levels at this near-river well have remained relatively stable since monitoring began in 2000.

Prepared by:

WEI
Wildermuth Environmental, Inc.

Author: NWS
Date: 05/13/2015
File: Exhibit_28.grf

Groundwater Levels at Wells (Perforated Interval Depth)

- — XRef 4802 (no perf data)
- — SARWC-07 (100-172 ft-bgs)
- — HCMP-8/1 (75-115 ft-bgs)
- — SARWC-11 (75-230 ft-bgs)
- — Archibald 1 (75-85 ft-bgs)

Production, Recharge, and Precipitation

- 🟦 Flow of the *Santa Ana River at MWD Xing*
- ▨ Discharge from the City of Riverside WWTP
- 🟧 Groundwater Production from Wells in the MZ5
- ⋯ CDFM Precipitation Plot - Data from PRISM 4-km grid for 1895-2014; Spatial Average for Chino Basin

2014 State of the Basin
Groundwater Levels

Time-Series Chart of Groundwater Levels, Production, Recharge, and Climate – MZ5
1978 to 2014

Exhibit 28

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 some data 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 OBMP implementation *Program Element 1 – Develop and Implement a Comprehensive Monitoring Program,* Watermaster began conducting a more robust water quality monitoring program in 1999. The Groundwater Quality Monitoring Program relies on well owners or their consultants to sample for water quality and provide that data to Watermaster on a routine cooperative basis, and Watermaster supplements with groundwater-quality data obtained from its own sampling programs. Watermaster obtains groundwater-quality data in the Chino Basin through the following programs:

- **Annual Key Well Groundwater Quality Monitoring Program.** Historically, available water-quality data were very limited for the private wells in the southern portion of the Basin. In 1999, the comprehensive monitoring program initiated the systematic sampling of private wells south of State Route 60 in the Chino Basin. Over a three-year period from 1999 to 2001, Watermaster sampled all available wells at least once to develop a robust baseline dataset. This program has since been reduced to approximately 110 key wells, located predominantly in the southern portion of the Basin: 90 wells are sampled on a triennial basis, and 20 are sampled on an annual basis.
- **Hydraulic Control Monitoring Program (HCMP).** Watermaster collects annual groundwater quality samples from the nine nested HCMP monitoring wells for the demonstration of Hydraulic Control. Each nest contains up to three wells in the borehole. In addition, Watermaster collects quarterly samples from four near-river wells to characterize the interaction of the Santa Ana River and groundwater. These shallow monitoring wells along the Santa Ana River consist of two former US Geological Survey (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).
- **Chino Basin Data Collection (CBDC).** Watermaster routinely and proactively collects groundwater-quality data from well owners, such as municipal producers and other government agencies. Groundwater-quality data are also obtained from special studies and monitoring that takes place under the orders of the RWQCB (landfills, groundwater quality investigations, *etc.*), the Department of Toxic Substances Control (DTSC) for the Stringfellow National Priorities List (NPL) site, the USGS, and others. These data are collected from the well owners and monitoring entities twice per year.

All groundwater-quality data are checked by Watermaster staff and uploaded to a centralized database management system that can be accessed online through HydroDaVE^{SM}. Groundwater-quality data collected by Watermaster are used for: this biennial State of the Basin report; the triennial ambient water quality update; and the demonstration of Hydraulic Control—the latter two are Watermaster and the IEUA maximum-benefit commitments in the Basin Plan. Groundwater-quality data are also used by Watermaster to analyze nonpoint-source groundwater contamination, and plumes associated with point-source discharges, to assess the overall health of the groundwater basin, and are used in conjunction with numerical models to assist Watermaster and other parties in evaluating proposed groundwater remediation strategies.

Exhibit 29 shows all wells with groundwater-quality monitoring results for the five-year period from July 2009 to June 2014. All available groundwater-quality data for this period were analyzed synoptically and temporally at all production and monitoring wells. The analysis does not represent a programmatic investigation of potential sources of chemical constituents in the Basin nor does it represent a randomized study designed to ascertain the water quality status of the Chino Basin. These data do, however, represent the most comprehensive information available to date.

All groundwater-quality data from the Chino Basin for the five-year period of July 2009 through June 2014 were analyzed for exceedances of Primary or Secondary, Federal or State, Maximum Contaminant Levels (MCLs), or State Notification Levels (NLs). Wells with constituent concentrations greater than half the MCL represent areas that warrant concern. Understanding the spatial distribution of wells with concentrations greater than regulatory standards is important because it indicates areas in the Basin where groundwater may be impaired from a beneficial use standpoint. Exhibits 30 through 41 show the areal distribution of constituent concentrations for constituents of potential concern (COPC) in the Chino Basin. The COPCs in the Chino Basin are defined as follows:

- Constituents associated with salt and nutrient management planning, which are primarily total dissolved solids (TDS) and nitrate.
- Other constituents where a primary MCL was exceeded in twenty or more wells from July 2009 to June 2014 and are not primarily exclusive to one particular point source (*i.e.*, the Stringfellow NPL Site, these include nitrate, perchlorate, total chromium, hexavalent chromium, arsenic, trichloroethene (TCE), tetrachloroethene (PCE), *cis*-1,2-dichloroethene (*cis*-1,2DCE), 1,1-dichloroethene (1,1-DCE), and 1,1-dichloroethane (1,1-DCA).
- Constituents for which the California DDW is in the process of developing an MCL that may impact future beneficial use of groundwater, this includes 1,2,3-trichloropropane (1,2,3-TCP).

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 study period. The following class interval convention is applied to each water quality standard:

Symbol	Class Interval
○	Not Detected
🔵	<0.5x WQS[3], but detected
🟢	0.5x WQS to WQS
🟡	WQS to 2x WQS
🟠	2x WQS to 4x WQS
🔴	> 4x WQS

---

[3] Where WQS is the appropriate water quality standard.

Exhibit 42 shows the locations of various known point-source discharges to groundwater and the associated areas of degradation. Understanding point sources of concern in the Chino Basin 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. If-needed, Watermaster will work with the RWQCB and the potentially responsible parties (PRPs) in determining sources of groundwater-quality contamination and assist with establishing a cleanup strategy. The following is a summary of all the regulatory and voluntary groundwater-quality contamination monitoring in the Chino Basin that are tracked by Watermaster:

- **Plume:** Alumax Aluminum Recycling Facility
  Constituents of Concern: TDS, sulfate, nitrate, chloride
  Order: RWQCB Cleanup and Abatement Order 99-38

- **Plume:** Alger Manufacturing Co.
  Constituents of Concern: volatile organic chemicals (VOCs)
  Order: Voluntary Cleanup and Monitoring

- **Plume:** Chino Airport
  Constituents of Concern: VOCs
  Order: RWQCB Cleanup and Abatement Order 90-134

- **Plume:** California Institute for Men (No Further Action status, as of 2/17/2009)
  Constituents of Concern: VOCs
  Order: Voluntary Cleanup and Monitoring

- **Plume:** Former Crown Coach International Facility
  Constituents of Concern: VOCs and Solvents
  Order: Voluntary Cleanup and Monitoring

- **Plume:** General Electric Flatiron Facility
  Constituents of Concern: VOCs and hexavalent chromium
  Order: Voluntary Cleanup and Monitoring

- **Plume: General Electric Test Cell Facility**
  Constituents of Concern: VOCs
  Order: Voluntary Cleanup and Monitoring

- **Plume:** 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.

- **Plume:** Former Kaiser Steel Mill – CCG Property
  Constituents of Concern: chromium, hexavalent chromium, other metals, VOCs
  Order: DTSC Consent Order 00/01-001

- **Plume:** Milliken Sanitary Landfill
  Constituents of Concern: VOCs
  Order: RWQCB Order No. 81-003

- **Plume:** Upland Sanitary Landfill
  Constituents of Concern: VOCs
  Order RWQCB Order No 98-99-07

- **Plume:** South Archibald Plume
  Constituents of Concern: (VOCs)
  Order: This plume is currently being voluntarily investigated by a group of potentially responsible parties per seven Draft Cleanup and Abatement Orders

- **Plume:** 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.

Groundwater-quality data collected from Watermaster's sampling programs, from other special studies, and from monitoring in the Basin under the orders of the RWQCB or DTSC are used by Watermaster to delineate plumes associated with VOC contamination every two years. Exhibit 42 shows the extent of contamination associated with the VOC plumes as of June 2014. The VOC plumes illustrate the estimated spatial extent of TCE or PCE, depending on the main constituent of concern. The methods employed to create these depictions are described on each exhibit. Exhibits 43 and 44 show more detailed delineations of the Chino Airport plume and the South Archibald plume, respectively. Because the extensive multi-depth groundwater quality monitoring completed in the Chino Airport region, Exhibit 43 shows Chino Airport plume delineation in the shallow and deep aquifers.

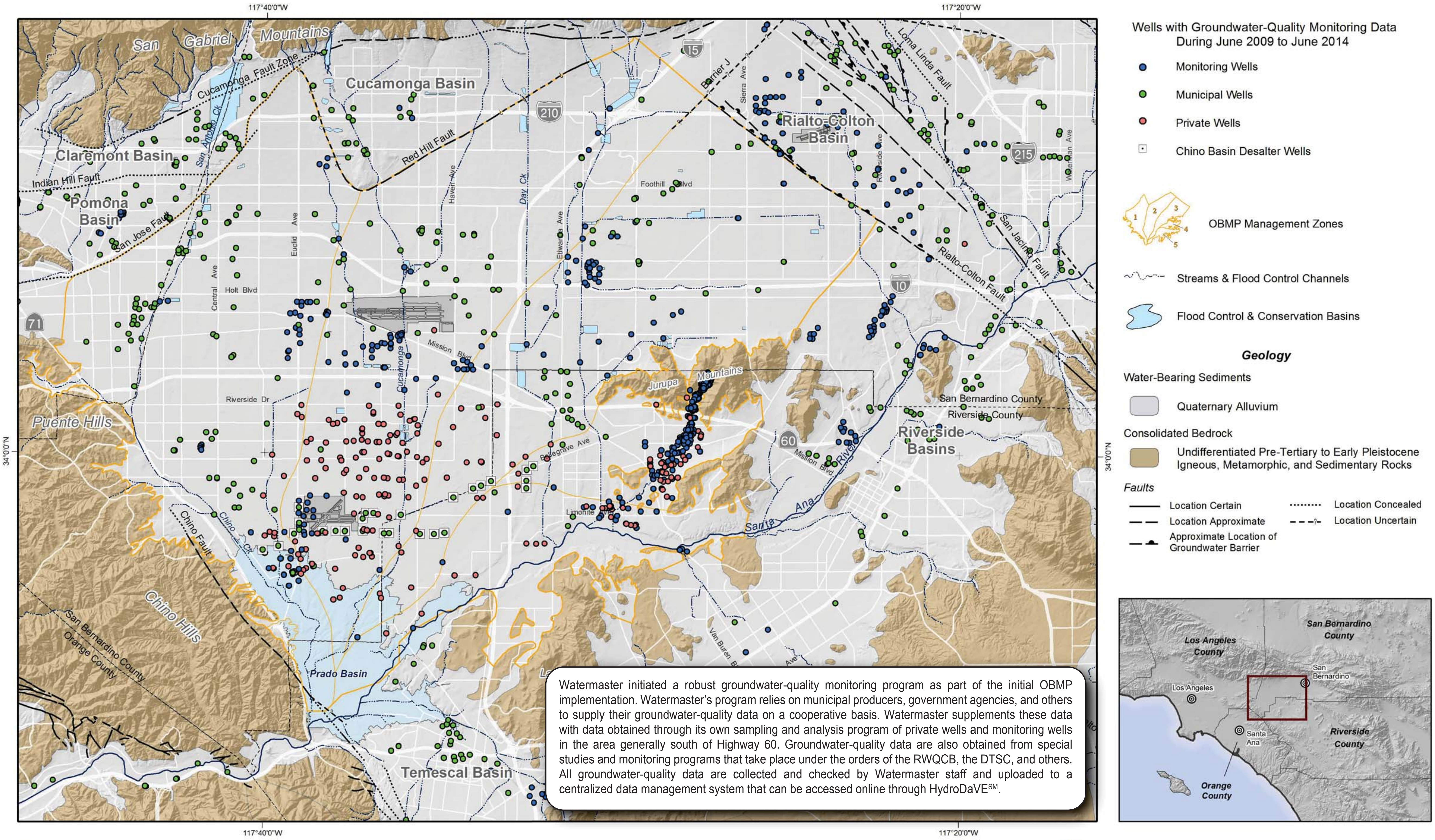
Exhibit 45 shows the VOC plumes and features pie charts that display the relative percent of TCE, PCE, and other VOCs detected at wells within the plume impacted areas. The pie charts demonstrate the chemical differentiation between the VOC plumes in the Chino Basin.

Exhibit 46 shows all GeoTracker and EnviroStor sites in the Chino Basin as of 2014. GeoTracker is the State Board's online data-management system for compliance data from contamination 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 thorough review of the GeoTracker and EnviroStor databases to identify sites in the Chino Basin that have impacted groundwater quality but have not been previously tracked by the Watermaster. There are 22 open sites and 24 closed sites with confirmed or potential impacts to groundwater quality on the GeoTracker and Envirostor databases where the groundwater data will be incorporated into the CBDC groundwater-quality program. Groundwater-quality for the open sites will be routinely collected for the CBDC program. Watermaster will continue to review the GeoTracker and Envirostror databases to track previously identified sites, identify new sites with potential or confirmed groundwater contamination, and add any new data to Watermaster's databases.

The remaining exhibits in this section display the overall state of groundwater quality in the Basin with respect to TDS and nitrate concentrations.

Exhibits 47 and 48 show trends in the ambient water quality determinations for TDS and nitrate by management zone and the associated anti-degradation and maximum-benefit water quality objectives. The maximum-benefit objectives established in the Basin Plan (RWQCB, 2004) raised the TDS and nitrate objectives for the Chino-North Management Zone (combined MZ1, MZ2, and MZ3 above Prado Basin). These "maximum-benefit" water quality objectives were based on the additional consideration of factors specified in California Water Code Section 13241 and the requirements of the State's Antidegradation Policy (SWRCB Resolution No. 68-16), which requires a demonstration that the change in the objective will be "[…] consistent with maximum benefit to the people of the State, will not unreasonably affect present and anticipated beneficial use of such water and will not result in water quality less than that prescribed in the policies." The application of the maximum-benefit objectives is contingent upon the implementation of specific projects and programs by Watermaster and the IEUA. These projects and programs, termed the "Chino Basin maximum-benefit commitments," are described in the Maximum Benefit Implementation Plan for Salt Management in the Basin Plan. The maximum-benefit objectives have allowed for more efficient and pragmatic water supply planning and salt/nutrient management.

Exhibits 49 through Exhibit 56 show TDS and nitrate time histories for selected wells from 1970 to 2014. These time histories illustrate groundwater-quality variations and trends within each management zone and the current state of groundwater quality compared to those historical trends. The wells were selected based on location, length of record, quality of data, geographical distribution, and screened intervals. Wells are identified by their local name (usually owner abbreviation and well number) or X Reference ID (XRef) if privately owned. The time histories also display the State of California MCL.



Watermaster initiated a robust groundwater-quality monitoring program as part of the initial OBMP implementation. Watermaster's program relies on municipal producers, government agencies, and others to supply their groundwater-quality data on a cooperative basis. Watermaster supplements these data with data obtained through its own sampling and analysis program of private wells and monitoring wells in the area generally south of Highway 60. Groundwater-quality data are also obtained from special studies and monitoring programs that take place under the orders of the RWQCB, the DTSC, and others. All groundwater-quality data are collected and checked by Watermaster staff and uploaded to a centralized data management system that can be accessed online through HydroDaVE℠.

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Date: 6/24/2015
Document Name: Exhibit_29_WQ_Wells

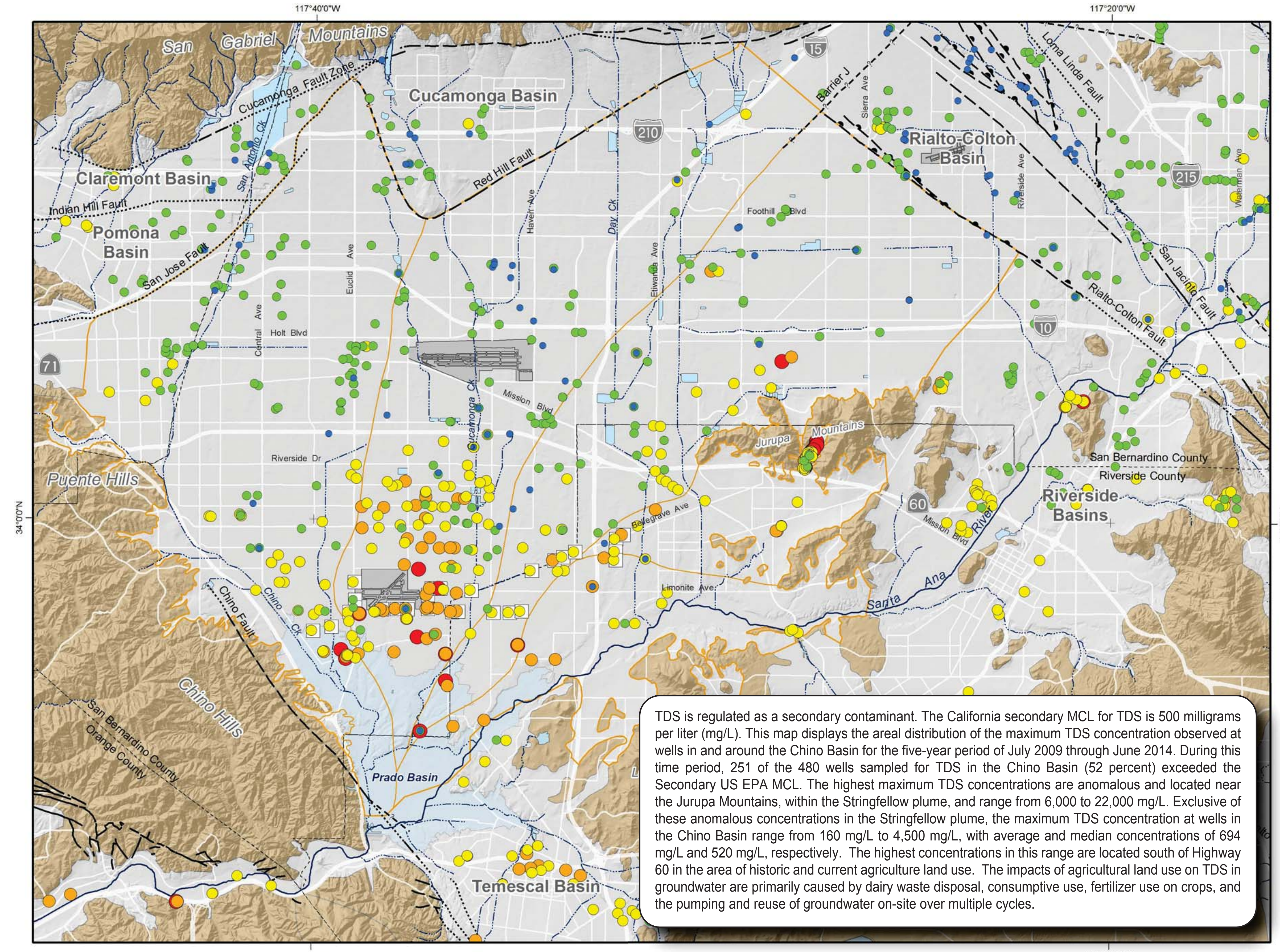
0 2 4 Miles
0 3 6 KM

2014 State of the Basin
Groundwater Quality

Wells with Groundwater Quality Data

July 2009 to June 2014

Exhibit 29



TDS is regulated as a secondary contaminant. The California secondary MCL for TDS is 500 milligrams per liter (mg/L). This map displays the areal distribution of the maximum TDS concentration observed at wells in and around the Chino Basin for the five-year period of July 2009 through June 2014. During this time period, 251 of the 480 wells sampled for TDS in the Chino Basin (52 percent) exceeded the Secondary US EPA MCL. The highest maximum TDS concentrations are anomalous and located near the Jurupa Mountains, within the Stringfellow plume, and range from 6,000 to 22,000 mg/L. Exclusive of these anomalous concentrations in the Stringfellow plume, the maximum TDS concentration at wells in the Chino Basin range from 160 mg/L to 4,500 mg/L, with average and median concentrations of 694 mg/L and 520 mg/L, respectively. The highest concentrations in this range are located south of Highway 60 in the area of historic and current agriculture land use. The impacts of agricultural land use on TDS in groundwater are primarily caused by dairy waste disposal, consumptive use, fertilizer use on crops, and the pumping and reuse of groundwater on-site over multiple cycles.

Total Dissolved Solids (TDS)
(mg/L)

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

Secondary US EPA MCL = 500 mg/L

OBMP Management Zones

Chino Basin Desalter Well

Streams & Flood Control Channels

Flood Control & Conservation Basins

Geology

Water-Bearing Sediments

Quaternary Alluvium

Consolidated Bedrock

Undifferentiated Pre-Tertiary to Early Pleistocene Igneous, Metamorphic, and Sedimentary Rocks

Faults

- Location Certain
- Location Approximate
- Approximate Location of Groundwater Barrier
- Location Concealed
- Location Uncertain

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Author: JMS
Date: 6/23/2015
Document Name: Exhibit_30_TDS

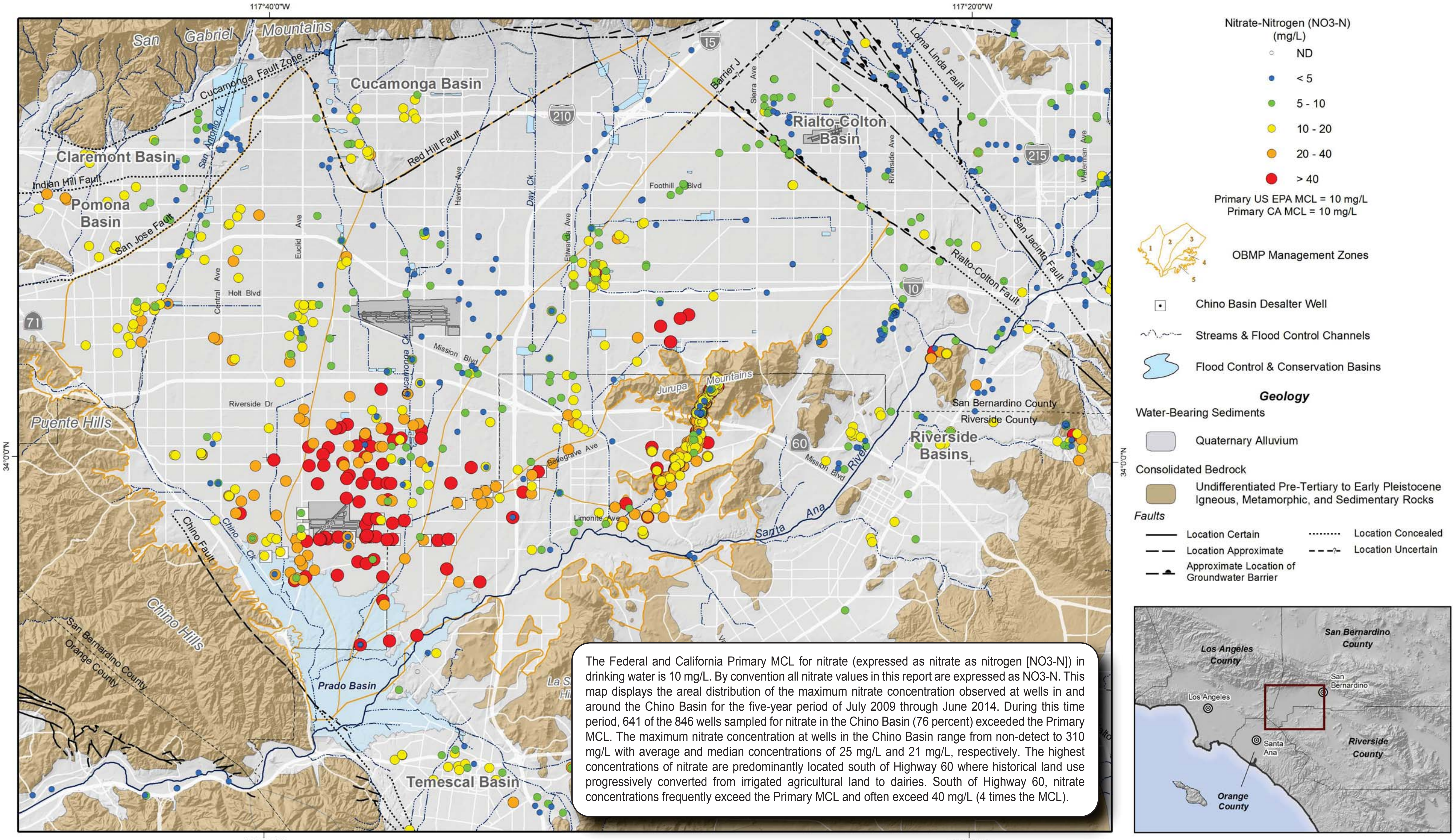
0 2 4 Miles
0 3 6 KM

2014 State of the Basin
Groundwater Quality

Total Dissolved Solids (TDS) in Groundwater

Maximum Concentration (July 2009 to June 2014)

Exhibit 30



The Federal and California Primary MCL for nitrate (expressed as nitrate as nitrogen [NO3-N]) in drinking water is 10 mg/L. By convention all nitrate values in this report are expressed as NO3-N. This map displays the areal distribution of the maximum nitrate concentration observed at wells in and around the Chino Basin for the five-year period of July 2009 through June 2014. During this time period, 641 of the 846 wells sampled for nitrate in the Chino Basin (76 percent) exceeded the Primary MCL. The maximum nitrate concentration at wells in the Chino Basin range from non-detect to 310 mg/L with average and median concentrations of 25 mg/L and 21 mg/L, respectively. The highest concentrations of nitrate are predominantly located south of Highway 60 where historical land use progressively converted from irrigated agricultural land to dairies. South of Highway 60, nitrate concentrations frequently exceed the Primary MCL and often exceed 40 mg/L (4 times the MCL).

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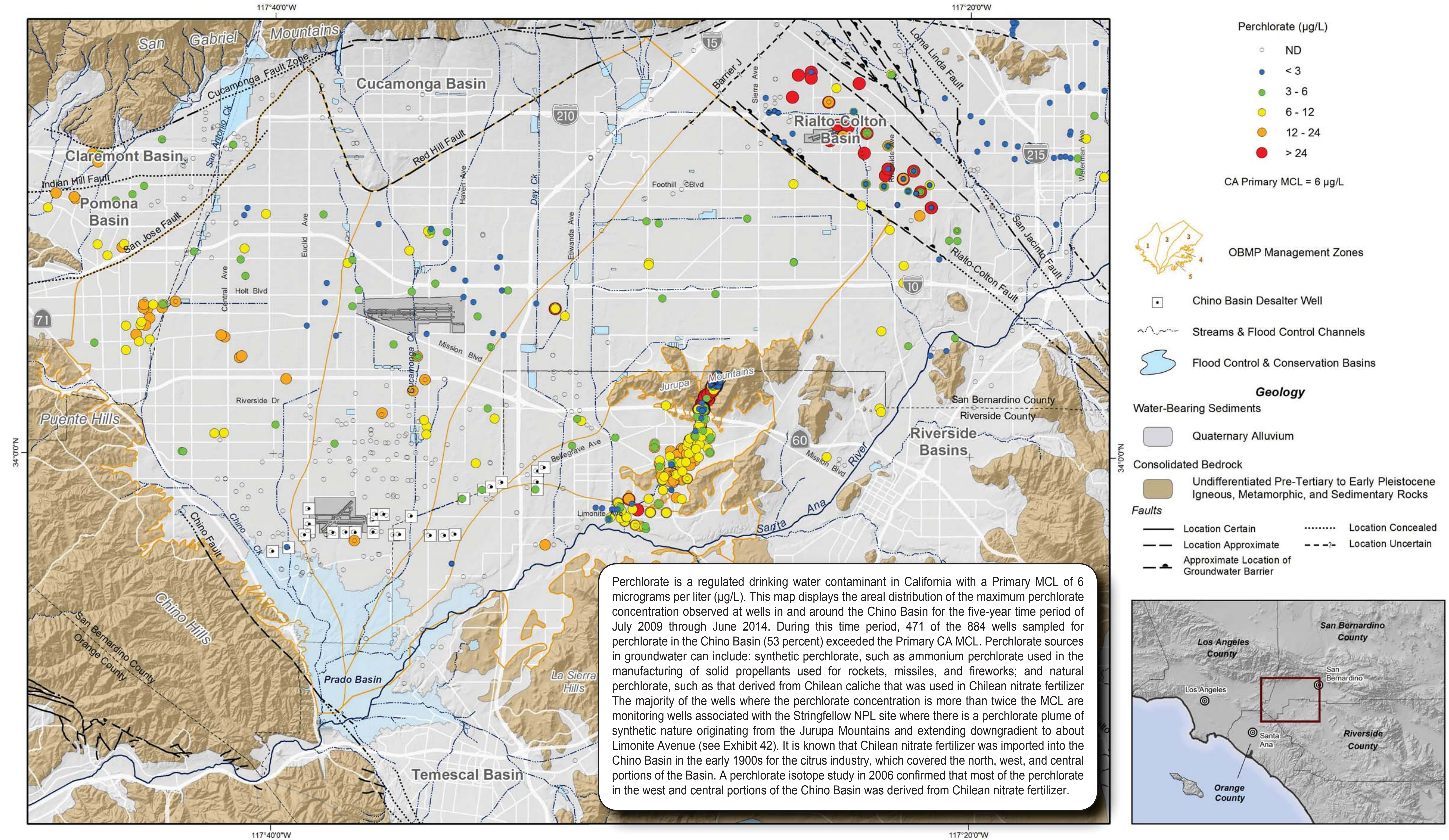
Document Name: Exhibit_31_NO3

2014 State of the Basin
Groundwater Quality

Nitrate as Nitrogen (NO_3-N) in Groundwater

Maximum Concentration (July 2009 to June 2014)

Exhibit 31



Perchlorate is a regulated drinking water contaminant in California with a Primary MCL of 6 micrograms per liter (µg/L). This map displays the areal distribution of the maximum perchlorate concentration observed at wells in and around the Chino Basin for the five-year time period of July 2009 through June 2014. During this time period, 471 of the 884 wells sampled for perchlorate in the Chino Basin (53 percent) exceeded the Primary CA MCL. Perchlorate sources in groundwater can include: synthetic perchlorate, such as ammonium perchlorate used in the manufacturing of solid propellants used for rockets, missiles, and fireworks; and natural perchlorate, such as that derived from Chilean caliche that was used in Chilean nitrate fertilizer The majority of the wells where the perchlorate concentration is more than twice the MCL are monitoring wells associated with the Stringfellow NPL site where there is a perchlorate plume of synthetic nature originating from the Jurupa Mountains and extending downgradient to about Limonite Avenue (see Exhibit 42). It is known that Chilean nitrate fertilizer was imported into the Chino Basin in the early 1900s for the citrus industry, which covered the north, west, and central portions of the Basin. A perchlorate isotope study in 2006 confirmed that most of the perchlorate in the west and central portions of the Chino Basin was derived from Chilean nitrate fertilizer.

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Document Name: Exhibit_32_CLO4

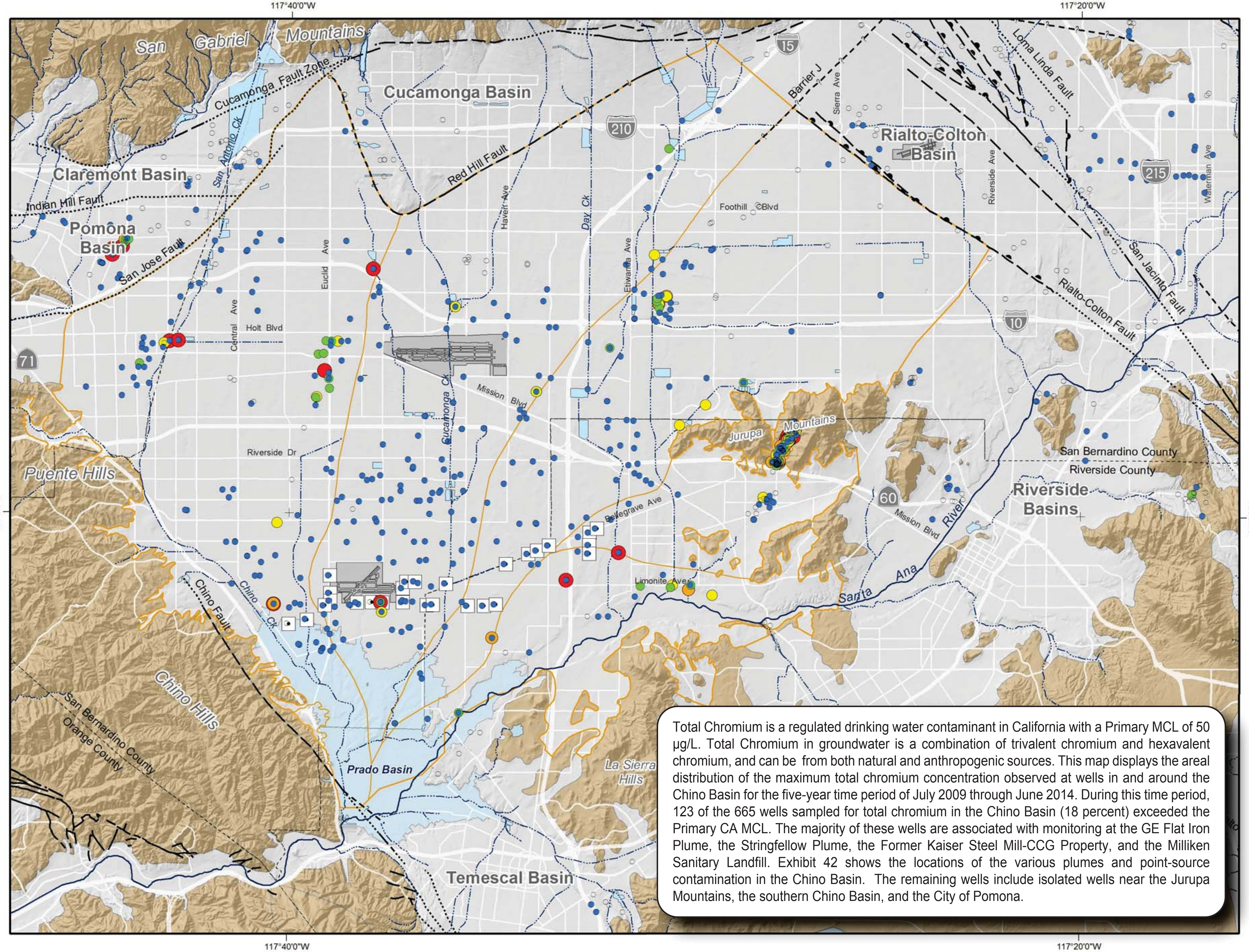
0 2 4 Miles
0 3 6 KM

2014 State of the Basin
Groundwater Quality

Perchlorate in Groundwater

Maximum Concentration (July 2009 to June 2014)

Exhibit 32



Total Chromium is a regulated drinking water contaminant in California with a Primary MCL of 50 µg/L. Total Chromium in groundwater is a combination of trivalent chromium and hexavalent chromium, and can be from both natural and anthropogenic sources. This map displays the areal distribution of the maximum total chromium concentration observed at wells in and around the Chino Basin for the five-year time period of July 2009 through June 2014. During this time period, 123 of the 665 wells sampled for total chromium in the Chino Basin (18 percent) exceeded the Primary CA MCL. The majority of these wells are associated with monitoring at the GE Flat Iron Plume, the Stringfellow Plume, the Former Kaiser Steel Mill-CCG Property, and the Milliken Sanitary Landfill. Exhibit 42 shows the locations of the various plumes and point-source contamination in the Chino Basin. The remaining wells include isolated wells near the Jurupa Mountains, the southern Chino Basin, and the City of Pomona.

Total Chromium (µg/L)

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

Primary US EPA MCL = 100 µg/L
Primary CA MCL = 50 µg/L

OBMP Management Zones

⊡ Chino Basin Desalter Well

Streams & Flood Control Channels

Flood Control & Conservation Basins

Geology

Water-Bearing Sediments

▭ Quaternary Alluvium

Consolidated Bedrock

▨ Undifferentiated Pre-Tertiary to Early Pleistocene Igneous, Metamorphic, and Sedimentary Rocks

Faults

- Location Certain
- Location Approximate
- Approximate Location of Groundwater Barrier
- Location Concealed
- Location Uncertain

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Date: 6/23/2015
Document Name: Exhibit_33_Cr

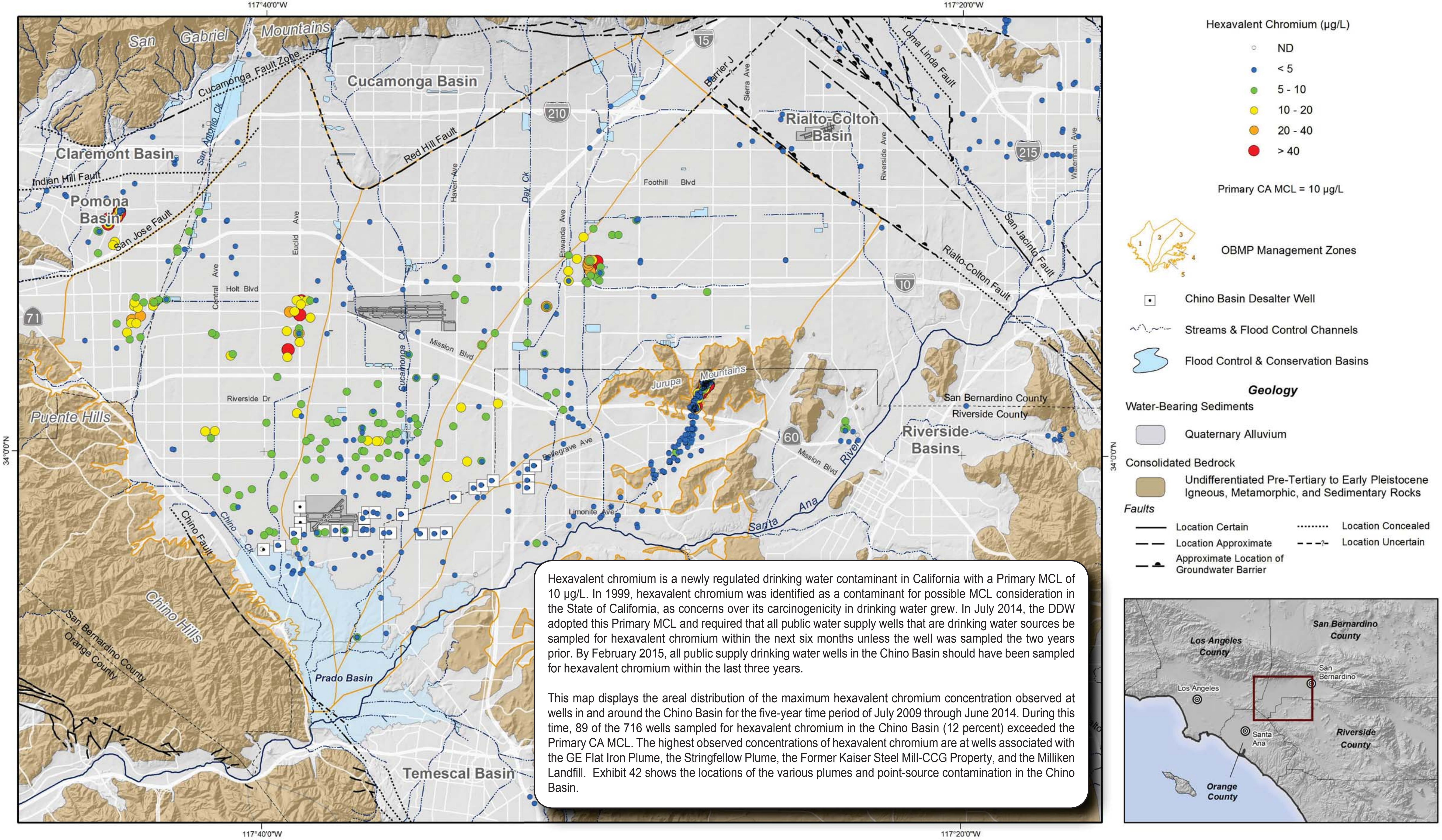
0 2 4 Miles
0 3 6 KM

2014 State of the Basin
Groundwater Quality

Total Chromium in Groundwater

Maximum Concentration (July 2009 to June 2014)

Exhibit 33



Hexavalent chromium is a newly regulated drinking water contaminant in California with a Primary MCL of 10 µg/L. In 1999, hexavalent chromium was identified as a contaminant for possible MCL consideration in the State of California, as concerns over its carcinogenicity in drinking water grew. In July 2014, the DDW adopted this Primary MCL and required that all public water supply wells that are drinking water sources be sampled for hexavalent chromium within the next six months unless the well was sampled the two years prior. By February 2015, all public supply drinking water wells in the Chino Basin should have been sampled for hexavalent chromium within the last three years.

This map displays the areal distribution of the maximum hexavalent chromium concentration observed at wells in and around the Chino Basin for the five-year time period of July 2009 through June 2014. During this time, 89 of the 716 wells sampled for hexavalent chromium in the Chino Basin (12 percent) exceeded the Primary CA MCL. The highest observed concentrations of hexavalent chromium are at wells associated with the GE Flat Iron Plume, the Stringfellow Plume, the Former Kaiser Steel Mill-CCG Property, and the Milliken Landfill. Exhibit 42 shows the locations of the various plumes and point-source contamination in the Chino Basin.

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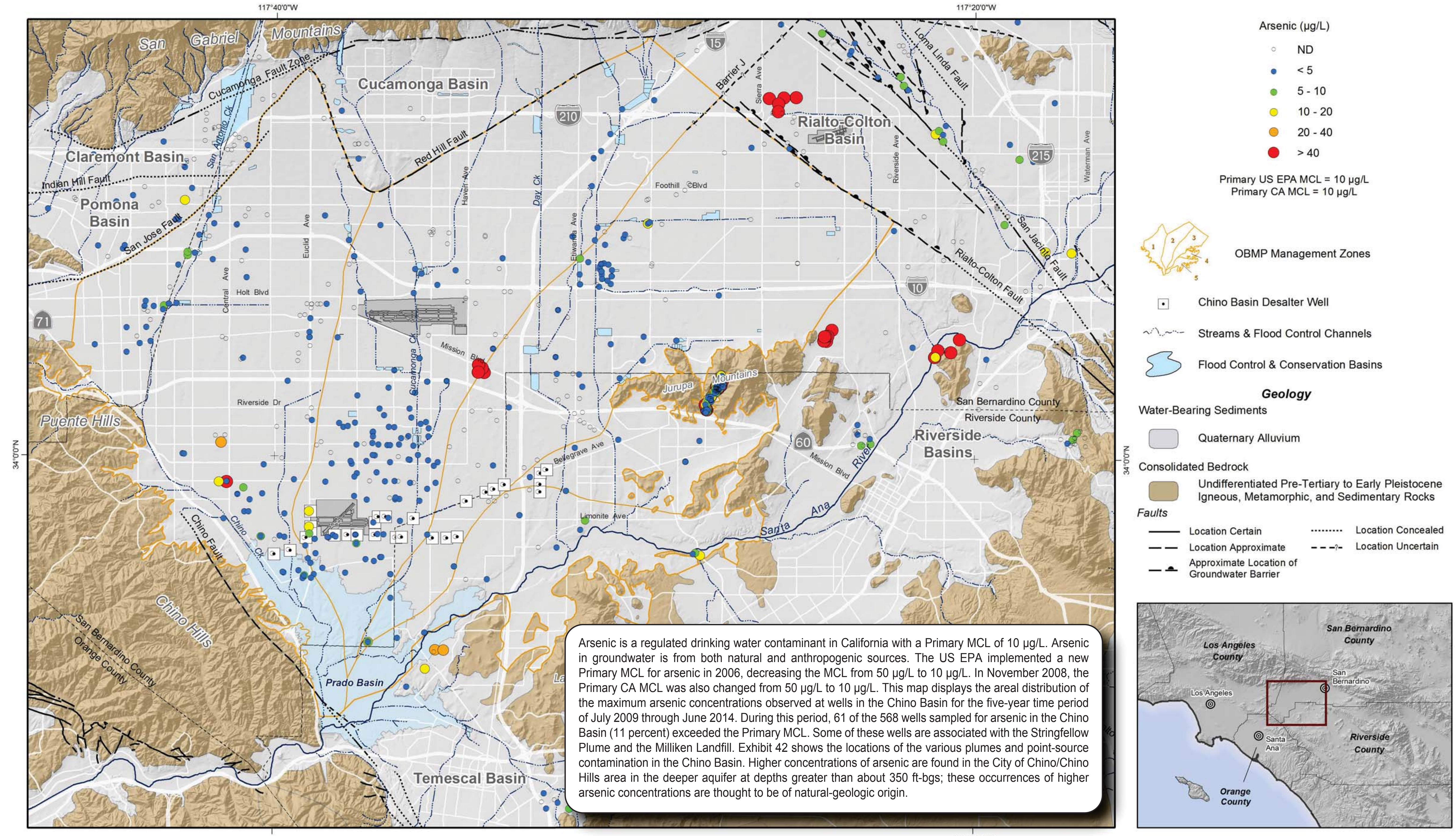
0 2 4 Miles
0 3 6 KM

2014 State of the Basin
Groundwater Quality

Hexavalent Chromium in Groundwater

Maximum Concentration (July 2009 to June 2014)

Exhibit 34



Arsenic is a regulated drinking water contaminant in California with a Primary MCL of 10 µg/L. Arsenic in groundwater is from both natural and anthropogenic sources. The US EPA implemented a new Primary MCL for arsenic in 2006, decreasing the MCL from 50 µg/L to 10 µg/L. In November 2008, the Primary CA MCL was also changed from 50 µg/L to 10 µg/L. This map displays the areal distribution of the maximum arsenic concentrations observed at wells in the Chino Basin for the five-year time period of July 2009 through June 2014. During this period, 61 of the 568 wells sampled for arsenic in the Chino Basin (11 percent) exceeded the Primary MCL. Some of these wells are associated with the Stringfellow Plume and the Milliken Landfill. Exhibit 42 shows the locations of the various plumes and point-source contamination in the Chino Basin. Higher concentrations of arsenic are found in the City of Chino/Chino Hills area in the deeper aquifer at depths greater than about 350 ft-bgs; these occurrences of higher arsenic concentrations are thought to be of natural-geologic origin.

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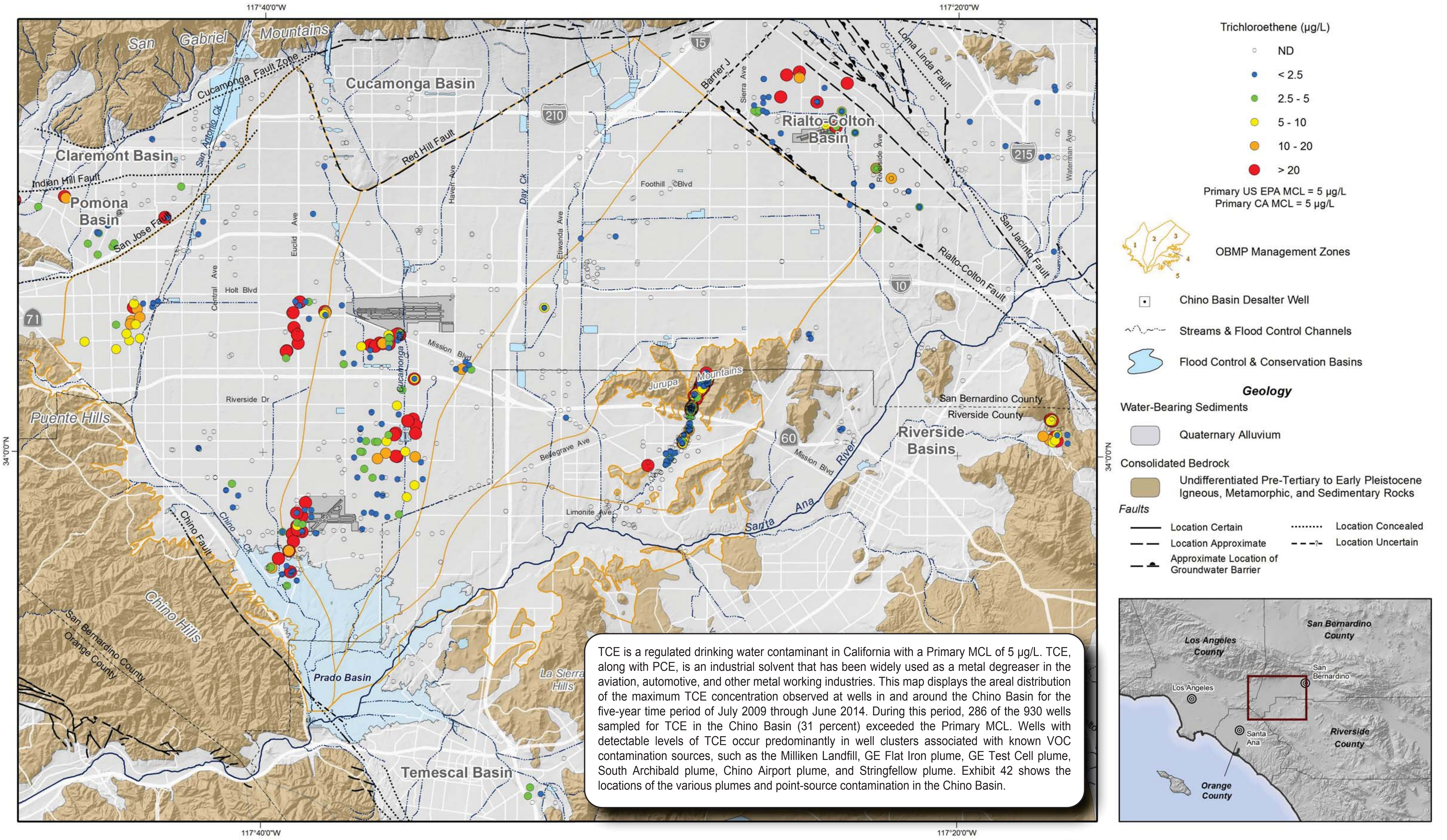
0 2 4 Miles
0 3 6 KM

2014 State of the Basin
Groundwater Quality

Arsenic in Groundwater

Maximum Concentration (July 2009 to June 2014)

Exhibit 35



TCE is a regulated drinking water contaminant in California with a Primary MCL of 5 µg/L. 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. This map displays the areal distribution of the maximum TCE concentration observed at wells in and around the Chino Basin for the five-year time period of July 2009 through June 2014. During this period, 286 of the 930 wells sampled for TCE in the Chino Basin (31 percent) exceeded the Primary MCL. Wells with detectable levels of TCE occur predominantly in well clusters associated with known VOC contamination sources, such as the Milliken Landfill, GE Flat Iron plume, GE Test Cell plume, South Archibald plume, Chino Airport plume, and Stringfellow plume. Exhibit 42 shows the locations of the various plumes and point-source contamination in the Chino Basin.

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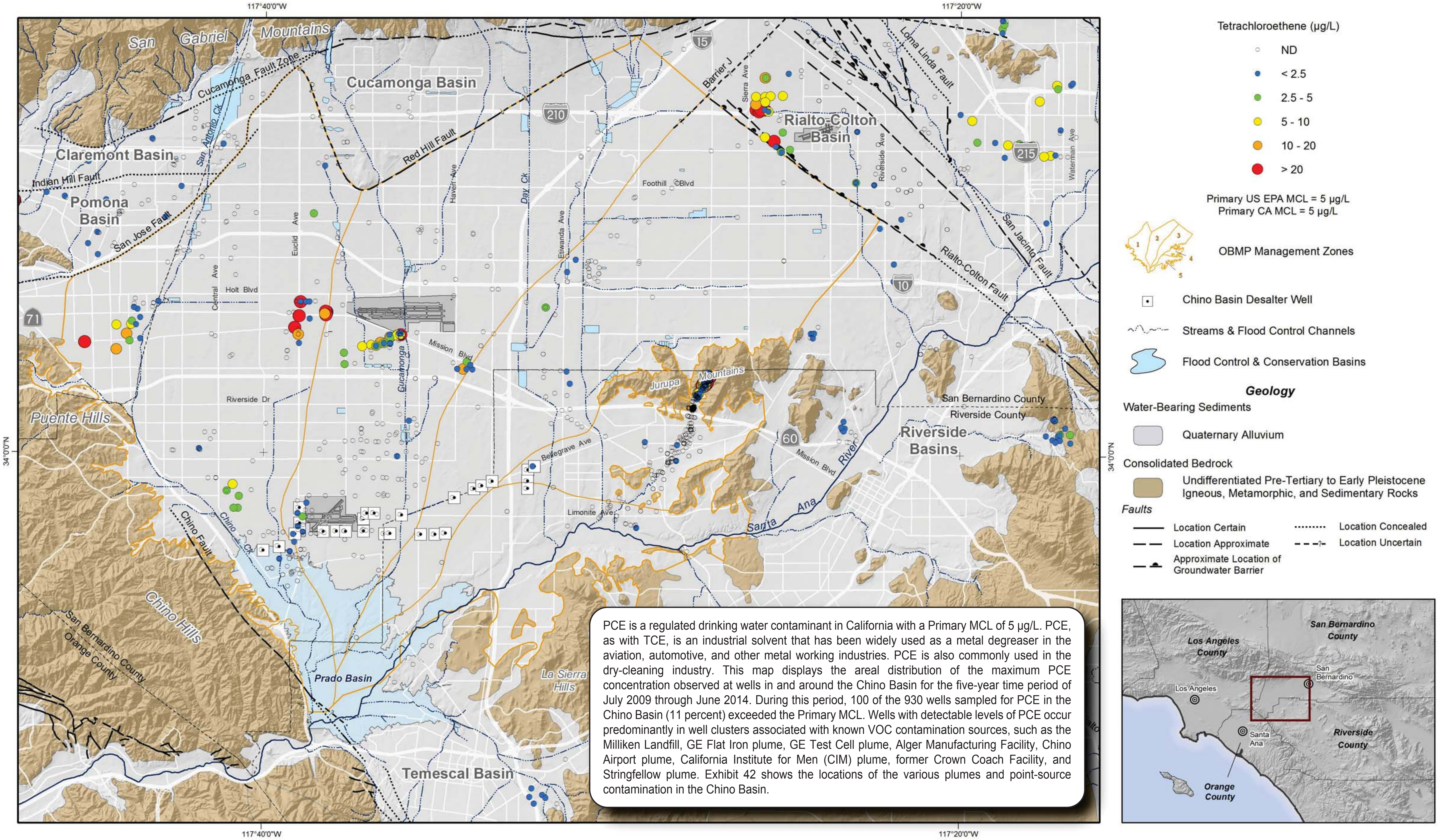
Document Name: Exhibit_36_TCE

2014 State of the Basin
Groundwater Quality

Trichloroethene (TCE) in Groundwater

Maximum Concentration (July 2009 to June 2014)

Exhibit 36



PCE is a regulated drinking water contaminant in California with a Primary MCL of 5 µg/L. PCE, as with TCE, 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. This map displays the areal distribution of the maximum PCE concentration observed at wells in and around the Chino Basin for the five-year time period of July 2009 through June 2014. During this period, 100 of the 930 wells sampled for PCE in the Chino Basin (11 percent) exceeded the Primary MCL. Wells with detectable levels of PCE occur predominantly in well clusters associated with known VOC contamination sources, such as the Milliken Landfill, GE Flat Iron plume, GE Test Cell plume, Alger Manufacturing Facility, Chino Airport plume, California Institute for Men (CIM) plume, former Crown Coach Facility, and Stringfellow plume. Exhibit 42 shows the locations of the various plumes and point-source contamination in the Chino Basin.

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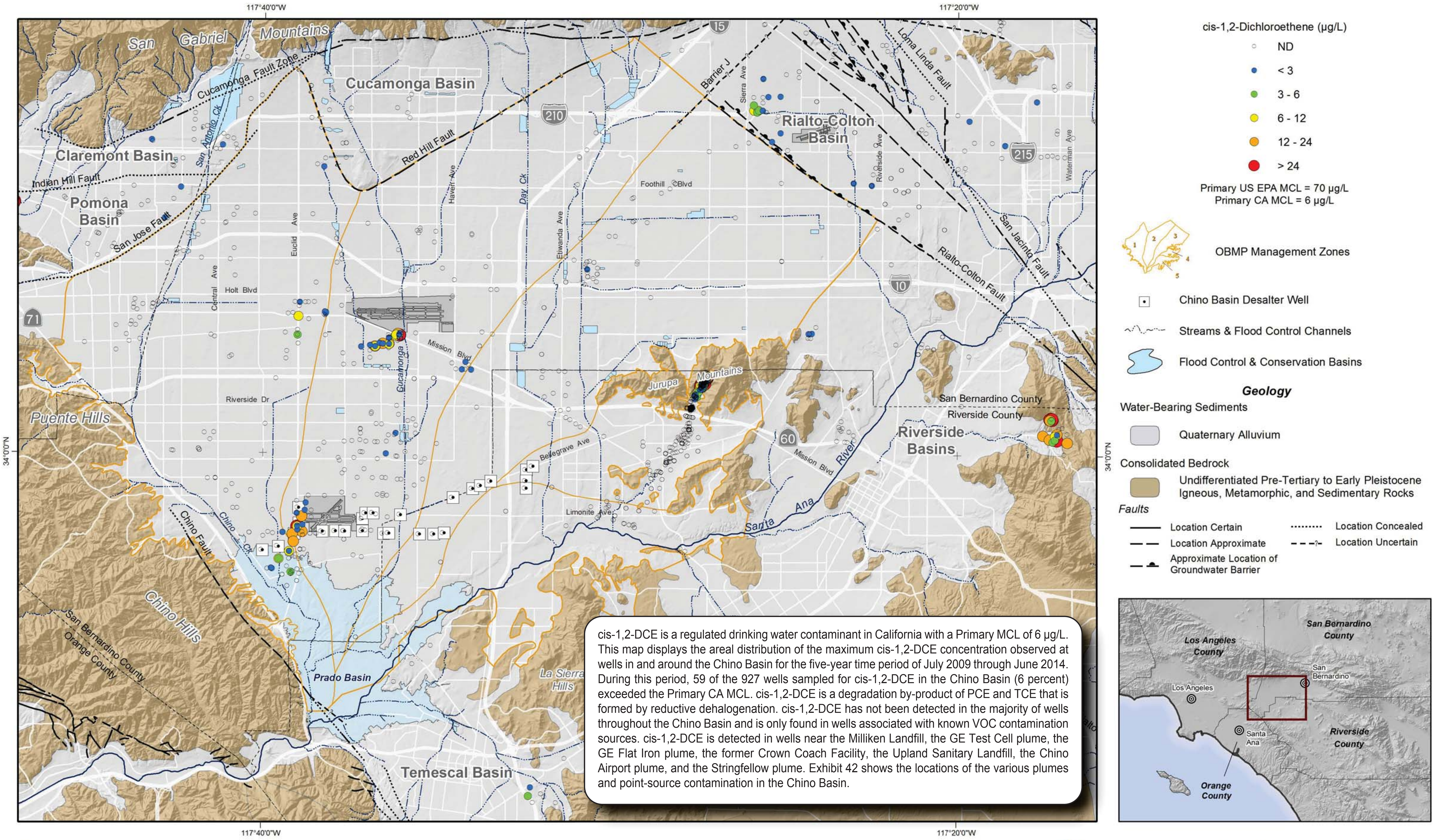
0 2 4 Miles
0 3 6 KM

2014 State of the Basin
Groundwater Quality

Tetrachloroethene (PCE) in Groundwater

Maximum Concentration (July 2009 to June 2014)

Exhibit 37



cis-1,2-DCE is a regulated drinking water contaminant in California with a Primary MCL of 6 µg/L. This map displays the areal distribution of the maximum cis-1,2-DCE concentration observed at wells in and around the Chino Basin for the five-year time period of July 2009 through June 2014. During this period, 59 of the 927 wells sampled for cis-1,2-DCE in the Chino Basin (6 percent) exceeded the Primary CA MCL. cis-1,2-DCE is a degradation by-product of PCE and TCE that is formed by reductive dehalogenation. cis-1,2-DCE has not been detected in the majority of wells throughout the Chino Basin and is only found in wells associated with known VOC contamination sources. cis-1,2-DCE is detected in wells near the Milliken Landfill, the GE Test Cell plume, the GE Flat Iron plume, the former Crown Coach Facility, the Upland Sanitary Landfill, the Chino Airport plume, and the Stringfellow plume. Exhibit 42 shows the locations of the various plumes and point-source contamination in the Chino Basin.

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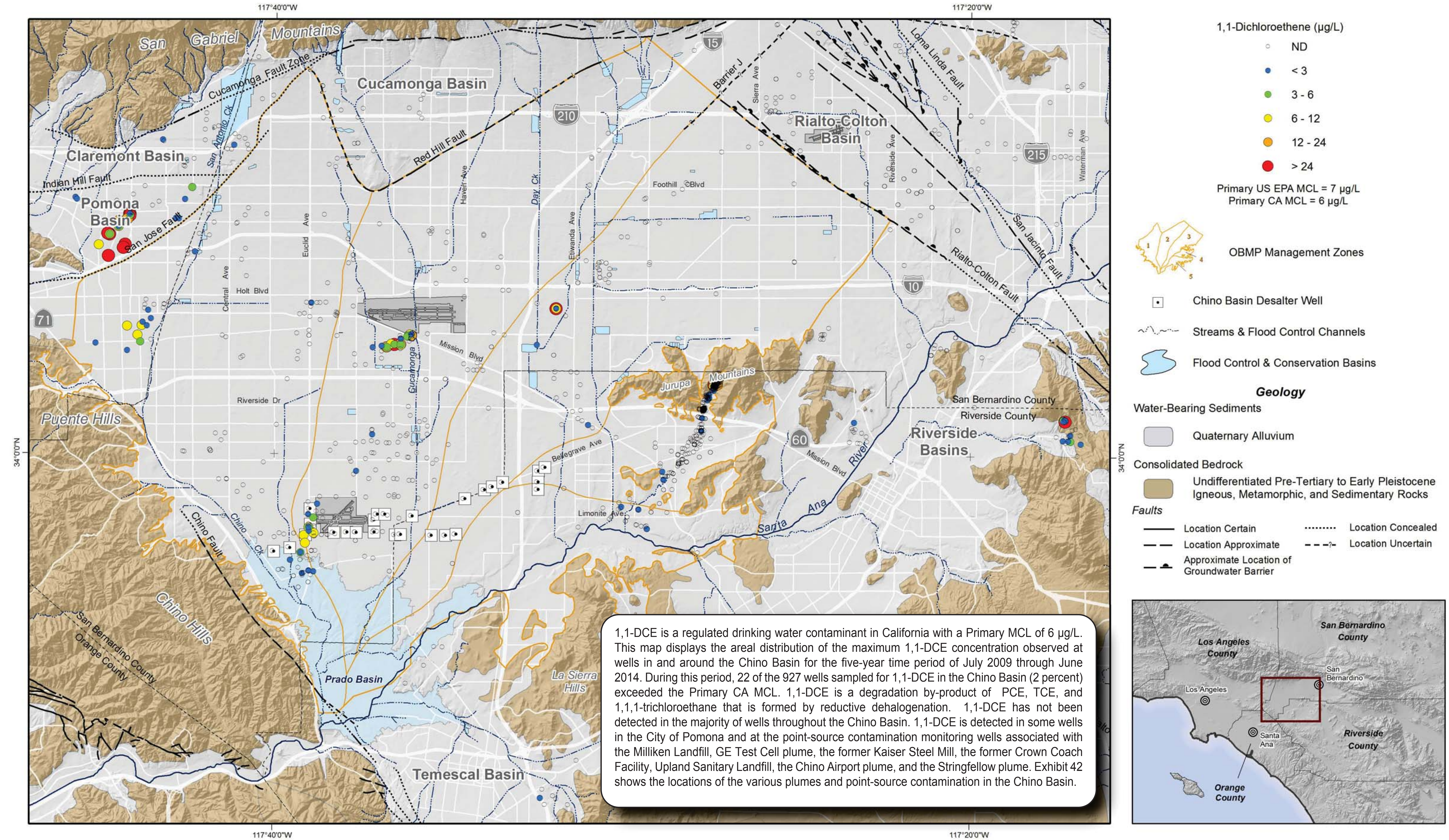
0 2 4 Miles
0 3 6 KM

2014 State of the Basin
Groundwater Quality

cis-1,2-Dichloroethene (cis-1,2-DCE) in Groundwater

Maximum Concentration (July 2009 to June 2014)

Exhibit 38



1,1-DCE is a regulated drinking water contaminant in California with a Primary MCL of 6 µg/L. This map displays the areal distribution of the maximum 1,1-DCE concentration observed at wells in and around the Chino Basin for the five-year time period of July 2009 through June 2014. During this period, 22 of the 927 wells sampled for 1,1-DCE in the Chino Basin (2 percent) exceeded the Primary CA MCL. 1,1-DCE is a degradation by-product of PCE, TCE, and 1,1,1-trichloroethane that is formed by reductive dehalogenation. 1,1-DCE has not been detected in the majority of wells throughout the Chino Basin. 1,1-DCE is detected in some wells in the City of Pomona and at the point-source contamination monitoring wells associated with the Milliken Landfill, GE Test Cell plume, the former Kaiser Steel Mill, the former Crown Coach Facility, Upland Sanitary Landfill, the Chino Airport plume, and the Stringfellow plume. Exhibit 42 shows the locations of the various plumes and point-source contamination in the Chino Basin.

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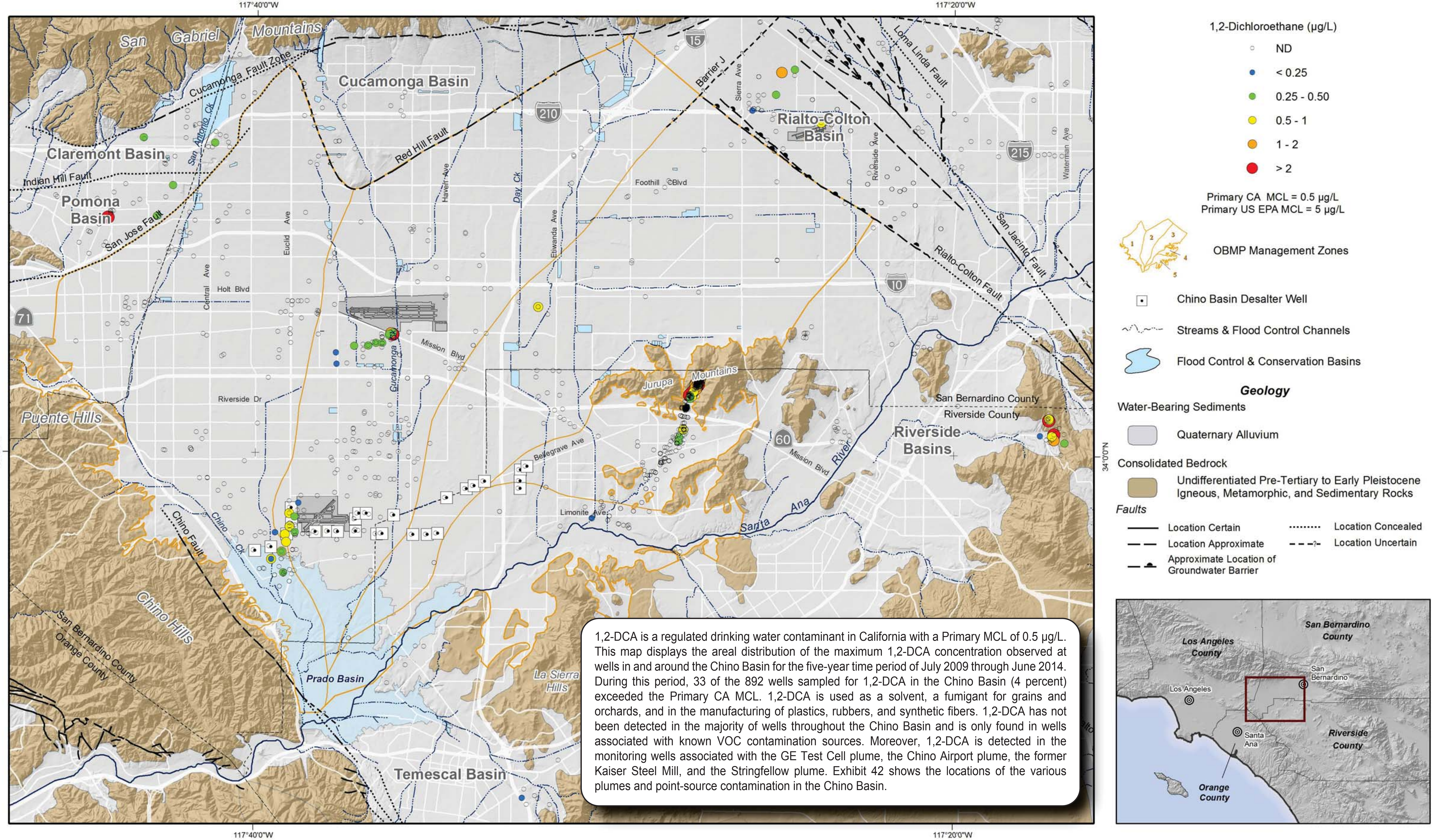
0 2 4 Miles
0 3 6 KM

2014 State of the Basin
Groundwater Quality

1,1-Dichloroethene (1,1-DCE) in Groundwater

Maximum Concentration (July 2009 to June 2014)

Exhibit 39



1,2-DCA is a regulated drinking water contaminant in California with a Primary MCL of 0.5 µg/L. This map displays the areal distribution of the maximum 1,2-DCA concentration observed at wells in and around the Chino Basin for the five-year time period of July 2009 through June 2014. During this period, 33 of the 892 wells sampled for 1,2-DCA in the Chino Basin (4 percent) exceeded the Primary CA MCL. 1,2-DCA is used as a solvent, a fumigant for grains and orchards, and in the manufacturing of plastics, rubbers, and synthetic fibers. 1,2-DCA has not been detected in the majority of wells throughout the Chino Basin and is only found in wells associated with known VOC contamination sources. Moreover, 1,2-DCA is detected in the monitoring wells associated with the GE Test Cell plume, the Chino Airport plume, the former Kaiser Steel Mill, and the Stringfellow plume. Exhibit 42 shows the locations of the various plumes and point-source contamination in the Chino Basin.

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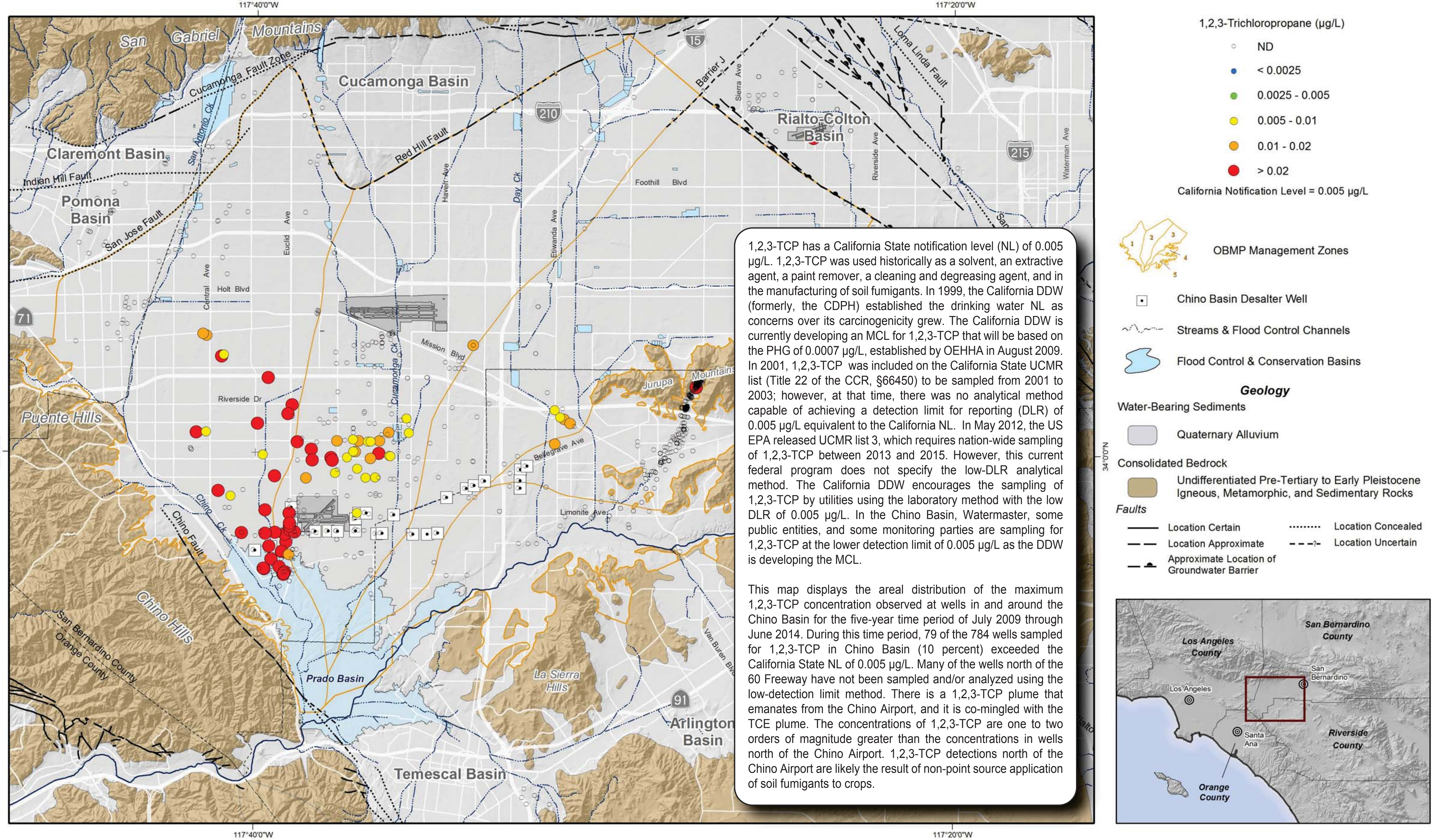
2014 State of the Basin
Groundwater Quality

1,2-Dichloroethane (1,2-DCA) in Groundwater

Maximum Concentration (July 2009 to June 2014)

Exhibit 40



1,2,3-TCP has a California State notification level (NL) of 0.005 µg/L. 1,2,3-TCP was used historically as a solvent, an extractive agent, a paint remover, a cleaning and degreasing agent, and in the manufacturing of soil fumigants. In 1999, the California DDW (formerly, the CDPH) established the drinking water NL as concerns over its carcinogenicity grew. The California DDW is currently developing an MCL for 1,2,3-TCP that will be based on the PHG of 0.0007 µg/L, established by OEHHA in August 2009. In 2001, 1,2,3-TCP was included on the California State UCMR list (Title 22 of the CCR, §66450) to be sampled from 2001 to 2003; however, at that time, there was no analytical method capable of achieving a detection limit for reporting (DLR) of 0.005 µg/L equivalent to the California NL. In May 2012, the US EPA released UCMR list 3, which requires nation-wide sampling of 1,2,3-TCP between 2013 and 2015. However, this current federal program does not specify the low-DLR analytical method. The California DDW encourages the sampling of 1,2,3-TCP by utilities using the laboratory method with the low DLR of 0.005 µg/L. In the Chino Basin, Watermaster, some public entities, and some monitoring parties are sampling for 1,2,3-TCP at the lower detection limit of 0.005 µg/L as the DDW is developing the MCL.

This map displays the areal distribution of the maximum 1,2,3-TCP concentration observed at wells in and around the Chino Basin for the five-year time period of July 2009 through June 2014. During this time period, 79 of the 784 wells sampled for 1,2,3-TCP in Chino Basin (10 percent) exceeded the California State NL of 0.005 µg/L. Many of the wells north of the 60 Freeway have not been sampled and/or analyzed using the low-detection limit method. There is a 1,2,3-TCP plume that emanates from the Chino Airport, and it is co-mingled with the TCE plume. The concentrations of 1,2,3-TCP are one to two orders of magnitude greater than the concentrations in wells north of the Chino Airport. 1,2,3-TCP detections north of the Chino Airport are likely the result of non-point source application of soil fumigants to crops.

1,2,3-Trichloropropane (µg/L)

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

California Notification Level = 0.005 µg/L

OBMP Management Zones

⊡ Chino Basin Desalter Well

Streams & Flood Control Channels

Flood Control & Conservation Basins

Geology

Water-Bearing Sediments

Quaternary Alluvium

Consolidated Bedrock

Undifferentiated Pre-Tertiary to Early Pleistocene Igneous, Metamorphic, and Sedimentary Rocks

Faults

- Location Certain
- Location Approximate
- Approximate Location of Groundwater Barrier
- Location Concealed
- Location Uncertain

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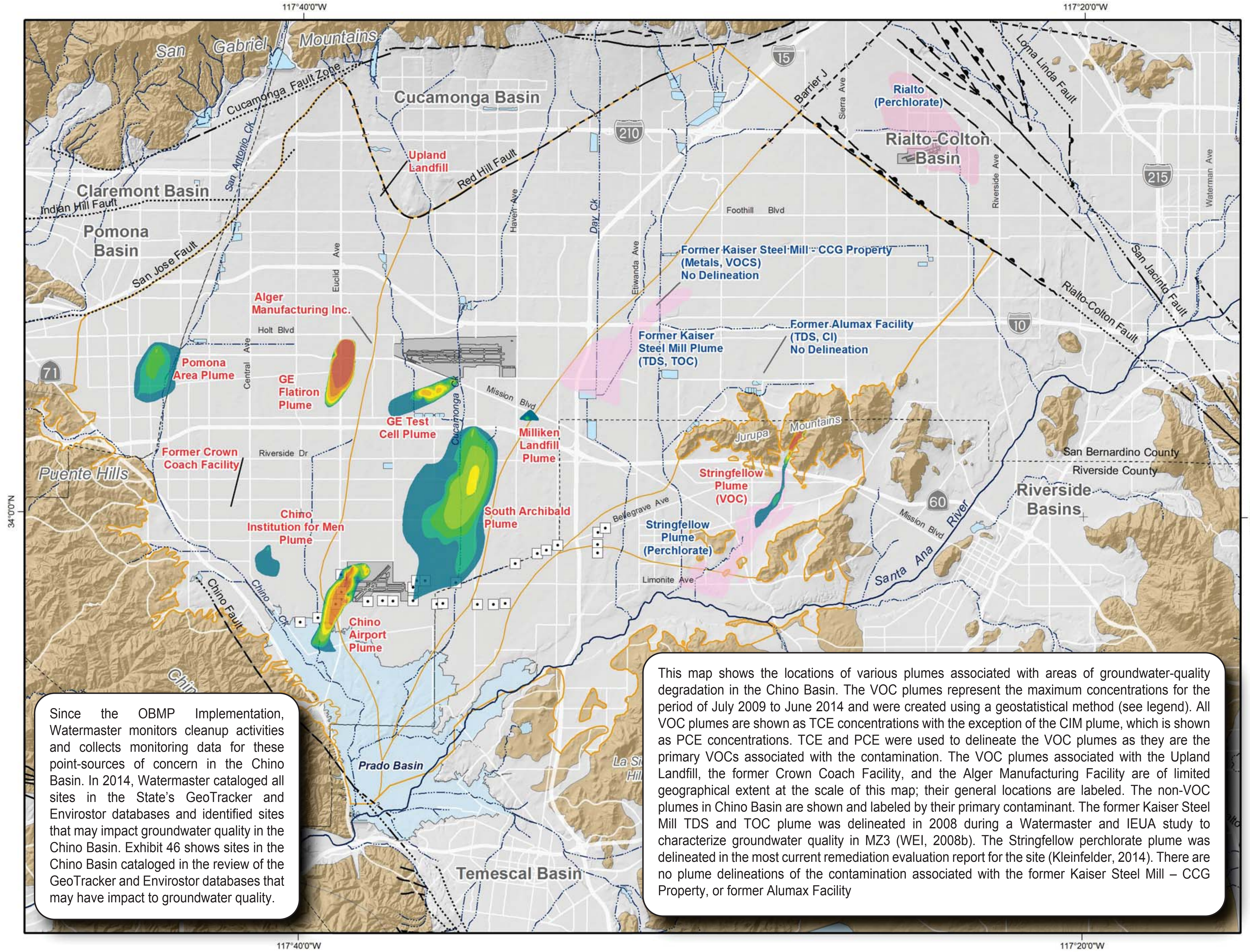
2014 State of the Basin
Groundwater Quality

1,2,3-Trichloropropane (1,2,3-TCP) in Groundwater

Maximum Concentration (July 2009 to June 2014)

Exhibit 41



Since the OBMP Implementation, Watermaster monitors cleanup activities and collects monitoring data for these point-sources of concern in the Chino Basin. In 2014, Watermaster cataloged all sites in the State's GeoTracker and Envirostor databases and identified sites that may impact groundwater quality in the Chino Basin. Exhibit 46 shows sites in the Chino Basin cataloged in the review of the GeoTracker and Envirostor databases that may have impact to groundwater quality.

This map shows the locations of various plumes associated with areas of groundwater-quality degradation in the Chino Basin. The VOC plumes represent the maximum concentrations for the period of July 2009 to June 2014 and were created using a geostatistical method (see legend). All VOC plumes are shown as TCE concentrations with the exception of the CIM plume, which is shown as PCE concentrations. TCE and PCE were used to delineate the VOC plumes as they are the primary VOCs associated with the contamination. The VOC plumes associated with the Upland Landfill, the former Crown Coach Facility, and the Alger Manufacturing Facility are of limited geographical extent at the scale of this map; their general locations are labeled. The non-VOC plumes in Chino Basin are shown and labeled by their primary contaminant. The former Kaiser Steel Mill TDS and TOC plume was delineated in 2008 during a Watermaster and IEUA study to characterize groundwater quality in MZ3 (WEI, 2008b). The Stringfellow perchlorate plume was delineated in the most current remediation evaluation report for the site (Kleinfelder, 2014). There are no plume delineations of the contamination associated with the former Kaiser Steel Mill – CCG Property, or former Alumax Facility

VOC Concentration (µg/L)
- > 0 to ≤ 5
- > 5 to ≤ 10
- > 10 to ≤ 20
- > 20 to ≤ 50
- > 50 to ≤ 100
- > 100 to ≤ 200
- > 200 to ≤ 500
- > 500

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 over the five-year period of July 2009 to June 2014. The VOC plume illustrations were created with the Geostatistical Analyst extension in ESRI's ArcView 10.1, using an ordinary kriging interpolation model with model input parameter estimation and optimization performed by semivariogram analysis in Golden Software's Surfer 8.09. Interpretations of the plume extent and boundary delineation were made based on measured concentrations and local groundwater flow patterns as predicted by the Chino Basin groundwater flow model.

VOC Plumes Labeled in Red by Name

Other Plumes - Labeled in Blue by Name and Dominant Contaminant

OBMP Management Zones

⊡ Chino Basin Desalter Well

Streams & Flood Control Channels

Flood Control & Conservation Basins

Geology

Quaternary Alluvium

Consolidated Bedrock

Undifferentiated Pre-Tertiary to Early Pleistocene Igneous, Metamorphic, and Sedimentary Rocks

Faults

Location Certain	Location Concealed
Location Approximate	Location Uncertain

Approximate Location of Groundwater Barrier

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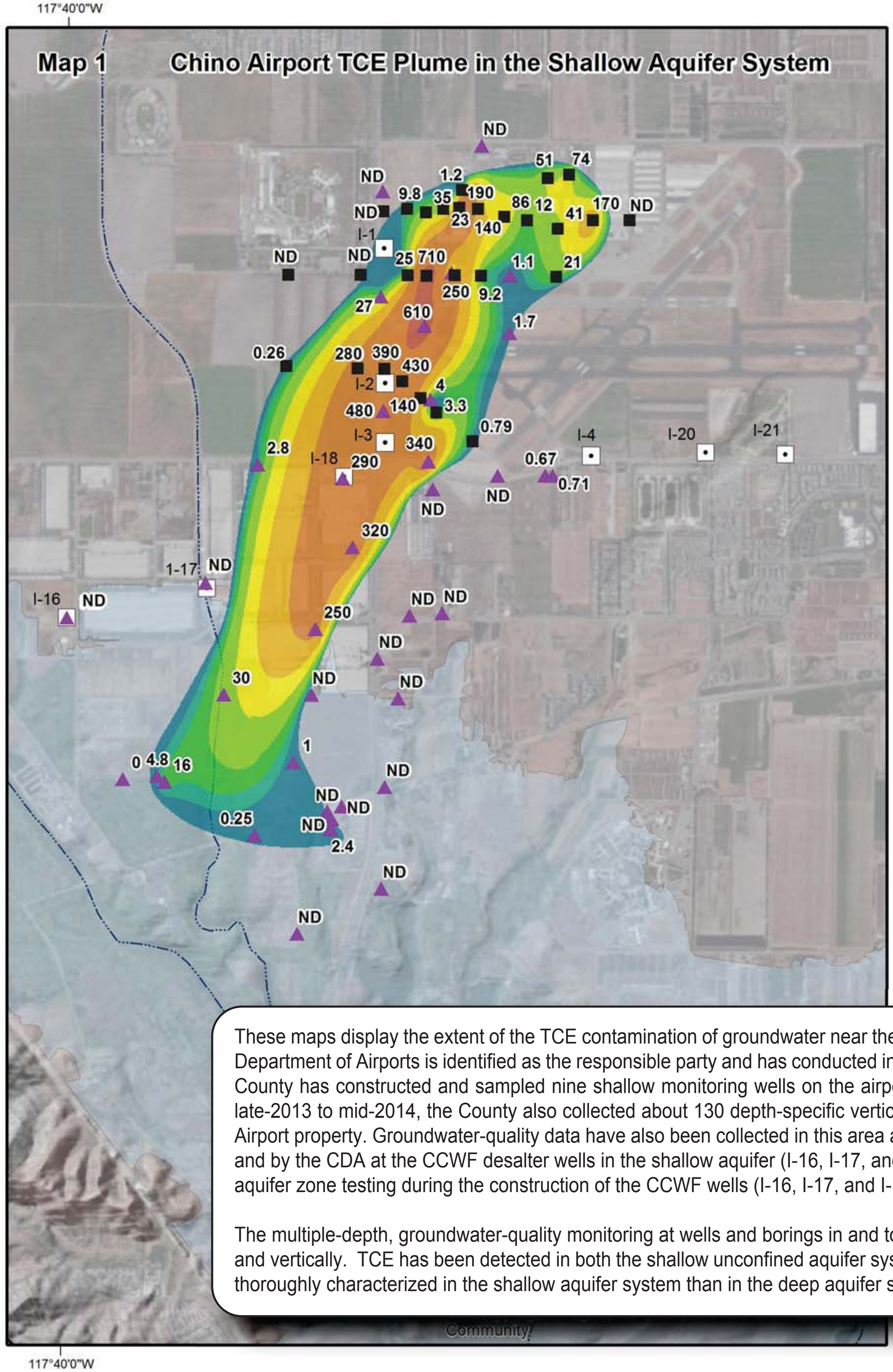
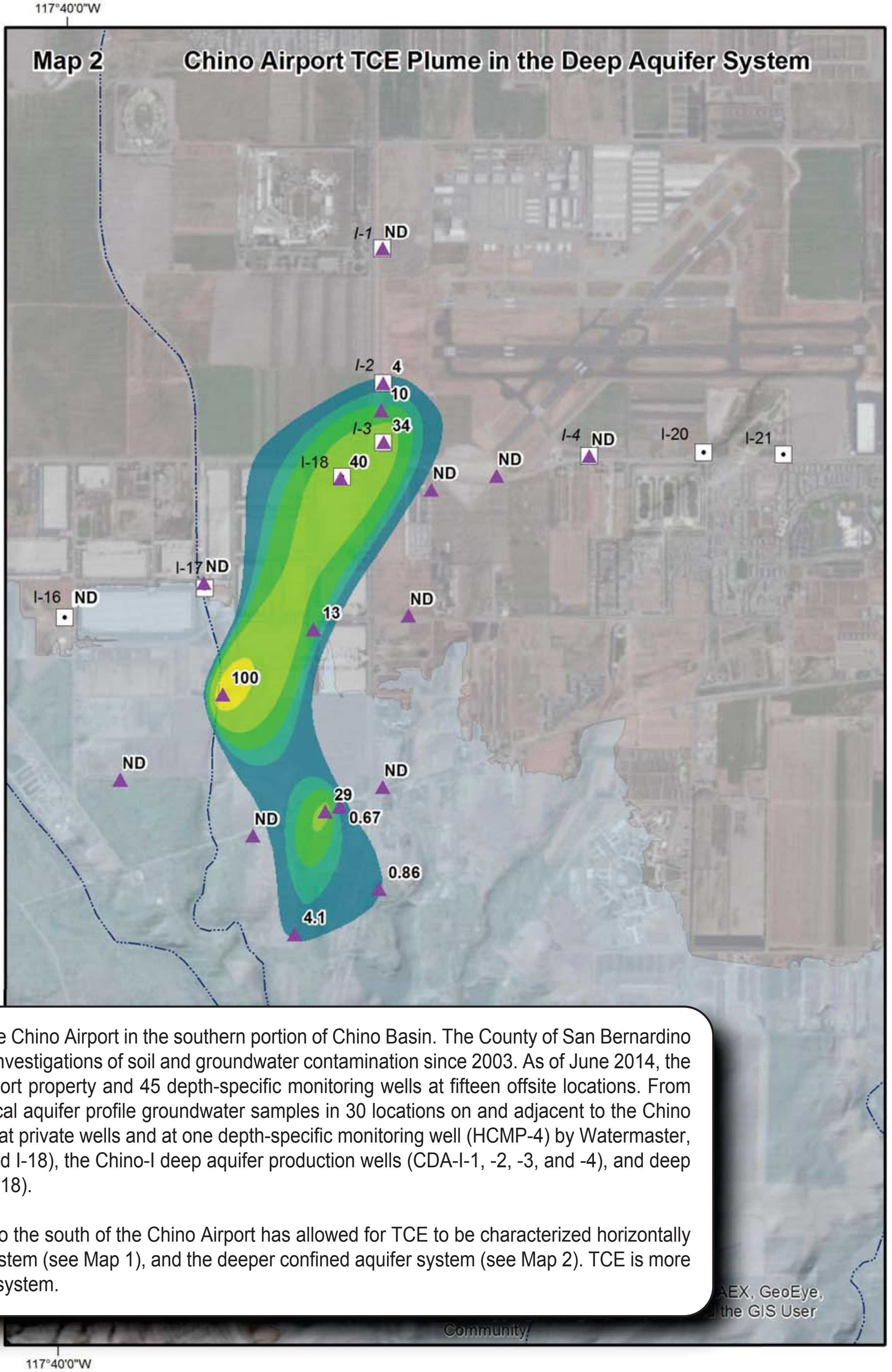
2014 State of the Basin
Groundwater Quality

Delineation of Groundwater Contamination Plumes and Point Sources of Concern

Exhibit 42





TCE Concentration (µg/L)

🟦	> 0 to ≤ 5
🟩	> 5 to ≤ 10
🟩	> 10 to ≤ 20
🟩	> 20 to ≤ 50
🟨	> 50 to ≤ 100
🟧	> 100 to ≤ 200
🟧	> 200 to ≤ 500
🟥	> 500

The VOC plumes shown on this map are generalized illustrations of the estimated spatial extent of TCE, based on the maximum concentrations measured at wells from July 2009 to June 2014. The VOC plume illustrations were created with the Geostatistical Analyst extension in ESRI's ArcView 10.1, using an ordinary kriging interpolation model with model input parameter estimation and optimization performed by semivariogram analysis in Golden Software's Surfer 8.09. Interpretations of the plume extent and boundary delineation were made based on measured concentrations and local groundwater flow patterns as predicted by the Chino Basin groundwater flow model.

TCE MCL = 5 µg/L

5 ▲	Wells & Maximum TCE Concentration (µg/L) for July 2009 to June 2014.
5 ■	Location of Depth-Specific Vertical Aquifer Profile Samples & Maximum TCE Concentration (µg/L) at that Location During 2013 to 2014 Sampling

ND = TCE was Non-Detect in Samples from July 2009 to June 2014

⊡	Chino Basin Desalter Well
~	Streams & Flood Control Channels
⬭	Flood Control & Conservation Basins

These maps display the extent of the TCE contamination of groundwater near the Chino Airport in the southern portion of Chino Basin. The County of San Bernardino Department of Airports is identified as the responsible party and has conducted investigations of soil and groundwater contamination since 2003. As of June 2014, the County has constructed and sampled nine shallow monitoring wells on the airport property and 45 depth-specific monitoring wells at fifteen offsite locations. From late-2013 to mid-2014, the County also collected about 130 depth-specific vertical aquifer profile groundwater samples in 30 locations on and adjacent to the Chino Airport property. Groundwater-quality data have also been collected in this area at private wells and at one depth-specific monitoring well (HCMP-4) by Watermaster, and by the CDA at the CCWF desalter wells in the shallow aquifer (I-16, I-17, and I-18), the Chino-I deep aquifer production wells (CDA-I-1, -2, -3, and -4), and deep aquifer zone testing during the construction of the CCWF wells (I-16, I-17, and I-18).

The multiple-depth, groundwater-quality monitoring at wells and borings in and to the south of the Chino Airport has allowed for TCE to be characterized horizontally and vertically. TCE has been detected in both the shallow unconfined aquifer system (see Map 1), and the deeper confined aquifer system (see Map 2). TCE is more thoroughly characterized in the shallow aquifer system than in the deep aquifer system.

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N

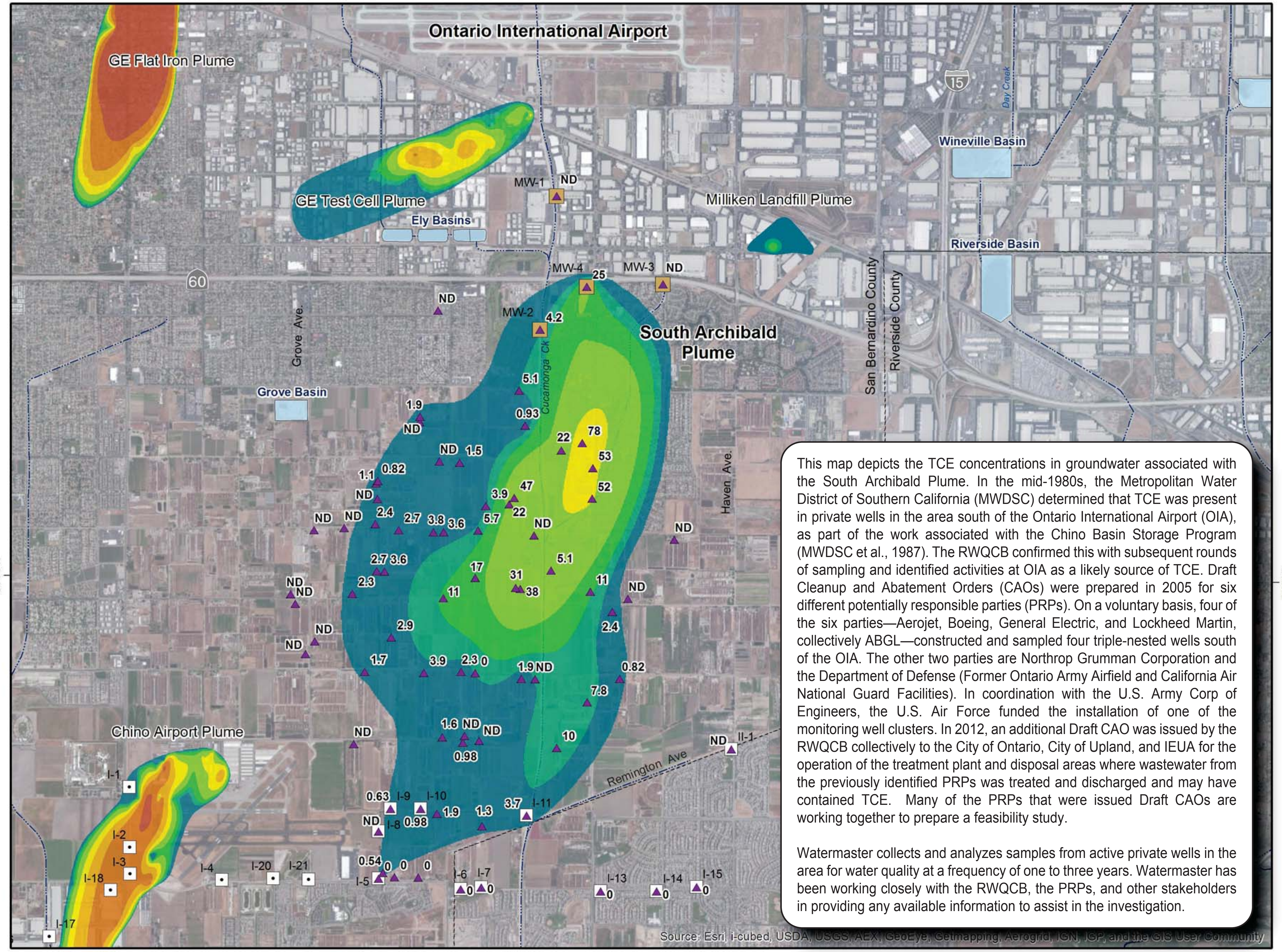
0 0.5 1 1.5 Miles

0 0.25 0.5 1 1.5 2 KM

2014 State of the Basin
Groundwater Quality

Chino Airport TCE Plume
Shallow and Deep Aquifers

Exhibit 43



This map depicts the TCE concentrations in groundwater associated with the South Archibald Plume. In the mid-1980s, the Metropolitan Water District of Southern California (MWDSC) determined that TCE was present in private wells in the area south of the Ontario International Airport (OIA), as part of the work associated with the Chino Basin Storage Program (MWDSC et al., 1987). The RWQCB confirmed this with subsequent rounds of sampling and identified activities at OIA as a likely source of TCE. Draft Cleanup and Abatement Orders (CAOs) were prepared in 2005 for six different potentially responsible parties (PRPs). On a voluntary basis, four of the six parties—Aerojet, Boeing, General Electric, and Lockheed Martin, collectively ABGL—constructed and sampled four triple-nested wells south of the OIA. The other two parties are Northrop Grumman Corporation and the Department of Defense (Former Ontario Army Airfield and California Air National Guard Facilities). In coordination with the U.S. Army Corp of Engineers, the U.S. Air Force funded the installation of one of the monitoring well clusters. In 2012, an additional Draft CAO was issued by the RWQCB collectively to the City of Ontario, City of Upland, and IEUA for the operation of the treatment plant and disposal areas where wastewater from the previously identified PRPs was treated and discharged and may have contained TCE. Many of the PRPs that were issued Draft CAOs are working together to prepare a feasibility study.

Watermaster collects and analyzes samples from active private wells in the area for water quality at a frequency of one to three years. Watermaster has been working closely with the RWQCB, the PRPs, and other stakeholders in providing any available information to assist in the investigation.

TCE Concentration (µg/L)

🟦	> 0 to ≤ 5
🟩	> 5 to ≤ 10
🟩	> 10 to ≤ 20
🟩	> 20 to ≤ 50
🟨	> 50 to ≤ 100
🟧	> 100 to ≤ 200
🟧	> 200 to ≤ 500
🟥	> 500

The VOC plumes shown on this map are generalized illustrations of the estimated spatial extent of TCE, based on maximum concentration measured from July 2009 to June 2014. The VOC plume illustrations were created with the Geostatistical Analyst extension in ESRI's ArcView 10.1, using an ordinary kriging interpolation model with model input parameter estimation and optimization performed by semivariogram analysis in Golden Software's Surfer 8.09. Interpretations of the plume extent and boundary delineation were made based on measured concentrations and local groundwater flow patterns as predicted by the Chino Basin groundwater flow model.

TCE MCL = 5 µg/L

🟫	ABGL Monitoring Wells
5 ▲	Wells & MaximumTCE Concentration (ug/L) from July 2009 to June 2014.

ND = TCE was Non Detect in Samples from July 2009 to June 2014

⊡	Chino Basin Desalter Well
~	Streams & Flood Control Channels
⬭	Flood Control & Conservation Basins

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0 0.5 1 1.5 Miles

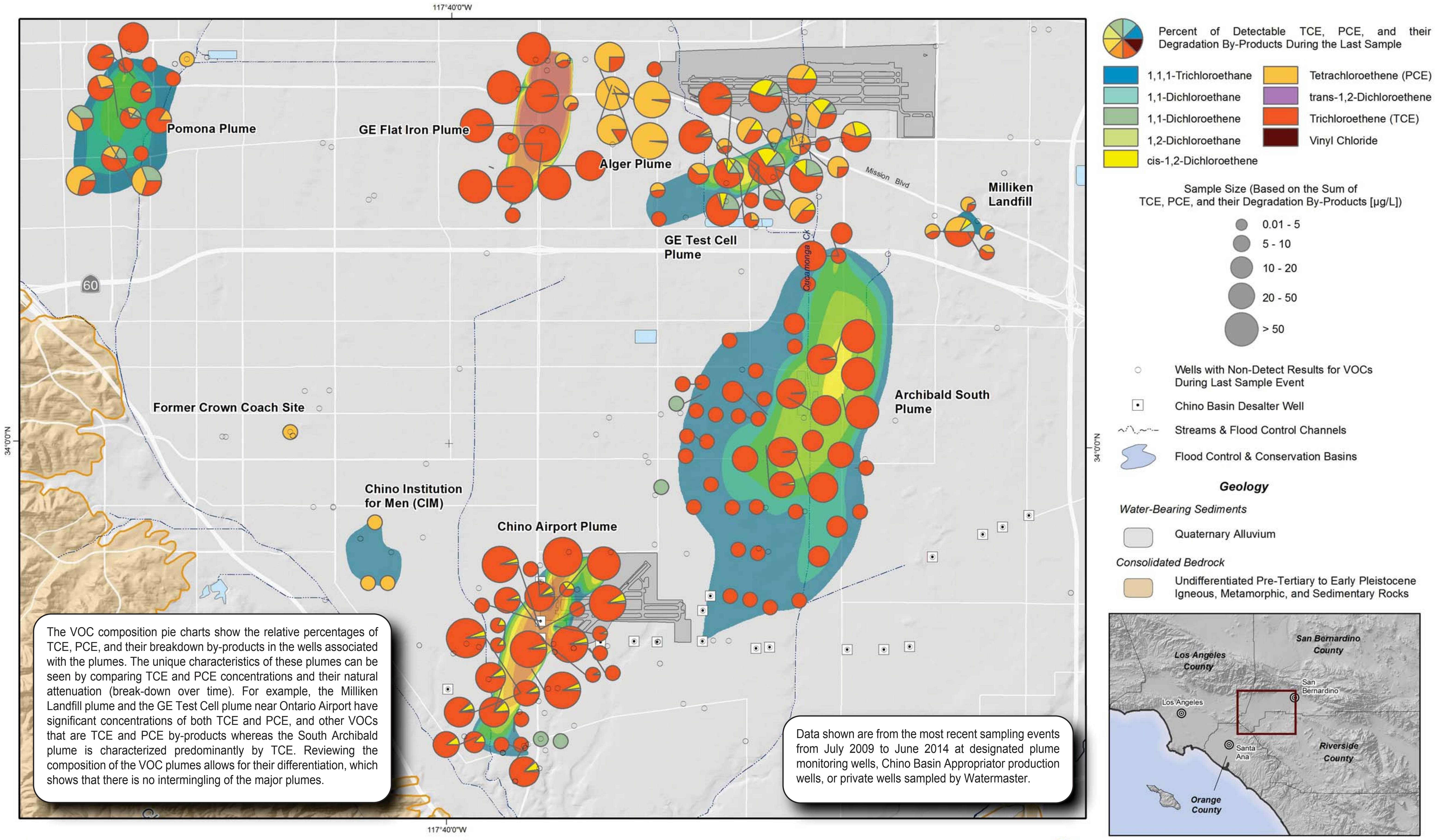
0 0.25 0.5 1 1.5 2 KM

N

2014 State of the Basin
Groundwater Quality

South Archibald TCE Plume

Exhibit 44



The VOC composition pie charts show the relative percentages of TCE, PCE, and their breakdown by-products in the wells associated with the plumes. The unique characteristics of these plumes can be seen by comparing TCE and PCE concentrations and their natural attenuation (break-down over time). For example, the Milliken Landfill plume and the GE Test Cell plume near Ontario Airport have significant concentrations of both TCE and PCE, and other VOCs that are TCE and PCE by-products whereas the South Archibald plume is characterized predominantly by TCE. Reviewing the composition of the VOC plumes allows for their differentiation, which shows that there is no intermingling of the major plumes.

Data shown are from the most recent sampling events from July 2009 to June 2014 at designated plume monitoring wells, Chino Basin Appropriator production wells, or private wells sampled by Watermaster.

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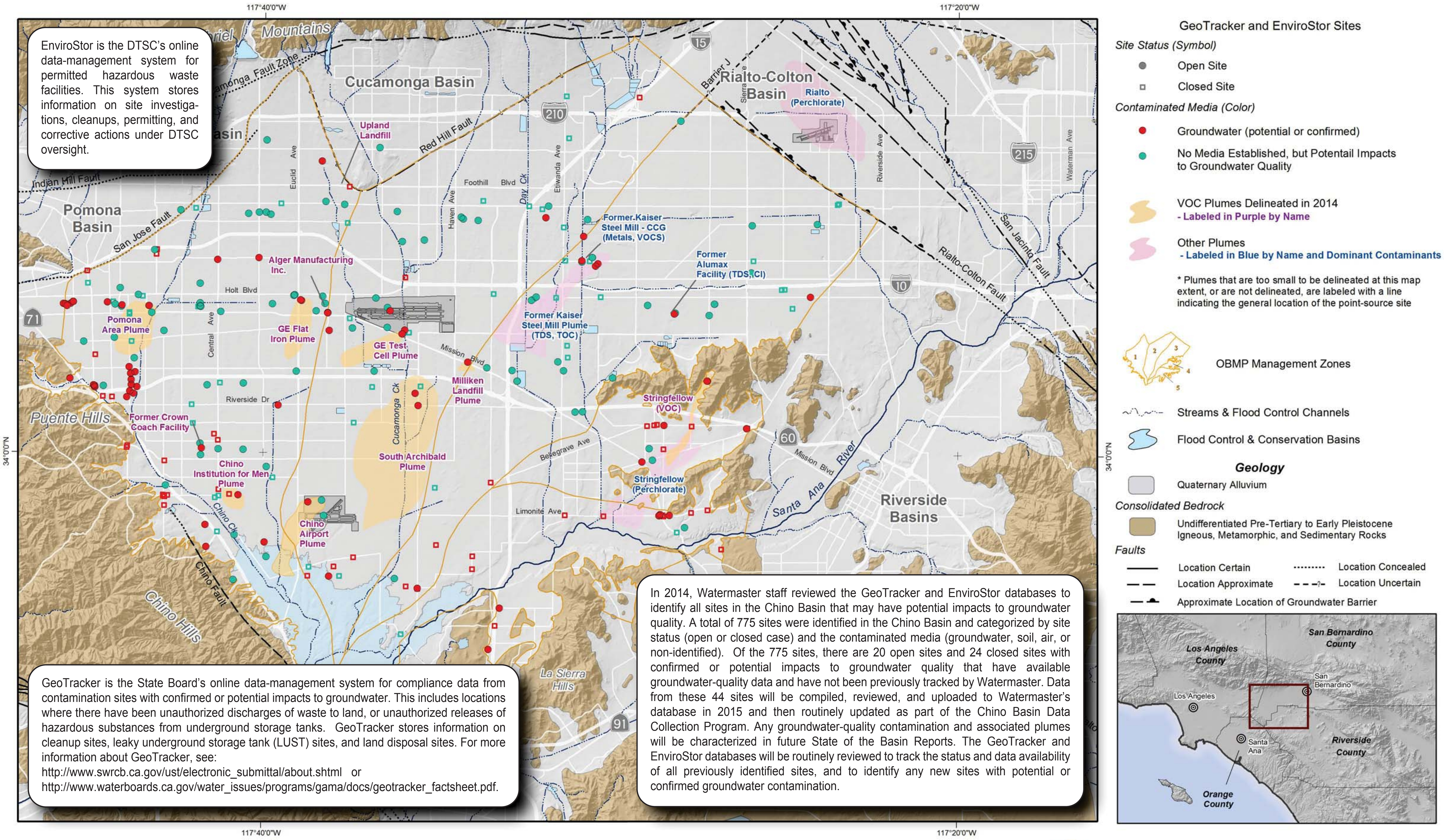
2014 State of the Basin
Groundwater Quality

VOC Composition Charts

Wells Within and Adjacent to VOC Plumes

Exhibit 45



EnviroStor is the DTSC's online data-management system for permitted hazardous waste facilities. This system stores information on site investigations, cleanups, permitting, and corrective actions under DTSC oversight.

GeoTracker is the State Board's online data-management system for compliance data from contamination 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. GeoTracker stores information on cleanup sites, leaky underground storage tank (LUST) sites, and land disposal sites. For more information about GeoTracker, see:
http://www.swrcb.ca.gov/ust/electronic_submittal/about.shtml or
http://www.waterboards.ca.gov/water_issues/programs/gama/docs/geotracker_factsheet.pdf.

In 2014, Watermaster staff reviewed the GeoTracker and EnviroStor databases to identify all sites in the Chino Basin that may have potential impacts to groundwater quality. A total of 775 sites were identified in the Chino Basin and categorized by site status (open or closed case) and the contaminated media (groundwater, soil, air, or non-identified). Of the 775 sites, there are 20 open sites and 24 closed sites with confirmed or potential impacts to groundwater quality that have available groundwater-quality data and have not been previously tracked by Watermaster. Data from these 44 sites will be compiled, reviewed, and uploaded to Watermaster's database in 2015 and then routinely updated as part of the Chino Basin Data Collection Program. Any groundwater-quality contamination and associated plumes will be characterized in future State of the Basin Reports. The GeoTracker and EnviroStor databases will be routinely reviewed to track the status and data availability of all previously identified sites, and to identify any new sites with potential or confirmed groundwater contamination.

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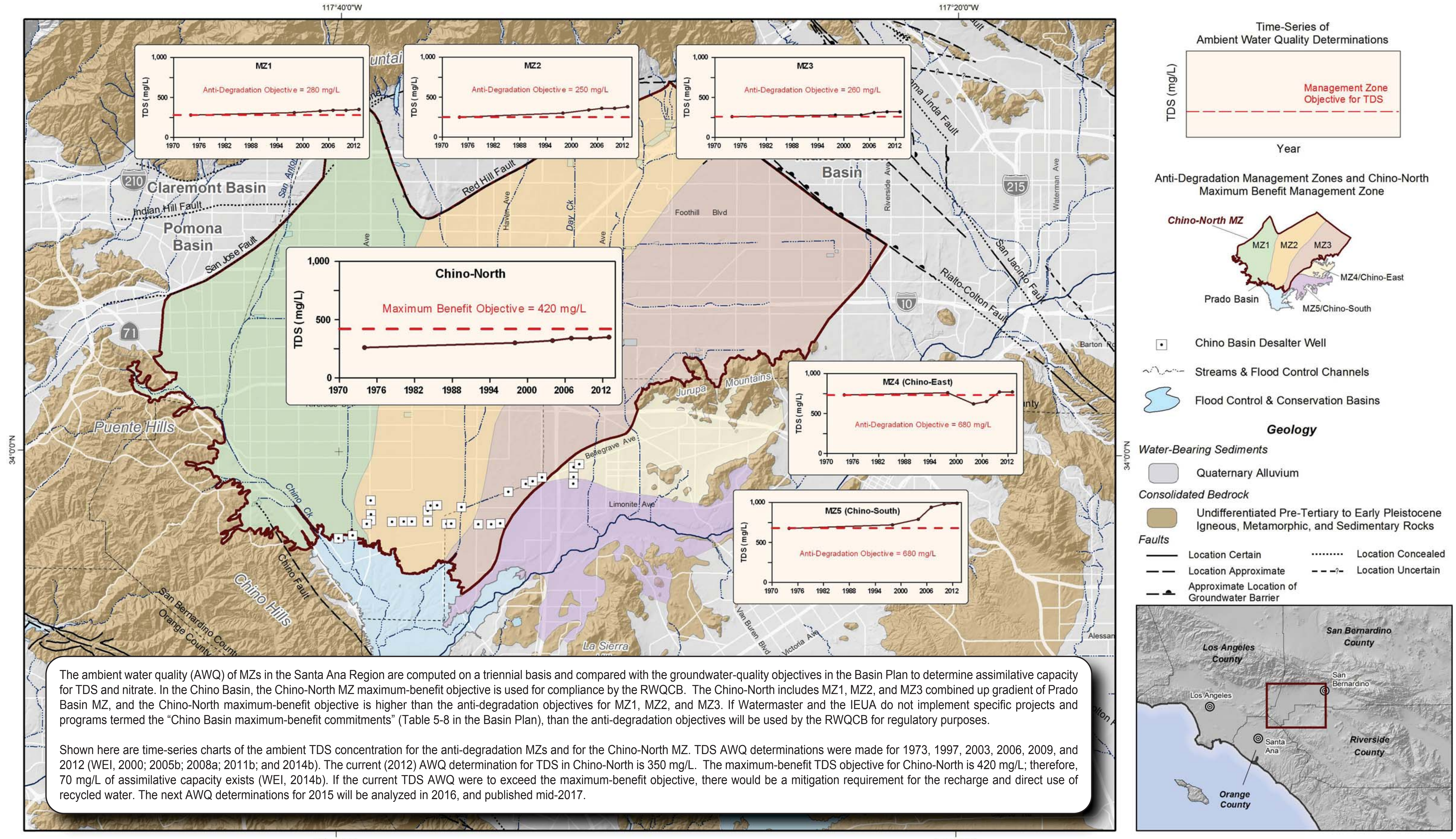
2014 State of the Basin
Groundwater Quality

GeoTracker and EnviroStor Sites in the Chino Basin

Site Status and Contaminated Media

Exhibit 46



The ambient water quality (AWQ) of MZs in the Santa Ana Region are computed on a triennial basis and compared with the groundwater-quality objectives in the Basin Plan to determine assimilative capacity for TDS and nitrate. In the Chino Basin, the Chino-North MZ maximum-benefit objective is used for compliance by the RWQCB. The Chino-North includes MZ1, MZ2, and MZ3 combined up gradient of Prado Basin MZ, and the Chino-North maximum-benefit objective is higher than the anti-degradation objectives for MZ1, MZ2, and MZ3. If Watermaster and the IEUA do not implement specific projects and programs termed the "Chino Basin maximum-benefit commitments" (Table 5-8 in the Basin Plan), than the anti-degradation objectives will be used by the RWQCB for regulatory purposes.

Shown here are time-series charts of the ambient TDS concentration for the anti-degradation MZs and for the Chino-North MZ. TDS AWQ determinations were made for 1973, 1997, 2003, 2006, 2009, and 2012 (WEI, 2000; 2005b; 2008a; 2011b; and 2014b). The current (2012) AWQ determination for TDS in Chino-North is 350 mg/L. The maximum-benefit TDS objective for Chino-North is 420 mg/L; therefore, 70 mg/L of assimilative capacity exists (WEI, 2014b). If the current TDS AWQ were to exceed the maximum-benefit objective, there would be a mitigation requirement for the recharge and direct use of recycled water. The next AWQ determinations for 2015 will be analyzed in 2016, and published mid-2017.

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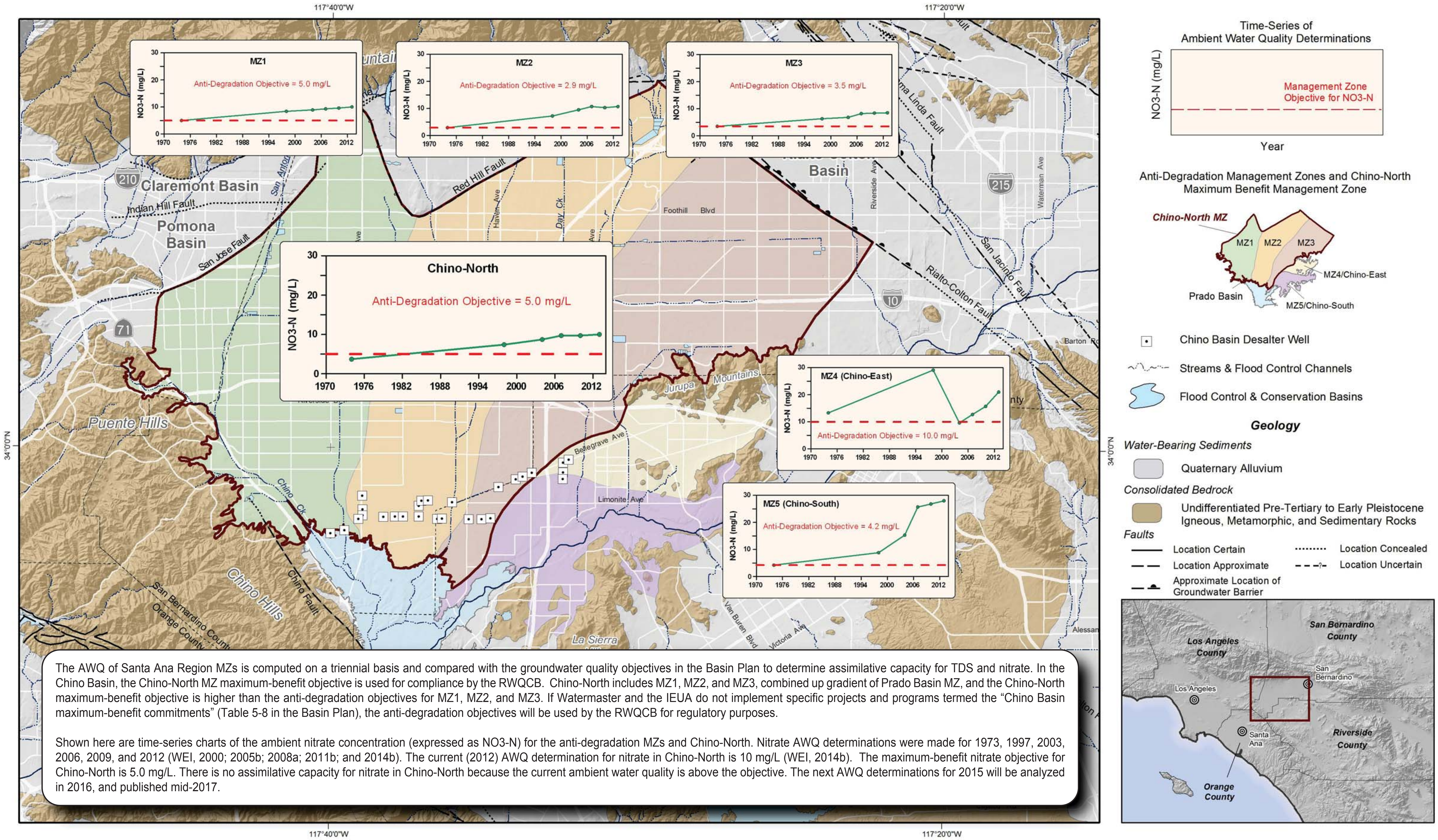
Document Name: Exhibit_47_AWQ_TDS

0 1 2 3 4 5 Miles
0 2 4 6 8 KM

2014 State of the Basin
Groundwater Quality

Trends in Ambient Water Quality Determinations for Total Dissolved Solids (TDS) By Management Zone

Exhibit 47



The AWQ of Santa Ana Region MZs is computed on a triennial basis and compared with the groundwater quality objectives in the Basin Plan to determine assimilative capacity for TDS and nitrate. In the Chino Basin, the Chino-North MZ maximum-benefit objective is used for compliance by the RWQCB. Chino-North includes MZ1, MZ2, and MZ3, combined up gradient of Prado Basin MZ, and the Chino-North maximum-benefit objective is higher than the anti-degradation objectives for MZ1, MZ2, and MZ3. If Watermaster and the IEUA do not implement specific projects and programs termed the “Chino Basin maximum-benefit commitments” (Table 5-8 in the Basin Plan), the anti-degradation objectives will be used by the RWQCB for regulatory purposes.

Shown here are time-series charts of the ambient nitrate concentration (expressed as NO3-N) for the anti-degradation MZs and Chino-North. Nitrate AWQ determinations were made for 1973, 1997, 2003, 2006, 2009, and 2012 (WEI, 2000; 2005b; 2008a; 2011b; and 2014b). The current (2012) AWQ determination for nitrate in Chino-North is 10 mg/L (WEI, 2014b). The maximum-benefit nitrate objective for Chino-North is 5.0 mg/L. There is no assimilative capacity for nitrate in Chino-North because the current ambient water quality is above the objective. The next AWQ determinations for 2015 will be analyzed in 2016, and published mid-2017.

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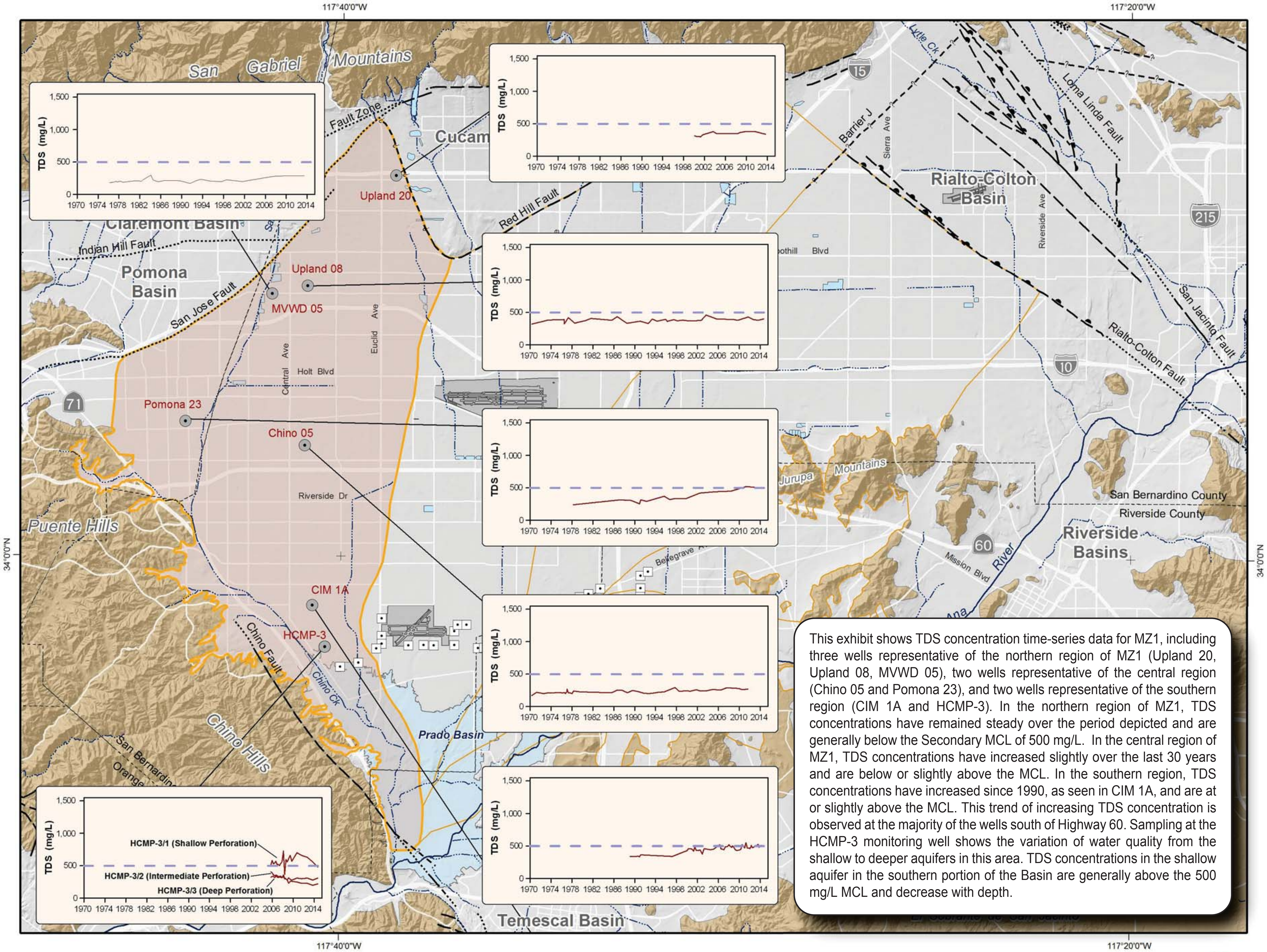
2014 State of the Basin
Groundwater Quality

Trends in Ambient Water Quality Determinations for Nitrate as Nitrogen (NO3-N) By Management Zone

Exhibit 48



This exhibit shows TDS concentration time-series data for MZ1, including three wells representative of the northern region of MZ1 (Upland 20, Upland 08, MVWD 05), two wells representative of the central region (Chino 05 and Pomona 23), and two wells representative of the southern region (CIM 1A and HCMP-3). In the northern region of MZ1, TDS concentrations have remained steady over the period depicted and are generally below the Secondary MCL of 500 mg/L. In the central region of MZ1, TDS concentrations have increased slightly over the last 30 years and are below or slightly above the MCL. In the southern region, TDS concentrations have increased since 1990, as seen in CIM 1A, and are at or slightly above the MCL. This trend of increasing TDS concentration is observed at the majority of the wells south of Highway 60. Sampling at the HCMP-3 monitoring well shows the variation of water quality from the shallow to deeper aquifers in this area. TDS concentrations in the shallow aquifer in the southern portion of the Basin are generally above the 500 mg/L MCL and decrease with depth.

🟧 MZ1 Boundary Area

⊙ Representative MZ1 Wells

Total Dissolved Solids (TDS) Concentration

TDS (mg/L)
Secondary US/CA EPA MCL = 500 mg/L
Year

OBMP Management Zones

⊡ Chino Basin Desalter Well

Streams & Flood Control Channels

Recharge Basins and Spreading Grounds

Geology

Water-Bearing Sediments

▭ Quaternary Alluvium

Consolidated Bedrock

▨ Undifferentiated Pre-Tertiary to Early Pleistocene Igneous, Metamorphic, and Sedimentary Rocks

Faults

Location Certain

Location Concealed

Location Approximate

Location Uncertain

Approximate Location of Groundwater Barrier

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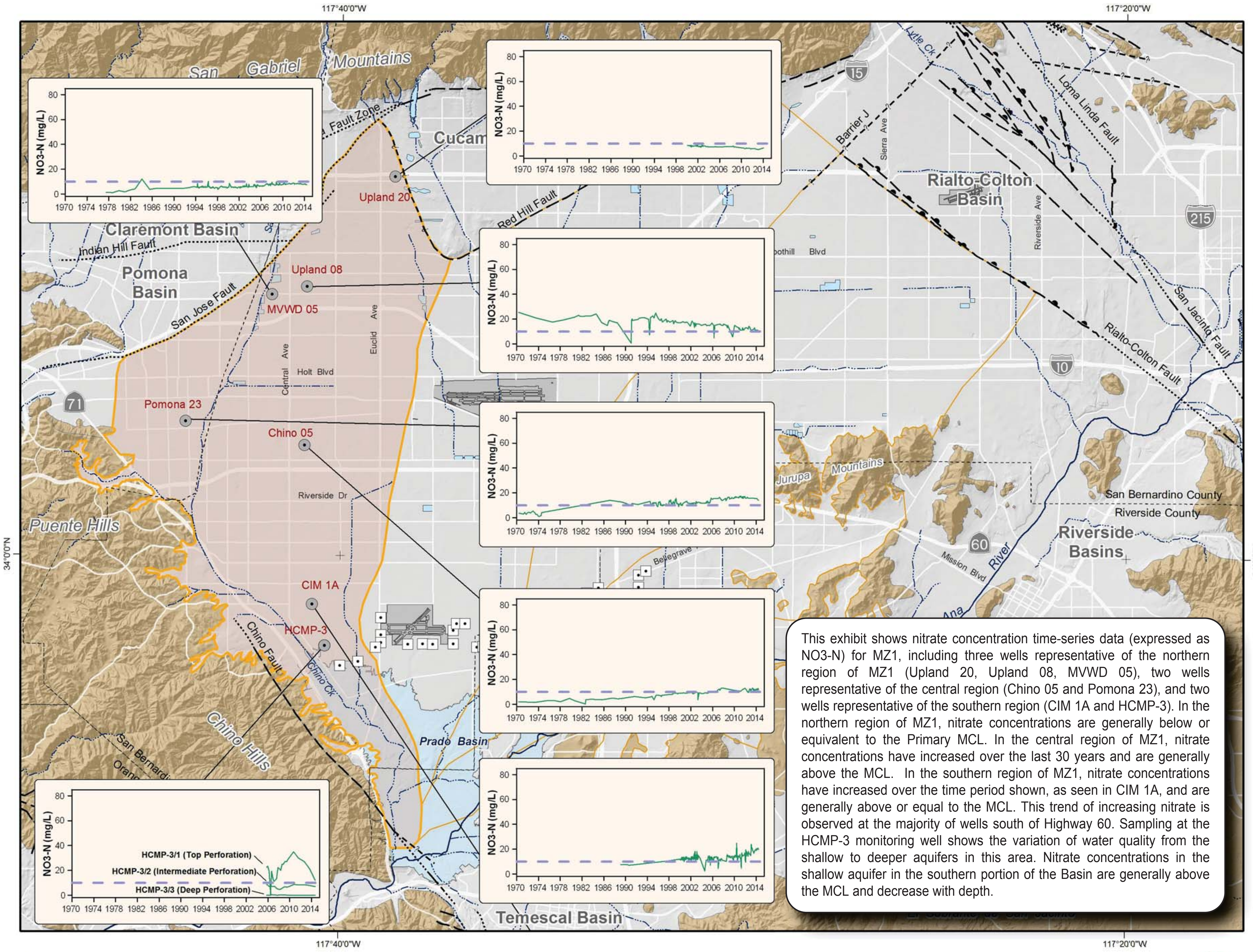
0 1 2 3 4 5 Miles
0 2 4 6 8 KM

2014 State of the Basin
Groundwater Quality

Chino Basin Management Zone 1

Trends in Total Dissolved Solids Concentrations

Exhibit 49

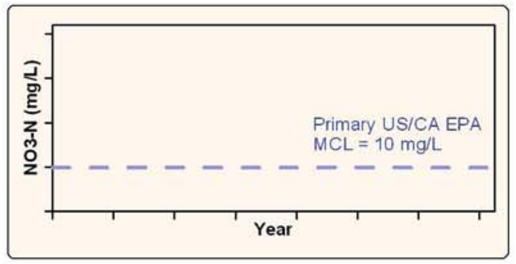


This exhibit shows nitrate concentration time-series data (expressed as NO3-N) for MZ1, including three wells representative of the northern region of MZ1 (Upland 20, Upland 08, MVWD 05), two wells representative of the central region (Chino 05 and Pomona 23), and two wells representative of the southern region (CIM 1A and HCMP-3). In the northern region of MZ1, nitrate concentrations are generally below or equivalent to the Primary MCL. In the central region of MZ1, nitrate concentrations have increased over the last 30 years and are generally above the MCL. In the southern region of MZ1, nitrate concentrations have increased over the time period shown, as seen in CIM 1A, and are generally above or equal to the MCL. This trend of increasing nitrate is observed at the majority of wells south of Highway 60. Sampling at the HCMP-3 monitoring well shows the variation of water quality from the shallow to deeper aquifers in this area. Nitrate concentrations in the shallow aquifer in the southern portion of the Basin are generally above the MCL and decrease with depth.

▭ MZ1 Boundary Area

◉ Representative MZ1 Wells

Nitrate as Nitrogen (NO3-N) Concentration



OBMP Management Zones

⊡ Chino Basin Desalter Well

Streams & Flood Control Channels

Recharge Basins and Spreading Grounds

Geology

Water-Bearing Sediments

Quaternary Alluvium

Consolidated Bedrock

Undifferentiated Pre-Tertiary to Early Pleistocene Igneous, Metamorphic, and Sedimentary Rocks

Faults

Location Certain	Location Concealed
Location Approximate	Location Uncertain
Approximate Location of Groundwater Barrier	

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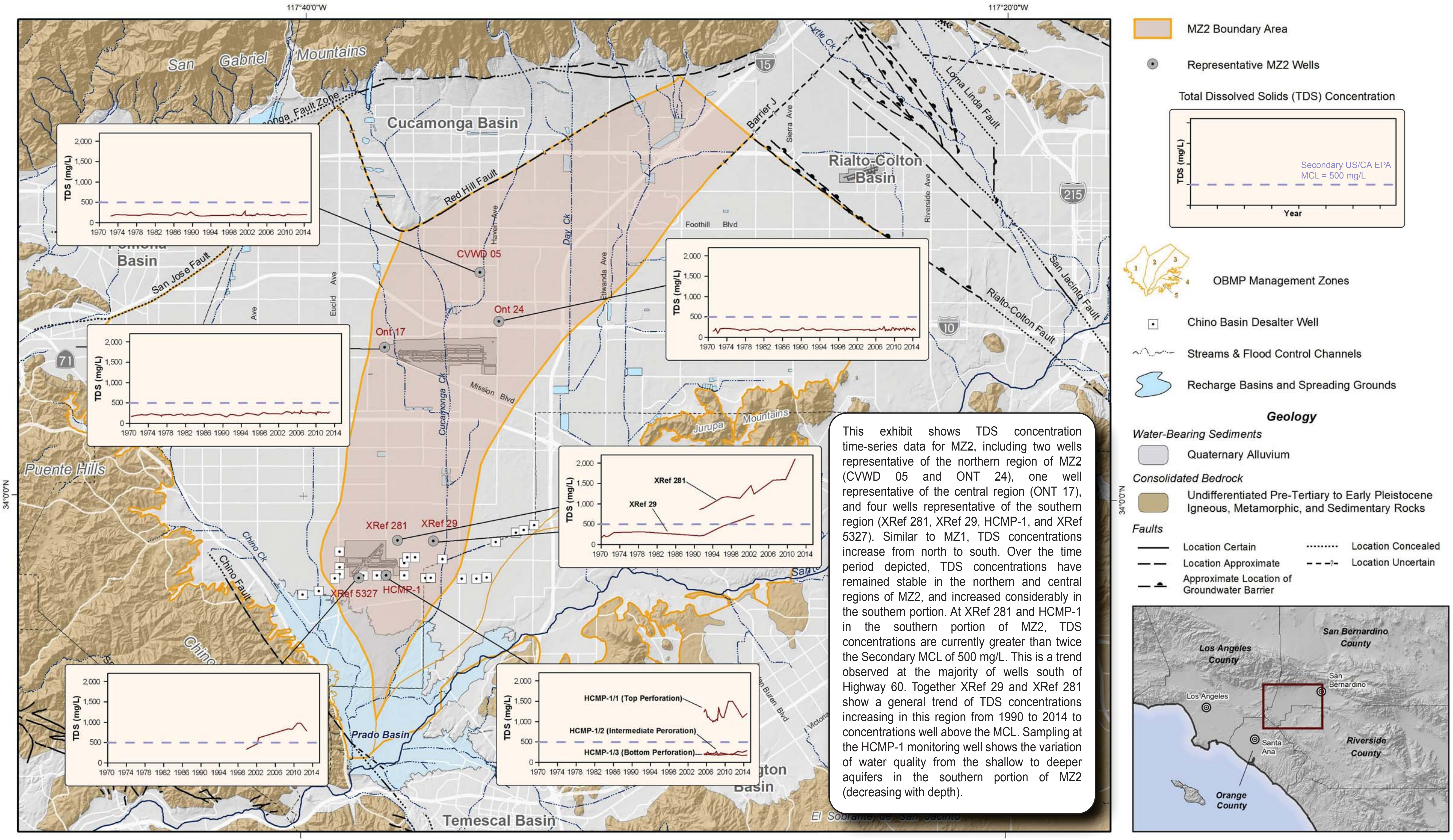
2014 State of the Basin
Groundwater Quality

Chino Basin Management Zone 1

Trends in Nitrate Concentrations

Exhibit 50



This exhibit shows TDS concentration time-series data for MZ2, including two wells representative of the northern region of MZ2 (CVWD 05 and ONT 24), one well representative of the central region (ONT 17), and four wells representative of the southern region (XRef 281, XRef 29, HCMP-1, and XRef 5327). Similar to MZ1, TDS concentrations increase from north to south. Over the time period depicted, TDS concentrations have remained stable in the northern and central regions of MZ2, and increased considerably in the southern portion. At XRef 281 and HCMP-1 in the southern portion of MZ2, TDS concentrations are currently greater than twice the Secondary MCL of 500 mg/L. This is a trend observed at the majority of wells south of Highway 60. Together XRef 29 and XRef 281 show a general trend of TDS concentrations increasing in this region from 1990 to 2014 to concentrations well above the MCL. Sampling at the HCMP-1 monitoring well shows the variation of water quality from the shallow to deeper aquifers in the southern portion of MZ2 (decreasing with depth).

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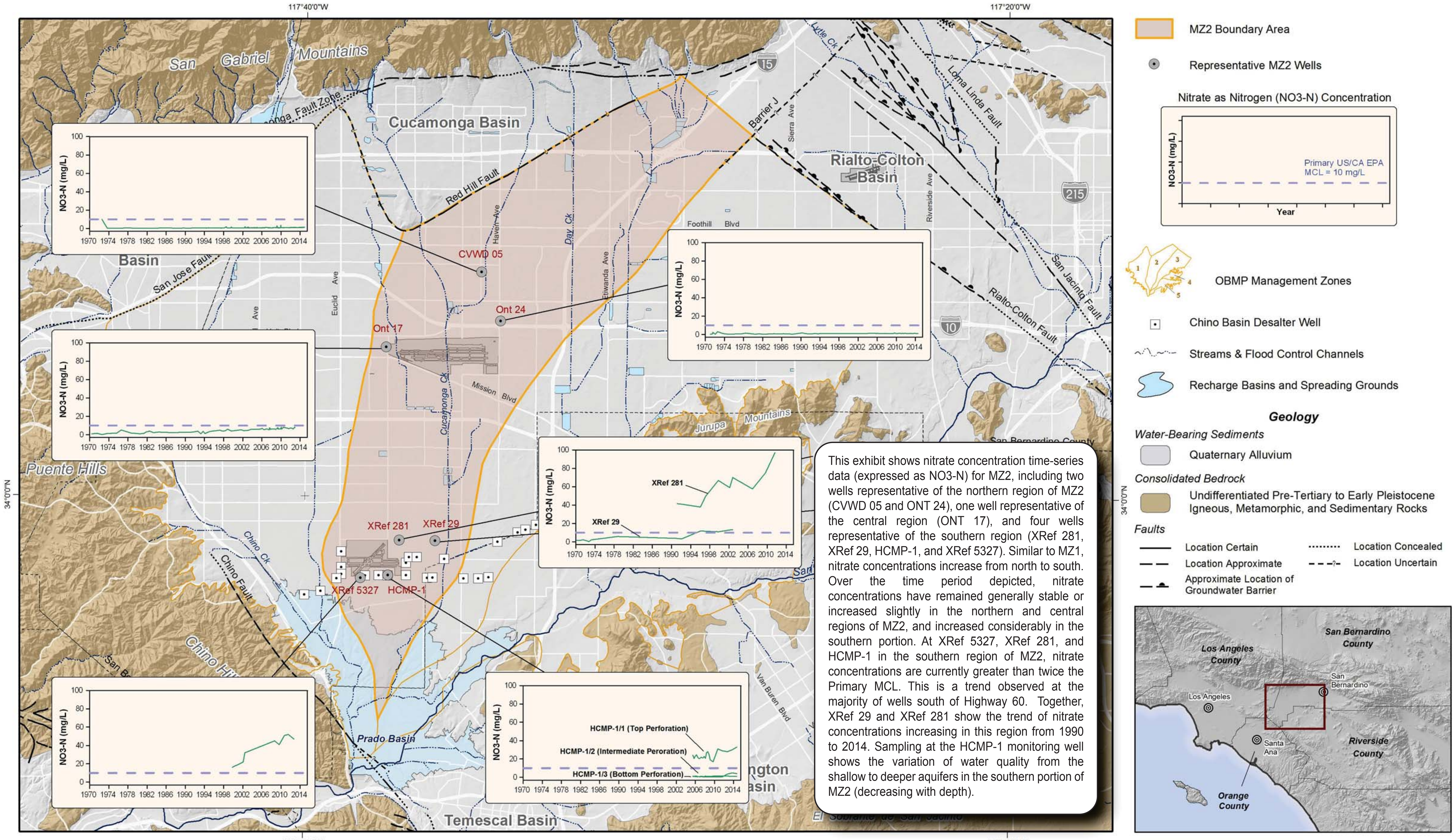
2014 State of the Basin
Groundwater Quality

Chino Basin Management Zone 2

Trends in Total Dissolved Solids Concentrations

Exhibit 51



This exhibit shows nitrate concentration time-series data (expressed as NO3-N) for MZ2, including two wells representative of the northern region of MZ2 (CVWD 05 and ONT 24), one well representative of the central region (ONT 17), and four wells representative of the southern region (XRef 281, XRef 29, HCMP-1, and XRef 5327). Similar to MZ1, nitrate concentrations increase from north to south. Over the time period depicted, nitrate concentrations have remained generally stable or increased slightly in the northern and central regions of MZ2, and increased considerably in the southern portion. At XRef 5327, XRef 281, and HCMP-1 in the southern region of MZ2, nitrate concentrations are currently greater than twice the Primary MCL. This is a trend observed at the majority of wells south of Highway 60. Together, XRef 29 and XRef 281 show the trend of nitrate concentrations increasing in this region from 1990 to 2014. Sampling at the HCMP-1 monitoring well shows the variation of water quality from the shallow to deeper aquifers in the southern portion of MZ2 (decreasing with depth).

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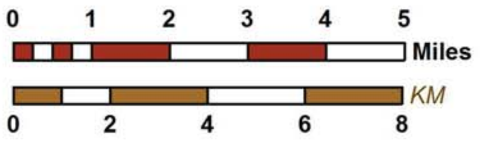
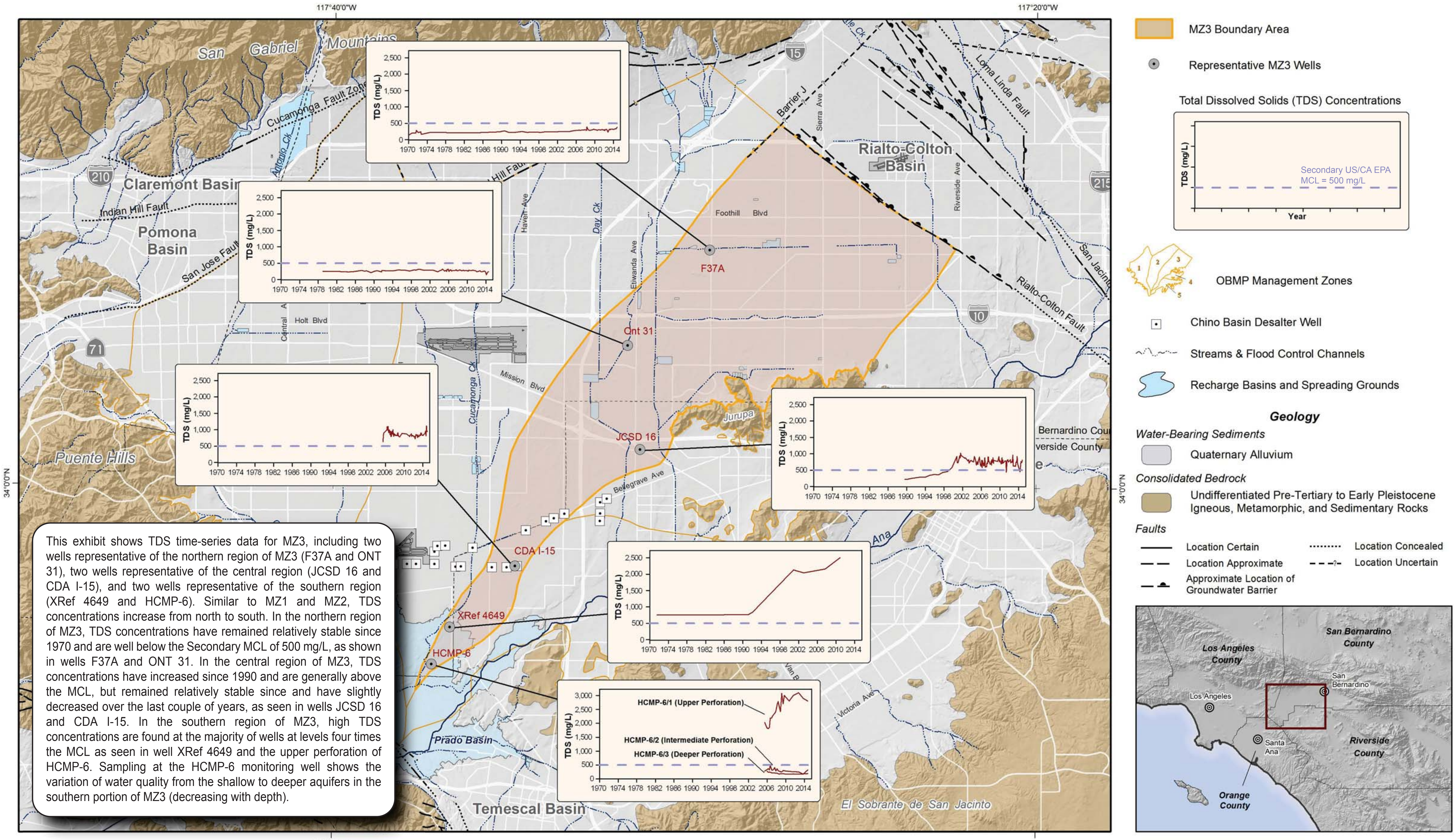


2014 State of the Basin
Groundwater Quality

Chino Basin Management Zone 2

Trends in Nitrate Concentrations

Exhibit 52



This exhibit shows TDS time-series data for MZ3, including two wells representative of the northern region of MZ3 (F37A and ONT 31), two wells representative of the central region (JCSD 16 and CDA I-15), and two wells representative of the southern region (XRef 4649 and HCMP-6). Similar to MZ1 and MZ2, TDS concentrations increase from north to south. In the northern region of MZ3, TDS concentrations have remained relatively stable since 1970 and are well below the Secondary MCL of 500 mg/L, as shown in wells F37A and ONT 31. In the central region of MZ3, TDS concentrations have increased since 1990 and are generally above the MCL, but remained relatively stable since and have slightly decreased over the last couple of years, as seen in wells JCSD 16 and CDA I-15. In the southern region of MZ3, high TDS concentrations are found at the majority of wells at levels four times the MCL as seen in well XRef 4649 and the upper perforation of HCMP-6. Sampling at the HCMP-6 monitoring well shows the variation of water quality from the shallow to deeper aquifers in the southern portion of MZ3 (decreasing with depth).

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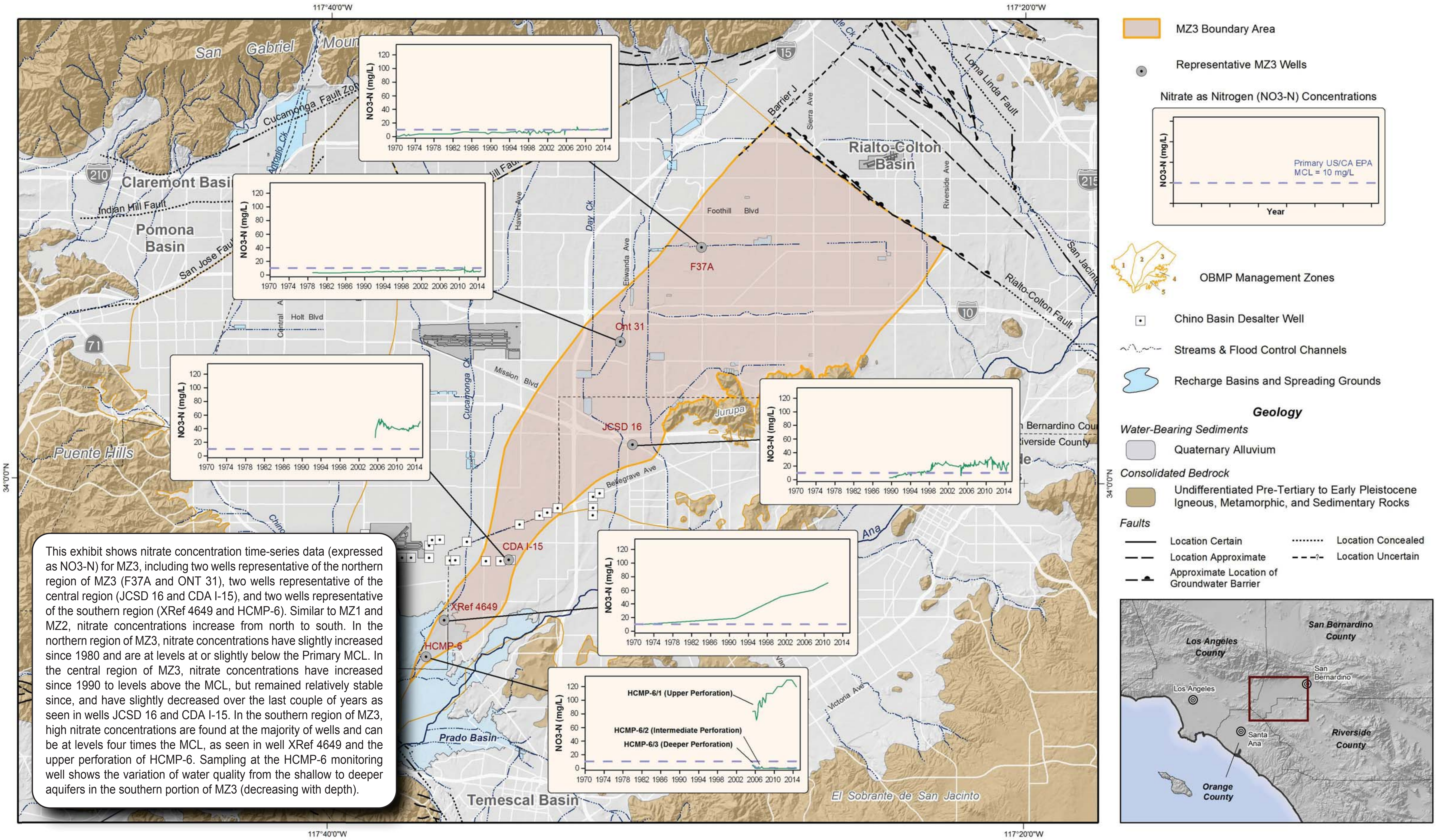
Document Name: Exhibit_53_MZ3_TDS

2014 State of the Basin
Groundwater Quality

Chino Basin Management Zone 3

Trends in Total Dissolved Solids Concentrations

Exhibit 53



This exhibit shows nitrate concentration time-series data (expressed as NO3-N) for MZ3, including two wells representative of the northern region of MZ3 (F37A and ONT 31), two wells representative of the central region (JCSD 16 and CDA I-15), and two wells representative of the southern region (XRef 4649 and HCMP-6). Similar to MZ1 and MZ2, nitrate concentrations increase from north to south. In the northern region of MZ3, nitrate concentrations have slightly increased since 1980 and are at levels at or slightly below the Primary MCL. In the central region of MZ3, nitrate concentrations have increased since 1990 to levels above the MCL, but remained relatively stable since, and have slightly decreased over the last couple of years as seen in wells JCSD 16 and CDA I-15. In the southern region of MZ3, high nitrate concentrations are found at the majority of wells and can be at levels four times the MCL, as seen in well XRef 4649 and the upper perforation of HCMP-6. Sampling at the HCMP-6 monitoring well shows the variation of water quality from the shallow to deeper aquifers in the southern portion of MZ3 (decreasing with depth).

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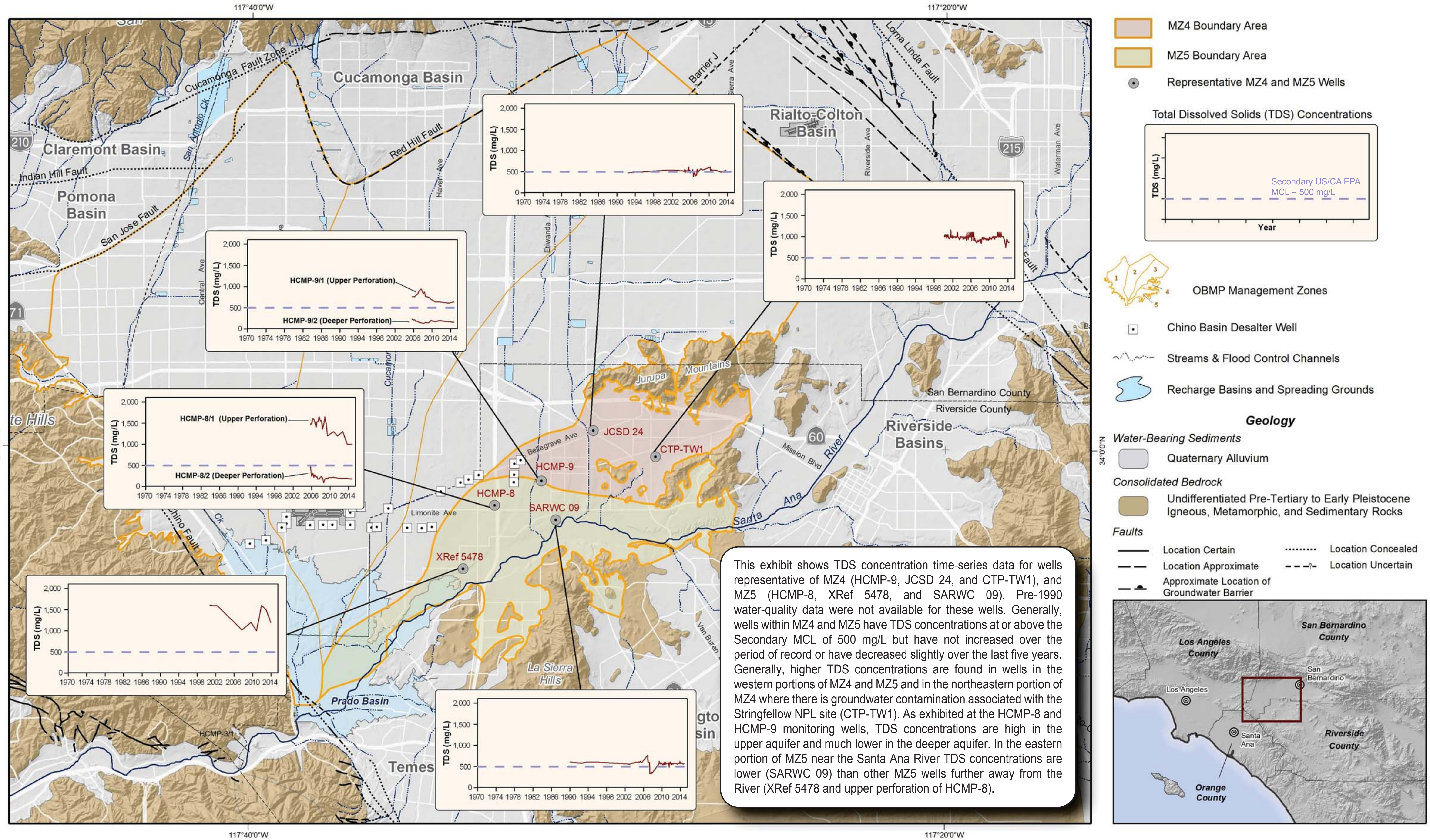
2014 State of the Basin
Groundwater Quality

Chino Basin Management Zone 3

Trends in Nitrate Concentrations

Exhibit 54



This exhibit shows TDS concentration time-series data for wells representative of MZ4 (HCMP-9, JCSD 24, and CTP-TW1), and MZ5 (HCMP-8, XRef 5478, and SARWC 09). Pre-1990 water-quality data were not available for these wells. Generally, wells within MZ4 and MZ5 have TDS concentrations at or above the Secondary MCL of 500 mg/L but have not increased over the period of record or have decreased slightly over the last five years. Generally, higher TDS concentrations are found in wells in the western portions of MZ4 and MZ5 and in the northeastern portion of MZ4 where there is groundwater contamination associated with the Stringfellow NPL site (CTP-TW1). As exhibited at the HCMP-8 and HCMP-9 monitoring wells, TDS concentrations are high in the upper aquifer and much lower in the deeper aquifer. In the eastern portion of MZ5 near the Santa Ana River TDS concentrations are lower (SARWC 09) than other MZ5 wells further away from the River (XRef 5478 and upper perforation of HCMP-8).

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Document Name: Exhibit_55_MZ4_5_TDS

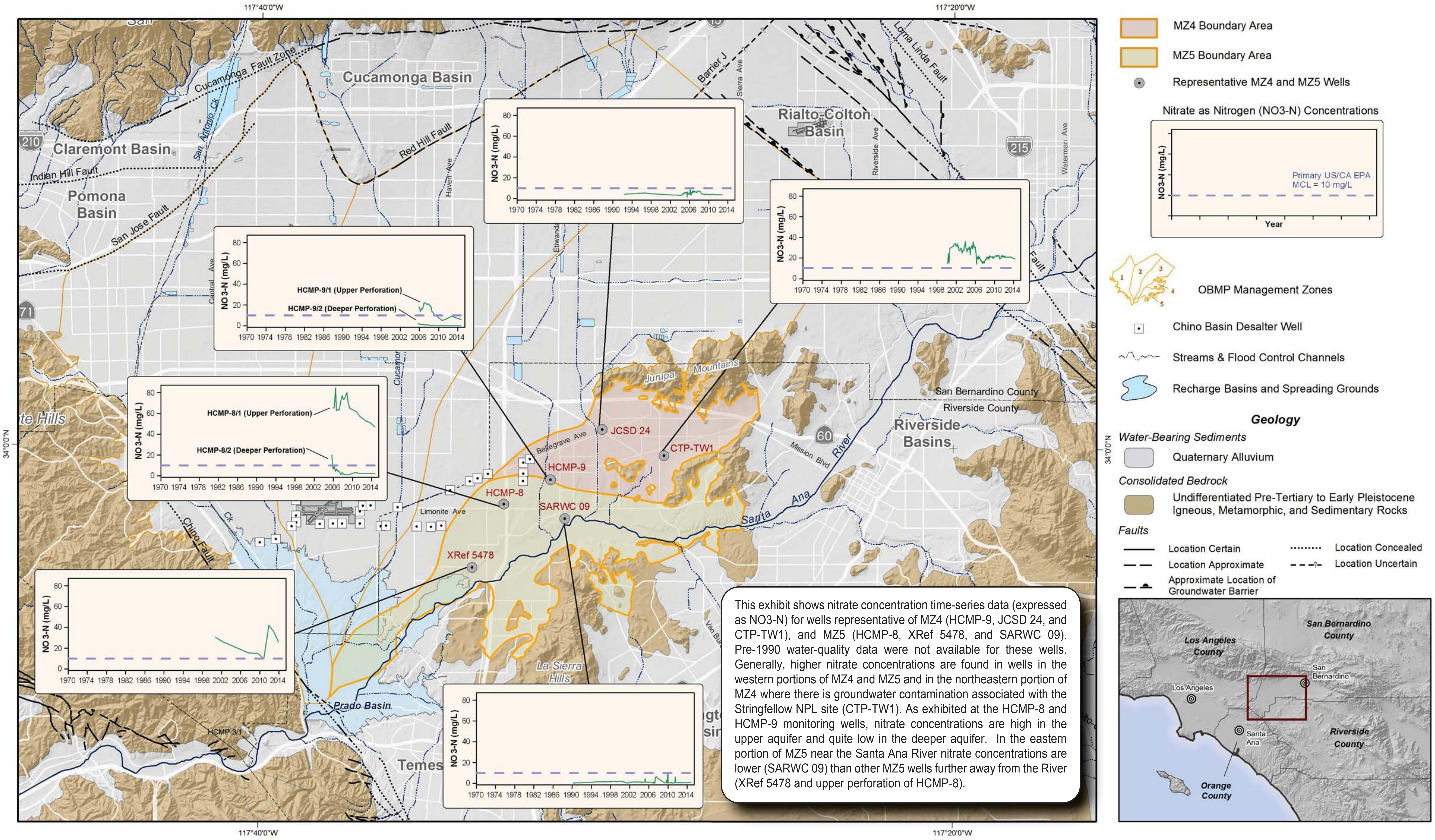
0 1 2 3 4 5 Miles
0 2 4 6 8 KM

2014 State of the Basin
Groundwater Quality

Chino Basin Management Zone 4 and Zone 5

Trends in Total Dissolved Solids Concentrations

Exhibit 55



This exhibit shows nitrate concentration time-series data (expressed as NO3-N) for wells representative of MZ4 (HCMP-9, JCSD 24, and CTP-TW1), and MZ5 (HCMP-8, XRef 5478, and SARWC 09). Pre-1990 water-quality data were not available for these wells. Generally, higher nitrate concentrations are found in wells in the western portions of MZ4 and MZ5 and in the northeastern portion of MZ4 where there is groundwater contamination associated with the Stringfellow NPL site (CTP-TW1). As exhibited at the HCMP-8 and HCMP-9 monitoring wells, nitrate concentrations are high in the upper aquifer and quite low in the deeper aquifer. In the eastern portion of MZ5 near the Santa Ana River nitrate concentrations are lower (SARWC 09) than other MZ5 wells further away from the River (XRef 5478 and upper perforation of HCMP-8).

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Document Name: Exhibit_56_MZ4_5_NO3

0 1 2 3 4 5 Miles
0 2 4 6 8 KM

2014 State of the Basin
Groundwater Quality

Chino Basin Management Zone 4 and Zone 5

Trends in Nitrate Concentrations

Exhibit 56

The exhibits in this section characterize the history and current state of land subsidence and ground fissuring in the Chino Basin using data from Watermaster's ground-level monitoring program.

One of the earliest indications of land subsidence in 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 pumping-induced decline of groundwater levels and subsequent aquifer-system compaction as the most likely cause of land subsidence and ground fissuring observed in MZ1. Program Element 1 – *Develop and Implement a Comprehensive Monitoring Program* called for basin-wide analysis of land subsidence via ground-level surveys and remote sensing (InSAR) and ongoing monitoring based on the analysis of the subsidence data. Program Element 4 – *Develop and Implement a Comprehensive Groundwater Management Plan for Management Zone 1* called for the development and implementation of an interim 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 management plan to abate future subsidence and fissuring or reduce it to tolerable levels.

In 2000, the Implementation Plan in the Peace Agreement called for an aquifer-system and land-subsidence investigation in the southwestern portion of MZ1 to support the development of a management plan for MZ1 (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, which retains continuing jurisdiction over the Chino Basin Adjudication, approved the MZ1 Plan and ordered its implementation. The MZ1 Plan calls for (1) the continued scope and frequency of monitoring implemented during the IMP within the MZ1 Managed Area (see Exhibit 58) and (2) expanded monitoring of the aquifer system and land subsidence in other areas of the Chino Basin where the IMP indicated concern for future subsidence and ground fissuring. Exhibit 58 and Exhibit 59 show the location of the so-called Areas of Subsidence Concern which are: Central MZ1, Northwest MZ1, Northeast, and Southeast Areas.

Watermaster's current ground-level monitoring program includes:

- *Piezometric Levels*. Piezometric levels are an important part of the ground-level monitoring program because piezometric changes are the mechanism for aquifer-system deformation and land subsidence. Watermaster monitors piezometric levels at about 30 wells as part of its ground-level monitoring program. Currently, a pressure-transducer/data-logger is installed at each of these wells and records one water-level reading every 15 minutes. Watermaster also records depth-specific water levels at the piezometers located at the Ayala Park Extensometer and Chino Creek Extensometer facilities once every 15 minutes.
- *Aquifer-System Deformation*. Watermaster records the vertical deformation of the aquifer-system at the Ayala Park Extensometer Facility (see Exhibit 58). At this facility, two extensometers are completed to depths of 550 ft-bgs (Shallow Extensometer) and 1,400 ft-bgs (Deep Extensometer). In 2012, Watermaster installed another extensometer facility south of the Chino Airport in the vicinity of the newly built CCWF (see Exhibit 59): the Chino Creek Extensometer Facility (CCX). The CCX also consists of two extensometers: one completed to a depth of 140 ft-bgs (CCX-1) and the other to 610 ft-bgs (CCX-2). Both facilities record the vertical component of aquifer-system compression and/or expansion once every 15 minutes, synchronized with the piezometric measurements.
- *Vertical Ground-Surface Deformation*. Watermaster monitors vertical ground-surface deformation via the ground-level surveying and remote sensing (InSAR) techniques established during the IMP. Currently, ground-level surveys are being conducted in the MZ1 Managed Area, the Southeast Area, and the Northwest MZ1 Area once per year. InSAR is the only monitoring technique being employed outside of these areas. InSAR data are collected and analyzed once per year.
- *Horizontal Ground-Surface Deformation*. Watermaster monitors horizontal ground-surface deformation across the historical zone of ground fissuring in the MZ1 Managed Area. These data are obtained by electronic distance measurements (EDMs) between benchmark monuments and by a horizontal extensometer and are used to characterize the horizontal component of ground motion caused by groundwater production on either side of the fissure zone.

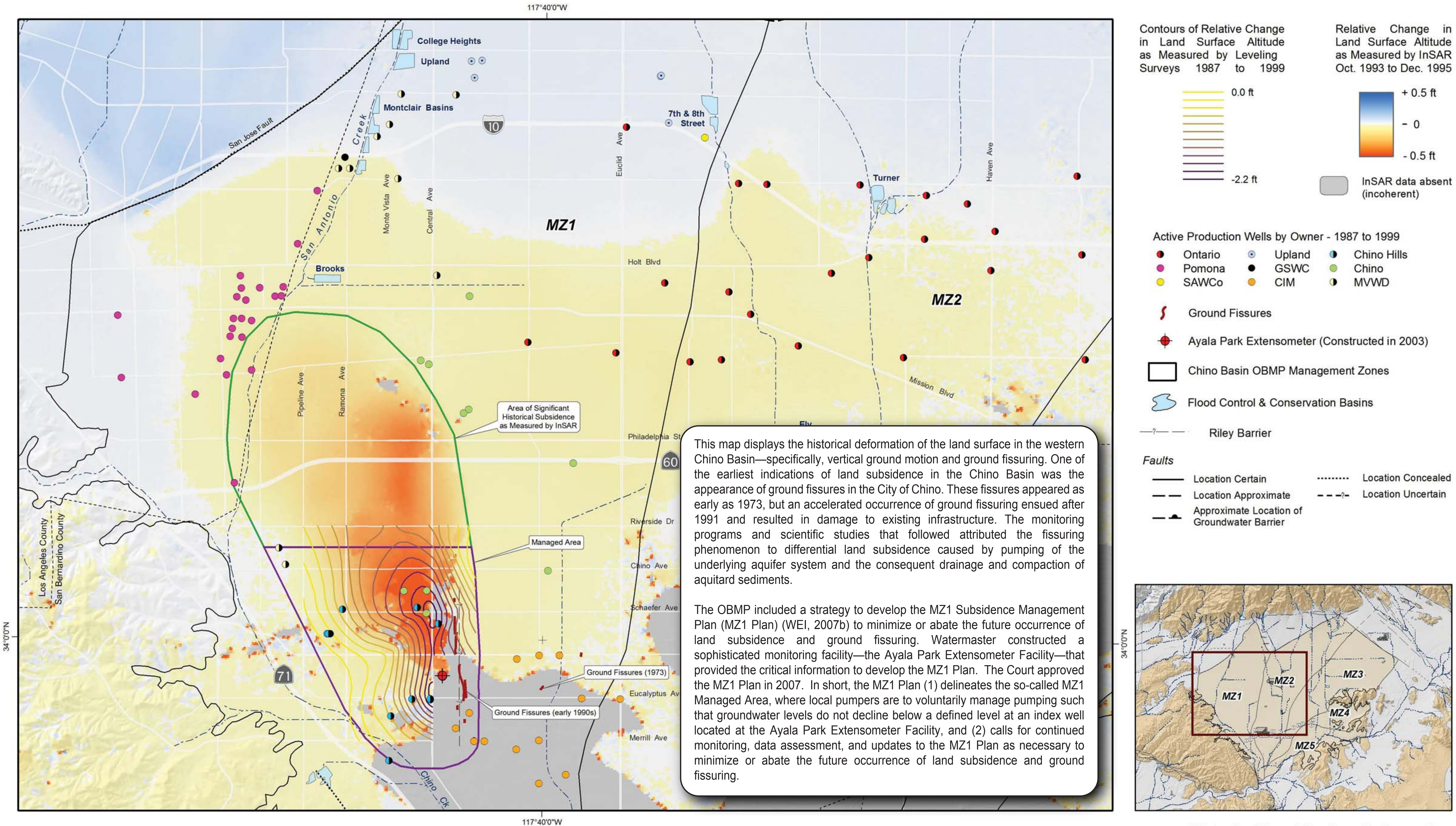
Exhibits 57 through 59 illustrate the historical occurrence of land subsidence in the Chino Basin, as interpreted from InSAR and ground-level surveys. These maps indicate that land subsidence concerns are primarily confined to the west side of the Chino Basin.

The land subsidence that has occurred in the Chino Basin was mainly controlled by changes in groundwater levels, which, in turn, were mainly controlled by pumping and recharge. Exhibits 60 through 64 show the relationships between groundwater pumping, recharge, recycled water reuse, groundwater levels, and vertical ground motion in the MZ1 Managed Area and the other Areas of Subsidence Concern. These graphics reveal cause-and-effect relationships, the current state of vertical ground motion, and the nature of the land subsidence.

Watermaster convenes a Ground-Level Monitoring Committee annually to review and interpret the data from the ground-level monitoring program. The committee evaluates the appropriateness of the Guidance Criteria in the MZ1 Plan and recommends changes if appropriate. The committee also recommends appropriate changes to the monitoring program.

Based on the data collected and analyzed for the ground-level monitoring program, the Ground-Level Monitoring Committee has become increasingly concerned with the occurrence of persistent differential subsidence within the Northwest MZ1 Area. Watermaster, consistent with the recommendation of the Ground-

Level Monitoring Committee, has determined that the MZ1 Plan needs to be updated to include a subsidence management plan for the Northwest MZ1 Area with the long-term objective to minimize or abate the occurrence of the differential land subsidence. This effort in the Northwest MZ1 Area is an example of adaptive management of land subsidence based on the monitoring data.



This map displays the historical deformation of the land surface in the western Chino Basin—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.

The OBMP included a strategy to develop the MZ1 Subsidence Management Plan (MZ1 Plan) (WEI, 2007b) to minimize or abate the future occurrence of land subsidence and ground fissuring. Watermaster constructed a sophisticated monitoring facility—the Ayala Park Extensometer Facility—that provided the critical information to develop the MZ1 Plan. The Court approved the MZ1 Plan in 2007. In short, the MZ1 Plan (1) delineates the so-called MZ1 Managed Area, where local pumpers are to voluntarily manage pumping such that groundwater levels do not decline below a defined level at an index well located at the Ayala Park Extensometer Facility, and (2) calls for continued monitoring, data assessment, and updates to the MZ1 Plan as necessary to minimize or abate the future occurrence of land subsidence and ground fissuring.

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Author: NWS
Date: 6/26/2015
File: Exhibit_57_InSAR

0 1 2 3 Miles
0 1 2 3 4 Kilometers

2014 State of the Basin
Ground-Level Monitoring

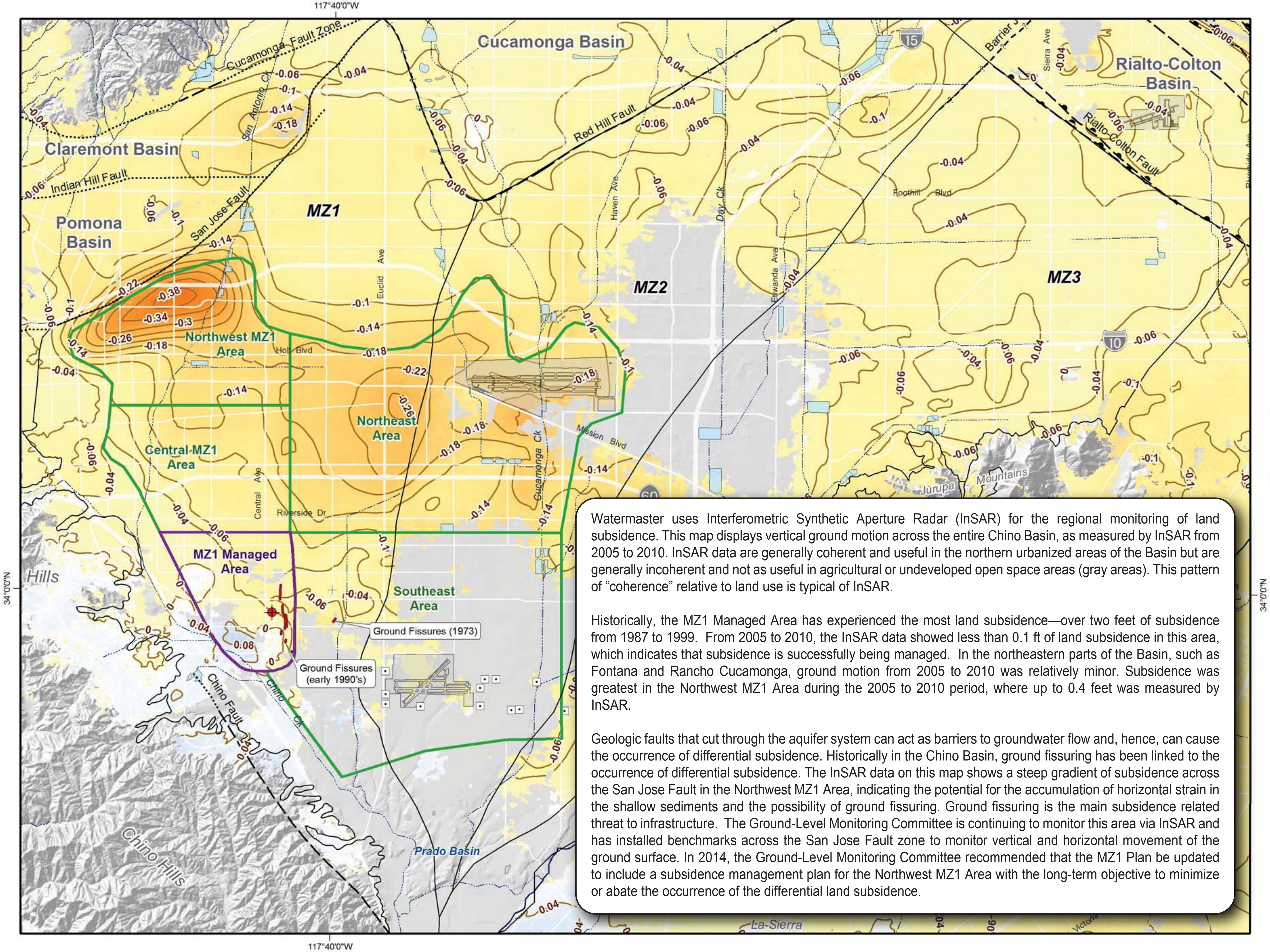
Historical Land Surface Deformation in Management Zone 1

Leveling Surveys (1987 to 1999) and InSAR (1993 to 1995)

Exhibit 57

Vertical Ground Motion as Measured by InSAR

2005 to 2010



Watermaster uses Interferometric Synthetic Aperture Radar (InSAR) for the regional monitoring of land subsidence. This map displays vertical ground motion across the entire Chino Basin, as measured by InSAR from 2005 to 2010. InSAR data are generally coherent and useful in the northern urbanized areas of the Basin but are generally incoherent and not as useful in agricultural or undeveloped open space areas (gray areas). This pattern of "coherence" relative to land use is typical of InSAR.

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

Geologic faults that cut through the aquifer system can act as barriers to groundwater flow and, hence, can cause the occurrence of differential subsidence. Historically in the Chino Basin, ground fissuring has been linked to the occurrence of differential subsidence. The InSAR data on this map shows a steep gradient of subsidence across the San Jose Fault in the Northwest MZ1 Area, indicating the potential for the accumulation of horizontal strain in the shallow sediments and the possibility of ground fissuring. Ground fissuring is the main subsidence related threat to infrastructure. The Ground-Level Monitoring Committee is continuing to monitor this area via InSAR and has installed benchmarks across the San Jose Fault zone to monitor vertical and horizontal movement of the ground surface. In 2014, the Ground-Level Monitoring Committee recommended that the MZ1 Plan be updated to include a subsidence management plan for the Northwest MZ1 Area with the long-term objective to minimize or abate the occurrence of the differential land subsidence.

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

+ 0.5 ft
0
-0.25
- 0.5 ft

▨ InSAR data absent (incoherent)

▣ Chino Basin Desalter Well

● Ayala Park Extensometer

☐ Chino Basin OBMP Management Zones

☐ MZ1 Managed Area

☐ Areas of Subsidence Concern

● Flood Control & Conservation Basins

Faults

- Location Certain
- Location Approximate
- Approximate Location of Groundwater Barrier
- Location Concealed
- Location Uncertain

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Date: 6/24/2015
File: Exhibit_58_InSAR

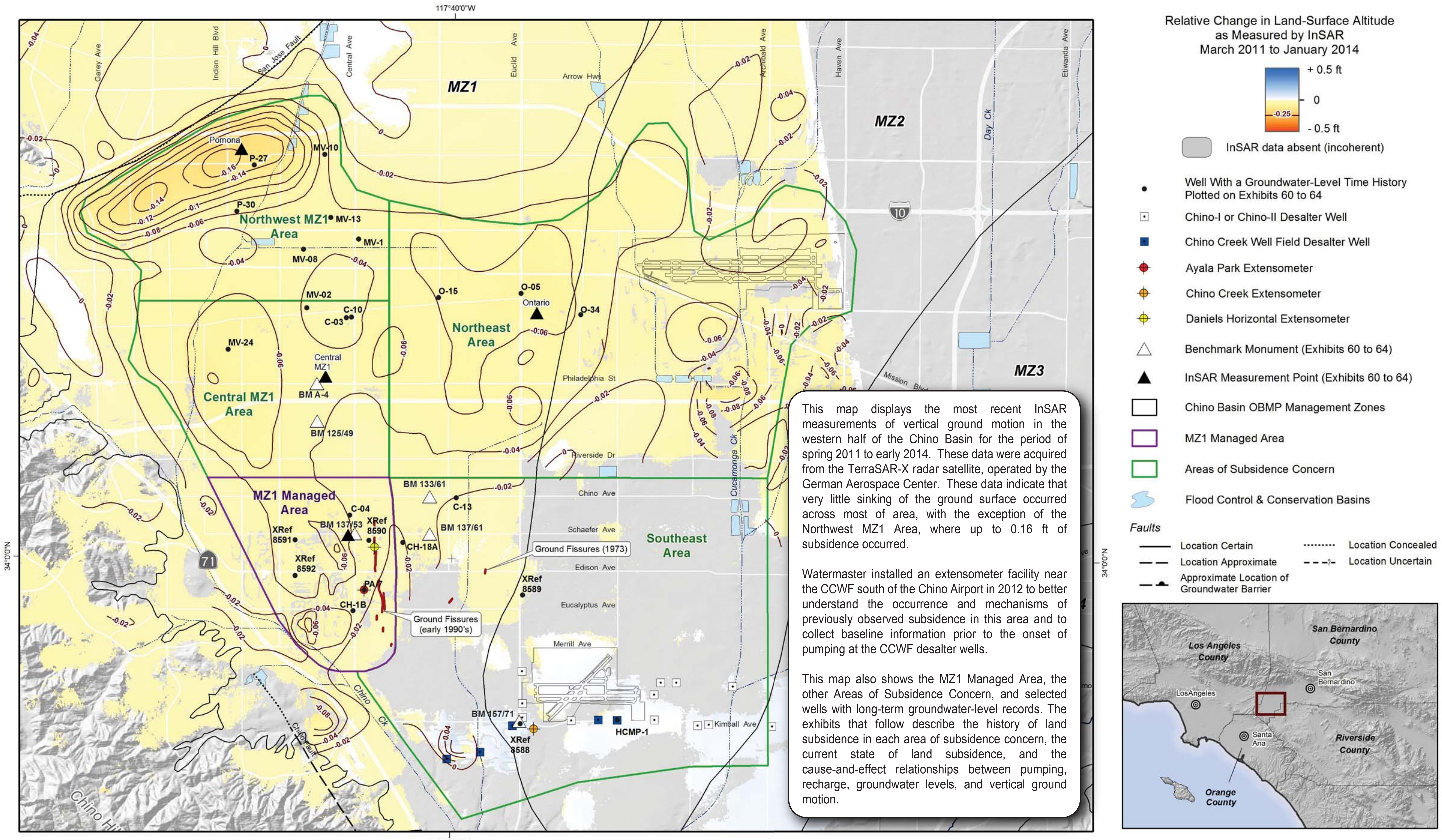
N

0 1 2 3 4 Miles

0 1 2 3 4 5 6 KM

2014 State of the Basin
Ground-Level Monitoring

Exhibit 58



This map displays the most recent InSAR measurements of vertical ground motion in the western half of the Chino Basin for the period of spring 2011 to early 2014. These data were acquired from the TerraSAR-X radar satellite, operated by the German Aerospace Center. These data indicate that very little sinking of the ground surface occurred across most of area, with the exception of the Northwest MZ1 Area, where up to 0.16 ft of subsidence occurred.

Watermaster installed an extensometer facility near the CCWF south of the Chino Airport in 2012 to better understand the occurrence and mechanisms of previously observed subsidence in this area and to collect baseline information prior to the onset of pumping at the CCWF desalter wells.

This map also shows the MZ1 Managed Area, the other Areas of Subsidence Concern, and selected wells with long-term groundwater-level records. The exhibits that follow describe the history of land subsidence in each area of subsidence concern, the current state of land subsidence, and the cause-and-effect relationships between pumping, recharge, groundwater levels, and vertical ground motion.

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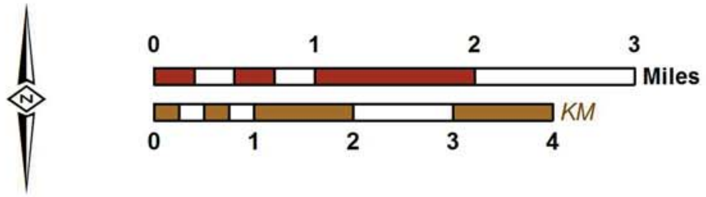
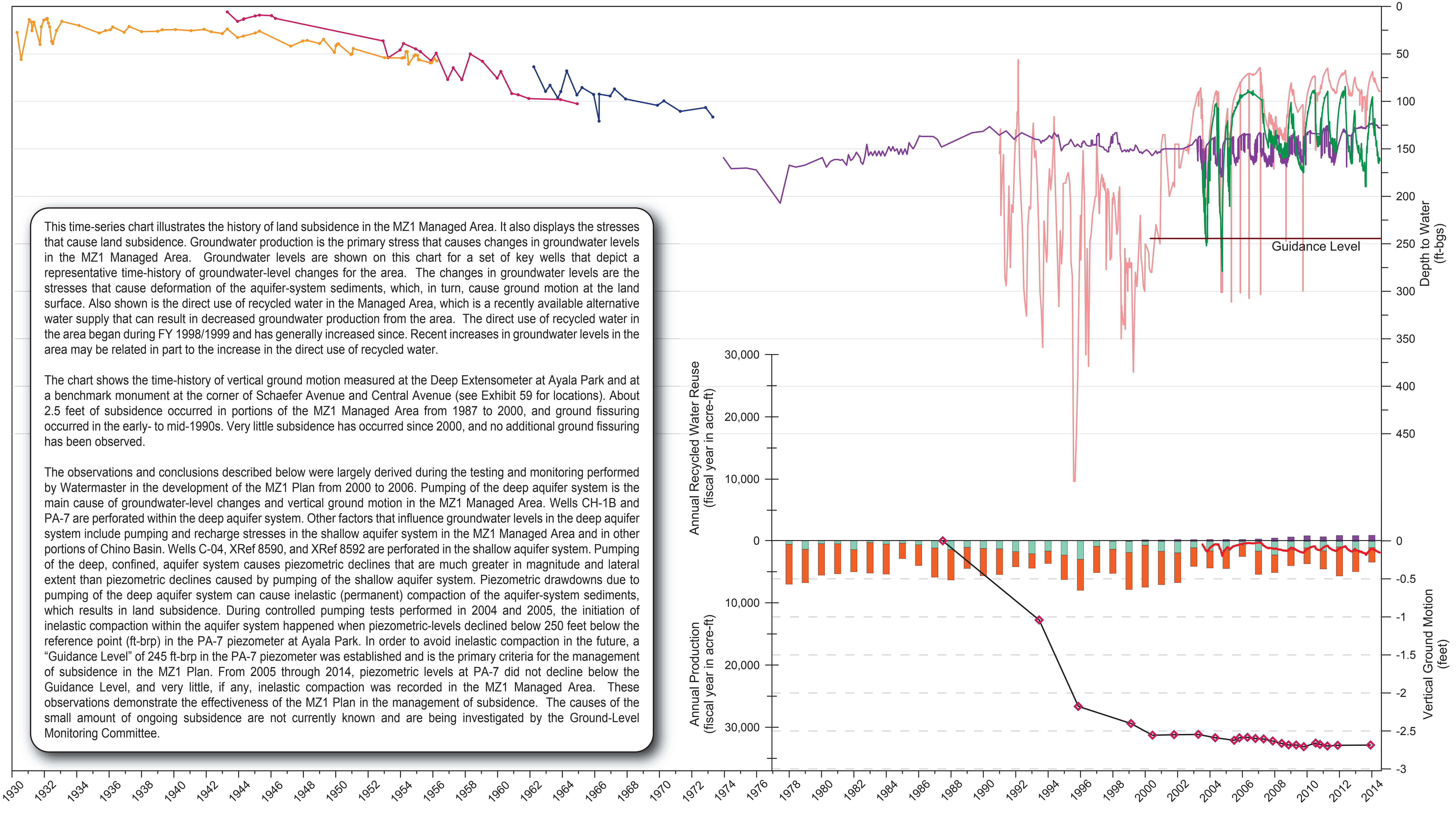


2014 State of the Basin
Ground-Level Monitoring

Vertical Ground Motion as Measured by InSAR

2011 to 2014

Exhibit 59



This time-series chart illustrates the history of land subsidence in the MZ1 Managed Area. It also displays the stresses that cause land subsidence. Groundwater production is the primary stress that causes changes in groundwater levels in the MZ1 Managed Area. Groundwater levels are shown on this chart for a set of key wells that depict a representative time-history of groundwater-level changes for the area. The changes in groundwater levels are the stresses that cause deformation of the aquifer-system sediments, which, in turn, cause ground motion at the land surface. Also shown is the direct use of recycled water in the Managed Area, which is a recently available alternative water supply that can result in decreased groundwater production from the area. The direct use of recycled water in the area began during FY 1998/1999 and has generally increased since. Recent increases in groundwater levels in the area may be related in part to the increase in the direct use of recycled water.

The chart shows the time-history of vertical ground motion measured at the Deep Extensometer at Ayala Park and at a benchmark monument at the corner of Schaefer Avenue and Central Avenue (see Exhibit 59 for locations). About 2.5 feet of subsidence occurred in portions of the MZ1 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.

The observations and conclusions described below were largely derived during the testing and monitoring performed by Watermaster in the development of the MZ1 Plan from 2000 to 2006. Pumping of the deep aquifer system is the main cause of groundwater-level changes and vertical ground motion in the MZ1 Managed Area. Wells CH-1B and PA-7 are perforated within the deep aquifer system. Other factors that influence groundwater levels in the deep aquifer system include pumping and recharge stresses in the shallow aquifer system in the MZ1 Managed Area and in other portions of Chino Basin. Wells C-04, XRef 8590, and XRef 8592 are perforated in the shallow aquifer system. Pumping of the deep, confined, aquifer system causes piezometric declines that are much greater in magnitude and lateral extent than piezometric declines caused by pumping of the shallow aquifer system. Piezometric drawdowns due to pumping of the deep aquifer system can cause inelastic (permanent) compaction of the aquifer-system sediments, which results in land subsidence. During controlled pumping tests performed in 2004 and 2005, the initiation of inelastic compaction within the aquifer system happened when piezometric-levels declined below 250 feet below the reference point (ft-brp) in the PA-7 piezometer at Ayala Park. In order to avoid inelastic compaction in the future, a “Guidance Level” of 245 ft-brp in the PA-7 piezometer was established and is the primary criteria for the management of subsidence in the MZ1 Plan. From 2005 through 2014, piezometric levels at PA-7 did not decline below the Guidance Level, and very little, if any, inelastic compaction was recorded in the MZ1 Managed Area. These observations demonstrate the effectiveness of the MZ1 Plan in the management of subsidence. The causes of the small amount of ongoing subsidence are not currently known and are being investigated by the Ground-Level Monitoring Committee.

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File: Exhibit_60_Managed.grf

Groundwater Levels at Wells (Top-Bottom Screen Interval)

Shallow Aquifer System
- C-04 (160-275 ft-bgs)
- XRef 8590 (80-225 ft-bgs)
- XRef 8591 (unknown)
- XRef 8592 (90-230 ft-bgs)

Deep Aquifer System
- CH-1B (440-1,180 ft-bgs)
- PA-7 (438-448 ft-bgs)

Vertical Ground Motion
- BM 137/53 Cumulative Displacement
- Ayala Park Deep Extensometer Measurements Between 30 and 1,400 ft-bgs

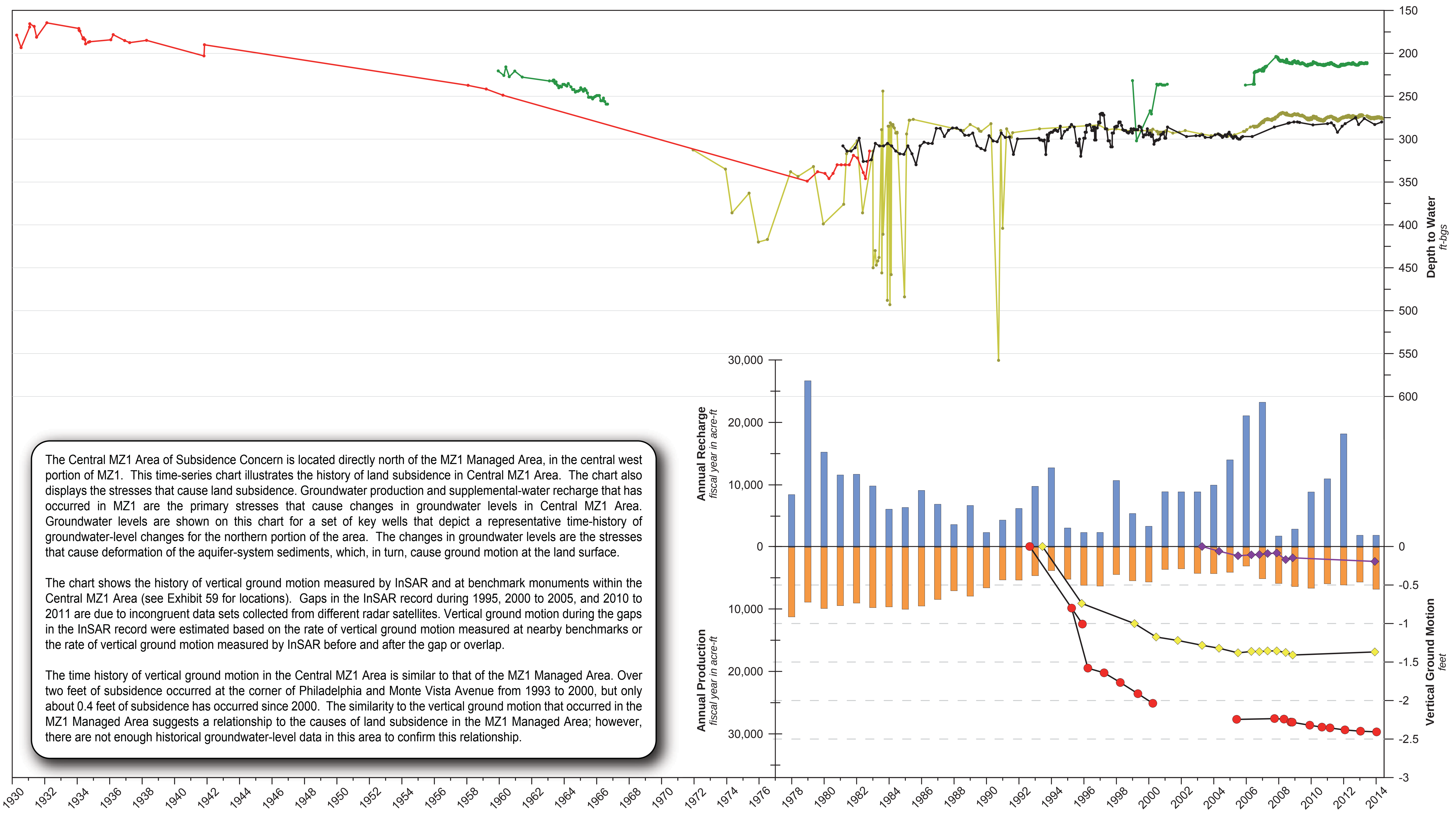
Recharge and Production
- Recycled Water Reuse Applied in the MZ1 Managed Area

Groundwater Production from Wells in the MZ1 Managed Area
- Deep Aquifer or Both Aquifers
- Shallow Aquifer or Unknown Aquifer

2014 State of the Basin
Ground-Level Monitoring

The History of Land Subsidence in the MZ1 Managed Area

Exhibit 60



The Central MZ1 Area of Subsidence Concern is located directly north of the MZ1 Managed Area, in the central west portion of MZ1. This time-series chart illustrates the history of land subsidence in Central MZ1 Area. The chart also displays the stresses that cause land subsidence. Groundwater production and supplemental-water recharge that has occurred in MZ1 are the primary stresses that cause changes in groundwater levels in Central MZ1 Area. Groundwater levels are shown on this chart for a set of key wells that depict a representative time-history of groundwater-level changes for the northern portion of the area. The changes in groundwater levels are the stresses that cause deformation of the aquifer-system sediments, which, in turn, cause ground motion at the land surface.

The chart shows the history of vertical ground motion measured by InSAR and at benchmark monuments within the Central MZ1 Area (see Exhibit 59 for locations). Gaps in the InSAR record during 1995, 2000 to 2005, and 2010 to 2011 are due to incongruent data sets collected from different radar satellites. Vertical ground motion during the gaps in the InSAR record were 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 gap or overlap.

The time history of vertical ground motion in the Central MZ1 Area is similar to that of the MZ1 Managed Area. Over two feet of subsidence occurred at the corner of Philadelphia and Monte Vista Avenue from 1993 to 2000, but only about 0.4 feet of subsidence has occurred since 2000. The similarity to the vertical ground motion that occurred in the MZ1 Managed Area suggests a relationship to the causes of land subsidence in the MZ1 Managed Area; however, there are not enough historical groundwater-level data in this area to confirm this relationship.

Groundwater Levels at Wells
(Top-Bottom Screen Interval)

- C-03 (230-450 ft-bgs)
- MV-24 (244-420 ft-bgs)
- MV-02 (397-962 ft-bgs)
- C-10 (355-1090 ft-bgs)

Vertical Ground Motion

- ● Central MZ1 Area InSAR
- ◆ BM A-4 Cumulative Displacement
- ◆ BM 125/49 Cumulative Displacement

Recharge and Production

- ▆ Recharge of Recycled Water, Storm Water*, and Imported Water at the College Heights, Upland, Montclair, and Brooks Recharge Basins; and at MVWD ASR Wells
*Storm Water is an estimated amount prior to Fiscal Year 04/05
- ▆ Groundwater Production from Wells in Central MZ1 Area

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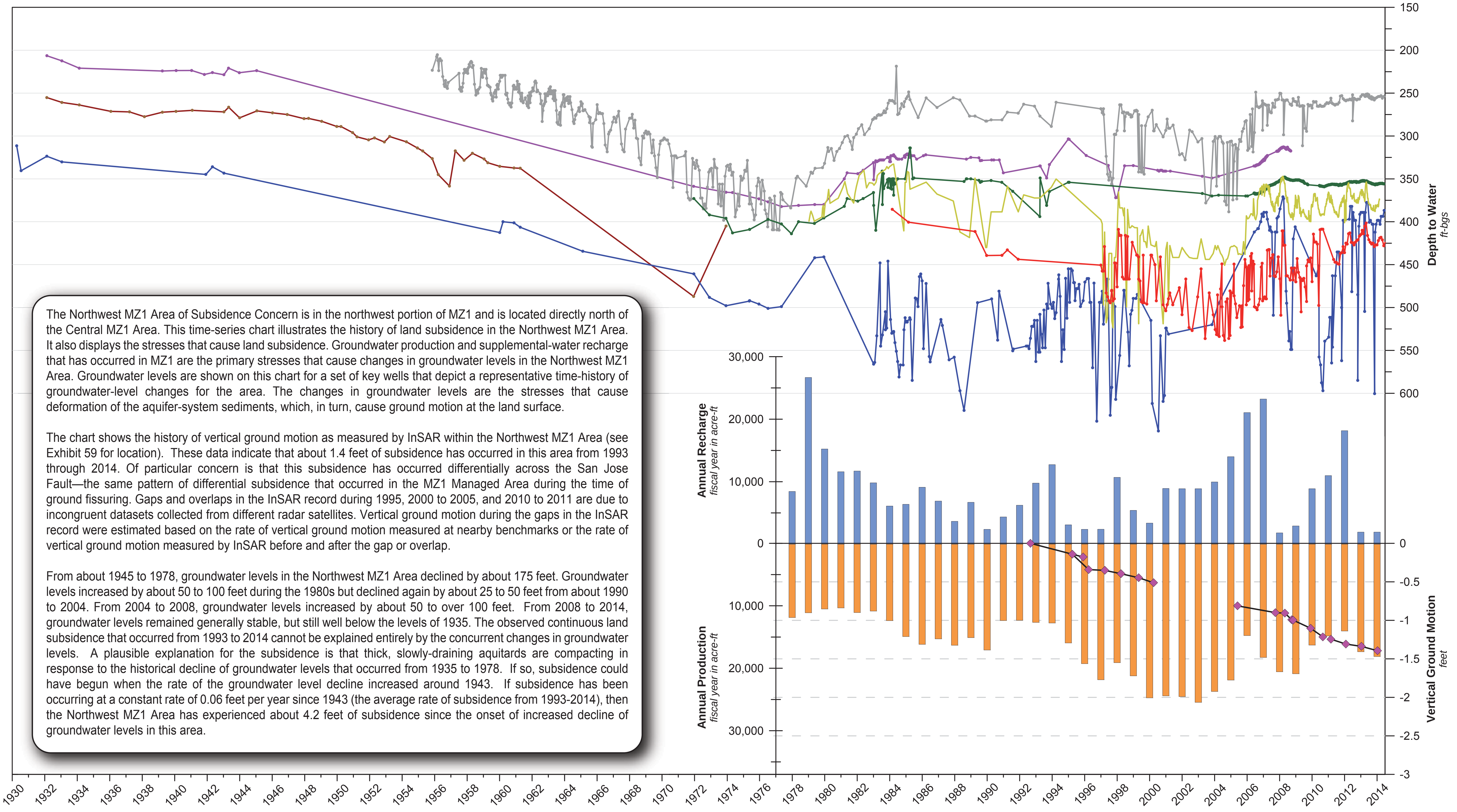
2014 State of the Basin
Ground-Level Monitoring

The History of Land Subsidence in the Central MZ1 Area

Exhibit 61



The Northwest MZ1 Area of Subsidence Concern is in the northwest portion of MZ1 and is located directly north of the Central MZ1 Area. This time-series chart illustrates the history of land subsidence in the Northwest MZ1 Area. It also displays the stresses that cause land subsidence. Groundwater production and supplemental-water recharge that has occurred in MZ1 are the primary stresses that cause changes in groundwater levels in the Northwest MZ1 Area. Groundwater levels are shown on this chart for a set of key wells that depict a representative time-history of groundwater-level changes for the area. The changes in groundwater levels are the stresses that cause deformation of the aquifer-system sediments, which, in turn, cause ground motion at the land surface.

The chart shows the history of vertical ground motion as measured by InSAR within the Northwest MZ1 Area (see Exhibit 59 for location). These data indicate that about 1.4 feet of subsidence has occurred in this area from 1993 through 2014. Of particular concern is that this subsidence has occurred differentially across the San Jose Fault—the same pattern of differential subsidence that occurred in the MZ1 Managed Area during the time of ground fissuring. Gaps and overlaps in the InSAR record during 1995, 2000 to 2005, and 2010 to 2011 are due to incongruent datasets collected from different radar satellites. Vertical ground motion during the gaps in the InSAR record were 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 gap or overlap.

From about 1945 to 1978, groundwater levels in the Northwest MZ1 Area declined by about 175 feet. Groundwater levels increased by about 50 to 100 feet during the 1980s but declined again by about 25 to 50 feet from about 1990 to 2004. From 2004 to 2008, groundwater levels increased by about 50 to over 100 feet. From 2008 to 2014, groundwater levels remained generally stable, but still well below the levels of 1935. The observed continuous land subsidence that occurred from 1993 to 2014 cannot be explained entirely by the concurrent changes in groundwater levels. A plausible explanation for the subsidence is that thick, slowly-draining aquitards are compacting in response to the historical decline of groundwater levels that occurred from 1935 to 1978. If so, subsidence could have begun when the rate of the groundwater level decline increased around 1943. If subsidence has been occurring at a constant rate of 0.06 feet per year since 1943 (the average rate of subsidence from 1993-2014), then the Northwest MZ1 Area has experienced about 4.2 feet of subsidence since the onset of increased decline of groundwater levels in this area.

Groundwater Levels at Wells (Top-Bottom Screen Interval)

- MV-01 (245-472 ft-bgs)
- MV-08 (225-447 ft-bgs)
- MV-10 (520-1084 ft-bgs)
- MV-13 (203-475 ft-bgs)
- P-18 (307-660 ft-bgs)
- P-27 (472-849 ft-bgs)
- P-30 (565-875 ft-bgs)

Vertical Ground Motion

- Northwest MZ1 Area InSAR Cumulative Displacement

Recharge and Production

- Recharge of Recycled Water, Storm Water*, and Imported Water at the College Heights, Upland, Montclair, and Brooks Recharge Basins; and at MVWD ASR Wells
*Storm Water is an estimated amount prior to Fiscal Year 04/05
- Groundwater Production from Wells in Northwest MZ1 Area

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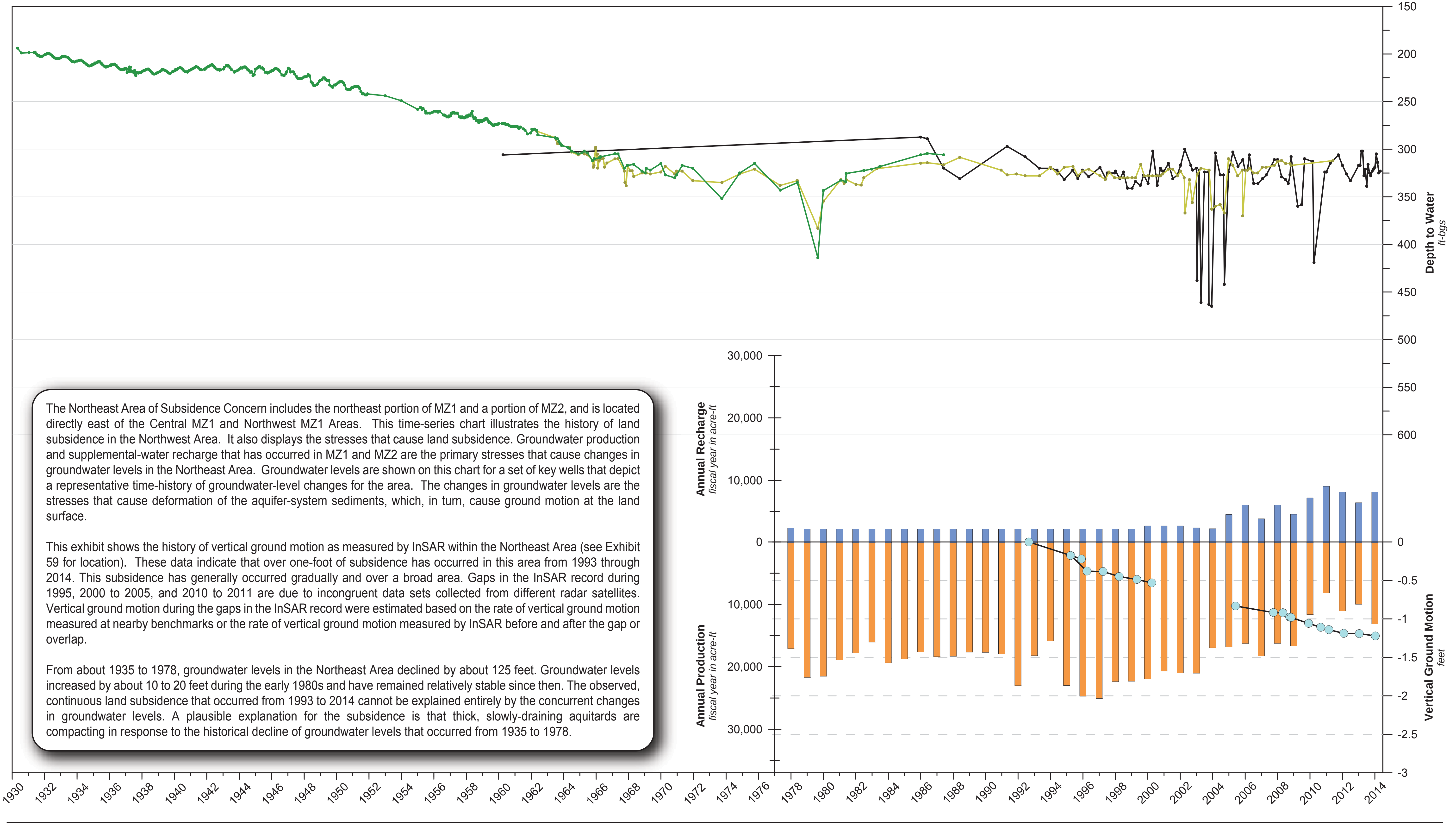
File: Exhibit_62_2014_Pomona.grf

The History of Land Subsidence in the Northwest MZ1 Area

2014 State of the Basin
Ground-Level Monitoring

Exhibit 62



The Northeast Area of Subsidence Concern includes the northeast portion of MZ1 and a portion of MZ2, and is located directly east of the Central MZ1 and Northwest MZ1 Areas. This time-series chart illustrates the history of land subsidence in the Northwest Area. It also displays the stresses that cause land subsidence. Groundwater production and supplemental-water recharge that has occurred in MZ1 and MZ2 are the primary stresses that cause changes in groundwater levels in the Northeast Area. Groundwater levels are shown on this chart for a set of key wells that depict a representative time-history of groundwater-level changes for the area. The changes in groundwater levels are the stresses that cause deformation of the aquifer-system sediments, which, in turn, cause ground motion at the land surface.

This exhibit shows the history of vertical ground motion as measured by InSAR within the Northeast Area (see Exhibit 59 for location). These data indicate that over one-foot of subsidence has occurred in this area from 1993 through 2014. This subsidence has generally occurred gradually and over a broad area. Gaps in the InSAR record during 1995, 2000 to 2005, and 2010 to 2011 are due to incongruent data sets collected from different radar satellites. Vertical ground motion during the gaps in the InSAR record were 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 gap or overlap.

From about 1935 to 1978, groundwater levels in the Northeast Area declined by about 125 feet. Groundwater levels increased by about 10 to 20 feet during the early 1980s and have remained relatively stable since then. The observed, continuous land subsidence that occurred from 1993 to 2014 cannot be explained entirely by the concurrent changes in groundwater levels. A plausible explanation for the subsidence is that thick, slowly-draining aquitards are compacting in response to the historical decline of groundwater levels that occurred from 1935 to 1978.

Groundwater Levels at Wells
(Top-Bottom Screen Interval)

- O-05 (360-470 ft-bgs)
- O-15 (474-966 ft-bgs)
- O-34 (522-1092 ft-bgs)

Vertical Ground Motion

- Northeast Area InSAR

Recharge and Production

🟦	Recharge of Recycled, Storm Water*, and Imported Water at the Ely, Grove, Turner, 7th Street and 8th Street Recharge Basins *Storm Water is an estimated amount prior to Fiscal Year 04/05
🟧	Groundwater Production from Wells in the Northeast Area

Prepared by:

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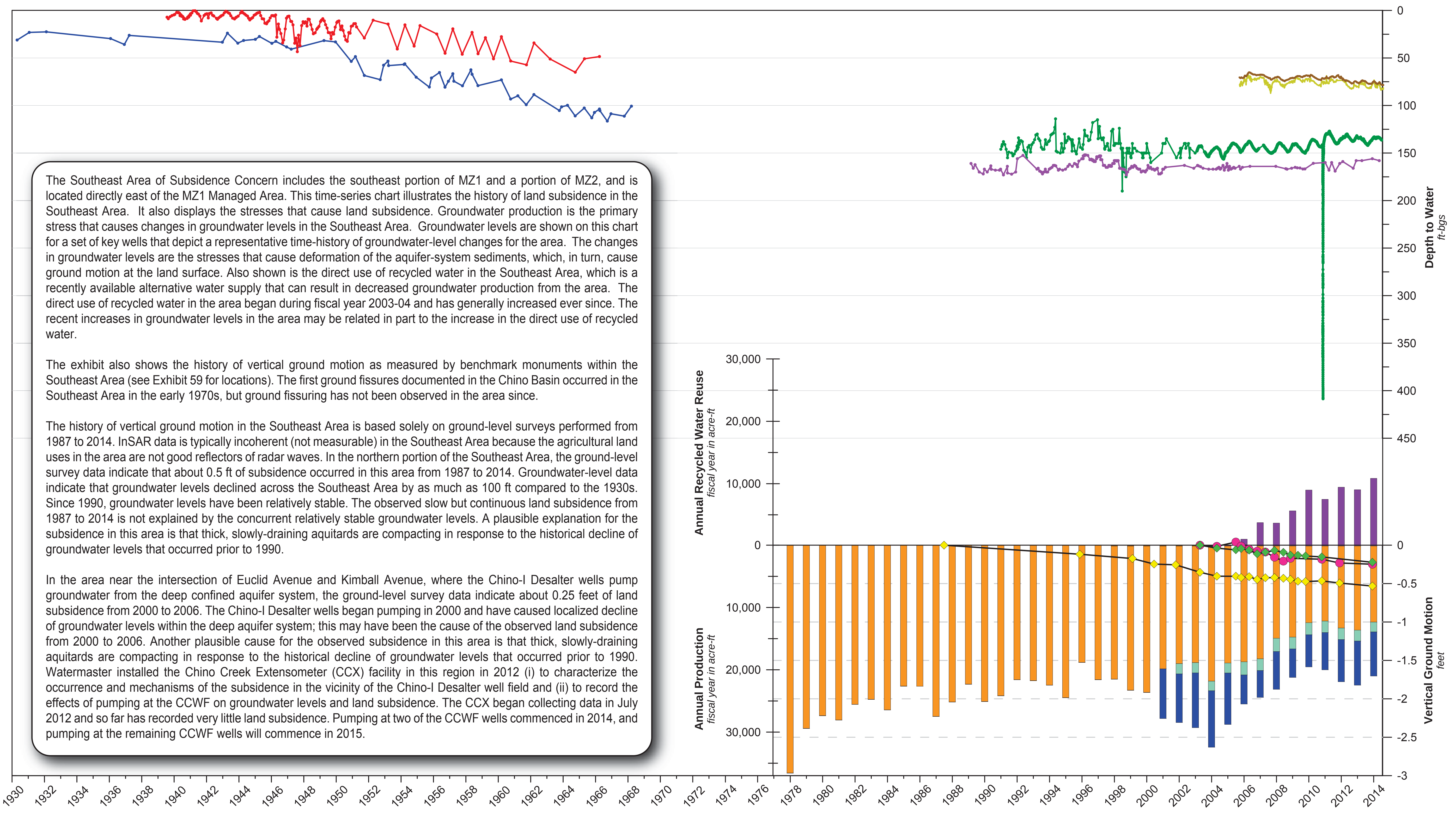
2014 State of the Basin
Ground-Level Monitoring

The History of Land Subsidence in the Northeast Area

Exhibit 63



The Southeast Area of Subsidence Concern includes the southeast portion of MZ1 and a portion of MZ2, and is located directly east of the MZ1 Managed Area. This time-series chart illustrates the history of land subsidence in the Southeast Area. It also displays the stresses that cause land subsidence. Groundwater production is the primary stress that causes changes in groundwater levels in the Southeast Area. Groundwater levels are shown on this chart for a set of key wells that depict a representative time-history of groundwater-level changes for the area. The changes in groundwater levels are the stresses that cause deformation of the aquifer-system sediments, which, in turn, cause ground motion at the land surface. Also shown is the direct use of recycled water in the Southeast Area, which is a recently available alternative water supply that can result in decreased groundwater production from the area. The direct use of recycled water in the area began during fiscal year 2003-04 and has generally increased ever since. The recent increases in groundwater levels in the area may be related in part to the increase in the direct use of recycled water.

The exhibit also shows the history of vertical ground motion as measured by benchmark monuments within the Southeast Area (see Exhibit 59 for locations). 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.

The history of vertical ground motion in the Southeast Area is based solely on ground-level surveys performed from 1987 to 2014. InSAR data is typically incoherent (not measurable) in the Southeast Area because the agricultural land uses in the area are not good reflectors of radar waves. In the northern portion of the Southeast Area, the ground-level survey data indicate that about 0.5 ft of subsidence occurred in this area from 1987 to 2014. Groundwater-level data indicate that groundwater levels declined across the Southeast Area by as much as 100 ft compared to the 1930s. Since 1990, groundwater levels have been relatively stable. The observed slow but continuous land subsidence from 1987 to 2014 is not explained by the concurrent relatively stable groundwater levels. A plausible explanation for the subsidence in this area is that thick, slowly-draining aquitards are compacting in response to the historical decline of groundwater levels that occurred prior to 1990.

In the area near the intersection of Euclid Avenue and Kimball Avenue, where the Chino-I Desalter wells pump groundwater from the deep confined aquifer system, the ground-level survey data indicate about 0.25 feet of land subsidence from 2000 to 2006. The Chino-I Desalter wells began pumping in 2000 and have caused localized decline of groundwater levels within the deep aquifer system; this may have been the cause of the observed land subsidence from 2000 to 2006. Another plausible cause for the observed subsidence in this area is that thick, slowly-draining aquitards are compacting in response to the historical decline of groundwater levels that occurred prior to 1990. Watermaster installed the Chino Creek Extensometer (CCX) facility in this region in 2012 (i) to characterize the occurrence and mechanisms of the subsidence in the vicinity of the Chino-I Desalter well field and (ii) to record the effects of pumping at the CCWF on groundwater levels and land subsidence. The CCX began collecting data in July 2012 and so far has recorded very little land subsidence. Pumping at two of the CCWF wells commenced in 2014, and pumping at the remaining CCWF wells will commence in 2015.

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2014 State of the Basin
Ground-Level Monitoring

The History of Land Subsidence in the Southeast Area

Exhibit 64

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