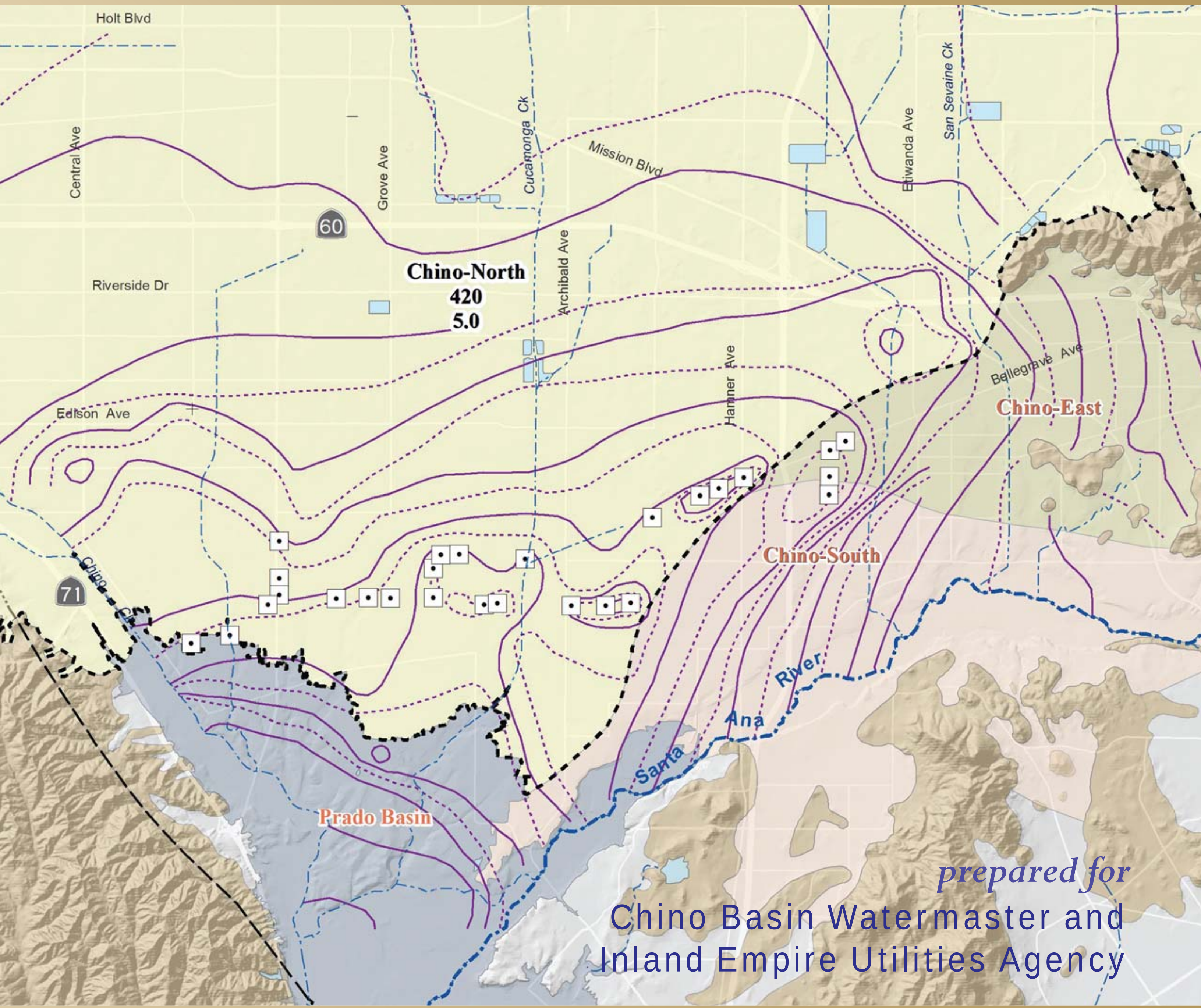
Optimum Basin Management Program

Chino Basin Maximum Benefit Annual Report 2016



prepared for

Chino Basin Watermaster and Inland Empire Utilities Agency

April 2017

WEI
Wildermuth Environmental, Inc.

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April 14, 2017

Regional Water Quality Control Board, Santa Ana Region
Attention: Mr. Kurt Berchtold
3737 Main Street, Suite 500
Riverside, California 92501-3348

Subject: Transmittal of the Chino Basin 2016 Maximum Benefit Annual Report

Dear Mr. Berchtold:

The Chino Basin Watermaster (Watermaster) and Inland Empire Utilities Agency (IEUA) hereby submit the Chino Basin Maximum Benefit Annual Report for 2016. This Annual Report is in partial fulfillment of the maximum benefit commitments made by Watermaster and the IEUA as discussed in Resolution No. R8-2004-0001 and its attachment: *Resolution Amending the Water Quality Control Plan for the Santa Ana River Basin to Incorporate an Updated Total Dissolved Solids (TDS) and Nitrogen Management Plan for the Santa Ana Region Including Revised Groundwater Subbasin Boundaries, Revised TDS and Nitrate-Nitrogen Quality Objectives for Groundwater, Revised TDS and Nitrogen Wasteload Allocations, and Revised Reach Designations, TDS and Nitrogen Objectives and Beneficial Uses for Specific Surface Waters.* Table 5-8a in the attachment to the Resolution identifies the Chino Basin Maximum Benefit Commitments which are specific projects and requirements that must be implemented to demonstrate that water quality consistent with maximum benefit to the people of the state will be maintained. This Annual Report describes the status of compliance with each commitment and the work performed during 2016.

If you have any questions, please do not hesitate to call.

Sincerely,

Chino Basin Watermaster

Peter Kavounas, P.E.
General Manager

Inland Empire Utilities Agency

Sylvie Lee, P.E.
Manager of Planning &
Environmental Resources

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Acronyms, Abbreviations, and Initialisms

acre-ft/yr	acre-feet per year
Basin Plan	Water Quality Control Plan for the Santa Ana River Basin
CCWF	Chino Creek Well Field
CDA	Chino Basin Desalter Authority
Chino-North	Chino-North Groundwater Management Zone
DTSC	California Department of Toxic Substance Control
ET	evapotranspiration
GMZ	Groundwater Management Zone
GWQMP	Groundwater Quality Monitoring Program
HCMP	Hydraulic Control Monitoring Program
IEUA	Inland Empire Utilities Agency
Judgment	OCWD vs. City of Chino et al., Case No. 117628, County of Riverside
mgd	million gallons per day
mg/L	milligrams per liter
MS	Microsoft
NAWQA	National Water Quality Assessment
OBMP	Optimum Basin Management Program
OCWD	Orange County Water District
PBHSP	Prado Basin Habitat Sustainability Program
PBMZ	Prado Basin Management Zone
Regional Board	Regional Water Quality Control Board, Santa Ana Region
SAR	Santa Ana River
SARWC	Santa Ana River Water Company
SARWM	Santa Ana River Watermaster
SOB	State of the Basin
SWP	State Water Project
TCS	trichloroethene
TDS	total dissolved solids
TIN	total inorganic nitrogen
USGS	United States Geological Survey
VOC	volatile organic compound
Watermaster	Chino Basin Watermaster
WEI	Wildermuth Environmental, Inc.

Section 1 – Introduction

This 2016 Maximum Benefit Annual Report was prepared by the Chino Basin Watermaster (Watermaster) and the Inland Empire Utilities Agency (IEUA) pursuant to their maximum-benefit commitments, as described in the Water Quality Control Plan for the Santa Ana River Basin (Basin Plan) (California Regional Water Quality Control Board, Santa Ana Region [Regional Board], 2008).

This introductory section provides background on: the Chino Basin Optimum Basin Management Program (OBMP) and Implementation Plan; the Regional Board's recognition of the Chino Basin OBMP Implementation Plan; the establishment of alternative, maximum-benefit groundwater-quality objectives for the Chino Basin; and the commitments made by Watermaster and the IEUA when the Regional Board granted them access to the assimilative capacity created by the application of the maximum-benefit objectives for regulatory purposes. This Annual Report describes the status of compliance with each commitment and the work performed during calendar year 2016.

1.1 Investigations of the Relationship between Groundwater Production and Santa Ana River Discharge

Figure 1-1 is a map of the Chino Basin. Groundwater generally flows from the forebay regions in the north and east toward the Prado Basin, where rising groundwater can become surface water in the Santa Ana River and its tributaries. Recent and past studies have provided some insight into the influence of groundwater production in the southern end of the Chino Basin on the Safe Yield of the Basin and the ability of production in this part of the Basin to control the discharge of rising groundwater to the Prado Basin and Santa Ana River. Several studies, as discussed below, quantify the impacts of the groundwater desalters in the southern Chino Basin on groundwater discharge to the Prado Basin and the Santa Ana River.

Desalter well fields were first described in *Nitrogen and TDS Studies, Upper Santa Ana Watershed* (James M. Montgomery, Consulting Engineers, Inc., 1991). This study matched desalter production to meet future potable demands in the lower Chino Basin through 2015. Well fields were sited to maximize the interception of rising groundwater discharge from the north and to induce streambed percolation in the Santa Ana River. The decrease in rising groundwater and increase in streambed infiltration were projected to account for 45 to 65 percent of total desalter production.

A design study for the Chino Basin Desalter well fields provided estimates of the volume of rising groundwater discharge intercepted by desalter production (Wildermuth, 1993). This study used a detailed model of the lower Chino Basin (a rectangular grid with 400-foot by 400-foot cells, covering the southern Chino Basin) to evaluate the hydraulic impacts of desalter production on rising groundwater discharge and groundwater levels at nearby wells. This study showed the relationship of intercepting rising groundwater discharge to well field locations and capacity. The fraction of total desalter well production composed of decreased rising groundwater discharge and increased streambed infiltration was estimated to range from 40 to 50 percent.

A subsequent analysis, consistent with the OBMP Implementation Plan and the Peace II Agreement, projected the increase in streambed infiltration to be about 20 percent of desalter production due to Watermaster's basin re-operation plan alone (Wildermuth Environmental, Inc. [WEI], 2009d). This projection resulted from evaluating the Peace II project description through 2060 with the 2007 Chino Basin Model using then current and projected groundwater production at the Chino Desalter wells.

In 2011, the Chino Basin Watermaster initiated the process to recalculate safe yield, which included an update and recalibration of its groundwater model. The 2013 Chino Basin Model was used to conduct a detailed investigation of the state of hydraulic control of rising groundwater discharge from the north, including an estimation of the historical amounts of rising groundwater discharge to the Santa Ana River and Santa Ana River recharge and for the period 1961 through 2011, and to project the same through 2050 (WEI, 2015c). The New Yield[1] from Santa Ana River recharge as estimated by the 2013 Chino Basin Model is 61 percent of desalter well production in fiscal year 2011 and levels off to about 49 percent of total future desalter well production through fiscal year 2030. This new yield induced by pumping at the desalter wells and reoperation is consistent with the planning estimates described in the previous studies.

These studies demonstrate that the yield of the Chino Basin is enhanced by increasing groundwater production in the southern portion of the Basin. These studies also indicate that the Chino Basin Desalter program and a slight permanent decrease in basin storage authorized in the Peace II agreement and approved by the Court will (i) capture groundwater flowing south from the forebay regions of the Chino Basin and (ii) reduce the outflow of high-salinity groundwater to the Santa Ana River, thereby providing greater protection of downstream beneficial uses.

1.2 The OBMP and the 2004 Basin Plan Amendment

The Chino Basin OBMP (WEI, 1999) was developed by Watermaster and the parties to the 1978 Chino Basin Judgment (Chino Basin Municipal Water District *v.* City of Chino et al.) pursuant to a February 19, 1998 court ruling. The OBMP maps a strategy that provides for the enhanced yield of the Chino Basin and seeks to provide reliable water supplies for development that is expected to occur within the Basin. The goals of the OBMP are: to enhance basin water supplies, to protect and enhance water quality, to enhance the management of the Basin, and to equitably finance the OBMP. The OBMP Implementation Plan is the court approved governing document for achieving the goals defined in the OBMP. The OBMP Implementation Plan is a comprehensive, long-range water management plan for the Chino Basin and includes the use of recycled water for direct reuse and artificial recharge. It also includes the capture of increased quantities of high quality storm water runoff, the recharge of imported water when total dissolved solids (TDS) concentrations are low, improving the water supply by desalting poor-

[1] New Yield as defined in the Peace Agreement "means proven increases in yield in quantities greater than historical amounts from sources of supply including, but not limited to, […] operations of the Desalters […] and other management activities implemented and operational after June 1, 2000." The net Santa Ana River recharge in fiscal year 2000 is the baseline from which to measure New Yield from Santa Ana River recharge in all subsequent years.

quality groundwater, supporting regulatory efforts to improve water quality in the Basin, and the implementation of management activities that will result in the reduced outflow of high-TDS/high-nitrate groundwater to the Santa Ana River and the Orange County Basin, thus ensuring the protection of downstream beneficial uses and water quality (WEI, 1999).

The 1995 Basin Plan contained restrictions on the use of recycled water for irrigation and groundwater recharge. In particular, it contained TDS objectives ranging from 220 to 330 milligrams per liter (mg/L) over a significant portion of the Basin. The ambient TDS concentrations in these areas exceeded the objectives, which meant that no assimilative capacity existed for the Basin. Therefore, the use of the IEUA's recycled water (which had a TDS concentration of about 490 mg/L at the time) for irrigation and groundwater recharge—one of the key elements of the OBMP Implementation Plan—would require mitigation even though recycled water reuse would not materially impact future TDS concentrations or impair the beneficial uses of Chino Basin groundwater.

In 1995, in part because of these considerations, the Regional Board initiated a collaborative study with 22 water supply and wastewater agencies, including Watermaster and the IEUA, to devise a new TDS and nitrogen management plan for the Santa Ana Watershed. This study culminated in the Regional Board's adoption of a Basin Plan amendment in January 2004 (Regional Board, 2004). This amendment included revised groundwater subbasin boundaries, termed "groundwater management zones" (GMZs), revised TDS and nitrate-nitrogen objectives for groundwater, revised TDS and nitrogen wasteload allocations, revised surface water reach designations, and revised TDS and nitrogen objectives and beneficial uses for specific surface waters. The technical work supporting the 2004 Basin Plan amendment was directed by the TIN/TDS Task Force and is summarized in *TIN/TDS Phase 2A: Tasks 1 through 5, TIN/TDS Study of the Santa Ana Watershed* (WEI, 2000).

The new TDS and nitrate-nitrogen objectives for the GMZs in the Santa Ana Watershed Basin were established to ensure that water quality is maintained pursuant to the State's antidegradation policy (State Board Resolution No. 68-16). These objectives were termed "antidegradation" objectives. Figure 1-1 shows the antidegradation objectives for the five Chino Basin GMZs[2]: Chino-1, Chino-2, Chino-3, Chino-East, and Chino-South. Note that the antidegradation TDS objectives for Chino-1, Chino-2, and Chino-3 are low (250 to 280 mg/L) and would restrict recycled water reuse and artificial recharge, as well as the recharge of imported water when its TDS concentration is above the objectives, without mitigation. Figure 1-2 shows the percent of time that the TDS concentration of State Water Project (SWP) water at Silverwood Lake[3] has been less than or equal to the TDS antidegradation objectives for these three GMZs based on the observed TDS concentrations from 1980 through 2016, a period of 37 years. The TDS concentrations of SWP water exceeded the antidegradation objectives in the Chino-1, -2, and -3 GMZs about 34, 50, and 44 percent of the time, respectively.

To address this issue, Watermaster and the IEUA proposed, and the Regional Board accepted, alternative and less stringent "maximum-benefit" objectives for a new GMZ, the Chino-North

[2] Note that the Prado Basin Management Zone is regulated by the Regional Board as a surface water management zone and does not have groundwater objectives assigned.

[3] Silverwood Lake in the San Bernardino Mountains is a reservoir on the east branch of the SWP that supplies the IEUA region with SWP water deliveries from the Metropolitan Water District of Southern California (MWD) via Devil Canyon Power Plant Afterbay and the Upper Feeder Pipeline.

GMZ (Chino-North), that combined Chino-1, Chino-2 and Chino-3 into one single management unit. All of the recharge activities that would occur as part of the OBMP Implementation Plan are within Chino-North. Figure 1-1 shows the maximum-benefit objectives for Chino-North—specifically the 420 mg/L TDS objective. This maximum-benefit TDS objective was higher than the then-current ambient TDS[4] concentration of 300 mg/L, thus creating 120 mg/L of assimilative capacity for TDS and allowing for recycled water reuse and recharge, and imported water recharge, without mitigation. Under maximum benefit, the TDS concentration of SWP water only exceeds the objective of 420 mg/L one percent of the time, as shown in Figure 1-2.

The maximum-benefit objectives were established based on demonstrations by Watermaster and the IEUA that the antidegradation requirements were satisfied. First, they demonstrated that beneficial uses would continue to be protected. Second, they showed that water quality consistent with maximum benefit to the people of the State of California would be maintained. Other factors—such as economics, the need to use recycled water, and the need to develop housing in the area—were also taken into account in establishing the maximum-benefit objectives.

1.3 Maximum Benefit Implementation Plan for Salt Management: Maximum-Benefit Commitments

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 Chapter 5 of the Basin Plan and listed in Table 5-8a therein (Regional Board, 2008). These commitments include:

1. The implementation of a surface-water monitoring program.
2. The implementation of a groundwater monitoring program.
3. The expansion of the Chino-I Desalter to 10 million gallons per day (mgd) and the construction of the Chino-II Desalter with a design capacity of 10 mgd.
4. The additional expansion of desalter capacity (20 mgd) pursuant to the OBMP and the Peace Agreement (tied to the IEUA's agency-wide effluent concentration).
5. The completion of the recharge facilities included in the Chino Basin Facilities Improvement Program.
6. The management of recycled water quality to ensure that the agency-wide, 12-month running average wastewater effluent quality does not exceed 550 mg/L and 8 mg/L for TDS and total inorganic nitrogen (TIN), respectively.
7. The management of basin-wide, volume-weighted TDS and nitrogen concentrations in artificial recharge to less than or equal to the maximum-benefit objectives.

[4] The current ambient TDS of the Chino-North GMZ, for the period of 1993 to 2012, is 350 mg/L (WEI, 2014c).

8. The achievement and maintenance of the "hydraulic control" of groundwater outflow from the Chino Basin, specifically from Chino-North, to protect Santa Ana River water quality.
9. The determination of ambient TDS and nitrogen concentrations of Chino Basin groundwater every three years.

If these maximum-benefit commitments are not met, the antidegradation objectives would apply for regulatory purposes. The application of the antidegradation objectives would result in no assimilative capacity for TDS and nitrate-nitrogen in the Chino-1, Chino-2, and Chino-3 GMZs, and the Regional Board would require mitigation for both recycled water and imported SWP water discharges to Chino-North that exceed the antidegradation objectives. Furthermore, the Regional Board would require that Watermaster and the IEUA mitigate the effects of discharges of recycled and imported SWP water that took place in excess of the antidegradation objectives under the maximum benefit objectives retroactively to January 2004. The mitigation for past discharges would be required to be completed within a ten-year period following the Regional Board's finding that the maximum-benefit commitments were not met.

1.4 Purpose and Report Organization

This report describes the status of compliance with the maximum-benefit commitments listed above and is organized as follows:

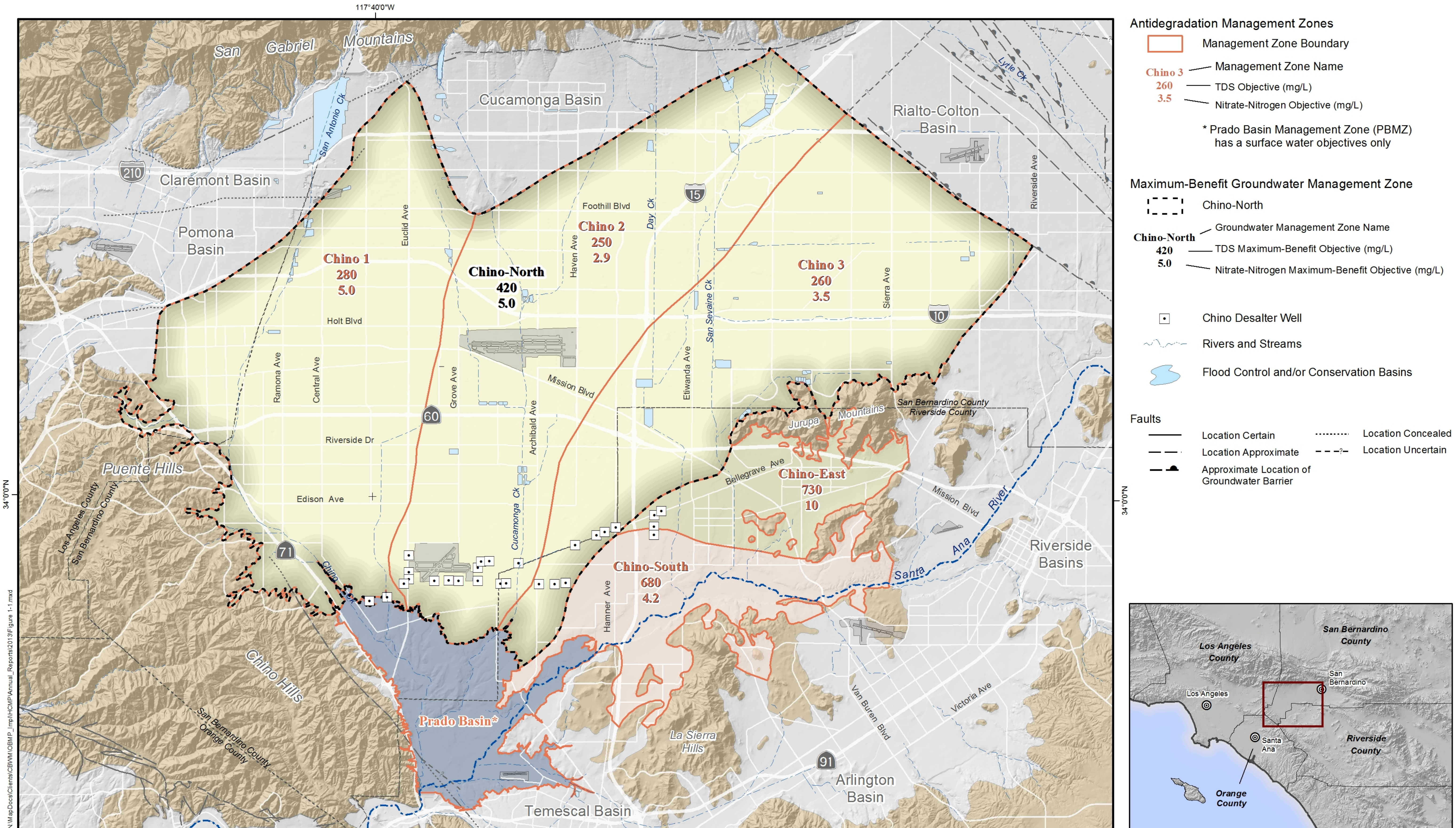
Section 1 – Introduction: This section provides context and background regarding the development of the maximum-benefit objectives and the associated maximum-benefit commitments for the Chino Basin.

Section 2 – Maximum-Benefit Commitment Compliance: Section 2 describes the status of compliance with each of the maximum-benefit commitments.

Section 3 – Data Collected in 2016: Section 3 describes the data collected in 2016 as part of the maximum benefit monitoring program.

Section 4 – The Influence of Rising Groundwater on the Santa Ana River: Section 4 characterizes the influence of rising groundwater on the flow and quality of the Santa Ana River between the Riverside Narrows and Prado Dam.

Section 5 – References: Section 5 provides the references consulted in performing the analyses described herein and in writing this report.



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0 2 4 6 Kilometers

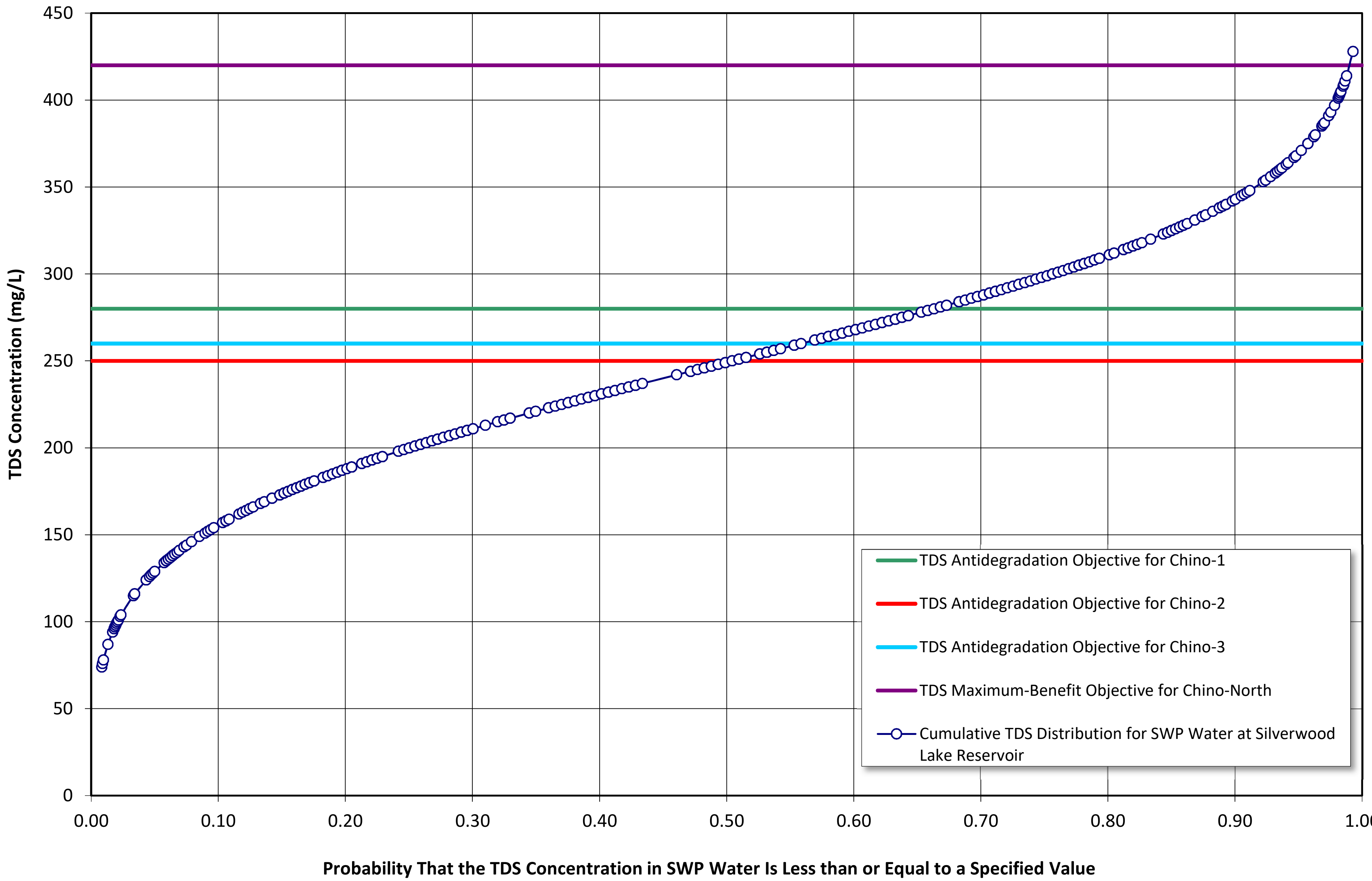
2016 Maximum Benefit Annual Report

Chino Basin Management Zones

Antidegradation & Maximum-Benefit Objectives for TDS and Nitrate-Nitrogen

Figure 1-1

Figure 1-2
Historical TDS Concentration in State Water Project (SWP) Water at Silverwood Lake Reservoir



Section 2 – Maximum-Benefit Commitment Compliance

Table 2-1 lists the status of compliance for each of the nine maximum-benefit commitments outlined in the Maximum Benefit Implementation Plan for Salt Management in Chapter 5 of the Basin Plan (Regional Board, 2008) as of December 31, 2016. A discussion of ongoing activities related to compliance with the commitments is provided below. For this discussion, the commitments are grouped together by four main topics covereing: hydraulic control, Chino Basin Desalters, recycled water recharge, and the recomputation of ambient groundwater quality.

2.1 Hydraulic Control

The Regional Board requires that Watermaster and the IEUA achieve and maintain "hydraulic control" of groundwater outflow from Chino-North (Commitment number 8). The Basin Plan defines hydraulic control as: "[…] eliminating groundwater discharge from the Chino Basin to the Santa Ana River, or controlling the discharge to *de minimis* levels […]." In practice, Watermaster and the IEUA use a more measurable definition of hydraulic control: eliminating groundwater discharge from Chino-North to the Prado Basin Management Zone (PBMZ) or controlling the discharge to *de minimis* levels. In a letter from the Regional Board to Watermaster and the IEUA, dated October 12, 2011, the Regional Board defined the *de minimis* discharge of groundwater from Chino-North to the PBMZ as less than 1,000 acre-feet/yr. (Regional Board, 2011).

2.1.1 Hydraulic Control Monitoring Program

The surface-water and groundwater monitoring programs (Commitments number 1 and number 2) were required, in part[5], to collect the data necessary to determine the state of hydraulic control and were thus referred to collectively as the Hydraulic Control Monitoring Program (HCMP). In May 2004, Watermaster and the IEUA submitted a surface-water and groundwater monitoring program work plan to the Regional Board entitled: *Final Hydraulic Control Monitoring Program Work Plan for the Optimum Basin Management Program* (Work Plan [WEI, 2004b]). The Regional Board adopted Resolution R8-2005-0064, approving this Work Plan, and required Watermaster and the IEUA to implement the HCMP. The concept of using multiple lines of evidence was included in the initial design of the HCMP because it was not clear at that time whether one line of evidence would clearly demonstrate hydraulic control. These multiple lines of evidence are summarized as follows:

- Collect and analyze groundwater-elevation data to determine the direction of groundwater flow in the southern part of the Basin and whether pumping at the Chino Desalter well fields is completely capturing all groundwater that would otherwise discharge out of Chino-North and into the PBMZ.
- Collect and analyze the chemistry of basin-wide groundwater and the Santa Ana River to (i) track the migration, or lack thereof, of the South Archibald volatile

[5] The groundwater monitoring program also supports the recomputation of ambient water quality, as well as a number of Watermaster's OBMP activities.

organic compound (VOC) plume beyond the Chino Desalter well fields, and (ii) identify the source of groundwater in the area of the Chino Basin between the Santa Ana River and the Chino Desalter well fields.

- Collect and analyze surface-water quality data and surface-water discharge measurements to determine if groundwater from the Chino Basin is rising as surface water and contributing to flow in the Santa Ana River or if the River is recharging the Basin.
- Use Watermaster's numerical groundwater-flow model to corroborate the results and interpretations of the first three lines of evidence.

Watermaster and the IEUA executed this surface-water and groundwater-monitoring program per the 2004 Basin Plan Amendment and Work Plan from 2004 through 2011 (WEI, 2007b; 2008b; 2009a; 2010; 2011a; and 2012b), and concluded that (i) hydraulic control has been achieved to the east of Chino-I Desalter Well 5, (ii) hydraulic control has not been achieved to the west of Chino-I Desalter Well 5, and (iii) the impact of rising groundwater discharge from Chino-North on surface-water quality in the Santa Ana River at Prado Dam has been *de minimis*. Watermaster and the IEUA also concluded that the data collected as part of the surface-water monitoring program were not necessary to determine the state of hydraulic control, and began the process of modifying the surface-water and groundwater-monitoring program and commitments accordingly. In 2010, the Chino Basin Desalter Authority[6] (CDA) began construction of the Chino Creek Well Field (CCWF), which was designed to achieve hydraulic control to the west of Chino-I Desalter Well 5 (see also: Section 2.1.3 and Figure 2-1).

On February 10, 2012, the Regional Board adopted an amendment to the Basin Plan to remove all references to specific monitoring locations and sampling frequencies for the groundwater and surface-water monitoring programs and, in their place, required that Watermaster and the IEUA submit (i) an updated surface-water monitoring program by February 25, 2012 and (ii) a revised groundwater monitoring program and schedule for achieving hydraulic control by December 31, 2013. Pursuant to (i), Watermaster and the IEUA submitted the *2012 Hydraulic Control Monitoring Program Work Plan* (2012 Work Plan) to the Regional Board on February 25, 2012 (WEI, 2012a). The 2012 Work Plan was adopted by the Regional Board on March 16, 2012 (Regional Board, 2012).[7] Pursuant to (ii), Watermaster and the IEUA submitted the *2014 Maximum Benefit Monitoring Work Plan* (2014 Work Plan) to the Regional Board on December 23, 2013 (WEI, 2013c).[8] The 2014 Work Plan was approved by the Regional Board on April 25, 2014 (Regional Board, 2014b).

Each year, the data collected pursuant to the 2014 Work Plan is summarized and included in the Chino Basin Maximum Benefit Annual Report (see Section 3 of this report).

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[6] www.chinodesalter.org

[7] The Basin Plan amendment was approved by the Office of Administrative Law on December 6, 2012, and at that time, the revised surface-water monitoring program (2012 Work Plan) was implemented.

[8] The name was changed from the Hydraulic Control Monitoring Program Work Plan to the Maximum Benefit Monitoring Program Work Plan to clarify that the 2014 Work Plan (as did its predecessor) contains the monitoring and data collection strategy for complying with both the maximum-benefit monitoring directives of demonstrating hydraulic control and computing ambient water quality.

2.1.2 Hydraulic Control Monitoring Program Objectives and Methods

Based on the results to date, the ongoing questions to be answered by the HCMP are:

1. Will hydraulic control of groundwater from Chino-North be maintained east of Chino-I Desalter Well 5?
2. Will the CCWF reduce groundwater discharge from Chino-North to the PBMZ past the desalter well field west of Chino-I Desalter Well 5 to the *de minimis* threshold of 1,000 acre-feet/yr or less?
3. Will the impact of groundwater discharge from Chino-North to the PBMZ that becomes rising groundwater on the surface-water quality in the Santa Ana River remain *de minimis*?

Watermaster and the IEUA use the following methods to answer these questions:

Method to Address Question 1. The groundwater monitoring program (groundwater level and quality) and periodic modeling will continue to be used to define the capture zone created by the Chino Desalter well field east of Chino-I Desalter Well 5. These methods will be sufficient to demonstrate hydraulic control in this area in the future.

Watermaster prepares a State of the Basin (SOB) Report every two years (WEI, 2002; 2005; 2007c; 2009c; 2011c; 2013b, and 2015b). The SOB Report includes a spring groundwater-elevation contour map of the southern portion of Chino Basin, showing the capture zone of the Chino Desalter well field, and a characterization of the state of hydraulic control based on the groundwater-elevation contours. The most up-to-date hydraulic control findings in the SOB Report will be referenced each year in the Chino Basin Maximum Benefit Annual Report (see Section 2.1.3 of this report).

Watermaster recalibrates and runs its groundwater-flow model at least every five years to assess the physical impacts of the implementation of the OBMP and Peace II Agreement, the state of hydraulic control, the balance of recharge and discharge, the cumulative impact of water rights transfers among the parties, and to recalculate safe yield. The most up-to-date modeling assessment of the then-current and projected state of hydraulic control will be referenced each year in the Maximum Benefit Annual Report (see Section 2.1.3 of this report).

Method to Address Question 2. The 2013 Chino Basin Model estimated that the amount of groundwater discharge from Chino-North to the PBMZ in the absence of the CCWF has been about 2,400 acre-ft/yr. The model was used to estimate the discharge once the CCWF wells are in operation. The results indicate that with planned production at the CCWF (1,529 acre-ft/yr), the groundwater discharge will decrease to about 900 acre-ft/yr by 2016, which is less than the *de minimis* threshold.

At least every five years, historical production and groundwater-level data for the CCWF and other wells will be used to recalibrate the Chino Basin Model. The model will be used to calculate annual groundwater discharge past the CCWF since the start of CCWF operations and to estimate future groundwater discharge past the CCWF based on projected groundwater pumping in the Basin. The most up-to-date modeling assessment of the then-current and projected groundwater discharge past the CCWF will be referenced each year in the Maximum Benefit Annual Report (see Section 2.1.3 of this report).

Method to Address Question 3. The HCMP has shown that the historical and current impacts of groundwater discharge from the Chino-North to the PBMZ that becomes rising groundwater on the surface-water quality of the Santa Ana River at Prado Dam is *de minimis*. Groundwater modeling shows that the implementation of CCWF pumping will further decrease the volume of groundwater discharge from the Chino-North that becomes rising groundwater in the PBMZ and thereby further reduce its impact on the Santa Ana River's water quality. Table 2-2 shows the estimated impact on the annual discharge and discharge-weighted TDS concentration of the Santa Ana River at Prado Dam resulting from groundwater discharge from the Chino-North to the PBMZ through the CCWF area for two hydraulic control scenarios: 1) achievement of hydraulic control to the *de minimis* threshold (<1,000 acre-ft/yr) of Chino-North discharge to the PBMZ and 2) hydraulic control at full containment, meaning zero Chino-North discharge to the PBMZ. For each hydraulic control scenario, Table 2-2 shows:

- the annual discharge of the Santa Ana River at Prado Dam and its associated TDS concentration without CCWF operation (historical reported values [SARWM, 2016]); values are the same for both scenarios,
- the volume and TDS concentration of groundwater produced by the CCWF,
- the estimated annual discharge and associated TDS of the Santa Ana River at Prado Dam had the CCWF been in operation,
- the estimated change in TDS concentration of the Santa Ana River at Prado Dam that results from the operation of the CCWF, and
- the estimated increase in the TDS concentration of the Santa Ana River at Prado Dam due to non-containment by the CCWF (e.g. the change in TDS concentration attributable to Scenario 2 minus the change in TDS concentration attributable to Scenario 1).

The mass-balance analysis in Table 2-2 demonstrates that operation of the CCWF reduces the TDS concentration of the Santa Ana River at Prado Dam by two to seven mg/L (average of one-percent decrease) for the *de minimis* threshold scenario, and by three to eleven mg/L (average of one and a half percent decrease) for the complete hydraulic control scenario. In addition, operating to full containment instead of the *de minimis* threshold only improves the TDS concentration of the Santa Ana River at Prado Dam by one to four mg/L, which is less than one percent of the TDS concentration at Prado Dam. Overall, the estimated impact of rising groundwater from Chino-North on the TDS concentration of the Santa Ana River at Prado Dam without CCWF operation is small, and from a mass-balance perspective is increasing the TDS concentration of the River by about one and a half percent. The operation of the CCWF to the *de minimis* threshold will reduce this impact.

Continued analysis of Santa Ana River flow and quality at Below Prado Dam will help determine the nature of the impact of groundwater discharge from Chino-North that becomes rising groundwater in the PBMZ. The impact of groundwater discharge from Chino-North to the PBMZ on Reach 2 of the Santa Ana River will be characterized each year in the Chino Basin Maximum Benefit Annual Report (see Section 4 of this report).

2.1.3 Status of Hydraulic Control

Watermaster and the IEUA have demonstrated in previous Annual Reports (WEI, 2007b; 2008b; 2009a; 2010; 2011a; 2012b; 2013a; 2014b; and 2015a) that complete hydraulic control has been achieved at and east of Chino-I Desalter Well 5. Figure 2-1 shows the most current characterization of the state of hydraulic control based on groundwater-elevation contours for spring 2014 from the 2014 SOB Report (WEI, 2015b)[9]. The spring 2014 groundwater-elevation contours are concurrent with the aforementioned analysis of hydraulic control and depict a regional depression in groundwater elevation around the desalter wells from and east of Chino-I Desalter Well 5, demonstrating the complete capture of all Chino-North groundwater by the desalter wells in this area and complete hydraulic containment.

The construction and operation of the CCWF, which began in 2010, is intended to achieve hydraulic control in the area west of Chino-I Desalter Well 5. In February 2016, the CCWF commenced full-scale operation with production at wells I-16, I-17, I-20, and I-21. The CCWF wells produced a total of about 1,665 acre-ft in 2016, which is more than the model-estimated production needed to achieve hydraulic control to the *de minimis* standard west of Chino-I Desalter Well 5.

In a letter dated January 23, 2014, the Regional Board required that Watermaster and the IEUA submit a plan detailing how hydraulic control will be sustained in the future as agricultural production in the southern region of Chino-North continues to decrease, and how the Chino Basin Desalters will achieve the required total groundwater production level of 40,000 acre-ft/year[10]. Watermaster and the IEUA coordinated with the CDA to develop a plan to achieve 40,000 acre-ft/yr of desalter well production and submitted a final plan to the Regional Board on June 30, 2015 (Watermaster & IEUA, 2015). The plan includes the construction and operation of three new wells for the Chino-II Desalter (refer to Figure 2-1 and Section 2.2 of this Report).

The 2013 Chino Basin Model Final Report (WEI, 2015c), includes a characterization of the projected future state of hydraulic control, which accounts for the land use transition from agricultural uses to urban uses and assumes the Chino Basin Desalter well fields produce 40,000 acre-ft/yr. Figure 2-2a and Figure 2-2b show the model-projected state of hydraulic control in 2020 and 2025, respectively. These figures include groundwater-elevation contours and arrows that depict groundwater-flow direction, which show full hydraulic containment of Chino-North groundwater at and east of Chino-I Desalter Well 5 in 2020 and 2025. The groundwater-flow

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[9] Updated groundwater-elevation contours for spring 2016 will be prepared for the 2016 SOB Report, which is due to be published in July 2017.

[10] The OBMP Phase I Report determined that at least 40,000 acre-ft/yr of groundwater production in the southern Chino Basin was necessary to maintain hydraulic control. This was based on the estimate agricultural production in the southern portion of the basin in 2000. Additionally, the OBMP specified that production at the Chino Basin Desalter wells would replace the agricultural production in the southern portion of the Basin that would be eliminated as the land use transitioned to urban uses. The Peace Agreement indicated that the need for and future location of desalter wells shall be determined by Watermaster to carry out the purpose of the OBMP. Per the 2007 Peace II Agreement (Article V), the required groundwater production of all desalter wells in Chino Basin will cumulatively be 40,000 acre-ft/yr.

direction indicates that groundwater will continue to flow past the CCWF and the model-estimated discharge in this area is projected to be about 900 acre-ft/yr in 2016 and gradually decline to about 400 acre-ft/yr by 2050 (WEI, 2015c).[11]

2.2 Chino Basin Desalters

The operation of the Chino Basin Desalters is fundamental to achieving hydraulic control, maximizing the yield of the Chino Basin, minimizing the loss of stored water, and protecting the water quality of the Santa Ana River. The first Chino Basin Desalter, Chino-I, began operation in late 2000 and had an original design capacity of 8 mgd. Commitment number 3 requires the expansion of Chino-I Desalter and the construction of Chino-II Desalter. Prior to the recharge of recycled water in the Chino Basin, the Chino-I Desalter was expanded to a capacity of 14 mgd, and a contract was awarded for the construction of the Chino-II Desalter. The Chino-II Desalter came online in June 2006 and has a capacity of 15 mgd. Commitment number 4 requires the submittal of plans to construct additional wells and facilities in addition to those described in Commitment number 3. As articulated in the OBMP Implementation Plan, the Peace Agreement, and the 2007 court-approved Peace II agreement, Watermaster and IEUA are required to expand desalter well production to about 40,000 acre-ft/yr.

The most recently completed expansion is the construction and operation of the CCWF wells. The five CCWF wells (I-16, I-17, I-18, I-20, and I-21) were constructed between September 2011 and May 2012[12] in the southwestern portion of the Chino Basin (see Figure 2-1). Production at CCWF wells I-16 and I-17 commenced in mid-2014. Production at CCWF wells I-20 and I-21 commenced in February 2016. The combined production capacity of these four wells is about 1,600 acre-ft/yr. Due to the presence of VOCs and nitrate there is no plan to produce well I-18 for the Chino-I Desalter system.

The final expansion plan to achieve the 40,000 acre-ft/yr of production is to construct and operate three new wells for the Chino-II Desalter, II-10, II-11, and II-12, the locations for which are shown in Figure 2-3[13]. Due to the location of these wells in proximity to the South Archibald trichloroethene (TCE) Plume, the CDA is collaborating with identified parties to integrate these wells into a remedial solution to address groundwater cleanup while maintaining hydraulic control[14]. The plan and schedule to construct the final three wells was submitted to the Regional

[11] The Chino Basin model is being updated in 2017 and new projections of hydraulic control will be published in fiscal 2017/18.

[12] Proposed CCWF Well I-19 was not constructed because the projected pumping estimates during borehole testing were too low to warrant construction.

[13] Note that the location of Well II-12 is approximate.

[14] In June 2013, the CDA entered into a Memorandum of Understanding with CDA Sponsor Agencies (Western Municipal Water District, City of Ontario, and Jurupa Community Service District), the IEUA, and City of Upland, regarding the South Archibald TCE Plume cleanup. The CDA is working with this group, and the "Airport Parties" (former industrial companies on the Ontario Airport property and the United States Army and Air Force) to find a mutually agreeable and beneficial solution to mitigate the TCE contamination.

Board on June 30, 2015 (Watermaster & IEUA, 2015) at which time it was estimated that all three wells would be constructed by May 2017.

The construction of wells II-10 and II-11 was completed in September 2015, and equipping of the wells began in 2016. Full equipping of wells II-10 and II-11 is on-hold and planned for completion in mid-2017 after the CDA completes construction of the raw-water pipeline to plumb the three new wells into the Chino-II Desalter. The CDA is currently in the land acquisition process for Well II-12, and as soon as that land is acquired a monitoring well will be constructed to support the design of the production well. The CDA has retained consultants for the construction and design of Well II-12, which is anticipated to begin in 2017.

Figure 2-3 shows the location of the existing and planned Chino Basin Desalter wells and total annual production since 2000. In 2016, the total annual production of the Chino Basin Desalter wells was 28,250 acre-ft. Over the last 17 years, the Chino Basin Desalters have produced about 370,000 acre-ft of high-TDS/nitrate water, or an average of about 21,800 acre-ft/yr.

2.3 Recycled Water Recharge and Quality

The recharge of recycled water, imported water, and storm water is an integral part of the OBMP Implementation Plan, and is necessary to maximize the use of the water resources of the Chino Basin. The IEUA, Watermaster, Chino Basin Water Conservation District, and San Bernardino County Flood Control District are partners in the implementation of the Chino Basin Recycled Water Groundwater Recharge Program. The IEUA manages the recharge program and performs recycled water recharge operations pursuant to Regional Board Orders R8-2007-0039 and R8-2009-0057. As required by these orders, the IEUA and Watermaster submit quarterly and annual reports to the Regional Board on Chino Basin recycled water recharge activities. Figure 2-4 is a map of existing recharge facilities in the Chino Basin, and Table 2-3 summarizes total annual recharge by water type from July 2005 (commencement of recycled water recharge activities) through 2016. Since 2005, about 116,000 acre-ft of imported water, 121,000 acre-ft of storm water, and 87,000 acre-ft of recycled water have been recharged to the Chino Basin.

Commitment number 7 requires that the use of recycled water for artificial recharge be limited to the amount that can be blended on a volume-weighted basis with other sources of recharge to achieve five-year running-average concentrations of no more than the maximum-benefit objectives (420 mg/L for TDS and 5 mg/L for nitrate-nitrogen). Recycled water recharge began in July 2005; thus, the first five-year period for which the metric was computed was July 2005 through June 2010. The metric is computed on a monthly basis. Table 2-4 summarizes the five-year running-average volume-weighted TDS and nitrate-nitrogen concentrations of recharge. The monthly recharge and water-quality data used to compute the five-year running-average TDS and nitrate-nitrogen metrics are plotted in Figures 2-5a and 2-5b, respectively. A table of the monthly data used to compute these metrics has been included as Appendix A to this report.

The five-year running-average, volume-weighted, TDS and nitrate-nitrogen concentrations have not exceeded the maximum-benefit objectives for TDS or nitrate-nitrogen. That said, over this time period, the five-year running average, volume-weighted, TDS and nitrate-nitrogen concentrations increased: TDS increased from 203 to about 350mg/L, and nitrate-nitrogen increased from 1.1 to about 2.8 mg/L. During 2016, the rate of increase of the metric values rose significantly. Prior to 2016 the TDS concentration metric was increasing at a rate of about 1.3 mg/L per month and the increase was primarily driven by the increase in recycled water recharge over time. Between May and September 2016, that rate increased to about 12 mg/L per month. The increase in the TDS concentration metric ceased in September 2016 and subsequently began to decrease and stabilize through the end of the year. The increase occurred in this manner because in May 2016 the last significant period of imported water recharge, which occurred between May and September of 2011, began to drop out of the 5-year period used for the calculation of the metric. The imported water recharge that occurred in October 2016 contributed to the decrease and stabilization of the metric through the end of the year. A similar pattern of change was observed for the nitrate-nitrogen concentration metric, as shown in Figure 2-5b. These observations demonstrate the importance of imported water recharge to complying with the long-term TDS metric, especially as the volume and TDS concentration of recycled water recharge increases over time.

As described in the Basin Plan, the IEUA wastewater effluent TDS and TIN permit limits are an important component of the maximum-benefit demonstration and provide a controlling point for the management of TDS and nitrate quality in the Chino Basin. The TDS and TIN permit limits for the IEUA agency-wide effluent (a volume-weighted average for all IEUA wastewater treatment facilities) are 550 mg/L and 8 mg/L, respectively, based on a 12-month running average. Commitment number 6 requires that the IEUA submit a plan and schedule to the Regional Board for the implementation of measures to ensure that the 12-month running-average of the IEUA agency-wide effluent concentration does not exceed these permit limits when either the 12-month running-average IEUA agency-wide effluent TDS concentration exceeds 545 mg/L for three consecutive months, or the TIN concentration exceeds 8 mg/L in any one month. The plan must be submitted within 60 days of finding an exceedance of one of these trigger limits. The plan and schedule must be implemented upon Regional Board approval. The 12-month running-average IEUA agency-wide effluent water quality is reported by the IEUA in the Groundwater Recharge Program Quarterly Monitoring Reports. Table 2-5 and Figure 2-6 show the monthly and 12-month running-average IEUA agency-wide effluent TDS and TIN concentrations for 2005 through 2016. Since the initiation of recycled water recharge in July 2005, the 12-month running average IEUA agency-wide TDS and TIN concentrations have never exceeded the triggers and have ranged between 459 and 534 mg/L and 5.0 and 7.8 mg/L, respectively. During 2016, the 12-month running average IEUA agency-wide TDS and TIN concentrations ranged between 504 and 515 mg/L and 5.6 and 6.1 mg/L, respectively.

During 2015, a historical-high 12-month running-average IEUA agency-wide effluent TDS concentration of 534 mg/L was calculated for three consecutive months: June, July and August. This 12-month running-average IEUA agency-wide effluent TDS concentration of 534 mg/L was only 11 mg/L below the trigger in Commitment number 6 to prepare a plan and schedule to ensure that the 12-month running-average IEUA agency-wide wastewater effluent TDS concentration does not exceed the permit limit of 550 mg/L. Figure 2-7 shows the monthly and 12-month running-average IEUA agency-wide effluent TDS concentration, plotted with: the monthly TDS concentrations of SWP water from Silverwood Lake[15]; the monthly volume-weighted TDS concentrations of the combined water supplies served in the area tributary to the IEUA's treatment plants; the volume of water supply served in the area tributary to IEUA's

[15] Source of imported SWP water to IEUA agencies.

treatment plants that is SWP water, and the volume of water supply served in the area tributary to IEUA's treatment plants that is from local sources (groundwater and surface water). From 2012 through 2015, the SWP water seasonal-high TDS concentrations continuously increased due to drought conditions. This increase correlates to the increase of the monthly combined water supply TDS concentration, and the monthly and 12-month running-average IEUA agency-wide effluent TDS concentrations. The increase in the TDS concentration of the combined monthly water supply is less than the increase in monthly SWP water TDS concentrations because it includes local water supplies with lower-TDS concentrations. In 2015, the proportion of the total water supply that is SWP water decreased, reducing the effect of the increasing TDS concentration of the SWP water on the volume-weighted TDS concentration of the total water supply. In 2016, the TDS concentration of SWP water decreased due to wet-winter conditions in northern California. This also increased the availability of the SWP water supply. The increased use of lower-TDS concentration SWP water in 2016 contributed to the decreasing trend of the 12-month running-average IEUA agency-wide effluent TDS concentration, which was 504 mg/L as of December 2016.

The relationships of the TDS concentrations plotted in Figure 2-7 indicate that the increase in the SWP water TDS concentration over the last few years has contributed in part to the increase in the TDS concentration of the IEUA agency-wide effluent. The increasing trend in the TDS concentration of the effluent is not solely explained by the TDS concentrations plotted in Figure 2-7, and there are likely other factors contributing to the increase as suggested by the difference in the magnitude of increase between the monthly water supply TDS concentrations (about 70 mg/L) and the monthly IEUA agency-wide effluent TDS concentrations (about 120 mg/L) from 2012 to 2015. Another likely cause of the increase in the effluent TDS concentration is the incorporation of the water conservation practices required by the State of California during the current drought. Water conservation practices in 2015 and 2016 are evident in the time history of the volume of total water supply plotted in Figure 2-7. What these trends suggest is that drought conditions have a meaningful impact on the TDS concentration of water supply and recycled water and that future droughts similar to the 2012-2016 period could lead to short term exceedances of the 12-month running-average IEUA agency-wide effluent TDS. For this reason, Watermaster and the IEUA have petitioned the Regional Board to consider modifying the TDS compliance metric for recycled water to a longer-term averaging period. The Regional Board agreed that an evaluation of the compliance metric is warranted and directed Watermaster and the IEUA to develop a technical scope of work to support the adoption of a longer-term averaging period. This scope will be developed and implemented in 2017.

2.4 Ambient Groundwater Quality

Commitment number 9 requires that Watermaster and the IEUA recompute the ambient TDS and nitrate concentrations for the Chino Basin and Cucamonga GMZs every three years, beginning in July 2005. The method used to compute ambient TDS and nitrate concentrations must be consistent with the method used by the TIN/TDS Task Force to determine the antidegradation objectives for the GMZs of the Santa Ana River Watershed. Watermaster and the IEUA have participated in each triennial, watershed-wide ambient water quality determination as members of the Basin Monitoring Program Task Force. The most recent recomputation, covering the 20-year period from 1993 to 2012, was completed in August 2014

(WEI, 2014c). Table 2-6 shows the results of the current and all historical ambient TDS and nitrate-nitrogen concentration determinations. The next recomputation, covering the 20-year period from 1996 to 2015, is due to be published in June 2017.

Table 2-1
Status of Compliance with the Chino Basin Maximum-Benefit Commitments

Description of Commitment	Compliance Date – as soon as possible, but no later than	Status of Compliance
1. Surface Water Monitoring Program[1] a. Submit draft Monitoring Program to Regional Board b. Implement Monitoring Program c. Submit Draft Revised Monitoring Program to Regional Board d. Implement Revised Monitoring Program e. Submit Draft Revised Monitoring Program(s) (subsequent to that required in "c", above) to Regional Board f. Implement Revised Monitoring Program(s) g. Annual data report submittal	a. January 23, 2005 b. Within 30 days from the date of Regional Board approval of the monitoring plan c. 15 days from 2012 Basin Plan Amendment (BPA) approval d. Upon Regional Board approval e. Upon notification of the need to do so from the Regional Board Executive Officer and in accordance with the schedule prescribed by the Executive Officer f. Upon Regional Board approval g. April 15th	a. Draft work plan submitted to the Regional Board on January 23, 2005 b. Monitoring plan initiated prior to Regional Board approval c. Draft work plan submitted to the Regional Board on February 16, 2012, six days after 2012 BPA approval d. Revised monitoring program began in December 2012 after the BPA was approved by the Office of Administrative Law on December 6, 2012 e. No revisions required by the Regional Board at this time f. n/a g. All annual reports submitted by April 15 of each year
2. Groundwater Monitoring Program[1] a. Submit Draft Monitoring Program to Regional Board b. Implement Monitoring Program c. Plan and schedule for demonstrating hydraulic control d. Implement hydraulic control demonstration	a. January 23, 2005 b. Within 30 days from the date of Regional Board approval of the monitoring plan c. By December 31, 2013 d. Upon Regional Board approval	a. Draft monitoring plan submitted to Regional Board on January 23, 2005 b. Monitoring program initiated prior to Regional Board approval c. Plan and schedule for demonstrating hydraulic control submitted in the 2014 Work Plan to the Regional Board on December 23, 2013

[1] The commitments related to surface water and groundwater monitoring were revised by a Basin Plan amendment approved by the Regional Board on February 10, 2012. The commitments and status of compliance shown in this table reflect the amended commitments for surface water and groundwater monitoring.

Table 2-1
Status of Compliance with the Chino Basin Maximum-Benefit Commitments

Description of Commitment	Compliance Date – as soon as possible, but no later than	Status of Compliance
e. Submit Draft Revised Monitoring Program(s) (subsequent to that required in "a", above) to Regional Board f. Implement revised monitoring plans (s) g. Annual data report submittal	e. Upon notification of the need to do so from the Regional Board Executive Officer and in accordance with the schedule prescribed by the Executive Officer f. Upon Regional Board approval g. April 15th	d. Implemented upon Regional Board approval e. No revisions required by Regional Board at this time f. n/a g. All annual reports submitted by April 15 of each year
3. Chino Desalters a. Chino-I Desalter expansion to 10 mgd b. Chino-II Desalter construction to 10 mgd capacity	a. Prior to the recharge of recycled water b. Recharge of recycled water allowed once award of contract and notice to proceed issued for construction of desalter treatment plant	a. Chino-I Desalter expansion to about 14 mgd was completed in April 2005 and operation began in October 2005; recycled water recharge began in July 2005. b. Contract for Chino-II Desalter awarded in early 2005; construction was completed to a capacity of 15 mgd, and the facility went online in June 2006.
4. Submittal of future desalters plan and schedule	October 1, 2005 Implement plan and schedule upon Regional Board approval	Several plans for desalter expansion have been submitted to the Regional Board since 2005. The current capacity of the constructed desalter wells is about 30 mgd. Watermaster and the IEUA submitted a plan to the Regional Board on June 30, 2015 to construct three additional wells to achieve the ultimate capacity of 40,000 acre-ft/yr, per the Peace and Peace II Agreements. Construction of two wells is completed and construction of the the third well is anticipated to begin in 2017.

Table 2-1
Status of Compliance with the Chino Basin Maximum-Benefit Commitments

Description of Commitment	Compliance Date – as soon as possible, but no later than	Status of Compliance
5. Recharge facilities (17) built and in operation	June 30, 2005	All facilities were built by June 30, 2005 for the Phase I Project of the Chino Basin Recycled Water Groundwater Recharge (GWR) Program and consisted of seven recharge sites. The Phase II Project began in May 2007 and incorporated seven additional recharge sites.
6. Submittal of IEUA wastewater quality improvement plan and schedule	60 days after agency-wide, 12-month running average effluent TDS quality equals or exceeds 545 mg/L for 3 consecutive months, or after agency-wide, 12-month running average TIN equals or exceeds 8 mg/L in any month Implement plan and schedule upon approval by Regional Board	These threshold events have not occurred; therefore, a wastewater quality improvement plan has not been submitted (See Table 2-4 and Figures 2-6 and 2-7 of this report).
7. Recycled water will be blended with other recharge sources such that the volume-weighted, 5-year running average TDS and nitrate-nitrogen concentrations of recharge are equal to or less than the maximum benefit water quality objectives. a. Submit a report that documents the location, amount of recharge, and TDS and nitrogen quality of storm water recharge before the OBMP recharge improvements were constructed and what is projected to occur after the recharge improvements are completed.	Compliance must be achieved by the end of the 5th year after initiation of recycled water recharge operations. a. Prior to initiation of recycled water recharge	a. No documentation of water quality data or quantity for storm water prior to OBMP initiation exists. Storm water has been monitored for flow, TDS, and nitrogen since 2005.

Table 2-1
Status of Compliance with the Chino Basin Maximum-Benefit Commitments

Description of Commitment	Compliance Date – as soon as possible, but no later than	Status of Compliance
b. Submit documentation of the amount and TDS and nitrogen quality of all sources of recharge and recharge locations. For storm water recharge used for blending, submit documentation that the recharge is the result of OBMP enhanced recharge facilities.	b. Annually, by April 15th, after initiation of construction of basins/other facilities to support enhanced storm water recharge	b. The volume-weighted, 5-year running average TDS and nitrate-nitrogen concentrations of Chino Basin recharge are less than the maximum-benefit water quality objectives (See Table 2-3, and Figures 2-4a and 2-4b of this report).
8. Hydraulic Control Failure a. Plan and schedule to correct loss of hydraulic control b. Achievement and maintenance of hydraulic control c. Mitigation plan for temporary failure to achieve/maintain hydraulic control	a. 60 days from Regional Board finding that hydraulic control is not being maintained b. In accordance with plan and schedule approved by the Regional Board c. By January 23, 2005	a. No mitigation plan and schedule for the loss of hydraulic control has been requested. b. Hydraulic control has been achieved to the east of Chino-I Desalter Well 5. Groundwater model estimates published in 2015 indicate that production in the amount of 1,520 acre-ft/yr at the CCWF will achieve hydraulic control west of Chino-I Desalter Well 5 to *de minimis* levels (<1,000 acre-ft/yr of groundwater flow past the CCWF well field in the PBMZ). Full production at the CCWF was achieved in 2016. Watermaster and the IEUA submitted a plan on June 30, 2015 to construct three additional wells to achieve the ultimate Desalter capacity of 40,000 acre-ft/yr. Construction of two wells is completed and construction of the third well is anticipated to begin in 2017. c. Plan submitted to the Regional Board on March 3, 2005. No mitigation action has been triggered.

Table 2-1
Status of Compliance with the Chino Basin Maximum-Benefit Commitments

Description of Commitment	Compliance Date – as soon as possible, but no later than	Status of Compliance
9. Ambient groundwater quality determination	July 1, 2005 and every three years thereafter	Watermaster and the IEUA have participated in the regional ambient water quality determination as requested by SAWPA. Watermaster and the IEUA provide their fair share of funds and substantial groundwater data for this effort.

Table 2-2
Estimated Impacts on the Annual Discharge and Annual Discharge-Weighted Total Dissolved Solids (TDS) Concentration of the Santa Ana River at Prado Dam for Two Scenarios of Hydraulic Control

(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)
						= (3) - (5)	=[(3)*(4) - (5)*(6)]/(7)	= (8) - (4)	= (9)/(4)*100		= (11)/(4)*100
Hydraulic Control Scenario	Water Year	Santa Ana River (SAR) at Prado Dam without CCWF in Operation[1]		CCWF Production		SAR at Prado Dam with CCWF in Operation[3]		Change in SAR at Prado Dam TDS Due to CCWF Operation		Difference in SAR at Prado Dam TDS Due to Non-Full Containment at CCWF[4]	Percentage of the SAR at Prado Dam TDS that is the Difference in TDS Due to Non-Full Containment at CCWF
		Discharge (AFY)	TDS (mg/L)	Production (AFY)	TDS[2] (mg/L)	Discharge (AFY)	TDS (mg/L)	TDS (mg/L)	TDS %	TDS (mg/L)	TDS %
Hydraulic Control at de minimis Threshold [5]	2009/2010	243,776	443	1,529	966	242,247	440	-3	-0.7	**2**	**0.4**
	2010/2011	324,892	528	1,529	966	323,363	526	-2	-0.4	**1**	**0.2**
	2011/2012	121,123	597	1,529	966	119,594	592	-5	-0.8	**3**	**0.5**
	2012/2013	100,003	621	1,529	966	98,474	616	-5	-0.9	**3**	**0.5**
	2013/2014	86,486	582	1,529	966	84,957	575	-7	-1.2	**4**	**0.7**
	2014/2015	107,600	522	1,529	966	106,071	516	-6	-1.2	**4**	**0.7**
Hydraulic Control at Full Containment[6]	2009/2010	243,776	443	2,405	966	241,371	438	-5	-1.2	-	-
	2010/2011	324,892	528	2,405	966	322,487	525	-3	-0.6	-	-
	2011/2012	121,123	597	2,405	966	118,718	590	-7	-1.3	-	-
	2012/2013	100,003	621	2,405	966	97,598	612	-9	-1.4	-	-
	2013/2014	86,486	582	2,405	966	84,081	571	-11	-1.9	-	-
	2014/2015	107,600	522	2,405	966	105,195	512	-10	-1.9	-	-

[1] Annual discharge and TDS concentration as estimated and reported by the Santa Ana River Watermaster

[2] Based on the volume-weighted average of measured TDS concentration at each CCWF well

[3] Annual discharge and TDS concentration for various levels of CCWF production

[4] Relative to the comparable water year and hydraulic control at full containment scenario

[5] In this scenario, groundwater discharge from the Chino-North is about 900 acre-ft/yr in the CCWF area, with production at CCWF wells I-16, I-17, I-20, and I-21

[6] In this scenario, there is full hydraulic containment of groundwater from the Chino-North through the CCWF area; in other words, discharge from Chino-North is 0 acre-ft/yr

Table 2-3

Annual Groundwater Recharge at Chino Basin Facilities - 2005 to 2016

Year	Imported water (acre-ft)	Storm water (acre-ft)	Recycled Water (acre-ft)	Total (acre-ft)
2005	22,015	16,334	868	39,217
2006	47,426	11,852	2,699	61,977
2007	3,948	6,074	1,622	11,644
2008	0	10,568	2,781	13,349
2009	20	8,220	4,516	12,756
2010	4,980	19,390	8,304	32,674
2011	32,913	10,762	6,914	50,589
2012	0	9,372	7,823	17,195
2013	0	3,429	14,394	17,823
2014	795	8,166	10,997	19,958
2015	0	6,769	12,056	18,825
2016	4,260	9,812	14,310	28,382
Total	**116,358**	**120,748**	**87,284**	**324,390**

Table 2-4

Monthly Calculation of the Five-Year, Volume-Weighted, Total Dissolved Solids (TDS) and Nitrate-Nitrogen Concentrations of Recharge Water Sources to the Chino Basin

Five-Year Period	TDS (mg/L)	Nitrate-N (mg/L)
July 2005 - June 2010	203	1.1
Aug 2005 - July 2010	205	1.1
Sept 2005 - Aug 2010	207	1.1
Oct 2005 - Sept 2010	208	1.1
Nov 2005 - Oct 2010	210	1.1
Dec 2005 - Nov 2010	211	1.2
Jan 2006 - Dec 2010	213	1.1
Feb 2006 - Jan 2011	212	1.2
March 2006 - Feb 2011	214	1.2
April 2006 - March 2011	216	1.2
May 2006 - April 2011	221	1.3
June 2006 - May 2011	222	1.3
July 2006 - June 2011	222	1.3
Aug 2005 - July 2011	218	1.2
Sept 2006 - Aug 2011	215	1.2
Oct 2006 - Sept 2011	213	1.2
Nov 2006 - Oct 2011	217	1.3
Dec 2006 - Nov 2011	220	1.3
Jan 2007 - Dec 2011	218	1.4
Feb 2007 - Jan 2012	218	1.4
March 2007 - Feb 2012	218	1.4
April 2007 - March 2012	216	1.4
May 2007 - April 2012	215	1.4
June 2007 - May 2012	217	1.4
July 2007 - June 2012	220	1.4
Aug 2007 - July 2012	221	1.4
Sept 2007 - Aug 2012	221	1.4
Oct 2007 - Sept 2012	222	1.4
Nov 2007 - Oct 2012	222	1.4
Dec 2007 - Nov 2012	223	1.4
Jan 2008 - Dec 2012	224	1.5
Feb 2008 - Jan 2013	231	1.6
March 2008 - Feb 2013	233	1.6
April 2008 - March 2013	235	1.6
May 2008 - April 2013	236	1.6
June 2008 - May 2013	237	1.6
July 2008 - June 2013	239	1.7
Aug 2008 - July 2013	240	1.7
Sept 2008 - Aug 2013	241	1.7
Oct 2008 - Sept 2013	243	1.7
Nov 2008 - Oct 2013	245	1.7
Dec 2008 - Nov 2013	247	1.7
Jan 2009 - Dec 2013	251	1.8

Table 2-4

Monthly Calculation of the Five-Year, Volume-Weighted, Total Dissolved Solids (TDS) and Nitrate-Nitrogen Concentrations of Recharge Water Sources to the Chino Basin

Five-Year Period	TDS (mg/L)	Nitrate-N (mg/L)
Feb 2009 - Jan 2014	253	1.8
March 2009 - Feb 2014	257	1.8
April 2009 - March 2014	259	1.9
May 2009 - April 2014	261	1.9
June 2009 - May 2014	263	1.9
July 2009 - June 2014	264	1.9
Aug 2009 - July 2014	265	1.9
Sept 2009 - Aug 2014	266	1.9
Oct 2009 - Sept 2014	268	1.9
Nov 2009 - Oct 2014	269	1.9
Dec 2009 - Nov 2014	269	1.9
Jan 2010 - Dec 2014	266	1.9
Feb 2010 - Jan 2015	273	2.0
March 2010 - Feb 2015	279	2.0
April 2010 - March 2015	280	2.0
May 2010 - April 2015	283	2.0
June 2010 - May 2015	283	2.1
July 2010 - June 2015	285	2.1
Aug 2010 - July 2015	286	2.1
Sept 2010 - Aug 2015	286	2.1
Oct 2010 - Sept 2015	287	2.1
Nov 2010 - Oct 2015	287	2.1
Dec 2010 - Nov 2015	289	2.1
Jan 2011 - Dec 2015	291	2.2
Feb 2011 - Jan 2016	288	2.2
March 2011 - Feb 2016	290	2.2
April 2011 - March 2016	292	2.2
May 2011 - April 2016	293	2.2
June 2011 - May 2016	300	2.3
July 2011 - June 2016	310	2.4
Aug 2011 - July 2016	323	2.6
Sept 2011 - Aug 2016	338	2.8
Oct 2011 - Sept 2016	354	3.0
Nov 2011 - Oct 2016	349	2.9
Dec 2011 - Nov 2016	352	2.9
Jan 2012 - Dec 2016	345	2.8

Table 2-5

Monthly and 12-Month Running Average of the IEUA Agency-Wide Effluent Total Inorganic Nitrogen (TIN) and Total Dissolved Solids (TDS) Concentrations 2005 to 2016

Month	TIN (mg/L)		TDS (mg/L)	
	Monthly	12-Month Running Average [1]	Monthly	12-Month Running Average
Jan-05	7.3	8.4	492	486
Feb-05	8.4	8.4	496	487
Mar-05	7.5	8.4	516	488
Apr-05	6.9	8.2	534	491
May-05	6.7	8.0	513	492
Jun-05	7.0	8.0	507	492
Jul-05	5.4	7.8	466	492
Aug-05	5.9	7.7	452	490
Sep-05	5.4	7.4	469	491
Oct-05	5.5	7.1	468	491
Nov-05	5.5	6.7	467	490
Dec-05	8.4	6.7	481	488
Jan-06	9.9	6.9	491	488
Feb-06	9.0	6.9	467	486
Mar-06	8.8	7.1	471	482
Apr-06	7.8	7.1	464	476
May-06	8.3	7.2	454	471
Jun-06	6.5	7.2	466	468
Jul-06	6.8	7.3	472	469
Aug-06	5.9	7.3	475	470
Sep-06	6.5	7.4	465	470
Oct-06	6.4	7.6	457	469
Nov-06	6.9	7.6	456	468
Dec-06	7.1	7.5	470	467
Jan-07	7.7	7.3	488	467
Feb-07	6.2	7.1	481	468
Mar-07	6.7	6.9	490	470
Apr-07	5.6	6.7	491	472
May-07	5.6	6.5	489	475
Jun-07	6.0	6.5	495	477
Jul-07	5.1	6.3	492	479
Aug-07	5.2	6.3	478	479
Sep-07	5.9	6.2	478	480
Oct-07	6.0	6.2	517	485
Nov-07	7.6	6.2	514	490
Dec-07	7.4	6.3	522	495
Jan-08	6.8	6.2	511	481
Feb-08	6.4	6.2	492	483
Mar-08	6.6	6.2	515	484
Apr-08	6.7	6.3	519	487
May-08	7.2	6.4	502	489
Jun-08	6.8	6.5	490	490

Table 2-5

Monthly and 12-Month Running Average of the IEUA Agency-Wide Effluent Total Inorganic Nitrogen (TIN) and Total Dissolved Solids (TDS) Concentrations 2005 to 2016

Month	TIN (mg/L)		TDS (mg/L)	
	Monthly	12-Month Running Average [1]	Monthly	12-Month Running Average
Jul-08	6.1	6.6	499	491
Aug-08	5.8	6.6	514	492
Sep-08	8.3	6.8	510	494
Oct-08	7.0	6.9	503	496
Nov-08	5.7	6.7	496	498
Dec-08	6.3	6.7	494	504
Jan-09	6.5	6.6	497	503
Feb-09	7.8	6.7	463	500
Mar-09	6.9	6.8	496	499
Apr-09	6.6	6.8	509	498
May-09	5.8	6.6	501	498
Jun-09	5.4	6.5	505	499
Jul-09	5.0	6.4	512	499
Aug-09	4.5	6.3	499	497
Sep-09	4.0	6.0	498	497
Oct-09	4.6	5.8	500	497
Nov-09	4.8	5.7	489	497
Dec-09	5.5	5.6	494	497
Jan-10	5.7	5.6	493	496
Feb-10	6.2	5.4	489	498
Mar-10	6.4	5.4	482	497
Apr-10	5.7	5.3	473	494
May-10	5.2	5.3	471	492
Jun-10	5.0	5.2	478	490
Jul-10	5.1	5.2	477	487
Aug-10	4.6	5.2	477	485
Sep-10	3.7	5.2	476	483
Oct-10	5.5	5.3	478	481
Nov-10	5.7	5.3	479	481
Dec-10	5.0	5.3	472	479
Jan-11	6.4	5.4	474	477
Feb-11	6.9	5.4	455	474
Mar-11	6.4	5.4	468	473
Apr-11	6.5	5.5	460	472
May-11	6.0	5.6	462	471
Jun-11	5.7	5.6	464	470
Jul-11	4.3	5.5	454	468
Aug-11	4.4	5.5	457	467
Sep-11	5.8	5.7	457	465
Oct-11	5.2	5.7	457	463
Nov-11	5.9	5.7	453	461
Dec-11	6.3	5.8	454	460

Table 2-5

Monthly and 12-Month Running Average of the IEUA Agency-Wide Effluent Total Inorganic Nitrogen (TIN) and Total Dissolved Solids (TDS) Concentrations 2005 to 2016

Month	TIN (mg/L)		TDS (mg/L)	
	Monthly	12-Month Running Average [1]	Monthly	12-Month Running Average
Jan-12	6.4	5.8	465	459
Feb-12	6.7	5.8	476	461
Mar-12	6.7	5.8	497	463
Apr-12	7.4	5.9	496	466
May-12	6.4	5.9	493	469
Jun-12	5.8	5.9	482	470
Jul-12	5.4	6.0	477	472
Aug-12	4.8	6.1	463	473
Sep-12	5.1	6.0	472	474
Oct-12	4.9	6.0	486	476
Nov-12	6.1	6.0	485	479
Dec-12	6.0	6.0	492	482
Jan-13	6.1	5.9	495	484
Feb-13	6.8	5.9	490	486
Mar-13	6.1	5.9	493	485
Apr-13	6.4	5.8	501	486
May-13	6.4	5.8	503	487
Jun-13	5.8	5.8	502	488
Jul-13	5.6	5.8	496	490
Aug-13	6.9	6.0	496	493
Sep-13	7.3	6.2	499	495
Oct-13	7.4	6.4	496	496
Nov-13	6.7	6.4	507	497
Dec-13	7.6	6.6	511	499
Jan-14	5.9	6.6	510	500
Feb-14	6.1	6.5	509	502
Mar-14	5.5	6.5	497	502
Apr-14	5.2	6.4	517	504
May-14	5.2	6.3	524	505
Jun-14	4.4	6.1	506	506
Jul-14	3.5	6.0	494	505
Aug-14	3.5	5.7	508	506
Sep-14	4.1	5.4	524	508
Oct-14	4.9	5.2	541	512
Nov-14	5.9	5.1	571	518
Dec-14	6.2	5.0	565	522
Jan-15	7.9	5.2	546	525
Feb-15	7.4	5.3	560	529
Mar-15	6.2	5.4	528	532
Apr-15	5.2	5.4	531	533
May-15	6.1	5.4	520	533
Jun-15	4.6	5.4	515	534

Table 2-5

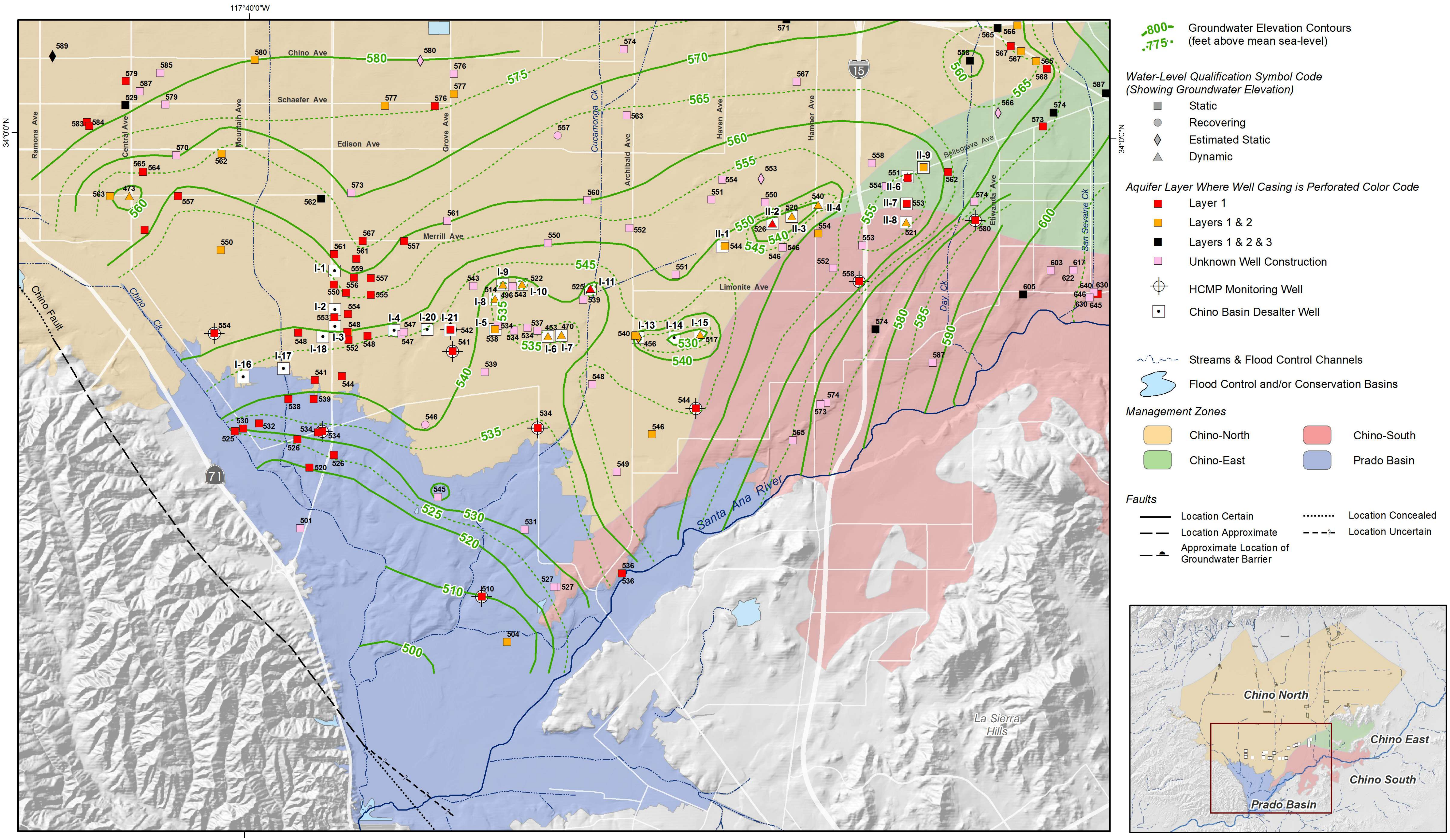
Monthly and 12-Month Running Average of the IEUA Agency-Wide Effluent Total Inorganic Nitrogen (TIN) and Total Dissolved Solids (TDS) Concentrations 2005 to 2016

Month	TIN (mg/L)		TDS (mg/L)	
	Monthly	12-Month Running Average [1]	Monthly	12-Month Running Average
Jul-15	5.2	5.6	500	534
Aug-15	4.7	5.7	503	534
Sep-15	4.8	5.7	508	532
Oct-15	5.2	5.8	506	529
Nov-15	5.4	5.7	505	524
Dec-15	6.2	5.7	503	519
Jan-16	7.3	5.7	504	515
Feb-16	6.5	5.6	495	510
Mar-16	5.9	5.6	521	509
Apr-16	5.8	5.6	514	508
May-16	5.7	5.6	514	507
Jun-16	5.3	5.7	519	508
Jul-16	6.2	5.7	514	509
Aug-16	6.5	5.9	502	509
Sep-16	6.4	6.0	492	507
Oct-16	5.8	6.1	491	506
Nov-16	5.5	6.1	489	505
Dec-16	5.8	6.0	495	504

1- The Agency-wide 12-month running average TIN limit in the NPDES permit was decreased from 10 mg/L to 8 mg/L, effective July 8, 2006. This decreased limit was anticipated; therefore, secondary treatment at all facilities was optimized to attain lower TIN. The 12-Month Running Average TIN has not been above the limit of 8 mg/L since the recycled water recharge program began in July 2005.

Table 2-6
Water Quality Objectives and Ambient Water Quality Determinations for the Chino Basin and Cucamonga Groundwater Management Zones

Groundwater Management Zone	Water Quality Objectives (mg/L)				Ambient Water Quality Determination (mg/L)									
	Antidegradation		Maximum Benefit		1997		2003		2006		2009		2012	
	TDS	NO_3-N	TDS	NO_3-N	TDS	NO_3-N	TDS	NO_3-N	TDS	NO_3-N	TDS	NO_3-N	TDS	NO_3-N
Chino-North	--	--	420	5	300	7.4	320	8.7	340	9.7	340	9.5	350	10
Chino 1	280	5	--	--	310	8.4	330	8.9	340	9.3	340	9.1	350	10
Chino 2	250	2.9	--	--	300	7.2	340	9.5	360	10.7	360	10.3	380	10.7
Chino 3	260	3.5	--	--	280	6.3	280	6.8	310	8.2	320	8.4	320	8.5
Cucamonga	210	2.4	380	5	260	4.4	250	4.3	250	4.0	250	4.1	260	4.1



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Document Name: Figure 2-1_HC_Spring14

0 1 2 Miles
0 1 2 3 KM

(Exhibit 22 from the 2014 Chino Basin State of the Basin Report - June 2015)

2016 Maximum Benefit Annual Report

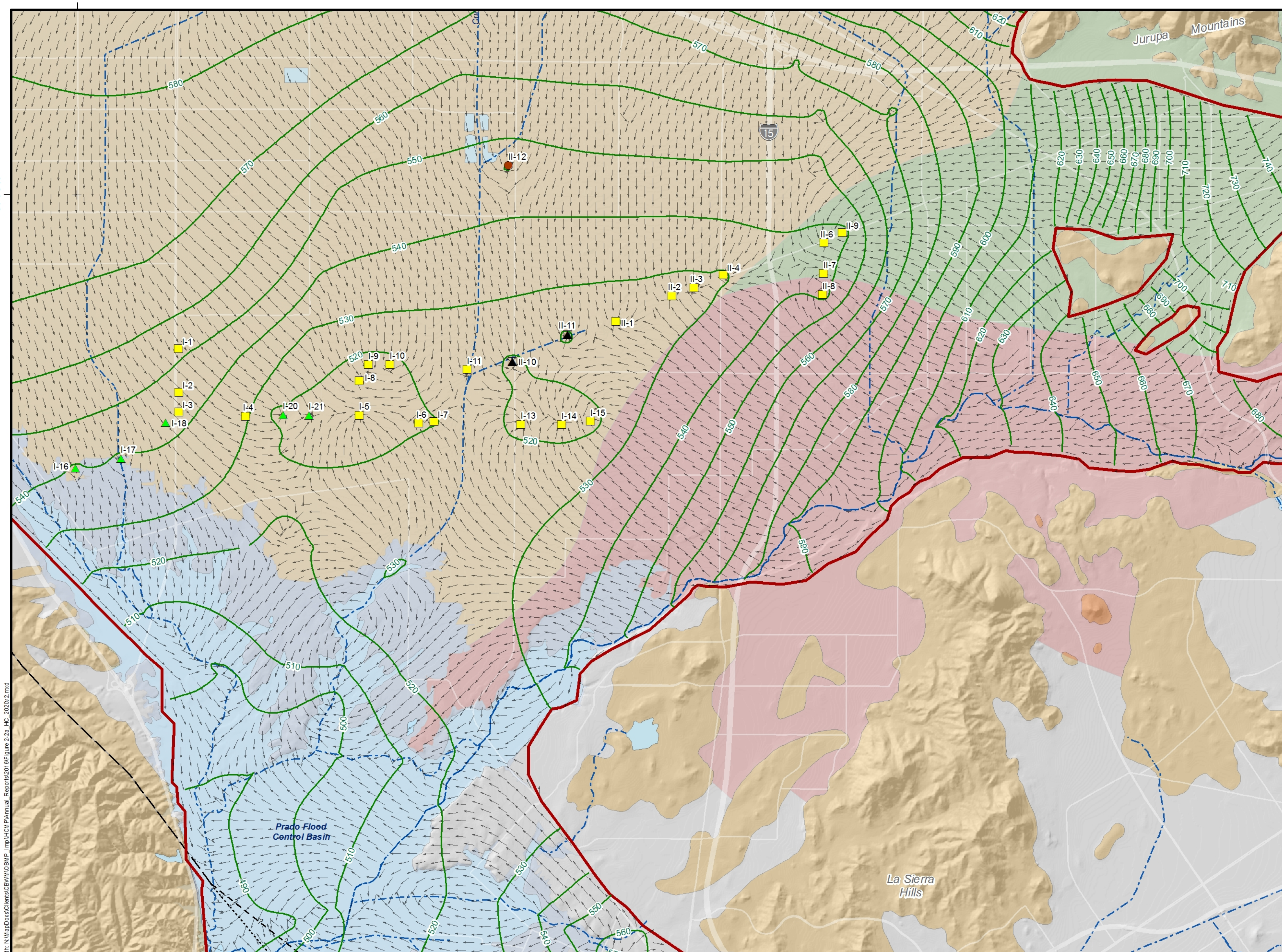
State of Hydraulic Control in Spring 2014

Shallow Aquifer System

Figure 2-1

117°40'0"W

34°0'0"N



117°40'0"W

2020 Groundwater Flow Vectors
Model Layer 1 - Scenario 5G

2020 Groundwater Elevation Contours (Secnario 5G)
(feet above mean sea-level)

Existing Chino Desalter Wells

New Chino Creek Well Field Wells

Future Chino II Desalter Wells (January 2016)

Location of Third
New Chino II Desalter Well (June 2016)

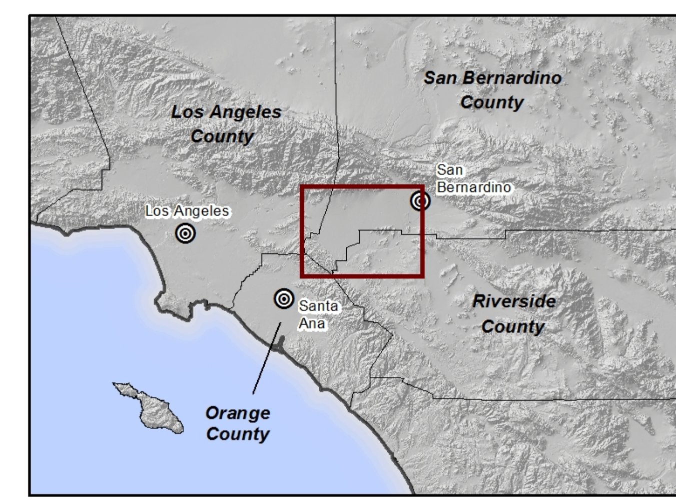
Groundwater Flow Model Boundary

Flood Control and/or Conservation Basins

Streams & Flood Control Channels

Management Zones

Chino-North
Chino-South
Chino-East
Prado Basin



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Date: 3/29/2017

0 1 2 Miles

0 0.5 1 1.5 Kilometers

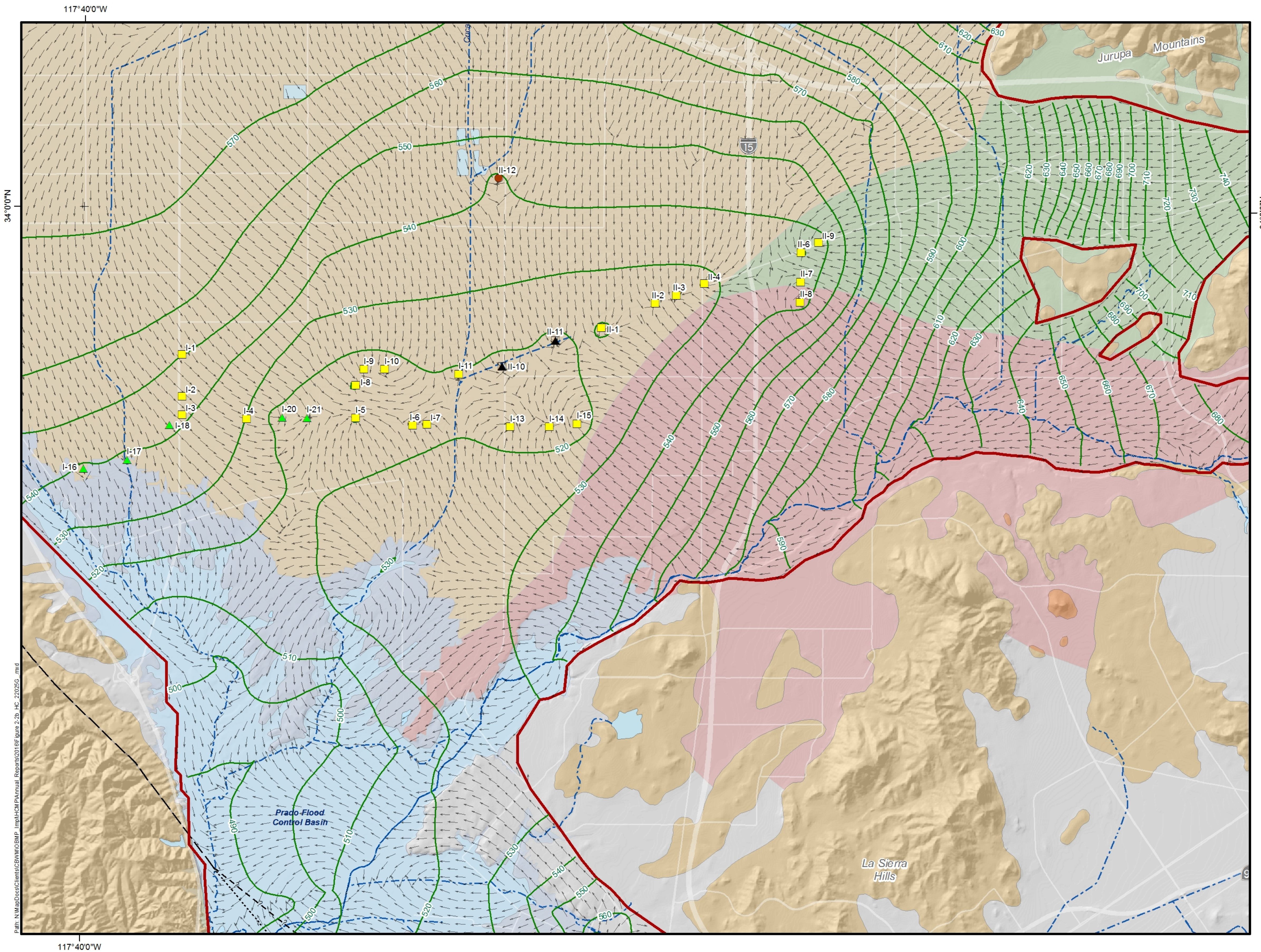
(Figure 7-8a from the 2013 Chino Basin Groundwater Model Update and Analysis of Safe Yield - October 2015)

2016 Maximum Benefit Annual Report

State of Hydraulic Control in 2020

Scenario 5G

Figure 2-2a



2025 Groundwater Flow Vectors
Model Layer 1 - Scenario 5G

2025 Groundwater Elevation Contours (Secnario 5G)
(feet above mean sea-level)

Existing Chino Desalter Wells

New Chino Creek Well Field Wells

Future Chino II Desalter Wells (January 2016)

Location of Third
New Chino II Desalter Well (June 2016)

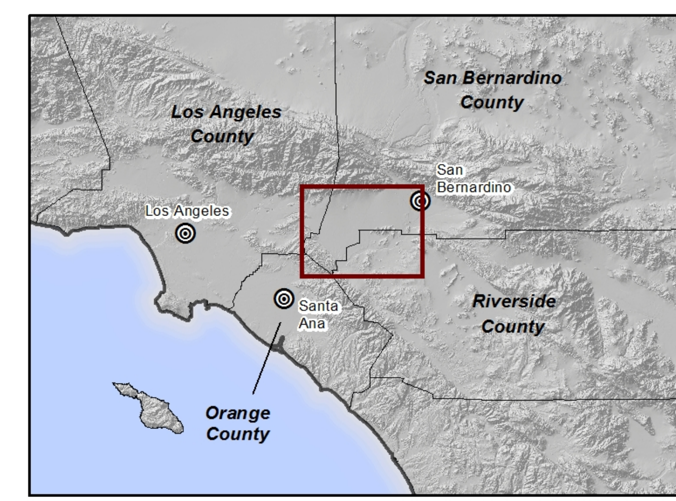
Groundwater Flow Model Boundary

Flood Control and/or Conservation Basins

Streams & Flood Control Channels

Management Zones

Chino-North	Chino-South
Chino-East	Prado Basin



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Author: NWS
Date: 3/29/2017

0 1 2 Miles

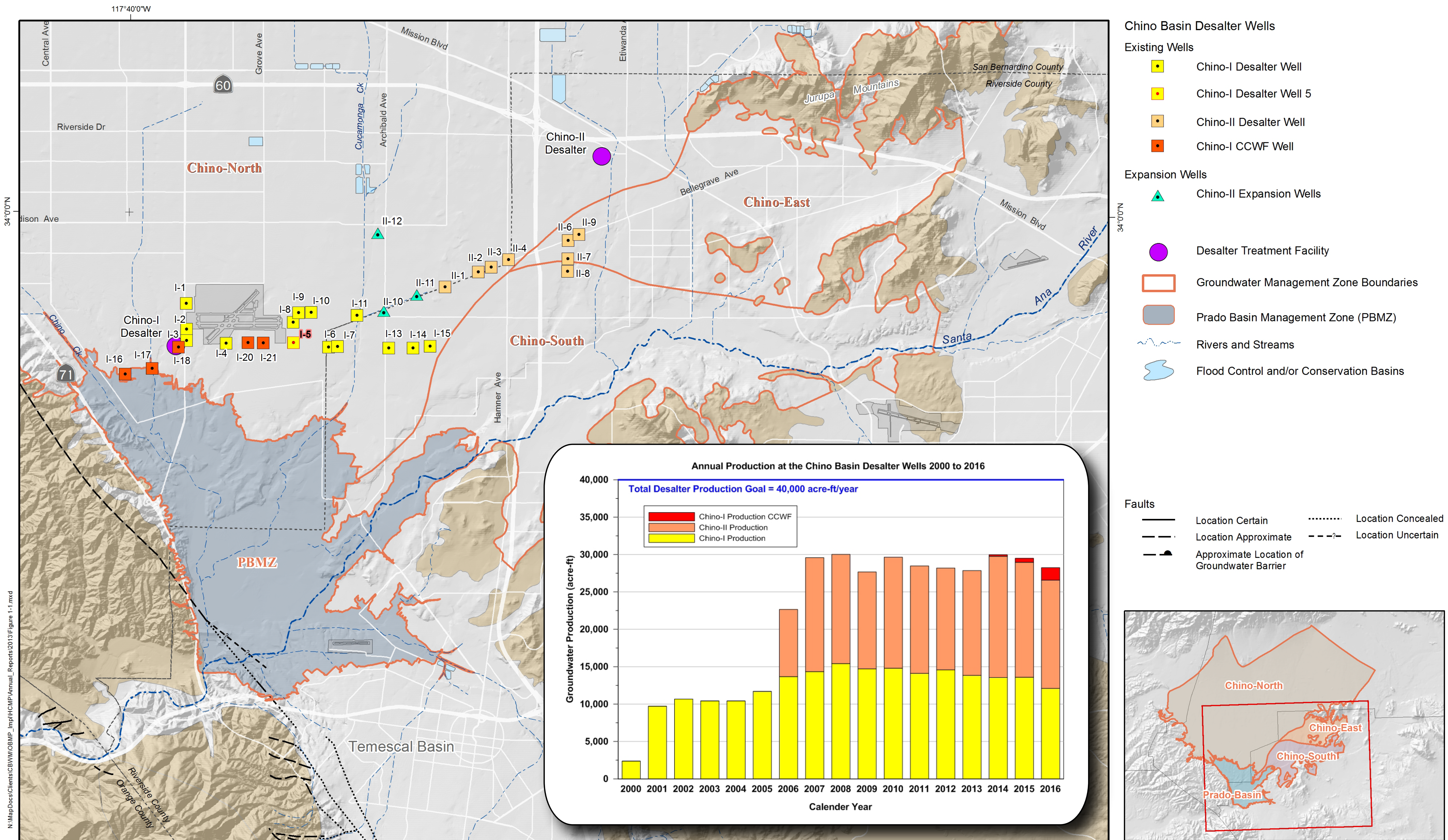
0 0.5 1 1.5 Kilometers

(Figure 7-8b from the 2013 Chino Basin Groundwater Model Update and Analysis of Safe Yield - October 2015)

2016 Maximum Benefit Annual Report

State of Hydraulic Control in 2025
Scenario 5G

Figure 2-2b



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File: Figure 2-3.mxd

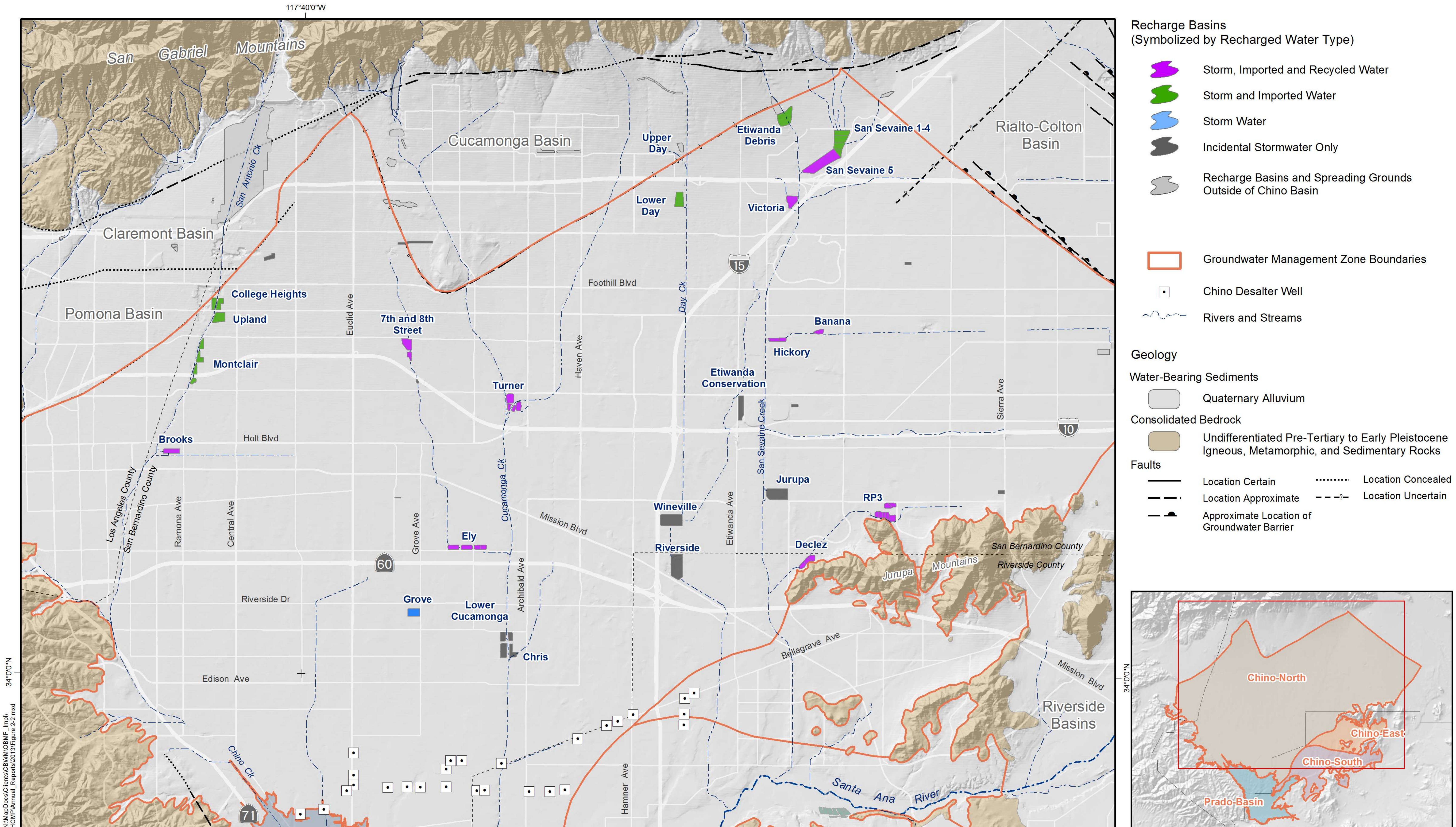
0 1 2 3 4 Miles
0 2 4 6 Kilometers

2016 Maximum Benefit Annual Report

Chino Basin Desalter Wells

Annual Production 2000 to 2016

Figure 2-3



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File: Figure 2-2.mxd

2016 Maximum Benefit Annual Report

Chino Basin Recharge Basins

Existing Facilities by Recharge Type as of 2016

Figure 2-4

Figure 2-5a

Volume and Total Dissolved Solids (TDS) Concentrations of Recharge Water Sources in the Chino Basin - 2005 to 2016

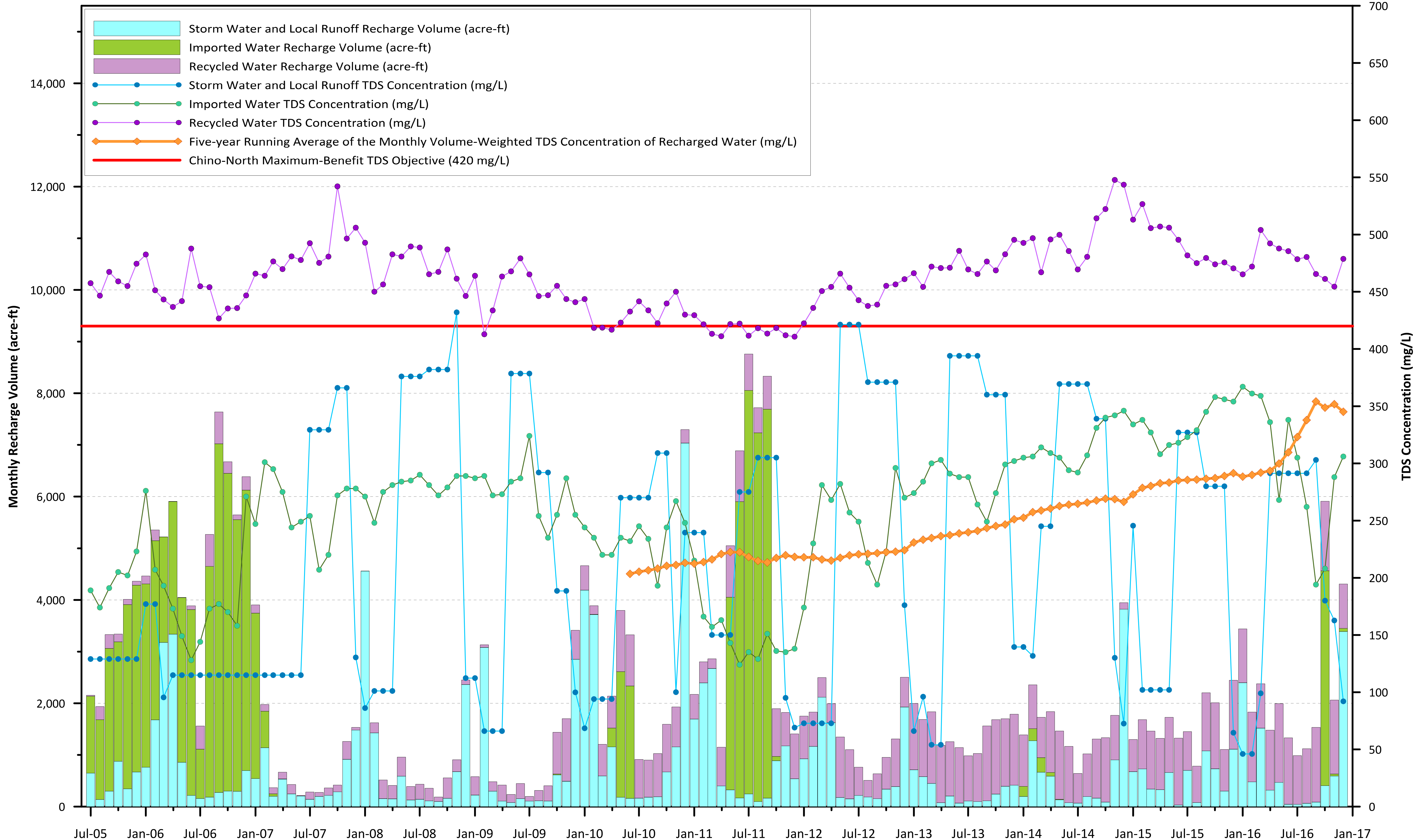


Figure 2-5b
Volume and Nitrate-Nitrogen Concentrations of Recharge Water Sources in the Chino Basin - 2005 to 2016

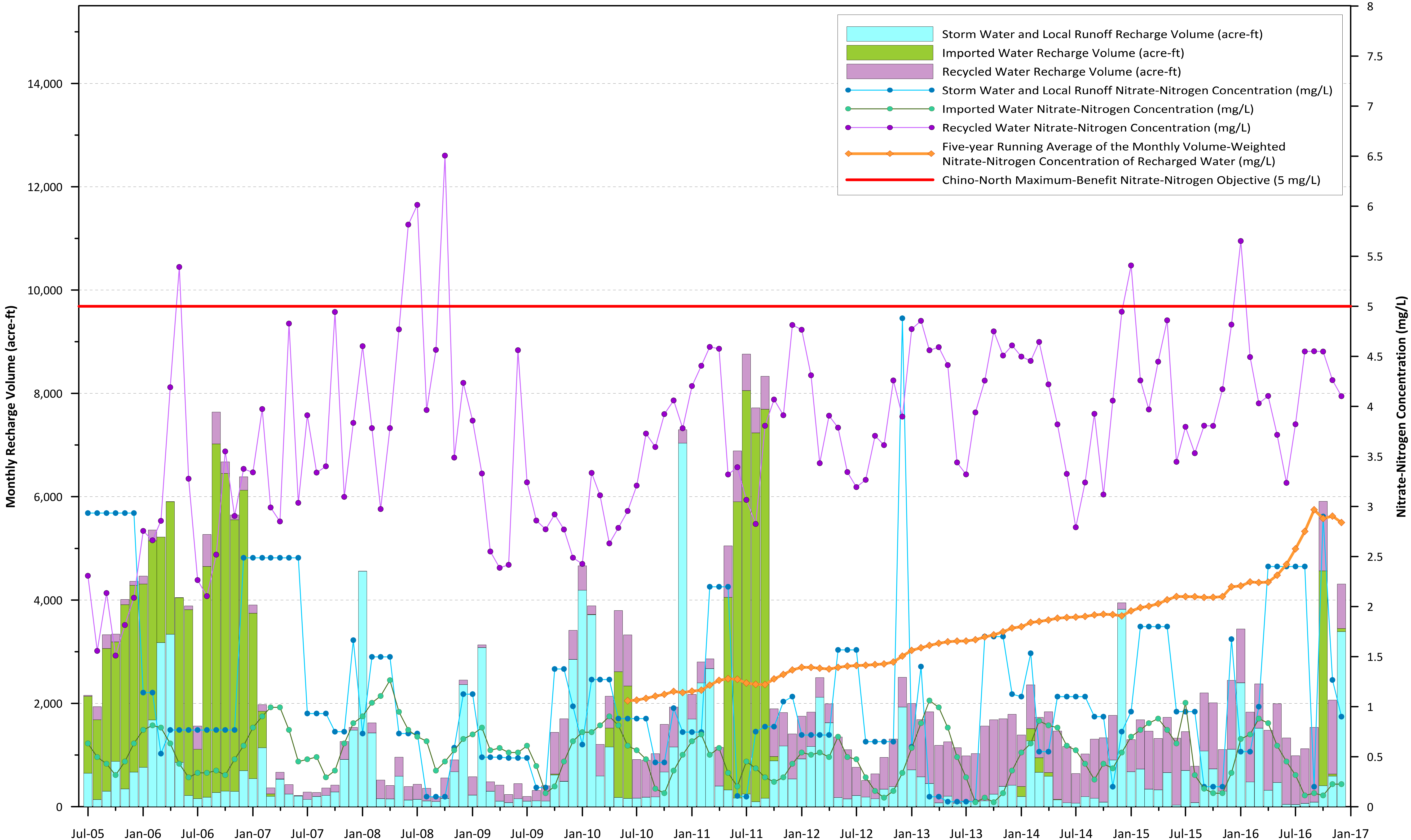


Figure 2-6
Monthly and 12-Month Running Average of the IEUA Agency-Wide Effluent
Total Dissolved Solids (TDS) and Total Inorganic Nitrogen (TIN) Concentrations, 2005 to 2016

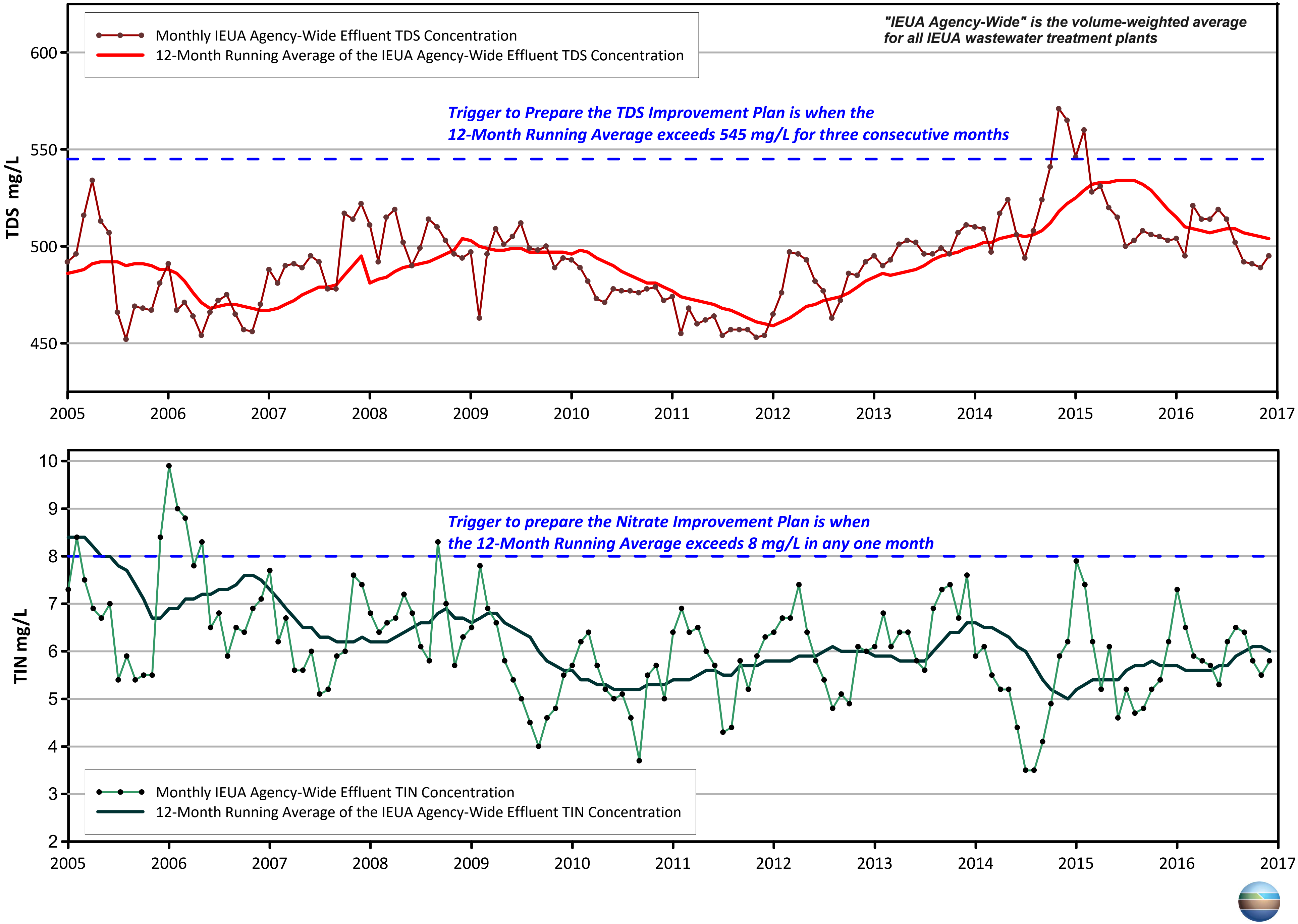
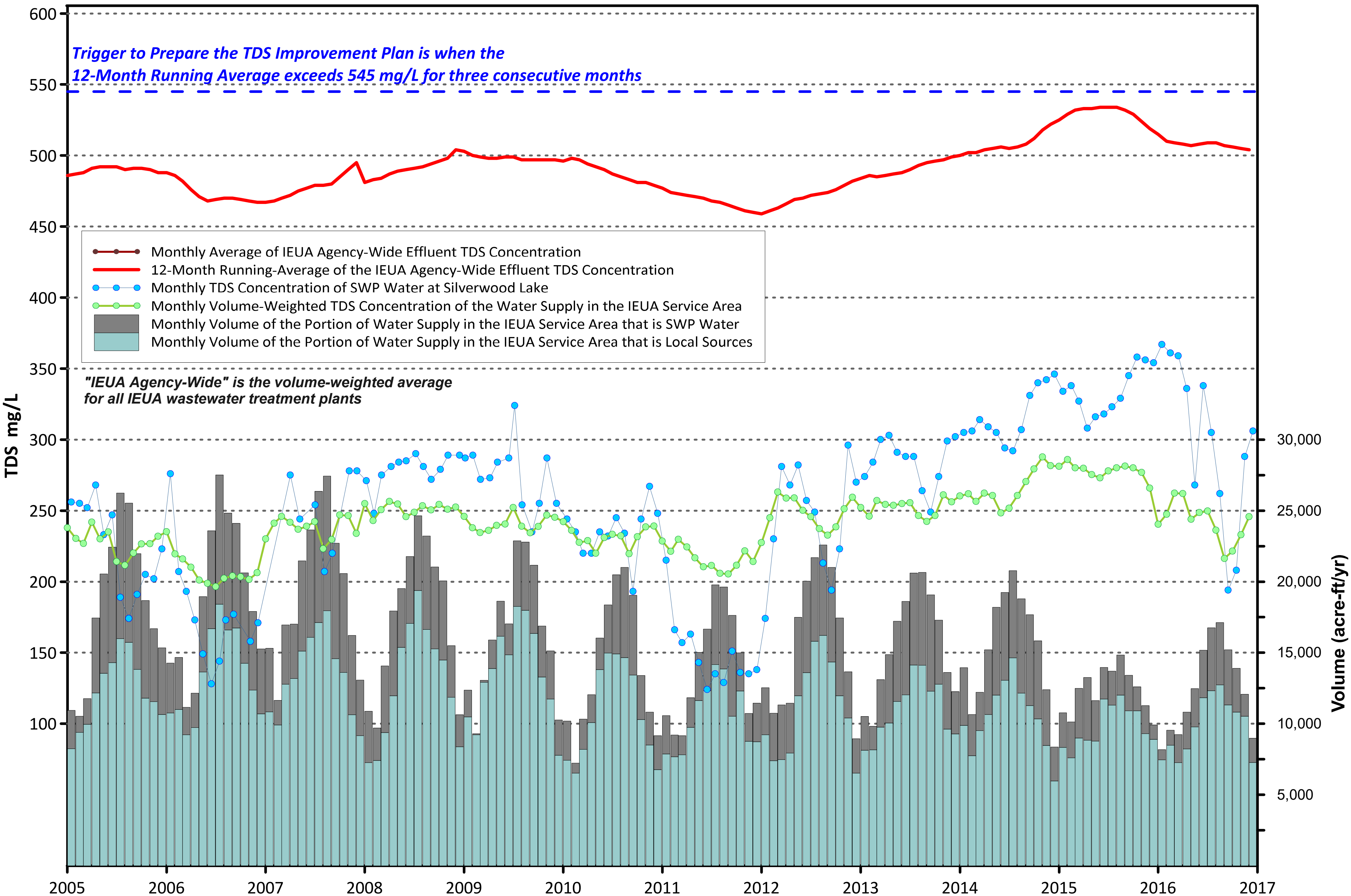


Figure 2-7

Monthly and 12-Month Running Average of the IEUA Agency-Wide Effluent Total Dissolved Solids (TDS) Concentrations, versus Monthly TDS Concentrations of the State Water Project (SWP) Water and the Monthly IEUA Volume-Weighted Water Supply, 2005 to 2016



Groundwater and surface-water data collected for the Maximum-Benefit Monitoring Program pursuant to the 2014 Work Plan are used for both maximum-benefit monitoring directives of demonstrating hydraulic control and computing ambient water quality every three years. The data collected in 2016 for the Maximum-Benefit Monitoring Program include groundwater elevation, groundwater quality, and surface-water quality. The 2016 data collection efforts are described below.

3.1 Groundwater Monitoring Program

Watermaster's Groundwater Monitoring Program consists of two main components: a groundwater-level monitoring program and a groundwater-quality monitoring program. These monitoring programs were designed and implemented to support the OBMP Implementation Plan and the other regulatory requirements of Watermaster and the IEUA. Watermaster's Groundwater Monitoring Program is summarized below with specific reference to the monitoring requirements of the maximum-benefit commitments.

3.1.1 Groundwater-Level Monitoring Program

Figure 3-1 shows the locations of the wells that are included in Watermaster's groundwater-level monitoring program. In total there are about 1,200 wells in the groundwater-level monitoring program. The groundwater-level monitoring program supports many Watermaster management functions, including: the periodic assessment of Safe Yield, groundwater model development and recalibration, cumulative impacts of transfers, balance of recharge and discharge, subsidence management, material physical injury assessments, estimation of storage change, other scientific demonstrations required for groundwater management; and many regulatory requirements such as demonstration of hydraulic control and the triennial ambient water quality recomputation. The wells within the southern portion of the Basin were selected for inclusion in the monitoring program to assist in Watermaster's analyses of hydraulic control, land subsidence, and desalter impacts to private well owners, and riparian vegetation in the PBMZ. The density of groundwater-level monitoring near the desalter well fields is greater than in outlying areas because hydraulic gradients are expected to be steeper near the desalter well fields, and these data are needed to assess the state of hydraulic control.

Figure 3-1 shows the wells where groundwater-level data were collected in 2016, symbolized by measurement frequency. At about 950 of these wells, water levels are measured by well owners, including municipal water agencies, the California Department of Toxic Substance Control (DTSC), the County of San Bernardino, and various consulting firms on behalf of their clients. The measurement frequency by municipal water agencies is typically about once per month, and Watermaster compiles the data quarterly. The measurement frequency by other well owners varies, and Watermaster compiles these data twice per year. The remaining approximately 250 wells shown in Figure 3-1 are mainly privately owned wells or dedicated monitoring wells that are primarily located in the southern portion of the Chino Basin. Watermaster staff measures water levels at these wells using manual methods once per month or with pressure transducers that record water levels once every 15 minutes. All water-level data are reviewed by Watermaster staff and uploaded to a centralized database management system that can be accessed online through HydroDaVE[SM]. All water-level data collected in 2016 are contained in the Microsoft (MS) Access database that has been included with this report as Appendix B. The well location information for private wells with water-level data is excluded from the database in this report for confidentiality reasons.

3.1.2 Groundwater-Quality Monitoring Program

Figure 3-2 shows the locations of the wells that are included in Watermaster's groundwater – quality monitoring program. In total there are about 885 wells in the groundwater-quality monitoring program. Watermaster obtains groundwater-quality data, in part, to comply with two maximum-benefit commitments: the triennial ambient water quality recomputation and the analysis of hydraulic control. These data are also used for Watermaster's biennial SOB report, to support ground-water modeling, to characterize non-point source contamination and plumes associated with point-source discharges, and to characterize present trends in water quality of the Basin.

Figure 3-2 shows the wells where groundwater-quality data were collected in 2016. At about 780 of these wells, water-quality samples were collected by well owners, including municipal water agencies, the DTSC, the County of San Bernardino, and various private companies and consulting firms. The sampling frequency and constituents tested vary by well and owner. These water quality data are compiled by Watermaster twice per year. The remaining approximately 105 wells shown in Figure 3-2 are privately owned agricultural wells or dedicated monitoring wells that were sampled by Watermaster for various purposes. All groundwater samples collected by Watermaster are tested for the analytes listed in Table 3-1. VOCs are sampled only at wells within or adjacent to known contamination plumes.

During 2016, Watermaster performed the following groundwater-quality sampling:

- Annual and triennial samples were collected for the Key Well Groundwater Quality Monitoring Program (GWQMP). The Key Well GWQMP consists of a network of about 100 private wells predominantly in the southern portion of the Chino Basin and 11 monitoring wells, which include two multi-nested MZ-3 monitoring wells (six well casings), and two multi-nested former Kaiser Steel monitoring wells (five well casings). About nine of the private wells are sampled every year; the remaining private wells are sampled every three years. Watermaster is constantly evaluating and revising the private wells in the Key Well GWQMP as wells are abandoned or destroyed due to urban development. During 2016, 45 private wells and ten monitoring wells were sampled from July through December 2016.

- Annual samples were collected from the nine multi-nested HCMP monitoring wells (21 well casings) in the southern portion of Chino Basin in August 2016.

- Quarterly samples were collected at four shallow monitoring wells along the Santa Ana River, which consist of two former United States Geological Survey (USGS) National Water Quality Assessment (NAWQA) Program wells (Archibald 1 and Archibald 2) and two Santa Ana River Water Company (SARWC) wells (Wells 9 and 11). Samples were collected in January, March, July, and October 2016.

- Quarterly samples were collected at the nine multi-nested Prado Basin Habitat Sustainability Program (PBHSP) monitoring wells (18 well casings). The wells were constructed from March through May 2015, and quarterly samples were collected in March, June, September, and December 2016.

All groundwater-quality data were reviewed by Watermaster staff and uploaded to a centralized database management system that can be accessed online through HydroDaVE^{SM}. All publically available water-quality data collected in 2016 are contained in the MS Access database included with this report as Appendix B. Groundwater-quality data collected at private wells in the Basin are excluded from the database in this report for confidentiality reasons.

3.2 Surface-Water Quality Monitoring Program

Watermaster collects quarterly surface-water quality samples from two sites along the Santa Ana River: *SAR at Etiwanda* and *SAR at River Road*. Figure 3-2 shows the locations of these sites. Surface-water quality data are used to characterize surface water and groundwater interactions along the Santa Ana River. Samples are collected on the same day as the quarterly groundwater-quality samples at the near-river NAWQA and SARWC wells. Samples were collected in January, March, July, and October 2016. Surface-water quality samples are tested for the analytes listed in Table 3-2. All surface-water quality data are reviewed by Watermaster and uploaded to a centralized database management system that can be accessed online through HydroDaVE^{SM}. All surface-water quality data collected in 2016 are contained in the MS Access database included with this report as Appendix B.

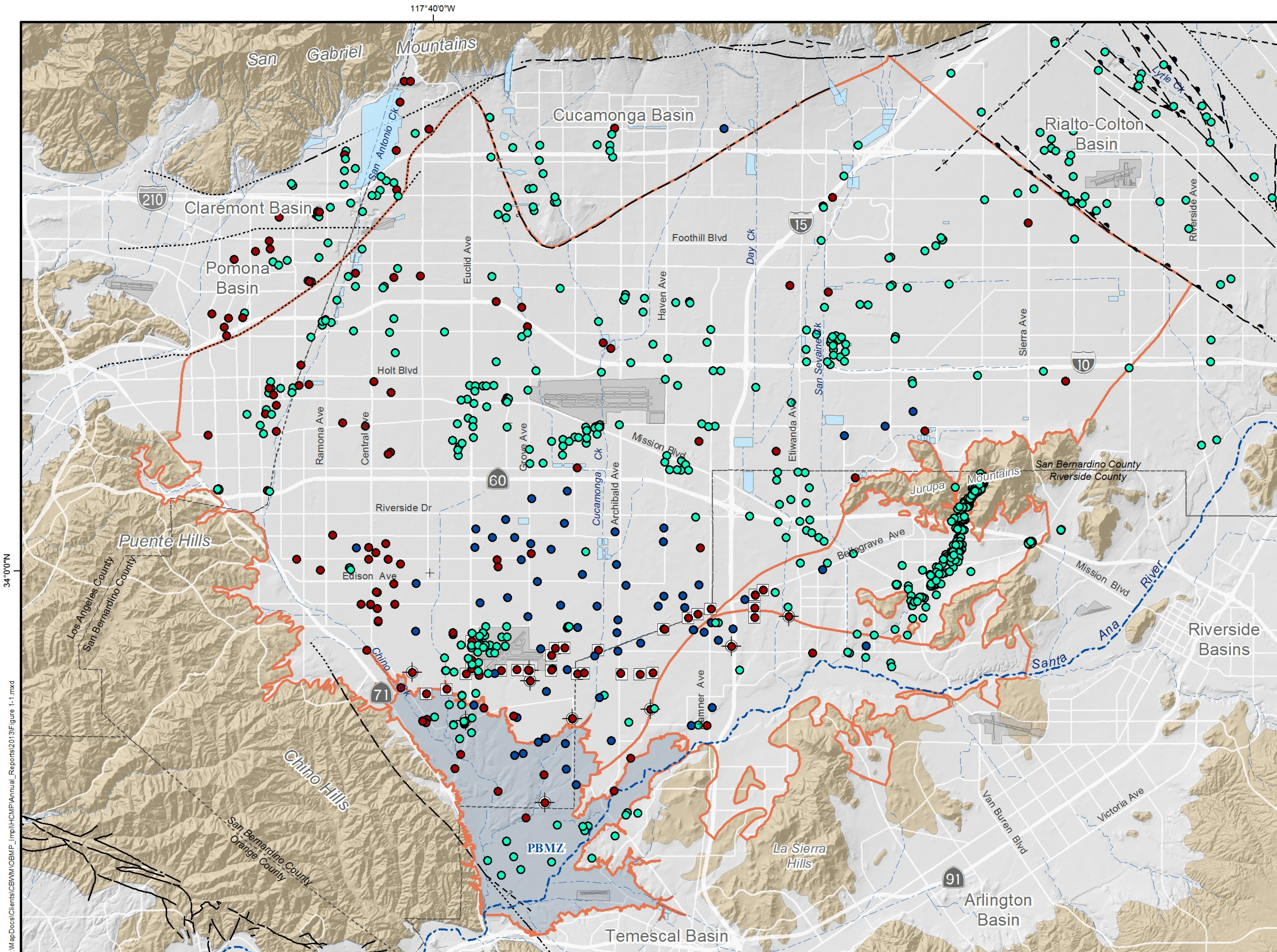
Table 3-1
Analyte List for the Groundwater-Quality Monitoring Program

Analyte	Method
Major cations: Ca, Mg, K, Si, Na	EPA 200.7
Major anions: Cl, SO_4, NO_2, NO_3	EPA 300.0
Total Hardness	SM 2340B
Total Alkalinity (incl. Carbonate, Bicarbonate, Hydroxide)	SM 2320B
Ammonia Nitrogen	EPA 350.1
Arsenic	EPA 200.8
Boron	EPA 200.7
Chromium, Total	EPA 200.8
Hexavalent Chromium	EPA 218.6
Fluoride	SM 4500F-C
Perchlorate	EPA 314.0
pH	SM2330B/SM 4500-HB
Specific Conductance	SM 2510B
Total Dissolved Solids	EPA 160.1/SM 2540C
Total Kjeldahl Nitrogen (TKN)	EPA 351.2
Organic Nitrogen	EPA 351.2
Total Organic Carbon	SM5310C/E415.3
Turbidity	EPA 180.1
VOCs[1]	EPA 524.2
1,2,3 -Trichloropropane (Low Detection)	CASRL 524M-TCP

[1] Only at wells within or near known VOC plumes (Chino Airport, South Archibald, etc.)

Table 3-2
Analyte List for the Surface-Water Monitoring Program

Analytes	Method
Major cations: K, Na, Ca, Mg	EPA 200.7
Major anions: Cl, SO_4, NO_2, NO_3	EPA 300.0
Total Hardness	SM 2340B
Total Alkalinity (incl. Carbonate, Bicarbonate, Hydroxide)	SM 2320B
Boron	EPA 200.7
Ammonia-Nitrogen	EPA 350.1
pH	SM 4500-HB
Specific Conductance	SM 2510B
Total Dissolved Solids	E160.1/SM2540C
Total Kjeldahl Nitrogen (TKN)	EPA 351.2
Organic Nitrogen	EPA 351.2
Turbidity	EPA 180.1
Total Organic Carbon	SM5310C/E415.3



Wells Measured in 2016
- Symbolized by Measurement Frequency

Measured Monthly by Watermaster

Measured by a Transducer at 15-minute Intervals. Data are Download by Watermaster Quarterly.

Measured at Variable Frequencies by Well Owner

HCMP Monitoring Well

Groundwater Management Zone Boundaries

Prado Basin Management Zone (PBMZ)

Chino Desalter Well

Rivers and Streams

Flood Control and/or Conservation Basins

Airport

Geology

Water-Bearing Sediments

Quaternary Alluvium

Consolidated Bedrock

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

Faults

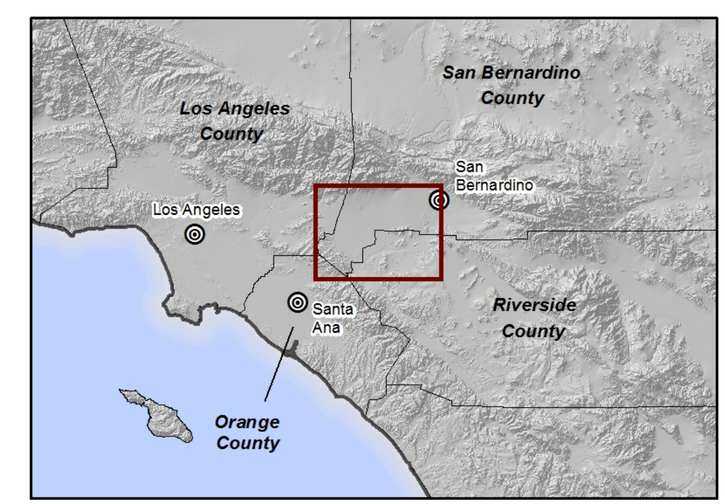
Location Certain

Location Concealed

Location Approximate

Location Uncertain

Approximate Location of Groundwater Barrier



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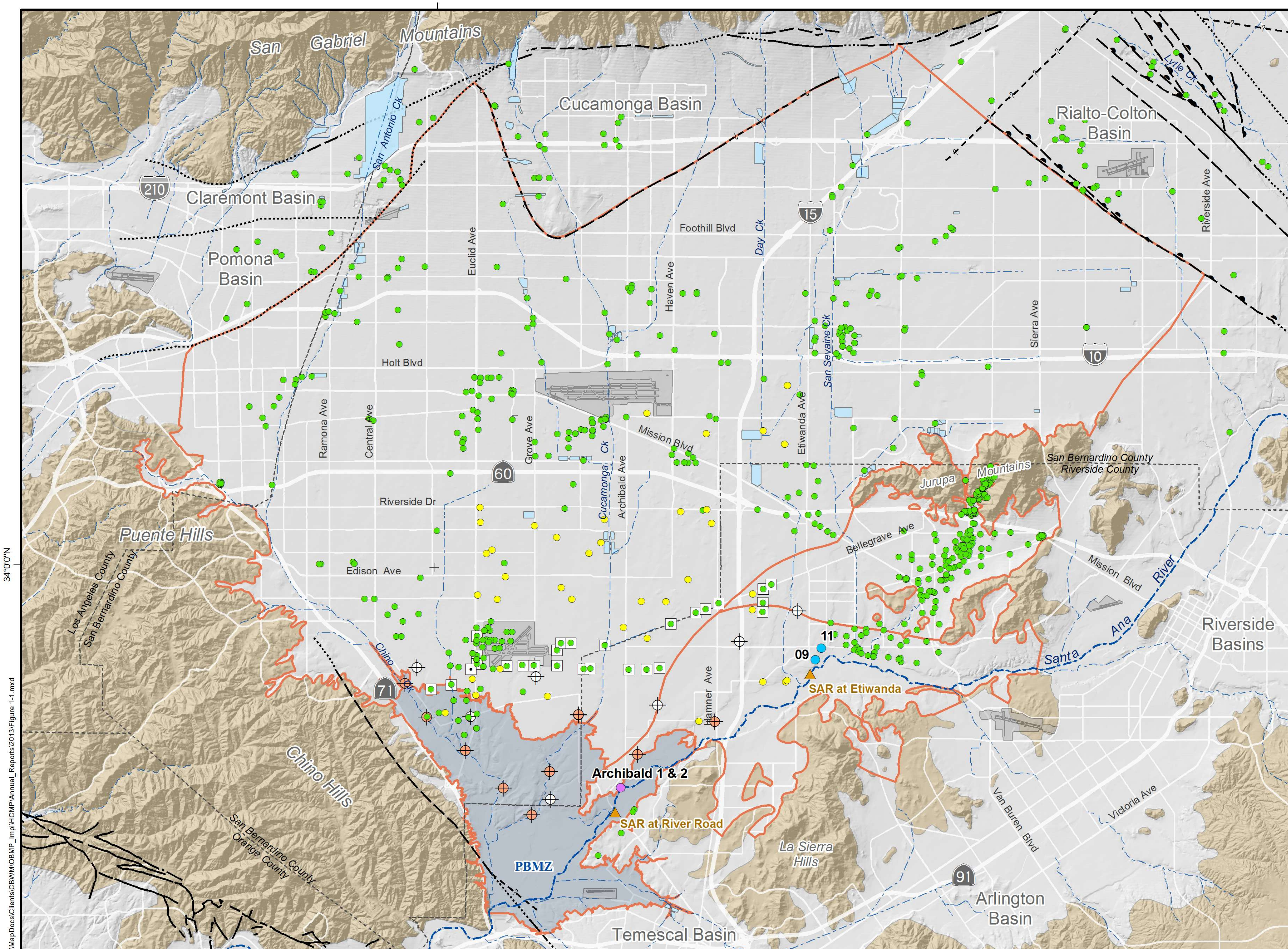
0 1 2 3 4 Miles
0 2 4 6 Kilometers

2016 Maximum Benefit Annual Report

Groundwater-Level Monitoring Program

Figure 3-1



Wells Sampled in 2016

- Well Sampled by Well Owner

Wells Sampled by Watermaster:

- Key Well GWQMP
- Santa Ana River Water Company Well
- USGS NAWQA Well
- HCMP Monitoring Well
- PBHSP Monitoring Well

- Surface-Water Quality Monitoring Site

- Groundwater Management Zone Boundaries
- Prado Basin Management Zone (PBMZ)
- Chino Desalter Well
- Rivers and Streams
- Flood Control and/or Conservation Basins
- Airport

Geology

Water-Bearing Sediments

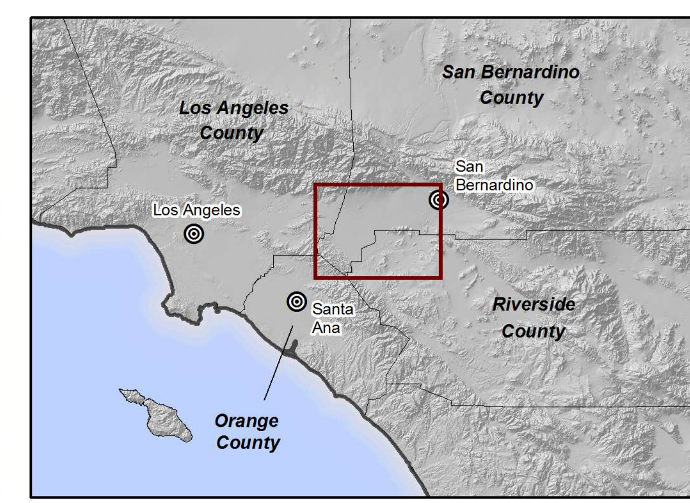
- Quaternary Alluvium

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 1 2 3 4 Miles
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2016 Maximum Benefit Annual Report

Groundwater and Surface-Water Quality Monitoring Program

Figure 3-2

Section 4 - The Influence of Rising Groundwater on the Santa Ana River

This section characterizes the influence of rising groundwater on the flow and quality of the Santa Ana River between the Riverside Narrows and Prado Dam. Rising groundwater to the Santa Ana River from the Chino Basin consists of groundwater from Chino-North that flows past the CCWF well field and unpumped groundwater south of and outside the influence of the Chino Desalter well fields[16]. This characterization is based on data that were collected and compiled by the Santa Ana River Watermaster (SARWM) and reported in their annual reports.

The Santa Ana River was adjudicated in the 1960s, and a stipulated judgment was filed in 1969 (Judgment) (OCWD v. City of Chino et al., Case No. 117628, County of Orange). Since the Judgment was filed, the SARWM has compiled annual reports that contain estimates of significant discharges to the Santa Ana River. The SARWM uses these data to estimate the storm flow discharge and base flow discharge of the River each water year as well as the volume-weighted TDS concentration of discharge at the Riverside Narrows and at Prado Dam. As defined in the Judgment, base flow discharge consists of rising groundwater and recycled water discharged in the upper Santa Ana River Watershed.

The available records from the SARWM were investigated to determine the relationship between the Santa Ana River and groundwater in the southern part of the Chino Basin. All available hydrologic studies conducted in support of the Judgment and the subsequent SARWM reports through water year 2016 were compiled (i) to estimate the annual net contribution of rising groundwater to the Santa Ana River and (ii) to examine the influence of rising groundwater on the flow and quality of the Santa Ana River.

4.1 Surface-Water Discharge Accounting

Data from the SARWM annual reports (SARWM, 2017) were used to develop a hydrologic budget for the Santa Ana River between the Riverside Narrows and Prado Dam. The purpose of this analysis is to estimate the magnitude of net rising groundwater in the Santa Ana River. Net rising groundwater is the combined losses and gains in flow due to rising groundwater, infiltration, and evapotranspiration (ET). Achieving hydraulic control should decrease net rising groundwater.

Table 4-1 lists the Santa Ana River storm and base flow discharges that enter the Chino Basin at the Riverside Narrows and leave the Chino Basin at below Prado Dam and the various discharge components in the reach between the San Jacinto Fault and Prado Dam. The SARWM estimates the storm flow discharge component of the hydrograph and subtracts storm flow discharge from the total observed discharge to obtain a "trial base flow." Note that subsurface inflow to the Chino Basin at the Riverside Narrows is negligible because the Riverside Narrows is a shallow bedrock narrows that forces groundwater in the Riverside Basin to rise and become surface flow. In addition, there is negligible subsurface discharge from the Chino Basin under

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[16] See groundwater flow vectors in Figures 2-2a and 2-2b.

the Santa Ana River because Prado Dam was constructed in a similar bedrock narrows and sits on a grout curtain that was constructed to eliminate underflow. Given these subsurface flow assumptions, the net rising groundwater to the Santa Ana River in the reach between the Riverside Narrows and Prado Dam can be calculated from the SARWM tabulations using the following equation:

$$Q_{RW} = Q_{BF\_PD} - Q_{BF\_RN} - \Sigma Q_{RECi} - \Sigma Q_{NONTDj}$$

Where:

- Q_{RW} is net rising groundwater to the Santa Ana River between the Riverside Narrows and Prado Dam.
- Q_{BF_PD} is non-storm discharge at Prado Dam
- Q_{BF_RN} is non-storm discharge at the Riverside Narrows
- ΣQ_{RECi} is the sum of all recycled water discharges to the Santa Ana River in the reach between the Riverside Narrows and Prado Dam
- ΣQ_{NONTDj} is the sum of all other estimated non-tributary discharges to the Santa Ana River in the reach between the Riverside Narrows and Prado Dam.

Estimates of net rising groundwater in the Santa Ana River between the Riverside Narrows and Prado Dam are shown in Column 15 of Table 4-1 for water years 1971 through 2016. The time history of net rising groundwater is shown graphically in Figure 4-1. With two exceptions, the net rising groundwater estimate is negative over the last 40 years. Negative values for net rising groundwater indicate that the volume of rising groundwater in this reach of the Santa Ana River is less than the combined volume of losses from the river due to streambed infiltration and ET. Net rising groundwater decreased (larger negative values) as the Chino-I and Chino-II Desalters ramped up production in the southern Chino Basin from. These observations are consistent with the conclusion from the monitoring data that the achievement of hydraulic control is occurring.

4.2 Surface-Water Quality at Prado Dam

Analysis of groundwater-elevation data in previous Annual Reports (WEI, 2007b; 2008b; 2009a; 2010; 2011a) and SOB Reports (WEI, 2009c; 2011c; 2013b; 2015b) indicates that the capture of Chino-North groundwater is incomplete in the southwestern portion of the Chino Basin. Groundwater modeling performed by the Watermaster has indicated that in the absence of pumping from the CCWF, about 2,400 acre-ft/yr of groundwater discharge from Chino-North to the PBMZ moves through this area within the shallow aquifer (WEI, 2015c). Groundwater discharge from Chino-North to the PBMZ is either pumped by wells, consumed by riparian vegetation in the PBMZ, or becomes rising groundwater and contributes to the Santa Ana River discharge at Prado Dam. Calibration of the Wasteload Allocation Model (1994-2006) determined that rising groundwater in the PBMZ had an average TDS concentration of about 850 mg/L (WEI, 2009b).

The volume and TDS concentrations of the Santa Ana River at Prado Dam, as reported in the SARWM Annual Reports (SARWM, 2017), were compiled to examine the influence of the groundwater discharge from Chino-North to the PBMZ that becomes rising groundwater. Figure 4-2 is a time-history chart of the annual discharge components in the Santa Ana River at Prado Dam and the associated annual volume-weighted TDS concentration as reported by the SARWM. The base flow discharge is represented by two bars, the rising groundwater discharge to the Santa Ana River from the Chino Basin, and the SARWM estimate of base flow discharge at Prado Dam minus the rising groundwater from the Chino Basin component— the sum of these two terms is equal to the SARWM estimate of base flow discharge at Prado Dam. The rising groundwater discharge to the Santa Ana River from the Chino Basin was estimated with the 2013 Chino Basin Model (WEI, 2015c). Recall that the total rising groundwater to the Santa Ana River from the Chino Basin consists of groundwater from Chino-North that flows past the CCWF well field and unpumped groundwater south of and outside the influence of the Chino Desalter well fields[17]. Finally, Figure 4-2 shows the five-year moving average of the annual flow-weighted TDS concentration of the Santa Ana River at Prado Dam, which is the metric the Regional Board uses to determine compliance with the TDS concentration objective of 650 mg/L for Reach 2 of the Santa Ana River (Reach 2 TDS metric) (Regional Board, 2008). Note that:

- Since about 1980, the annual estimates of the total rising groundwater discharge to the Santa Ana River from the Chino Basin, which ranged from about 13,500 to 29,000 acre-ft/yr, have been a small percentage of the total annual flow at Prado Dam, ranging from about three percent during wet years to about 21 percent during dry years.
- From 2005 to 2015, the model-estimated groundwater discharge from Chino-North to the PBMZ, about 2,400 acre-ft/yr without CCWF operation, represents a small fraction of the total rising groundwater from Chino Basin: it represents about 13 percent of the total rising groundwater discharge to the Santa Ana River from the Chino Basin, and about two percent of the total flow in the Santa Ana River at Prado Dam.
- In 2016, the CCWF commenced full production, meaning that the estimated groundwater discharge from Chino-North to the PBMZ was about 900 acre-ft/yr[18]. This represents about five percent of the total rising groundwater discharge to the Santa Ana River from the Chino Basin, and less than one percent of the total flow in the Santa Ana River at Prado Dam.
- Since about 1980, the Reach 2 TDS metric has ranged between 481 and 603 mg/L and has not exceeded the TDS objective of 650 mg/L—even during extended dry periods when storm water dilution of the Santa Ana River is

[17] See groundwater flow vectors in Figures 2-2a and 2-2b of this report.

[18] See Table 7-9 of WEI, 2015c. Updated modeling estimates of the groundwater discharge from Chino-North to the PBMZ based on historical water levels and CCWF production will be available after the next Chino Basin Groundwater Model update that includes multiple years of CCWF pumping as part of the model calibration period, likely the 2022 model update. The forthcoming 2017 model is based on a historical period through June 2016.

relatively little (e.g. water years 1984 through 1992, 1999 through 2004, and 2012 through 2016). In water year 2016, the Reach 2 TDS metric was 569 mg/L.

- The Reach 2 TDS metric has been increasing since water year 2005, which coincides with a dry climatic period and a steady decrease in the volume of base flow discharge, which is mostly attributable to the decrease in low-TDS wastewater discharges to the Santa Ana River.

These observations suggest that the rising groundwater discharge to the Santa Ana River from the Chino Basin has had a *de minimis* impact on the flow and TDS concentration of the Santa Ana River since about 1980 and has never contributed to an exceedance of the TDS objective for Reach 2. Since the attainment of hydraulic control east of Chino-I-Desalter Well 5, groundwater discharge from Chino-North to the PBMZ that becomes rising groundwater in the Santa Ana River has decreased, and is only a small portion of the total rising groundwater in the Santa Ana River from the Chino Basin, and therefore has a small impact on the surface water quality in the Santa Ana River at Prado Dam. Under full operation of the CCWF groundwater discharge from the Chino-North to the PBMZ is projected to decrease further and will have even less influence on the TDS concentration of the Santa Ana River at Prado Dam. Based on the trends observed since 2005, the Reach 2 TDS metric will likely continue to increase as the other conditions that affect the flow and quality of the Santa Ana River change over time, such as continued reduction of wastewater effluent discharges to the River, and/or an increase in the duration and frequency of dry periods. Given that wastewater effluent discharges are projected to decline further, the maintenance of hydraulic control of Chino-North will become increasingly important to protecting downstream beneficial uses.

Table 4-1
Estimate of Net Rising Groundwater to the Santa Ana River between Riverside Narrows and Prado Dam
(acre-ft/yr)

Water Year	Santa Ana River at Riverside Narrows								Santa Ana River below Prado Dam								
	(1) Groundwater Discharge from Bunker Hill	(2) Recycled Water Discharges	(3) Non-Tributary Discharges	(4)=(6)-(5) Q_{BF_RN} Non-Storm Discharge at Riverside Narrows	(5) Storm Discharge at Riverside Narrows	(6) Total Discharge at Riverside Narrows	(7)=(1)+(2)+(3) Groundwater Discharge from Bunker Hill + Recycled Water Discharge + Other Non-Tributary Discharges	(8)=(4)-(7) Net Rising Groundwater Contribution to Surface Discharge	(9) ΣQ_{REC} Recycled Water Discharges	(10) ΣQ_{NONTD} Non-Tributary Discharges	(11)=(13)-(12) Q_{BF_PD} Non-Storm Discharge at Prado Dam	(12) Storm Discharge at Prado Dam	(13) Total Discharge at Prado Dam	(14)=(4)+(9)+(10) Non-Storm Discharge at Riverside Narrows + Recycled Water Discharge + Other Non-Tributary Discharges	(15)=(11)-(14) Q_{RW} Net Rising Groundwater Contribution to Surface Discharge	(16)=(13)-(6) Gain in Total Flow from Riverside Narrows to Prado Dam	(17)=(12)-(5) Gain in Storm Water Discharge between Riverside Narrows and Prado Dam
1970 - 1971	0	22,650	0	35,681	7,051	42,732	22,650	13,031	21,810	0	38,402	13,462	51,864	57,491	(19,089)	9,132	6,411
1971 - 1972	0	20,650	0	35,161	6,096	41,257	20,650	14,511	28,980	0	40,416	11,327	51,743	64,141	(23,725)	10,486	5,231
1972 - 1973	0	23,460	11,617	17,582	15,466	33,048	35,077	(17,495)	32,780	0	49,472	28,485	77,957	50,362	(890)	44,909	13,019
1973 - 1974	0	22,530	0	17,203	8,291	25,494	22,530	(5,327)	36,830	63,035	107,784	19,543	127,327	117,068	(9,284)	101,833	11,252
1974 - 1975	0	21,050	0	16,771	4,199	20,970	21,050	(4,279)	40,600	27,939	81,742	11,655	93,397	85,310	(3,568)	72,427	7,456
1975 - 1976	0	22,030	0	18,350	9,277	27,627	22,030	(3,680)	42,680	60,170	106,797	13,793	120,590	121,200	(14,403)	92,963	4,516
1976 - 1977	0	23,240	0	19,474	5,397	24,871	23,240	(3,766)	41,800	8,350	57,603	14,675	72,278	69,624	(12,021)	47,407	9,278
1977 - 1978	0	24,780	0	23,100	159,400	182,500	24,780	(1,680)	44,220	1,466	60,707	194,349	255,056	68,786	(8,079)	72,556	34,949
1978 - 1979	200	25,940	0	27,208	20,708	47,916	26,140	1,068	46,570	9,897	82,572	62,646	145,218	83,675	(1,103)	97,302	41,938
1979 - 1980	1,000	27,540	0	25,805	228,528	254,333	28,540	(2,735)	48,200	23,820	90,921	445,253	536,174	97,825	(6,904)	281,841	216,725
1980 - 1981	3,000	27,850	0	18,915	15,783	34,698	30,850	(11,935)	52,300	0	91,377	26,923	118,300	71,215	20,162	83,602	11,140
1981 - 1982	6,500	30,590	0	31,715	51,335	83,050	37,090	(5,375)	55,990	0	81,883	61,819	143,702	87,705	(5,822)	60,652	10,484
1982 - 1983	11,000	31,380	0	55,884	224,103	279,987	42,380	13,504	55,960	7,720	120,566	306,519	427,085	119,564	1,002	147,098	82,416
1983 - 1984	14,000	29,610	0	55,403	27,684	83,087	43,610	11,793	57,190	12,550	122,116	55,825	177,941	125,143	(3,027)	94,854	28,141
1984 - 1985	12,000	31,170	0	63,968	15,145	79,113	43,170	20,798	63,440	3,883	125,358	37,889	163,247	131,291	(5,933)	84,134	22,744
1985 - 1986	8,000	33,450	0	64,631	34,969	99,600	41,450	23,181	65,620	1,836	127,550	70,158	197,708	132,087	(4,537)	98,108	35,189
1986 - 1987	5,000	36,330	0	57,965	20,128	78,093	41,330	16,635	68,670	0	120,182	23,343	143,525	126,635	(6,453)	65,432	3,215
1987 - 1988	3,000	39,160	0	53,526	26,521	80,047	42,160	11,366	77,500	5,679	130,117	42,714	172,831	136,705	(6,588)	92,784	16,193
1988 - 1989	1,700	39,470	0	50,330	12,387	62,717	41,170	9,160	85,260	6,582	126,488	33,171	159,659	142,172	(15,684)	96,942	20,784
1989 - 1990	1,000	40,420	0	51,500	7,000	58,500	41,420	10,080	82,840	1,020	120,503	24,314	144,817	135,360	(14,857)	86,317	17,314
1990 - 1991	500	39,530	394	43,710	30,815	74,525	40,424	3,286	84,230	8,052	119,911	75,275	195,186	135,992	(16,081)	120,661	44,460
1991 - 1992	100	37,080	0	38,610	33,158	71,768	37,180	1,430	89,360	8,033	115,551	82,729	198,280	136,003	(20,452)	126,512	49,571
1992 - 1993	0	38,220	0	39,714	227,670	267,384	38,220	1,494	95,570	5,273	133,438	438,563	572,001	140,557	(7,119)	304,617	210,893
1993 - 1994	0	36,170	144	29,639	15,838	45,477	36,314	(6,675)	90,180	5,424	117,075	41,622	158,697	125,243	(8,168)	113,220	25,784
1994 - 1995	0	38,650	2,206	45,632	199,985	245,617	40,856	4,776	95,020	18,945	144,619	284,651	429,270	159,597	(14,978)	183,653	84,666
1995 - 1996	0	43,660	1,470	53,935	29,321	83,256	45,130	8,805	95,270	25,137	158,468	58,692	217,160	174,342	(15,874)	133,904	29,371
1996 - 1997	0	49,960	2,762	63,285	43,995	107,280	52,722	10,563	93,760	48,473	187,911	61,783	249,694	205,518	(17,607)	142,414	17,788
1997 - 1998	0	56,746	1,342	64,147	150,228	214,375	58,088	6,059	104,774	6,665	162,029	300,604	462,633	175,586	(13,557)	248,258	150,376
1998 - 1999	0	54,111	0	70,912	5,382	76,294	54,111	16,801	112,349	2,684	161,321	23,673	184,994	185,945	(24,624)	108,700	18,291
1999 - 2000	0	52,404	0	61,260	14,312	75,572	52,404	8,856	112,380	19,945	168,214	40,269	208,483	193,585	(25,371)	132,911	25,957
2000 - 2001	0	57,753	2,760	62,366	15,725	78,091	60,513	1,853	115,097	10,686	167,305	54,621	221,926	188,149	(20,844)	143,835	38,896
2001 - 2002	0	52,465	9,410	65,845	2,999	68,844	61,875	3,970	110,283	9,053	164,353	10,615	174,968	185,181	(20,828)	106,124	7,616
2002 - 2003	0	53,833	3,664	59,089	33,077	92,166	57,497	1,592	117,208	8,570	158,347	97,810	256,157	184,867	(26,520)	163,991	64,733
2003 - 2004	0	52,808	1,537	53,980	23,356	77,336	54,345	(365)	110,907	10,598	156,785	57,317	214,102	175,485	(18,700)	136,766	33,961
2004 - 2005	0	54,429	0	63,384	292,119	355,503	54,429	8,955	133,684	964	169,017	469,515	638,532	198,032	(29,016)	283,028	177,396
2005 - 2006	0	54,427	727	65,570	46,270	111,840	55,154	10,416	126,192	1,473	161,840	85,734	247,574	193,235	(31,395)	135,734	39,464
2006 - 2007	0	51,675	1,846	55,002	2,866	57,868	53,521	1,481	120,247	2,324	143,246	12,901	156,147	177,573	(34,327)	98,279	10,035
2007 - 2008	0	50,252	4,065	48,537	30,082	78,619	54,317	(5,780)	108,567	5,385	130,798	68,896	199,694	162,489	(31,691)	121,075	38,814
2008 - 2009	0	47,297	1,460	43,080	25,947	69,027	48,757	(5,677)	97,676	1,671	109,039	53,662	162,701	142,427	(33,388)	93,674	27,715
2009 - 2010	0	47,628	0	43,671	68,960	112,631	47,628	(3,957)	92,603	86	107,999	135,775	243,774	136,360	(28,361)	131,143	66,815
2010 - 2011	0	47,335	0	47,516	126,559	174,075	47,335	181	91,195	11,874	119,323	205,568	324,891	150,585	(31,262)	150,816	79,009
2011 - 2012	0	44,745	0	40,447	4,602	45,049	44,745	(4,298)	76,192	0	93,803	27,325	121,128	116,639	(22,836)	76,079	22,723
2012 - 2013	0	42,045	0	34,214	7,123	41,337	42,045	(7,831)	71,100	268	82,222	17,776	99,998	105,582	(23,360)	58,661	10,653
2013 - 2014	0	39,943	0	30,083	12,683	42,766	39,943	(9,860)	63,214	0	63,536	22,950	86,486	93,297	(29,761)	43,720	10,267
2014 - 2015	0	37,954	0	26,084	15,874	41,958	37,954	(11,870)	66,875	0	64,048	45,452	109,500	92,959	(28,911)	67,542	29,578
2015 - 2016	0	38,809	0	28,695	12,312	41,007	38,809	(10,114)	66,223	12,412	83,638	29,660	113,298	107,330	(23,692)	72,291	17,348
Total	67,000	1,793,229	45,404	2,018,579	2,370,726	4,389,305	1,905,633	112,946	3,589,396	457,942	5,326,392	4,301,301	9,627,693	6,065,917	(739,525)	5,238,387	1,930,575
Average	1,457	38,983	987	43,882	51,538	95,420	41,427	2,455	78,030	9,955	115,791	93,507	209,298	131,868	(16,077)	113,878	41,969
Standard Dev	3,392	11,317	2,316	16,344	73,807	77,318	11,464	9,348	29,019	14,574	38,200	120,739	134,528	42,240	11,406	63,833	50,883
Coef of Var	233%	29%	235%	37%	143%	81%	28%	381%	37%	146%	33%	129%	64%	32%	-71%	56%	121%
Median	0	38,985	0	44,671	20,418	75,933	41,435	1,488	80,170	5,552	120,047	49,557	173,900	133,724	(15,978)	98,194	25,871
Max	14,000	57,753	11,617	70,912	292,119	355,503	61,875	23,181	133,684	63,035	187,911	469,515	638,532	205,518	20,162	304,617	216,725
Min	0	20,650	0	16,771	2,866	20,970	20,650	(17,495)	21,810	0	38,402	10,615	51,743	50,362	(34,327)	9,132	3,215

Source -- All data except historical values for "Groundwater Discharge from Bunker Hill" were obtained from the Annual Reports of the SARWM. "Groundwater Discharge from Bunker Hill" was abstracted from Table 6 of the draft report *Hydrology, Description of Computer Models, and Evaluation of Selected Water-Management Alternatives in the San Bernardino Area, California* (USGS, 1997).

(Red Text) indicates negative values.

Figure 4-1
Net Annual Rising Groundwater to the Santa Ana River between Riverside Narrows and Prado Dam
Water Years 1971 through 2016

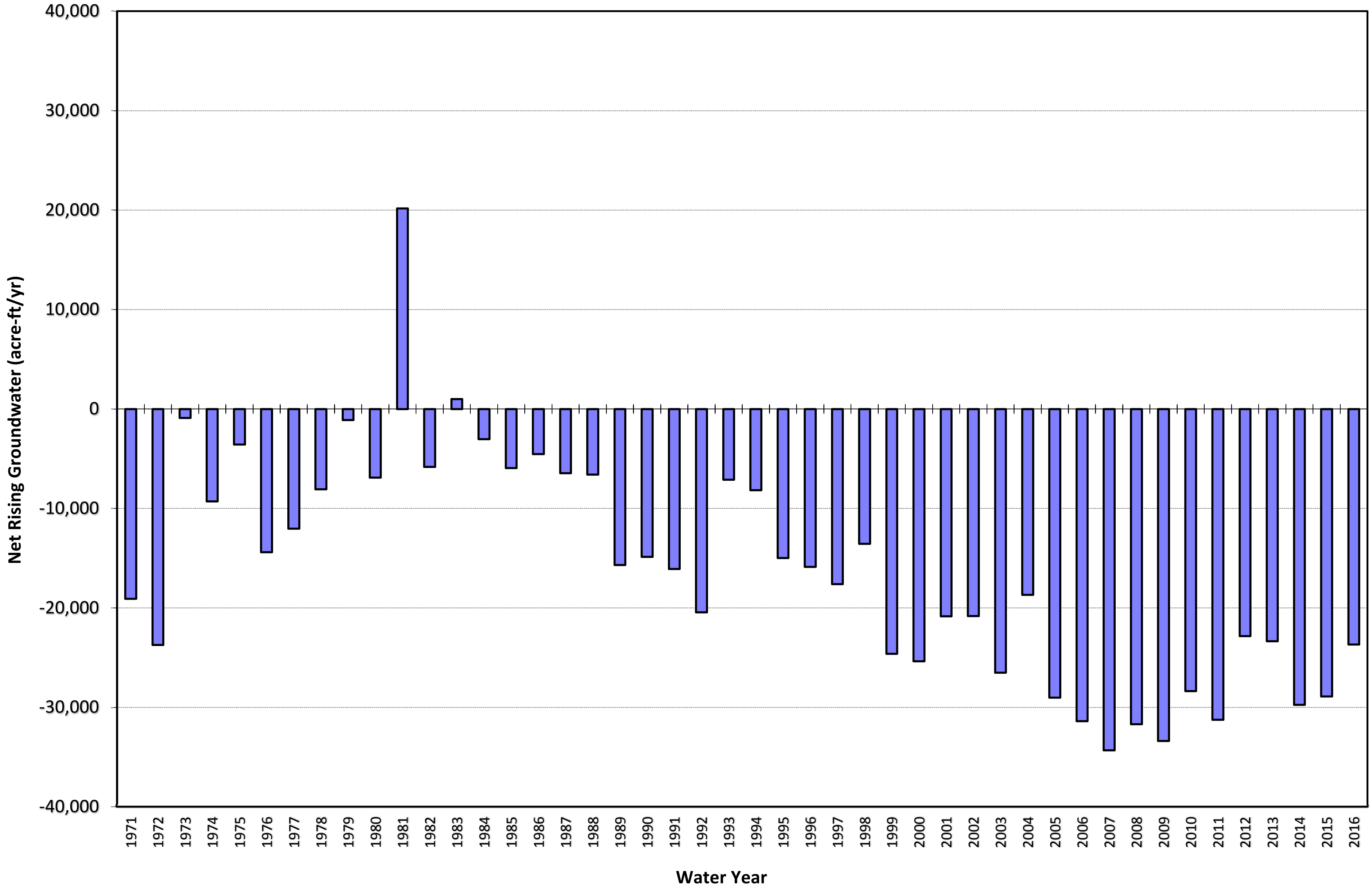
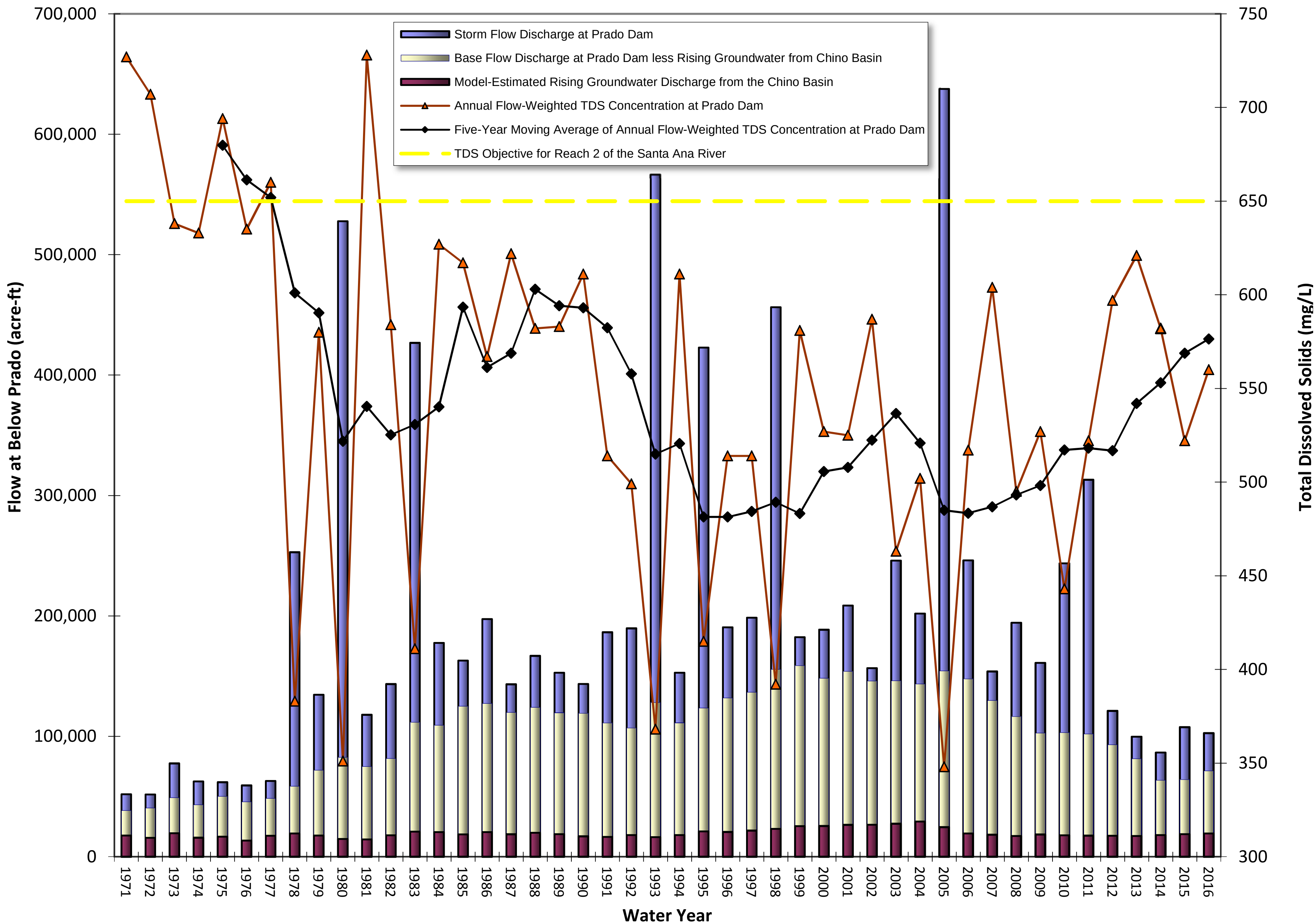


Figure 4-2
TDS and Components of Discharge of the Santa Ana River at Prado Dam



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Appendices

Appendix A

IEUA Five-Year Volume-Weighted TDS and TIN Computation

Appendix A: TDS and NO_3-N Data Table

	Volume (acre-feet)				TDS (mg/L)					NO_3-N (mg/L)				
Month	SW/LR	IW	RW	Total	SW/LR (Mean)	IW	RW	Σ (Vol x TDS)	5-yr Avg	SW/LR (Mean)	IW	RW*	Σ (Vol x TDS)	5-yr Avg
Jul-05	647	1,488	20	2,155	129	189	458	373806		2.9	0.6	2.3	2885	
Aug-05	137	1,545	254	1,936	129	174	447	399909		2.9	0.5	1.6	1564	
Sep-05	299	2,763	268	3,329	129	191	467	691278		2.9	0.4	2.1	2634	
Oct-05	876	2,313	150	3,340	129	205	459	656175		2.9	0.3	1.5	3529	
Nov-05	344	3,567	100	4,010	129	202	455	810393		2.9	0.5	1.8	2800	
Dec-05	669	3,617	77	4,362	129	223	475	929286		2.9	0.6	2.1	4408	
Jan-06	762	3,548	154	4,463	177	276	483	1188208		1.1	0.8	2.8	4015	
Feb-06	1,679	3,467	209	5,355	177	207	451	1109014		1.1	0.8	2.7	5287	
Mar-06	3,177	2,043	0	5,219	95	193	443	697408		0.5	0.8	2.9	3297	
Apr-06	3,337	2,568	0	5,905	115	173	437	827652		0.8	0.6	4.2	4182	
May-06	857	3,190	0	4,046	115	149	442	573690		0.8	0.4	5.4	2025	
Jun-06	216	3,597	73	3,886	115	128	488	520838		0.8	0.3	3.3	1460	
Jul-06	156	956	449	1,561	115	144	455	359551		0.8	0.3	2.3	1459	
Aug-06	182	4,467	619	5,269	115	173	454	1074838		0.8	0.3	2.1	2955	
Sep-06	273	6,749	616	7,638	115	177	427	1488730		0.8	0.4	2.5	4197	
Oct-06	300	6,150	224	6,675	115	170	435	1177526		0.8	0.3	3.6	2969	
Nov-06	296	5,257	93	5,646	115	158	436	905165		0.8	0.5	2.9	2989	
Dec-06	697	5,429	260	6,386	115	271	447	1667416		2.5	0.6	3.4	5918	
Jan-07	543	3,201	160	3,904	115	247	466	927308		2.5	0.8	3.3	4413	
Feb-07	1,140	706	130	1,976	115	301	464	403809		2.5	0.9	4.0	3989	
Mar-07	200	48	117	365	115	295	477	93031		2.5	1.0	3.0	895	
Apr-07	532	4	130	666	115	275	470	123292		2.5	1.0	2.8	1698	
May-07	245	0	182	427	115	244	481	115621		2.5	0.8	4.8	1487	
Jun-07	206	0	10	216	115	249	478	28445		2.5	0.5	3.0	543	
Jul-07	141	0	141	282	329	254	492	115864		0.9	0.5	3.9	683	
Aug-07	197	0	78	275	329	207	475	101948		0.9	0.5	3.3	444	
Sep-07	218	0	143	361	329	220	481	140613		0.9	0.3	3.4	690	
Oct-07	285	0	132	417	366	272	542	175777		0.7	0.4	4.9	865	
Nov-07	915	0	346	1,261	366	278	497	506679		0.7	0.6	3.1	1757	
Dec-07	1,481	0	53	1,534	130	278	506	219871		1.7	0.8	3.8	2667	
Jan-08	4,558	0	1	4,559	86	271	493	392987		0.7	0.9	4.6	3337	
Feb-08	1,427	0	196	1,623	101	248	450	232422		1.5	1.0	3.8	2878	
Mar-08	155	0	360	515	101	275	456	179969		1.5	1.1	3.0	1303	
Apr-08	150	0	260	410	101	281	483	140669		1.5	1.3	3.8	1208	
May-08	588	0	369	957	376	284	481	398503		0.7	0.9	4.8	2190	
Jun-08	128	0	261	389	376	285	490	175914		0.7	0.8	5.8	1612	
Jul-08	142	0	291	433	376	290	489	195594		0.7	0.7	6.0	1854	
Aug-08	111	0	245	356	382	281	465	156409		<0.1	0.7	4.0	982	
Sep-08	99	0	86	185	382	272	467	78001		<0.1	0.4	4.6	402	
Oct-08	161	0	395	556	382	279	487	253867		<0.1	0.5	6.5	2586	
Nov-08	677	0	229	906	432	289	461	398131		0.6	0.6	3.5	1198	
Dec-08	2,363	0	88	2,451	112	289	446	304660		1.1	0.7	4.2	3031	
Jan-09	224	0	356	580	112	287	464	190341		1.1	0.7	3.9	1625	
Feb-09	3,080	0	52	3,132	66	289	413	224746		0.5	0.8	3.3	1698	
Mar-09	299	0	182	481	66	272	434	98661		0.5	0.6	2.6	612	
Apr-09	106	0	311	417	66	273	463	151093		0.5	0.6	2.4	795	
May-09	79	0	156	235	379	284	468	102878		0.5	0.5	2.4	416	
Jun-09	153	0	293	446	379	287	479	198306		0.5	0.5	4.6	1411	
Jul-09	107	0	90	197	379	324	465	82368		0.5	0.6	3.2	344	
Aug-09	113	0	200	313	292	254	446	122229		0.2	0.4	2.9	594	
Sep-09	108	0	296	404	292	235	447	163848		0.2	0.1	2.8	841	
Oct-09	614	17	807	1,438	189	255	455	487420		1.4	0.2	2.9	3205	
Nov-09	489	3	1,210	1,702	189	287	444	629794		1.4	0.5	2.8	4026	
Dec-09	2,851	0	563	3,414	100	255	441	532946		1.0	0.7	2.5	4262	

Appendix A: TDS and NO_3-N Data Table

	Volume (acre-feet)				TDS (mg/L)					NO_3-N (mg/L)				
Month	SW/LR	IW	RW	Total	SW/LR (Mean)	IW	RW	Σ (Vol x TDS)	5-yr Avg	SW/LR (Mean)	IW	RW*	Σ (Vol x TDS)	5-yr Avg
Jan-10	4,190	0	473	4,663	68	244	444	496489		0.6	0.7	2.4	3751	
Feb-10	3,715	6	167	3,888	94	235	418	420493		1.3	0.7	3.3	5281	
Mar-10	593	0	612	1,205	94	220	419	311908		1.3	0.8	3.1	2658	
Apr-10	1,156	365	617	2,138	94	220	417	446130		1.3	0.9	2.6	3421	
May-10	179	2,433	1,185	3,797	270	235	423	1121340		0.9	0.8	2.8	5436	
Jun-10	159	2,176	990	3,325	270	232	433	976102	203	0.9	0.6	3.0	4391	1.1
Jul-10	164	0	748	912	270	245	442	374597	205	0.9	0.6	3.2	2544	1.1
Aug-10	183	0	718	901	270	234	434	360817	207	0.9	0.5	3.7	2838	1.1
Sep-10	190	0	836	1,026	309	193	423	411920	208	0.4	0.2	3.6	3088	1.1
Oct-10	670	0	923	1,593	309	244	440	612919	210	0.4	0.1	3.9	3917	1.1
Nov-10	1,156	0	773	1,929	100	267	450	463450	211	1.0	0.4	4.1	4277	1.2
Dec-10	7,036	0	262	7,298	240	248	430	1797782	213	0.7	0.5	3.8	6238	1.1
Jan-11	1,695	0	478	2,173	240	215	430	611254	212	0.7	0.7	4.2	3273	1.2
Feb-11	2,395	0	407	2,802	240	166	422	745176	214	0.7	0.7	4.4	3579	1.2
Mar-11	2,673	0	188	2,861	150	157	413	478632	216	2.2	0.5	4.6	6738	1.2
Apr-11	399	0	751	1,150	150	163	411	368605	221	2.2	0.6	4.6	4313	1.3
May-11	323	3,729	997	5,049	150	143	422	1002210	222	2.2	0.3	3.3	5282	1.3
Jun-11	167	5,736	984	6,887	275	124	422	1172590	222	0.1	0.2	3.4	4521	1.3
Jul-11	244	7,810	706	8,760	275	135	412	1412035	218	0.1	0.5	3.1	5715	1.2
Aug-11	97	7,138	486	7,721	305	129	418	1153623	215	0.8	0.4	2.8	4185	1.2
Sep-11	163	7,529	639	8,331	305	151	413	1450791	213	0.8	0.3	3.8	4772	1.2
Oct-11	888	83	924	1,895	305	136	418	668564	217	0.8	0.2	4.1	4490	1.3
Nov-11	1,174	0	648	1,822	95	135	412	378506	220	1.1	0.3	3.9	3767	1.3
Dec-11	538	0	870	1,408	69	138	411	394455	218	1.1	0.4	4.8	4779	1.4
Jan-12	926	0	826	1,752	73	174	422	416352	218	0.7	0.5	4.8	4600	1.4
Feb-12	1,166	0	664	1,830	73	230	436	374306	218	0.7	0.5	4.3	3698	1.4
Mar-12	2,117	0	381	2,498	73	281	451	325796	216	0.7	0.5	3.4	2825	1.4
Apr-12	1,625	0	367	1,992	73	268	454	285010	215	0.7	0.5	3.9	2598	1.4
May-12	177	0	1,171	1,348	421	282	466	620049	217	1.6	0.7	3.8	4712	1.4
Jun-12	151	0	952	1,103	421	257	454	495353	220	1.6	0.5	3.3	3420	1.4
Jul-12	216	0	547	763	421	249	443	333110	221	1.6	0.5	3.2	2085	1.4
Aug-12	186	0	322	508	371	213	438	209899	221	0.7	0.3	3.3	1173	1.4
Sep-12	154	0	481	635	371	194	439	268173	222	0.7	0.2	3.7	1883	1.4
Oct-12	338	0	615	953	371	223	455	405346	222	0.7	0.1	3.6	2441	1.4
Nov-12	388	0	921	1,309	371	296	456	564333	223	0.7	0.2	4.3	4175	1.4
Dec-12	1928	0	576	2,504	176	270	461	604864	224	4.9	0.3	3.9	11654	1.5
Jan-13	713	0	1,284	1,997	66	274	466	645687	231	0.6	0.6	4.8	6556	1.6
Feb-13	579	0	1,107	1,686	96	284	454	558439	233	1.4	0.8	4.9	6185	1.6
Mar-13	449	0	1,387	1,836	54	300	472	678910	235	0.1	1.1	4.6	6370	1.6
Apr-13	75	0	1,113	1,188	54	303	471	527969	236	0.1	1.0	4.6	5117	1.6
May-13	204	0	1,052	1,256	394	291	471	575868	237	0.1	0.8	4.4	4652	1.6
Jun-13	68	0	1,074	1,142	394	288	486	548488	239	0.1	0.5	3.4	3698	1.7
Jul-13	108	0	876	984	394	288	469	453794	240	0.1	0.3	3.3	2914	1.7
Aug-13	98	0	930	1,028	394	264	466	471527	241	0.1	0.0	3.9	3669	1.7
Sep-13	112.1	0	1449	1,561	360	249	476	730660	243	1.7	0.1	4.3	6359	1.7
Oct-13	242	0	1441	1,683	360	274	469	762469	245	1.7	0.0	4.7	7255	1.7
Nov-13	394	0	1307	1,701	360	299	483	772794	247	1.7	0.1	4.5	6561	1.7
Dec-13	414	0	1374	1,788	140	302	495	738433	251	1.1	0.4	4.6	6798	1.8

Appendix A: TDS and NO_3-N Data Table

	Volume (acre-feet)				TDS (mg/L)					NO_3-N (mg/L)				
Month	SW/LR	IW	RW	Total	SW/LR (Mean)	IW	RW	Σ (Vol x TDS)	5-yr Avg	SW/LR (Mean)	IW	RW*	Σ (Vol x TDS)	5-yr Avg
Jan-14	196	195	997	1,388	140	305	493	578128	253	1.1	0.5	4.5	4805	1.8
Feb-14	1,274	235	848	2,357	132	306	497	661107	257	1.5	0.6	4.5	5879	1.8
Mar-14	665	282	782	1,729	245	314	467	616698	259	0.6	0.9	4.6	4239	1.9
Apr-14	589	72	1,177	1,838	245	309	496	749989	261	0.6	0.8	4.2	5349	1.9
May-14	131	11	1,322	1,464	369	305	500	712383	263	1.1	0.8	3.8	5203	1.9
Jun-14	76	0	1,090	1,166	369	294	486	557325	264	1.1	0.6	3.3	3708	1.9
Jul-14	67	0	574	641	369	292	470	294238	265	1.1	0.6	2.8	1676	1.9
Aug-14	195	0	825	1,020	369	307	481	468433	266	1.1	0.4	3.2	2887	1.9
Sep-14	163	0	1145	1,308	339	331	514	643986	268	0.9	0.3	3.9	4641	1.9
Oct-14	87	0	1247	1,334	339	340	522	680739	269	0.9	0.4	3.1	3968	1.9
Nov-14	903	0	864	1,767	130	342	548	590670	269	0.2	0.4	4.1	3686	1.9
Dec-14	3820	0	126	3,946	73	346	544	345444	266	0.8	0.5	4.9	3488	1.9
Jan-15	676	0	623	1,299	246	334	513	485557	273	1.0	0.7	5.4	4011	2.0
Feb-15	729	0	954	1,683	102	338	527	576798	279	1.8	0.8	4.3	5375	2.0
Mar-15	339	0	1,123	1,462	102	327	506	602367	280	1.8	0.8	4.0	5067	2.0
Apr-15	327	0	994	1,321	102	308	507	537312	283	1.8	0.9	4.4	5008	2.0
May-15	660	0	1,069	1,729	102	316	506	608234	283	1.8	0.8	4.9	6383	2.1
Jun-15	30	0	1,296	1,326	327	318	495	651848	285	1.0	0.6	3.4	4494	2.1
Jul-15	702	0	750	1,452	327	323	482	590867	286	1.0	1.0	3.8	3514	2.1
Aug-15	79	0	705	784	327	329	475	360708	286	1.0	0.3	3.5	2565	2.1
Sep-15	1,078	0	1,125	2,203	280	345	480	841340	287	0.2	0.2	3.8	4498	2.1
Oct-15	732	0	1,278	2,010	280	358	474	810732	287	0.2	0.1	3.8	5009	2.1
Nov-15	300	0	806	1,106	280	356	476	467334	289	0.2	0.1	4.2	3422	2.1
Dec-15	1,112	0	1,333	2,445	65	354	470	698826	291	1.7	0.3	4.8	8283	2.2
Jan-16	2,398	0	1,042	3,440	46	367	465	595099	288	0.6	0.7	5.7	7209	2.2
Feb-16	478	0	1,352	1,830	46	361	472	660132	290	0.6	0.7	4.5	6337	2.2
Mar-16	1,519	0	858	2,377	99	359	504	582813	292	1.0	0.9	4.0	4977	2.2
Apr-16	317	0	1,162	1,479	291	336	492	664347	293	2.4	0.8	4.1	5529	2.2
May-16	468	0	1,525	1,993	291	268	488	880267	300	2.4	0.6	3.7	6789	2.3
Jun-16	45	0	1,286	1,331	291	338	486	637463	310	2.4	0.5	3.2	4269	2.4
Jul-16	43	0	944	987	291	305	479	464231	323	2.4	0.3	3.8	3711	2.6
Aug-16	64	0	1,057	1,121	291	262	480	526390	338	2.4	0.1	4.5	4961	2.8
Sep-16	87	0	1,447	1,534	303	194	466	699940	354	0.2	0.1	4.6	6602	3.0
Oct-16	405	4,160	1,345	5,910	180	208	461	1558536	349	2.9	0.1	4.5	7761	2.9
Nov-16	591	40	1,432	2,063	163	288	454	758363	352	1.3	0.2	4.3	6861	2.9
Dec-16	3,389	60	860	4,309	92	306	479	741934	345	0.9	0.2	4.1	6591	2.8

SW/LR (Mean): Stormwater / Local Runoff (Mean) is a monthly average value of all SW/LR data collected during the month. For months without data available, previous month's data is carried down

IW: Imported Water based on monthly Table D data received from the Metropolitan Water District

RW: Recycled Water based on a monthly average of all available RP-1 & RP-4 effluent data and RP-1/RP-4 RW Blend at NRG Turnout data

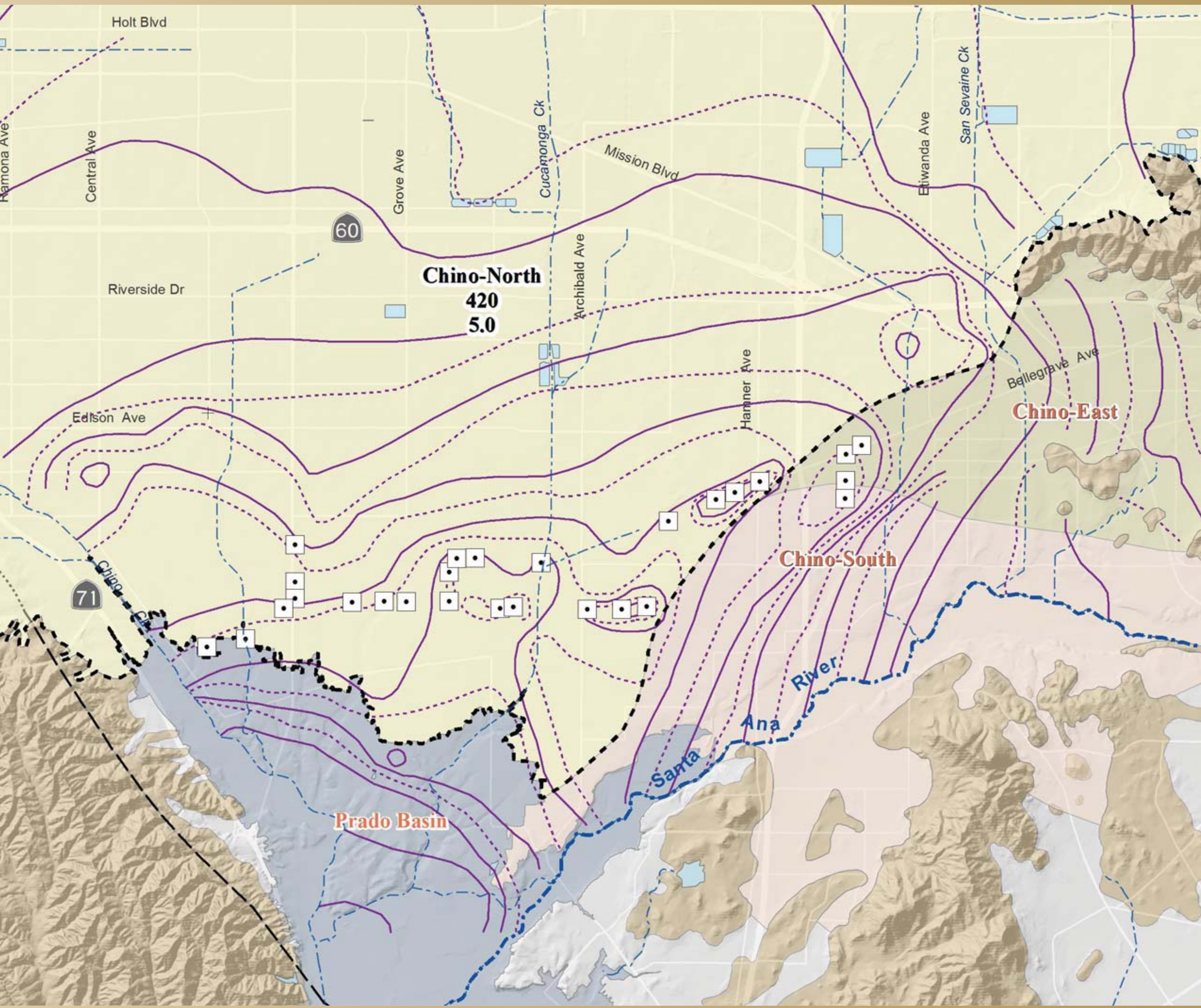
* 25% nitrogen loss coefficient has been applied to calculate recycled water nitrate-nitrogen quality per Basin Plan Amendment

Maximum Benefit Water Quality Objectives in Chino North Management Zone for TDS is 420 mg/L and nitrate-nitrogen is 5 mg/L, based on a 5-year running average

Appendix B

Database

WEI
Wildermuth Environmental, Inc.



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