



April 13, 2023

Regional Water Quality Control Board, Santa Ana Region  
Attention: Jayne Joy  
3737 Main Street, Suite 500  
Riverside, California 92501-3348

**Subject: Transmittal of the Chino Basin Optimum Basin Management Program (OBMP)  
2022 Maximum Benefit Annual Report**

Dear Ms. Smythe,

The Chino Basin Watermaster (Watermaster) and Inland Empire Utilities Agency (IEUA) hereby submit the Chino Basin OBMP Maximum Benefit Annual Report for 2022. 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 2022.

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

Sincerely,

**Chino Basin Watermaster**

**Inland Empire Utilities Agency**

Peter Kavounas, P.E.  
General Manager

Shivaji Deshmukh, P.E.  
General Manager

# Chino Basin Optimum Basin Management Program 2022 Maximum Benefit Annual Report

PREPARED FOR

Chino Basin Watermaster and the  
Inland Empire Utilities Agency



PREPARED BY



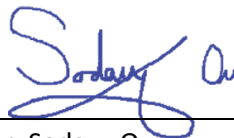
# Chino Basin Optimum Basin Management Program 2022 Maximum Benefit Annual Report

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Prepared for

## Chino Basin Watermaster and the Inland Empire Utilities Agency

Project No. 941-80-21-64



Project Manager: Sodavy Ou

4/13/2023

Date



QA/QC Review: Veva Veamer

4/13/2023

Date

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## LIST OF ACRONYMS AND ABBREVIATIONS

afy	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 GMZ	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
maximum benefit SNMP	Maximum Benefit Salt and Nutrient Plan
MCL	Maximum Contaminant Level
mgd	million gallons per day
mg/l	milligrams per liter
MWD	Metropolitan Water District of Southern California
Nitrate	Nitrate As Nitrogen
NAWQA	National Water Quality Assessment
OBMP	Optimum Basin Management Program
PBHSP	Prado Basin Habitat Sustainability Program
PBMZ	Prado Basin Management Zone
Regional Board	California Regional Water Quality Control Board, Sant Ana Region
SARWC	Santa Ana River Water Company
SARWM	Santa Ana River Watermaster
SOB	State of the Basin Report
State Board	State Water Resources Control Board
SWP	State Water Project
TCE	Trichloroethene
TDS	Total Dissolved Solids
TIN	Total Inorganic Nitrogen
TKN	Total Kjeldahl Nitrogen
USGS	United States Geological Survey
VOC	Volatile Organic Compound
Watermaster	Chino Basin Watermaster
WEI	Wildermuth Environmental, Inc.

# Optimum Basin Management Program

## Chino Basin Maximum Benefit Annual Report 2022

### 1.0 INTRODUCTION

This 2022 Maximum Benefit Annual Report was prepared by the Chino Basin Watermaster (Watermaster) and the Inland Empire Utilities Agency (IEUA) pursuant to the Chino Basin maximum benefit salt and nutrient management plan (maximum benefit SNMP), as described in the Water Quality Control Plan for the Santa Ana River Basin (Basin Plan)<sup>1</sup>.

This introductory section provides background on: 1) the relationship between groundwater production in the Chino Basin and the Santa Ana River discharge, 2) the Chino Basin Optimum Basin Management Program (OBMP) and the OBMP Implementation Plan, 3) the establishment of the alternative, maximum-benefit groundwater-quality objectives for the Chino Basin and Cucamonga Basin to create assimilative for recycled water use, and 4) the commitments made by Watermaster and the IEUA when the California Regional Water Quality Control Board, Santa Ana Region (Regional Board) amended the Basin Plan to include the maximum benefit SNMP for regulatory purposes. This Annual Report describes the status of compliance with the maximum-benefit commitments and the work performed during calendar year 2022.

### 1.1 Investigations of the Relationship between Groundwater Production and Santa Ana River Discharge in the Southern Chino Basin

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 becomes surface water in the Santa Ana River and its tributaries. Recent and past studies have provided insight into the influence of groundwater pumping in the southern Chino Basin on the Safe Yield of the Basin, and on the discharge of rising groundwater to the Prado Basin and the Santa Ana River. Several studies, as discussed below, have quantified the impacts of groundwater pumping at the Chino Basin Desalter well field on groundwater discharge to the Prado Basin and the Santa Ana River. Groundwater pumping from the Chino Basin Desalter well field was intended to replace agricultural pumping in the southern Chino Basin as agriculture lands are developed into housing and urban developments<sup>2</sup> to maintain the yield of the Basin and prevent discharge of poor-quality rising groundwater from the Basin to the Santa Ana River. The Chino Basin Desalters are operated by the Chino Basin Desalter Authority<sup>3</sup> (CDA).

The Chino Basin Desalter well field was 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 southern Chino Basin through 2015. Well fields were sited to maximize the interception of rising groundwater discharge from the north and to induce streambed infiltration 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 pumping.

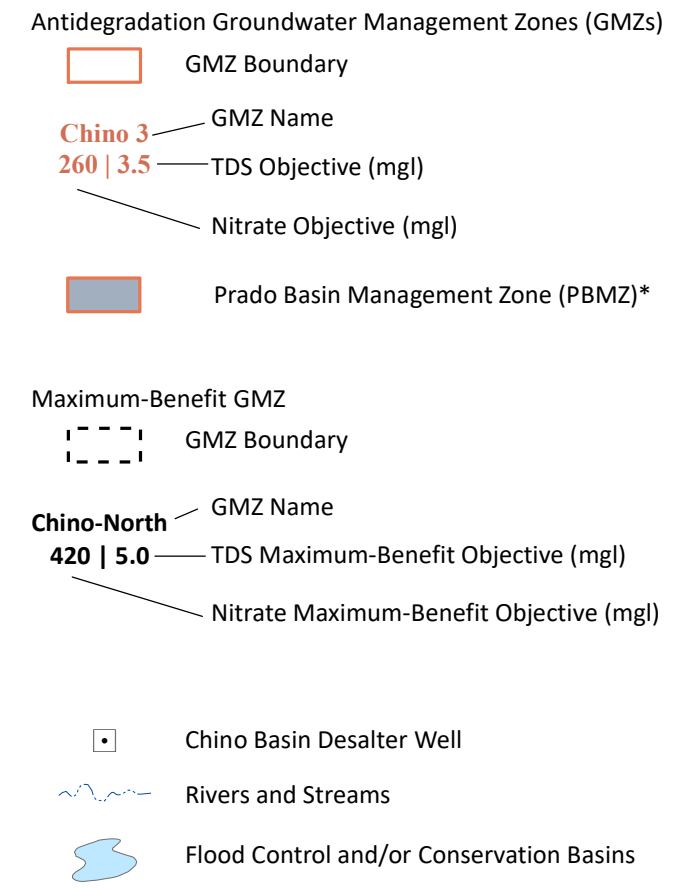
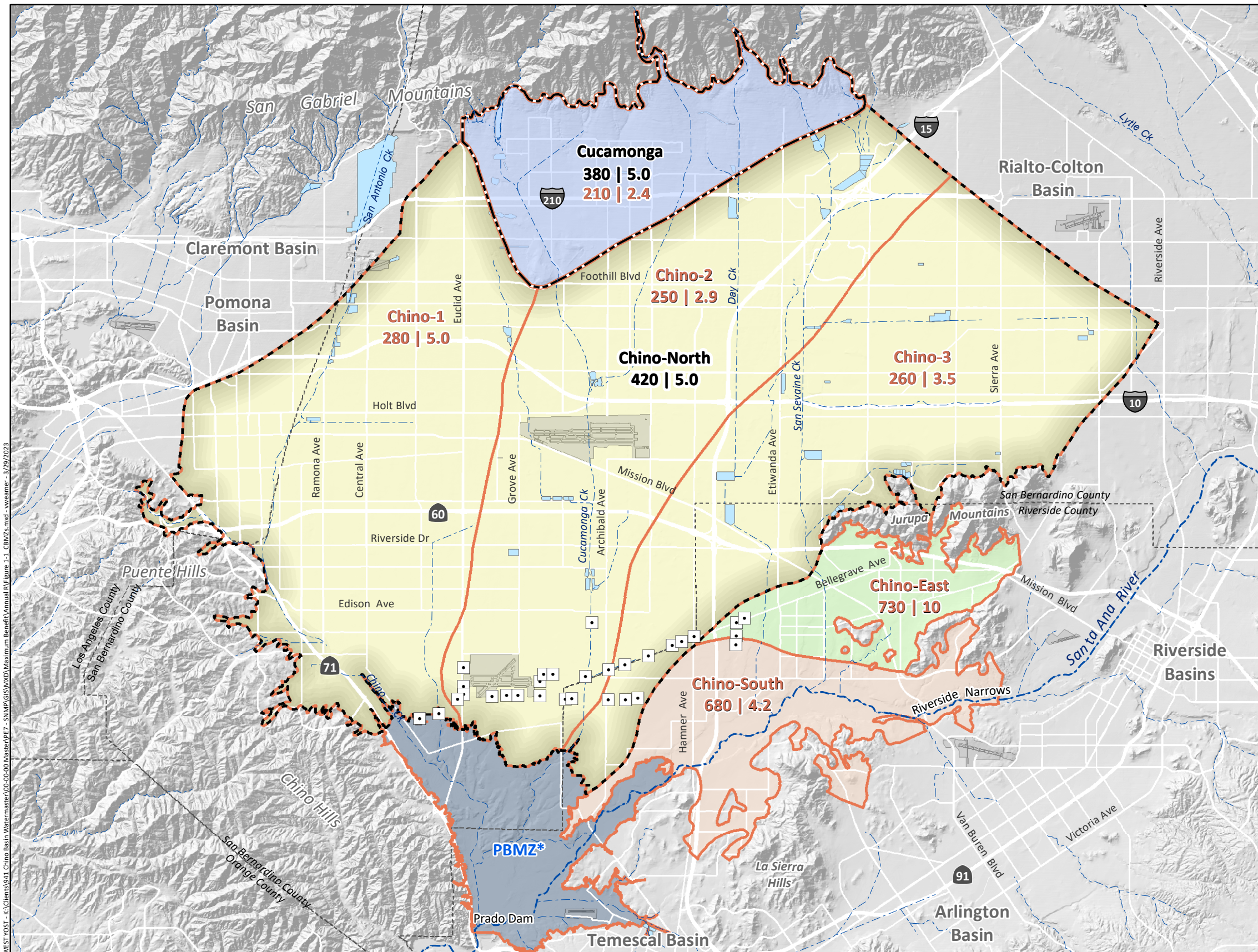
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<sup>1</sup> [https://www.waterboards.ca.gov/santaana/water\\_issues/programs/basin\\_plan/](https://www.waterboards.ca.gov/santaana/water_issues/programs/basin_plan/)

<sup>2</sup> The 2000 OBMP indicated that agricultural pumping would decrease by 40,000 afy.

<sup>3</sup> <https://www.chinodesalter.org/>





\*PBMZ has a surface water objective.



## Chino Basin Optimum Basin Management Program 2022 Maximum Benefit Annual Report

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A design study for the Chino Basin Desalter well field provided estimates of the volume of rising groundwater discharge that would be intercepted by the desalter wells (Wildermuth Environmental, Inc. [WEI], 1993). This study used a detailed model of the southern Chino Basin to evaluate the hydraulic impacts of desalter pumping on rising groundwater discharge and groundwater levels at nearby wells.

This study showed the relationship of intercepting rising groundwater discharge at the well field locations and well pumping capacity. The fraction of total desalter well pumping 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 pumping due to Watermaster's basin re-operation<sup>4</sup> plan alone (WEI, 2009d). This projection was made using the 2007 Chino Basin Model to evaluate the then-current and projected groundwater pumping at the Chino Basin Desalter wells through 2060, as envisioned in the Peace II Agreement project description.

In 2011, the Watermaster initiated the process to recalculate the Safe Yield, which included an update and recalibration of its groundwater model. The 2013 Chino Basin Model was used to 1) estimate the historical volumes of rising groundwater discharge to the Santa Ana River and the streambed infiltration in the Santa Ana River for the period 1961 through 2011; and 2) project the volumes of groundwater discharge and streambed infiltration through 2050 (WEI, 2015c). The projected New Yield<sup>5</sup> from Santa Ana River recharge estimated by the 2013 Chino Basin Model was 61 percent of desalter well pumping in fiscal year 2011 and decreased to about 49 percent of total future desalter well pumping through fiscal year 2030. This New Yield induced by pumping at the desalter wells and Chino Basin re-operation 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 pumping in the southern portion of the Basin. These studies also indicated that the Chino Basin Desalter and re-operation authorized in the Peace II Agreement and approved by the Court will 1) capture groundwater flowing south from the forebay regions of the Chino Basin; and 2) reduce the outflow of high-salinity groundwater to the Santa Ana River, thereby providing greater protection of downstream beneficial uses.

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<sup>4</sup> Re-operation as defined in Peace II Agreement "means the controlled overdraft of the Basin by the managed withdrawal of groundwater Production for the Desalters and the potential increase in the cumulative un-replenished Production from 200,000 acre-feet authorized by paragraph 3 of the Engineering Appendix Exhibit I to the Judgement, to 600,000 acre-feet for the express purpose of securing and maintaining Hydraulic Control as a component of the Physical Solution."

<sup>5</sup> 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.



## 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 reliable water supplies for the development expected to occur within the Basin. The goals of the OBMP are to: enhance basin water supplies, protect and enhance water quality, enhance the management of the Basin, and equitably finance the OBMP. The OBMP Implementation Plan is the court-ordered 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 groundwater recharge. It also includes: the capture of increased quantities of high-quality storm water, recharge of imported water when its total dissolved solids (TDS) concentrations are low; improving the water supply by desalting poor-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 poor-quality (high salinity) groundwater to the Santa Ana River and the Orange County Basin to protect downstream beneficial uses and water quality.

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 Chino Basin. The ambient TDS concentrations in these areas exceeded the objectives, which meant that no assimilative capacity existed for the discharge or recharge of high-TDS water sources over 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 the Chino Basin.

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 ([2004 Basin Plan amendment], Regional Board, 2004). The 2004 Basin Plan amendment included revised: groundwater subbasin boundaries, termed "groundwater management zones" (GMZs); TDS and nitrate as nitrogen (nitrate) objectives for the GMZs; TDS and nitrogen wasteload allocations; surface water reach designations and their TDS and nitrate objectives and beneficial uses. The technical work supporting the 2004 Basin Plan amendment was directed by the total inorganic nitrogen (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 objectives for the GMZs in the Santa Ana River Basin were established to ensure that water quality is maintained pursuant to the State Water Resources Control Board's (State Board) Antidegradation Policy (State Board Resolution No. 68-16). These objectives were termed "antidegradation" objectives. Figure 1-1 shows the locations and the antidegradation objectives the five Chino Basin GMZs<sup>6</sup>: 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

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<sup>6</sup> 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.

## Chino Basin Optimum Basin Management Program 2022 Maximum Benefit Annual Report



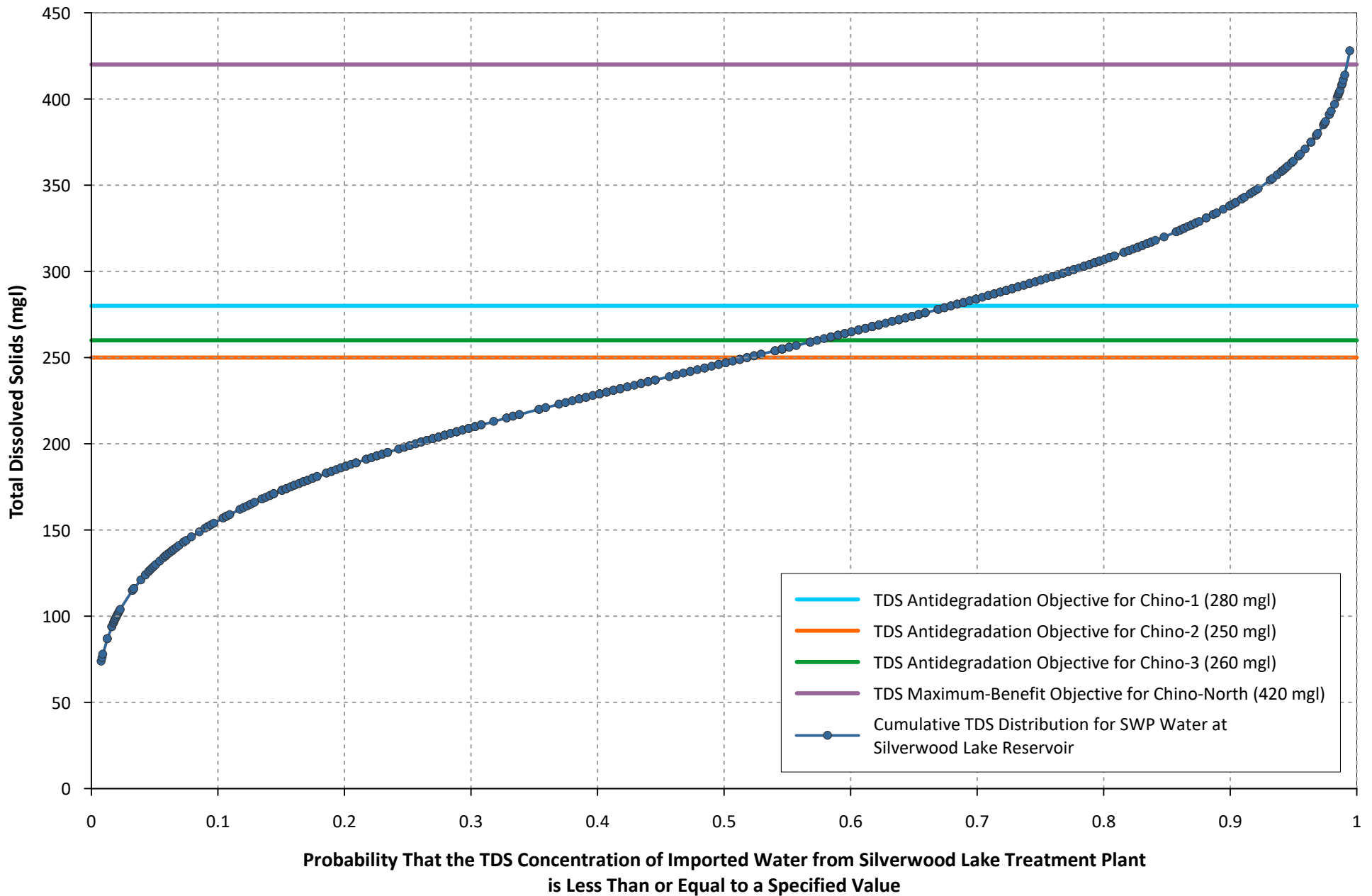
TDS concentration is above the objectives, without mitigation. Figure 1-2 is a cumulative distribution plot that shows the percent of time that the TDS concentration of imported State Water Project (SWP) water at Silverwood Lake<sup>7</sup> has been less than or equal to the TDS antidegradation objectives for these three GMZs based on the observed TDS concentrations from 1980 through 2021, a period of 41 years. Since 1980, the TDS concentrations of SWP water have been less than the antidegradation objectives in the Chino-1, -2, and -3 GMZs about 67, 51, and 57 percent of the time, respectively.

To address this issue, Watermaster and the IEUA proposed, and the Regional Board approved, alternative “maximum-benefit” TDS and nitrate objectives for certain portions of the Chino Basin and the Cucamonga GMZ. A new GMZ, the Chino-North GMZ (Chino-North), combined the Chino-1, Chino-2, and Chino-3 GMZs into one single management unit, as shown in Figure 1-1. All the groundwater recharge activities that would occur as part of the OBMP Implementation Plan are within boundary of Chino-North. The Cucamonga GMZ was included as part of the Chino Basin maximum benefit SNMP so that recycled water recharge or reuse in the Cucamonga GMZ may be pursued as part of the Chino Basin OBMP. The TDS and nitrate maximum-benefit objectives established for Chino-North are 420 and 5 mg/l, respectively. The maximum-benefit TDS objective was higher than the then-current ambient TDS 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 the immediate need for mitigation. The TDS concentration of SWP water is projected be less than the 420 mg/l maximum-benefit objective 99 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 State Board’s antidegradation requirements were satisfied. Watermaster and IEUA demonstrated that: the beneficial uses of the Chino Basin would continue to be protected and water quality consistent with maximum benefit to the people of the State of California would be maintained. Other factors consistent with California Water Code Section 13241—such as economics, the need to use recycled water, and the need to develop housing in the area—were also considered in establishing the maximum-benefit objectives.

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<sup>7</sup> 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 the Devil Canyon Power Plant Afterbay and Upper Feeder Pipeline.



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Prepared by:



Prepared for:

**Chino Basin Watermaster and  
the Inland Empire Utilities Agency**  
2022 Maximum Benefit  
Annual Report



**Cumulative Distribution of  
State Water Project TDS Concentrations**  
Silverwood Lake Reservoir - 1980 to 2022

**Figure 1-2**



### **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 are listed in Table 5-8a therein (Regional Board, 2016). 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 a capacity of 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 (to 40 mgd) pursuant to the OBMP and the Peace Agreement, the timing for which is tied to the IEUA’s agency-wide effluent concentration)<sup>8</sup>
5. The completion of the groundwater recharge facilities included in the 2001 Watermaster Recharge Master Plan.
6. The management of recycled water quality to ensure that the IEUA agency-wide, 12-month running average volume-weighted effluent TDS concentration does not equal or exceed 550 mg/l and the TIN concentration does not equal or exceed 8 mg/l.
7. The management of basin-wide, volume-weighted TDS and nitrate concentrations in artificial recharge to less than or equal to the maximum-benefit objectives on a five-year volume-weighted basis.
8. The achievement and maintenance of the “hydraulic control” of groundwater outflow from the Chino Basin, specifically from the Chino-North GMZ, in order to protect Santa Ana River water quality and downstream beneficial uses.
9. The determination of ambient TDS and nitrate concentrations of Chino and Cucamonga GMZs 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 a finding of no assimilative capacity for TDS and nitrate 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.

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<sup>8</sup> The expansion to provide an additional 20 mgd of desalter pumping capacity was initially required to occur when the 12-month running average for the IEUA agency-wide effluent TDS concentration exceeded 545 mg/l for three consecutive months. The expansion has occurred even though this water quality condition has never been triggered and has instead been driven by the implementation of the Peace II Agreement and achieving hydraulic control.



## 1.4 Purpose and Report Organization

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

- **Section 2.0** – Maximum-Benefit Commitment Compliance. This section describes the status of compliance with each of the maximum-benefit commitments.
- **Section 3.0** – Data Collected in 2022. This section describes the data collected in 2022 as part of the maximum-benefit monitoring program.
- **Section 4.0** – 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.
- **Section 5.0** – References. This section provides the references consulted in performing the analyses described herein and in writing this report.



## 2.0 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, 2016) as of December 31, 2022. A discussion of ongoing activities related to commitment compliance is provided below. For this discussion, the commitments are grouped together into four main topics: hydraulic control, Chino Basin Desalters, recycled water recharge and quality, 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 an amount less than 1,000 acre-feet per year (afy). (Regional Board, 2011).

Commitment number 8 requires the achievement and maintenance of hydraulic control, and a plan to mitigate the loss or temporary loss of hydraulic control (see Table 2-1). The monitoring data collected in compliance with Commitments number 1 and number 2 are used to demonstrate the occurrence and maintenance of hydraulic control.

#### 2.1.1 Hydraulic Control Monitoring Program

The surface-water and groundwater monitoring programs implemented for Commitments number 1 and number 2 are designed, in part, to collect the data necessary to determine the state of hydraulic control and are 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 (2004 Work Plan [WEI, 2004b]). The Regional Board adopted Resolution R8-2005-0064, approving the 2004 Work Plan, and required Watermaster and the IEUA to implement the HCMP.



**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>1. Surface Water Monitoring Program<sup>(a)</sup></b>		
a. Submit draft Monitoring Program to Regional Board	a. January 23, 2005	a. Draft work plan submitted to the Regional Board on January 23, 2005
b. Implement Monitoring Program	b. Within 30 days from the date of Regional Board approval of the monitoring plan	b. Monitoring plan initiated prior to the Regional Board approval
c. Submit Draft Revised Monitoring Program to Regional Board	c. 15 days from 2012 Basin Plan Amendment (BPA) approval	c. Draft work plan submitted to the Regional Board on February 16, 2012, six days after 2012 BPA approval
d. Implement Revised Monitoring Program	d. Upon Regional Board 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. Submit Draft Revised Monitoring Program(s) (subsequent to that required in “c”, above) to Regional Board	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	e. No revisions requested by the Regional Board
f. Implement Revised Monitoring Program(s)	f. Upon Regional Board approval	f. N/A
g. Annual data report submittal	g. April 15th	g. All annual reports submitted by April 15 of each year since 2006
<b>2. Groundwater Monitoring Program<sup>(a)</sup></b>		
a. Submit Draft Monitoring Program to Regional Board	a. January 23, 2005	a. Draft monitoring plan submitted to Regional Board on January 23, 2005
b. Implement Monitoring Program	b. Within 30 days from the date of Regional Board approval of the monitoring plan	b. Monitoring program initiated prior to Regional Board approval
c. Plan and schedule for demonstrating hydraulic control	c. By December 31, 2013	c. Plan and schedule for demonstrating hydraulic control submitted in the 2014 Work Plan to the Regional Board on December 23, 2013
d. Implement hydraulic control demonstration	d. Upon Regional Board approval	d. Hydraulic control demonstration reported in all annual reports
e. Submit Draft Revised Monitoring Program(s) (subsequent to that required in “a”, above) to Regional Board	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	e. No revisions requested by Regional Board
f. Implement revised monitoring plans (s)	f. Upon Regional Board approval	f. N/A
g. Annual data report submittal	g. April 15th	g. All annual reports submitted by April 15 of each year
<b>3. Chino Desalters</b>		
a. Chino-I Desalter expansion to 10 mgd	a. Prior to the recharge of recycled water	a. Chino-I Desalter expansion to a pumping capacity of 14 mgd (15,700 afy) was completed in April 2005 and operation began in October 2005; recycled water recharge began in July 2005
b. Chino-II Desalter construction to 10 mgd capacity	b. Recharge of recycled water allowed once award of contract and notice to proceed issued for construction of desalter treatment plant	b. Contract for Chino-II Desalter awarded in early 2005; construction was completed to a pumping capacity of 10 mgd (11,00 afy), and the facility went online in June 2006
<b>4. Submittal of future desalters plan and schedule</b>		
	<p>Plan due: October 1, 2005</p> <p>Trigger for construction: when the IEUA agency-wide 12-month running average effluent TDS concentration exceeds 545 mg/l for three consecutive months.</p> <p>Implement plan and schedule upon Regional Board approval.</p>	<p>Starting in 2005, several plans were submitted to the Regional Board for desalter expansion to achieve hydraulic control and meet the pumping capacity of 40,000 afy pursuant to the Peace II Agreement. Although the IEUA recycled water effluent has never reached 545 mg/l based on 12-month average, the Chino Desalter Authority (CDA) proceeded to expand the capacity of the desalters to ensure the attainment of hydraulic control. In June 2020, the CDA facilities reached a pumping capacity of 40,000 afy.</p>
<b>5. Recharge facilities (17) built and in operation</b>		
	June 30, 2005	<p>Watermaster and the IEUA partnered with the San Bernardino County Flood Control District and the Chino Basin Water Conservation District for completion of the Chino Basin Facilities Improvement Program to construct and/or improve eighteen recharge sites. There are currently 17 basins in the Chino Basin Groundwater Recharge Program.</p>

**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>6. Submittal of IEUA wastewater quality improvement plan and schedule</b>		
	<p>60 days after agency-wide, 12-month running average effluent concentration equals or exceeds 545 mg/l for TDS for three consecutive months or equals or exceeds 8mg/l for TIN in any month.</p> <p>Implement plan and schedule upon approval by Regional Board.</p>	<p>These thresholds have not been triggered; therefore, a wastewater quality improvement plan has not been submitted (See Table 2-5, and Figure 2-8 of this report).</p> <p>Due to the drought conditions and water conservation measures, the effluent TDS concentration reached a historical-high of 534 mg/l in 2015, which was only 11 mg/l below the 545 mg/l action limit. To account for impacts of drought and water conservation measures on the effluent TDS concentration, a technical investigation was initiated in 2017 to evaluate the potential water quality impacts of updating the compliance metric to allow for a longer-term averaging period. The technical study was completed in December 2021. Watermaster and the IEUA prepared and submitted the technical study and a regulatory compliance proposal letter to request a longer-term averaging period in December 2021. Watermaster and the IEUA are working with the Regional Board staff to incorporate the proposal into the Basin Plan.</p>
<b>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.</b>		
	<p>Compliance must be achieved by the end of the 5<sup>th</sup> year after initiation of recycled water recharge operations.</p>	
<p>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.</p>	<p>a. Prior to initiation of recycled water recharge.</p>	<p>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 in accordance with water recharge permits.</p>
<p>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.</p>	<p>b. Annually, by April 15th, after initiation of construction of basins/other facilities to support enhanced storm water recharge.</p>	<p>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 2-6a and 2-6b of this report).</p>
<b>8. Hydraulic Control Failure</b>		
<p>a. Plan and schedule to correct loss of hydraulic control</p>	<p>a. 60 days from Regional Board finding that hydraulic control is not being maintained</p>	<p>a. There has been no finding that hydraulic control is not being maintained to trigger preparation of a plan and schedule.</p>
<p>b. Achievement and maintenance of hydraulic control.</p>	<p>b. In accordance with plan and schedule approved by the Regional Board</p>	<p>b. Hydraulic control has been achieved at and to the east of Chino-I Desalter Well 20. Groundwater model estimates published in 2014 indicate that a total production of 1,529 afy at the CCWF will achieve hydraulic control west of Chino-I Desalter Well 5 to de minimis levels (&lt;1,000 afy of groundwater flow past the CCWF to the PBMZ). In 2016, the CCWF began full operation to achieve hydraulic control. Production at the CCWF has decreased below 1,529 afy since 2017 due to the detection of 1,2,3-TCP concentration above the MCL at CCWF Well I-17. In 2020, Watermaster used the groundwater model to estimate the historical (2004-2018) and projected (2019-2050) groundwater discharge past the CCWF under revised pumping conditions at the CCWF. The results indicate that both the estimated historical and projected discharge past the CCWF area is below the <i>de minimis threshold</i> (1,000 afy). The model assumes an average pumping 992 afy at the CCWF from fiscal year 2019 through the remainder of the planning period. Watermaster is working with the Regional Board to update the definition of <i>de minimis</i> threshold at CCWF to maintain hydraulic control based on the new model results. This is part of the updated mitigation plan for temporary loss of hydraulic control that was submitted to the Regional Board in June 2022.</p>

**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
c. Mitigation plan for temporary failure to achieve/maintain hydraulic control	c. The original plan by January 23, 2005 and updated plan by June 30, 2022.	c. The original mitigation plan was submitted to the Regional Board on March 3, 2005. Due to the revised pumping conditions at the CCWF, the Regional Board requested Watermaster and the IEUA to develop an updated plan to establish new metrics to assess compliance with <i>de minimis</i> outflow requirements and to develop an updated mitigation plan should water quality or other concerns lead to a broad reduction in desalter pumping. Watermaster and the IEUA prepared and submitted the updated plan to the Regional Board in June 2022. The updated mitigation plan is pending review by the Regional Board.
<b>9. Ambient Groundwater Quality Determination</b>		
	July 1, 2005 and every three years thereafter	Watermaster and the IEUA have participated in the regional triennial 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.
<p>(a) 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.</p> <p>afy = acre-feet per year  mgd = million gallons per day mgl = milligrams per liter  TDS = Total dissolved solids</p>		



## Chino Basin Optimum Basin Management Program 2022 Maximum Benefit Annual Report



The initial design of the HCMP included multiple lines of evidence to demonstrate hydraulic control. The multiple lines of evidence were:

- Collect and analyze groundwater-elevation data to determine the direction of groundwater flow in the southern part of the Chino Basin and whether pumping at the Chino Basin Desalter well field 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 (1) track the migration, or lack thereof, of the South Archibald volatile organic compound (VOC) plume beyond the Chino Basin Desalter well field; and (2) identify the source of groundwater in the area of the Chino Basin between the Santa Ana River and the Chino Basin Desalter well field.
- 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 the surface-water and groundwater-monitoring programs pursuant to the 2004 Work Plan from 2004 through 2011 and concluded that: 1) hydraulic control had been achieved to the east of Chino-I Desalter Well 5, 2) hydraulic control had not yet been achieved to the west of Chino I Desalter Well 5, and 3) 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* (WEI, 2007b; 2008b; 2009a; 2010; 2011a; and 2012b). In 2010, the 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 of this report). Watermaster and the IEUA also concluded that the data collected as part of the surface-water monitoring programs were not necessary to determine the state of hydraulic control and began the process of working with the Regional Board to modify the surface-water and groundwater-monitoring programs and maximum-benefit commitments accordingly (WEI, 2011a and 2012b).

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: 1) an updated surface-water monitoring program by February 25, 2012 and 2) a revised groundwater monitoring program and schedule for achieving hydraulic control by December 31, 2013. Pursuant to 1), 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).<sup>9</sup> Pursuant to 2, Watermaster and the IEUA submitted the *2014 Maximum Benefit Monitoring Work Plan* (2014 Work Plan) to the

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<sup>9</sup> The 2012 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.

## Chino Basin Optimum Basin Management Program 2022 Maximum Benefit Annual Report

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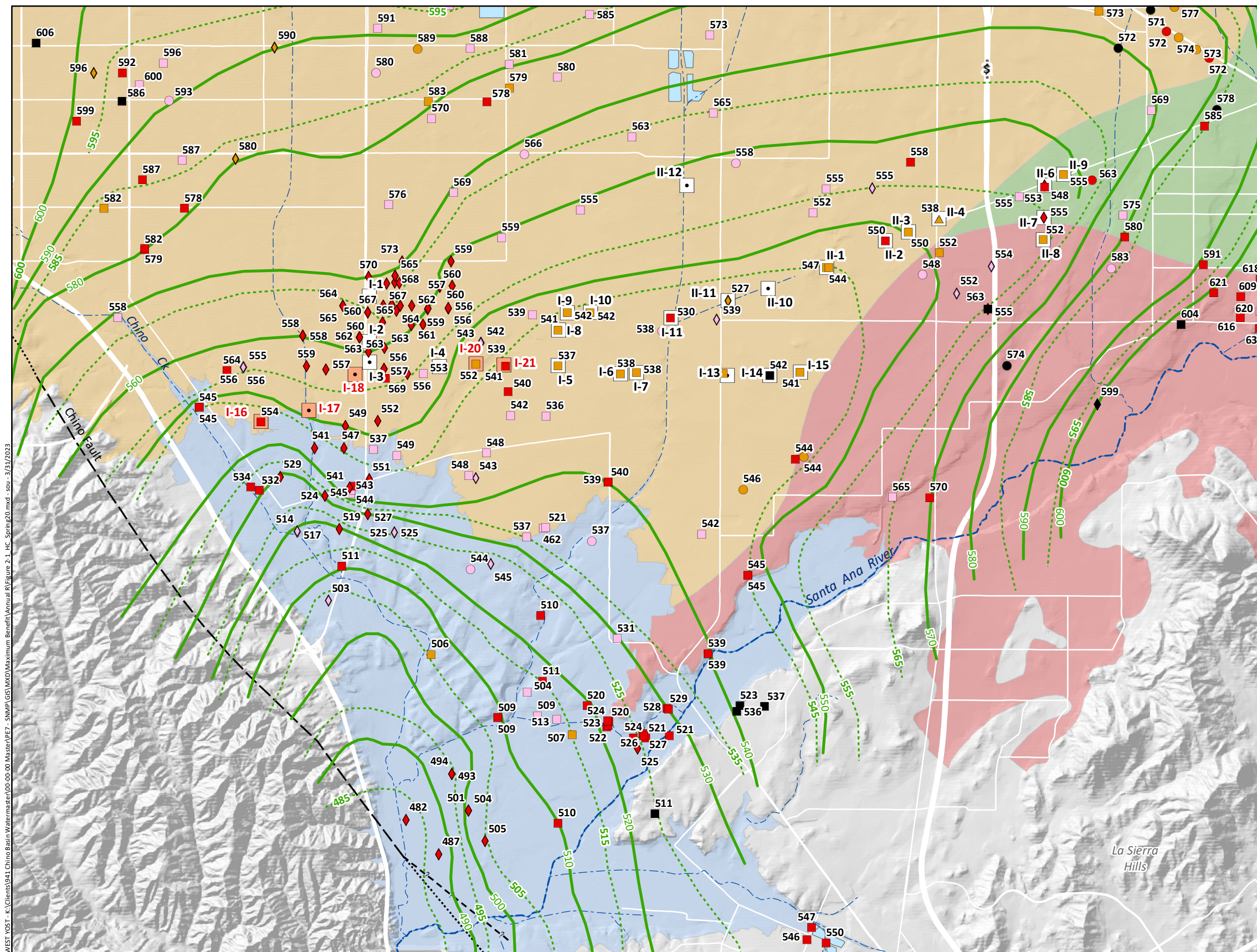


Regional Board on December 23, 2013 (WEI, 2013c).<sup>10</sup> The 2014 Work Plan was approved by the Regional Board on April 25, 2014 (Regional Board, 2014b).

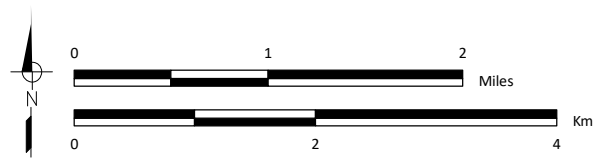
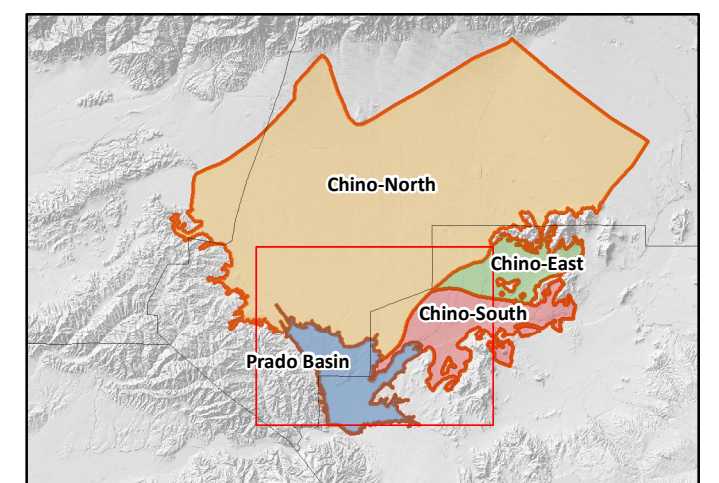
Each year, the data collected pursuant to the 2014 Work Plan is summarized and included in the Chino Basin Maximum Benefit Annual Report (see Section 3.0 of this report).

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<sup>10</sup> 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 (and 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.



- 800-775** Groundwater-Elevation Contours (feet above mean sea-level)
- Well Activity During Groundwater Level Measurement (Number Indicates Groundwater Elevation)
  - Measured Static
  - ◆ Interpolated Static
  - ▲ Dynamic, Recovering, or Activity Unknown
- Aquifer Layer Where Well Casing is Perforated (Color Code)
  - Layer 1
  - Layers 1 & 2
  - Layers 1 & 2 & 3
  - Unknown Well Construction
- ⊕ HCMP Monitoring Well
  - Chino Basin Desalter Well (labeled in black)
  - Chino Basin Desalter Well - CCWF (labeled in red)
  - ☁ Flood Control and/or Conservation Basins
  - ~ Streams & Flood Control Channels
- Management Zones**
  - Chino-North GMZ
  - Chino-East GMZ
  - Chino-South GMZ
  - Prado Basin MZ
- Faults**
  - Location Certain
  - - - Location Approximate
  - ⋯ Location Concealed
  - · - · Location Uncertain
  - Approximate Location of Groundwater Barrier





## 2.1.2 Hydraulic Control Monitoring Program Objectives and Methods

The 2014 Work Plan describes the following as the ongoing questions to be answered by the HCMP:

1. Will hydraulic control of groundwater from Chino-North be maintained east of Chino-I Desalter Well 5?
2. Will the CCWF continue to 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 afy or less?
3. Will the impact of rising groundwater discharge from Chino-North to the PBMZ 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-level monitoring program and periodic groundwater modeling will continue to be used to define the capture zone created by the Chino Basin 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. The SOB Report includes a spring groundwater-elevation contour map of the southern portion of Chino Basin, showing the capture zone of the Chino Basin 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 in the 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 recalculation of 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 operation of the CCWF is intended to achieve hydraulic control and reduce groundwater discharge west of Chino-I Desalter Well 5 to the *de minimis* threshold of 1,000 afy or less. The 2013 Chino Basin Model estimated that the rate of groundwater discharge from Chino-North to the PBMZ in the absence of the CCWF was about 2,400 afy (WEI, 2014a). The model was used to estimate the discharge once the CCWF wells are in operation. The results indicated that with planned pumping at the CCWF of 1,529 afy, the groundwater discharge from Chino-North to the PBMZ would decrease to about 900 afy 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 2.1.4 of this report).





**Method to Address Question 3:** The monitoring data from HCMP has demonstrated that the historical and current impacts of rising groundwater discharge from Chino-North to the PBMZ on the surface-water quality of the Santa Ana River at Prado Dam is *de minimis*. Groundwater modeling shows that pumping at the CCWF will further decrease the volume of groundwater discharge from Chino-North that becomes rising groundwater in the PBMZ and thereby further reduces the impact on Santa Ana River water quality.

A 2015 mass-balance analysis estimated the impact of groundwater discharge from Chino-North to the PBMZ through the CCWF on the volume-weighted TDS concentration of the Santa Ana River at Prado Dam (WEI, 2016). The mass-balance analysis estimated that without the CCWF, rising groundwater from Chino-North would increase the TDS concentration of the Santa Ana River at Prado Dam by approximately 8 mg/l (a one and a half percent increase) relative to full hydraulic control in this area. The operation of the CCWF to the *de minimis* threshold reduces the impact to a 4 mg/l increase (a half percent increase) relative to full hydraulic control in this area (WEI, 2016).

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 Maximum Benefit Annual Report (see Section 4.2.2 of this report).

### 2.1.3 Current Status of Hydraulic Control

Figure 2-1 shows the most current characterization of the state of hydraulic control based on groundwater-elevation contours for spring 2020 from the 2020 SOB Report (West Yost, 2021a).<sup>11</sup> The spring 2020 groundwater-elevation contours show a regional depression in groundwater elevation at and east of Chino-I Desalter Well I-20, demonstrating that groundwater flowing from Chino-North to the PBMZ is being captured by the desalter wells in this area. This characterization of the state of hydraulic control is consistent with past characterizations in the Maximum Benefit Annual Reports since 2017 (WEI 2017; 2018; 2019; 2020a; West Yost 2021b; 2022). Prior to 2017, complete hydraulic control had been achieved at and east of Chino-I Desalter Well 5 (WEI, 2007b; 2008b; 2009a; 2010; 2011a; 2012b; 2013a; 2014b; 2015a; and 2016).

For the area west of Chino-I Desalter Well 5, the operation of the CCWF is intended to achieve hydraulic control to *de minimis* levels (<1,000 afy). In February 2016, the CCWF commenced full-scale operation with production at Wells I-16, I-17, I-20, and I-21 and, by definition, hydraulic control was determined to have been achieved in this area. In 2022, the CCWF wells produced a total of about 1,171 acre-feet (af) which is less than the amount previously characterized (1,529 afy) to ensure *de minimis* outflows. Production at the CCWF has decreased since 2017 as a result of the new maximum contaminant level (MCL) for 1,2,3-Trichloropropane (1,2,3-TCP), which required the CDA to temporarily shut down operation of CCWF Well I-1712. In 2020, Watermaster used the Chino Basin Model to estimate the historical (2004-2018) and projected (2019-2050) volume of groundwater discharge past the CCWF (WEI, 2020b) under revised pumping conditions at the CCWF. The model-results indicate that both the estimated historical and projected discharge past the CCWF area is always below the *de minimis* threshold level of 1,000 afy (see Section 2.1.4). The model assumes an annual average pumping volume at the CCWF of 992 af from fiscal year 2019 through the remainder of the planning period. Watermaster and the IEUA

<sup>11</sup> Watermaster is currently preparing the spring 2022 groundwater-elevation contours, which will be published in the 2022 SOB Report in June 2023.

<sup>12</sup> 1,2,3-TCP concentrations in groundwater samples from CCWF Well I-17 exceed the MCL.

# Chino Basin Optimum Basin Management Program 2022 Maximum Benefit Annual Report



are working with the Regional Board to update the definition of the minimum pumping required at the CCWF to maintain *de minimis* outflow as part of the updated mitigation plan for the temporary loss of hydraulic control submitted to the Regional Board in June 2022 (see Section 2.1.5). The updated mitigation plan proposed to remove the definition of required CCWF pumping since the model results performed for the mitigation plan indicate that hydraulic control is maintained in the absence of pumping at the CCWF. The mitigation plan is pending review and approval by the Regional Board.

## 2.1.4 Future Projection of Hydraulic Control

In 2020, Watermaster completed its five-year update and recalibration of the Chino Basin Model to recalculate the Safe Yield of the Chino Basin (WEI, 2020b). As part of the 2020 Safe Yield recalculation, the future state of hydraulic control was estimated using the updated Chino Basin Model. A planning scenario was developed to recalculate Safe Yield based on the recent planning work reported in the *2018 Storage Framework Investigation* (WEI, 2019a) and the *2020 Storage Management Plan* (WEI, 2019b). This scenario, referred to herein as 2020 SYR1 is based on the water demands and water supply plans provided by the Watermaster Parties, planning hydrology that incorporates climate change impacts on precipitation and evapotranspiration (ET), and assumptions regarding cultural conditions and future groundwater replenishment. The projected state of hydraulic control was estimated with the Chino Basin Model by simulating the Chino Basin's response to the 2020 SYR1 scenario. The attainment of hydraulic control is assessed using model-predicted groundwater elevation data to evaluate whether all groundwater north of the desalter wells is captured by the Chino Basin Desalter well field (total hydraulic containment standard) or that groundwater discharge through the Chino Basin Desalter well field is, in aggregate, less than 1,000 afy (*de minimis* standard).

Figure 2-2 shows the model-projected state of hydraulic control in 2030 for the 2020 SYR1 scenario. The figure includes groundwater-elevation contours and groundwater flow direction for model layer 1 projected for July 2030. The model-estimated groundwater elevations and flow directions show full hydraulic containment of Chino-North groundwater at and east of Chino-I Well I-20, and groundwater discharge from the Chino-North to the PBMZ is projected to not be fully contained by the Chino Basin Desalter well field west of Well I-20.

The volume of groundwater discharge to the west of Well I-20 was estimated through the analysis of model projected discharges across a "line of control" approximately perpendicular to the groundwater flow direction past the CCWF (WEI, 2020b). Figure 2-2 shows the location of the line of control. Figure 2-3 is a time-history chart that shows the historical and projected volume of groundwater discharge across the line of control (2004 to 2050). Over this period, the groundwater discharge across the line of control ranges from 380 to 740 afy, averages 490 afy, and is always less than the *de minimis* discharge threshold of 1,000 afy. Additionally, as shown in Figure 2-2, there are several active private pumping wells downgradient of the line of control that further reduce rising groundwater outflow to the PBMZ. As describe above in Section 2.1.3, Watermaster is working with the Regional Board to formally update the definition of the minimum pumping required at the CCWF to maintain outflow from the Chino-North to *de minimis* levels. This is part of the updated mitigation plan for the temporary loss of hydraulic control described in Section 2.1.5.

## 2.1.5 Mitigation Plan for Temporary Loss of Hydraulic Control

Part of Commitment number 8 is the development of mitigation plan for the temporary loss of hydraulic control. Watermaster and the IEUA prepared and submitted the initial mitigation plan to the Regional Board on March 3, 2005 (2005 mitigation plan). At a meeting with the Regional Board on March 2021,

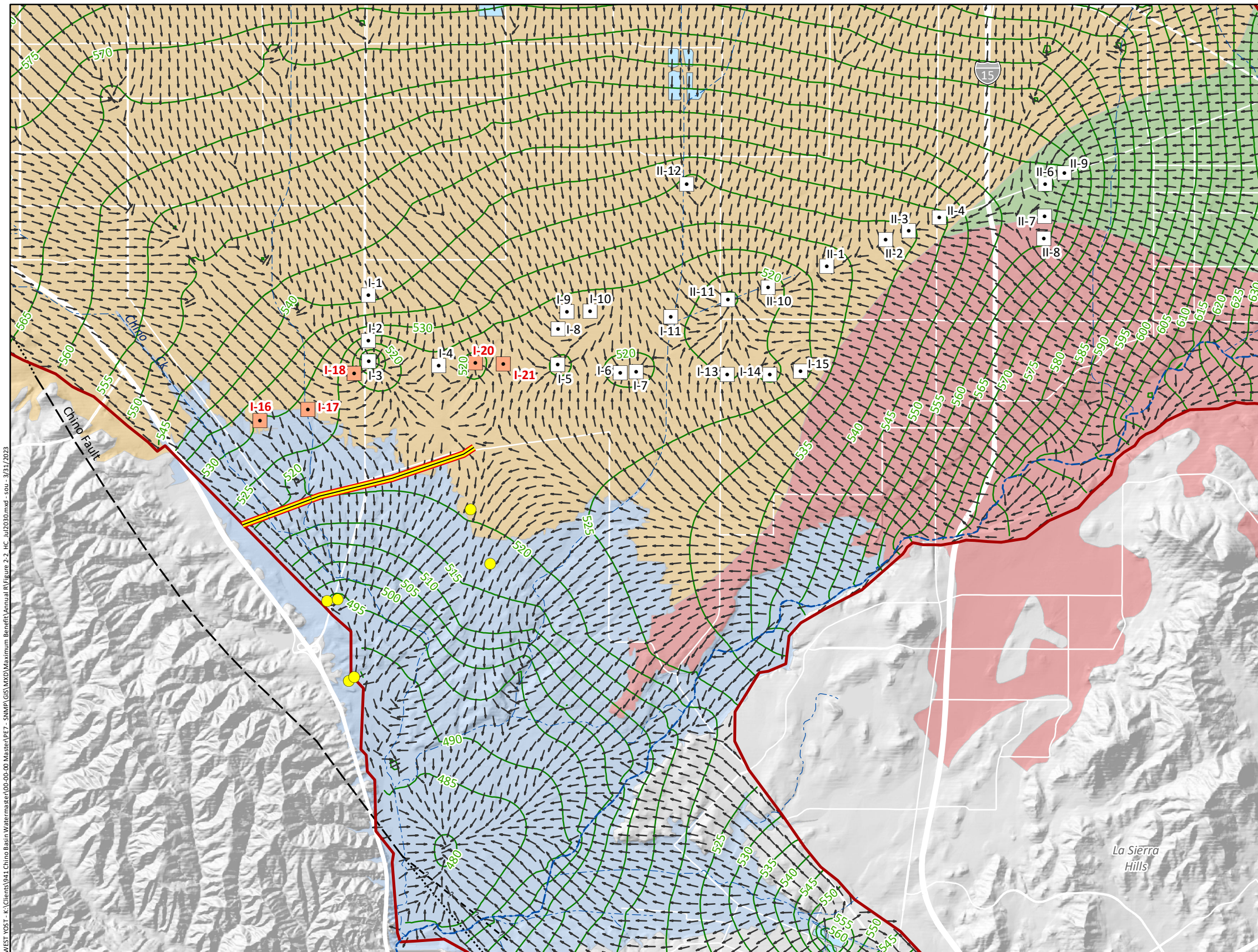
## Chino Basin Optimum Basin Management Program 2022 Maximum Benefit Annual Report

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Watermaster, IEUA, and CDA requested that Regional Board staff consider: 1) formally updating the definition of the minimum pumping required at the CCWF to maintain hydraulic control based on the latest and CDA operation and Watermaster modeling, and 2) allowing for defined operational flexibility for the maximum-benefit commitment to operate the Chino Desalter wells at a rate of 40,000 afy. In a September 2021 letter, the Regional Board requested Watermaster to update the mitigation plan based on the requested considerations (Regional Board, 2021). Watermaster prepared and submitted the updated mitigation plan to the Regional Board on June 21, 2022. The updated mitigation plan included: an updated plan and schedule for the mitigation of any temporary loss of hydraulic control, a proposed definition of the required minimum CCWF pumping to maintain outflows to the PBMZ to de minimis levels (see Section 2.1.3 of this report), and a proposed definition of operational flexibility around the 40,000 afy requirement for the aggregate pumping at CDA facilities (see Section 2.2 of this report). The updated mitigation plan is pending review by the Regional Board.

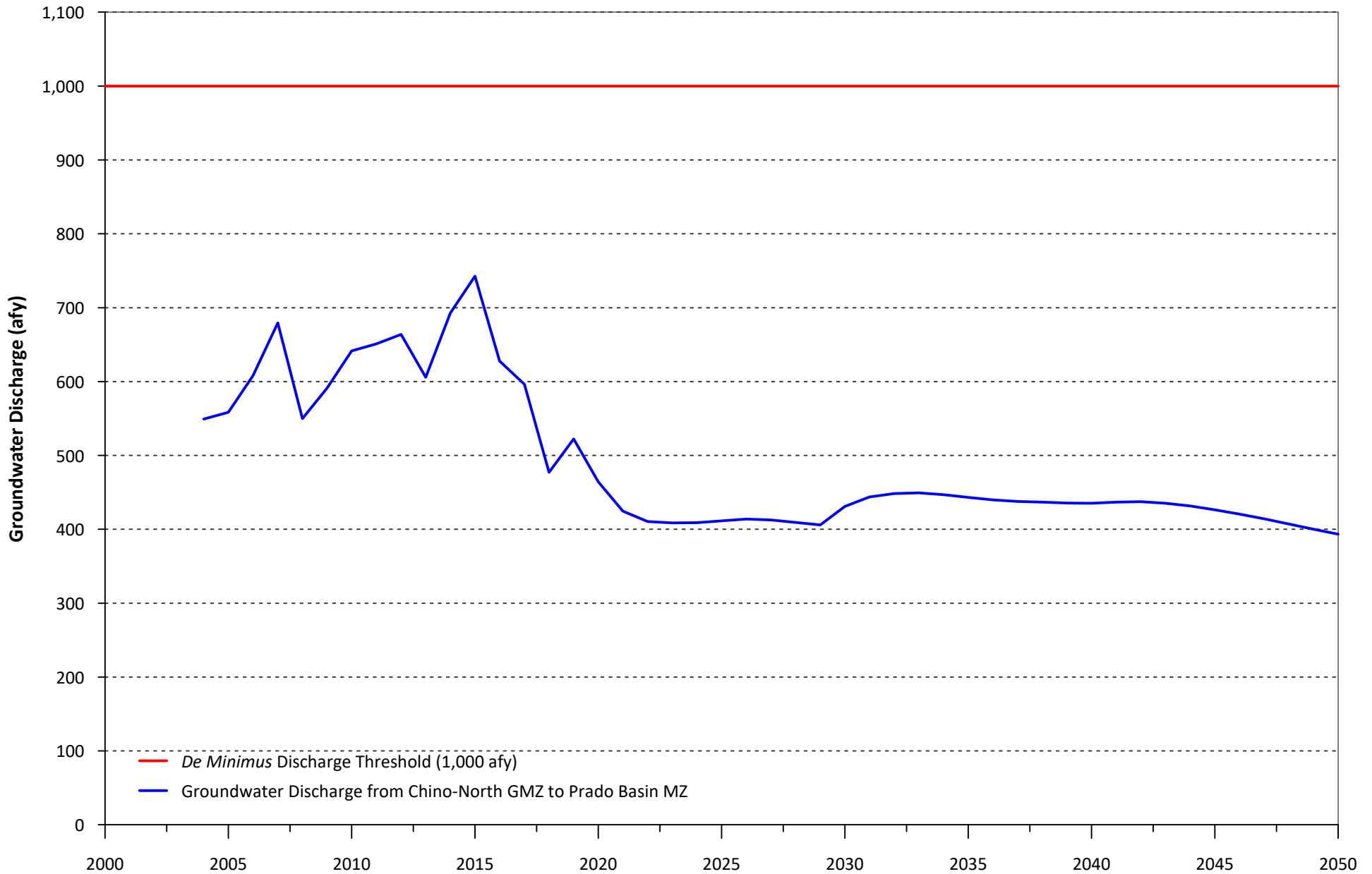
The September 2021 letter from the Regional Board also requested new annual performance reporting on the Chino Basin Desalters, which can be included in the Maximum Benefit Annual Reports. The requested annual performance report of the Chino Basin Desalters is described in Section 2.2.1.



- 2030 Model-Estimated Groundwater Elevation Contours - Model Layer 1 (feet above mean sea-level)
  - 2030 Model-Estimated Groundwater Flow Directions - Model Layer 1
  - Line of Control for Assessment of Hydraulic Control
  - Private Wells Assumed Active Downgradient of the Line of Control
  - Chino Basin Desalter Well (labeled in black)
  - Chino Basin Desalter Well - CCWF (labeled in red)
  - Groundwater Flow Model Boundary
  - Flood Control and/or Conservation Basins
  - Streams & Flood Control Channels
- Management Zones**
- |                 |                 |
|-----------------|-----------------|
| Chino-North GMZ | Chino-South GMZ |
| Chino-East GMZ  | Prado Basin MZ  |

(Figure 7-14 of the 2020 Safe Yield Recalculation - May 2020)





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(Figure 7-15 from the Safe Yield Recalculation Report - May 2020)

Prepared by:



Prepared for:

Chino Basin Watermaster and  
the Inland Empire Utilities Agency  
2022 Maximum Benefit  
Annual Report



**Historical and Projected Groundwater Discharge  
from the Chino-North GMZ to Prado Basin MZ  
2005 to 2050**

**Figure 2-3**



## 2.2 Chino Basin Desalters

The operation of the Chino Basin Desalters is fundamental to the maximum benefit requirement of achieving hydraulic control to protect the water quality of the Santa Ana River and manage TDS and nitrate loading from the use and recharge of recycled and imported waters. The desalter operations are also essential for maximizing the yield of the Chino Basin and minimizing the loss of stored water. The first Chino Basin Desalter, Chino-I, began operation in late 2000 and had an original design capacity of 8 mgd (8,960 afy). Commitments number 3 and number 4 are related to the Chino Basin Desalters.

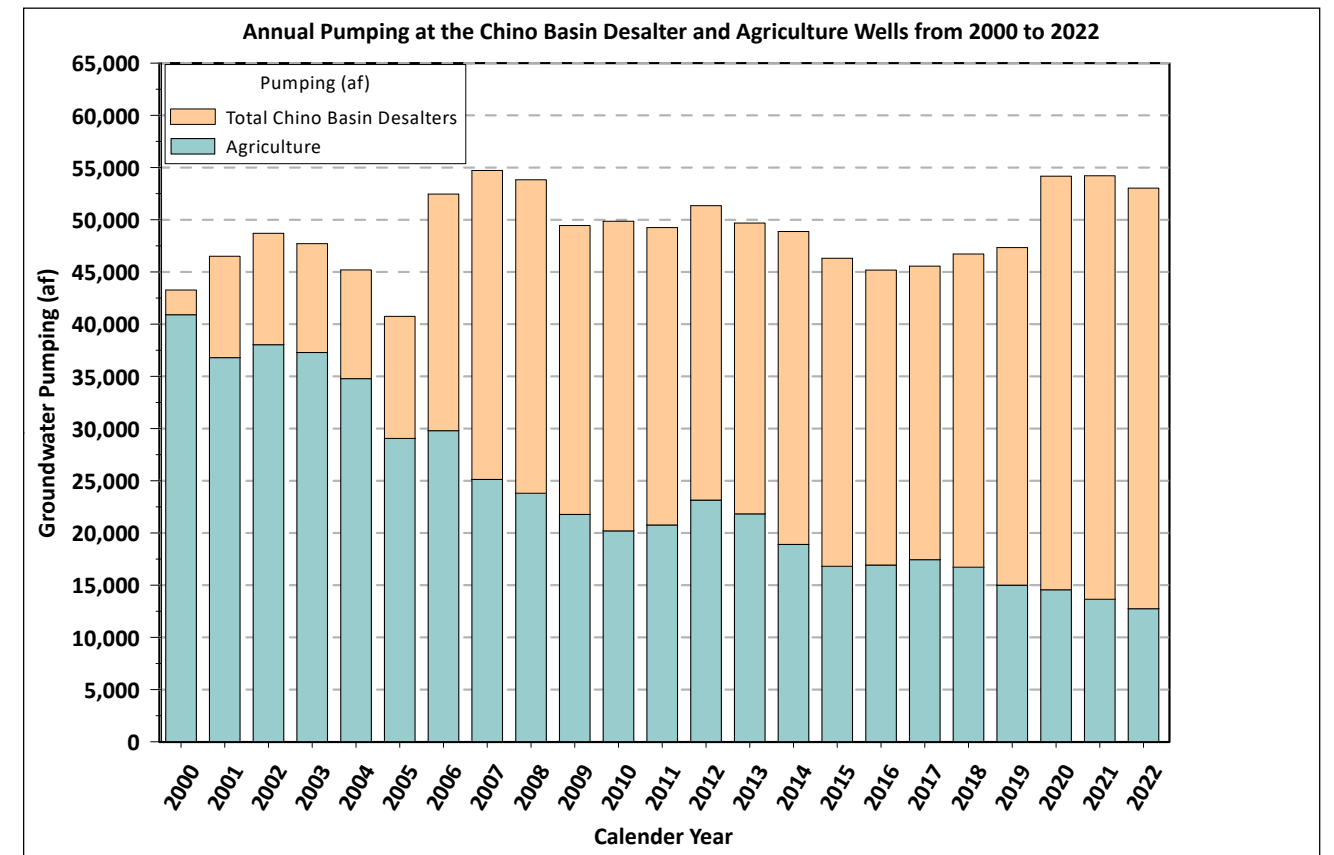
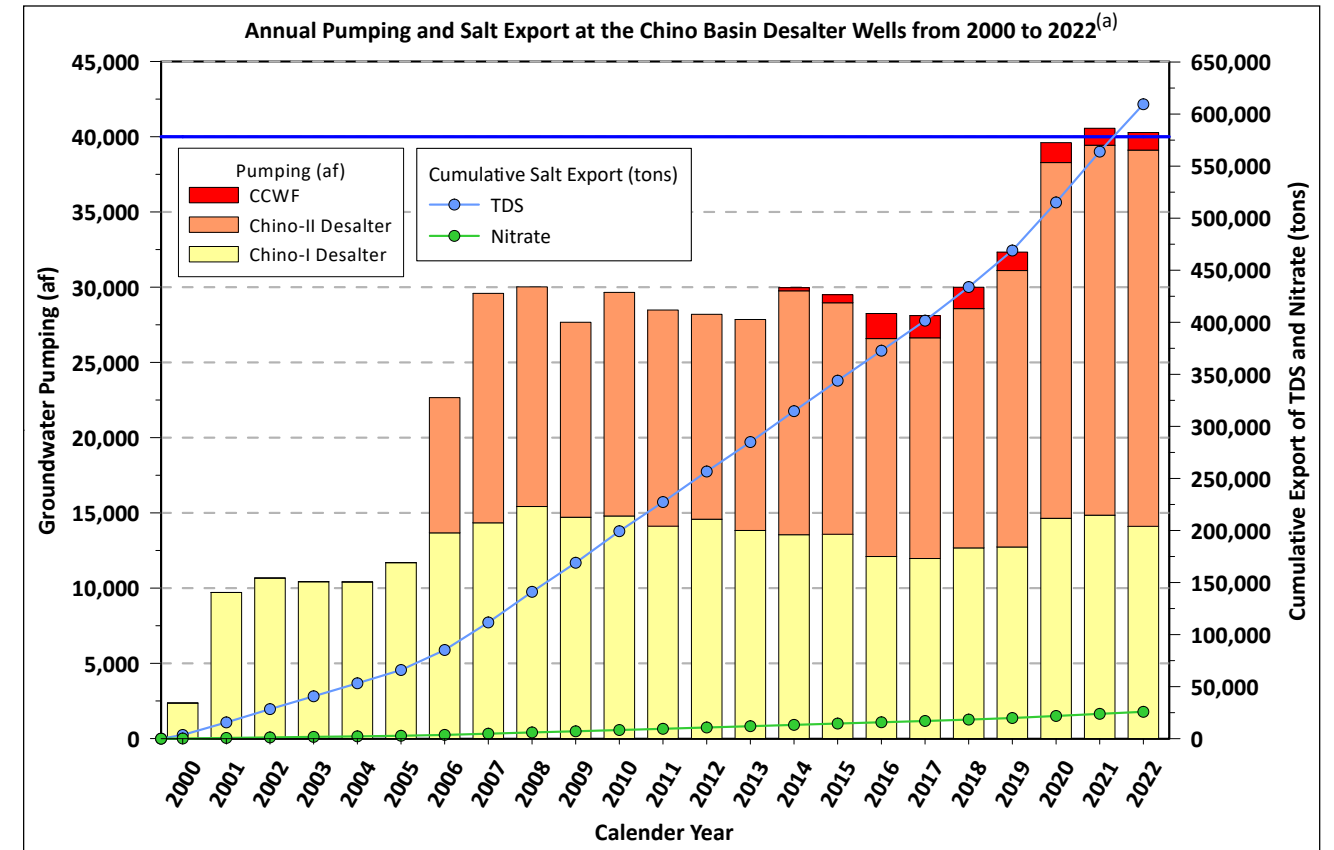
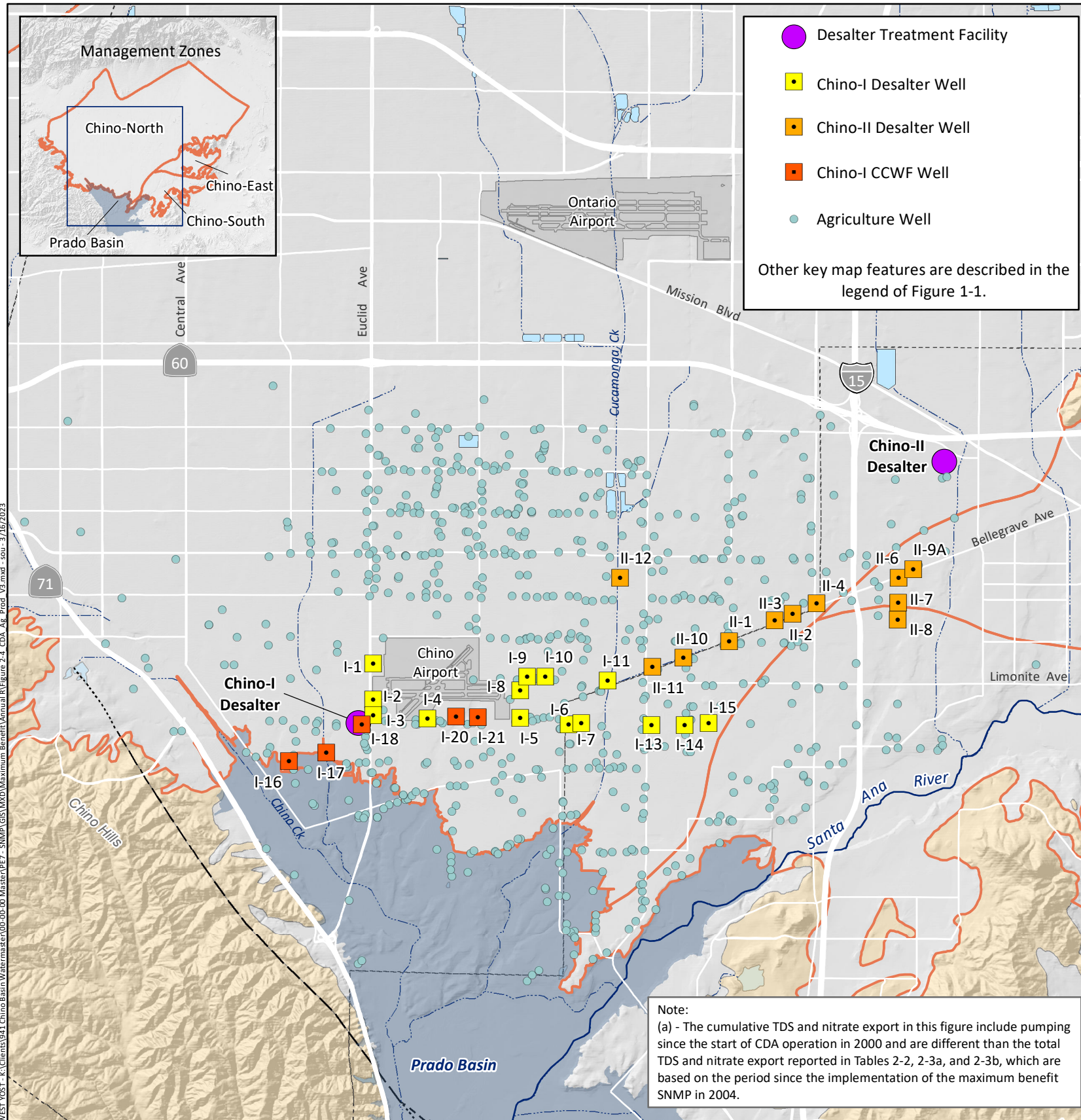
Commitment number 3 required the expansion of Chino-I Desalter and the construction of Chino-II Desalter. In 2005, the Chino-I Desalter was expanded to a capacity of 14 mgd (15,680 afy), and a contract was awarded for the construction of the Chino-II Desalter. The Chino-II Desalter began operation in June 2006 with a capacity of 15 mgd (16,800 afy), bringing the total Chino Basin Desalter capacity to 29 mgd (32,480 afy).

Commitment number 4 requires the submittal of plans to construct the additional wells and facilities needed to achieve the ultimate capacity defined in the OBMP Implementation Plan, to maintain hydraulic control once agricultural pumping ceases in the southern end of the Basin, and to ensure the offset of TDS and nitrate consistent with the maximum benefit proposal. The Basin Plan requires that the construction of the desalter expansion begin once the IEUA effluent compliance metric (the 12-month running average of the IEUA volume-weighted agency-wide recycled water effluent TDS concentration) equals or exceeds 545 mg/l for three consecutive months. Although the IEUA effluent compliance metric has never reached 545 mg/l, the CDA proceeded to expand the capacity of the desalters to ensure the attainment of hydraulic control.

The CCWF wells (I-16, I-17, I-18, I-20, and I-21) were constructed between September 2011 and May 2012<sup>13</sup> in the southwestern portion of the Chino Basin to achieve hydraulic control to the west of Well I-5 (see Section 2.1.1 of this report). The well locations are shown in Figure 2-4. Pumping commenced at CCWF Wells I-16 and I-17 in mid-2014 and Wells I-20 and I-21 in February 2016. The combined pumping capacity of these four wells is about 1,529 afy (1.4 mgd). Due to the presence of VOCs at Well I-18, the CDA has not produced groundwater at this well since its construction. And as previously noted in Section 2.1.3, Well I-17 has been offline since 2017 due to the detection of 1,2,3-TCP concentrations above the new CA Primary MCL. The VOC concentrations (including 1,2,3-TCP) at CCWF Well I-17 and I-18 are associated with the Chino Airport plume. Additionally, Chino-I Desalter Wells I-1, I-2, I-3, and I-4 in the vicinity of the CCWF were also taken out of service starting in 2018 due to the presence of 1,2,3-TCP and trichloroethene (TCE) associated with the Chino Airport plume and other contaminants. Implementation of a remedial action plan for cleanup of the Chino Airport plume is underway that includes the utilization of CCWF Wells I-16, I-17, I-18, and potentially I-20 and I-21, and Chino-I Desalter Wells I-1, I-2, I-3, and I-4, as part of a pump-and-treat system, along with ten extraction well clusters constructed by the County of San Bernardino, who is the identified responsible party for the plume. Groundwater pumped from the CCWF, Chino-I Desalter wells, and County wells will be treated at the Chino-I Desalter facility using new and existing treatment infrastructure. It is anticipated that pumping at CCWF wells as part of this pump and treat system will commence at Well I-17 in April 2023 and at Well I-18 soon after.

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<sup>13</sup> Proposed CCWF Well I-19 was not constructed because the projected pumping estimates during borehole testing were too low to warrant construction.



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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 pumping in the southern region of Chino Basin continues to decrease, and how the Chino Basin Desalters will achieve the required groundwater production of 40,000 afy<sup>14</sup>. Watermaster and the IEUA coordinated with the CDA to develop a plan to achieve 40,000 afy of desalter production and submitted the plan to the Regional Board on June 30, 2015 (Watermaster & IEUA, 2015). The plan included the construction and operation of three new wells for the Chino-II Desalter (II-10, II-11, and II-12). Due to the proximity of these wells to the South Archibald TCE plume, the CDA has been collaborating with the responsible parties of the plume to integrate these wells into the remedial solution to address groundwater cleanup of the plume while maintaining hydraulic control<sup>15</sup>. The plan included the construction of a dedicated pipeline to convey groundwater produced from these wells to the Chino-II Desalter facility to remove VOCs via air stripping. The construction of Wells II-10 and II-11 was completed in September 2015, and pumping initiated in September 2018 and July 2018, respectively. The construction of Well II-12 was completed in November 2020. The equipping of Well II-12 and construction of the dedicated raw water pipeline were completed, and pumping commenced at Well II-12 in August 2021.

Figure 2-4 shows the location of the Chino Basin Desalter wells and two bar charts of annual pumping in the southern region of the Chino Basin since 2000. The top chart shows annual pumping of the Chino Basin Desalter wells and what component is Chino-I, Chino-II, and CCWF. In June 2020, the CDA facilities reached the pumping capacity necessary to meet the 40,000 afy required to replace the lost agriculture pumping in the southern Chino Basin and maintain hydraulic control. This pumping capacity was achieved without the inclusion of Well II-12, which was part of the final expansion plan designed to meet the 40,000 afy. In 2022, total pumping by the Chino Basin Desalter wells was approximately 40,280 af. Watermaster, IEUA, and the CDA are working with the Regional Board on a definition of operational flexibility around the 40,000 afy requirement for the aggregate pumping at the Chino Basin Desalter wells, as part of the updated mitigation plan for the temporary loss of hydraulic control submitted to the Regional Board in June 2022 (see Section 2.1.5). The updated mitigation plan included a proposed definition of operational flexibility of total Chino Basin Desalter well pumping as a five-year running average of 40,000 afy with a maximum annual deviation of +/- 2,100 afy. The mitigation plan and the proposed definition of operational flexibility is pending review and approval by the Regional Board.

Also included in the top chart in Figure 2-4 is the cumulative export of TDS and nitrate mass (tons) from the Chino Basin via pumping at the desalter wells since operation began in 2000<sup>16</sup>. Since 2000, the Chino Basin Desalter wells have pumped 537,725 af of high-TDS/nitrate water and exported about 609,500 tons

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<sup>14</sup> As articulated in the OBMP Implementation Plan, the Peace Agreement, and the Peace II Agreement, Watermaster and the IEUA are required to expand desalter well pumping to about 40,000 afy to replace the agricultural pumping that is lost in the southern portion of the basin.

<sup>15</sup> 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 the 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.

<sup>16</sup> Note that this cumulative total is different than the total salt export reported in Section 2.2.1 below for the CDA annual performance reporting required by the Regional Board. Pursuant to the September 2021 letter, the Regional Board is only interested in the cumulative loading and export since the start of the maximum benefit SNMP in January 2004.



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of TDS and 26,000 tons of nitrate from the Chino Basin. In 2022, the Chino Basin Desalter wells exported 45,520 and 1,940 tons of TDS and nitrate, respectively.

The bottom chart in Figure 2-4 shows the annual aggregate pumping at the Chino Basin Desalter wells and agricultural wells in southern Chino Basin since 2000. This chart demonstrates how the Chino Basin Desalter well pumping is replacing the lost agriculture pumping in the southern Chino Basin.

## 2.2.1 Annual Performance Reporting on the Chino Basin Desalters

The Regional Board previously required the CDA to provide quarterly reporting on the status of the last expansion of the Chino Basin Desalters to achieve 40,000 afy. In 2021, the Regional Board terminated this quarterly reporting requirement and requested the CDA, Watermaster, and the IEUA to provide annual performance reporting on the Chino Basin Desalters. This request was included in the September 2021 letter from the Regional Board that requested the update to the mitigation plan for the temporary loss of hydraulic control (see Section 2.1.5 of this report). Pursuant to the September 2021 letter, the annual performance reporting on the Chino Basin Desalters can be included in the maximum benefit annual reports, and must include the quarterly and cumulative: 1) groundwater pumping and TDS and nitrate mass removed from each desalter well from 2004 to present, and 2) the TDS and nitrate budget (salt budget) from 2004 to present from the operation of the OBMP projects including: recycled water reuse; recharge of recycled, imported, and storm waters; and pumping of the Chino Basin Desalter wells.

Table 2-2 summarizes the annual and total Chino Basin Desalter pumping and mass of TDS and nitrate export by the desalter wells since the implementation of the maximum benefit program in 2004.<sup>17</sup> The quarterly calculations of the data in Table 2-2 are provided in Appendix A.

Tables 2-3a and 2-3b<sup>18</sup> show the quarterly and cumulative TDS and nitrate budgets (loading and export) and net loading to the Chino Basin from the operation of the OBMP projects. Specifically, Tables 2-3a and 2-3b show the quarterly volume (af), volume-weighted concentration (mg/l), and mass (tons) for each loading activity (recycled water use and recharge of recycled, imported, and storm waters) and export activity (Chino Basin Desalter pumping). Salt loadings are shown as positive values to represent salts added to the basin while salt exports are shown as negative values to represent salts removed from the basin. The total TDS or nitrate loading in tons for all activities are provided in column m, and the TDS or nitrate export in tons are provided in column p. The net TDS or nitrate loading in column q are the sum of the quarterly loading and export (column m plus column p). A positive net loading demonstrates that more salt is loaded to the basin than is exported from the basin, and a negative net loading demonstrates that more salt is exported from the basin than is loaded to the basin.

Figure 2-5a and Figure 2-5b plot the quarterly salt loading, export, and cumulative net loading, for TDS and nitrate, respectively, since the implementation of the maximum benefit SNMP in 2004 through 2022.

<sup>17</sup> Note that the total TDS and nitrate mass export in Section 2.2.1 include CDA pumping since 2004 and are different than the cumulative TDS and nitrate export reported in Section 2.2, which are since 2000 for the entire period of operation of the Desalters. For the annual performance reporting required by the Regional Board, the period of interest in the cumulative loading and export since the start of the maximum benefit SNMP in January 2004.

<sup>18</sup> Includes recycled water recycled in Chino-North and Cucamonga GMZs.

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Table 2-3a and Figure 2-5a show that for TDS:

- The quarterly loading from OBMP activities has ranged from 930 to 8,900 tons and averaged 4,920 tons.
- The quarterly export from CDA operations has ranged from negative 2,730 to negative 13,520 tons and averaged negative 7,480 tons.
- The quarterly net loading operations has ranged from 1,810 to negative 7,230 tons and averaged negative 2,560 tons.
- For the period of analysis, the quarterly net TDS loading was always negative except for:
  - 2005 (quarter 2 and 4) and 2006 (quarter 1 and 4) due to high volumes of imported water and storm water recharge and limited CDA pumping.
  - 2011 (quarter 3) and 2017 (quarter 2 through 4) due to high volume of imported water recharge
- The cumulative net TDS loading since the implementation of the maximum benefit SNMP in 2004 through 2022 is negative 194,538 tons, which demonstrate that more TDS was exported from the Chino Basin through the operation of the Chino Basin Desalters compared to TDS loading to the basin from the recycled water reuse and recharge of recycled, imported, and storm waters.

Table 2-3b and Figure 2-5b show that for nitrate:

- The quarterly loading from OBMP activities has ranged from 9 to 92 tons and averaged 45 tons.
- The quarterly export from CDA operations has ranged from negative 110 to negative 536 tons and averaged negative 317 tons.
- The quarterly net loading operations has ranged from negative 75 to negative 488 tons and averaged negative 270 tons.
- The cumulative net nitrate loading since the implementation of the maximum benefit SNMP in 2004 through 2022 is negative 20,626 tons, which demonstrate that more nitrate was exported from the Chino Basin through the operation of the Chino Basin Desalters compared to nitrate loading to the basin from the recycled water reuse and recharge of recycled, imported, and storm water.





**Table 2-2. Annual and Total Pumping and Removal of TDS and Nitrate by Desalter Well from 2004 to 2022**

Desalter Facility	Well Name		2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022	Total		
Chino-II	II-12	Volume (af)	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	353	2,994	3,347	
		TDS (tons)	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	154	1,807	1,961
		Nitrate (tons)	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	4	55	59
<b>Total</b>		Volume (af)	10,410	11,692	22,659	29,590	30,021	27,668	29,654	28,482	28,197	27,853	29,969	29,501	28,249	28,673	29,997	32,332	39,609	40,564	40,280	545,400		
		TDS (tons)	12,487	12,758	19,222	26,475	29,403	27,925	30,313	28,012	29,339	28,299	29,680	29,270	28,811	28,865	32,301	35,077	46,199	48,804	45,520	568,759 <sup>(a)</sup>		
		Nitrate (tons)	514	548	844	1,145	1,217	1,082	1,235	1,161	1,275	1,244	1,265	1,265	1,248	1,230	1,338	1,513	1,964	2,047	1,940	24,075 <sup>(a)</sup>		

(a) The total TDS and nitrate mass export in this table include CDA pumping since 2004 and are different than the cumulative TDS and nitrate export reported in Figure 2-4, which are based on the entire period of operation of the Desalters since 2000. Pursuant to the September 2021 letter from the Regional Board, the period of interest in the CDA cumulative export is the period since the start of the maximum benefit SNMP in January 2004.



Table 2-3a. Quarterly and Cumulative TDS Budget from the Operations of the OBMP Projects from 2004 through 2022.

Calendar Year Quarter	TDS Loading												TDS Export			Net TDS Loading (tons)	Cumulative Net TDS Loading (tons)	
	TDS Loading from the Direct Use of Recycled Water <sup>(1)</sup>			TDS Loading from Recycled Water Recharge			TDS Loading from Imported Water Recharge <sup>(2)</sup>			TDS Loading from Storm Water Recharge			TDS Export from Chino Basin Desalter Pumping					
	Direct Use Volume (af)	Volume-wtd TDS (mg/l)	Loading (tons)	Recharge Volume (af)	Volume-Wtd TDS (mg/l)	Loading (tons)	Recharge Volume (af)	Volume-Wtd TDS (mg/l)	Loading (tons)	Recharge Volume (af)	Volume-Wtd TDS (mg/l)	Loading (tons)	Total Loading (tons)	Pumping Volume (af)	Volume-Wtd TDS (mg/l)			Export <sup>(3)</sup> (tons)
	(a)	(b)	(c)	(d)	(e)	(f)	(g)	(h)	(i)	(j)	(k)	(l)	(m) = (c) + (f) + (i) + (l)	(n)	(o)			(p)
2020 Q3	6,788	506	4,666	4,221	452	2,590	106	241	35	46	334	21	7,312	10,215	916	(12,707)	(5,396)	(145,965)
2020 Q4	3,193	485	2,105	5,171	443	3,112	2,021	245	673	1,558	303	640	6,531	10,202	809	(11,204)	(4,673)	(150,638)
2021 Q1	2,405	491	1,586	2,567	462	1,611	100	270	37	3,048	162	672	3,905	9,470	865	(11,133)	(7,227)	(157,865)
2021 Q2	4,950	507	3,353	3,769	465	2,380	2	275	1	413	250	140	5,875	10,269	934	(13,031)	(7,157)	(165,022)
2021 Q3	7,069	509	4,806	4,201	465	2,655	201	301	82	360	290	142	7,685	10,594	940	(13,520)	(5,835)	(170,857)
2021 Q4	4,174	493	2,760	4,219	458	2,625	71	282	27	5,773	251	1,964	7,377	10,231	800	(11,119)	(3,742)	(174,600)
2022 Q1	2,703	473	1,735	2,618	448	1,593	1,470	266	532	1,491	178	361	4,221	9,302	772	(9,755)	(5,534)	(180,134)
2022 Q2	5,235	485	3,451	4,004	449	2,442	0	--	0	484	242	159	6,052	10,439	854	(12,111)	(6,059)	(186,192)
2022 Q3	8,082	492	5,405	4,336	463	2,728	0	--	0	515	331	231	8,364	10,826	875	(12,870)	(4,505)	(190,698)
2022 Q4	3,558	496	2,399	4,499	475	2,900	0	--	0	4,473	271	1,645	6,944	9,713	817	(10,785)	(3,840)	(194,538)
<b>Total</b>	<b>257,265</b>		<b>174,831</b>	<b>172,408<sup>(4)</sup></b>		<b>107,536</b>	<b>202,357<sup>(4)</sup></b>		<b>48,674</b>	<b>183,011<sup>(4)</sup></b>		<b>43,172</b>	<b>374,213</b>	<b>545,329</b>		<b>(568,751)<sup>(5)</sup></b>	<b>(194,538)</b>	

Notes:

(1) Include recycled water use in Chino-North and Cucamonga GMZs.

(2) The imported water available to Chino Basin, State Water Project water, is considered the alternative water supply that would be used if recycled water was not permitted for recharge and reuse.

(3) Exports are shown as negative values to represent salt removed from the Chino Basin.

(4) Total recharge volumes for recycled water, imported water, and storm water in this table include groundwater recharge from 2004 to 2021. These total volumes differ from the volumes in Table 2-3 of this Annual Report which only includes groundwater recharge since the implementation of the Chino Basin Recycled Water Groundwater Recharge Program in 2005 to 2021.

(5) The total TDS and nitrate mass export in this table include CDA pumping since 2004 and are different than the cumulative TDS and nitrate export reported in Figure 2-4, which are based on the entire period of operation of the Desalters since 2000. Pursuant to the September 2021 letter from the Regional Board, the period of interest in the salt loading and export is the period since the start of the maximum benefit SNMP in January 2004.

(Red Text) Indicates negative values.





Table 2-3b. Quarterly and Cumulative Nitrate Budget from the Operations of the OBMP Projects from 2004 through 2022.

Calendar Year Quarter	Nitrate Loading												Nitrate Export			Net Nitrate Loading (tons)	Cumulative Net Nitrate Loading (tons)	
	Nitrate Loading from the Direct Use of Recycled Water <sup>(1)</sup>			Nitrate Loading from Recycled Water Recharge			Nitrate Loading from Imported Water Recharge <sup>(2)</sup>			Nitrate Loading from Storm Water Recharge			Nitrate Export from Chino Basin Desalter Pumping					
	Direct Use Volume (af)	Volume-wtd Nitrate (mg/l)	Loading (tons)	Recharge Volume (af)	Volume-Wtd Nitrate (mg/l)	Loading (tons)	Recharge Volume (af)	Volume-Wtd Nitrate (mg/l)	Loading (tons)	Recharge Volume (af)	Volume-Wtd Nitrate (mg/l)	Loading (tons)	Total Loading (mg/l)	Pumping Volume (af)	Volume-Wtd Nitrate (mg/l)			Export <sup>(3)</sup> (tons)
(a)	(b)	(c)	(d)	(e)	(f)	(g)	(h)	(i)	(j)	(k)	(l)	(m) = (c) + (f) + (i) + (l)	(n)	(o)	(p)	(q) = (m) + (p)	(r)	
2020 Q3	6,788	4.4	40.4	4,221	3.7	21.0	106	0.2	0.0	46	0.6	0.0	61.5	10,215	37	(513.8)	(452.3)	(16,596.0)
2020 Q4	3,193	4.1	17.7	5,171	3.7	26.1	2,021	0.2	0.6	1,558	0.5	1.1	45.5	10,202	38	(522.7)	(477.2)	(17,073.2)
2021 Q1	2,405	4.0	12.9	2,567	3.5	12.3	100	0.9	0.1	3,048	0.3	1.3	26.6	9,470	37	(477.0)	(450.4)	(17,523.6)
2021 Q2	4,950	4.2	28.0	3,769	3.8	19.4	2	1.8	0.0	413	0.4	0.2	47.6	10,269	38	(536.0)	(488.3)	(18,011.9)
2021 Q3	7,069	4.2	39.8	4,201	3.8	21.7	201	1.4	0.4	360	2.5	1.2	63.1	10,594	37	(525.9)	(462.9)	(18,474.8)
2021 Q4	4,174	4.2	23.3	4,219	3.9	22.5	71	1.5	0.1	5,773	2.5	19.8	65.8	10,231	37	(507.7)	(441.9)	(18,916.7)
2022 Q1	2,703	4.4	16.0	2,618	4.4	15.5	1,470	0.4	0.9	1,491	1.8	3.7	36.1	9,302	35	(447.6)	(411.5)	(19,328.2)
2022 Q2	5,235	4.5	32.2	4,004	4.5	24.6	0	--	0.0	484	1.4	0.9	57.8	10,439	37	(525.2)	(467.4)	(19,795.6)
2022 Q3	8,082	4.6	50.0	4,336	4.6	26.8	0	--	0.0	515	0.5	0.3	77.2	10,826	35	(519.9)	(442.7)	(20,238.3)
2022 Q4	3,558	4.9	23.5	4,499	4.9	29.8	0	--	0.0	4,473	1.0	6.3	59.6	9,713	34	(447.7)	(388.1)	(20,626.4)
<b>Total</b>	<b>257,265</b>		<b>1,865.6</b>	<b>172,408<sup>(4)</sup></b>		<b>1,133.1</b>		<b>202,357<sup>(4)</sup></b>		<b>119.4</b>		<b>183,011<sup>(4)</sup></b>	<b>330.5</b>	<b>3,448.6</b>	<b>545,329</b>	<b>(24,075)<sup>(5)</sup></b>	<b>(20,626.4)</b>	

(1) Include recycled water use in Chino-North and Cucamonga GMZs.

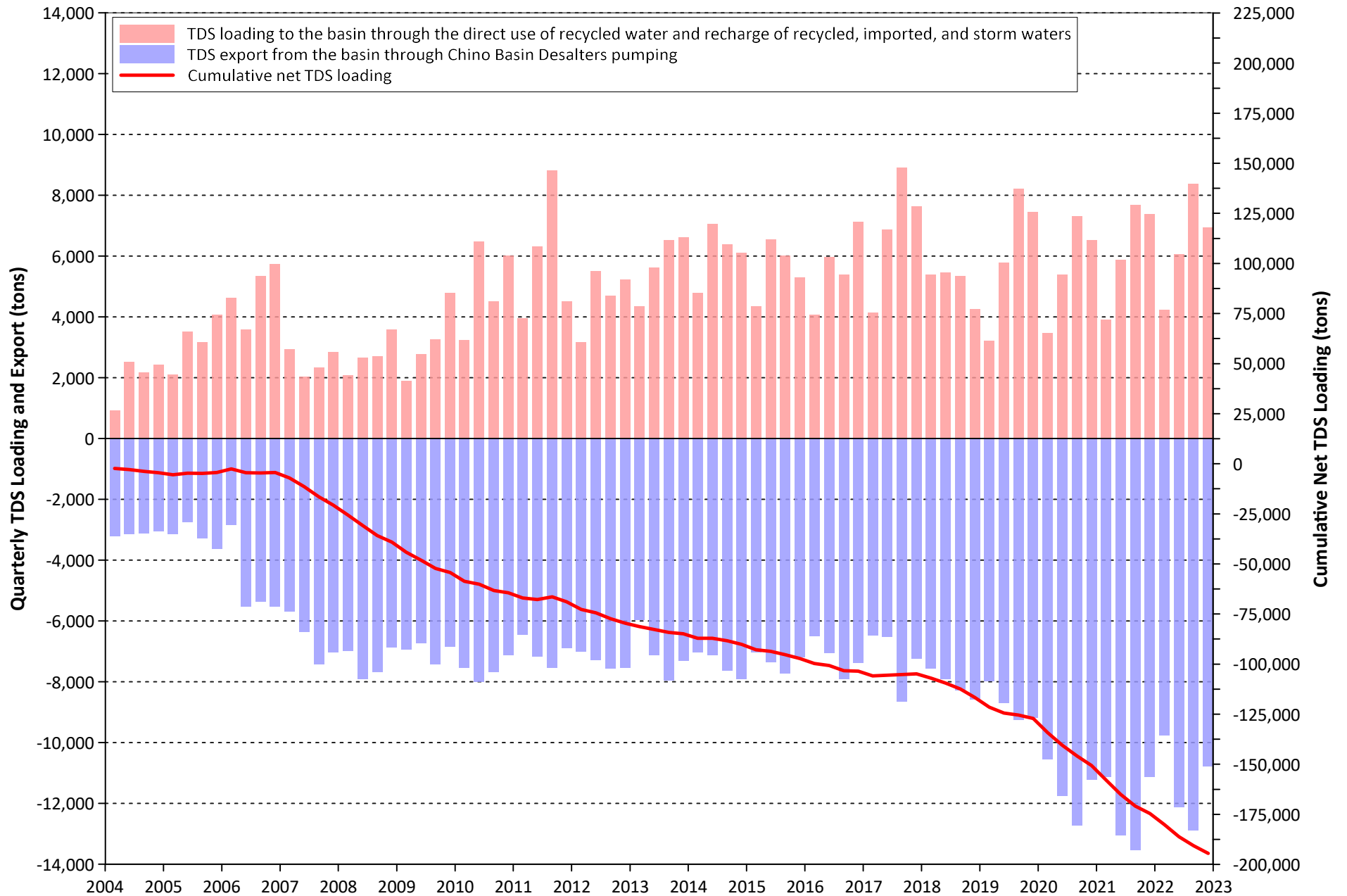
(2) The imported water available to Chino Basin, State Water Project water, is considered the alternative water supply that would be used if recycled water was not permitted for recharge and reuse

(3) Exports are shown as negative values to represent salt removed from the Chino Basin.

(4) Total recharge volumes for recycled water, imported water, and storm water in this table include groundwater recharge from 2004 to 2022. These total volumes differ from the volumes in Table 2-3 of this Annual Report which only includes groundwater recharge since the implementation of the Chino Basin Recycled Water Groundwater Recharge Program in 2005 to 2022.

(5) The total TDS and nitrate mass export in this table include CDA pumping since 2004 and are different than the cumulative TDS and nitrate export reported in Figure 2-4, which are based on the entire period of operation of the Desalters since 2000. Pursuant to the September 2021 letter from the Regional Board, the period of interest in the salt loading and export is the period since the start of the maximum benefit SNMP in January 2004.

(Red Text) Indicates negative values.



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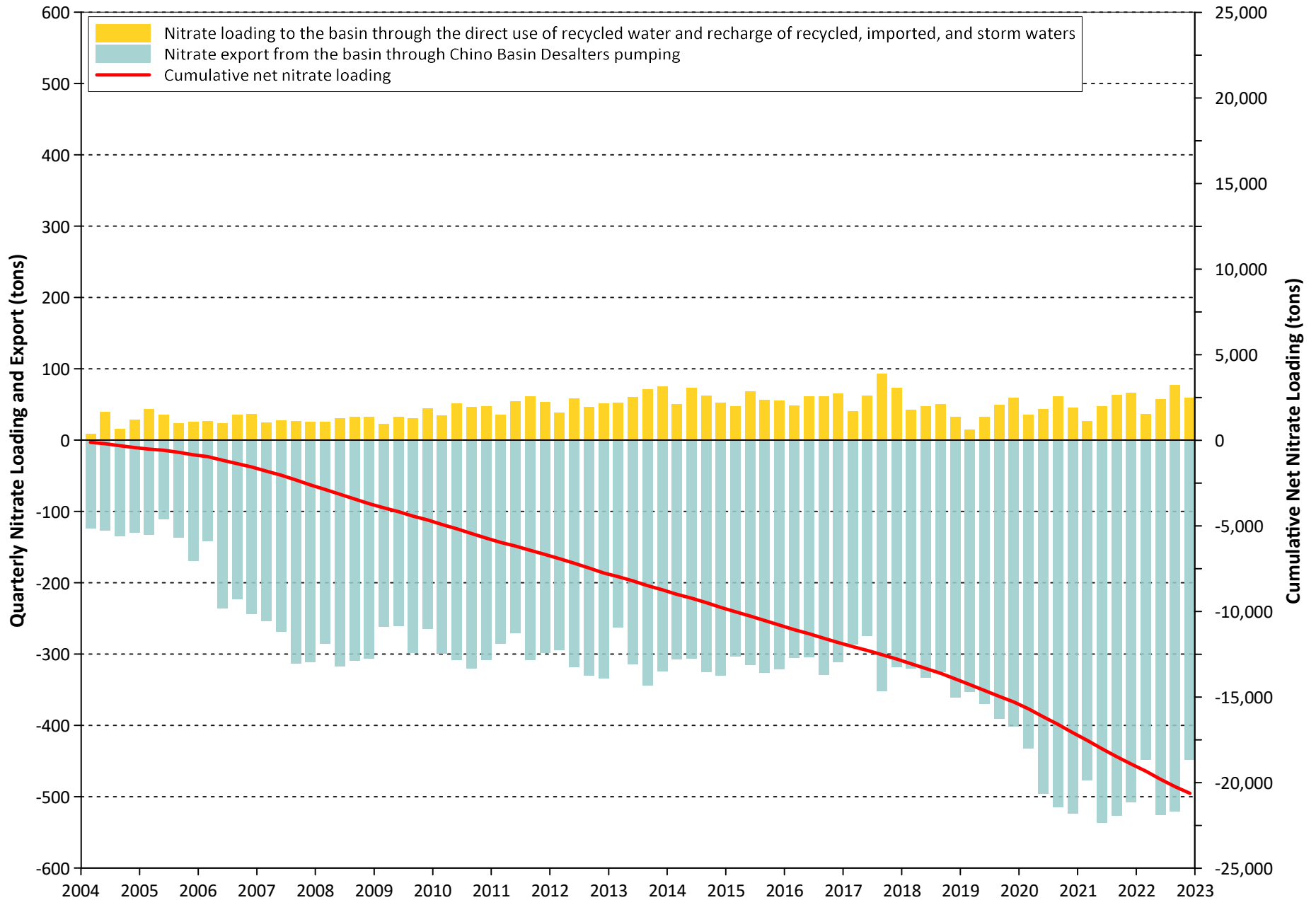
Prepared for:

**Chino Basin Watermaster and the Inland Empire Utilities Agency**  
2022 Maximum Benefit Annual Report



**Quarterly TDS Loading and Export and Cumulative Net TDS Loading from OBMP Projects 2004 to 2022**

**Figure 2-5a**



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**Quarterly Nitrate Loading and Export and Cumulative Net Nitrate Loading from OBMP Projects 2004 to 2022**

**Figure 2-5b**



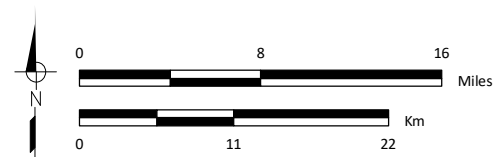
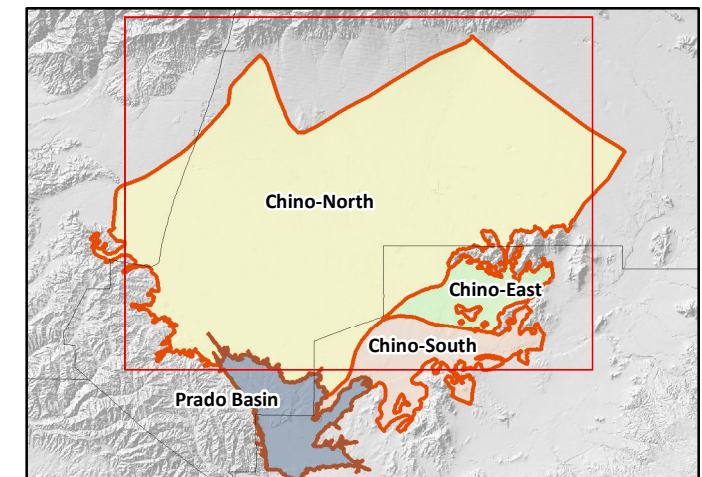
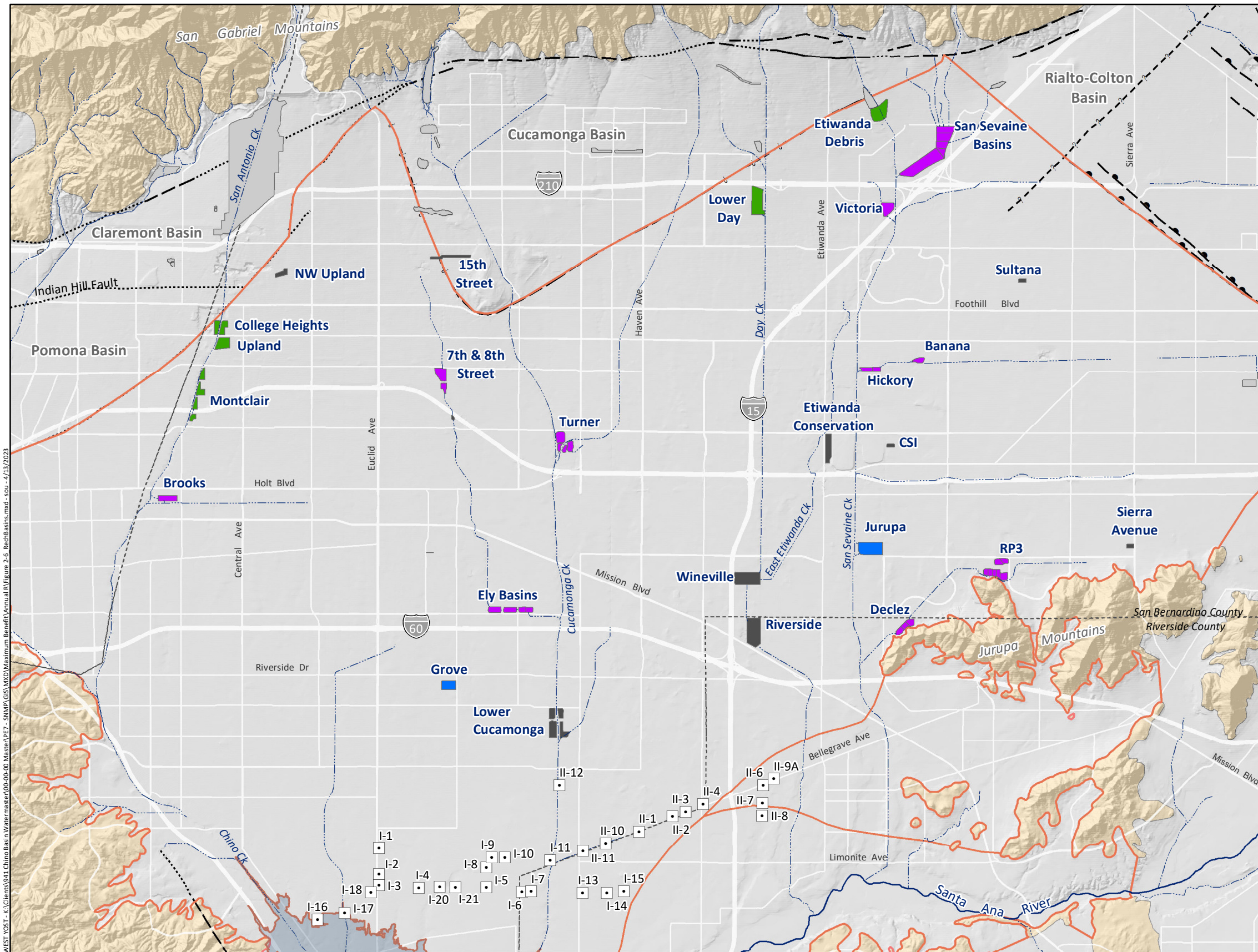
## 2.3 Recycled Water Recharge, Reuse, and Quality

### 2.3.1 Recycled Water Recharge

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 the recharge activities in Chino Basin. Figure 2-6 is a map of existing recharge facilities in the Chino Basin used for imported, storm, and recycled water recharge. Table 2-3 summarizes the total annual recharge, by water type, from July 2005 (commencement of the Chino Basin Recycled Water Groundwater Recharge Program) through December 2022. Since July 2005, a total of 538,458 af of water has been recharged in the Chino Basin as a result of the OBMP and maximum benefit SNMP. Currently, there is no recharge in Cucamonga GMZ.

**Table 2-3. Annual Groundwater Recharge by Water Type at Recharge Facilities in Chino Basin – 2005 to 2022**

Calendar Year	Imported water, af	Storm water, af	Recycled Water, af	Total, af
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	8,078	51,753
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
2017	39,502	7,447	14,362	61,310
2018	5,990	6,751	12,510	25,251
2019	25,700	14,460	11,160	51,321
2020	3,637	7,265	15,509	26,411
2021	375	9,593	14,756	24,723
2022	1,470	6,964	15,456	23,889
<b>Total</b>	<b>193,031</b>	<b>173,227</b>	<b>172,201</b>	<b>538,458</b>



## Chino Basin Optimum Basin Management Program 2022 Maximum Benefit Annual Report

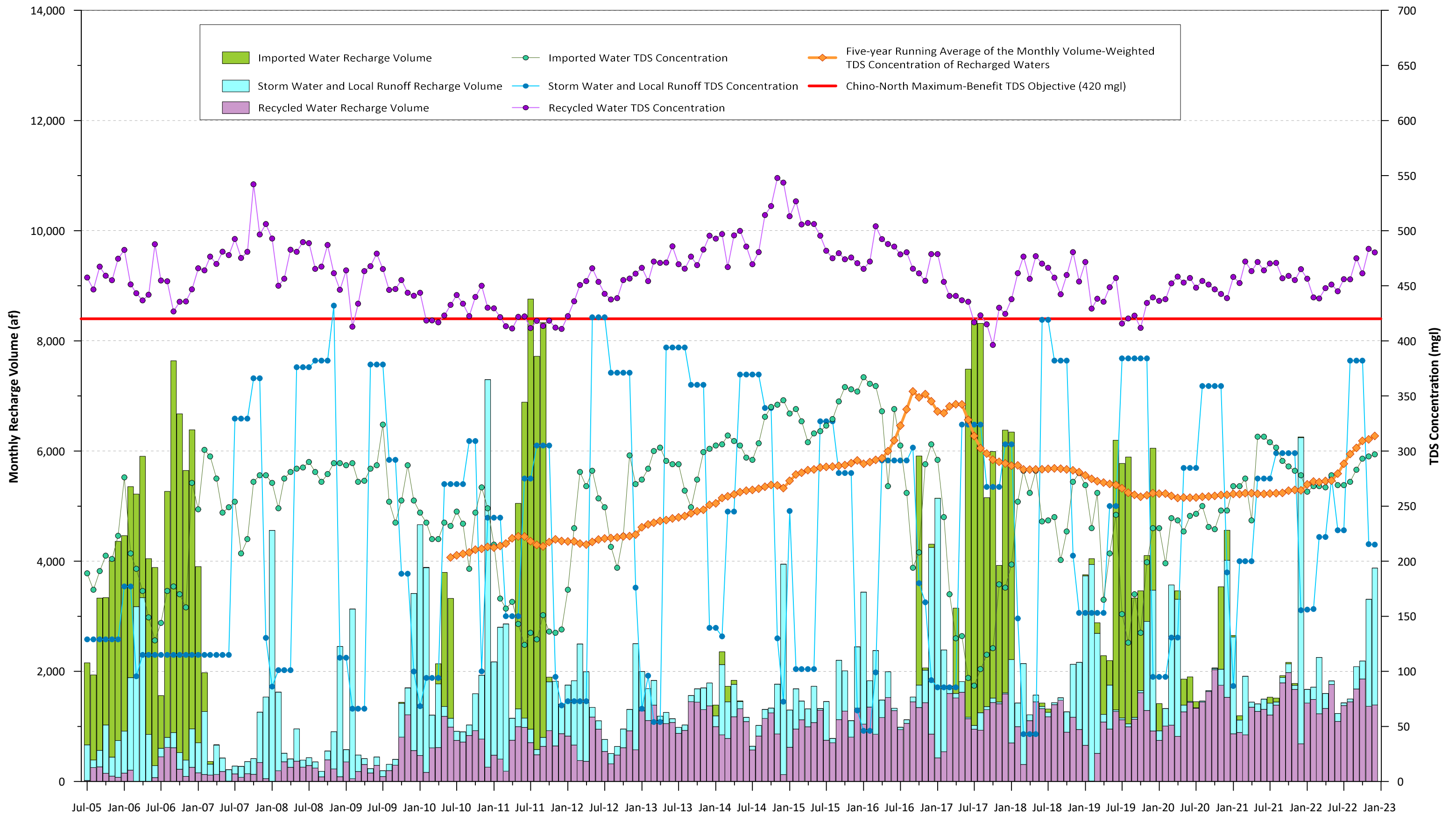


Commitment number 7 requires that the use of recycled water for artificial recharge be limited to the amount that can be blended on a volume-weighted basis with other sources of recharge to achieve five-year running-average concentrations of no more than the Chino-North maximum-benefit objectives (420 mg/l for TDS and 5 mg/l for nitrate). 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. This metric is computed monthly. Table 2-4 summarizes the five-year running-average volume-weighted TDS and nitrate concentrations of the combined recharge sources. The monthly recharge and water-quality data used to compute the five-year running-average TDS and nitrate metrics are plotted in Figures 2-7a and 2-7b, respectively. A table of the monthly data used to compute these metrics, by recharge source, is included as Appendix B to this report.

The five-year running-average, volume-weighted TDS and nitrate concentrations have not exceeded the maximum-benefit objectives for TDS or nitrate. Since June 2010, the five-year running average, volume-weighted TDS concentrations of the managed recharge ranged from 203 mg/l to 354 mg/l, averaged about 266 mg/l, and was 314 mg/l as of December 2022. Over the same period, the five-year running average, volume-weighted nitrate ranged from 1.1 mg/l to about 3 mg/l, averaged about 1.8 mg/l, and was 1.8 mg/l as of December 2022. The maximum five-year running average, volume-weighted TDS and nitrate concentrations were observed in September 2016 when the preceding five-year period had almost no imported water recharge.

Prior to 2016, the TDS concentration metric was increasing monotonically at a rate of about 1.3 mg/l per month, primarily driven by the increasing proportion of recycled water recharge relative to imported and storm waters. Between May and September 2016, that rate increased to about 12 mg/l per month, reflecting the loss of the last significant period of imported water recharge (May and September of 2011) from the 5-year period used for the metric calculation. The TDS concentration metric decreased from September 2016 through April 2020 and stabilized through December 2021. This trend is due to the increase in imported water and storm water recharge that occurred from October 2016 through January 2018, March 2019 through December 2019, and November 2020 through December 2020; and the increase in storm water recharge during water year 2019 and December 2021. The TDS concentration metric increased after December 2021 through December 2022 due to minimal imported water recharge in majority of 2021 and 2022. A similar trend was observed for the nitrate concentration metric, as shown in Figure 2-7b. These observations demonstrate the importance of periodic imported water recharge and large storm events to complying with the long-term TDS metric contained in the maximum benefit commitments.

Although the five-year running average, volume-weighted TDS concentration of the recharge water has never exceeded the maximum benefit objective, long-term drought conditions may reduce imported water recharge and increase recycled water recharge and can increase the five-year running average, volume-weighted TDS concentration. For example, the state-wide drought that lasted from 2012 to 2016 caused the five-year running average, volume-weighted TDS concentration to increase monotonically as shown in Figure 2-7a. For this reason, Watermaster and the IEUA has been working collaboratively with the Regional Board and conducted a technical study to propose a longer-term averaging period for the combined recharge water. Discussion of this work and proposal are included in Section 2.3.3.



Prepared by:



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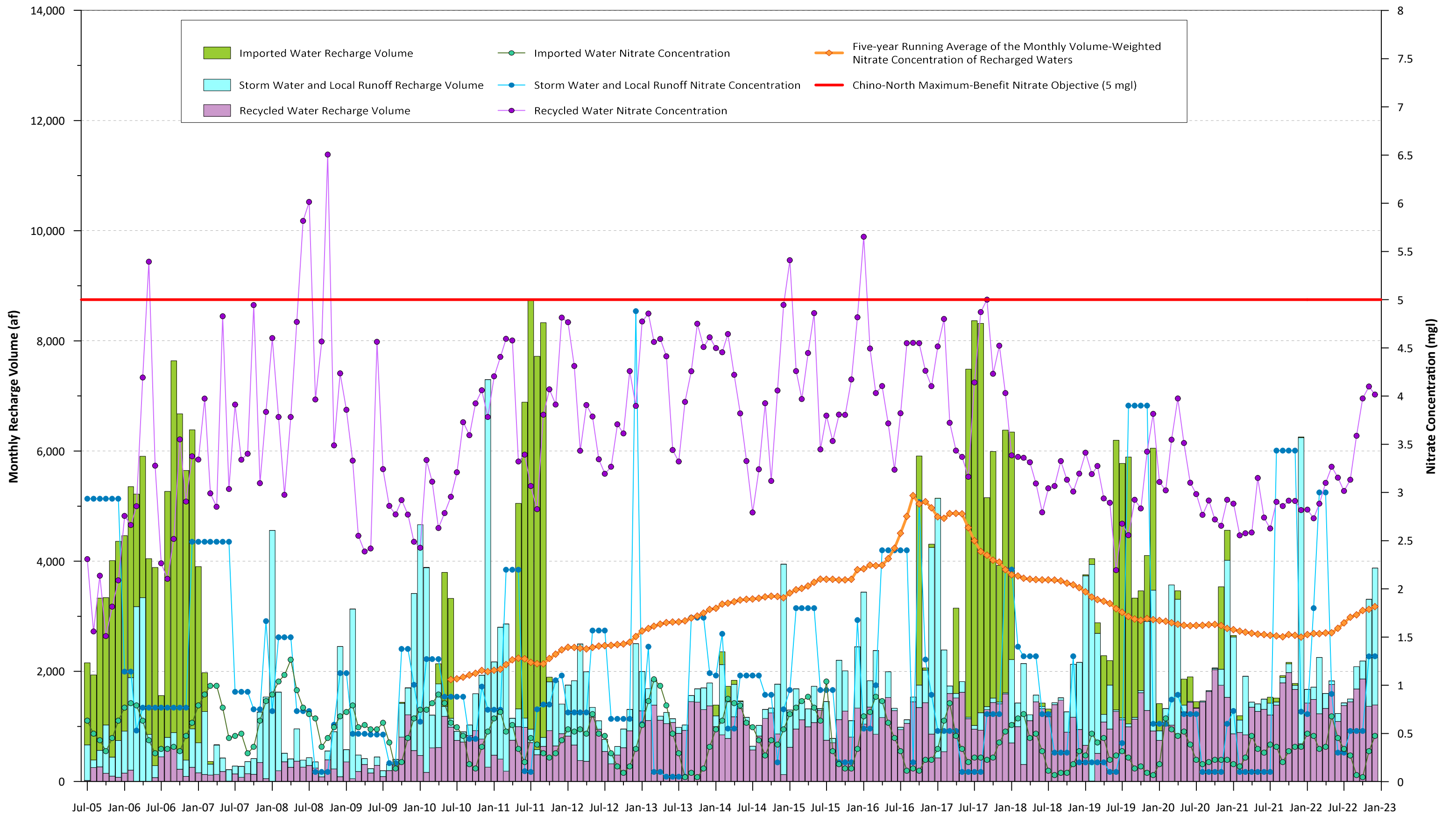
Prepared for:

Chino Basin Watermaster and  
the Inland Empire Utilities Agency  
2022 Maximum Benefit  
Annual Report



**Volume and TDS Concentrations of  
Recharge Water Sources in Chino Basin  
2005 to 2022**

**Figure 2-7a**



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**Volume and Nitrate Concentrations of  
Recharge Water Sources in Chino Basin**  
2005 to 2022

**Figure 2-7b**



# Chino Basin Optimum Basin Management Program 2022 Maximum Benefit Annual Report



**Table 2-4. Monthly Calculation of the Five-Year, Volume-Weighted TDS and Nitrate Concentrations of Recharge Water Sources to the Chino Basin<sup>(a)</sup> - 2005 to 2022**

Five-Year Period	TDS, mg/l	Nitrate, mg/l
Jul 2005 - Jun 2010	203	1.1
Aug 2005 - Jul 2010	205	1.1
Sep 2005 - Aug 2010	207	1.1
Oct 2005 - Sep 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
Mar 2006 - Feb 2011	214	1.2
Apr 2006 - Mar 2011	216	1.2
May 2006 - Apr 2011	221	1.3
Jun 2006 - May 2011	222	1.3
Jul 2006 - Jun 2011	222	1.3
Aug 2006 - Jul 2011	218	1.2
Sep 2006 - Aug 2011	215	1.2
Oct 2006 - Sep 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
Mar 2007 - Feb 2012	218	1.4
Apr 2007 - Mar 2012	216	1.4
May 2007 - Apr 2012	215	1.4
Jun 2007 - May 2012	217	1.4
Jul 2007 - Jun 2012	220	1.4
Aug 2007 - Jul 2012	221	1.4
Sep 2007 - Aug 2012	221	1.4
Oct 2007 - Sep 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
Mar 2008 - Feb 2013	233	1.6
Apr 2008 - Mar 2013	235	1.6
May 2008 - Apr 2013	236	1.6
Jun 2008 - May 2013	237	1.6

# Chino Basin Optimum Basin Management Program 2022 Maximum Benefit Annual Report



**Table 2-4. Monthly Calculation of the Five-Year, Volume-Weighted TDS and Nitrate Concentrations of Recharge Water Sources to the Chino Basin<sup>(a)</sup> - 2005 to 2022**

Five-Year Period	TDS, mg/l	Nitrate, mg/l
Jul 2008 - Jun 2013	239	1.7
Aug 2008 - Jul 2013	240	1.7
Sep 2008 - Aug 2013	241	1.7
Oct 2008 - Sep 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
Feb 2009 - Jan 2014	253	1.8
Mar 2009 - Feb 2014	257	1.8
Apr 2009 - Mar 2014	259	1.9
May 2009 - Apr 2014	261	1.9
Jun 2009 - May 2014	263	1.9
Jul 2009 - Jun 2014	264	1.9
Aug 2009 - Jul 2014	265	1.9
Sep 2009 - Aug 2014	266	1.9
Oct 2009 - Sep 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
Mar 2010 - Feb 2015	279	2.0
Apr 2010 - Mar 2015	280	2.0
May 2010 - Apr 2015	283	2.0
Jun 2010 - May 2015	283	2.1
Jul 2010 - Jun 2015	285	2.1
Aug 2010 - Jul 2015	286	2.1
Sep 2010 - Aug 2015	286	2.1
Oct 2010 - Sep 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
Mar 2011 - Feb 2016	290	2.2
Apr 2011 - Mar 2016	292	2.2
May 2011 - Apr 2016	293	2.2
Jun 2011 - May 2016	300	2.3

# Chino Basin Optimum Basin Management Program 2022 Maximum Benefit Annual Report



**Table 2-4. Monthly Calculation of the Five-Year, Volume-Weighted TDS and Nitrate Concentrations of Recharge Water Sources to the Chino Basin<sup>(a)</sup> - 2005 to 2022**

Five-Year Period	TDS, mg/l	Nitrate, mg/l
Jul 2011 - Jun 2016	310	2.4
Aug 2011 - Jul 2016	323	2.6
Sep 2011 - Aug 2016	338	2.8
Oct 2011 - Sep 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
Feb 2012 - Jan 2017	336	2.7
Mar 2012 - Feb 2017	334	2.7
Apr 2012 - Mar 2017	340	2.8
May 2012 - Apr 2017	342	2.8
Jun 2012 - May 2017	342	2.8
Jul 2012 - Jun 2017	328	2.6
Aug 2012 - Jul 2017	314	2.5
Sep 2012 - Aug 2017	302	2.4
Oct 2012 - Sep 2017	298	2.3
Nov 2012 - Oct 2017	292	2.3
Dec 2012 - Nov 2017	290	2.3
Jan 2013 - Dec 2017	289	2.2
Feb 2013 - Jan 2018	287	2.1
Mar 2013 - Feb 2018	287	2.1
Apr 2013 - Mar 2018	283	2.1
May 2013 - Apr 2018	283	2.1
Jun 2013 - May 2018	283	2.1
Jul 2013 - Jun 2018	283	2.1
Aug 2013 - Jul 2018	284	2.1
Sep 2013 - Aug 2018	284	2.1
Oct 2013 - Sep 2018	284	2.1
Nov 2013 - Oct 2018	283	2.1
Dec 2013 - Nov 2018	282	2.0
Jan 2014 - Dec 2018	281	2.0
Feb 2014 - Jan 2019	278	2.0
Mar 2014 - Feb 2019	275	1.9
Apr 2014 - Mar 2019	273	1.9
May 2014 - Apr 2019	271	1.9
Jun 2014 - May 2019	270	1.8

# Chino Basin Optimum Basin Management Program 2022 Maximum Benefit Annual Report



**Table 2-4. Monthly Calculation of the Five-Year, Volume-Weighted TDS and Nitrate Concentrations of Recharge Water Sources to the Chino Basin<sup>(a)</sup> - 2005 to 2022**

Five-Year Period	TDS, mg/l	Nitrate, mg/l
Jul 2014 - Jun 2019	269	1.8
Aug 2014 - Jul 2019	266	1.8
Sep 2014 - Aug 2019	262	1.7
Oct 2014 - Sep 2019	260	1.7
Nov 2014 - Oct 2019	258	1.7
Dec 2014 - Nov 2019	260	1.7
Jan 2015 - Dec 2019	262	1.7
Feb 2015 - Jan 2020	261	1.7
Mar 2015 - Feb 2020	261	1.7
Apr 2015 - Mar 2020	259	1.6
May 2015 - Apr 2020	257	1.6
Jun 2015 - May 2020	258	1.6
Jul 2015 - Jun 2020	258	1.6
Aug 2015 - Jul 2020	258	1.6
Sep 2015 - Aug 2020	258	1.6
Oct 2015 - Sep 2020	259	1.6
Nov 2015 - Oct 2020	259	1.6
Dec 2015 - Nov 2020	260	1.6
Jan 2016 - Dec 2020	260	1.6
Feb 2015 - Jan 2021	261	1.6
Mar 2015 - Feb 2021	261	1.6
Apr 2015 - Mar 2021	262	1.6
May 2015 - Apr 2021	262	1.5
Jun 2015 - May 2021	261	1.5
Jul 2015 - Jun 2021	261	1.5
Aug 2015 - Jul 2021	261	1.5
Sep 2015 - Aug 2021	262	1.5
Oct 2015 - Sep 2021	262	1.5
Nov 2015 - Oct 2021	264	1.5
Dec 2015 - Nov 2021	265	1.5
Jan 2016 - Dec 2021	264	1.5
Feb 2016 - Jan 2022	270	1.5
Mar 2016 - Feb 2022	272	1.5
Apr 2016 - Mar 2022	272	1.5
May 2016 - Apr 2022	273	1.5
Jun 2016 - May 2022	273	1.5



**Table 2-4. Monthly Calculation of the Five-Year, Volume-Weighted TDS and Nitrate Concentrations of Recharge Water Sources to the Chino Basin<sup>(a)</sup> - 2005 to 2022**

Five-Year Period	TDS, mg/l	Nitrate, mg/l
Jul 2016 - Jun 2022	279	1.6
Aug 2016 - Jul 2022	288	1.6
Sep 2016 - Aug 2022	297	1.7
Oct 2016 - Sep 2022	303	1.7
Nov 2016 - Oct 2022	309	1.8
Dec 2016 - Nov 2022	311	1.8
Jan 2016 - Dec 2022	314	1.8

(a) See Appendix B for the data used to compute the metrics.

### 2.3.2 Recycled Water Use

Maximizing recycled water recycled is an integral part of the OBMP’s goal to enhance water supplies. The direct use of recycled water increases the availability of native and imported waters for higher-priority beneficial uses. The IEUA has progressively built infrastructure to deliver recycled water to all its member agencies throughout much of the Chino-North and Cucamonga GMZs. Table 2-3a and Table 2-b include the quarterly recycled water use and corresponding quarterly TDS and nitrate loadings since the implementation of the maximum benefit SNMP in 2004 through 2022.<sup>19</sup> From 2004 through 2022, quarterly recycled water use ranged from 635 to 8,080 af and averaged around 3,385 af. In 2022, the total recycled water use was 19,578 af. Of this total:

- 5,082 af (about 26 percent of total use) of recycled water was used in Cucamonga GMZ.
- 14,496 af (about 74 percent of total use) of recycled water was use in Chino-North GMZs.

The TDS and nitrate concentrations of the IEUA agency-wide TDS and nitrate concentration are discussed in Section 2.3.3 below.

### 2.3.3 Recycled Water Quality

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 concentrations in the Chino Basin. The TDS and TIN permit limits for the IEUA are 550 mg/l and 8 mg/l, respectively. Compliance with these limits is based on the volume-weighted, 12-month running average of the agency-wide effluent for all IEUA wastewater treatment facilities. The volume-weighted, 12-month running average of the IEUA agency-wide effluent is referred to as the “effluent compliance metric”. 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 effluent compliance metric does not exceed the permit limits when the TDS effluent compliance metric exceeds 545 mg/l for three consecutive months or the TIN effluent compliance metric exceeds 8 mg/l in any one month (action limits). The plan must be submitted within 60 days of a finding that one of these “action limits” has been

<sup>19</sup> Recycled water use started in 1997 in Chino Basin and in 2013 in Cucamonga GMZ.

# Chino Basin Optimum Basin Management Program 2022 Maximum Benefit Annual Report



exceeded. The plan and schedule must be implemented upon Regional Board approval. The effluent compliance metric is calculated and reported by the IEUA in the Chino Basin Recycled Water Groundwater Recharge Program Quarterly Monitoring Reports.

Table 2-5 and Figure 2-8 show the monthly, volume-weighted IEUA agency-wide effluent TDS and TIN concentrations and the calculated effluent compliance metric for 2005 through 2022. Since the initiation of recycled water recharge in July 2005, the TDS and TIN effluent compliance metrics have ranged between 456 and 534 mg/l and 3.8 and 7.8 mg/l, respectively, and have never exceeded the permit limits<sup>20</sup>. During 2022, the TDS and TIN effluent compliance metrics ranged between 484 and 494 mg/l and 4.3 and 4.6 mg/l, respectively.

Month	TIN, mg/l		TDS, mg/l	
	Monthly	12-Month Running Average <sup>(a)</sup>	Monthly	12-Month Running Average
Jan 2005	7.3	8.4	492	486
Feb 2005	8.4	8.4	496	487
Mar 2005	7.5	8.4	516	488
Apr 2005	6.9	8.2	534	491
May 2005	6.7	8.0	513	492
Jun 2005	7.0	8.0	507	492
Jul 2005	5.4	7.8	466	492
Aug 2005	5.9	7.7	452	490
Sep 2005	5.4	7.4	469	491
Oct 2005	5.5	7.1	468	491
Nov 2005	5.5	6.7	467	490
Dec 2005	8.4	6.7	481	488
Jan 2006	9.9	6.9	491	488
Feb 2006	9.0	6.9	467	486
Mar 2006	8.8	7.1	471	482
Apr 2006	7.8	7.1	464	476
May 2006	8.3	7.2	454	471
Jun 2006	6.5	7.2	466	468
Jul 2006	6.8	7.3	472	469
Aug 2006	5.9	7.3	475	470

<sup>20</sup> 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.

# Chino Basin Optimum Basin Management Program 2022 Maximum Benefit Annual Report



**Table 2-5. Monthly and 12-Month Running Average of the IEUA Agency-Wide Effluent  
TIN and TDS Concentrations – 2005 to 2022**

Month	TIN, mg/l		TDS, mg/l	
	Monthly	12-Month Running Average <sup>(a)</sup>	Monthly	12-Month Running Average
Sep 2006	6.5	7.4	465	470
Oct 2006	6.4	7.6	457	469
Nov 2006	6.9	7.6	456	468
Dec 2006	7.1	7.5	470	467
Jan 2007	7.7	7.3	488	467
Feb 2007	6.2	7.1	481	468
Mar 2007	6.7	6.9	490	470
Apr 2007	5.6	6.7	491	472
May 2007	5.6	6.5	489	475
Jun 2007	6.0	6.5	495	477
Jul 2007	5.1	6.3	492	479
Aug 2007	5.2	6.3	478	479
Sep 2007	5.9	6.2	478	480
Oct 2007	6.0	6.2	517	485
Nov 2007	7.6	6.2	514	490
Dec 2007	7.4	6.3	522	495
Jan 2008	6.8	6.2	511	481
Feb 2008	6.4	6.2	492	483
Mar 2008	6.6	6.2	515	484
Apr 2008	6.7	6.3	519	487
May 2008	7.2	6.4	502	489
Jun 2008	6.8	6.5	490	490
Jul 2008	6.1	6.6	499	491
Aug 2008	5.8	6.6	514	492
Sep 2008	8.3	6.8	510	494
Oct 2008	7.0	6.9	503	496
Nov 2008	5.7	6.7	496	498
Dec 2008	6.3	6.7	494	504
Jan 2009	6.5	6.6	497	503
Feb 2009	7.8	6.7	463	500
Mar 2009	6.9	6.8	496	499
Apr 2009	6.6	6.8	509	498
May 2009	5.8	6.6	501	498
Jun 2009	5.4	6.5	505	499

# Chino Basin Optimum Basin Management Program 2022 Maximum Benefit Annual Report



**Table 2-5. Monthly and 12-Month Running Average of the IEUA Agency-Wide Effluent  
TIN and TDS Concentrations – 2005 to 2022**

Month	TIN, mg/l		TDS, mg/l	
	Monthly	12-Month Running Average <sup>(a)</sup>	Monthly	12-Month Running Average
Jul 2009	5.0	6.4	512	499
Aug 2009	4.5	6.3	499	497
Sep 2009	4.0	6.0	498	497
Oct 2009	4.6	5.8	500	497
Nov 2009	4.8	5.7	489	497
Dec 2009	5.5	5.6	494	497
Jan 2010	5.7	5.6	493	496
Feb 2010	6.2	5.4	489	498
Mar 2010	6.4	5.4	482	497
Apr 2010	5.7	5.3	473	494
May 2010	5.2	5.3	471	492
Jun 2010	5.0	5.2	478	490
Jul 2010	5.1	5.2	477	487
Aug 2010	4.6	5.2	477	485
Sep 2010	3.7	5.2	476	483
Oct 2010	5.5	5.3	478	481
Nov 2010	5.7	5.3	479	481
Dec 2010	5.0	5.3	472	479
Jan 2011	6.4	5.4	474	477
Feb 2011	6.9	5.4	455	474
Mar 2011	6.4	5.4	468	473
Apr 2011	6.5	5.5	460	472
May 2011	6.0	5.6	462	471
Jun 2011	5.7	5.6	464	470
Jul 2011	4.3	5.5	454	468
Aug 2011	4.4	5.5	457	467
Sep 2011	5.8	5.7	457	465
Oct 2011	5.2	5.7	457	463
Nov 2011	5.9	5.7	453	461
Dec 2011	6.3	5.8	454	460
Jan 2012	6.4	5.8	465	459
Feb 2012	6.7	5.8	476	461
Mar 2012	6.7	5.8	497	463
Apr 2012	7.4	5.9	496	466



# Chino Basin Optimum Basin Management Program 2022 Maximum Benefit Annual Report



**Table 2-5. Monthly and 12-Month Running Average of the IEUA Agency-Wide Effluent  
TIN and TDS Concentrations – 2005 to 2022**

Month	TIN, mg/l		TDS, mg/l	
	Monthly	12-Month Running Average <sup>(a)</sup>	Monthly	12-Month Running Average
May 2012	6.4	5.9	493	469
Jun 2012	5.8	5.9	482	470
Jul 2012	5.4	6.0	477	472
Aug 2012	4.8	6.1	463	473
Sep 2012	5.1	6.0	472	474
Oct 2012	4.9	6.0	486	476
Nov 2012	6.1	6.0	485	479
Dec 2012	6.0	6.0	492	482
Jan 2013	6.1	5.9	495	484
Feb 2013	6.8	5.9	490	486
Mar 2013	6.1	5.9	493	485
Apr 2013	6.4	5.8	501	486
May 2013	6.4	5.8	503	487
Jun 2013	5.8	5.8	502	488
Jul 2013	5.6	5.8	496	490
Aug 2013	6.9	6.0	496	493
Sep 2013	7.3	6.2	499	495
Oct 2013	7.4	6.4	496	496
Nov 2013	6.7	6.4	507	497
Dec 2013	7.6	6.6	511	499
Jan 2014	5.9	6.6	510	500
Feb 2014	6.1	6.5	509	502
Mar 2014	5.5	6.5	497	502
Apr 2014	5.2	6.4	517	504
May 2014	5.2	6.3	524	505
Jun 2014	4.4	6.1	506	506
Jul 2014	3.5	6.0	494	505
Aug 2014	3.5	5.7	508	506
Sep 2014	4.1	5.4	524	508
Oct 2014	4.9	5.2	541	512
Nov 2014	5.9	5.1	571	518
Dec 2014	6.2	5.0	565	522
Jan 2015	7.9	5.2	546	525
Feb 2015	7.4	5.3	560	529

# Chino Basin Optimum Basin Management Program 2022 Maximum Benefit Annual Report



**Table 2-5. Monthly and 12-Month Running Average of the IEUA Agency-Wide Effluent  
TIN and TDS Concentrations – 2005 to 2022**

Month	TIN, mg/l		TDS, mg/l	
	Monthly	12-Month Running Average <sup>(a)</sup>	Monthly	12-Month Running Average
Mar 2015	6.2	5.4	528	532
Apr 2015	5.2	5.4	531	533
May 2015	6.1	5.4	520	533
Jun 2015	4.6	5.4	515	534
Jul 2015	5.2	5.6	500	534
Aug 2015	4.7	5.7	503	534
Sep 2015	4.8	5.7	508	532
Oct 2015	5.2	5.8	506	529
Nov 2015	5.4	5.7	505	524
Dec 2015	6.2	5.7	503	519
Jan 2016	7.3	5.7	504	515
Feb 2016	6.5	5.6	495	510
Mar 2016	5.9	5.6	521	509
Apr 2016	5.8	5.6	514	508
May 2016	5.7	5.6	514	507
Jun 2016	5.3	5.7	519	508
Jul 2016	6.2	5.7	514	509
Aug 2016	6.5	5.9	502	509
Sep 2016	6.4	6.0	492	507
Oct 2016	5.8	6.1	491	506
Nov 2016	5.5	6.1	489	505
Dec 2016	5.8	6.0	495	504
Jan 2017	6.5	6.0	495	504
Feb 2017	6.7	6.0	489	503
Mar 2017	5.3	5.9	469	499
Apr 2017	5.8	6.0	468	495
May 2017	5.7	6.0	464	491
Jun 2017	5.5	6.0	461	486
Jul 2017	6.8	6.0	447	480
Aug 2017	6.0	6.0	446	476
Sep 2017	5.7	5.9	440	471
Oct 2017	6.1	6.0	428	466
Nov 2017	6.5	6.0	455	463
Dec 2017	6.8	6.0	444	459

# Chino Basin Optimum Basin Management Program 2022 Maximum Benefit Annual Report



**Table 2-5. Monthly and 12-Month Running Average of the IEUA Agency-Wide Effluent TIN and TDS Concentrations – 2005 to 2022**

Month	TIN, mg/l		TDS, mg/l	
	Monthly	12-Month Running Average <sup>(a)</sup>	Monthly	12-Month Running Average
Jan 2018	5.3	6.0	464	456
Feb 2018	5.3	5.9	488	456
Mar 2018	4.4	5.8	504	459
Apr 2018	5	5.8	485	460
May 2018	4.8	5.7	495	463
Jun 2018	4.7	5.6	490	465
Jul 2018	4.6	5.4	484	468
Aug 2018	4.3	5.3	478	471
Sep 2018	5.2	5.3	467	473
Oct 2018	4.7	5.1	496	479
Nov 2018	5.9	5.1	505	483
Dec 2018	5	4.9	488	487
Jan 2019	6.2	5.0	503	490
Feb 2019	4.9	5.0	485	490
Mar 2019	5.7	5.1	495	489
Apr 2019	5.2	5.1	476	489
May 2019	4.2	5.0	487	488
Jun 2019	3	4.9	489	488
Jul 2019	3.2	4.8	447	485
Aug 2019	3.8	4.7	447	482
Sep 2019	4	4.6	452	481
Oct 2019	4.5	4.6	445	477
Nov 2019	3.9	4.5	465	473
Dec 2019	4	4.4	461	471
Jan 2020	3.5	4.2	470	468
Feb 2020	4	4.1	473	467
Mar 2020	4	4.0	492	467
Apr 2020	3.8	3.8	504	469
May 2020	4.4	3.9	499	470
Jun 2020	4.3	4.0	488	470
Jul 2020	4.8	4.1	477	473
Aug 2020	4.5	4.2	485	476
Sep 2020	4.2	4.2	481	478
Oct 2020	4.2	4.1	482	482

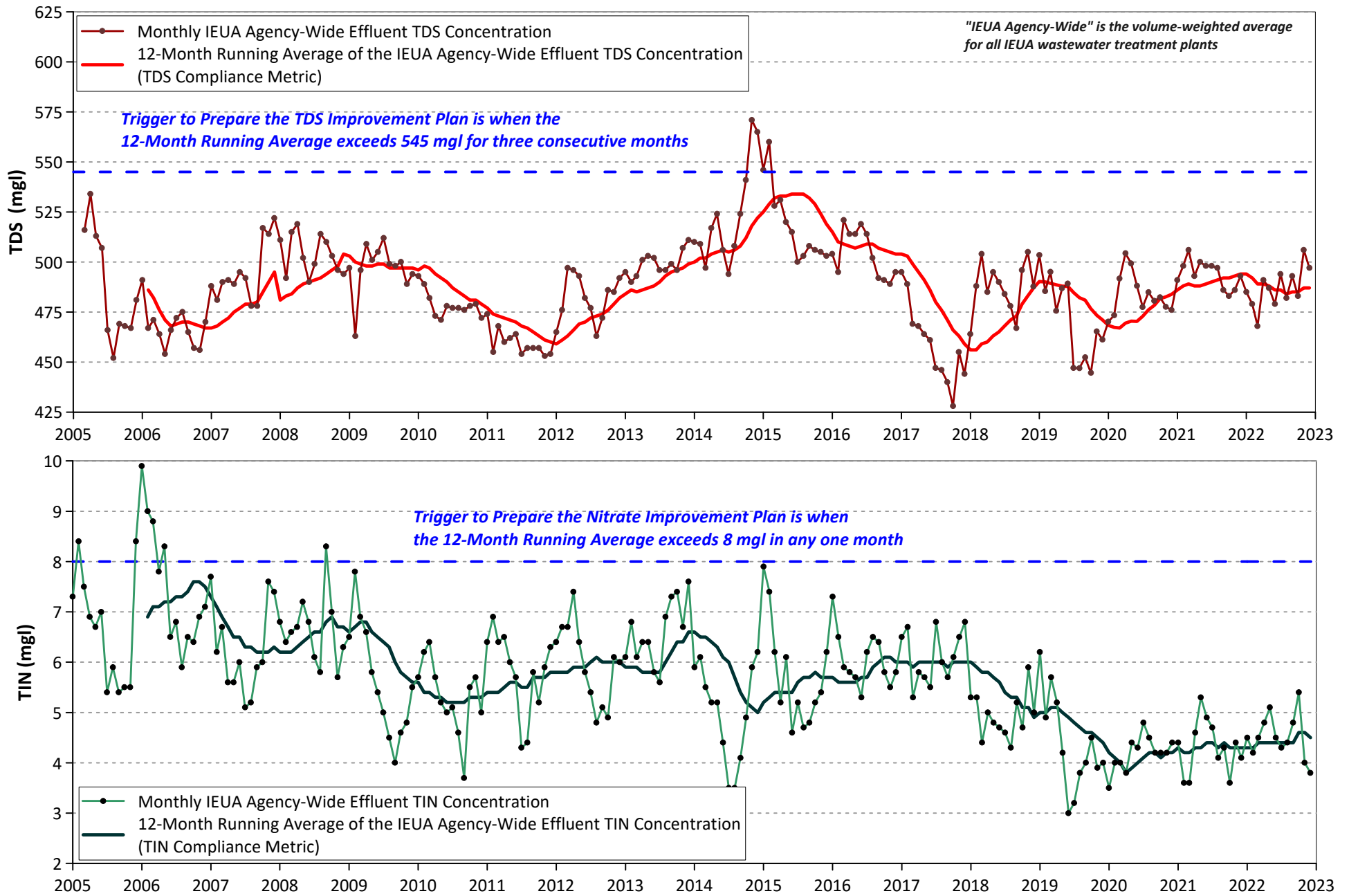
# Chino Basin Optimum Basin Management Program 2022 Maximum Benefit Annual Report



**Table 2-5. Monthly and 12-Month Running Average of the IEUA Agency-Wide Effluent TIN and TDS Concentrations – 2005 to 2022**

Month	TIN, mg/l		TDS, mg/l	
	Monthly	12-Month Running Average <sup>(a)</sup>	Monthly	12-Month Running Average
Nov 2020	4.2	4.2	478	483
Dec 2020	4.4	4.2	476	484
Jan 2021	4.4	4.3	491	486
Feb 2021	3.6	4.2	498	488
Mar 2021	3.6	4.2	506	489
Apr 2021	4.6	4.3	493	488
May 2021	5.3	4.3	500	488
Jun 2021	4.9	4.4	498	489
Jul 2021	4.7	4.4	498	490
Aug 2021	4.1	4.3	497	491
Sep 2021	4.3	4.4	486	492
Oct 2021	3.6	4.3	483	492
Nov 2021	4.4	4.3	486	493
Dec 2021	4.1	4.3	493	494
Jan 2022	4.5	4.3	485	494
Feb 2022	4.2	4.3	479	492
Mar 2022	4.5	4.4	468	489
Apr 2022	4.8	4.4	491	489
May 2022	5.1	4.4	487	488
Jun 2022	4.5	4.4	479	486
Jul 2022	4.3	4.4	494	486
Aug 2022	4.4	4.4	482	484
Sep 2022	4.8	4.4	493	485
Oct 2022	5.4	4.6	483	485
Nov 2022	4.0	4.6	506	487
Dec 2022	3.8	4.5	497	487

(a) 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.



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Monthly and 12-Month Running Average of  
the IEUA Agency-Wide Effluent  
TDS and TIN Concentrations - 2005 to 2022

Figure 2-8

## Chino Basin Optimum Basin Management Program 2022 Maximum Benefit Annual Report



During 2015, the TDS effluent compliance metric reached a historical-high value of 534 mg/l for three consecutive months in June, July, and August. This was only 11 mg/l below the action limit defined in Commitment number 6.

The TDS concentration of the effluent is influenced by the volume and TDS concentration of the water supplies served in the service areas tributary to the IEUA's treatment plants. Figure 2-9 includes the: 1) monthly volume-weighted IEUA agency-wide effluent TDS concentration and effluent compliance metric; 2) monthly TDS concentrations of SWP water from Silverwood Lake<sup>21</sup>; 3) monthly, volume-weighted TDS concentrations of the combined water supplies served in the area tributary to the IEUA's treatment plants (e.g. total water supply, including SWP water); 4) volume of water supply served in the area tributary to the IEUA's treatment plants that is SWP water; and 5) the volume of water supply served in the area tributary to the IEUA's treatment plants that is from local sources (groundwater and surface water). A review of Figure 2-9 demonstrates the following on the water supply influence on the effluent compliance metric:

- The trend of the TDS effluent compliance metric follows the trend of the TDS concentration of the SWP water and the volume-weighted TDS concentration of the total water supply.
- From 2012 through early 2016, the SWP water TDS concentrations increased due to the statewide drought conditions that began in 2012. This increase correlates to the increase of the monthly total water supply volume-weighted TDS, and the effluent compliance metric that almost exceeded the action limit in Commitment Number 6 in 2015.
- The increase in the volume-weighted TDS concentration of the total water supply is less than the increase in TDS concentrations of the SWP supply 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 SWP water on the volume-weighted TDS concentration of the total water supply.
- In 2011, 2017 and 2019, 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, which resulted in a decreasing trend of the effluent compliance metrics during the same period.
- Over this past year in 2022, the TDS concentration of the SWP water gradually increased while the proportion of the total water supply that is SWP decreased; these factors contributed to slight increase starting mid-year in the effluent compliance metric.

The relationships of the TDS concentrations plotted in Figure 2-9 indicate that the increase in the TDS concentration of SWP water during drought conditions contributes, in part, to the increase in the TDS concentration of the IEUA's effluent. 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 drought conditions. Water conservation practices are evident in the decreased volume of total water supply plotted in Figure 2-9 since 2015, with 2015 having the lowest volume due to the state drought conservation mandates implemented at that time.

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<sup>21</sup> Source of imported SWP water to the IEUA agencies.

## Chino Basin Optimum Basin Management Program 2022 Maximum Benefit Annual Report

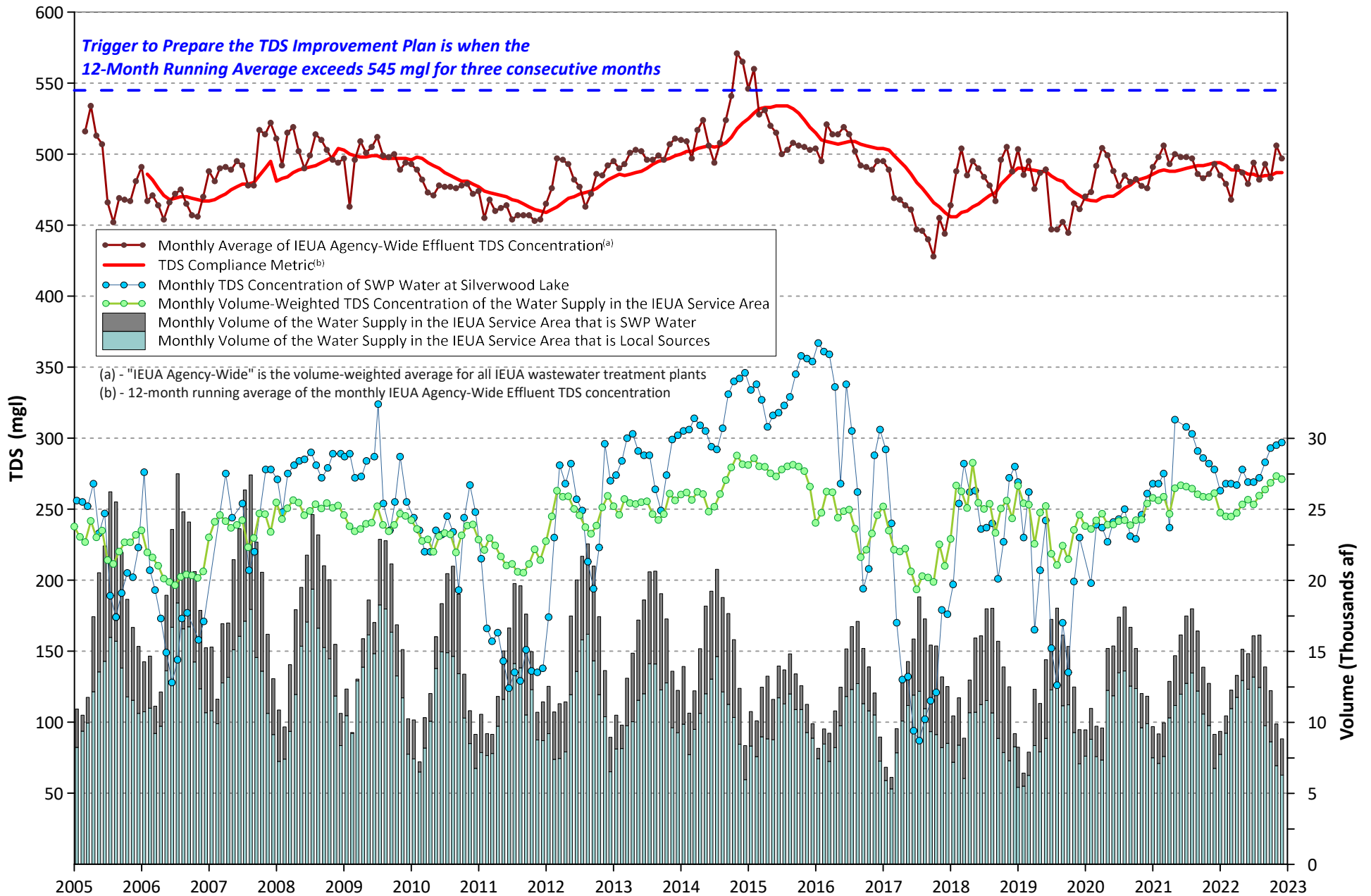
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These observed water quality and water use trends suggest that drought conditions have a meaningful impact on the TDS concentrations of the water supply and recycled water and that future droughts similar to the 2012 to 2016 period could lead to short-term exceedances of the effluent compliance metric that is based on a short-term averaging period of 12-months. Additionally, drought conditions can influence the volume-weighted TDS concentration of recharge water (mixture of recycled, storm, and imported waters). For this reason, Watermaster and the IEUA petitioned the Regional Board to modify the TDS compliance metrics for recycled water effluent (Commitment Number 6) and recharge water (Commitment Number 7) 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 analyze the impacts of the proposed change. The scope of work was submitted to the Regional Board in 2017 and includes the following tasks:

- Develop numerical modeling tools (R4, Hydrus 2D, MODFLOW, MT3D) to evaluate the projected TDS and nitrate concentrations of the Chino Basin.
- Define a baseline (status-quo) scenario and evaluate it with the new modeling tools.
- Define salinity management planning scenarios and evaluate them with the new modeling tools to compare the projected TDS and nitrate concentrations against the baseline scenario.
- Use the results to develop a draft regulatory compliance strategy that includes a longer-term average period for recycled water TDS concentrations.
- Collaborate with the Regional Board to review and finalize the regulatory strategy.
- Support the Regional Board in the preparation of a Basin Plan amendment upon approval of the regulatory strategy.

Watermaster and the IEUA began implementing the scope of work in July 2017 and worked collaboratively with Regional Board staff to review interim work products and address new technical questions that arose. Watermaster and the IEUA completed the technical work, which includes characterization of the processes that contribute to the loading and unloading of TDS and nitrate to the Chino Basin and projections of the TDS concentration of Chino Basin groundwater, water supply, IEUA effluent, managed artificial recharge, and Santa Ana River under a baseline planning scenario and two alternative planning scenarios. The documentation of the technical work and the regulatory compliance proposal letter to modify the recycled water compliance metrics to a longer-term averaging period were submitted to the Regional Board in December 2022. Watermaster and the IEUA are currently working with the Regional Board to incorporate the updates to the Maximum Benefit SNMP.



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**The IEUA TDS Compliance Metric Compared to  
Monthly SWP TDS Concentration**  
2005 to 2022

**Figure 2-9**

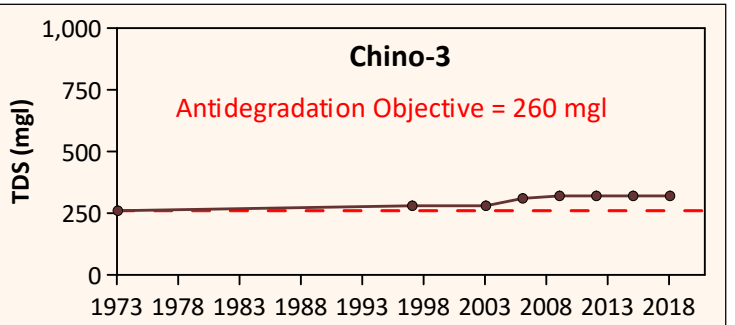
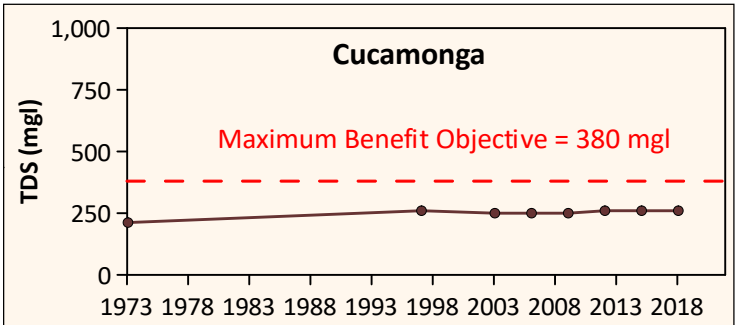
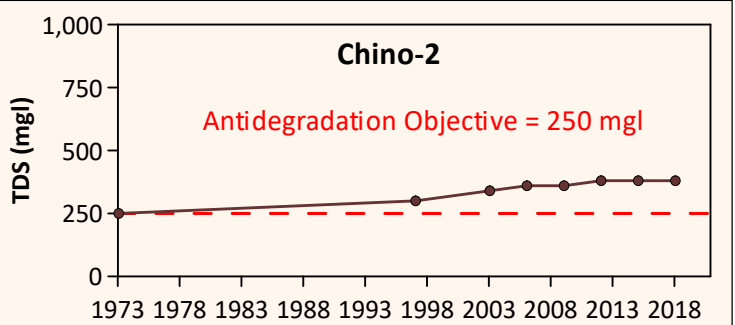
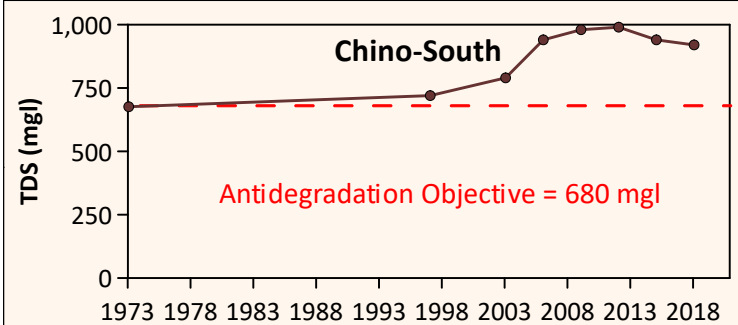
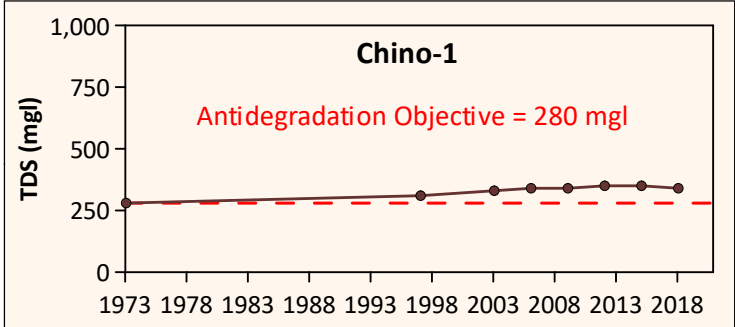
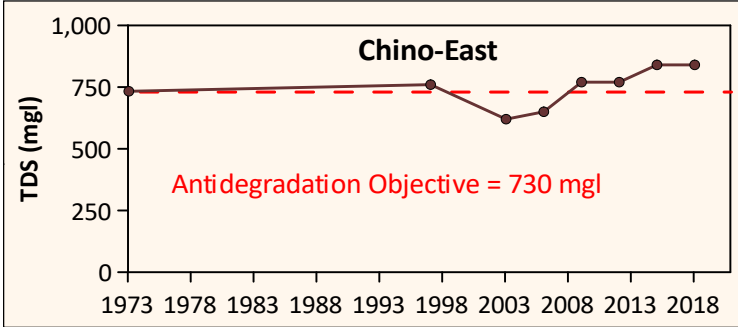
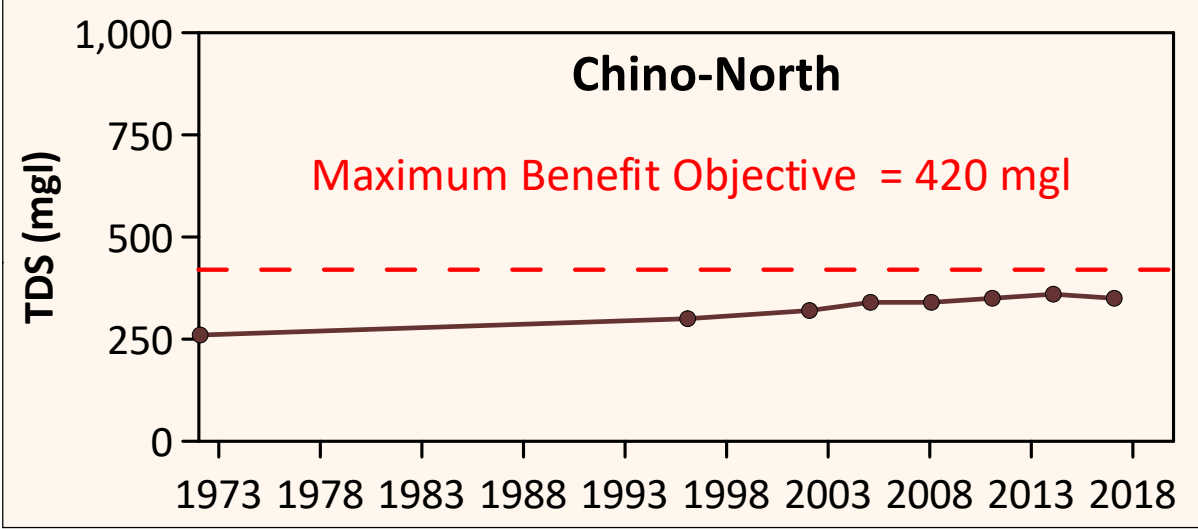
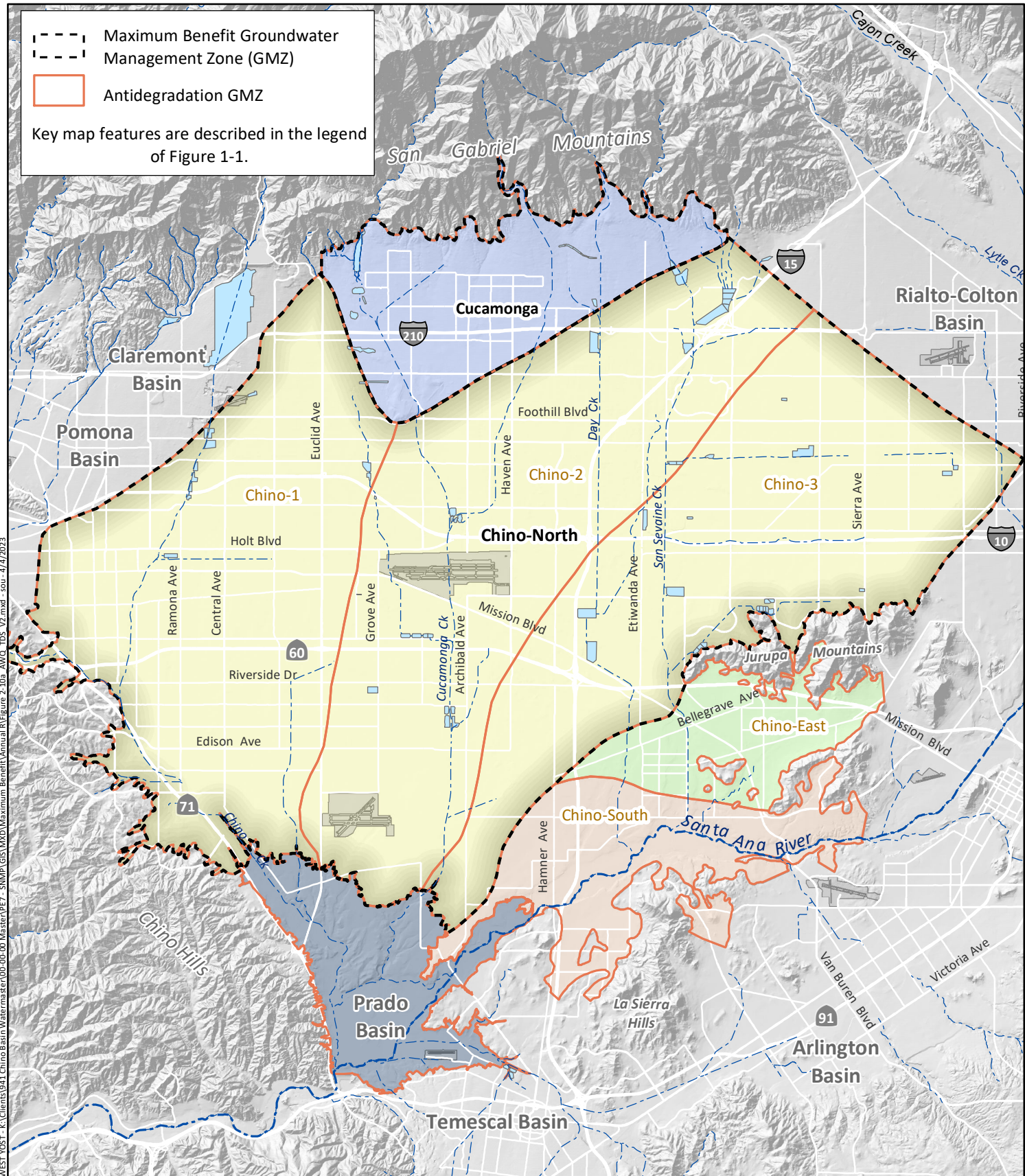


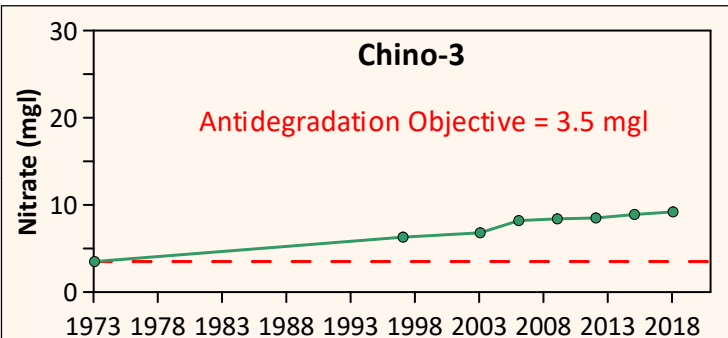
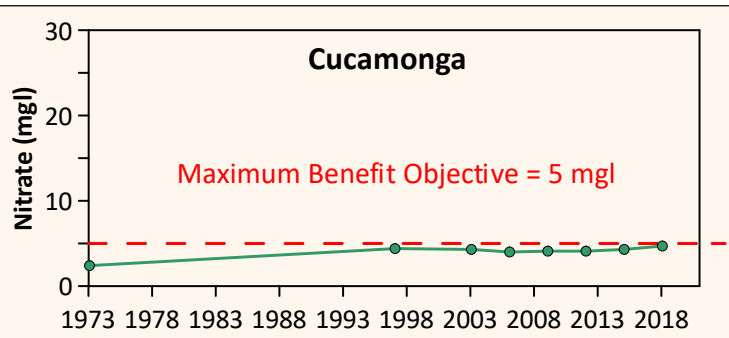
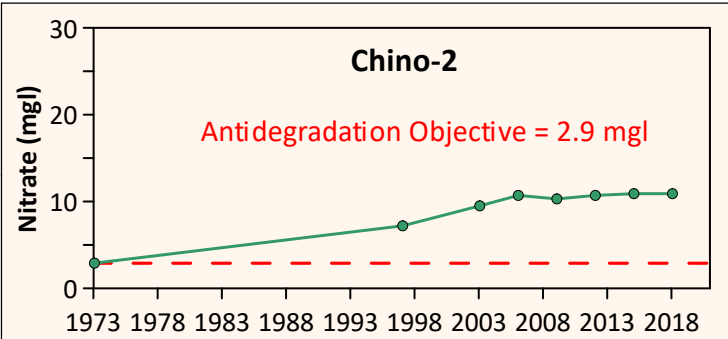
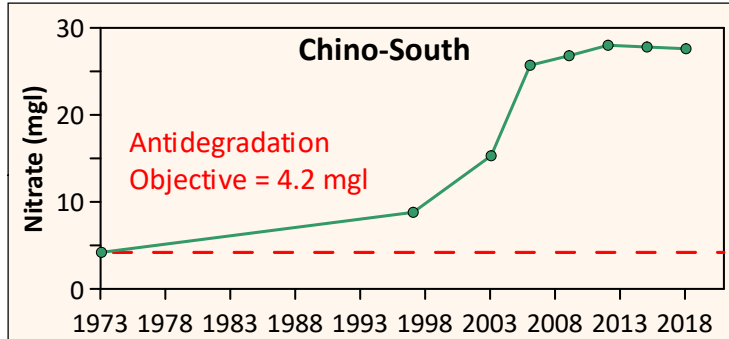
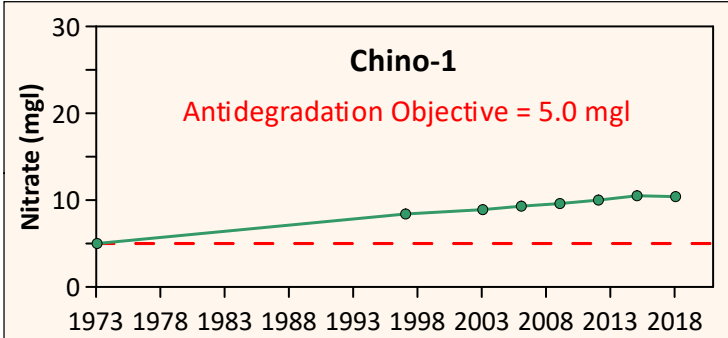
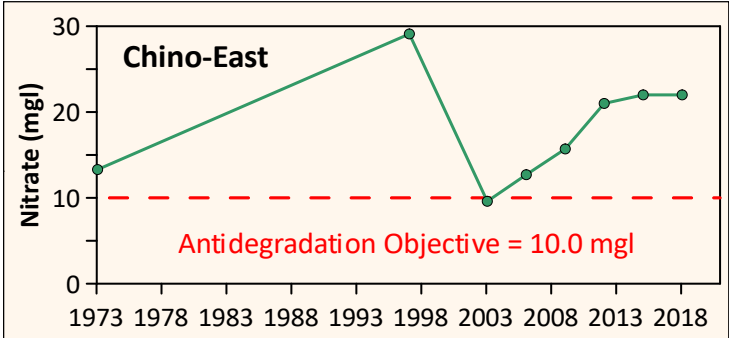
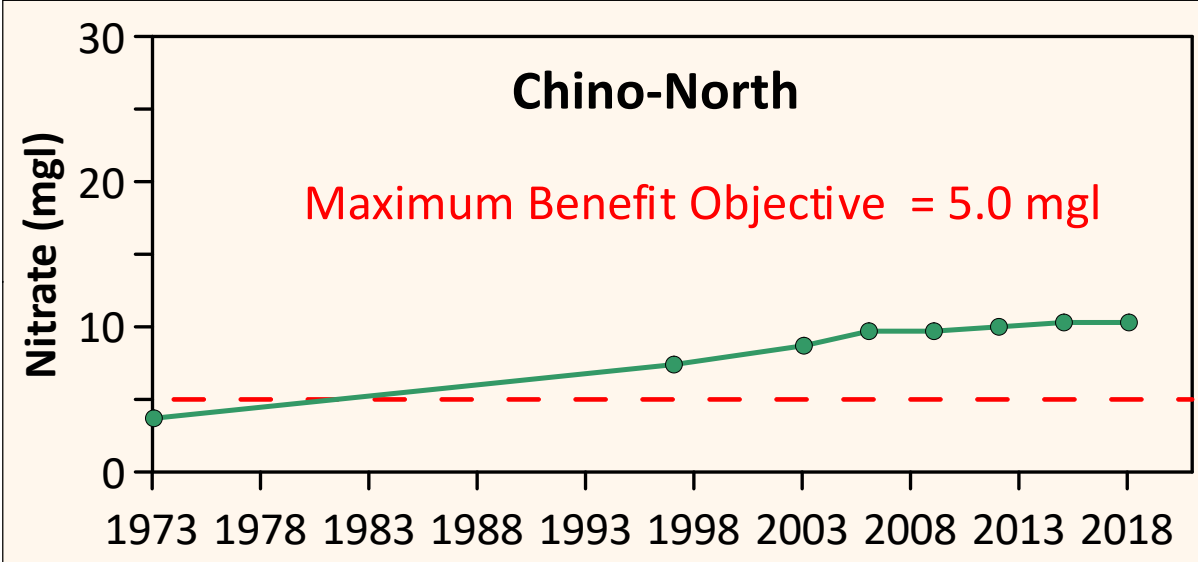
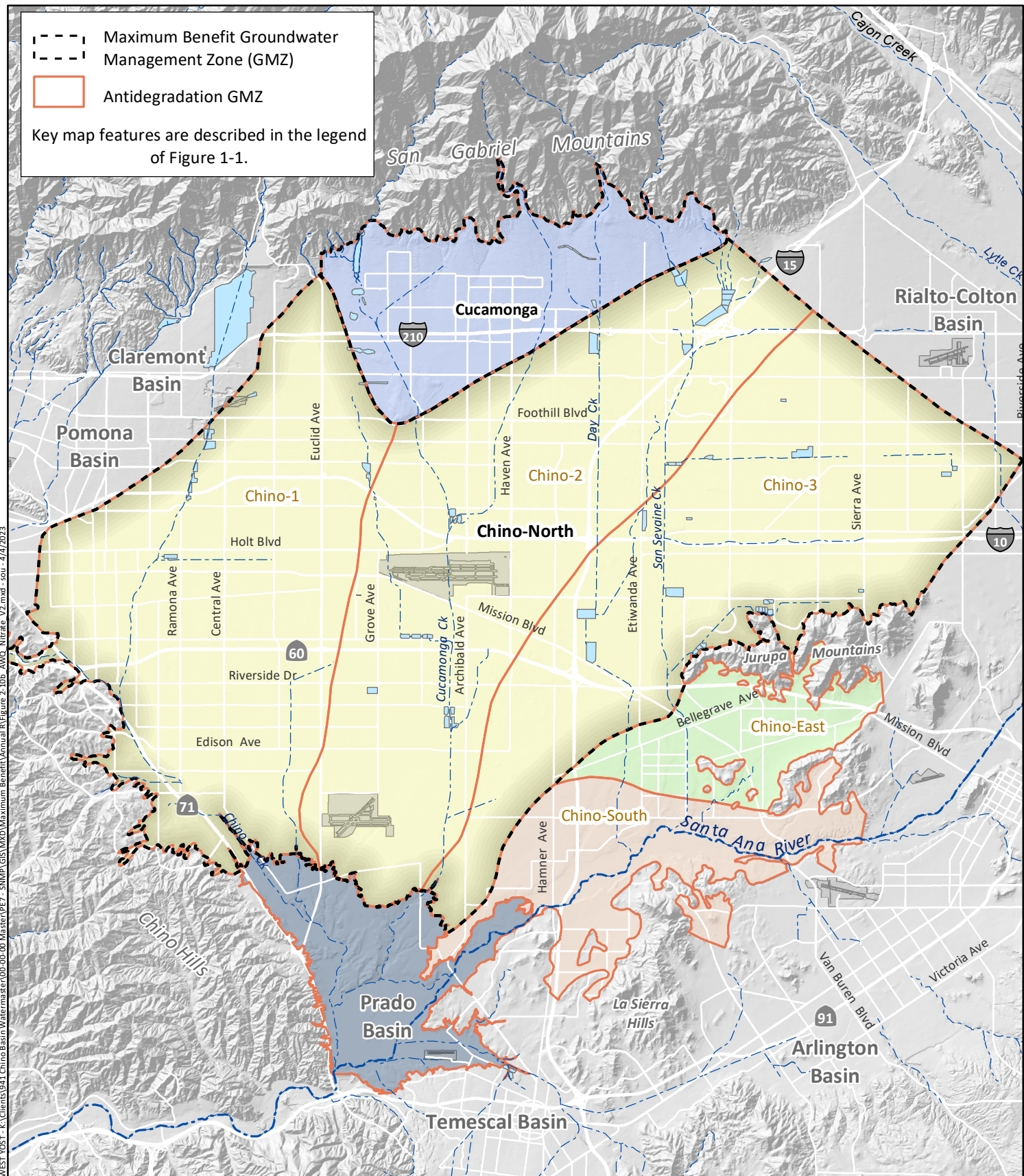


## 2.4 Ambient Groundwater Quality

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 was 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. The most recent recomputation, covering the 20-year period from 1999 to 2018 was completed in July 2020 (WSC, 2020). Figure 2-10a and Figure 2-10b show trends of all historical and current ambient TDS and nitrate concentration determinations for each GMZ. A review of these figures demonstrates that:

- Chino-North GMZ
  - The 2018 ambient TDS concentration of Chino-North is 350 mg/l, which is 10 mg/l less than the 2015 ambient TDS concentration of 360 mg/l.
  - As of 2018, the current ambient TDS concentration is 350 mg/l and there is 70 mg/l of assimilative capacity for TDS.
  - As of 2018, the current ambient nitrate concentration is 10.3 mg/l and there is no assimilative capacity for nitrate, which has been the case since the adoption of the maximum benefit objectives in 2004.
- Cucamonga GMZ
  - The ambient TDS concentration has remained consistent at 260 mg/l from the 2012 to 2018 computations.
  - As of 2018, the current ambient TDS concentration is 260 mg/l and there is 120 mg/l of assimilative capacity for TDS.
  - As of 2018, the current ambient nitrate concentration is 4.7 mg/l and there is 0.3 mg/l of assimilative capacity for nitrate.







### **3.0 DATA COLLECTED IN 2022**

Groundwater and surface-water data collected for the Maximum-Benefit Monitoring Program pursuant to the 2014 Work Plan are used for both the maximum benefit monitoring directives of demonstrating hydraulic control and computing ambient water quality every three years. The data collected in 2022 for the Maximum-Benefit Monitoring Program include groundwater elevation, groundwater quality, and surface-water quality. The 2022 data collection efforts are described below.

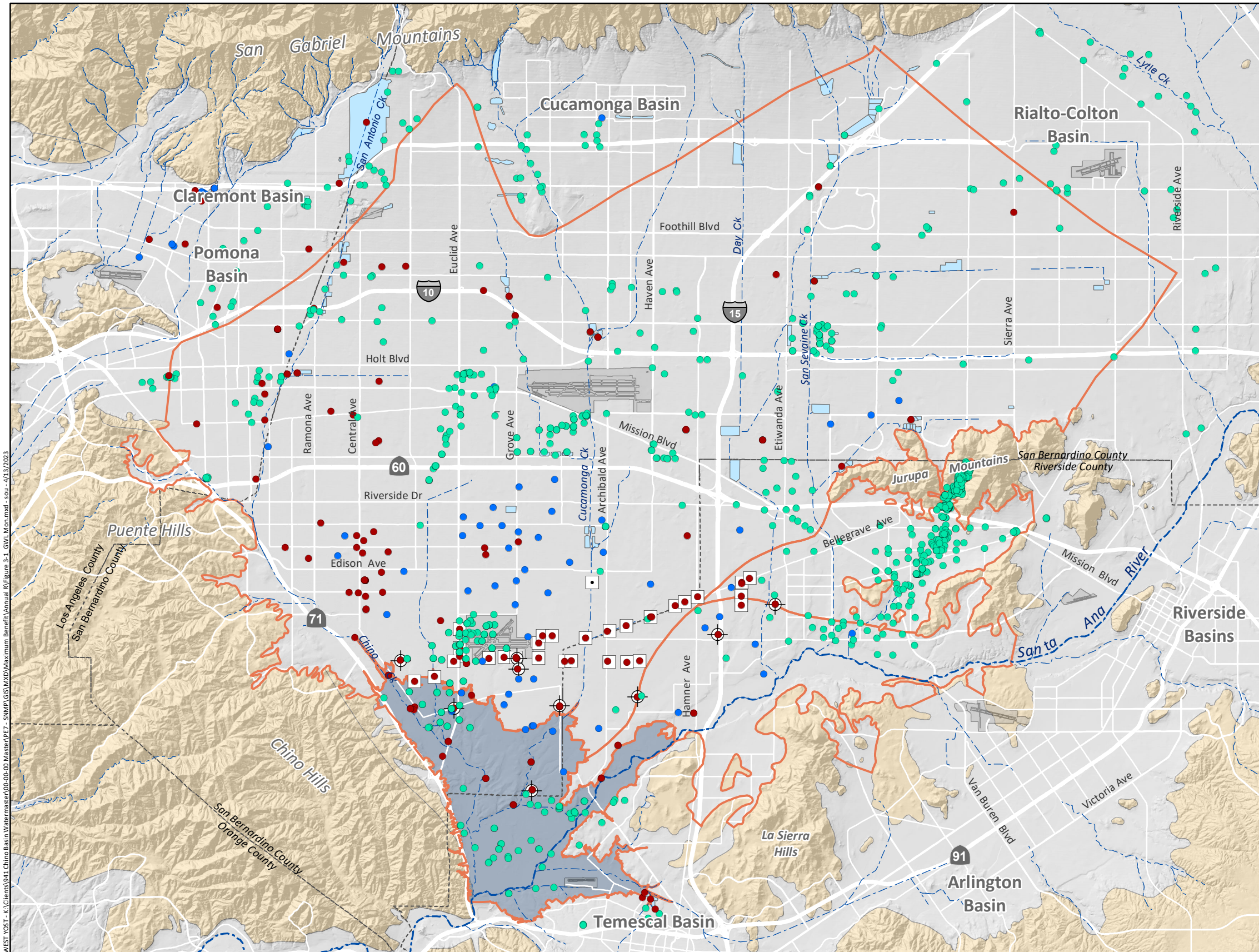
### **3.1 Groundwater Monitoring Program**

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 1,262 wells that are included in Watermaster's 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 the 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 impacts of desalter pumping to private well owners and impacts to riparian vegetation in the PBMZ. The density of groundwater-level monitoring well network near the desalter well field is greater than in outlying areas because hydraulic gradients are expected to be steeper near the desalter well field, 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 2022, symbolized by measurement frequency. At about 1,010 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 collects and compiles the data quarterly. The measurement frequency by other well owners varies, and Watermaster collects and compiles these data twice per year. The remaining 230 wells shown in Figure 3-1 are privately-owned wells or dedicated monitoring wells and majority of these wells are 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 with data loggers that record water levels once every 15 minutes. Watermaster staff download the data loggers at wells with transducers installed on a quarterly basis. All water-level data are reviewed by Watermaster staff and uploaded to a centralized database management system that can be accessed online through HydroDaVE<sup>SM</sup>. All groundwater-level data collected in 2022 are contained in the Microsoft (MS) Access database that has been included with this report as Appendix C. The well location information for private wells with groundwater-level data is excluded from the database in this report for confidentiality reasons.



**Wells Measured in 2022**  
Symbolized by Measurement Frequency

- Measured Monthly by Watermaster
- Measured by a Transducer at 15-minute Intervals. Data are Downloaded by Watermaster Quarterly.
- Measured at Variable Frequencies by Well Owner

HCMP Monitoring Well

Groundwater Management Zone Boundaries

Prado Basin Management Zone

Chino Basin Desalter Well

Rivers and Streams

Flood Control and/or Conservation Basins

Airport

**Geology**

**Water-Bearing Sediments**

Quaternary Alluvium

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

**Faults**

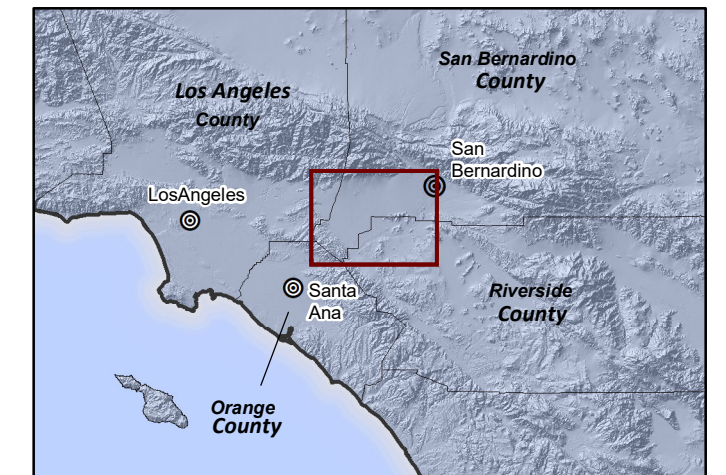
Location Certain

Location Approximate

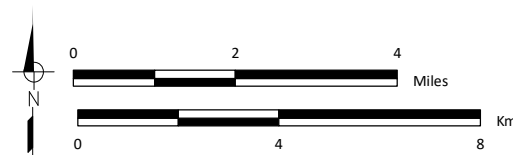
Approximate Location of Groundwater Barrier

Location Concealed

Location Uncertain



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**Groundwater-Level Monitoring Program**  
*Wells Monitored in 2022*

**Figure 3-1**



**3.1.2 Groundwater-Quality Monitoring Program**

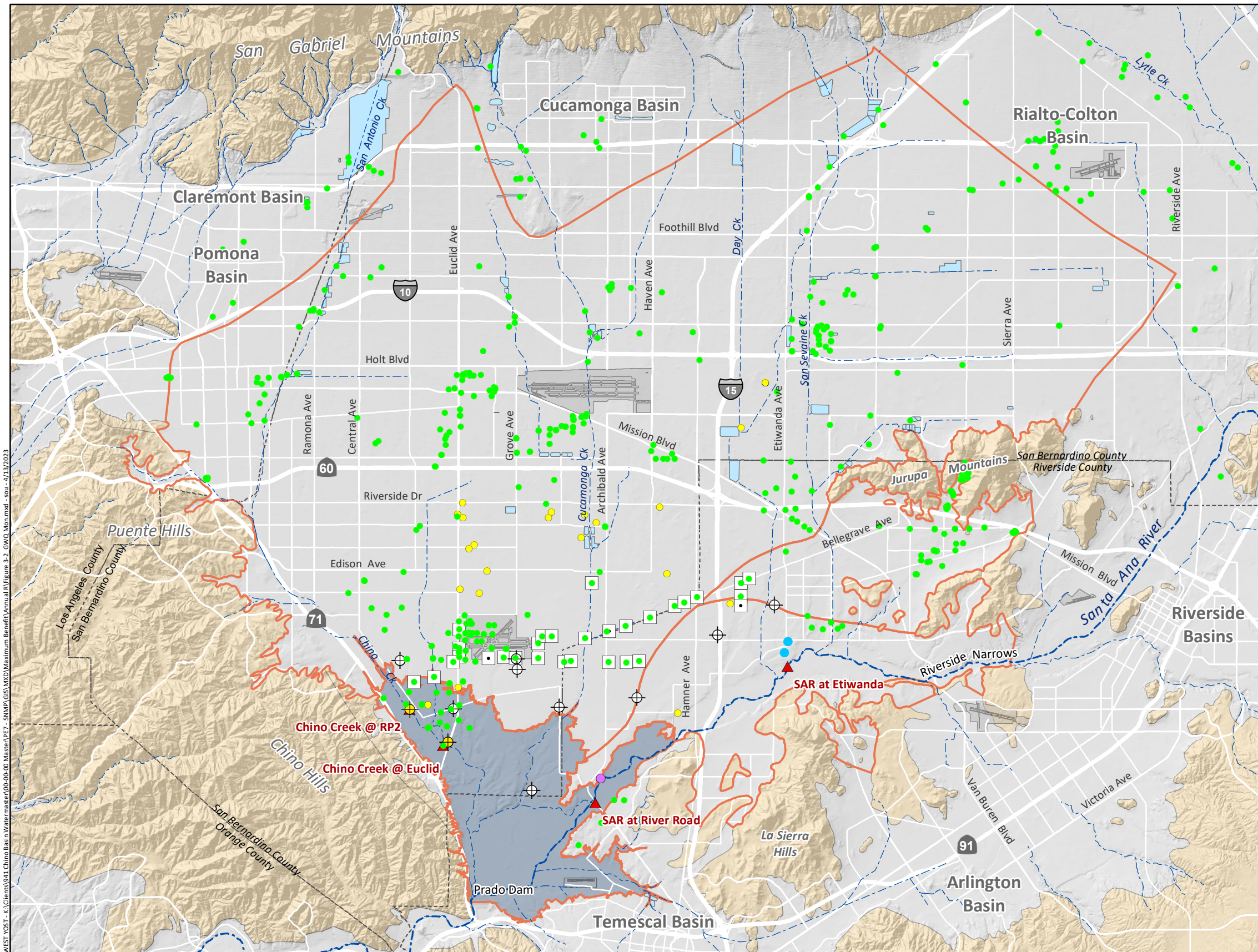
Figure 3-2 shows the locations of the 573 wells that are included in Watermaster’s groundwater-quality monitoring program. Watermaster obtains groundwater-quality data, in part, to comply with two maximum-benefit commitments: the triennial ambient water quality recomputation and the analysis of hydraulic control. These data are also used to: prepare Watermaster’s biennial SOB report, support groundwater modeling, characterize non-point source contamination and plumes associated with point-source discharges, and characterize present trends in groundwater-quality.

Figure 3-2 shows the wells with groundwater-quality data sampled by Watermaster or well owners in 2022. At 522 of these wells, groundwater-quality were sampled 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 groundwater-quality data are collected and compiled by Watermaster twice per year. The remaining 51 wells shown in Figure 3-2 are privately-owned 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. Note that VOCs are sampled only at wells within or adjacent to known contamination plumes.

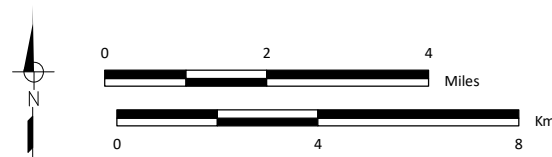
**Table 3-1. Analyte List for the Groundwater-Quality Monitoring Program**

Analyte	Laboratory Analysis Method
Major cations: Ca, Mg, K, Si, Na	EPA 200.7
Major anions: Cl, SO <sub>4</sub> , NO <sub>2</sub> , NO <sub>3</sub>	EPA 300.0
Major Trace Elements Al, As, Ba, Cr, Mn	EPA 200.8
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
Gross Alpha/Beta	EPA 900.0
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
Total Phosphorus	SM4500-PE/EPA 365.1
Turbidity	EPA 180.1
VOCs <sup>(a)</sup>	EPA 524.2
1,2,3 -Trichloropropane (Low Detection)	CASRL 524M-TCP

(a) Only at wells within or near known VOC plumes (Chino Airport, South Archibald, Pomona, GE Flatiron, GE Test cell, Former Crown Coach Facility, Alger Manufacturing Inc., Chino Institution for Men, Milliken Landfill, String Fellow)



- Wells Sampled in 2022**
- 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**
- ▭ Groundwater Management Zone Boundaries
  - ▭ Prado Basin Management Zone
  - Chino Basin Desalter Well
- Rivers and Streams**
- ▭ Rivers and Streams
  - ▭ Flood Control and/or Conservation Basins
  - ▭ Airport
- Geology**
- Water-Bearing Sediments**
- ▭ Quaternary Alluvium
  - ▭ 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





In 2022, 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 79 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 seven of the private wells in proximity to contaminant plumes are sampled every year; the remaining private wells are sampled every three years. All of the monitoring wells are sampled every year. Watermaster is constantly evaluating and revising the private wells in the Key Well GWQMP as wells are abandoned or destroyed due to urban development. 18 private wells and four monitoring wells were sampled from July through October 2022.
- Annual samples were collected from nine multi-nested HCMP monitoring wells (21 well casings) in the southern portion of Chino Basin in August 2022.
- 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 10). Samples were collected in January, April, July, and October 2022. SARWC 10 was added to the monitoring program in 2022 to replace SARWC 11 that was destroyed in late 2021.
- Collected high-frequency specific conductance (EC) and temperature data measured by transducers installed at four Prado Basin Habitat Sustainability Program (PBHSP) monitoring wells in two locations along Chino Creek. This monitoring is part of a pilot monitoring program for the PBHSP to help discern groundwater/surface-water interactions. Transducer were downloaded quarterly.

All groundwater-quality data are reviewed by Watermaster staff and uploaded to a centralized database management system that can be accessed online through HydroDaVE<sup>SM</sup>. All publicly available groundwater-quality data collected in 2022 are contained in the MS Access database included with this report as Appendix C. Groundwater-quality data collected at private wells in the Chino 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*, and high-frequency EC and temperature data measured by transducers installed at two sites along Chino Creek, *CK at RP2* and *CK at Euclid*, for the PBHSP. Figure 3-2 shows the locations of these sites.

For surface water sites 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, April, July, and October 2022. Surface-water quality samples are tested for the analytes listed in Table 3-2. For the surface water sites along Chino Creek, the transducers that measure the high-frequency EC and temperature data were downloaded quarterly on the same days as the nearby PBHSP monitoring wells. These data are part of a pilot monitoring program for the PBHSP to help discern groundwater/surface-water interactions for the PBHSP. All surface-water quality data are reviewed by Watermaster and uploaded to a centralized database management system that can be accessed online



# Chino Basin Optimum Basin Management Program 2022 Maximum Benefit Annual Report



through HydroDaVE<sup>SM</sup>. All surface-water quality sample data collected in 2022 are contained in the MS Access database included with this report as Appendix C.

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

Analytes	Laboratory Analysis Method
Major cations: K, Na, Ca, Mg	EPA 200.7
Major anions: Cl, SO <sub>4</sub> , NO <sub>2</sub> , NO <sub>3</sub>	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



## **4.0 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 (see locations in Figure 1-1). Rising groundwater from the Chino Basin to the Santa Ana River consists of groundwater from Chino-North that flows past the CCWF and unpumped groundwater south of and outside the influence of the Chino Basin Desalter well field.<sup>22</sup>

### **4.1 Surface-Water Discharge Accounting**

Annual estimates of the Chino Basin recharge and discharges (computational results from Watermaster’s Chino Basin groundwater model) are used to evaluate the annual net contribution of rising groundwater to 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 between Riverside Narrows and Prado Dam, which is the extent of the Santa Ana River flowing through Chino Basin (see Figure 1-1). Net rising groundwater is the combined losses and gains in Santa Ana River flow due to rising groundwater, streambed infiltration, and evapotranspiration (ET). Achieving hydraulic control should decrease net rising groundwater.

Table 4-1 is a water budget table from Watermaster’s groundwater model that was updated and recalibrated to recalculate the safe yield in 2020 (WEI, 2020b). The water budget table lists the annual recharge and discharge components for the Chino Basin as an input to, or computed by, the model for the calibration period of fiscal year 1978 to 2018, plus fiscal year 2019 through 2022 from the planning period for scenario 2020 SYR1. Column 9, *Santa Ana River Streambed Infiltration*, is the annual estimate of streambed infiltration from the Santa Ana River to the Chino Basin in the area downstream of the Riverside Narrows and the lower reaches of Chino and Mill Creeks. Column 19, *Rising Groundwater*, is the annual estimate of the combined groundwater discharge from Chino Basin to the Santa Ana River, Chino Creek, and Mill Creek. The net rising groundwater from Chino Basin to the Santa Ana River between Riverside Narrows and Prado Dam is calculated in Column 23 as the difference between groundwater discharge and streambed infiltration (Column 19 minus Column 9). Figure 4-1 shows the time history of this net rising groundwater calculation. With three exceptions, in 2001, 2003, and 2004, the net rising groundwater estimate is negative over the 45-year period. 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. Net rising groundwater decreased (larger negative values) as the Chino-I and Chino-II Desalters increased production in the southern Chino Basin starting in fiscal year 2005. These observations are consistent with conclusions from the monitoring data and demonstrate that hydraulic control is being achieved.

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<sup>22</sup> See groundwater flow vectors in Figure 2-2.



**Table 4-1. Water Budget for the Chino Basin for the Calibration and Planning Periods and Estimated Net Rising Groundwater**

Fiscal Year	Recharge													Discharge						Change in Storage		Net Rising Groundwater Contribution to Surface Discharge (23) = (19) - (9)	
	Subsurface Inflow							Deep Infiltration of Precipitation and Applied Water	Santa Ana River Streambed Infiltration <sup>(a)</sup>	Streambed Infiltration from the Santa Ana River Tributaries	Managed Aquifer Recharge			Total Recharge	Groundwater Pumping			Riparian Veg ET	Rising Groundwater <sup>(d)</sup>	Total Discharge	Annual		Cumulative
	Bloomington Divide	Chino/Puente Hills, Jurupa Hills, and Rialto Basin	Net Temescal Basin	Pomona Basin	Claremont Basin	Cucamonga Basin	Spadra Basin				Storm Water	Recycled Water	Imported Water		CDA Pumping	Overlying Non Ag and Appropriative Pools <sup>(b,c)</sup>	Overlying Agricultural Pool						
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)	(13)	(14)	(15)	(16)	(17)	(18)	(19)	(20)	(21)	(22)	(23) = (19) - (9)	
<b>Statistics for the Calibration Period 1978 through 2018</b>																							
Total	759,181	418,268	141,217	150,832	123,084	511,073	24,857	5,278,938	1,764,633	166,546	373,291	309,962	504,977	10,519,406	873,302	5,303,840	2,663,380	951,253	918,080	10,711,301	(191,894)	(846,553)	
Percent	7.2%	4.0%	1.3%	1.4%	1.2%	4.9%	0.2%	50.2%	16.8%	1.6%	3.5%	2.9%	4.8%	100.0%	8.2%	49.5%	24.9%	8.9%	8.6%	100.0%			
Average	14,108	7,924	2,864	2,733	2,319	10,081	476	103,679	32,722	3,603	5,756	4,150	11,196	201,445	12,408	100,689	56,689	17,805	17,674	205,298	(3,852)	(15,048)	
Median	14,378	7,697	2,858	2,713	2,277	10,335	474	109,843	33,477	1,028	4,662	1,303	7,401	194,101	523	101,301	45,302	17,824	15,603	207,298	(7,388)	(17,537)	
Maximum	16,088	11,289	6,493	3,222	2,752	12,032	961	133,497	38,002	24,456	17,648	15,728	35,621	270,704	40,566	137,345	120,072	19,282	29,844	226,223	74,898	291,979	1,045

Source: Water Budget from the Chino Basin groundwater model that was updated and recalibrated to calculate Safe Yield in 2020. The period includes the calibration period of fiscal year 1978 to 2018 and fiscal year 2019 to 2021 of the planning simulation period for Scenario 2020 SYR1 with updated historical managed aquifer recharge and pumping.

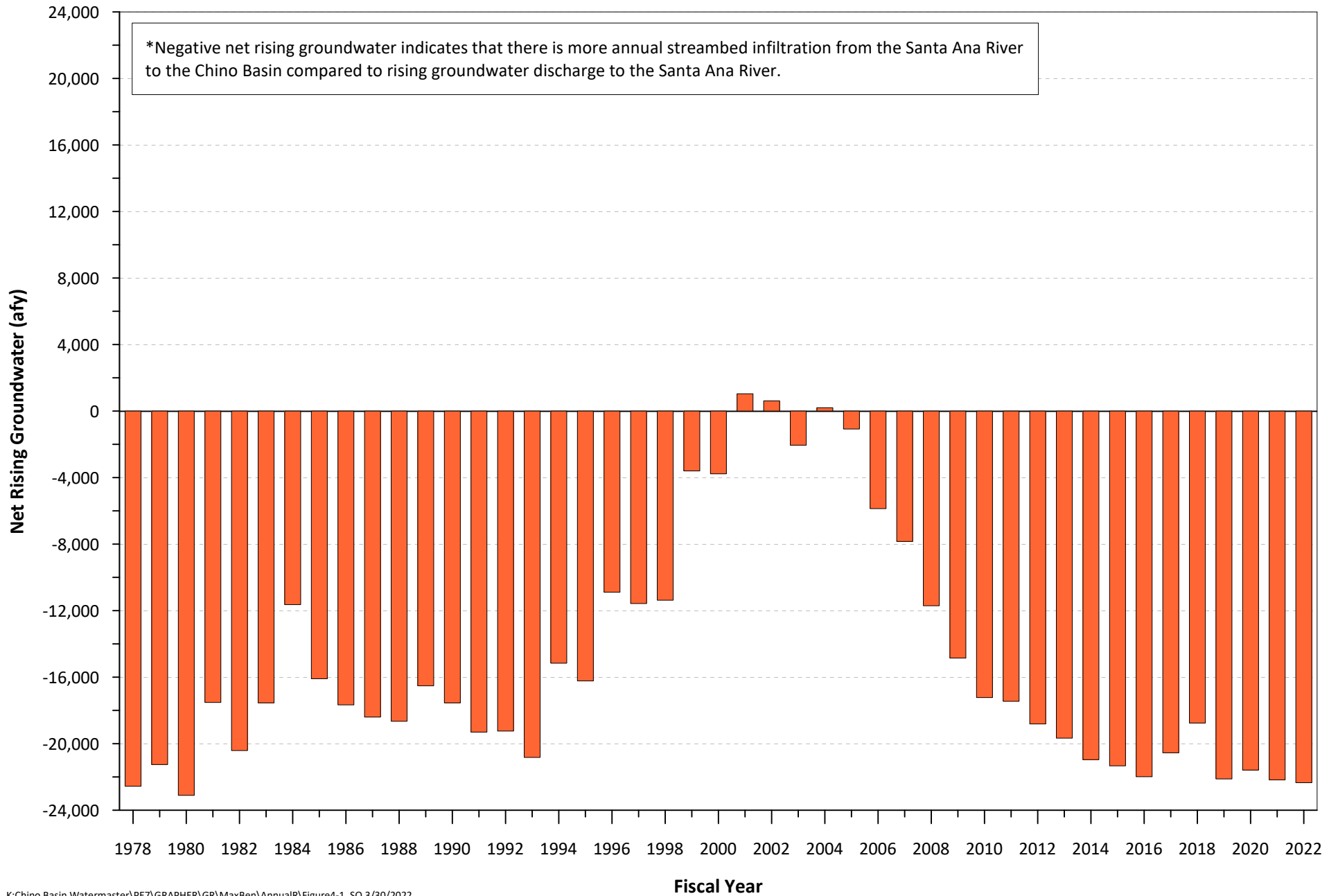
(a) Streambed infiltration from Santa Ana River includes infiltration at Santa Ana River below Riverside Narrows and at lower reaches of Chino and Mill Creeks

(b) Does not include San Antonio Water Company Wells 15 and 16, and Santa Ana River Water Company Well 9.

(c) Less injection in wells by General Electric.

(d) Rising groundwater discharge to Santa Ana River and Chino and Mill Creeks.

(Red Text) Indicates negative values.



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Prepared by:



Prepared for:

Chino Basin Watermaster and  
the Inland Empire Utilities Agency  
2022 Maximum Benefit  
Annual Report



Net Annual Rising Groundwater Contribution to  
Surface Discharge in Santa Ana River between  
Riverside Narrows and Prado Dam - 1978 to 2022

Figure 4-1

## 4.2 Analysis of Surface and Groundwater Interactions from Monitoring Data

Surface water and groundwater quality data collected for the Maximum Benefit Monitoring Program along the Santa Ana River in the Chino Basin can be used to 1) characterize the groundwater and surface water interactions at these locations, and 2) determine if these locations are areas of surface water recharge to Chino Basin (losing reach) or an area of rising groundwater discharge from Chino Basin (gaining reach). As described in Section 3.2, Watermaster collects quarterly surface-water quality samples from two sites along the Santa Ana River in Chino Basin, *SAR at Etiwanda* and *SAR at River Road*, and four nearby wells (SARWC 9 and 10<sup>23</sup> *SAR at Etiwanda*; and Archibald 1 and 2 near *SAR at River Road*). Figures 4-2a and 4-2b are exhibits that show the analysis of the groundwater and surface water interaction at these two sites along the Santa Ana River. The surface and groundwater quality data are used along with surface water discharge data, groundwater elevation measurements, model-simulated groundwater-flow directions, and groundwater quality at other wells, to analyze the groundwater and surface water interactions at these locations. Each figure includes the following data graphics:

- *A Piper diagram of general-mineral chemistry for groundwater and surface water.* Groundwater in the Chino Basin typically has a different general mineral chemistry than that of discharge in the Santa Ana River which is predominantly tertiary-treated discharge from publicly owned treatment works (POTWs) and storm water discharge. Piper diagrams compare groundwater and surface-water via a graphical display of the ratio of the major cations and anions. Each piper diagram shows the chemistry for the surface water station and the near-river wells, along with well/s further away from the river for comparison to typical Chino Basin groundwater. Water from similar or related sources will generally plot in similar locations on a piper diagram. The piper diagram indicates where typical groundwater and surface water chemistry plot in the diagram for the region of interest based on available data.
- *A map of model-simulated groundwater-flow directions for 2022.* The simulated groundwater-flow directions are output information from the Chino Basin groundwater-flow model for Layer 1 for September 30, 2022 and are shown with arrow symbols. Model-simulated groundwater-flow directions can corroborate an understanding of the groundwater/surface-water interactions derived from the measured data. Groundwater-flow directions (arrows) that converge on a stream segment indicate a gaining reach (i.e., groundwater discharge to stream). Groundwater-flow directions that diverge from a stream segment indicate a losing reach (i.e., streambed recharge to the basin).
- *A time-series chart of the surface-water discharge in Santa Ana River, groundwater elevation at the near-river monitoring wells, and the thalweg elevation in the adjacent river.* The groundwater elevation time-series are charted with the thalweg elevation of the adjacent river to determine the potential for groundwater discharge or streambed recharge. The thalweg elevation was determined from a 1-meter horizontal resolution digital elevation model of the ground surface (Associated Engineers, 2007).<sup>24</sup> And, daily discharge data at the USGS gage station at the Riverside Narrows (*SAR at MWD Xing*) are charted and compared

<sup>23</sup> SARWC 11 was replaced with nearby SARWC 10 in 2022.

<sup>24</sup> The 1-meter resolution digital elevation model of the ground surface uses the Ayala Park datum, which is the same datum that was used to establish the reference-point elevations at the near-river monitoring wells. This allows for an accurate comparison between the thalweg elevation and the measured groundwater elevations.



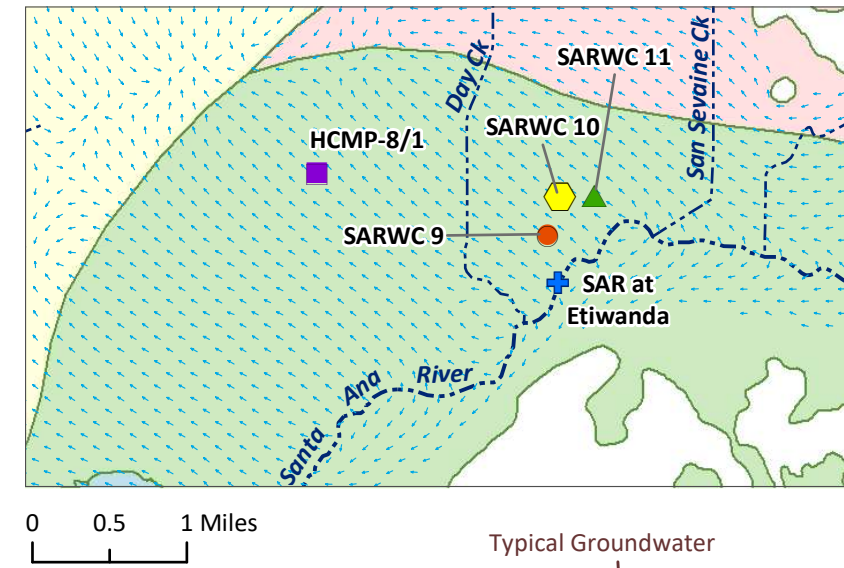
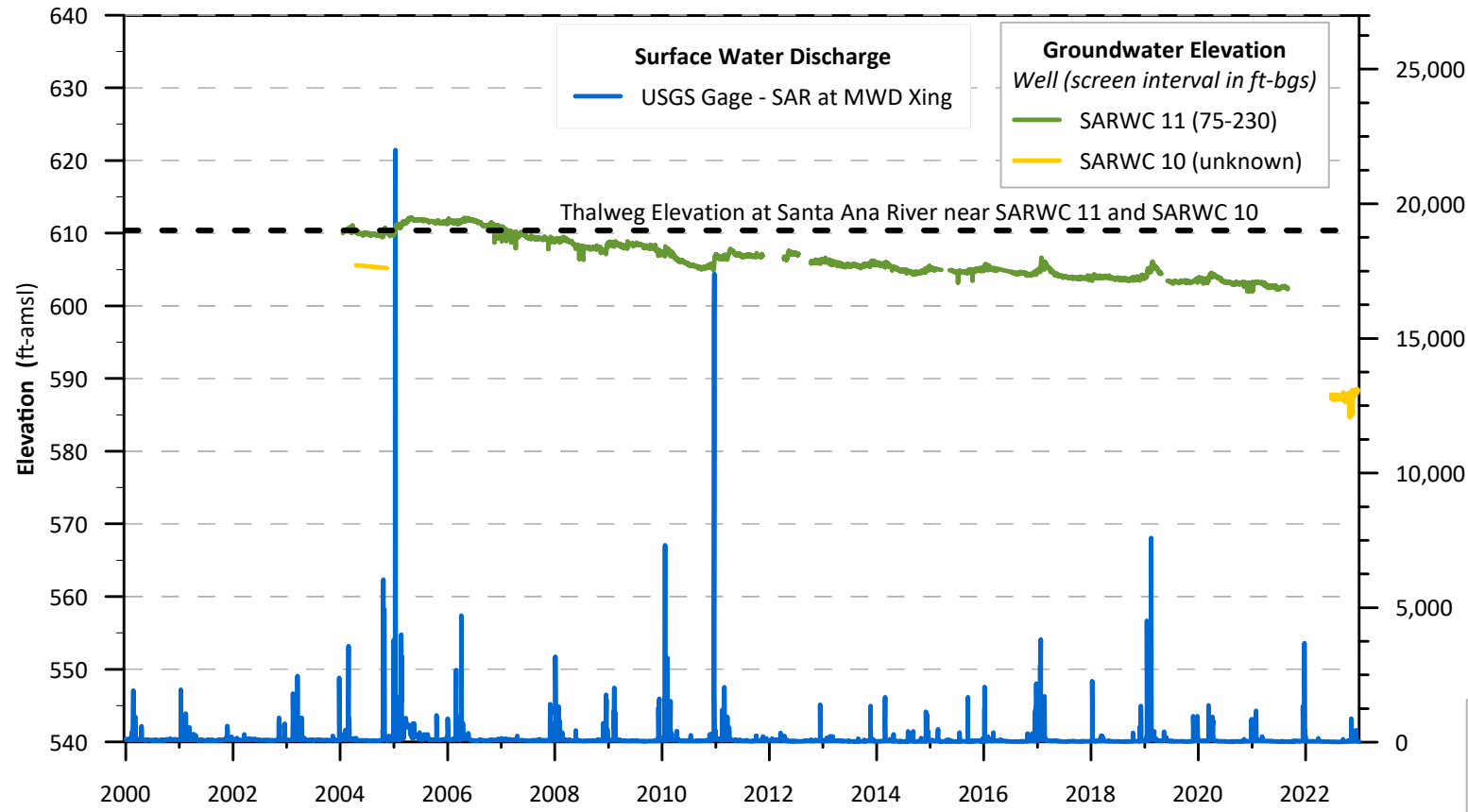
with groundwater elevations at the near-river wells to characterize the relationship between discharge in the Santa Ana River and groundwater levels.

- *A time-series chart of TDS concentrations in groundwater and surface water.* On these charts, TDS concentrations for groundwater and surface water are compared to help determine the source of groundwater at the near-river monitoring wells. The TDS concentrations of Santa Ana River discharge typically range from 500-700 mg/l. In the southern portion of Chino Basin, shallow groundwater quality not impacted by the Santa Ana River can have TDS concentrations ranging from about 1,000 - 4,000 mg/l.

The analysis of the data in Figure 4-2a indicates that the *SAR at Etiwanda* area is an overall losing reach of the Santa Ana River in Chino Basin, characterized by streambed recharge, and demonstrating hydraulic control:

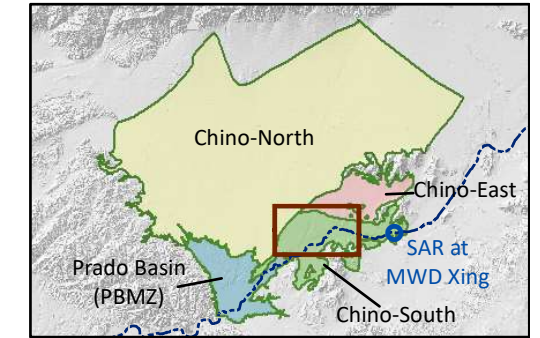
- The general-mineral chemistry for the near-river wells, SARWC 9, 10, and 11, plots very close to the chemistry of surface water for *SAR at Etiwanda* on the piper diagram, indicating that the source of the groundwater at these near-river wells is streambed recharge of the Santa Ana River. The general-mineral chemistries of the SARWC wells 9, 10, and 11 do not plot near that of well HCMP-8/1, which is not near the river and is representative of typical shallow groundwater in the southern Chino Basin, further demonstrating that the near-river wells are influenced by stream bed recharge of the Santa Ana River.
- The simulated groundwater-flow directions (arrow symbols on the map) diverge from the Santa Ana River, indicating that this is an area of streambed recharge.
- Starting in 2007, groundwater elevations at the SARWC 11 transition from just at the thalweg elevation of the adjacent Santa Ana River to below the thalweg, indicating that this is an area of streambed recharge from mid-2007. This transition aligns with the onset of the Chino-II Desalter pumping and the Peace Agreement.
- Groundwater elevations at SARWC 11 increase slightly during and immediately after periods of storm water discharge as measured by the USGS gage located upstream (SAR at MWD Xing), suggesting that storm water discharge is a source of recharge to the groundwater.
- Groundwater elevations at the new monitoring well SARWC 10 was below the thalweg elevation in 2022 indicating that this is an area of streambed recharge in 2022.
- The TDS concentrations at SARWCs 10, 9, and 11 typically fluctuate between 330 and 660 mg/l, which are similar to the TDS concentrations in the Santa Ana River as sampled *at SAR at Etiwanda*, while the TDS concentrations of the further away well HCMP-8/1 are higher ranging from about 1,000 to 1,600 mg/l. These observations further indicate that the source of groundwater at the SARWC wells is Santa Ana River recharge.

### Groundwater Elevation, Thalweg Elevation, and Surface Water Discharge

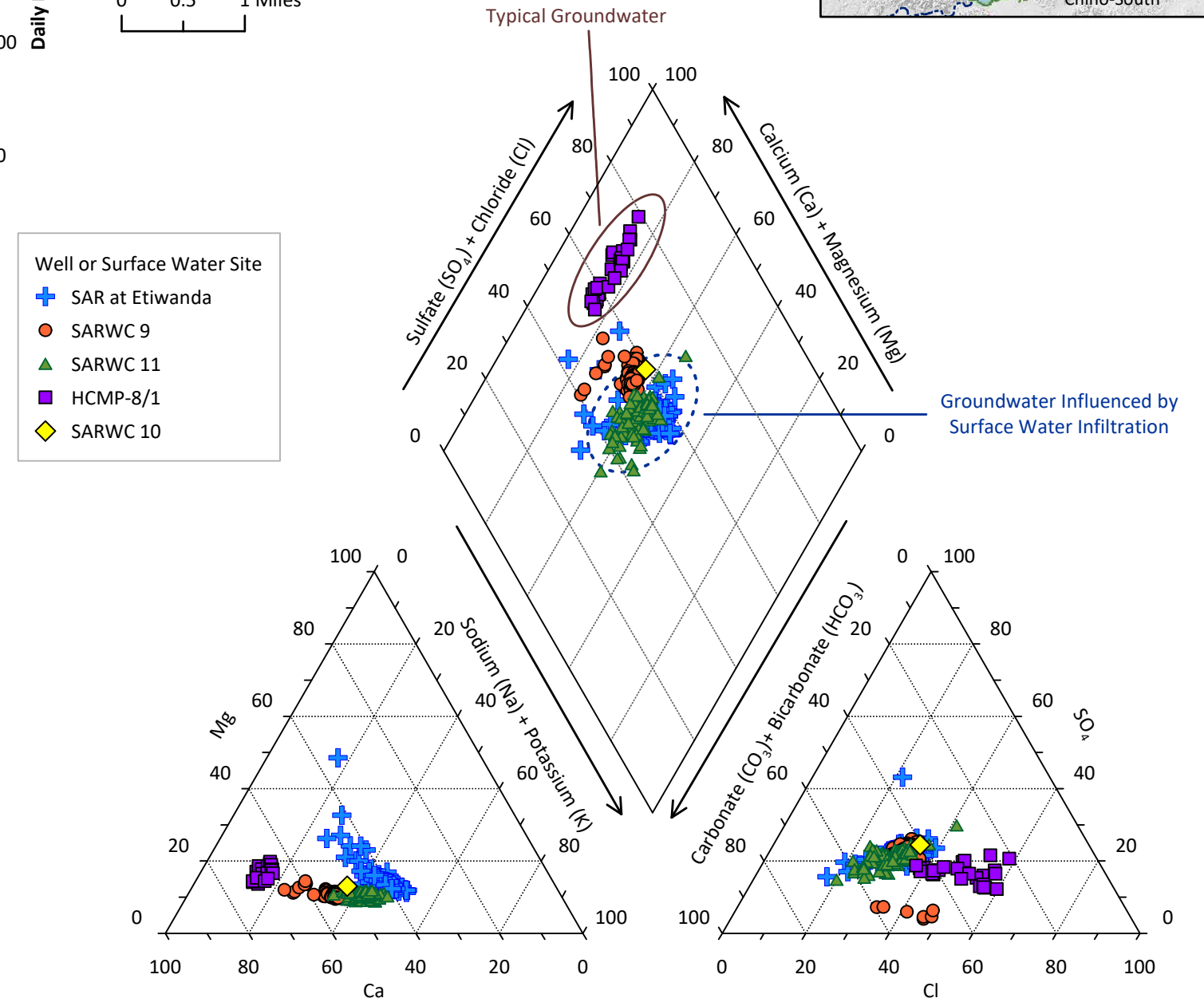
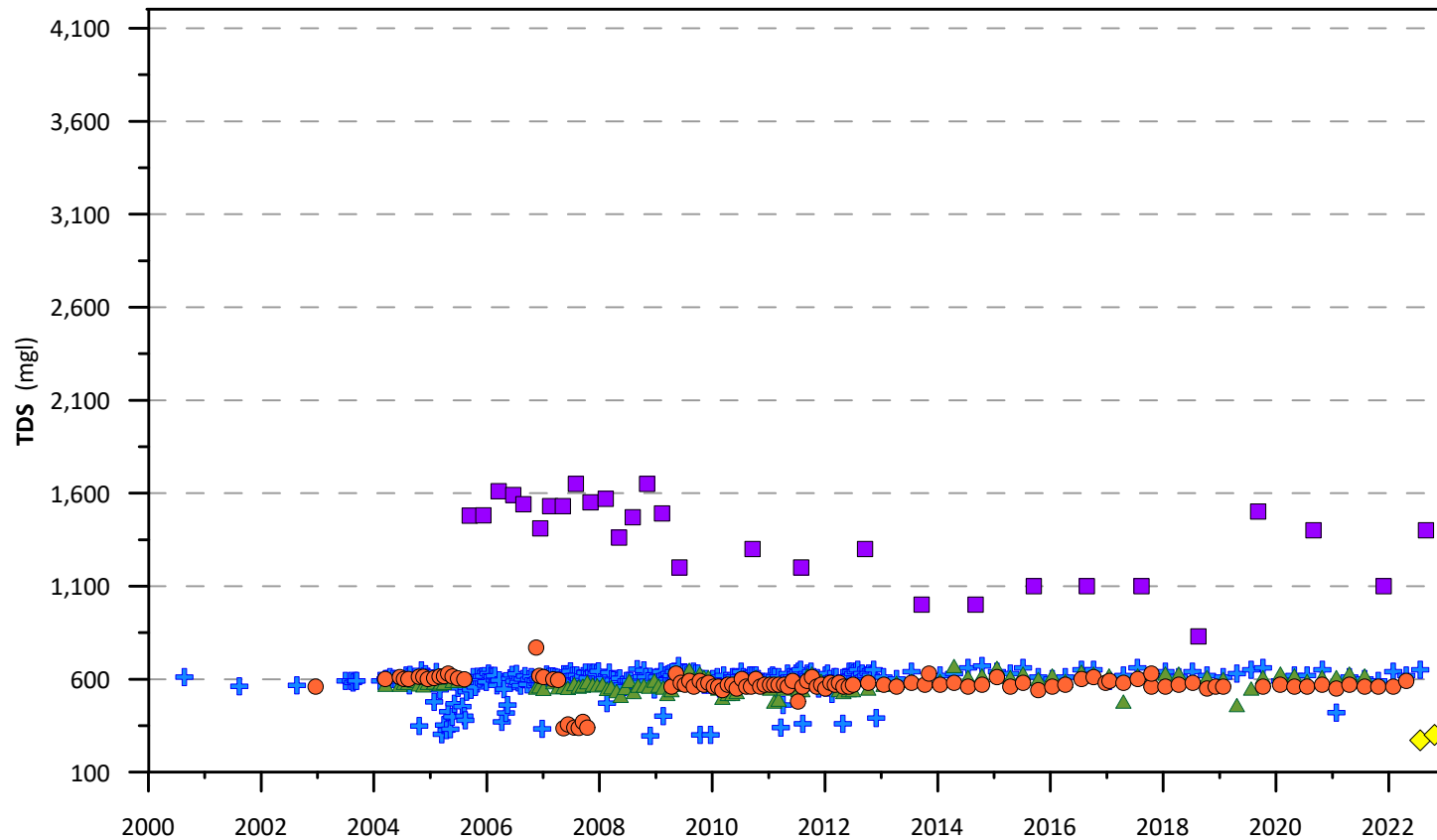


← 2022 Groundwater Flow Direction (Model Layer 1)

Chino Basin Maximum Benefit Management Zones



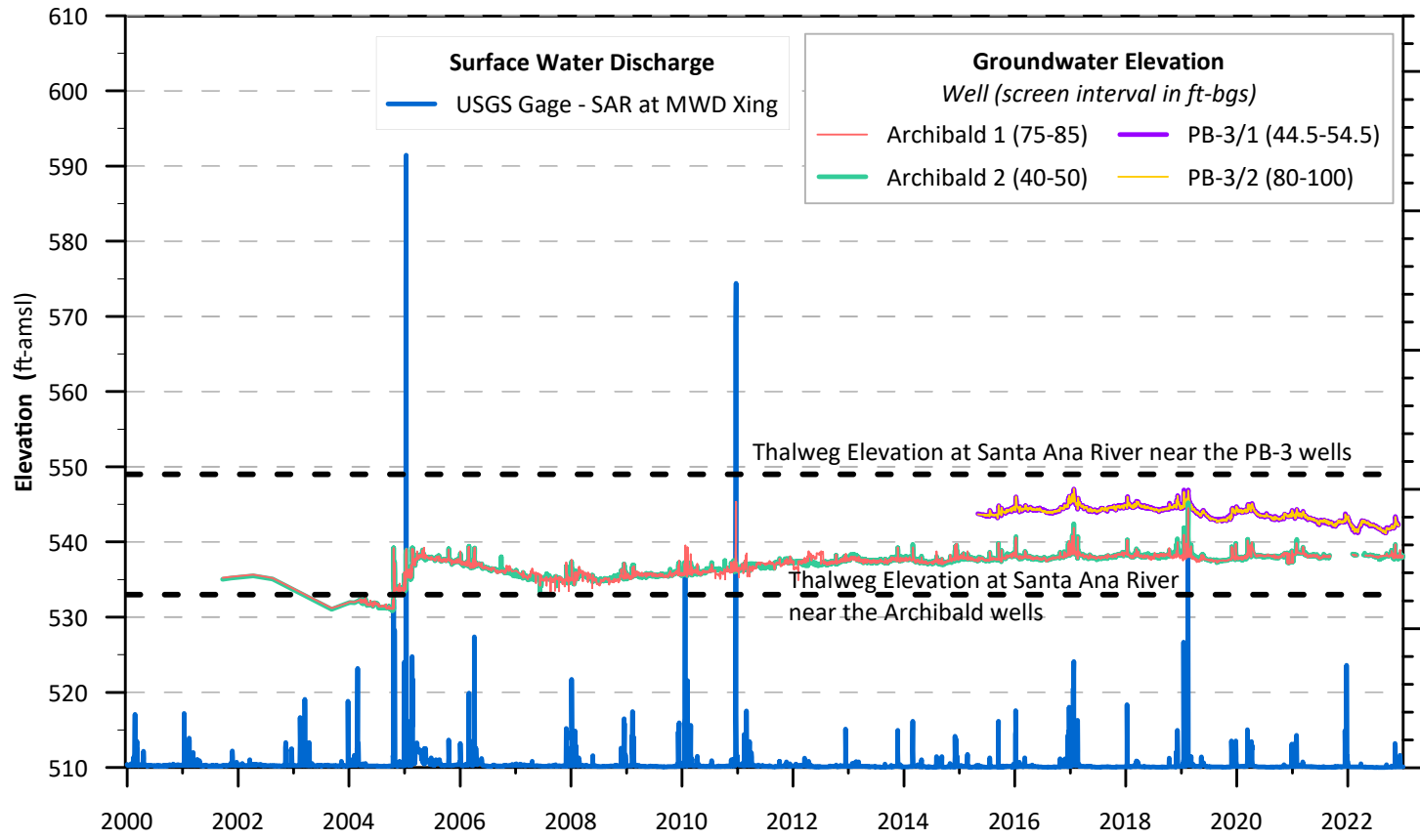
### TDS Concentration in Groundwater and Surface Water



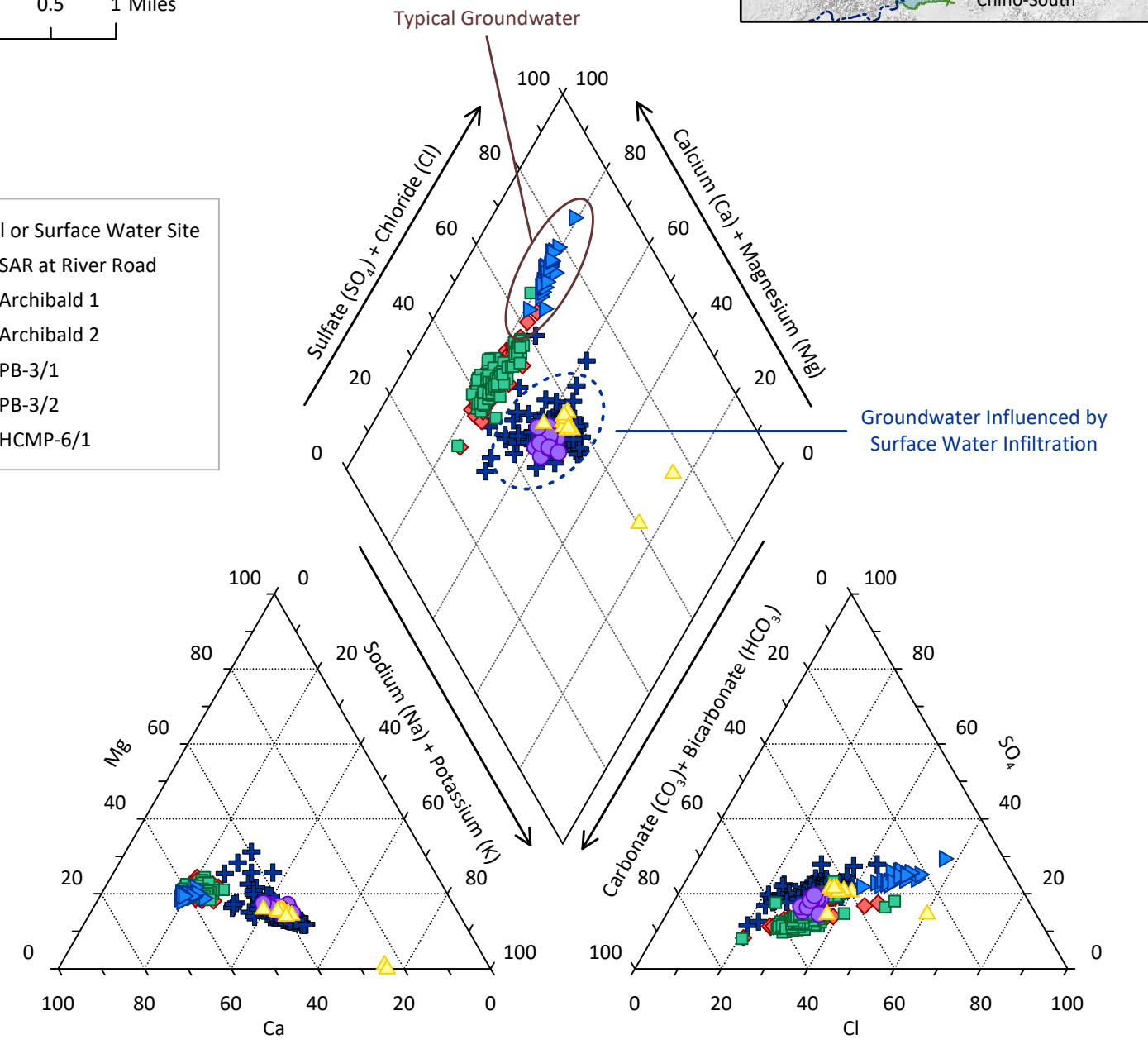
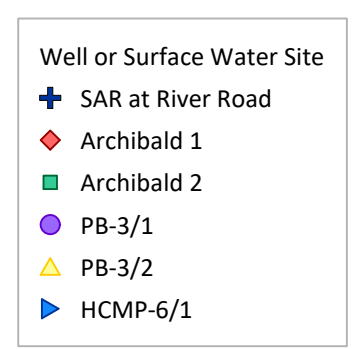
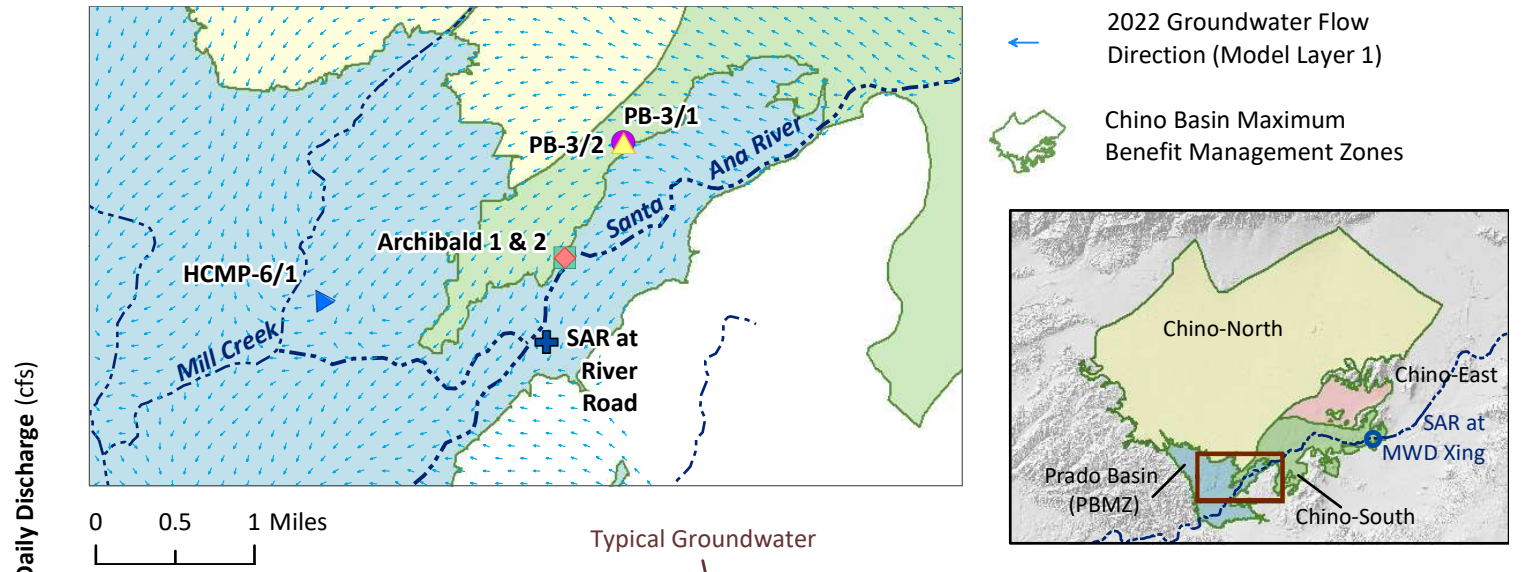
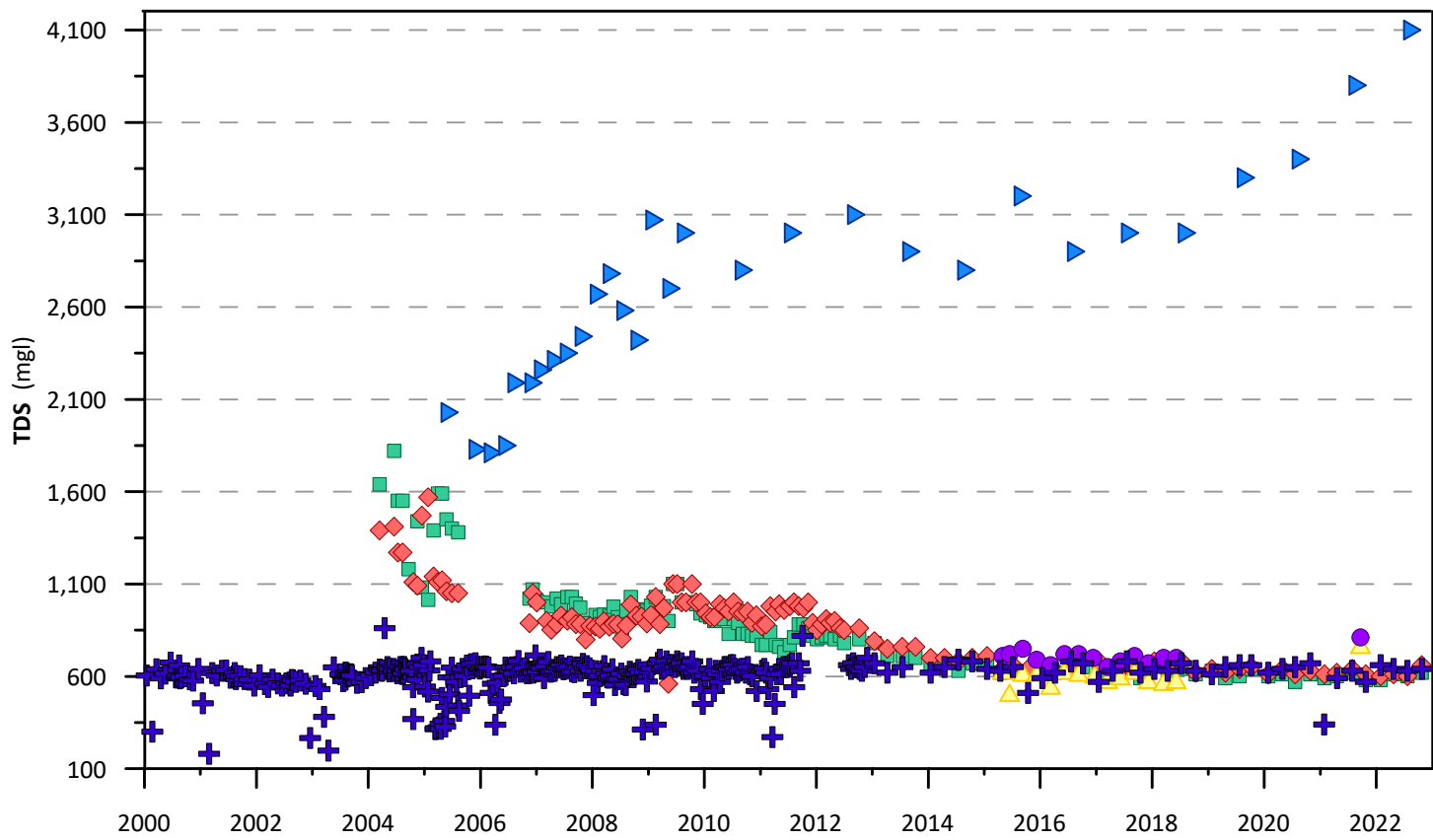
Prepared for:



### Groundwater Elevation, Thalweg Elevation, and Surface Water Discharge



### TDS Concentration in Groundwater and Surface Water



## Chino Basin Optimum Basin Management Program 2022 Maximum Benefit Annual Report



The analysis of the data in Figure 4-2b indicates that the *SAR at River Road* area is an overall gaining reach of the river, characterized by groundwater discharge to the river from the southern Chino Basin south of the desalters in Chino-South GMZ and PBMZ, however the primary source of the groundwater in this area is mix of surface water recharge and groundwater discharge. The approximate area near the Archibald 1 and 2 wells is where the Santa Ana River changes from an overall area of streambed recharge (losing reach) to an area of rising groundwater discharge (gaining reach) in the PBMZ:

- In the piper diagram, the general-mineral chemistry for both near-river wells, Archibald 1 and Archibald 2, plots between the chemistry of surface water for *SAR at River Road* and well HCMP-6/1 that is not near the river, indicating that the source of groundwater at these near-river wells is a combination of streambed recharge and groundwater. Also shown on this piper diagram are the near-river wells PB-3/1 and PB-3/2 just slightly upstream from the Archibald wells. The general-mineral chemistry for both PB-3/1 and PB-3/2 plots with the chemistry of surface water for *SAR at River Road*, indicating that the source of the groundwater at these near-river wells just upgradient of the Archibald wells is streambed recharge of the Santa Ana River. This further demonstrates that the Archibald wells are an area characterized primarily by Chino Basin discharge to the river and there is a transition in the surface water and groundwater interaction between the PB-3 and Archibald wells.
- The simulated groundwater-flow directions (arrow symbols on the map) converge at the Santa Ana River at the Archibald 1 and 2 wells location, indicating that this is an area of rising groundwater discharge. However, the simulated flow directions show this is a transitional area where the groundwater-flow directions change from diverging along the river indicating streambed recharge, to converging indicating an area of rising groundwater discharge. The groundwater-flow directions are diverging along from *SAR at Etiwanda* to the *SAR at River Road*, indicating a long stretch of streambed recharge, and demonstrating hydraulic control up stream of the *SAR at River Road* in Chino Basin.
- Groundwater elevations at Archibald 1 and 2 are above the thalweg elevation of the Santa Ana River near the Archibald wells, indicating that this is an area of groundwater discharge. The groundwater elevation at the upstream PB-3/1 and PB-3/2 wells are below the thalweg elevation, indicating that this is an area of streambed recharge.
- Groundwater elevations at the Archibald 1 and 2 increase slightly during and immediately after periods of storm water discharge as measured by the USGS gage located upstream (*SAR at MWD Xing*), suggesting that storm water discharge is a source of recharge to the groundwater.
- The TDS concentrations at Archibald 1 and 2 near-river wells have declined over the period of record, ranging between 700 to 1,500 mg/l from 2004 to 2013, and since 2013 have ranged between 500 to 600 mg/l which are similar to the concentrations in the Santa Ana River.
- This trend suggests that over time, the groundwater in the area of the Archibald wells became more influenced by groundwater that is recharged by the Santa Ana River upstream (such as the PB-3 area). The TDS concentrations of the PB-3 wells upstream range from 500 to 700 mg/l which are similar to the TDS concentrations in the Santa Ana River. In contrast, the TDS concentrations of the further away HCMP-6/1 well are higher, ranging from about 1,500 to 3,800 mg/l. These observations further indicate that the source of groundwater at the Archibald wells is groundwater discharge that has been influenced by groundwater receiving recharge of the Santa Ana River upgradient (northeast) of the Archibald wells.



### 4.3 Surface-Water Quality at Prado Dam

Rising groundwater from the Chino Basin to the Santa Ana River consists of groundwater from Chino-North that flows past the CCWF and unpumped groundwater outside of the area of influence of the Chino Basin Desalter well field. 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 Santa Ana River discharge at Prado Dam. Calibration of the 2008 Wasteload Allocation Model (1994-2006) estimated that rising groundwater in the PBMZ had an average TDS concentration of about 850 mg/l (WEI, 2009b). This estimate is consistent with a 2015 TDS mass-balance characterization of the Santa Ana River (WEI, 2015d) and sampling at the PBSHP monitoring wells the PBMZ (WEI, 2019c).

The Santa Ana River Watermaster (SARWM) compiles annual reports pursuant to the 1969 stipulated judgment<sup>25</sup> that contain annual estimates of: significant discharges to the Santa Ana River, estimates of the storm flow and base flow discharge, and the volume-weighted TDS concentration of discharge at the Riverside Narrows and at Prado Dam (SARWM, 2022). These estimates are used herein to demonstrate the impact of rising groundwater outflow on the TDS concentration of the Santa Ana River at Prado Dam. Figure 4-3 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 concentrations as reported by the SARWM. The base flow discharge is represented by two bars: 1) the SARWM estimate of base flow discharge at Prado Dam minus the rising groundwater from the Chino Basin component and 2) the total rising groundwater discharge from the Chino Basin to the Santa Ana River estimated with the 2020 Chino Basin Model update as shown in column 19 of Table 4-1. The sum of these two terms equals the SARWM estimate of base flow discharge at Prado Dam. Figure 4-3 also shows the five-year moving average of the SARWM's estimate of the annual flow-weighted TDS concentration of the Santa Ana River at Prado Dam. This five-year moving average is the metric the Regional Board uses to determine compliance with the Basin Plan TDS concentration objective of 650 mg/l for Reach 2 of the Santa Ana River (Reach 2 TDS metric) (Regional Board, 2016). Note that:

- Since about 1980, annual estimates of total rising groundwater discharge from the Chino Basin to the Santa Ana River, which ranged from about 13,000 to 30,000 afy and averaged around 17,860 afy, have been a small percentage of total annual flow at Prado Dam, ranging from about three percent during wet years to about 17 percent during dry years.
- From 2005 to 2015, the model-estimated groundwater discharge from Chino-North to the PBMZ past the CCWF ranged from 550 afy to 740 afy without the operation of the CCWF<sup>26</sup>, which represents a small fraction of the total rising groundwater from the Chino Basin to the Santa Ana River. It represents, on average, about four percent of total rising groundwater discharge from the Chino Basin to the Santa Ana River, and about less than one percent of the total flow in the Santa Ana River at Prado Dam.

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<sup>25</sup> The Santa Ana River was adjudicated in the 1960s, and a stipulated judgment was filed in 1969 (Orange County Water District v. City of Chino et al., Case No. 117628, County of Orange). Since the Judgment was filed, the SARWM has compiled annual reports

<sup>26</sup> See Figure 2-3 of this report for modeling projections of groundwater discharge from Chino-North to the PBMZ past the CCWF.

## Chino Basin Optimum Basin Management Program 2022 Maximum Benefit Annual Report

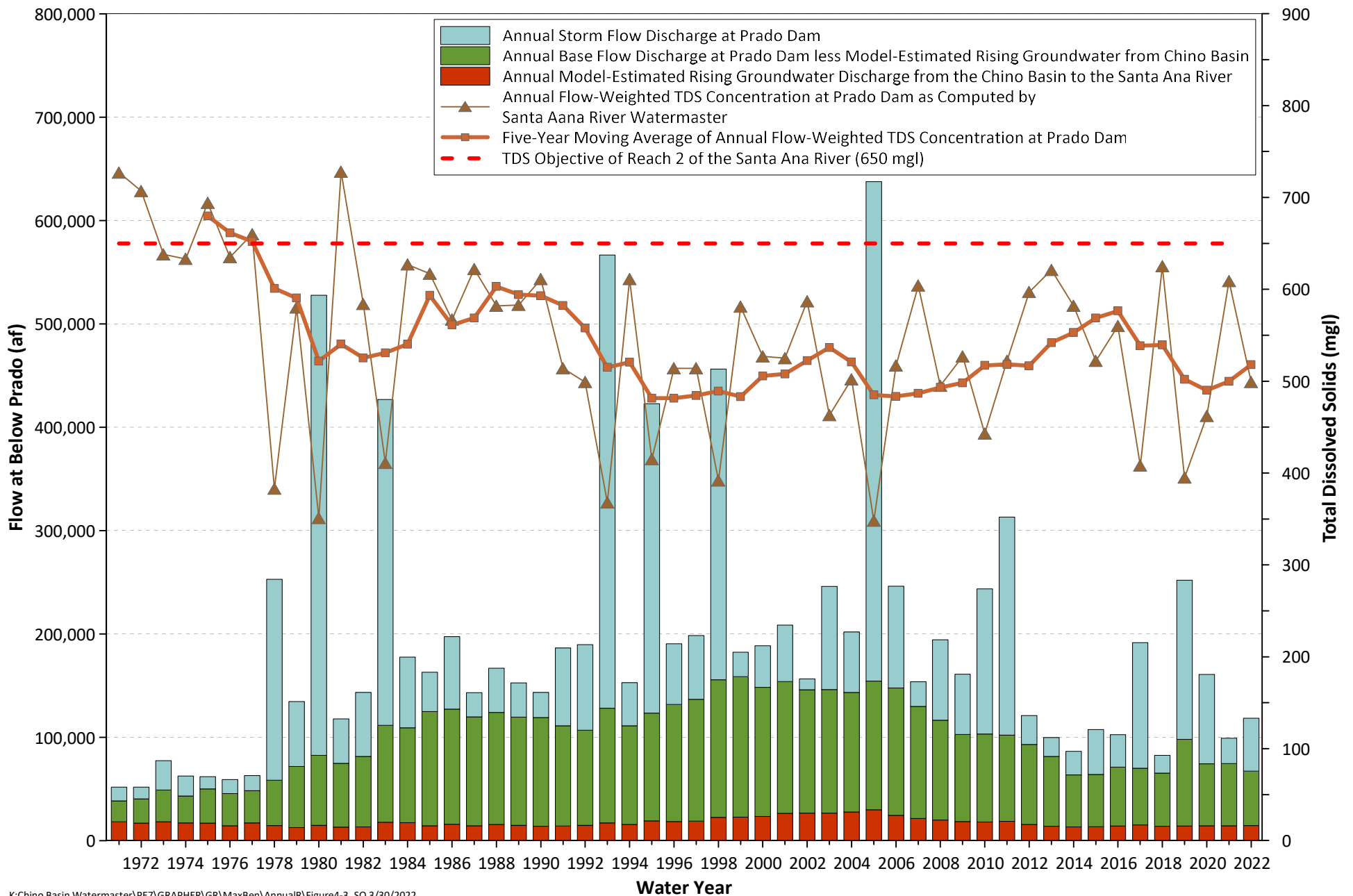


- In 2016, the CCWF commenced operation, further reducing the groundwater discharge from the Chino-North to the PBMZ to the *de minimis* threshold levels (less than 1,000 afy). The model-projected groundwater discharge past the CCWF ranges from about 400 to 630 afy in 2016 through 2050.<sup>27</sup> This represents about three 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 480 and 600 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 relatively little (e.g., water years 1984 through 1992, 1999 through 2004, and 2012 through 2016).
- The Reach 2 TDS metric increased continuously from water year 2006 to water year 2016, which coincides with a dry climatic period with a decrease in low-TDS storm water flow and a steady decrease in the volume of base flow discharge. The decrease in baseflow is mostly attributable to the decrease in wastewater discharges to the Santa Ana River.
- In water year 2022, the Reach 2 TDS metric was 518 mg/l, an increase of 18 mg/l from the previous year.

These observations suggest that the rising groundwater discharge from the Chino Basin to the Santa Ana River has had a *de minimis* impact on the flow and TDS concentration of the Santa Ana River since 1978, and has never contributed to an exceedance of the TDS objective for Reach 2. The groundwater discharge from the Chino-North to the PBMZ that becomes rising groundwater discharge in the Santa Ana River has historically been small compared to total discharge in the Santa Ana River and has further decreased with the operation of the CCWF. Based on the trends observed since 2005, the Reach 2 TDS metric will likely continue to increase as other conditions that affect the flow and quality of the Santa Ana River change over time, such as the continued reduction of wastewater effluent discharges to the River, and/or an increase in the duration and frequency of dry periods due to climate change. Given that POTW effluent discharges are projected to further decline, the maintenance of hydraulic control of Chino-North will become increasingly important to protecting the water quality of the Santa Ana River at Prado Dam and downstream beneficial uses.

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<sup>27</sup> See Figure 2-3 of this report for modeling projections of groundwater discharge from Chino-North to the PBMZ past the CCWF.



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2022 Maximum Benefit  
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**TDS and Components of Discharge of the  
Santa Ana River at Prado Dam**  
Water Year 1971 to 2022

**Figure 4-3**

# Chino Basin Optimum Basin Management Program 2022 Maximum Benefit Annual Report



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Quarterly Pumping and Export of TDS and Nitrate by the  
Chino Basin Desalters from 2004 to 2022 (Digital)

The IEUA Five-Year, Volume-Weighted TDS and TIN  
Computation for Managed Aquifer Recharge

Table No. 1: TDS and NO<sub>3</sub>-N Data Table

Month	Volume (acre-feet)				TDS (mg/L)					NO <sub>3</sub> -N (mg/L)				
	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	373809		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	

Table No. 1: TDS and NO<sub>3</sub>-N Data Table

Month	Volume (acre-feet)				TDS (mg/L)					NO <sub>3</sub> -N (mg/L)				
	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	0	1,449	1,561	360	249	476	730624	243	1.7	0.1	4.3	6359	1.7
Oct-13	242	0	1,441	1,683	360	274	469	762469	245	1.7	0.0	4.7	7255	1.7
Nov-13	394	0	1,307	1,701	360	299	483	772794	247	1.7	0.1	4.5	6561	1.7
Dec-13	414	0	1,374	1,788	140	302	495	738433	251	1.1	0.4	4.6	6798	1.8

Table No. 1: TDS and NO<sub>3</sub>-N Data Table

Month	Volume (acre-feet)				TDS (mg/L)					NO <sub>3</sub> -N (mg/L)				
	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	1,145	1,308	339	331	514	643986	268	0.9	0.3	3.9	4641	1.9
Oct-14	87	0	1,247	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	4160	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
Jan-17	4712	0	431	5,143	86	292	479	609244	336	0.5	0.3	4.5	4419	2.7
Feb-17	1846	0	542	2,388	86	240	454	403660	334	0.5	0.6	4.8	3571	2.7
Mar-17	136	0	1598	1,734	86	170	441	715947	340	0.5	0.8	3.7	6018	2.8
Apr-17	81	1551	1517	3,149	86	130	441	877108	342	0.5	0.5	3.4	5987	2.8
May-17	194	0	1620	1,814	324	132	437	770616	342	<0.1	0.3	3.4	5477	2.8
Jun-17	26	6319	1141	7,486	324	94	435	1099173	328	<0.1	0.2	3.2	4895	2.6
Jul-17	68	7346	952	8,366	324	87	417	1057919	314	<0.1	0.2	4.1	5772	2.5
Aug-17	317	7068	932	8,317	324	102	423	1217994	302	<0.1	0.2	4.9	6326	2.4
Sep-17	53	3794	1307	5,154	267	115	415	992861	298	0.7	0.2	5.0	7428	2.3
Oct-17	83	4477	1433	5,993	267	121	396	1131570	292	0.7	0.2	4.2	7231	2.3
Nov-17	32	2480	1413	3,926	267	179	430	1060282	290	0.7	0.4	4.5	7422	2.3
Dec-17	23	4768	1591	6,381	306	176	424	1521360	289	2.2	0.5	4.0	8937	2.2



2022 Maximum Benefit Digital Database