December 23, 2013

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

Subject: Transmittal of the Draft 2014 Maximum Benefit Monitoring Program Work Plan and Proposed Schedule for Achieving Hydraulic Control.

Dear Mr. Berchtold,

The Chino Basin Watermaster (Watermaster) and Inland Empire Utilities Agency (IEUA) hereby submit the Draft 2014 Maximum Benefit Monitoring Program Work Plan.

The Regional Board adopted a Basin Plan Amendment on February 10, 2012 which required that Watermaster and the IEUA submit (1) an updated surface-water monitoring program by February 25, 2012 and (2) a revised groundwater monitoring plan and schedule for demonstrating 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 16, 2012. The 2012 Work Plan was adopted by the Regional Board under order R8-2012-0026 on March 16, 2012. Pursuant to (2), this letter and the enclosed Draft 2014 Maximum-Benefit Monitoring Program Work Plan contain the schedule and monitoring and data collection plan for complying with both maximum-benefit monitoring directives: demonstrating hydraulic control and computing ambient water quality every three years.

Plan and Schedule for the Achievement of Hydraulic Control

To date, the results of the Hydraulic Control Monitoring Program (HCMP) have shown that (i) hydraulic control east of Chino-I Desalter Well 5 has been achieved, (ii) hydraulic control west of Chino-I Desalter Well 5 has not been fully achieved, and (iii), currently, the impact of rising groundwater outflow from the Chino Basin on surface-water quality in the Santa Ana River is *de minimis*.

The plan for achieving hydraulic control in the area west of Chino-I Desalter Well 5 is to operate the Chino Creek Well Field (CCWF). In a letter from the Regional Board to Watermaster and the IEUA, dated October 12, 2011, the Regional Board defined *de minimis* flow of groundwater from Chino-North to the PBMZ as less than 1,000 acre-feet/yr through the CCWF. CCWF well construction was completed in 2012 and consists of Chino-I Desalter Well Nos. 16, 17, 18, 20, and 21. The final production capacity of the Chino Creek Well field will range between 1,500 acre-ft/yr and 1,800 acre-ft/yr.

The state of hydraulic control in the vicinity of the CCWF was evaluated with the re-calibrated 2013 Watermaster groundwater model (WEI, 2013).

Three hydraulic control simulations were performed for a range of CCWF production rates: no CCWF production (0 acre-ft/yr), 1,500 acre-ft/yr, and 1,800 acre-ft/yr. The model results indicated the following:

- The underflow of groundwater through the CCWF area without the CCWF operating is about 2,400 acre-ft/yr.
- The underflow of groundwater through the CCWF area at a production rate of about 1,500 acre-ft/yr (will be about 900 acre-ft/yr.
- The underflow of groundwater through the CCWF area at a production rate of 1,800 acre-ft will be about 600 acre-ft/yr.

Therefore, the operation of the CCWF as constructed is modeled to result in an underflow less than the *de minimis* threshold of 1,000 acre-ft/yr, as defined by the Regional Board.

Initiation of production from the CCWF is expected to proceed according to the following schedule:

MILESTONE	DATE MILESTONE ACHIEVED
CCWF will begin operating at a capacity of about 600 acre-ft/yr (Wells 16 and 17 online)	March 31, 2014
CCWF will begin operating at a capacity of about 1,500 acre-ft/yr (Wells 20 and 21 online)	December 31, 2014
CCWF will begin operating at a capacity of about 1,800 acre-ft/yr (Well 18 online-pending review of operational function and results of pilot treatment work)	April 30, 2016

Monitoring, Data Collection, and Reporting on the Achievement of Hydraulic Control

The questions that need to be answered by the monitoring and data collection program in the future are:

1. Will hydraulic control be maintained east of Chino-I Desalter Well 5?
2. Will the Chino Creek Well Field (CCWF) reduce groundwater flow past the desalter well field to *de minimis* amounts west of Chino-I Desalter Well 5?
3. Will the impact of rising groundwater outflow from the Chino Basin on surface-water quality in the Santa Ana River remain *de minimis*?

Section 2 of the Draft 2014 Maximum Benefit Monitoring Program Work Plan describes the methods to answer these questions, and the monitoring and data collection program required to answer the questions by the defined methods. In summary, these methods are:

1. Existing groundwater-level monitoring and periodic modeling will continue to be used to define the capture zone created by the existing Chino Desalter well fields.

2. Groundwater modeling will be used to calculate the amount of groundwater flowing past the CCWF (west of Chino-1 Desalter Well 5) to determine if the flow is *de minimis* or not. CCWF production data, groundwater level data from existing monitoring wells, and expanded groundwater-level monitoring at new monitoring wells constructed for the Prado Basin Habitat Sustainability Program (PBHSP) will be used to re-calibrate the Chino Model on a five-year schedule to calculate annual flow past the CCWF over the previous five-year period and estimate future flow past the CCWF based on pumping plans in the Chino Basin.

3. Continued analysis of Santa Ana River flow and quality at Below Prado Dam will determine the nature of the impact of rising groundwater.

Watermaster and the IEUA will submit the following reports to document their data collection efforts and to demonstrate compliance with the maximum benefit commitments.

- Chino Basin Maximum Benefit Annual Report: Watermaster and the IEUA will submit an annual report to the Regional Board on April 15^{th} of each year, describing the status of compliance with the maximum benefit commitments, which will include an Access Database of all maximum benefit monitoring data.

- Biennial State of the Basin Report: Watermaster prepares a State of the Basin Report every two years, which will include groundwater level contours within the HCMP study area that will demonstrate the direction of groundwater flow in the vicinity of the Chino Desalter well fields.

- Groundwater Modeling Reports: Watermaster will be recalibrating the Chino Basin Groundwater model approximately every five years. A detailed assessment of the state of hydraulic control will be included as part of model analysis, specifically to compute the annual groundwater underflow past the CCWF in the previous five years and to estimate future underflow based on the pumping plans in the Chino Basin.

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

Sincerely,

<u>Chino Basin Watermaster</u>

P. Kavounas

Peter Kavounas
General Manager

<u>Inland Empire Utilities Agency</u>

P. Joseph Grindstaff

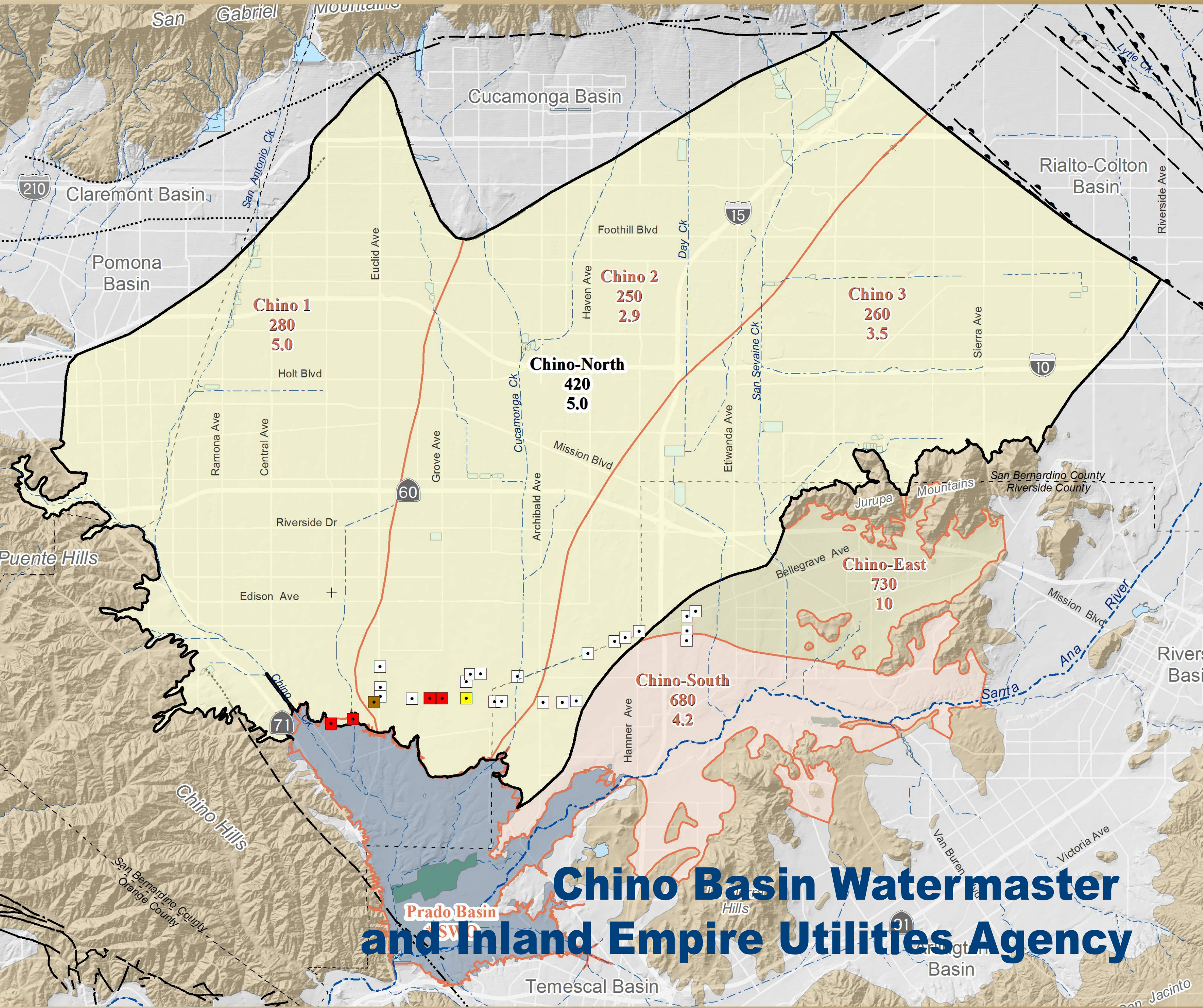
Joseph Grindstaff
General Manager

CC: Hope Smythe/Regional Water Quality Control Board
Samantha Adams/Wildermuth Environmental Inc.
Mark Wildermuth/Wildermuth Environmental Inc.

Enclosure: Draft 2014 Maximum Benefit Monitoring Program Work Plan

Optimum Basin Management Program
Maximum Benefit Monitoring Program
2014 Work Plan

Final



Chino Basin Watermaster and Inland Empire Utilities Agency

December 2013

WILDERMUTH™ ENVIRONMENTAL INC.

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Acronyms, Abbreviations, and Initialisms

Basin Plan	Water Quality Control Plan for the Santa Ana River Basin (Region 8)
CBDC	Chino Basin Data Collection
CCWF	Chino Creek Well Field
CDA	Chino Desalter Authority
DTSC	California Department of Toxic Substance Control
HCMP	Hydraulic Control Monitoring Program
IEUA	Inland Empire Utilities Agency
KWMP	Key Well Monitoring Program
mg/L	milligrams per liter
mgd	million gallons per day
NAWQA	National Water Quality Assessment Program
OBMP	Optimum Basin Management Program
OCWD	Orange County Water District
PBHSP	Prado Basin Habitat Sustainability Program
PBMZ	Prado Basin Management Zone
QA/QC	quality assurance/quality control
Regional Board	Regional Water Quality Control Board, Santa Ana Region
SARWC	Santa Ana River Water Company
SWP	State Water Project
TDS	total dissolved solids
TIN	total inorganic nitrogen
USGS	United States Geological Survey
VOC	volatile organic compound
Watermaster	Chino Basin Watermaster
1,2,3-TCP	1,2,3-Trichloropropane
TCE	Trichloroethylene
WEI	Wildermuth Environmental Inc.

Section 1 – Background and Objectives

This section provides background information on the events that led to the Chino Basin Optimum Basin Management Program (OBMP) and the 2004 Basin Plan Amendment, the concept of hydraulic control, the formation of the Hydraulic Control Monitoring Program (HCMP), and a summary of the results, conclusions, and recommendations of the first six years of HCMP implementation, which ultimately led to the 2012 Basin Plan Amendment and the need to prepare an updated monitoring program work plan.

This report describes the updated 2014 Maximum Benefit Monitoring Program work plan.[1]

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

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

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

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

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[1] The monitoring program was formerly named the Hydraulic Control Monitoring Program. It was renamed to the Chino Basin Maximum Benefit Monitoring Program because the objective of the monitoring program as a whole is to satisfy all of Watermaster and the IEUA's Maximum Benefit commitments in the Basin Plan, which include more than just a component to monitor for hydraulic control (refer to Section 1.3). This updated name gives more clarity to the scope of the monitoring program work plan.

A subsequent analysis, consistent with the OBMP and the Peace II Agreement, projected the increase in streambed infiltration to be about 20 percent of desalter production due to Chino Basin Watermaster's (Watermaster) reoperation plan alone (Wildermuth Environmental Inc. [WEI], 2009b). This projection resulted from evaluating the Peace II project description through 2060 with an updated groundwater flow model, using existing Chino Desalter wells and the planned Chino Creek Well Field (CCWF). The streambed infiltration resulting from the desalters and reoperation was estimated in 2013 as part of the Chino Basin model recalibration effort. The streambed infiltration including production from the desalters and reoperation is projected to be about 50 percent of desalter production in 2060 (WEI, 2013).

These studies suggest that the yield of the Chino Basin could be increased by simply increasing groundwater production near the river. These studies also suggest that an expanded desalter program (as shown in Figure 1-1) and a slight permanent decrease in basin storage will (1) capture all groundwater flowing south from the forebay regions of the Chino Basin and (2) reduce the outflow of high salinity groundwater from the southern Chino Basin to the Santa Ana River, thereby providing greater protection of downstream beneficial uses.

1.2 The OBMP and the 2004 Basin Plan Amendment

The Chino Basin OBMP was developed by Watermaster and the parties to the 1978 Judgment (Chino Basin Municipal Water District *v.* City of Chino *et al.*). The OBMP maps a strategy that will provide for the enhanced yield of the Chino Basin and seeks to provide reliable water supplies for development that is expected to occur within the Basin. The goals of the OBMP are: to enhance basin water supplies, to protect and enhance water quality, to enhance the management of the Basin, and to equitably finance the OBMP. The OBMP is a comprehensive, long-range water management plan for the Chino Basin and includes the use of recycled water for direct reuse and artificial recharge. It also includes the capture of increased quantities of high quality storm water runoff, the recharge of imported water when total dissolved solids (TDS) concentrations are low, improving the water supply by desalting poor quality groundwater, supporting regulatory efforts to improve water quality in the Basin, and the implementation of management activities that will result in the reduced outflow of high-TDS/high-nitrate groundwater to the Santa Ana River and the Orange County Basin, thus ensuring the protection of downstream beneficial uses and water quality (WEI, 1999).

For the Chino Basin, the 1995 Water Quality Control Plan for the Santa Ana River Basin (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 most of the Chino Basin. The ambient TDS concentrations in the Chino Basin exceeded these objectives, which meant that no assimilative capacity existed for most of the Basin. Therefore, the use of the Inland Empire Utilities Agency's (IEUA's) recycled water (that has a TDS concentration of about 500 mg/L) for irrigation and groundwater recharge—one of the key elements of the OBMP—would require mitigation even though recycled water reuse would not materially impact future TDS concentrations or impair the beneficial uses of Chino Basin groundwater.

In 1995, in part because of these considerations, the Regional Water Quality Control Board, Santa Ana Region (Regional Board) initiated a collaborative study with 22 water supply and wastewater agencies, including Watermaster and the IEUA, to devise a new TDS and nitrogen management plan for the Santa Ana Watershed. This study culminated in the Regional

Board's adoption of a Basin Plan amendment in January 2004 (Regional Board, 2004). This amendment included revised groundwater subbasin boundaries (termed "management zones"), revised TDS and nitrate-nitrogen objectives for groundwater, revised TDS and nitrogen wasteload allocations, revised reach designations, and revised TDS and nitrogen objectives and beneficial uses for specific surface waters. The technical work supporting the 2004 Basin Plan Amendment was directed by the Nitrogen/TDS Task Force (Task Force) and is summarized in *TIN/TDS Phase 2A: Tasks 1 through 5, TIN/TDS Study of the Santa Ana Watershed* (WEI, 2000).

The new TDS and nitrate-nitrogen objectives for the groundwater management zones in the Santa Ana Region were established to ensure that historical quality is maintained pursuant to the State's antidegradation policy (State Board Resolution No. 68-16). These objectives were termed "antidegradation" objectives. Figure 1-1 shows the antidegradation objectives for the Chino Basin management zones. Note that the antidegradation TDS objectives across most of the Chino Basin are still very low (250-280 mg/L), which would still restrict recycled water reuse and the artificial recharge of imported water.

To address this issue, Watermaster and the IEUA proposed, and the Regional Board accepted, alternative and less stringent "maximum-benefit" objectives for a large portion of the Chino Basin. Figure 1-1 shows the maximum-benefit objectives—specifically the 420 mg/L TDS objective for the Chino-North management zone. This maximum-benefit TDS objective is higher than the current ambient TDS concentration (340 mg/L in 2009), thus creating assimilative capacity and allowing for recycled water reuse and recharge without mitigation.

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

The Watermaster and IEUA's maximum-benefit demonstrations are contingent upon the implementation of specific projects and programs. These projects and programs are termed "Chino Basin maximum-benefit commitments" and are listed in Table 5-8a of the Basin Plan (Regional Board, 2008). These commitments include:

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

7. The management of volume-weighted TDS and nitrogen in artificial recharge to less than or equal to the maximum benefit objectives
8. The achievement and maintenance of "hydraulic control" of groundwater outflow from the Chino Basin to protect Santa Ana River water quality
9. The determination of ambient TDS and nitrogen concentrations of Chino Basin groundwater every three years

If these projects and programs are not implemented to the Regional Board's satisfaction, the antidegradation objectives would apply for regulatory purposes. In this situation, the Regional Board would require mitigation for TDS and nitrate-nitrogen discharges in these management zones that took place in excess of the antidegradation objective limits. The application of the antidegradation objectives would result in a finding that there is no assimilative capacity for TDS in the Chino-1, Chino-2, and Chino-3 management zones, thus eliminating the ability to recharge recycled water and imported State Water Project (SWP) water when TDS concentrations exceed the antidegradation objectives.

1.3 Maximum-Benefit Monitoring Commitments

The maximum-benefit commitments explicitly require Watermaster and the IEUA to implement surface water and groundwater monitoring programs (commitments #1 and #2). The purpose of these requirements are to ensure that Watermaster and the IEUA collect the requisite data (1) to demonstrate compliance with hydraulic control requirements (commitment #8) and (2) to recompute ambient water quality every three years (commitment #9). In May 2004, Watermaster and the IEUA submitted a work plan to the Regional Board: *Final Hydraulic Control Monitoring Program Work Plan for the Optimum Basin Management Program* (WEI, 2004). The Regional Board adopted Resolution R8-2005-0064[2]approving this work plan and required Watermaster and the IEUA to implement the HCMP.

1.3.1 Hydraulic Control Monitoring Program

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 the Chino-North management zone to the Prado Basin management zone (PBMZ), or controlling the discharge to *de minimis* levels. The concept of using multiple lines of evidence was included in the initial design of the HCMP because it was not clear at the time whether one line of evidence would clearly demonstrate hydraulic control. Both the Orange County Water District (OCWD) and the Regional Board wanted multiple lines of evidence. These multiple lines of evidence are summarized as follows:

[2] Resolution Approving the Chino Basin and Cucamonga Basin Maximum Benefit Surface Water and Groundwater Monitoring Program Proposals as Required in the Total Dissolved Solids and Nitrogen Management Plan Specified in the Water Quality Control Plan for the Santa Ana River Basin.

1. Collect and analyze groundwater-elevation data to determine the direction of groundwater flow in the southern part of the Basin and whether pumping at the Chino Desalter well fields is completely capturing all groundwater that would otherwise discharge out of the Chino-North management zone and into the PBMZ.
2. Collect and analyze the chemistry of basin-wide groundwater and the Santa Ana River (a) to track the migration, or lack thereof, of the Archibald South volatile organic compound (VOC) plume beyond the Chino Desalter well fields and (b) to identify the source of groundwater in the area between the Santa Ana River and the Chino Desalter well fields.
3. 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 percolating and recharging the Basin.
4. Use Watermaster's computer-simulation groundwater-flow model to corroborate the results and interpretations of the first three lines of evidence.

Based on the data from 2004 through 2011, Watermaster and the IEUA concluded that hydraulic control has been achieved across the central and eastern portions of the Chino Desalter well fields, but some groundwater discharge occurs from Chino-North to the PBMZ west of Chino-I Desalter Well 5 (WEI, 2007; WEI 2008; WEI 2009a; WEI 2010; WEI 2011; WEI 2012). The Chino Basin Desalter Authority (CDA) is constructing the CCWF to gain hydraulic control west of Chino-I Desalter Well 5 (see Figure 1-1).

Watermaster and the IEUA also concluded that data collected as part of the surface water monitoring program was not necessary to determine the state of hydraulic control.[3] The 2009 Maximum Benefit Monitoring Program Annual Report (WEI, 2010) recommended that:

1. *The elimination of groundwater discharge from Chino-North to the PBMZ by the Chino Desalter well fields, or the control of the discharge to* de minimis *levels, is the measureable definition of hydraulic control.*
2. *Future annual reports should focus on the analysis of groundwater data (piezometric levels and groundwater quality) since these are the main data sets used to show the extent of complete capture of Chino-North groundwater by the Chino Desalter well fields.*
3. *Future annual reports should deemphasize the analysis of surface water data (flow and water quality) since these data are not necessary to show the extent of the complete capture of Chino-North groundwater by the Chino Desalter well fields. Future annual reports should continue to report on the flow and quality of the Santa Ana River at*

[3] A large majority of the surface water and treatment plant data collected (primarily from those monitoring sites located on the tributaries of the Santa Ana River, such as Cucamonga, Mill, and Temescal Creeks) have not been used, or needed, to demonstrate hydraulic control. Furthermore, estimating rising groundwater based on direct stream flow measurements along the Santa Ana River has been problematic: all of the inflows in a given reach cannot be quantified. Some of these inflows can change during the period in which upstream and downstream discharge measurements are taken, and discharge in the Santa Ana River can change at the discharge measurement stations in the period between upstream and downstream measurements.

Below Prado as a check on the conclusion that the influence of rising groundwater in the Prado Basin on the flow and quality of the Santa Ana River is de minimis*.*

4. *If Watermaster and the IEUA have satisfied all other Chino Basin maximum benefit commitments, the Regional Board should reduce the surface-water monitoring commitments in the Chino Basin Maximum Benefit Monitoring Program as they are currently defined in the Basin Plan.*

The Regional Board adopted an amendment to the Basin Plan on February 10, 2012 to implement these recommendations. This amendment removed all references to specific monitoring locations and sampling frequencies for surface-water monitoring 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 draft revised groundwater monitoring plan and schedule for demonstrating 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 16, 2012 (WEI, 2012). The 2012 Work Plan was adopted by the Regional Board under order R8-2012-0026 on March 16, 2012. Pursuant to (2), this 2014 Maximum-Benefit Monitoring Program Work Plan contains the updated monitoring and data collection plan for complying with both maximum-benefit monitoring directives: demonstrating hydraulic control and computing ambient water quality every three years.

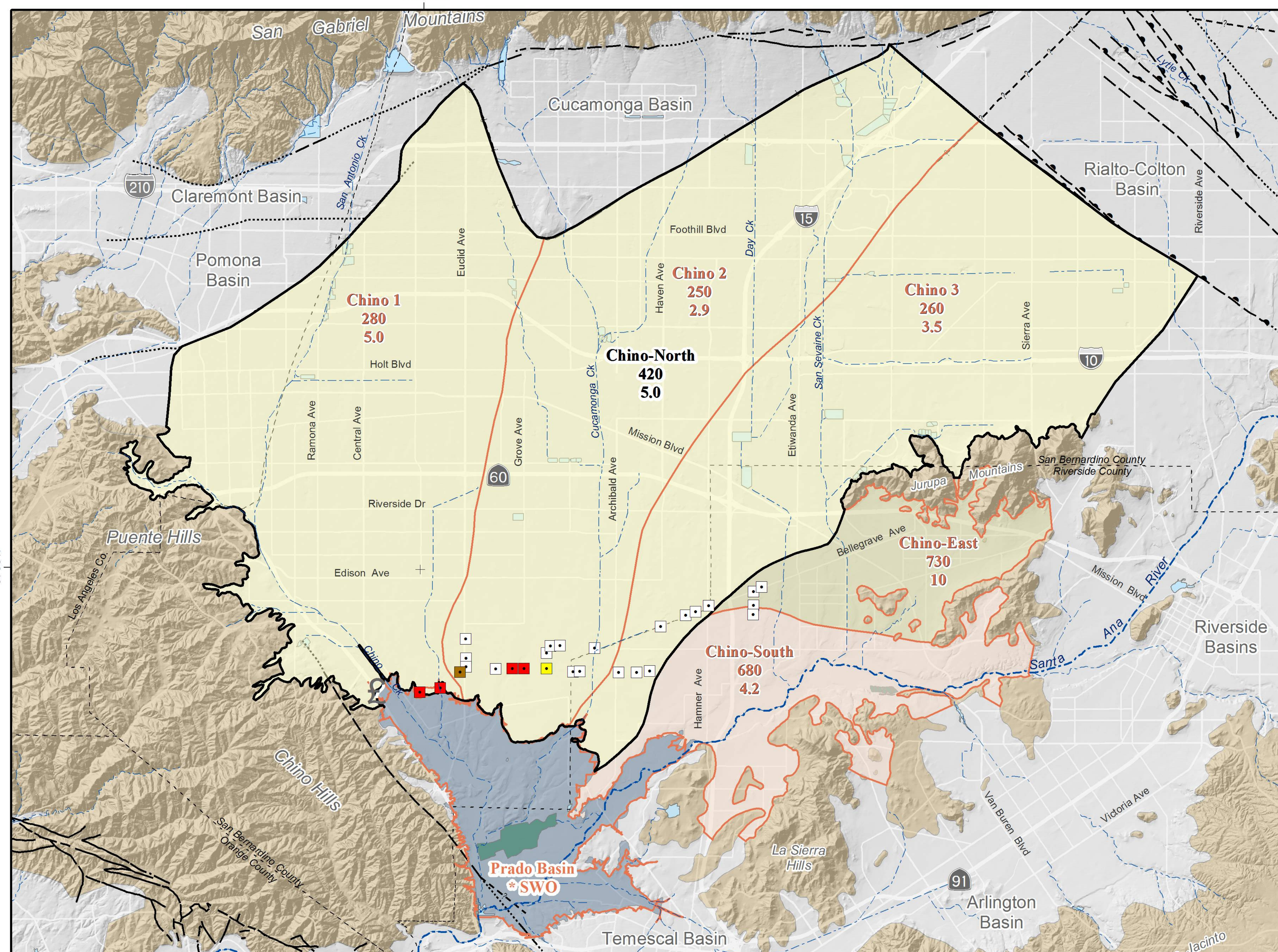
1.4 2014 Maximum-Benefit Monitoring Program Work Plan Report Organization

The remainder of this report describes the monitoring and data collection programs that Watermaster and the IEUA will implement to satisfy the maximum-benefit commitments to demonstrate hydraulic control and compute ambient water quality. The remaining sections include:

Section 2: This section describes the questions to be answered by the Hydraulic Control Monitoring Program, the methods to answer those questions, and the monitoring and data collection program required to answer the questions by the defined methods.

Section 3: This section describes the ambient water quality recomputation and the monitoring and data collection programs required to perform the triennial recomputation.

Section 4: This section describes the reports that Watermaster and the IEUA will prepare to document compliance with the maximum benefit monitoring commitments.



Antidegradation Management Zones

Anti-Degradation Management Zone Boundaries

Chino 3 — Management Zone Name
260 — TDS Objective (mg/L)
3.5 — Nitrate-Nitrogen Objective (mg/L)

Maximum Benefit Management Zones

Chino-North Management Zone Boundary

Chino-North — Management Zone Name
420 — TDS Maximum Benefit Objective (mg/L)
5.0 — Nitrate-Nitrogen Maximum Benefit Objective (mg/L)

*SWO = Surface Water Objective Only

Other Features

- Chino Desalter Well
- Chino-I Desalter Well No. 5
- Chino Creek Desalter Well
- Chino-I-CCWF Well No. 18
- Rivers and Streams
- Flood Control and Conservation Basins
- Constructed Wetlands

Geology

Water-Bearing Sediments

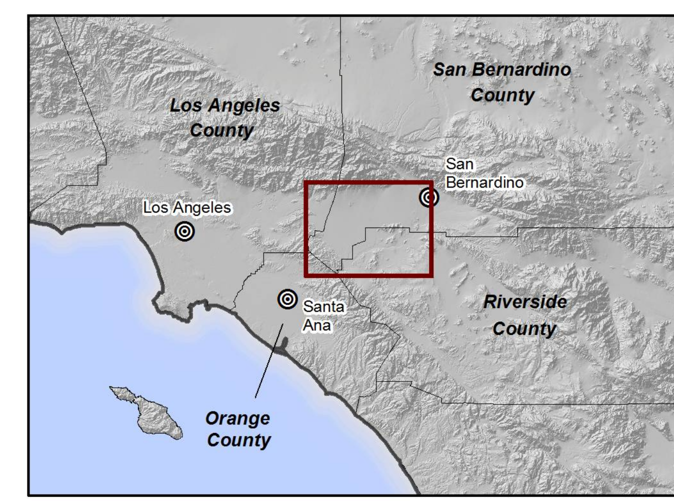
- Quaternary Alluvium

Consolidated Bedrock

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

Faults

- Location Certain
- Location Concealed
- Location Approximate
- Location Uncertain



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Chino Basin Maximum Benefit Monitoring Program
Draft 2014 Work Plan

Chino Basin Management Zones

Antidegradation & Maximum Benefit Objectives for TDS and Nitrate-Nitrogen

Figure 1-1

To date, the results of the HCMP have shown that (i) hydraulic control east of Chino-I Desalter Well 5 has been achieved, (ii) hydraulic control west of Chino-I Desalter Well 5 has not been fully achieved, and (iii), currently, the impact of rising groundwater outflow from the Chino Basin on surface-water quality in the Santa Ana River is *de minimis*.

The questions that need to be answered by the HCMP in the future are:

1. Will hydraulic control be maintained east of Chino-I Desalter Well 5?
2. Will the CCWF reduce groundwater flow past the desalter well field to *de minimis* amounts west of Chino-I Desalter Well 5?
3. Will the impact of rising groundwater outflow from the Chino Basin on surface-water quality in the Santa Ana River remain *de minimis*?

Watermaster and the IEUA will use the following methods to answer these questions.

Method to Address Question 1. Existing groundwater-level monitoring and periodic modeling will continue to be used to define the capture zone created by the existing Chino Desalter well fields (e.g. develop groundwater elevation contours from both measured data and model generated data). These methods will be sufficient to demonstrate hydraulic control in this area in the future.

Method to Address Question 2. In a letter from the Regional Board to Watermaster and the IEUA, dated October 12, 2011, the Regional Board defined *de minimis* flow of groundwater from Chino-North to the PBMZ as less than 1,000 acre-feet/yr based on 2009 computer-simulation modeling of groundwater flow with the CCWF in operation. CCWF well construction was completed in 2012 and consists of Chino-I Desalter Well Nos. 16, 17, 18, 20, and 21. The final production capacity of the Chino Creek Well field will range between 1,500 acre-ft/yr and 1,800 acre-ft/yr.

The state of hydraulic control in the vicinity of the CCWF was evaluated with the re-calibrated 2013 Watermaster groundwater model (WEI, 2013). Three hydraulic control simulations were performed for a range of CCWF production rates: no CCWF production (0 acre-ft/yr)1,500 acre-ft/yr and 1,800 acre-ft/yr. The model results indicated the following:

- The underflow of groundwater through the CCWF area without the CCWF operating is about 2,400 acre-ft/yr.
- The underflow of groundwater through the CCWF area at a production rate of about 1,500 acre-ft/yr (will be about 900 acre-ft/yr.
- The underflow of groundwater through the CCWF area at a production rate of 1,800 acre-ft will be about 600 acre-ft/yr.

Therefore, the operation of the CCWF as constructed is modeled to result in an underflow less than the *de minimis* threshold of 1,000 acre-ft/yr, as defined by the Regional Board.

Groundwater modeling will be used to calculate the amount of groundwater flowing past the CCWF (west of Chino-1 Desalter Well 5) to determine if the flow is *de minimis* or not. CCWF production data, groundwater level data from existing monitoring wells, and expanded groundwater-level monitoring at new monitoring wells constructed for the Prado Basin

Habitat Sustainability Program (PBHSP) will be used to re-calibrate the Chino Model on a five-year schedule to calculate annual flow past the CCWF over the previous five-year period and estimate future flow past the CCWF based on pumping plans in the Chino Basin.

Method to Address Question 3. The HCMP has shown that currently the impact of rising groundwater outflow from the Chino Basin on surface-water quality in the Santa Ana River is *de minimis*. Groundwater modeling suggests that the implementation of the Peace II Agreement (i.e. the CCWF and basin re-operation) will further decrease the volume of rising groundwater outflow to the Santa Ana River and thereby further reduce its impact on the River's water quality. Continued monitoring and analysis of Santa Ana River flow and quality will determine the nature of the impact of rising groundwater.

The following sections describe the groundwater and surface water monitoring program and data collection efforts required to address these three questions.

2.1 Groundwater-Level Monitoring and Data Collection

Watermaster implements various groundwater-level monitoring and data collection efforts that were designed and implemented to support the OBMP program elements and the other regulatory requirements of Watermaster and the IEUA. These programs are described below. Watermaster and the IEUA will use the data collected from these programs to (1) determine the direction of groundwater flow in the southern part of the Basin and whether pumping at the Chino Desalter well fields is capturing groundwater that would otherwise discharge out of Chino-North to the PBMZ and (2) periodically recalibrate the Chino Groundwater Model to calculate the amount of groundwater underflow through the CCWF area.

Currently, about 1,100 wells comprise Watermaster's groundwater-level monitoring programs. These wells are shown in Figure 2-1, symbolized by their measurement frequency.

Chino Basin Watermaster groundwater-level monitoring programs. Water levels are measured by Watermaster staff using manual methods once per month or with pressure transducers that record water levels at 15-minute intervals at about 200 private wells or dedicated monitoring wells, located mainly in the southern portion of the Chino Basin. The wells in the monitoring program within the southern portion of the Basin were preferentially selected to assist in Watermaster's evaluation of hydraulic control, land subsidence, and desalter impacts to private well owners. Note that the density of groundwater level monitoring wells near the desalter well fields is greater than in outlying areas, given that hydraulic gradients are expected to be steeper near the desalter well fields. The following groups of wells are monitored as part of the HCMP:

- **HCMP Wells.** The wells specific to the HCMP are the nine nested sets of monitoring wells (HCMP-1 through HCMP-9) that were drilled and installed in 2004 and 2005. The pressure transducers installed in these wells record groundwater level measurements at 15-minute intervals. Watermaster downloads and recalibrates the transducers on a quarterly basis.
- **Private Wells.** Watermaster staff monitors groundwater levels at about 74 private wells in the southern portion of the Chino Basin manually once per month.

- **Desalter Wells.** Watermaster staff monitors groundwater levels at the desalter wells manually once per month or with pressure transducers. Watermaster downloads and recalibrates the transducers on a quarterly basis.

- **Prado Basin Habitat Sustainability Program (PBHSP).** Watermaster and the IEUA, through the Prado Basin Habitat Sustainability Committee, plan to install single and dual-clustered monitoring wells at nine locations between the desalter well field and Prado Dam to monitor groundwater in the perched and regional groundwater aquifers. The objectives of the HCMP were considered in locating these wells. Pressure transducers will be installed in the PBHSP wells upon completion to measure groundwater levels as part of the Prado Basin Habitat Sustainability Program. These wells are expected to be complete in early 2014. The hydrologic environment of each well will be assessed and, if appropriate, groundwater level data from these wells will be used for the assessment of hydraulic control.[4] Figure 2-1 shows the proposed locations of the PBHSP wells.

Chino Basin Data Collection. Groundwater levels at the remaining 900 wells are measured by well owners, which include municipal water agencies, the California Department of Toxic Substance Control (DTSC), the County of San Bernardino, and various private consulting firms. The measurement frequency is typically once per month. Watermaster collects these water level data twice per year. The County of San Bernardino, Department of Airports also installed a series of monitoring wells in the vicinity of the Chino Airport plume and may drill additional wells in the future.

All field activities performed by Watermaster staff for these projects are in general accordance with the guidelines established by the California EPA (1994) and the US EPA (1998) and summarized in the Standard Operating Procedures in Appendix A. These protocols are followed to ensure the collection of high quality and well documented data. Water-level data are checked by Watermaster staff for Quality Assurance/Quality Control (QA/QC) and uploaded to HydroDaVE℠, a centralized relational database.

2.2 Groundwater and Surface-Water Quality Monitoring and Data Collection

The objectives of the groundwater and surface-water monitoring and data-collection components for the demonstration of hydraulic control are: (1) to characterize the groundwater/surface water interactions along the Santa Ana River and (2) to characterize the influence of rising groundwater on the flow and quality of the Santa Ana River at Prado Dam.

2.2.1 Groundwater and Surface-Water Quality Monitoring

Watermaster will collect quarterly water-quality samples from four near-river wells and two surface water sites in the Santa Ana River. The shallow monitoring wells along the Santa Ana River consist of two former USGS National Water Quality Assessment Program (NAWQA)

[4] Wells screened in perched layers will not be used in contouring efforts to determine regional groundwater elevation.

wells (Archibald 1 and Archibald 2) and two Santa Ana River Water Company (SARWC) wells (Well 9 and Well 11). The two surface water stations are SAR at Etiwanda and SAR at River Road. These sites are shown in Figure 2-2.

The groundwater and surface-water samples will be tested, at a minimum, for the analytes shown in Tables 2-1 and 2-2, respectively. Groundwater and surface-water sample handling, documentation, and submittal for laboratory analysis will follow the procedures outlined in Appendix A. All groundwater and surface water quality data are checked by Watermaster staff for QA/QC and uploaded to HydroDaVE^{SM}. The data will be analyzed and compared using Piper diagrams and time-series charts of water character index and TDS to characterize the Santa Ana River as a losing or gaining reach at each monitoring location.

2.2.2 The Influence of Rising Groundwater on the Santa Ana River

The data published by the Santa Ana River Watermaster will be collected annually and used to characterize the influence of rising groundwater on the flow and quality of the Santa Ana River and to determine if there is an observable impact on the surface water quality at Below Prado under the current state of hydraulic control. Specifically, these data will be used (1) to create time-series charts of the estimated annual net contribution of rising groundwater to the flow of the Santa Ana River and (2) to compute the five-year moving average of the annual flow-weighted TDS concentration of the Santa Ana River at Below Prado, which is the metric the Regional Board uses to determine compliance with the TDS objective for Reach 2 of the Santa Ana River.

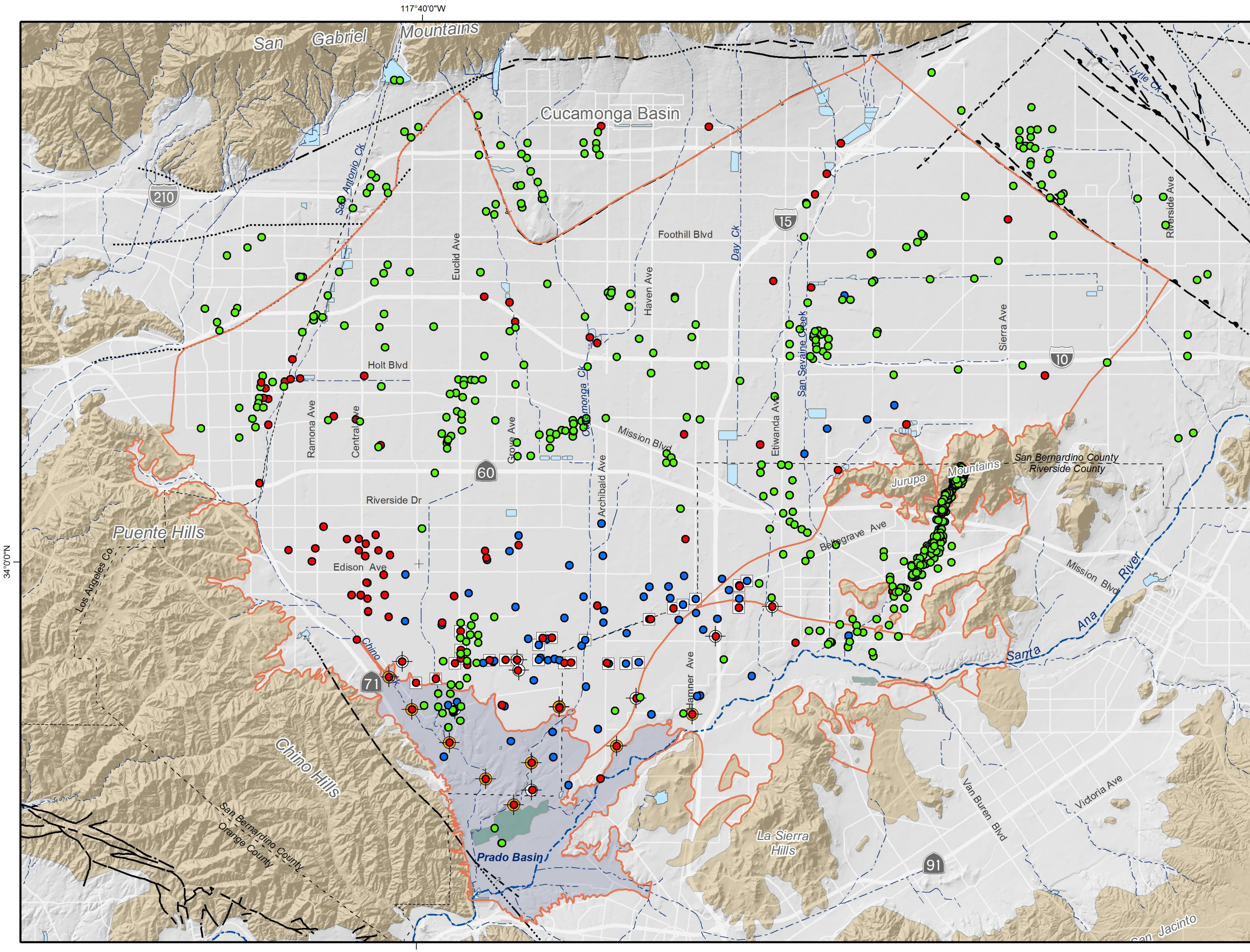
Table 2-1
Analyte List for the Groundwater Quality Monitoring Program

Analytes	Method
Major cations: K, Na, Ca, Mg	EPA 200.7
Major anions: Cl, SO_4, NO_2, NO_3	EPA 300.0
Total Alkalinity (incl. Bicarbonate, Carbonate, Hydroxide	SM 2320B
Boron	EPA 200.7
Chromium, Hexavalent	EPA 218.6
Chromium, Total	EPA 200.8
Ammonia-Nitrogen	EPA 350.1
Perchlorate	ML/EPA 314
pH	SM 4500-HB
Specific Conductance	SM 2510B
Total Dissolved Solids	E160.1/SM2540C
Total Hardness	SM 2340B
Total Kjeldahl Nitrogen (TKN)	EPA 351.2
Turbidity	EPA 180.1
Total Organic Carbon	SM5310C/E415.3
VOCs[1]	SM 8260

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

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

Analytes	Method
Major cations: K, Na, Ca, Mg	EPA 200.7
Major anions: Cl, SO_4, NO_2, NO_3	EPA 300.0
Total Alkalinity (including Bicarbonate, Carbonate, 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 Hardness	SM 2340B
Total Kjeldahl Nitrogen (TKN)	EPA 351.2
Turbidity	EPA 180.1
Total Organic Carbon	SM5310C/E415.3



Basin-Wide Monitoring Program by Measurement Frequency

- Monthly Measurement (74 Wells)
- Measurement by Transducer (136 Wells)
- Owner Measures Water Level (876 Wells)
- HCMP Monitoring Wells
- Proposed Prado Basin Habitat Sustainability Program (PBHSP) Wells

Other Features

- Chino Basin Maximum Benefit Management Zone Boundaries
- Prado Flood Control Basin
- Chino Desalter Well
- Rivers and Streams
- Flood Control and Conservation Basins
- Constructed Wetlands

Geology

Water-Bearing Sediments

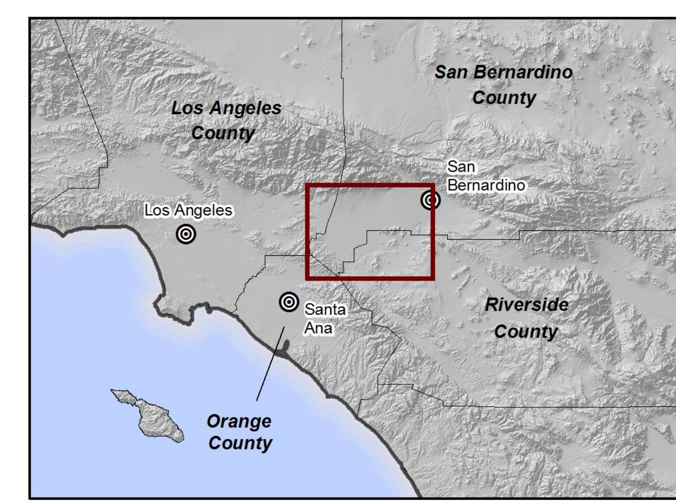
- Quaternary Alluvium

Consolidated Bedrock

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

Faults

- Location Certain
- Location Approximate
- Location Concealed
- Location Uncertain



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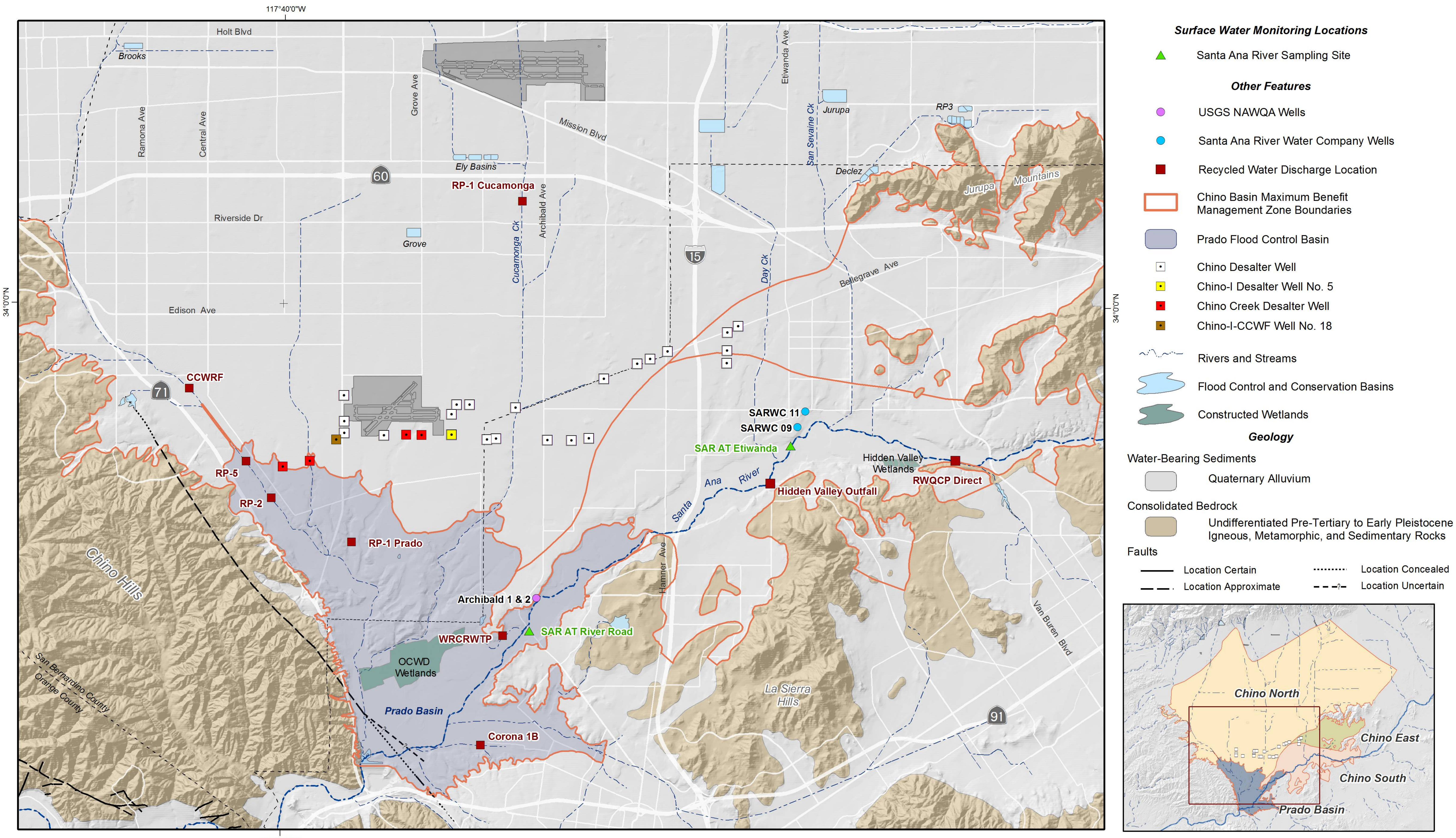
File: Figure 2-1.mxd

0 1 2 3 4 Miles
0 2 4 6 KM

Chino Basin Maximum Benefit Monitoring Program
Draft 2014 Work Plan

Groundwater-Level Monitoring Program

Figure 2-1



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Chino Basin Maximum Benefit Monitoring Program
Draft 2014 Work Plan

Surface-Water Monitoring Program

Figure 2-2

The 2004 Basin Plan Amendment directed members of the Basin Monitoring Program Task Force (Task Force) to supervise and oversee the recomputation of ambient water quality, among other related tasks (Regional Board, 2004). The recomputation of ambient water quality is completed triennially pursuant to the 2004 Basin Plan Amendment. The Santa Ana Watershed Project Authority (SAWPA) administers the triennial recomputation effort on behalf of the Task Force.

Specifically, the 2004 Basin Plan Amendment states: "Data to be collected and analyzed shall address, at a minimum: (1) determination of current ambient quality in groundwater management zones; (2) determination of compliance with TDS and nitrate-nitrogen objectives for the management zones; (3) evaluation of assimilative capacity findings for groundwater management zones; and (4) assessment of the effects of recharge of surface water POTW discharges on the quality of affected groundwater management zones" (WEI, 2011). Basin-wide groundwater-level and groundwater-quality data are needed to achieve these objectives.

The Chino Basin maximum-benefit commitments require Watermaster and the IEUA to compute ambient TDS and nitrogen concentrations of Chino Basin groundwater every three years. To comply with this requirement, Watermaster and the IEUA participate in the SAWPA ambient water quality recomputation effort by contributing a share of the funding to perform the technical work and providing the data needed to perform the analysis in the Chino-North, Chino-East, and Chino-South management zones. The following monitoring programs are conducted to provide data in sufficient temporal and spatial density to support the ambient water quality recomputation. The data are provided to SAWPA and its consultants on a triennial basis.

3.1 Groundwater-Level Monitoring Programs

As described in Section 2, Watermaster implements various groundwater-level monitoring and data collection efforts, which were designed and implemented to support the OBMP program elements and to demonstrate hydraulic control. The groundwater-level data collected through these monitoring efforts are of sufficient spatial and temporal density to support the ambient water quality determination. Please refer to Section 2 of this report for details on the groundwater-level monitoring and data collection programs.

3.2 Groundwater-Quality Monitoring Programs

Watermaster implements various groundwater-quality monitoring and data collection efforts, which were designed and implemented to support the OBMP program elements and the other regulatory requirements of Watermaster and the IEUA. In addition to the HCMP groundwater quality monitoring described in Section 2, the water-quality monitoring programs include the Chino Basin Data Collection Program (CBDC) and the Key Well Groundwater Quality Monitoring Program (KWGQMP). The locations of wells with water quality data are shown in Figure 3-1.

Chino Basin Data Collection. Watermaster's CBDC program routinely and proactively collects groundwater quality data from municipal producers and other government agencies.

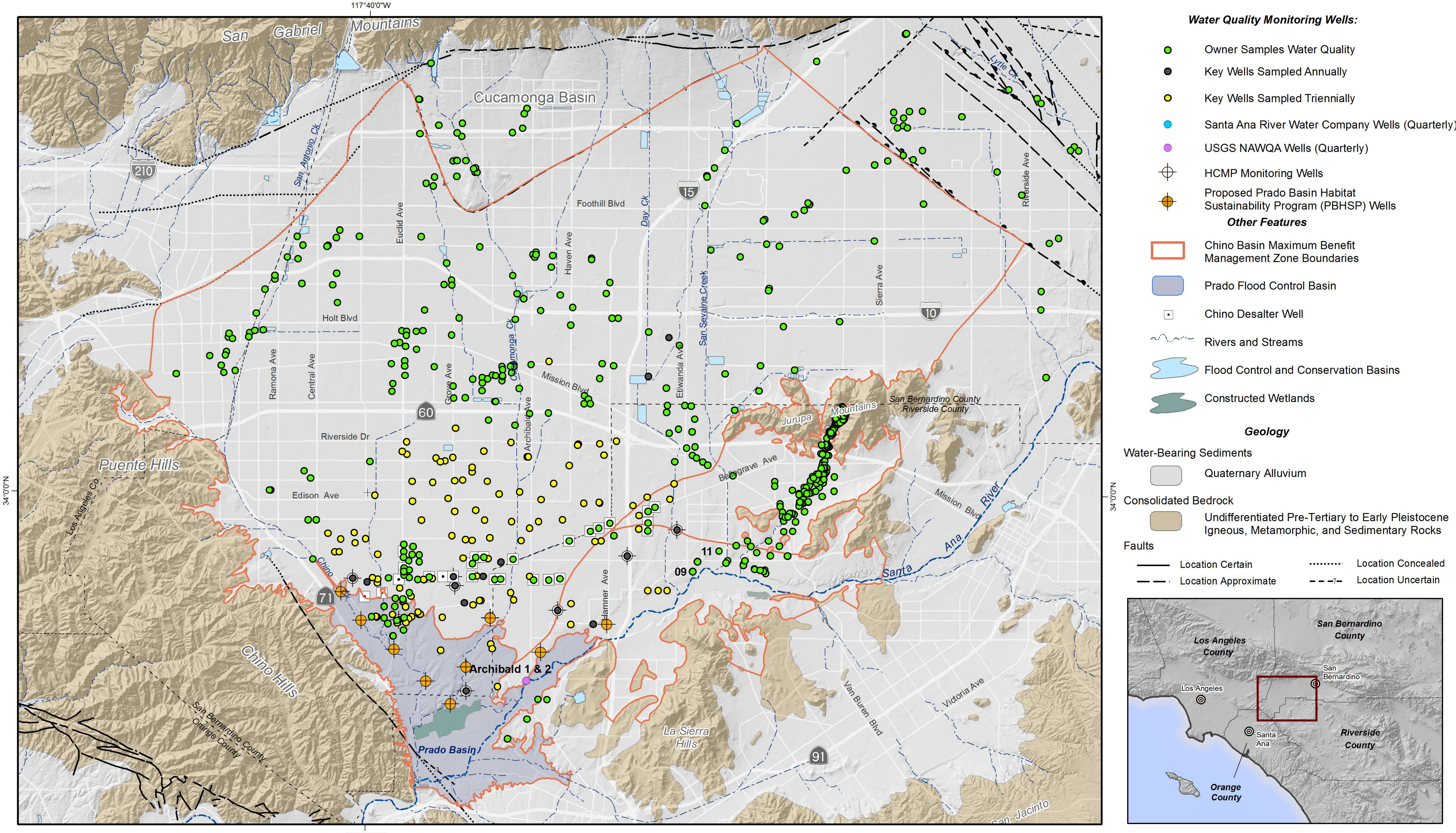
Water quality data are also obtained from special studies and monitoring that takes place under the orders of the Regional Board (recycled water recharge permits, landfills, groundwater quality investigations, etc.), the DTSC (Stringfellow NPL site), the US Geological Survey (USGS), and others. Watermaster has worked closely with Appropriative Pool members and their state-certified laboratories to obtain water quality data as electronic data deliverables directly from each laboratory. The water quality data are checked by Watermaster staff for QA/QC and uploaded to HydroDaVE^{SM}.

Key Well Groundwater Quality Monitoring Program. The objective of the KWGWQMP is to supplement water quality data collected through the CBDC to fill spatial data gaps across the Basin. To the extent possible, Watermaster relies on existing private and monitoring wells to fill the data gaps. Several well groups, installed for various purposes, are sampled for the KWGWQMP:

- **Private wells.** Watermaster staff collects groundwater quality samples from a network of about 120 private wells in the southern portion of the Chino Basin. About twenty of these wells, located in proximity to known VOC plumes, are sampled every year; the remaining wells are sampled every three years.
- **Existing monitoring wells.** Watermaster staff collects annual groundwater quality samples from the 21 HCMP monitoring wells, six MZ-3 monitoring wells, and five Former Kaiser Steel monitoring wells annually.
- **New monitoring wells.** Watermaster staff will collect annual groundwater quality samples from the three new PBHSP monitoring wells that are located within the Chino-North management zone (see Figure 3-1).

Groundwater samples collected by Watermaster staff for the KWGWQMP are tested, at a minimum, for the analytes listed in Table 2-1. All field activities performed by Watermaster staff for these projects are in general accordance with the guidelines established by the California EPA (1994) and the US EPA (1998) and summarized in the Standard Operating Procedures in Appendix A. These protocols are followed to ensure the collection of high quality and well documented data. All groundwater quality data are checked by Watermaster staff for QA/QC and uploaded to HydroDaVE^{SM}.

Watermaster is constantly revising the KWGWQMP as private wells are abandoned due to urban development. Watermaster and the IEUA may need to construct additional monitoring wells in the future as private agriculture wells are lost to the urbanization of the Basin. As part of the triennial ambient water quality recomputation, SAWPA identifies critical data gaps that could impact future ambient water quality determinations. Watermaster and the IEUA will evaluate the need to fill any data gaps identified by SAWPA.



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File: Figure 3_1.mxd

0 1 2 3 4 Miles

0 2 4 6 KM

Chino Basin Maximum Benefit Monitoring Program
Draft 2014 Work Plan

Groundwater-Quality Monitoring Program

Figure 3-1

Watermaster and the IEUA will submit the following reports to document their data collection efforts and to demonstrate compliance with the maximum benefit commitments.

1. **Chino Basin Maximum Benefit Annual Report:** Watermaster and the IEUA will submit an annual report to the Regional Board on April 15th of each year, describing the status of compliance with the maximum benefit commitments. The annual report will include a Microsoft Access database containing all groundwater-level and groundwater-quality data collected[5] as well as the following report sections:

   Section 1 – Introduction: Section 1 will describe the background that led to the development of the maximum-benefit objectives and the associated maximum-benefit commitments for the Chino Basin.

   Section 2 – Maximum-Benefit Commitment Compliance: Section 2 will describe the status of compliance with each of the maximum-benefit commitments. This section will include a description of the state of hydraulic control as described in the latest State of the Basin Report (see #2 below) or Chino Groundwater Model Report (see #3 below) if applicable. This section will also reference the latest ambient water quality results published by SAWPA.

   Section 3 – Maximum Benefit Monitoring Program Data Collection: Section 3 will describe the data collected during the reporting year as part of the maximum benefit monitoring program.

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

   Section 5 – References: Section 5 will provide the references consulted in performing the analyses described in writing the report.

2. **Biennial State of the Basin Report:** Watermaster prepares a State of the Basin Report every two years. The State of the Basin Report will include groundwater level contours within the HCMP study area that will demonstrate the direction of groundwater flow in the vicinity of the Chino Desalter well fields. The report will include a characterization of the state of hydraulic control based on the groundwater elevation contours. Watermaster and the IEUA will submit a copy of this report to the Regional Board beginning June 30, 2015 and every two years thereafter. Any hydraulic control findings in the State of the Basin Report will be referenced in the Chino Basin Maximum Benefit Annual Report.

3. **Groundwater Modeling Reports:** Watermaster will be recalibrating the Chino Basin Groundwater model approximately every five years. A detailed assessment of the state of hydraulic control will be included as part of model analysis, specifically to

[5] Well location, construction details, and groundwater quality data of privately owned wells are excluded from this database pursuant to confidentiality agreements between the Watermaster and the private well owners.

compute the annual groundwater underflow past the CCWF in the previous five years and to estimate future underflow based on the pumping plans in the Chino Basin. The preliminary schedule for completing the next model recalibration is June 30, 2018. This schedule is consistent with the modeling schedule needed to recompute the Safe Yield of the Chino Basin in 2020 as prescribed by the Watermaster Rules and Regulations. Any hydraulic control findings will be referenced in the Chino Basin Maximum Benefit Annual Report.

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Appendix A

Standard Operating Procedures (SOP)

Table of Contents

1.1 Scope and Application

This SOP sets the guidelines for determining the depth to water in an open borehole, cased borehole, production well, monitoring well, or piezometer.

1.2 Method Summary

Generally, water level measurements from boreholes, piezometers, production wells, or monitoring wells are used to construct water table or potentiometric surface maps. Ideally, water level measurements within a given study area should be collected within a 24-hour period. Certain situations may necessitate that all water level measurements be taken within a shorter time interval. These situations may include:

- the magnitude of observed changes between wells appears too large
- atmospheric pressure changes
- aquifers that are tidally influenced
- aquifers affected by river stage, impoundments, and/or unlined ditches
- aquifers stressed by intermittent pumping of production wells
- aquifers being actively recharged due to precipitation events

However, water level collection within a large groundwater basin can require a longer period to complete.

A survey mark or reference point (RP) must be placed on the casing or sounding tube for use as an RP for measurement. Many times the lip of the riser pipe or sounding tube will not be flat, so the exact location of measurement must be marked. Another measuring reference must be placed on the grout apron or ground surface. This reference is referred to as the site point (SP). Both the RP and SP should be documented on the site sketch and by photograph.

Data should be collected from the least to the most contaminated wells (if necessary). Working with decontaminated equipment, lower the water level measurement device into the well until the water surface or bottom of the casing is encountered. Measure the distance from the water surface to the RP on the well casing and record on the field data sheet. An example of the field data sheet for measuring groundwater levels is included as Attachment A. Repeat the measurement at least twice, 5 minutes apart, to ensure the quality of the measurement. Remove all downhole equipment and replace the well casing cap. Decontaminate as directed in the project work plan or in *Section 8 – Decontamination of Field Equipment* of this SOP document between each well and at the end of the day.

1.3 Interferences and Potential Problems

- The chalk used on steel tape may contaminate a well. Check the chalk type against well water quality requirements before using this method.

- Some types of electric sounders use metal indicators at 5-foot intervals around a conducting wire. These intervals should be checked with a surveyor's tape periodically to ensure accuracy.
- If oil is present on the water surface, it can insulate the contacts of the probe on an electric sounder or give false readings due to the thickness of the oil. Determining the thickness and density of the oil layer is warranted in order to determine the correct water level. Measure the top of the water surface, below the oil, using a steel tape with oil indicating paste or an equivalent method. Record this level, and note the presence of oil in the well on the field data sheet. Record the level of the top of the oil. The true water level can be estimated by adding three-quarters of the thickness of the oil layer to the oil-water interface elevation (U.S. Geological Survey, 2006).
- Turbulence in a well and/or cascading water can make water level determination difficult with either an electric sounder or steel tape.
- Water levels in newly constructed wells should be allowed to stabilize for a minimum of 24 hours prior to measurement after well construction and development. In low yield situations, recovery may take longer.
- The designated RP should be used at all times to ensure consistency. If the designated RP is not available or was modified or destroyed, a new RP must be designated and documented.
- An airline measures drawdown during pumping. It is only accurate to 0.5 feet unless it is calibrated for various "drawdowns."
- Water levels should be checked at least twice, 5 minutes apart, for consistency and repeatability and to ensure that the water level is not being affected by nearby pumping, cessation of pumping, or recharge.

1.4 Equipment

There are a number of devices that can be used to measure water levels, such as electric sounders, steel tape, or airlines. The device should be adequate to attain an accuracy of 0.01 feet. The following equipment is needed to measure water levels:

- Water level measurement device and backup
- Digital camera
- Tools for accessing well and measurement point (RP)
- Keys to access well site
- Metal tape measure
- Black electrical tape
- Chalk (if using steel tape)
- Paper towels
- Nitrile gloves

- Field reference notebook
- Field data sheets
- Decontamination solution and equipment
- Wristwatch or other device with a clock
- Compressed air for airline measurements

1.5 Preparation

1. Determine the extent of the sampling effort, the sampling methods to be employed, and which equipment and supplies are needed.
2. Prepare scheduling and coordinate with staff, well owners, clients, and regulatory agencies, if appropriate.
3. Decontaminate and pre-clean equipment, according to the work plan or *Section 8 – Decontamination of Field Equipment* in this SOP document, and ensure that it is in working order.
4. Research water level trends in the area to become familiar with the range of water levels in the project region. Pay special attention to water levels from the current season.
5. Synchronize your wrist watch or other clock device to Pacific Standard Time (PST) or Pacific Daylight Time (PDT), if it is in effect. Set it to within 1 second of the actual time. Use this site:

   www.time.gov

   (This site is set to adjust to Daylight Saving Time when in effect.)
6. Print a field data sheet for each well to be measured plus extra.

1.6 Procedures

1. Wear clean nitrile gloves at all times when collecting a water level measurement.
2. Perform a general site survey prior to site entry in accordance with the health and safety plan.
3. If possible and where applicable, start at the wells that are least contaminated and proceed to the wells that are most contaminated.
4. Clean all equipment entering the well as specified in the site plan or *Section 8 – Decontamination of Field Equipment* in this SOP document.
5. If required by site-specific conditions, monitor the headspace of the well with a photoionization detector (PID) or flame ionization detector (FID) to determine the oxygen levels and presence of volatile organic compounds, and record outputs on the field data sheet.

6. Identify and mark all measurement locations, and record any changes on the field data sheet, the site sketch, and by photograph.

7. Remove well cap.

8. Note well name, well ID, date, observer name, and method used on the field data sheet.

9. Lower electric water level measuring device or equivalent (i.e. metal tape or airline) into the well until water surface is encountered. In most cases, an electric sounder will be used. If the electric sounder is not getting a reading, use a different sounder, the metal tape method, or the airline method, depending on the circumstance.

10. Measure the distance from the water surface to the RP on the well casing. If using an electronic sounder, verify the distance several times by lifting the device a few inches above the water level and slowly lowering it back down until it sounds. If necessary to get a clear tone, adjust the sensitivity of the meter: remove the meter from the well, test the sounder in a bucket of water, adjust the meter sensitivity accordingly, and reinstall the meter in the well. Record all measurements on the field data sheet, and note the time of each measurement in PST or PDT, as applicable.

11. Note the well's activity during the measurement (i.e. static, dynamic, unknown, or recovering) on the field data sheet. A well is considered recovering for 24 hours after it has turned off.

12. Record the designated RP used (i.e. top of sounding tube, top of casing, plug hole) on the field data sheet.

13. Measure the distance of the ground surface (GS) to the RP (GS to RP), and note it on the field data sheet. If the RP is above the ground surface, the GS to RP will be a positive number, and if the RP is below the ground surface, the GS to RP will be a negative number.

14. Check that the photographs are current and the well sketch is up-to-date with the correct RPs and measured GS to RP. If measuring a well for the first time, provide a well sketch using the field sketch form. Always make sure that the GS to RP on the sketch and on the field data sheet are the same and that the RP is clearly marked on the well.

15. Wait 5 minutes to take a second measurement regardless if the activity has changed or not. If the well activity changes, wait at least 2 minutes to take a measurement after the well turns on/off. If the well activity changes again within that time, make a note of the timing, take a measurement, wait a few minutes (depending on the pump cycling frequency), and take a third measurement.

16. Fill out the field data sheets completely. Provide comments on anything of significance that is not directly implied by the data recorded on the sheet, such as well condition, well property characteristics, well pumping cycles, problems at the well, oil in the well, etc.

17. Remove all downhole equipment, replace well casing cap, and secure, as necessary.

18. Decontaminate the first ten feet or the wetted part of the equipment, whichever is greater, after each water level measurement. If contamination is observed along any other length of the equipment, decontaminate the affected sections. At the end of the day, decontaminate and clean the entire length of the equipment as outlined above. Dry the line before placing it back on the reel.

19. At the end of the day, scan copies of all completed field data sheets, and give them to the project manager. Place the original field data sheets in the project binder.

1.7 Reagents

Decontamination solutions are used in this procedure. Where the decontamination of equipment is required, refer to the site-specific work plan or Section 8 – *Decontamination of Field Equipment* of this SOP document.

1.8 Calculations

To convert depth-to-water measurements to groundwater elevation above mean sea level, use the following equation:

$$Ew = E-D$$

where:

Ew = Elevation of water above mean sea level

E = Elevation above sea level at point of measurement

D = Depth to water

1.9 Quality Assurance/Quality Control

The following general quality assurance/quality control procedures apply:

- All data must be documented on standard field data sheets or within site logbooks. Should log books be used, copies of the pages used must be scanned and placed in the project folder.
- All instrumentation must be operated in accordance with the operating instructions supplied by the manufacturer.
- The water level within each well should be tested at least twice, 5 minutes apart, in order to compare results. Measurements should agree to within 0.01 feet. If they do not, wait another 5 minutes and measure the water level again. Record all measurements.

1.10 Data Validation

Data should be compared to previous data for each well. If data are significantly different, any possible causes should be noted on the field data sheet.

1.11 Health and Safety

When working with potentially hazardous materials, follow U.S. EPA, OSHA, and site or project specific health and safety procedures.

1.12 References

U.S. Geological Survey. (2006). *Collection of Water Samples: U.S. Geological Survey Techniques of Water-Resources Investigations*, ver. 2.0. Vol. 9, chap. A4.

Section 2 – Groundwater Level Monitoring Using Transducers

2.1 Scope and Application

The purpose of this SOP is to set guidelines for gathering data from transducers.

Transducers are used to gain a very accurate understanding of changes in groundwater surface due to the effects of surrounding well activity and/or surface-groundwater water interactions.

2.2 Equipment

- Stainless steel wire or direct read cable and well cap
- If using stainless steel wire:
  - Wire line counter
  - Carabineers (at least 2 per well)
  - Well caps and plugs with eye bolts attached
  - Stainless steel oval sleeve (at least 4 per well)
  - Wire rope thimble (at least 2 per well)
- Transducer(s)
- Laptop
- Communication cable from the laptop to transducer or direct read cable
- Digital camera
- Tools (pipe wrench, pliers, channel locks, crimper, wire cutters, etc.)
- Keys to access well sites
- Well owner contact information
- Water level measurement device (i.e. electric sounder) (see Section 1 – *Groundwater Level Monitoring* of this SOP document)
- Measuring tape for RP and well dimensions (in tenths of a foot)
- Project notebook, pen, pencil
- Maps
- Decontamination solution and equipment
- Field data sheets (transducer field data forms and site inspection for transducer installation forms)
- Shop towels

2.3 Preparation

1. Determine appropriate transducer type. Refer to water level histories and well inspection sheets for information on the appropriate transducer model and submergence rating.

2. Order transducers and direct read cables, if applicable. Allow several weeks for them to be delivered.

3. Order the following for the stainless steel cable hanging apparatus when direct read cables will not be used:

   a. Appropriate well caps and plugs for wells that will receive transducers (refer to field inspection sheets for size and tread type).

   b. Eye bolts, nuts, and lock nuts (one each per well). Eye bolts must be small enough to fit inside well caps or plugs and have an opening large enough for quick links.

   c. Length of stainless steel wire for total depth of each transducer.

   d. Type 304 Stainless Steel Oval Sleeve for 1/32" rope diameter, ¼" sleeve length. At least four per transducer are necessary.

   e. Type 304SS Light-Duty Wire Rope Thimble for 3/32", 7/64", and 1/8" wire rope diameter. At least two per transducer are necessary.

   f. Quick links with an opening that is large enough to fit items *e* and *b* above into the opening. At least two per transducer are necessary.

4. When the materials arrive, use a wire counter to accurately measure wire lengths for each well. Assemble wire ends, and test them with weight and force. Roll wire onto individual cable reels for storage and transportation. This can also be done in the field.

5. Prepare well caps. Drill holes in the end of the well caps and plugs. Install the eye bolts with the nut on the inside of the cap or plug and the lock nut on the outside. Tighten the lock nut to secure the eye bolt. Hammer the end of the eye bolt to the lock nut to prevent tampering.

6. Test transducers. Transducers either need to be tested in a test well or bucket or checked within 2 weeks of installation to prevent loss of data due to malfunction. Test the transducer in the office using the following method:

   a. Inspect transducer, cap, and O-rings for damage or manufacturing defects.

   b. Attach appropriate transducer communication cable to the laptop computer and transducer. Follow directions to communicate and start a test as outlined below. Set the test to record every 30 seconds.

   c. Set up a test well or bucket with fresh water to submerge the transducer by at least a couple of feet.

d. Insert the transducer in the water after a sample test has been started.

e. Write down the time the test was started and the time the transducer was submerged. Use seconds in the notation.

f. Record the time and amount of water added (in feet above the transducer's measuring point).

g. After a few minutes (i.e. several recorded measurements), add or remove water, and record the time and the new water level height.

h. Repeat Step *g* at least twice.

i. Remove transducer from the water, and record the time.

j. Dry off the transducer connection, and attach the transducer to the laptop computer.

k. Stop the test (as described below), and process the data as necessary. Compare the data to your depth and time notes. Assess the transducer's accuracy and precision, and troubleshoot with the manufacturer as necessary to ensure reliable transducer data. Record your conclusions and the serial number of the transducer in the transducer tracking sheet.

2.4 Procedures

1. Load all equipment needed for installation.

2. Perform a general site survey prior to site entry in accordance with the health and safety plan. And, if required by site-specific conditions, monitor the headspace of the well with PID or FID to determine the oxygen levels and presence of volatile organic compounds, and record outputs on the field data sheet.

3. Decontaminate all equipment as outlined in the work plan or Section 8 – *Decontamination of Field Equipment* of this SOP document before using it on each well. If possible and where applicable, start at the wells that are least contaminated and proceed to the wells that are most contaminated.

4. Identify and mark all RP locations.

5. Measure the water level below the reference point, and record the measurement and time on the field data sheet. Lock the water level indicator just above the water surface, and leave it in the well. Enter the manual water level into the transducer software, if applicable.

6. Completely fill out the field data sheets.

7. Record the manufacturer, model, serial number, the rated water level or pressure range, and installed depth of the transducer on the field data sheet.

8. If using stainless steel wire, skip to Step 9. If the transducer will be installed on a direct-read cable, attach it and carefully lower it into the well.

9. Connect the transducer and cable to the laptop computer. Open the appropriate software for the transducer model.

10. Set up the location information on the transducer.

11. Check and record the battery power of the transducer. The battery power should be 100% when the transducer is installed.

12. If the water level indicator can safely be left in the well, raise it to just above the water level and skip to *Step 13*. If the water level indicator must be removed prior to transducer installation due to limited space inside the well, measure the water level below the reference point a second time, and record the measurement and time on the field data sheet. Remove the water level indicator from well. Enter the manual water level into the software in *Step 13* below, if applicable.

13. Start a new test on the transducer (see manufacturer instructions). Set the transducer for the next time interval designated by the project work plan. For example, set it to start on the next 15 minute time interval (i.e. :15, :30, :45, or :00) when recording measurements at increments of 15 minutes. Note: if the transducer is on stainless steel wire, the test should be started far enough in the future to allow for full installation of the transducer and settling of the water surface prior to the first measurement.

14. If the transducer is on a stainless steel wire, attach the transducer to the hanging wire, and carefully lower it into the well. If it is on a direct-read cable, disconnect it from the laptop and carefully secure it to the well head. Minimize disturbance to the water surface.

15. If the water level indicator was left in the well in *Step 12* above, measure the water level a third time, preferably a few seconds after the transducer records its first measurement. This will ensure that the water surface has not been disturbed when the transducer measures the water level. Record the measurement and time on the field data sheet.

16. Attach well casing cap and secure, as necessary. Clean up and secure the site.

17. Decontaminate all equipment as outlined in the work plan or Section 8 – *Decontamination of Field Equipment* of this SOP document.

2.5 Reagents

Decontamination solutions are used in this procedure. Where the decontamination of equipment is required, refer to the project or site-specific work plan or Section 8 – *Decontamination of Field Equipment* of this SOP document.

2.6 Calculations

Check the manual water level against the transducer record after it has downloaded onto the laptop. If necessary, calculate the depth to water from transducer submergence (head) in feet.

$$DTW = (a^i+b^i)-a^{current}$$

where:

DTW = depth to water

a^i = depth of water above transducer at time of water level sounding (from the transducer data)

b^i = depth to water from water level sounding

$a^{current}$ = depth of water above transducer at the time to be calculated

2.7 Quality Assurance/Quality Control

The following general quality assurance/quality control procedures apply:

- All data must be documented on standard field data sheets or within personal/site logbooks.
- All instrumentation must be operated in accordance with the operating instructions supplied by the manufacturer.
- The water level within each well should be tested at least twice in order to compare results and ensure reliability. If water levels change by more than 0.02 feet for inactive wells and 0.2 feet for active wells, measure the water level a third time. Record all measurements on the field data sheet.

2.8 Data Validation

Check the manual water levels against the transducer water levels. If necessary, calculate the drift of the transducer, and record it on the field data sheet.

2.9 Health and Safety

When working with potentially hazardous materials, follow U.S. EPA, OSHA, and site-specific health and safety procedures.

3.1 Low Flow Sampling Method with Dedicated Pumps

This procedure is designed to assist in collecting representative groundwater samples from monitoring wells equipped with dedicated low flow pumps. The groundwater samples will be collected using low-flow (minimal drawdown) purging and sampling methods modeled after industry standards (Puls, and Barcelona, 1996; ASTM D 6771 - 02).

The objective is to purge and sample the well so that the collected water is representative of the formation water from the aquifer's identified zone of interest.

The wells to be sampled are equipped with dedicated bladder (squeeze-type) pumps manufactured by QED Environmental Systems, Inc. Each dedicated bladder pump is positioned with its inlet located within the screened interval of the well. The dedicated down-well equipment, including bladder pumps, Teflon-lined PE tubing, and well seals, should be installed a minimum of 72 hours prior to the scheduled sampling event to allow the well to reestablish equilibrium. At the time of equipment installation, each well's pump should be flow tested to determine and document, the specific well's optimum flow rate that will result in achieving a minimal drawdown and stabilization of the static water level (SWL) within the drawdown parameters detailed below. Once established, this rate will be reproduced for each subsequent sampling event. If a significant change in initial water level occurs between events, it may be necessary to reestablish the optimum flow rate at each sampling event.

3.1.1 Initial Pump Flow Test Procedures

If possible, the optimum flow rate for each well will be established during well development or redevelopment, or in advance of the actual sampling event. The monitoring well must be gauged for depth to water (SWL) prior to the installation of the dedicated pump and before pumping of any water from the well. The measurement will be documented on a field data sheet.

After pump installation, and confirmation that the SWL has returned to its original level, the bladder pump should be started at a discharge rate between 0.5 to 1.0 liters per minute without an in-line flow cell connected. The water level in the well casing must be monitored continuously for any change from the original measurement. If significant drawdown is observed, the pump's flow rate should be incrementally reduced until the SWL drawdown ceases and stabilizes. Total drawdown from the initial (static) water level should not exceed 25 percent of the distance between pump inlet location and the top of the well screen (for example, if a well has a 10-foot screen zone and the pump inlet is located mid-screen; the maximum drawdown should be 1.25 feet). In any case, the water level in the well should not be lowered below the top of the screen/intake zone of the well. In cases of wells with partially penetrating screens, the distance interval is taken to be between the pump inlet and the SWL.

Once the specific well's optimum flow rate, without an in-line flow cell connected, has been determined and documented, connect the in-line flow cell system and determine the control settings required to achieve the well's determined optimum flow rate with the in-line flow cell connected (Due to the system's back-pressure, the flow rate could be decreased by 10 to 20 percent). All control settings are to be documented on the field data sheet as specific to that particular well's ID and will be utilized for its subsequent purging and sampling events.

Should it be determined that a specific well is incapable of maintaining a sustainable yield of at least 100 milliliters per minute without continuing drawdown, it will be identified as a problematic well and passive sampling methods will be incorporated (including working with the analytical lab to minimize sample volumes to the extent feasible or purging of 1 to 3 pump-system volumes and collecting sample volumes at 100 milliliters per minute flow rate without the need for parameter stabilization).

3.1.2 Method Summary

Prior to the initiation of the well purge, the SWL will be measured and documented. See the *Groundwater Level Monitoring* section of this SOP document for details. The well's dedicated pump will be started utilizing its documented control settings, and its flow rate will be confirmed by a volumetric discharge measurement with the in-line flow cell connected. If necessary, any minor modifications to the control settings to achieve the well's optimum flow rate will be documented on the field data sheet. When the optimum pump flow rate has been established, the SWL drawdown has stabilized within the required range, and at least one pump system volume (bladder volume + discharge tubing volume) has been purged, begin taking field water quality parameter measurements of pH, temperature, electrical conductivity (EC), oxygen reduction potential (ORP), dissolved oxygen (DO), and turbidity using an in-line flow cell and standalone turbidity meter. Though turbidity is not a water chemistry indicator parameter, it is useful as an indicator of pumping stress on the formation. All water chemistry field measurements will be documented on the field data sheet. Measurements should be taken every few minutes* until stabilization has been achieved. Stabilization is achieved after all parameters have stabilized for three consecutive readings at predetermined intervals.* In lieu of measuring all five parameters, a minimum subset would include pH, conductivity, and turbidity or dissolved oxygen. Three consecutive measurements indicating stability should be within:

Parameter	Stabilization Criteria
Temperature	± 3% of reading (minimum of ± 0.2° C)
pH	± 0.2 pH units
Electrical Conductivity (EC)	± 3% of reading
Dissolved Oxygen (DO)	± 10% of reading or ±0.2 mg/L, whichever is greater
Redox (ORP)	± 20 mV
Turbidity	± 10% NTU

When water quality parameters have stabilized, and there has been no change in the stabilized SWL (i.e. no continuous drawdown), sampling collection may begin.

*Minimum-Intervals will be determined by dividing the flow cell volume by the well's sustainable flow rate to ensure a complete change out of the flow cell's volume between readings (i.e.) MP20D's 175 milliliter (mL) flow cell volume / 100 mL/minute well flow = 2 minute intervals for monitoring for stabilization). It is suggested that the intervals be 5 minutes between readings as long as the flow cell volume is replaced within these intervals.

3.1.3 Equipment

The following equipment is needed to conduct low flow purging and sampling:

- Dedicated bladder pump installed within the well's screened interval
- Pump controller and air source set to operate at the specific well's documented optimum flow rate
- In-line flow cell and meter(s) with connection fittings and tubing to measure water quality
- Water level measurement device or installed dedicated water level measurement system
- Sample containers appropriate for the analytical requirements
- Field data sheets
- 300-500 milliliter graduated cylinder
- 5 gallon bucket(s) for containerizing purge water
- Wristwatch with second hand, digital watch, smart phone, or stopwatch
- Cleaning and decontamination supplies
- Chain-of-custody forms

3.1.4 Procedures

1. Calibrate all field instruments at the start of each day's deployment per the instrument manufacturer's instructions. Record calibration data on the "Field Instruments Calibration Documentation Form." If a QED Model MP20D Flow Cell is utilized, use the unit's SETUP menu to set the parameters, ranges, and time intervals to be utilized for the PurgeScan feature to calculate and determine when water chemistry has stabilized.

2. Perform a general site survey prior to site entry in accordance with the health and safety plan.

3. Note the well condition and activity in the vicinity of the well.

4. Remove the wellhead cover, measure the depth to water from the reference mark on the wellhead, and record the measurement on the field data sheet. Lock the water level measurement device in place so that the level can be monitored during purging and sampling. When placing the probe in the well, take precautions to not disturb or agitate the water. If utilizing a drawdown controller, lower the probe to a depth below the existing SWL that is determined to be the maximum allowable SWL drawdown for the specific well, and set the switch to drawdown mode. Connect the connecting cable to the appropriate controller.

5. Connect the compressed air source's airline to the pump controller's "AIR IN" connection (if utilizing a gas-engine operated compressor, locate the compressor at least 25 feet, downwind from the wellhead).

6. Connect the pump controller "AIR OUT" air-line to the bladder pump's air supply fitting at the wellhead.

7. Connect the pump discharge line to the in-line flow cell's "IN" fitting.

8. Connect the flow cell's "OUT" line, and secure to drain the purge water into the purge water collection container.

9. Start the air supply to the pump. Set the pump controller settings to the documented settings for the specific well (these settings include the refill time interval, the discharge time interval, and the throttle pressure for QED Models MP10/MP10H/MP10UH). Confirm that the flow rate is equal to the well's established optimum, sustainable flow rate—modify as necessary (documenting any required modifications). Determine the EC value of the water, and use this value to set the EC parameter range in the MP20 unit's PurgeScan SETUP Menu.

10. Monitor the water level and confirm that the drawdown has stabilized within the well's allowable limits. If using QED's MP30 unit, switch off the drawdown switch, and raise the probe to confirm SWL. Lower the probe to the predetermined depth, and switch the drawdown switch back on.

11. After a single pump-system's volume (bladder volume + discharge tubing volume) has been adequately purged, read and record water quality field measurements every three to five minutes (as determined above in *Method Summary*) until all parameters have stabilized within their allowable ranges for at least three consecutive measurements. When stabilization has been achieved, sample collection may begin. If a QED Model MP20D unit is being used, the unit will alert the user that the stabilization has been achieved. Make sure that the PurgeScan's SETUP menu for EC reflects a range of +/- 3%-5% of the purge water's EC actual value.

12. Disconnect the flow cell and its tubing, from the pump discharge line before collecting samples. Decrease the pumping rate to 80-100 milliliters per minute or less by lowering the controller's air pressure setting prior to collecting samples for volatile organic chemicals (VOCs). Utilize the QED Model MP10/MP15 Controller's 'MANUAL SAMPLE' button to ensure minimized sample exposure to ambient air. Refer to the task instructions for the correct order and procedures for filling sample containers. Place the samples in a cooler with enough chemical ice substitute packs to keep them at 4 degrees Celsius. (See the Project Analyte Setup, Sample Handling, and Waste Disposal section of this SOP document for details.)

13. Sample Collection:

    a. While holding the sample container at the base, remove plastic seal around the cap before attempting to open the bottle. If the cap is found to be loose or cracked, if it contains no seal, if the seal pulls away from the cap, if the bottle appears dirty, or if there are any other conditions that place the quality of the bottle in doubt, the bottle is to be rejected and a proper container used. (All containers should be checked prior to going to the site.)

b. Remove the cap with your free hand, exercising care not to touch the edge or bottom of the cap or the top or neck of the bottle. Avoid breathing on the cap or bottle.

c. Hold the cap in one hand during the entire bottle filling operation; do no lay it down.

d. Note any source of VOCs around the well, such as exhaust sources, on the field data sheet.

e. For VOC sample bottles, no head space (air bubbles) should remain in the sample container.

f. Once samples for VOCs have been collected, reestablish pump flow rate to the original purge flow rate by inputting the documented controller settings for the well without the in-line flow cell connected, and collect remaining samples.

g. All other sampling containers are to be filled to the "fill line," leaving enough air space in the container to allow for mixing by shaking in the lab. The cap should be carefully replaced.

h. Place samples on ice in a cooler as soon as possible. Keep samples cold (4 degrees Celsius) until delivered to the laboratory. Transport samples to an approved water quality laboratory within 24 hours or according to the analyte holding times, whichever is shorter.

i. A Chain-of-Custody form shall be filled out for each cooler, and a copy shall be retained for project records. Be sure to indicate on the Chain-of-Custody that travel blanks are included and should be analyzed by the laboratory. Refer to the *Project Analyte Setup, Sample Handling, and Waste Disposal* section of this SOP document for details.

14. When all sample containers have been filled, make a final measurement of the well's SWL, and record the measurement on the field data sheet. If the well has a "QED" dedicated bottom sounder, measure the well's total depth, and record the measurement as well.

15. Measure and record the total purge volume collected. Consolidate generated purge water.

16. Disconnect the controller air supply to the pump.

17. Remove the portable water level measurement device from the well.

18. Secure and lock the wellhead cover. Move equipment to next well to be sampled.

19. Decontaminate all equipment as outlined in the work plan or Section 8 – *Decontamination of Field Equipment* of this SOP document

20. At the end of each day, post-calibrate all field instruments, and record the measurements on the "Field Calibration Documentation Form".

21. At the end of the day, scan copies of all completed field sheets, and email them to the project manager. The original sheets should be kept in the project binder.

3.2 Low Flow Sampling Method with Portable Pumps

This procedure is designed to assist in collecting representative groundwater samples from monitoring wells not equipped with dedicated low-flow pumps. The groundwater samples will be collected using low-flow (minimal drawdown) purging and sampling methods modeled after industry standards (Puls, and Barcelona, 1996; ASTM D 6771 - 02).

The field sampler's objective is to purge and sample the well so that the water that is discharged from the pump, and subsequently collected, is representative of the formation water from the aquifer's identified zone of interest.

The wells to be sampled are to be equipped with portable QED Well Wizard™ bladder (squeeze-type) pumps manufactured by QED Environmental Systems, Inc. Each portable bladder pump is to be positioned with its inlet located within the screened interval of the well—generally at mid-saturated screen or at least 5 feet below the current SWL for partially penetrating screens. The portable down-well equipment, including bladder pumps, PE tubing, and well seals, is to be carefully installed just prior to the scheduled sampling event to allow minimum disturbance to the well equilibrium. At the time of initial equipment installation, each well should be flow tested to determine and document the specific well's optimum flow rate that would result in achieving a minimal drawdown of the initial SWL within the drawdown parameters detailed below. Once established, this rate will be reproduced for each subsequent sampling event. If a significant change in water level occurs between events, it may be necessary to reestablish the optimum flow rate at each sampling event.

3.2.1 Initial Pump Flow Test Procedures

If possible, the optimum flow rate for each well will be established during well development or redevelopment, or in advance of the actual sampling event. The monitoring well must be gauged for depth to water (SWL) prior to the installation of the portable pump and before pumping of any water from the well. The measurement will be documented on a field data sheet.

After pump deployment and confirmation that the SWL has returned to its original level, the bladder pump should be started at a discharge rate between 0.5 to 1.0 liters per minute without an in-line flow cell connected. The water level in the well casing must be monitored continuously for any change from the original measurement. If significant drawdown is observed, the pump's flow rate should be incrementally reduced until the drawdown ceases and stabilizes. Total drawdown from the initial SWL should not exceed 25 percent of the distance between pump inlet location and the top of the well screen (for example, if a well has a 10-foot screen zone and the pump inlet is located mid-screen, the maximum drawdown should be 1.25 feet). In any case, the water level in the well should not be lowered below the top of the screen/intake zone of the well. In cases of wells with partially penetrating screens, the distance interval is taken to be between the pump inlet and the SWL.

Once the specific well's optimum flow rate, without an in-line flow cell connected, has been determined and documented, connect the in-line flow cell system to the well discharge and determine the control settings required to achieve the well's determined optimum flow rate with the in-line flow cell connected (due to the system's back-pressure, the flow rate could be decreased by 10 to 20 percent). All control settings are to be documented on the field data sheet specific to that particular well's ID and will be utilized for subsequent purging and sampling events.

Should it be determined that a specific well is incapable of maintaining a sustainable yield of at least 100 milliliters per minute without continuing SWL drawdown, it will be identified as a problematic well, and passive sampling methods will be incorporated (including working with the analytical lab to minimize sample volumes to the maximum extent feasible or purging of 1 to 3 system volumes and collecting sample volumes at a 100 milliliters per minute flow rate without the need for parameter stabilization).

3.2.2 Method Summary

Prior to the initiation of purging a well, the SWL will be measured and documented. The properly decontaminated portable pump will then be slowly lowered into the well until its inlet is properly positioned within the saturated screened interval or halfway between the SWL and the bottom of the screen (for partially penetrating screens) and then started utilizing its previously documented control settings. Its flow rate will be confirmed by volumetric discharge measurement with the in-line flow cell connected. If necessary, any minor modifications to the control settings to achieve the well's optimum flow rate will be documented on the field data sheet.

When the optimum pump flow rate has been established and the SWL drawdown has stabilized within the required range, the field crew will begin taking field measurements for pH, temperature, electrical conductivity (EC), oxygen reduction potential (ORP), dissolved oxygen (DO), and turbidity. The water chemistry will be taken using a "QED" model MP20/MP20D with a 'stand-alone' turbidity meter or a QED model MP20DT in-line flow cell. All water chemistry field measurements will be documented on the field data sheet. Measurements should be taken every three to five minutes* until stabilization has been achieved. Stabilization is achieved after all parameters have stabilized for three consecutive readings. In lieu of measuring all five parameters, a minimum subset would include pH, conductivity, and turbidity or dissolved oxygen. Three consecutive measurements indicating stability should be within:

Parameter	Stabilization Criteria
Temperature	± 3% of reading (minimum of ± 0.2° C)
pH	± 0.2 pH units, minimum
Electrical Conductivity (EC)	± 3% of reading
Dissolved Oxygen (DO)	± 10% of reading or ±0.2 mg/L, whichever is greater
Redox (ORP)	± 20 mV
Turbidity	± 10% NTU

*Minimum-Intervals will be determined by dividing the flow cell volume by the well's sustainable flow rate to ensure a complete change out of the flow cell's volume between readings (i.e. MP20D's 175 mL flow cell volume / 100 mL/minute well flow = 2 minute intervals for monitoring for stabilization). It is suggested that the intervals be 5 minutes between readings as long as the flow cell volume is replaced within these intervals.

3.2.3 Equipment

The following equipment is needed to conduct low flow purging and sampling:

- Portable bladder pump, with sufficient air/liquid discharge tubing, installed within the well's screened interval
- Pump controller and air source set to operate at the specific well's documented optimum flow rate
- In-line flow cell and meter(s) with connection fittings and tubing to measure water quality
- A stand-alone turbidity meter
- A water level measurement device or installed dedicated water level measurement system
- Sample containers appropriate for the analytical requirements
- Field data sheets
- 300-500 milliliter graduated cylinder
- 5 gallon bucket(s) for containerizing purge water
- Wristwatch with second hand or stopwatch
- Sufficient cleaning and decontamination supplies
- Chain-of-custody forms

3.2.4 Procedures

1. Calibrate all field instruments at the start of each day's deployment or per the site's QA/QC plan or the instrument manufacturer's instructions. Record calibration data on the field instruments' calibration documentation forms.

2. Perform a general site survey prior to site entry in accordance with the health and safety plan.

3. Note the well condition and activity in the vicinity of the well.

4. Decontaminate the portable pump and/or water gauging probe by washing with phosphate-free detergent, rinsing with potable water, and rinsing with deionized water.

5. Attach the well's dedicated air and discharge lines to the portable pump and install a new disposable bladder or the well's dedicated bladder, if so configured.

6. Remove the wellhead cover.

7. Measure the depth to water from the surveyed reference mark on the wellhead and record the measurement on the field data sheet.

8. Remove the water level measurement device.

9. For portable pump usage, connect the appropriate lengths of air and discharge tubing to facilitate pump inlet being supported at the desired level within the well's screened interval by use of the portable well plate. Ensure that the air supply tubing is properly connected to the pump's air fitting and not to the pump discharge.

10. Install the portable pump slowly and carefully. Reinstall the water level measurement device, and lock the device in place so that the level can be monitored during purging and sampling. When placing the pump and/or probe in the well, take precautions not to disturb or agitate the water. If utilizing a QED Model MP30 Drawdown Controller system, set the unit to drawdown mode, connect the control cable to the QED pump controller, and lower the probe to a point below the current SWL within the allowed SWL drawdown range for the specific well (see above on the 25 percent guidance allowance).

11. Connect the compressed air source's airline to the pump controller's "AIR IN" connection (if utilizing a gas-engine operated compressor, locate the compressor at least 25 feet downwind from the wellhead).

12. Connect the pump controller "AIR OUT" air-line to the bladder pump's air supply fitting at the wellhead.

13. Connect the pump discharge line to the in-line flow cell's "IN" fitting.

14. Connect the flow cell's "OUT" line, and secure to drain the purge water into the purge water collection container.

15. Start the air supply to the pump. Set the pump controller settings to the documented interval settings for the specific well. It is advisable that the air supply pressure be started at 40 to 50 pounds per square inch (PSI) initially and then raised in increments as the

pump's discharge line becomes filled. This is especially critical for deeper pump depths (see *Field Tip* section at the end of this document).

16. Confirm the final flow rate is equal to or just below the well's established optimum flow rate. Modify as necessary (documenting any required modifications).

17. Monitor the water level and confirm that the drawdown has stabilized within the well's allowable limits.

18. Start the MP20 unit's stabilization evaluation when water is at the desired flow rate. Read and record water quality field measurements every three to five minutes* until all parameters have stabilized within their allowable ranges for at least three consecutive measurements. When stabilization has been achieved, sample collection may begin.

19. *Readings are to be taken at minimum time intervals such that a full replacement of the flow cell's volume has been effected (175 mL flow cell volume with 100 mL pump flow rate calls for a time interval of at least 2 minutes).

20. Disconnect the flow cell and its tubing from the pump discharge line before collecting samples. Decrease the pump rate to 100 milliliters per minute or less by lowering the controller's air pressure setting prior to collecting samples for volatiles. Utilize the QED Model MP10/MP15 Controller's 'MANUAL SAMPLE' button to ensure minimized sample exposure to the ambient air. Refer to the task instructions for the correct order and procedures for filling sample containers. Place the samples in a cooler with enough ice to keep them at 4 degrees Celsius.

21. Sample Collection:

    a. While holding the sample container at the base, remove plastic seal around the cap before attempting to open the bottle. If the cap is found to be loose or cracked, if it contains no seal, if the seal pulls away from the cap, if the bottle appears dirty, or if there are any other conditions that place the quality of the bottle in doubt, the bottle is to be rejected, and a proper container used. (All containers should be checked prior to going in the field.)

    b. Remove the cap with your free hand, exercising care not to touch the edge or bottom of the cap or the top or neck of the bottle. Avoid breathing on the cap or bottle.

    c. Hold the cap in one hand during the entire bottle filling operation; do no lay it down.

    d. Note any source of VOCs around the well, such as exhaust sources, on the field data sheet.

    e. For VOC sample bottles, no head space (air bubbles) should remain in the sample container.

    f. Once samples for VOCs have been collected, reestablish pump flow rate to the original purge flow rate by inputting the documented controller settings for the well without the in-line flow cell connected, and collect remaining samples.

g. All other sampling containers are to be filled to the "fill line," leaving enough air space in the container to allow for mixing by shaking in the lab. The cap should be carefully replaced.

h. Place samples on ice in a cooler as soon as possible. Keep samples cold (4 degrees Celsius) until delivered to the laboratory. Transport samples to an approved water quality laboratory within 24 hours or according to the analyte holding times, whichever is shorter.

i. A Chain-of-Custody form shall be filled out for each cooler, and a copy shall be retained for project records. Be sure to indicate on the Chain-of-Custody that travel blanks are included and should be analyzed by the laboratory. Refer to the *Project Analyte Setup, Sample Handling, and Waste Disposal* section of this SOP document for details.

22. When all sample containers have been filled, make a final measurement of the well's SWL, and record the measurement on the field data sheet. If the well has a "QED" dedicated bottom sounder, measure the well's total depth, and record the measurement as well.

23. Disconnect the controller air supply to the pump.

24. Remove the pump from the well.

25. Measure and record the total purge volume collected. Consolidate generated purge water.

26. Remove the portable water level measurement device from the well.

27. Secure and lock the wellhead cover. Move equipment to next well to be sampled

28. Decontaminate all equipment as outlined in the *Decontamination of Field Equipment* section of this SOP document.

29. At the end of each day, post-calibrate all field instruments, and record the measurements on the "Field Calibration Documentation Form."

30. At the end of the day, scan copies of all completed field sheets, and email them to the project manager. The original sheets should be kept in the project binder.

3.3 Sampling Active Agricultural Wells

This procedure is designed to assist field technicians in taking representative groundwater samples from privately owned, active agricultural wells for the Key Well Water Quality Monitoring Program. Ideally, groundwater samples should be collected per the EPA's SOP for the Standard/Well-Volume Method which dictates that a minimum of three casing volumes of water should be purged from a well prior to beginning water quality sampling procedures. However, for many of the wells in the key well monitoring program, there is often not enough data available to determine if and when a sufficient volume of water has been purged. For example, the total depth and diameter of key well program wells is rarely available. Or, the field technician may be in a situation where there is no control over how long the well has been pumping or will remain on. This modified procedure is designed to help the field technician collect the best possible sample in the absence of the information typically used to determine that sufficient water has been purged from the well casing.

There are two general situations encountered when sampling agricultural and industrial wells: (a) water pumps from the well into a pressure tank or (b) water pumps from the well directly into a pipeline system. This SOP provides procedures for each situation.

Wells that feed into a pressure tank typically cycle on and off for short periods of time. The well is triggered on when the pressure in the tank drops below a specified level. The pumping cycles can be as short as 1 minute to longer than 10 minutes, and the cycle is typically not long enough to purge three casing volumes of water. However, the wells are typically cycling on and off throughout the day, so it is unlikely that the sample collected will contain stagnant casing water.

Whenever possible, contact the well owner in advance, or speak to a property manager on site, to determine when the well is typically on so you can arrange to collect the sample after the well has been running for at least an hour or so. If no one is available to provide this information, you can still rely on parameter stabilization to indicate that it is okay to collect your sample. The length of the pumping cycle will determine how often to collect parameters to determine stabilization. Once the pump cycle length has been determined, you can begin the sampling procedure.

Wells that feed directly into a pipeline system deliver water directly to the end use, such as an irrigation system, instead of a storage container. Thus, it is easier to measure for parameter stabilization and collect samples because the well is running continuously (compared to the short cycles typical in wells hooked into pressure tanks). However, if the well is not on when you arrive at the sampling site, a sample cannot be collected until permission is obtained from the well owner to power up the well. Whenever possible, contact the well owner in advance, or speak to a property manager on site, to determine when the well is typically on so you can arrange to collect the sample after the well has been running for at least an hour or so. If no one is available to grant permission to turn on the well, try returning to the site another day. These wells are generally running in the early morning hours, so that is the best time to make a return attempt to sample the well.

3.3.1 Equipment

- In-line flow cell and meter
- Water level measurement device
- Sample containers, coolers, and frozen blue-ice packs or ice
- Nitrile or latex-type gloves
- Field data sheets
- Fittings and spigots
- Well stocked tool box (including wrenches for well access)
- Digital camera

- Sufficient cleaning and decontamination supplies
- Chain-of-custody forms

3.3.2 Preparation

1. Calibrate all field instruments at the start of each day's deployment per the instrument manufacturer's instructions. Record calibration data on the "Field Calibration Documentation Form." The daily calibration record should be kept with the project files.

2. Organize sample containers into plastic zip-lock bags, and check to make sure there are no problems with the sample bottles (cracked caps, broken seals, etc.). Do not fill out container labels with well information until you are on-site to collect a sample.

3. Be sure to print and bring along copies of the field data sheets.

3.3.3 Procedures

1. Calibrate all field instruments at the start of each day's deployment per the instrument manufacturer's instructions. Record calibration data on the field instruments' calibration documentation form. If a QED Model MP20D Flow Cell is utilized, use the unit's SETUP menu to properly setup the parameters, ranges, and time intervals to be utilized for the PurgeScan feature to calculate and determine when water chemistry has stabilized.

2. Perform a general site survey prior to site entry in accordance with the health and safety plan.

3. Note the well condition and activity in the vicinity of the well.

4. Nitrile or latex-type gloves will be worn at all times while handling all fittings, spigots, and sampling containers. New gloves will be worn at each sampling site. The water level measurement device and all fittings and spigots will be decontaminated as appropriate.

5. Determine your sampling location and attach sampling spigot, if necessary. Sampling points must be on the well pump side of any storage container such as a water tank or reservoir. Remove any aerators, strainers, hose attachments, mixing type faucets, and purification devices from the tap.

6. Label all bottles. Sample containers must be kept clean and free from contamination before and after collecting the sample. They will not be opened prior to collecting the sample.

7. Remove the wellhead cover.

8. Prior to the initiation of well sampling, a water level will be measured and documented, if possible. Record the well activity (static, pumping, or recovering) at the time of measurement and the activity of any other wells in close proximity to the well being sampled. (Note: in the case of low-flow pumping, a water level is considered to be "recovering" until the water level is rising by less than 0.05-feet per minute.) Lock the water level measurement device in place so that the level can be monitored during purging

and sampling. When placing the probe in the well, take precautions not to disturb or agitate the water.

9. Flush the sampling port for at least 10 seconds before beginning parameter stabilization and sampling procedures. Attach the in-line flow meter.

10. Begin water quality field parameter stabilization procedure (and water level measurements, if possible). All data will be documented on the field data sheet. Stabilization is achieved after all parameters have stabilized for three consecutive readings. Three consecutive measurements indicating stability should be within:

Parameter	Stabilization Criteria
Temperature	± 3% of reading (minimum of ± 0.2° C)
pH	± 0.2 pH units, minimum
Electrical Conductivity (EC)	± 3% of reading
Dissolved Oxygen (DO)	± 10% of reading or ±0.2 mg/L, whichever is greater
Redox (ORP)	± 20 mV
Turbidity	± 10% NTU

   a. If the well feeds into a pressure tank and the pumping cycle is less than six minutes, water quality parameters will be observed throughout the cycle, and values will be recorded during the last minute of each pumping cycle until parameter stabilization is demonstrated across three pumping cycles.

   b. If the well feeds into a pressure tank and the pumping cycle is longer than six minutes, the water quality parameters will be measured every five minutes until stabilization is achieved. Continue stabilization over multiple cycles if necessary.

   c. If the well feeds directly into a pipeline and is pumping continuously, the water quality parameters will be measured every five minutes until stabilization is achieved. Continue stabilization over multiple cycles if necessary.

   d. If the parameters are not stabilizing, contact the project manager.

11. Sample Collection:

   a. Disconnect the flow cell, and its tubing, from the pump discharge line before collecting samples.

   b. The flow rate should be low enough to ensure that no agitation or splashing occurs as the container is filled.

c. At a well that has short cycles, it may take multiple pumping cycles to fill the entire set of sample bottles. It should be noted on the field data sheet if multiple pump cycles were needed to fill the bottles and which analyte bottles were filled in each successive cycle.

d. Collect the samples in the following order: VOCs, semi-volatile organic compounds/pesticides, inorganics, other unfiltered samples, filtered samples (USEPA).

e. While holding the sample container at the base, remove plastic seal around cap before attempting to open the bottle. If the cap is found to be loose or cracked, if it contains no seal, if the seal pulls away from the cap, if the bottle appears dirty, or if there are any other conditions that place the quality of the bottle in doubt, the bottle is to be rejected and a proper container used. (All containers should be checked prior to going in the field.)

f. Remove the cap with your free hand, exercising care not to touch the edge or bottom of the cap or the top or neck of the bottle. Avoid breathing on the cap or bottle.

g. Hold the cap in one hand during the entire bottle filling operation; do no lay it down.

h. Note any source of VOCs around the well, such as exhaust sources, on the field data sheet.

i. For VOC sample bottles, no head space (air bubbles) should remain in the sample container.

j. All other sampling containers are to be filled to the "fill line," leaving enough air space in the container to allow for mixing by shaking in the lab. The cap should be carefully replaced.

k. Place samples on ice in a cooler as soon as possible. Keep samples cold (4 degrees Celsius) until delivered to the laboratory. Transport samples to an approved water quality laboratory within 24 hours.

l. A Chain-of-Custody form shall be filled out for each cooler, and a copy shall be retained for project records. Be sure to indicate on the Chain-of-Custody that travel blanks are included and should be analyzed by the laboratory.

12. When all sample containers have been filled, make a final measurement of the well's SWL, and record the measurement on the field data sheet. If the well has a "QED" dedicated bottom sounder, measure the well's total depth and record the measurement, as well.

13. Measure and record the total purge volume collected. Consolidate generated purge water.

14. Remove the portable water level measurement device from the well.

15. Secure and lock the wellhead cover. Move equipment to next well to be sampled.

16. Decontaminate all equipment as outlined in the *Decontamination of Field Equipment* section of this SOP document.

17. At the end of each day, post-calibrate all field instruments, and record the measurements on the "Field Calibration Documentation Form."

18. At the end of the day, scan copies of all completed field sheets, and email them to the project manager. The original sheets should be kept in the project binder. Decontaminate all equipment as outlined in the *Decontamination of Field Equipment* section of this SOP document.

3.4 Reagents

No chemical reagents are used in this procedure with the exception of decontamination solutions. Where decontamination of equipment is required, refer to the *Decontamination of Field Equipment* section of this SOP document and/or the site-specific work plan.

3.5 Calculations

This section is not applicable to this SOP.

3.6 Quality Assurance/Quality Control

The following general quality assurance procedures apply:

- All data must be documented on standard field data sheets or within personal/site logbooks.
- All instrumentation must be operated in accordance with operating instructions as supplied by the manufacturer, unless otherwise specified in the work plan.
- The water level within each well should be measured at least twice in order to compare results.

3.7 Data Validation

Parameter stabilization methods are used to ensure that collected samples are representative of groundwater near the well.

3.8 Health and Safety

When working with potentially hazardous materials, follow U.S. EPA, OSHA, and site-specific health and safety procedures.

3.9 References

ASTM Designation: D 6771 – 02. *Standard Practice for Low-Flow Purging and Sampling for Wells and Devices Used for Ground-Water Quality Investigations.*

Puls, R.W. and M.J. Barcelona. U.S. EPA, (April 1996). *Low-Flow (Minimal Drawdown) Ground-water Sampling Procedures.* Ground Water Issue, Publication Number EPA/540/S-95/504.

U.S. Environmental Protection Agency, Region 9. (May 2002). S*tandard Operating Procedure for the Standard/Well-Volume Method for Collecting a Ground-Water Sample from Monitoring Wells for Site Characterization*. http://www.epa.gov/region09/qa/pdfs/finalgwsamp_sop.pdf

4.1 Scope and Application

This procedure is applicable to the collection of representative grab samples from streams and rivers. These are standard (i.e. typically applicable) operating procedures which may be varied or changed as required, dependent upon site conditions, equipment limitations, or limitations imposed by the procedure or other procedure limitations. In all instances, the ultimate procedures employed should be documented and associated with the final report.

4.2 Method Summary

Sampling situations vary widely; therefore, no universal sampling procedure can be recommended. However, sampling of both aqueous and non-aqueous liquids from the above mentioned sources is generally accomplished through the use of one of the following samplers or techniques:

- Dip sampler
- Direct method

These sampling techniques will allow for the collection of representative samples from the majority of surface waters and impoundments encountered.

4.3 Interferences and Potential Problems

There are two primary interferences or potential problems with surface water sampling. These include cross contamination of samples and improper sample collection:

1. Cross contamination problems can be eliminated or minimized through the use of dedicated sampling equipment. If this is not possible or practical, decontamination of sampling equipment is necessary. Refer to the *Sample Equipment Decontamination* section of this SOP document.

2. Improper sample collection can involve using contaminated equipment, disturbance of the stream or impoundment substrate, and sampling in an obviously disturbed area.

Following proper decontamination procedures and minimizing disturbance of the sample site will eliminate these problems.

4.4 Equipment

The equipment needed for the collection of surface water samples may include (depending on technique chosen):

- Dip sampler
- Line and messengers
- Sample bottles/preservatives

- Ziploc bags
- Ice/chemical ice substitute
- Coolers
- Chain-of-custody forms
- Sample bottle labels
- Field data sheets
- Decontamination equipment
- Maps/plot plan
- Safety equipment
- Compass
- Tape measure
- Survey stakes, flags, or buoys and anchors
- Digital camera
- Logbook/waterproof pen

4.5 Preparation

1. Determine the extent of the sampling effort, the sampling methods to be employed, and the types and amounts of equipment and supplies needed.
2. Obtain the necessary sampling and monitoring equipment.
3. Decontaminate the equipment, and ensure that it is in working order.
4. Prepare scheduling and coordinate with staff, clients, and regulatory agencies, as appropriate.
5. Perform a general site survey prior to site entry in accordance with the project-specific Health and Safety Plan.
6. Use stakes, flagging, or buoys to identify and mark all sampling locations. Take photographs of each site during each sampling event to help document current conditions. If required, the proposed locations may be adjusted based on site access, property boundaries, and surface obstructions. If collecting sediment samples, this procedure may disturb the bottom. Document adjustments to the proposed locations in the site logbook, field data sheets, and using photographs, as appropriate.

4.5.1 Representative Sampling Considerations

In order to collect a representative sample, the hydrology and morphology of a stream or impoundment should be determined prior to sampling. This will aid in determining the presence of flow patterns in streams and appropriate sample locations and depths.

Water quality measurements (such as DO, pH, temperature, EC, and ORP) can assist in the interpretation of analytical data and the selection of sampling sites and depths when surface water samples are collected.

Generally, the deciding factors in the selection of a sampling device for sampling liquids in streams, rivers, lakes, ponds, lagoons, and surface impoundments are:

- Will the sample be collected from the shore or a boat?
- What is the desired depth at which you wish to collect the sample?
- What is the overall depth and flow direction of the river or stream?

4.5.2 Sampler Composition

The appropriate sampling device must be of a proper composition. Selection of samplers constructed of glass, stainless steel, PVC, or PFTE (Teflon) should be based upon the analyses to be performed.

4.6 Procedures

4.6.1 Dip Sampler

A dip sampler is useful in situations where a sample is to be recovered from an outfall pipe or along a lagoon bank where direct access is limited. The long handle on such a device allows access from a discrete location. Sampling procedures are as follows:

1. Assemble the device in accordance with the manufacturer's instructions.
2. Decontaminate the device as appropriate.
3. Extend the device to the sample location, and collect the sample by dipping the sampler into the media. For shallow stream stations, collect the sample under the water surface while pointing the sample container upstream; the container must be upstream of the collector. Avoid disturbing the media.
4. Retrieve the sampler, and transfer the sample to the appropriate sample container.

4.6.2 Direct Method

The direct method may be utilized to collect water samples from the surface directly into the sample bottle.

Using adequate protective clothing, access the sampling station by appropriate means. For shallow stream stations, collect the sample under the water surface while pointing the sample container upstream; the container must be upstream of the collector. Avoid disturbing the media. For lakes and other impoundments, collect the sample under the water surface avoiding surface debris and the boat wake.

When using the direct method, do not use pre-preserved sample bottles as the collection method may dilute the concentration of preservative necessary for proper sample preservation.

4.7 Reagents

Reagents will be utilized for preservation of samples and for decontamination of sampling equipment. The preservatives required are specified by the analysis to be performed. Where decontamination of equipment is required, refer to the Decontamination of Field Equipment section of these SOP documents and/or the site-specific work plan.

4.8 Quality Assurance/Quality Control

There are no specific quality assurance (QA) activities that apply to the implementation of these procedures. However, the following general QA procedures apply:

- All data must be documented on field data sheets or within site logbooks.
- All instrumentation must be decontaminated prior to collection of a sample.
- All instrumentation must be operated in accordance with the operating instructions as supplied by the manufacturer, unless otherwise specified in the work plan. Equipment checkout and calibration activities must occur prior to sampling/operation, and they must be documented.
- Field blanks are to be used for VOC samples at a rate of one per day.

4.9 Health and Safety

When working with potentially hazardous materials, follow U.S. EPA, OSHA, and site-specific health and safety procedures.

Section 5 – Project Analyte Setup, Sample Handling, and Waste Disposal

5.1 Project Analyte Setup

A list of analytes for each site will be developed and kept with the project files. The analyte list will include the following information:

- Project name
- Site numbers for samples for each analyte that will be collected
- Analyte name
- The analysis method name
- The preservative needed in the sample bottle for each analyte
- The sample holding time for the analyte and analysis method
- The extraction holding time
- The sample size required for the analyte and analysis method
- The containers in which samples will be collected for each analyte
- The accuracy of the testing required of the laboratory (This will include the allowable laboratory control sample percent recovery and the allowable matrix spike percent recovery.)
- The acceptable precision required of the laboratory (This will be expressed as the relative percent difference maximum.)

Sample labels will be filled out with indelible ink and uniquely numbered.

5.2 Sample Labeling

Sample labels will be filled out with indelible ink and uniquely numbered. Labels may be partially completed prior to sample collection. The time should not be completed until the time of sample collection. At a minimum, each numbered label shall contain the following information:

- Project name
- Project number
- Site number, if applicable
- Date and time of sample collection
- Sampler's initials
- Analyses required
- Preservatives (if applicable)

5.3 Sample Handling

Water quality samples will be collected in appropriate containers supplied by the analytical laboratory. Preservatives required for water samples will be added to the appropriate container by the laboratory prior to sample collection. Care should be taken to ensure that foreign objects do not enter the sample containers.

5.4 Sample Packaging

Water quality samples will be placed on a chemical ice substitute or ice in a portable insulated cooler immediately following sample collection. A completed chain-of-custody form for each cooler will be prepared and placed in a resealable plastic bag inside the cooler. Coolers will be wrapped with strapping tape at two locations to secure lids.

5.5 Sample Shipping

Collected samples will be delivered to the designated analytical laboratory by the sampler or a bonded courier. If samples are to be shipped through mail carriers, the tracking numbers and the dates and times of transfers shall be recorded on the chain-of-custody, and shipping receipts shall be kept in the project folders. Sample transportation will follow EPA and Department of Transportation (DOT) regulations.

5.5.1 Sample Documentation

Documentation of observations and data acquired in the field will provide information on the acquisition of samples and a permanent record of field activities. The observations and data will be recorded with indelible ink on field data sheets, the chain-of-custody, and, if applicable, in a permanently bound weatherproof field book with consecutively numbered pages.

The information in the documentation will include the following at a minimum:

- Project name
- Location of sample
- Sampler's initials
- Date and time of sample collection
- Field water quality parameters, possibly including the temperature, pH, electrical conductivity, DO, and ORP, of the matrix being sampled
- Sample identification numbers and sample depth (if applicable)
- Description of samples (matrix sampled)
- Analysis to be performed
- Number and volume of samples
- Sample method

- Sample handling
- Field observations, including site weather conditions
- Personnel and equipment present

Changes or deletions on the field data sheets or field book should be lined out with a single strike mark, initialed, dated by person making change, and remain legible. Sufficient information should be recorded to allow the sampling event to be reconstructed without relying on the sample collector's memory. If a field book is used, the person making the entry will sign each page of the field book. Anyone making entries in another person's field book will sign and date those entries.

5.5.2 Sample Tracking

During field sampling activities, traceability of the sample must be maintained from the time the samples are collected until laboratory data are issued. Information on the custody, transfer, handling, and shipping of samples will be recorded on a chain-of-custody form. The chain-of-custody is a one-page form typically with carbon-copies attached.

The sample handler will be responsible for initiating and filling out the chain-of-custody form. The sampler will sign the chain-of-custody when the sampler relinquishes the samples to anyone else, including the bonded courier. A chain-of-custody form will be completed for each cooler of samples collected daily and will contain the following information:

- Sampler's signature and affiliation
- Chain-of-custody ID
- Date and time of collection
- Sample identification number
- Sample type/matrix
- Analyses requested
- Number of containers
- Signature of persons relinquishing custody, dates, and times
- Signature of persons accepting custody, dates, and times (laboratory)
- Method of shipment, if applicable

The person responsible for delivery of the samples to the laboratory will sign the chain-of-custody form and document the shipment method. Upon receipt at the laboratory, the person receiving the samples will sign the chain-of-custody form. Copies of the chain-of-custody forms and all custody documentation will be received and kept in the central files. The original chain-of-custody forms will remain with the samples until final disposition of the samples by the laboratory. The analytical laboratory will dispose of the samples in an appropriate manner. After sample receipt, a copy of the original chain-of-custody will be sent to the Project Manager by the analytical laboratory to be incorporated into the central files.

5.6 Waste Disposal

Wastes produced during the sampling of lysimeters, surface waters, and wells will include the following:

- Purge water
- Instrument calibration fluids
- Paper and plastic trash

These wastes will be disposed of in accordance with local, state, and federal requirements. Purge water of unknown quality will be contained within an appropriate receptacle until properly disposed of at an appropriate disposal facility or until analytical results indicate the water is not hazardous and meets regulatory requirements for surface disposal. Purge water of known quality (i.e. routine groundwater sampling and analysis have been performed) that is not hazardous and meets regulatory requirements for surface disposal may be disposed of at the site of origin. Instrument calibration fluids and general trash shall be disposed in a suitable waste disposal container.

6.1 Scope and Application

Inspection and documentation of all monitoring stations is critical to maintain current information on sites and to make adjustments to field monitoring plans.

6.2 Method Summary

The inspection process should be focused around the accurate documentation of all applicable aspects of the site as they relate to current and possible future monitoring applications. The process involves the documentation of as much information as possible for each station, using a variety of instruments.

6.3 Interferences and Potential Problems

This section is not applicable to this SOP.

6.4 Equipment

The following equipment is necessary for the completion of the inspection process:

- Tools
- Keys to access station
- GPS
- Digital camera
- Compass
- Measuring tape
- Permanent marker
- Sketch form
- Pen

6.5 Preparation

1. Collect and review all field inspection sheets for each station scheduled for site inspection.
2. Determine if the inspection sheet and other information are complete or need revisions, and make note of those stations that will need to have a complete inspection performed. If a completed sketch exists, photographs are up-to-date, and both are accurate, continue onto the sample/data collection process.
3. Prepare scheduling and coordinate with staff, clients, and regulatory agencies, if appropriate.

6.6 Procedures

If an inspection document has not been completed or needs to be updated, follow the procedures below to complete all information for each site.

1. Perform a general site survey prior to site entry in accordance with the health and safety plan.
2. Collect coordinates of the site or site components using GPS.
3. Create a sketch of the site on the sketch form.
    a. Include Well ID and Alias ID (where applicable). The Alias ID or Local Name may be written on the site.
    b. Include a general map, using major roads to show general site location and minor roads, trails, buildings, and private roads to show site location within the property. Note compass direction, and write well access comments (i.e. locked gate, escort required, etc.).
    c. Include a station sketch in map or profile view with compass direction. This will include all features of the site. For example, at a well site, this includes the well, any pump, discharge line(s), sampling ports, meters, on-site tanks, etc.
    d. Include a reference sketch in profile view with compass direction. This includes a sketch of the wellhead or lysimeter head, where data are gathered, etc. For wells, include any surface or below ground features that affect the site point (SP), and reference point (RP). Measure and record distances between the ground surface (GS), SP, and RP. Also, include pipe/casing diameters, where they can be determined.
4. Take the following photographs, as applicable to the site type:
    a. Site. This will document the entire site, including access to the site (roads, gates, etc.). Take several site photographs if necessary.
    b. Station. This will document all of the features of the site. For example, at a well site, include the pressure tank, the power and hours meters, the pump (if present), the SP, the RP(s), and the GS. If needed, take photographs from several directions. At well sites, take these photographs after the SP and RP have been marked.
    c. Reference Point. The RP photograph will be of the main RP where data are collected. Take photographs of any other possible RPs. Take one photograph for each RP. Take these photographs after the main RP has been marked.
    d. Flow Meter, Power Meter, Hours Meter. These photographs should be taken of each meter, perpendicular to the face. The text on the flow meter should be clearly legible so that it can be read later. This will help clarify units, decimal places, meter model, etc. Take more than one photograph of each meter if located inside of a box or away from the well.
    e. Water Quality Sampling Port. The water quality photograph should be of the port location on a well site and should show the port type.

f. Pump Identification. The pump identification photograph (at well sites) should be taken of the tag on the pump (i.e. vertical turbine pumps) that identifies the serial number of the pump and other information about it, such as horse power.

6.7 Reagents

This section is not applicable to this SOP.

6.8 Calculations

This section is not applicable to this SOP.

6.9 Quality Assurance/Quality Control

Every time a site is visited, the site inspection information should be verified and updated as necessary.

6.10 Data Validation

This section is not applicable to this SOP.

6.11 Health and Safety

When working with potentially hazardous materials, follow U.S. EPA, OSHA, and site-specific health and safety procedures. Wellhead treatment equipment may be present at well sites. This equipment should not be accessed by personnel not trained to do so. Review safety information provided by the well owner and MSDS/SDS for onsite chemicals if potential exposure exists.

7.1 Scope and Application

Nuisance water is defined here as moderate to heavy precipitation, standing water, or runoff. Nuisance water, if allowed to enter a well, can contaminate the well and aquifer(s) that the well is in communication with. When gaining access to a well, every effort must be taken to ensure that nuisance water does not enter the well.

7.2 Procedures

When accessing a well with nuisance water present, the following procedures must be followed:

- Wells with access through an open top—such as piezometers or a production well without a pump—should be protected from heavy rain with the use of an instant canopy/shelter (e.g. an EZ-Up®) or an umbrella. If protection of this nature is not possible, contact the Project Manager or Field Manager to discuss the circumstances before accessing the well.
- When a damaged casing is encountered such that nuisance water can enter the casing, contact the Project Manager or Field Manager from the site to discuss the condition of the well and possible solutions. Take photographs of the part of the well of concern and the nearest surface water body or runoff path, if applicable, and follow up at the end of the day with an email to the Project Manager and Field Manager with the photographs attached.
- When runoff or standing water is in immediate danger of entering a well casing, the casing should not be opened. Contact the Project Manager or Field Manager from the site to discuss the circumstances. Take photographs of the well of concern and the nearest surface water body or runoff path, if applicable, and follow up at the end of the day with an email to the Project Manager and Field Manager with the photographs attached.

7.3 Health and Safety

When working with potentially hazardous materials, follow U.S. EPA, OSHA, and site-specific health and safety procedures. Flash flooding and contaminated runoff may occur during rain events. Consult local weather warning centers for conditions prior to approaching sites where significant surface water runoff may occur.

Section 8 – Decontamination of Field Equipment

8.1 Scope and Application

Removing or neutralizing contaminants that have accumulated on sampling equipment ensures the protection of personnel from permeating substances, reduces or eliminates the transfer of contaminants to clean areas, prevents the mixing of incompatible substances, and minimizes the likelihood of sample cross-contamination.

8.2 Method Summary

Contaminants can be physically removed from equipment or deactivated by sterilization or disinfection. Gross contamination of equipment requires physical decontamination, including abrasive and non-abrasive methods. These include the use of brushes, air and wet blasting, and high pressure water cleaning, followed by a wash/rinse process using appropriate cleaning solutions. The use of a solvent rinse is required when organic contamination is present.

8.3 Interferences and Potential Problems

- The use of distilled/deionized water, commonly available from commercial vendors, may be used for decontamination of sampling equipment, provided that it has been verified by laboratory analysis to be analyte free.
- An untreated potable water supply is not an acceptable substitute for tap water. Tap water may be used from any municipal water treatment system for mixing decontamination solutions.
- Acids and solvents utilized in the decontamination sequence pose health and safety risks, such as inhalation or skin contact, and raise shipping concerns of permeation and/or degradation. Review and follow all applicable warnings, requirements, and recommendations stated on the MSDS/SDS prior to working with these materials.
- The site work plan must address the disposal of the spent decontamination solutions.
- Several procedures can be established to minimize contact with waste and the potential for contamination. For example:
    - Utilize practices that minimize contact with hazardous substances.
    - Use remote sampling, handling, and container-opening techniques when appropriate.
    - Cover monitoring and sampling equipment with protective material to minimize contamination.
    - Use disposable outer garments and disposable sampling equipment when appropriate.

8.4 Equipment

Depending on the method used, as detailed below, the following equipment may be necessary.

- appropriate personal protective equipment
- non-phosphate detergent
- selected solvents (see below)
- long-handled plastic brushes
- drop cloths/plastic sheeting
- paper towels
- tap water
- distilled/deionized water
- metal/plastic containers for the storage and disposal of contaminated wash solutions
- pressurized sprayers for tap and deionized/distilled water
- sprayers for solvents
- trash bags
- aluminum foil
- safety glasses or a splash shield
- emergency eyewash bottle

8.5 Preparation

As part of the health and safety plan for each project or site, develop and set up a decontamination plan before any personnel or equipment enter areas of potential exposure. The equipment decontamination plan should include:

- the number, location, and layout of decontamination stations
- the decontamination equipment needed
- appropriate decontamination methods
- methods for the disposal of contaminated clothing, apparatus, and solutions (USEPA, 1994)

All personnel, samples, and equipment leaving a contaminated area of a site must be decontaminated. Various decontamination methods will physically remove contaminants and/or inactivate contaminants by disinfection or sterilization.

In many cases, gross contamination can be removed by physical means. The physical decontamination techniques appropriate for equipment decontamination can be grouped into two categories: abrasive methods and non-abrasive methods. Abrasive cleaning methods work by rubbing and wearing away the top layer of the surface containing the contaminant. Non-abrasive cleaning methods work by forcing the contaminant off of a surface with pressure. In general, less of the equipment surface is removed using non-abrasive methods.

Disinfectants are a practical means of inactivating infectious agents. Standard sterilization methods involve heating the equipment; though sterilization is impractical for large or heat sensitive equipment. Rinsing removes contaminants through dilution, physical attraction, and solubilization.

8.6 Procedures

1. Where applicable, use a brush in each wash for the physical removal of contaminates.
2. Wash equipment with bleach and water solution.
3. Wash equipment with a non-phosphate detergent solution.
4. Rinse with tap water.
5. Rinse with distilled/deionized water.
6. Rinse with 10% nitric acid if the sample will be analyzed for trace metals.
7. Rinse with distilled/deionized water.
8. Use a solvent rinse (pesticide grade) if the sample will be analyzed for organics.
9. Air dry the equipment completely.
10. Rinse again with distilled/deionized water.
11. Towel dry sounder or steel tape equipment prior to winding it onto the spool.

The nitric acid rinse and subsequent distilled/deionized water rinses may be eliminated if metals are not of concern at a site. Similarly, the solvent rinse and subsequent air dry and distilled/deionized water rinse steps may be eliminated if organics are not of concern at the site. Selection of the solvent for use in the decontamination process is based on the contaminants present at the site. Typical solvents used for the removal of organic contaminants include acetone, hexane, or water. If a particular contaminant fraction is not present at the site, the eleven-step decontamination procedure listed above may be modified for site specificity. The decontamination solvent used should not be among the contaminants of concern at the site (USEPA, 1994).

Table 1 lists solvent rinses that may be required for the elimination of particular chemicals. After each solvent rinse, the equipment should be air dried and rinsed with distilled/deionized water.

Sampling equipment that requires the use of plastic tubing must be disassembled, and the tubing should be replaced with clean tubing before the commencement of sampling and between sampling locations.

Solvent	Soluble Contaminants
Water	Low-chain hydrocarbons Inorganic compounds Salts Some organic acids and other polar compounds
Dilute Acids	Basic (caustic) compounds Amines Hydrazines
Dilute Bases – for example, detergent and soap	Metals Acidic compounds Phenol Thiols Some nitro and sulfonic compounds
Organic Solvents(1) – for example, alcohols, ethers, ketones, aromatics, straight-chain alkanes (e.g., hexane), and common petroleum products (e.g. fuel, oil, kerosene)	Nonpolar compounds (e.g. some organic compounds)

i. - WARNING: Some organic solvents can permeate and/or degrade protective clothing.
ii. Source: (USEPA, 1994)

8.7 Reagents

The solvents used in this decontamination procedure are the reagents. The following solvents may be utilized for decontamination purposes:

- 10% nitric acid[1]
- acetone (pesticide grade)[2]
- hexane (pesticide grade)[2]
- methanol[2]

[1] Only if sample is to be analyzed for trace metals

[2] Only if sample is to be analyzed for organics (USEPA, 1994)

8.8 Calculations

This section is not applicable to this SOP.

8.9 Quality Assurance/Quality Control

The rinsate blank is a quality assurance/quality control option specific to the decontamination of field equipment process. The rinsate blank provides information on the effectiveness of the decontamination process employed in the field.

A rinsate blank consists of a sample of analyte-free water (i.e. deionized) that is passed over and/or through a decontaminated field sampling device and placed in a clean sample container. The sample is then submitted to a laboratory for analysis of contaminates of interest.

Rinsate blanks should be run if stated in the work plan, if contamination is suspected, or when the decontamination procedure is modified. Rinsate blanks are not required if dedicated sampling equipment is used.

8.10 Data Validation

This section is not applicable to this SOP.

8.11 Health and Safety

When working with potentially hazardous materials, follow U.S. EPA, OSHA, and site-specific health and safety procedures.

Decontamination can pose hazards under certain circumstances even though performed to protect health and safety. Hazardous substances may be incompatible with decontamination methods. For example, the decontamination solution or solvent may react with contaminants to produce heat, explosion, or toxic products (USEPA, 1994). Decontamination methods may be incompatible with clothing or equipment: some solvents can permeate or degrade protective clothing. Also, decontamination solutions and solvents may pose a direct health hazard to workers through inhalation, skin contact, or combustion.

The decontamination solutions and solvents must be determined to be compatible before use. Any method that permeates, degrades, or damages personal protective equipment must not be used. If decontamination methods pose a direct health hazard, measures must be taken to protect personnel or the methods should be modified to eliminate the hazard. (USEPA, 1994)

Decontamination solutions and solvents must be stored in appropriate containers and in temperature and humidity controlled environments, as specified on the product containers or MSDS/SDS sheets. Handling of these substances should be as specified on the product containers or MSDS/SDS sheets. Nitrile gloves, eye protection, and other personal protection equipment may be necessary.

8.12 References

U.S. Environmental Protection Agency. (1994). Sampling Equipment Decontamination, SOP#: 2006. Rev. #: 0.0. August 1994.