Pure Water Monterey
A Groundwater Replenishment Project

FINAL
ENGINEERING REPORT

VOLUME I: ENGINEERING REPORT

MONTEREY ONE WATER PURE WATER MONTEREY GROUNDWATER REPLENISHMENT PROJECT

Revised
April 2019

Nellor Environmental Associates, Inc.
4024 Walnut Clay Dr.
Austin, TX 78731
512.374.9330

Trussell Technologies, Inc.
1939 Harrison Street
Suite 600
Oakland, CA 94612
510.457.2200
www.trusselltech.com
www.toddgroundwater.com

Todd Groundwater
2490 Mariner Square Loop
Suite 215
Alameda, CA 94501
510.747.6920

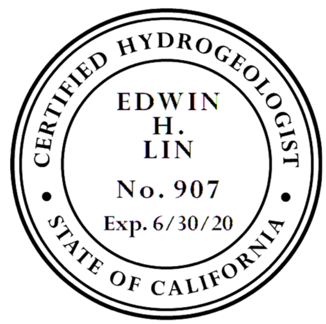
SIGNATURE PAGE

John D. Kenny, P.E.
Supervising Engineer
Trussell Technologies, Inc.

April 4, 2019

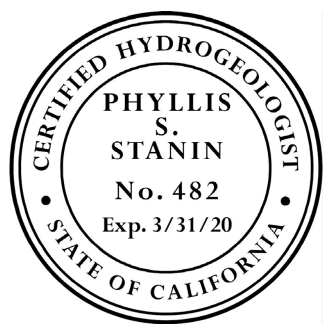
Edwin Lin, PG, CHg
Principal Hydrogeologist
Todd Groundwater

April 4, 2019



Phyllis S. Stanin, PG, CH, CEG
Vice President/Principal Geologist,
Todd Groundwater

April 4, 2019



SUMMARY OF REVISIONS TO FINAL ENGINEERING REPORT MONTEREY ONE WATER PURE WATER MONTEREY GROUNDWATER REPLENISHMENT PROJECT

The Final Engineering Report for the Monterey Regional Water Pollution Control Agency (MRWPCA) Pure Water Monterey Groundwater Replenishment Program (dated July 1, 2016) was originally approved by the State Water Resources Control Board, Division of Drinking Water (SWRCB-DDW) on November 7, 2016. Since Engineering Report approval, the operational capacity of the MRWPCA Advanced Water Purification Facility (AWP Facility) was increased from 4.0 MGD to 5.0 MGD in order to deliver 600 AFY of purified recycled water to Marina Coast Water District (MCWD) for urban landscape irrigation, injection wells have been installed, and MRWPCA has changed its name to Monterey One Water (M1W).

The Engineering Report was revised in November 2017 to identify MCWD's recycled water use and plans for program approval under Order WQ 2016-0068-DDW, describe the new AWP Facility capacity and final design specifications, and incorporate the monitoring and reporting requirements specified for the Pure Water Monterey Project in Order No. R3-2017-0003.

The April 2019 revisions to the Engineering Report address SWRCB-DDW comments dated August 23, 2018 (for M1W Engineering Report) and November 29, 2018 (for MCWD Engineering Report), consistency with MCWD facility descriptions, 2018 Recycled Water Policy Amendment requirements, final locations and specifications of the injection wells, revised groundwater modeling results based on injection well installation and planned operation, additional pathogenic log removal credits for Reverse Osmosis treatment, selected approach for the groundwater tracer study, and the Project Sponsor's name change to Monterey One Water.

Table of Contents

List of Tables

List of Figures

Appendices (Volume II)

Acronyms

A	Ampere
AAL	Archived Advisory Level
AF	Acre-feet
AFY	Acre-feet per year
AGR	Agricultural water supply
AOC	Assimilable organic carbon
AOP	Advanced oxidation process
ASR	Aquifer Storage and Recovery
ASTM	American Society for Testing and Materials International
ATS	Automatic Transfer Switch
AWP	Advanced Water Purification
BAF	Biologically activated filtration
BDP	Brine Differentiation Plots
bgs	Below ground surface
HCO_3^-	Bicarbonate ion
BOD_5	Biochemical oxygen demand – five day
BPA	Bisphenol A
BPTC	Best Practicable Treatment or Control
°C	Degrees Centigrade
$CaCl_2$	Calcium chloride
$CaCO_3$	Calcium carbonate
CalAm	California American Water Company
$Ca(OH)_2$	Hydrated lime
$CBOD_5$	Carbonaceous biochemical oxygen demand – five day
CFR	Code of Federal Regulations
CIP	Clean in place
CCLEAN	Central Coast Long-term Environmental Assessment Network
CCPP	Calcium Carbonate Precipitation Potential
CCR	California Code of Regulations
C_e	Treated water concentration
CECs	Constituents of emerging concern
CEPT	Chemically Enhanced Primary Treatment
CEQA	California Environmental Quality Act
cfm	Cubic feet per minute
CHG	Certified Hydrogeologist

C_i	Feed concentration
CIU	Categorical Industrial User
CO_2	Carbon dioxide
CSIP	Castroville Seawater Intrusion Project
CT	Concentration multiplied by the contact time
CWA	Clean Water Act
CWSRF	Clean Water State Revolving Fund
d	Day
DBPs	Disinfection by-products
DDW	State Water Resources Control Board Division of Drinking Water
DEET	N,N-diethyl-meta-toluamide
DFA	Division of Financial Assistance
2,6-DNT	Dinitrotoluene
DO_3	Dissolved ozone
DOC	Dissolved organic carbon
DWR	California Department of Water Resources
EC	Electrical conductivity
EDB	1,2-Dibromoethane
EED	Electrical energy dose
EE/O	Electrical energy per log order reduction
EFM	Enhanced flux maintenance
EIR	Environmental Impact Report
ELAP	Environmental Laboratory Accreditation Program
EPDM	Ethylene Propylene diene rubber
EQ	Equalization
ESCA	Environmental Services Cooperative Agreement
FDA	Food and Drug Administration
fps	Feet per second
FORA	Fort Ord Reuse Authority
FRP	Fiberglass reinforced plastic
FTAE	FactoryTalk Alarm and Event
ft/day	Feet per day
ft^2/day	Square feet per day
gpd/ft^2	Gallons per day per square foot
G:L	Gas to liquid ratio
gpd	Gallons per day
gph	Gallons per hour

gpm	Gallons per minute
GRRP	Groundwater Replenishment Reuse Project
GSE	Ground surface elevation
GWRS	Groundwater Replenishment System
H_2O_2	Hydrogen peroxide
HAA5	Haloacetic acids (five): monochloroacetic acid, dichloroacetic acid, trichloroacetic acid, monobromoacetic acid, and dibromoacetic acid
HDPE	High density polyethylene
HMI	Human-machine Interface
HMX	cyclotetramethylene tetranitramine
hp	Horsepower
HRT	Hydraulic residence time
IAP	Independent Advisory Panel
I/O	Input and output
IU	Industrial user
IWTF	Industrial Waste Treatment Facility
K or K_h	Horizontal hydraulic conductivity
kDa	kilodaltons
kV	Kilovolt
kW	Kilowatts
kWh/kgal	Kilowatt-hours per thousand gallons
lbs/day	Pounds per day
lb/gal	Pounds per gallon
lb/hr	Pounds per hour
LC-MS-MS	Liquid Chromatography Tandem Mass Spectrometry
LOX	Liquid oxygen
LPUV	Low pressure, high intensity UV
LSI	Langelier Saturation Index
LT2ESWTR	Long Term 2 Enhanced Surface Water Treatment Rule
LRV	Log reduction value
L:W	Length to width ratio
M1W	Monterey One Water
MCC	Motor control center
MCL	Maximum Contaminant Level
MCWD	Marina Coast Water District
MCWRA	Monterey County Water Resources Agency
MEC	Measured Environmental Concentration
meq/L	milliequivalents per liter

mV	millivolts
MF	Membrane filtration
MFI	Modified Fouling Index
MFL	Million fibers per liter
MF/UF	Microfiltration/Ultrafiltration
mgd	Million gallons per day
mg/L	Milligrams per liter
MPA	Masters of Public Administration
MPN	Most probable number
MPUV	Medium pressure, high intensity UV
MPWMD	Monterey Peninsula Water Management District
MRL	Method Reporting Level
MRP	Monitoring and reporting program
MRWPCA	Monterey Regional Water Pollution Control Agency
msl	Mean sea level
MTL	Monitoring Trigger Level
MUN	Municipal and domestic supply
mV	Millivolts
N	Nitrogen
N/A	Not applicable
NaCl	Sodium chloride
NAE	National Academy of Engineering
NaOCl	Sodium hypochlorite
NaOH	Sodium hydroxide
ND	Not detected above MRL
NDMA	N-nitrosodimethylamine
NEPA	National Environmental Policy Act
ng/L	Nanograms per liter
NH_3	Ammonia
NL	Notification Level
nm	Namometers
NO_3	Nitrate
NOM	Natural organic matter
NPDES	National Pollutant Discharge Elimination System
NTU	Nephelometric turbidity units
NWRI	National Water Research Institute
O	Oxygen

O_3:TOC	Ozone to Total Organic Carbon Ratio
OCWD	Orange County Water District
OEM	Original Equipment Manufacturers
O&M	Operation and maintenance
OOP	Operation Optimization Plan
ORP	Oxidation-reduction potential
OSS	Ozone system supplier
P	Phosphorus
P_L	Total lamp power
PCA	Pretreatment Compliance Audit
PCBs	Polychlorinated Biphenyls
PCI	Pretreatment Compliance Inspection
pCi/L	Picocuries per liter
PDT	Pressure decay test
P.E.	Professional Engineer
P.G.	Professional Geologist
PG&E	Pacific Gas and Electric Company
Ph.D.	Doctor of Philosophy
PLC	Programmable Logic Controller
PM	Preventative maintenance
PoLi	Pesticides of local interest
ppm	Parts per million
PRT	Pathogen Retention Time
psi	Pounds per square inch
psid	Pounds per square inch – differential
psig	Pounds per square inch gage
PSU	Power supply unit
PTFE	Polytetrafluoroethylene
PVC	Polyvinyl chloride
PVDF	Polyvinylidene difluoride
PWPS	AWP Product Water Pump Station
Q	Flowrate
QA/QC	Quality assurance/quality control
REHS	Registered Environmental Health Specialist
RDX	Cyclotrimethylene trinitramine cyclonite
RF	Reverse filtration
RF/AS	Reverse filtration/air scrubbing

RMA	Running monthly average
RO	Reverse osmosis
rpm	Revolutions per minute
RRT	Response Retention Time
RTP	Regional Treatment Plant
RUWAP	Regional Urban Water Augmentation Project
RWP	MCWD Recycled Water Project
RWC	Recycled Municipal Wastewater Contribution
RWQCB	Regional Water Quality Control Board
S	Storativity
SAR	Sodium Adsorption Ratio
SCADA	Supervisory control and data acquisition
scfm	Standard cubic feet per minute
scfh	Standard cubic feet per hour
SIU	Significant Industrial User
SM	Standard Methods for the Examination of Water and Wastewater
SNMP	Salt/Nutrient Management Plan
SOPs	Standard operating procedures
SRF	State Revolving Fund
SS	Stainless steel
SVRP	Salinas Valley Reclamation Project
SWRCB	State Water Resources Control Board
SWTR	Surface Water Treatment Rule
T	Transmissivity
t_{10}	Time for 10% of the input concentration to be observed at the outlet of the system
TBD	To be determined
TDS	Total dissolved solids
TEFC	Totally enclosed fan-cooled
TIPS	Thermally induced phase separation
T&O	Taste and odor
TOC	Total organic carbon
TMF	Technical Managerial and Financial Assessment
TNT	2,4,5-trinitrotoluene
TSS	Total suspended solids
UCMR	Unregulated Contaminant Monitoring Rule
µg/L	microgram per liter
UIC	Underground Injection Control

µmhos/cm	Micromhos per centimeter equivalent to µS/cm
µS/cm	Microsiemens per centimeter
U.S. EPA	United States Environmental Protection Agency
UV	Ultraviolet light
UV/H_2O_2	Ultraviolet light with hydrogen peroxide
UVI	Ultraviolet light intensity
UVT	Ultraviolet light transmittance
VAC	Volts alternating current
VOC	Volatile organic chemicals (SVOC are semi- VOCs)
WDRs/WRRs	Waste Discharge Requirements/Water Reclamation Requirements
WQ	Water quality
WY	Water Year

1. PROJECT OVERVIEW

1.1. PUBLIC OUTREACH AND COORDINATION

M1W's community outreach activities include updates to its website to provide information on facility tours and classroom presentations; new outreach materials on the RTP; materials regarding pharmacies offering drug take-back programs; participation/exhibits in community events; school outreach (presentations, materials, teacher curriculum training and workshops); RTP tours; commercials and advertising for controlling fats, oil and grease; and participation in the Monterey County Oil Recycling Program.

As part of outreach for the Project, since 2008, M1W staff have escorted interested members of the local community to visit the Orange County Water District's (OCWD's) Groundwater Replenishment System (GWRS). The tours introduced community leaders to a concept of replenishing the local aquifers with purified water.

Since 2013, M1W has taken steps to implement a similar program. A temporary small pilot AWP plant was installed in the fall of 2013 at the RTP to collect data on the quality of product water and information for design of the full-scale AWP Facility. In the fall of 2015, M1W completed the installation of a permanent AWP Demonstration Facility. This new facility features all of the treatment technologies that will be included in the full-scale AWP Facility. It is set up to facilitate tours and allow visitors to taste the product water. Tours of the facility began in August 2015 and have continued to the present day.

As part of the CEQA public participation process for the adopted EIR for the Project, the following activities took place:

- Notices regarding the April 2015 Draft EIR were emailed to 700 agencies, interested organizations, and individuals; placed as newspaper advertisements; distributed to State agencies through the State Clearinghouse; placed in public locations such as libraries, M1W's and Monterey Peninsula Water Management District's (MPWMD's) websites and offices, and key project sites; and posted with the Monterey County Clerk.
- Public meetings to provide information on the Project and CEQA process were held on May 20 and 21, 2015.
- The public was provided a 45-day comment period for the Draft EIR.
- Notices about the availability of the Final EIR were distributed in September 2015 to all entities that received the Draft EIR and,
- The Final EIR was certified and the Project was approved at a public hearing held on October 8, 2015.

A similar level of outreach was conducted for the September 2016 Engineering Report. A public hearing was held on August 22, 2016 with 30-days prior notice (via emails and letters) given to well owners in the Seaside Groundwater Basin. In addition, a notice was published in the Monterey County Herald and posted on the M1W website. Public comments were solicited by M1W during the hearing and 10-days after the hearing.

The Tentative Order WDRs/WRRs were posted on the Central Coast RWQCB's website for a 30-day public comment period and the Central Coast RWQCB provided public notice of the March 9, 2017 permit adoption hearing.

1.2. BACKGROUND

The Pure Water Monterey project (Project) is a groundwater replenishment reuse water supply project that will serve northern Monterey County, California. It will provide: (1) purified recycled water (product water) for replenishment of the Seaside Groundwater Basin (Seaside Basin) that serves as a drinking water supply; (2) purified recycled water (product water) for landscape irrigation by the Marina Coast Water District (MCWD); and (3) recycled water to augment the existing Castroville Seawater Intrusion Project's (CSIP's) agricultural irrigation supply. The planned date for Project startup is 2019.

- **Replenishment of the Seaside Basin**. The Project will enable the California American Water Company (CalAm) to reduce its diversions from the Carmel River system by up to 3,500 acre-feet per year (AFY) by injecting the same amount of product water into the Seaside Basin. The product water will be produced at a new Advanced Water Purification (AWP) Facility at the Monterey One Water (M1W)[1] Regional Wastewater Treatment Plant (RTP) and will be conveyed to and injected into the Seaside Basin via a new pipeline and new well facilities. The injected water will then mix with the existing groundwater and be stored for future urban use (including use as a potable source of supply) by CalAm.

- **Landscape irrigation by MCWD**. The Project will provide up to 600 AFY of AWP Facility product water for landscape irrigation by MCWD customers. The product water will be diverted from the AWP Facility product water conveyance pipeline. The quality of the product water will meet all recycled water quality requirements for landscape irrigation, as it will be treated to the higher water quality standards required for groundwater replenishment. Treatment and production by M1W are described in this Engineering Report. A separate Engineering Report will be submitted by MCWD to describe the recycled water distribution system, recycled water uses, and recycled water program administration. MCWD will also separately submit a Notice of Intent for recycled water program coverage under the Statewide General Order Water Reclamation Requirements for Recycled Water Use (Order WQ 2016-0068-DDW).

- **Additional recycled water for agricultural irrigation in northern Salinas Valley**. An existing tertiary recycled water facility at the RTP that is part of the Salinas Valley Reclamation Project (SVRP) will be provided additional source waters (treated first at the RTP) in order to provide supplementary tertiary recycled water for use in the CSIP agricultural irrigation system.[2] It is anticipated that in normal and wet years approximately 4,500 to 4,750 AFY of additional recycled water supply could be created for agricultural irrigation purposes. In drought

[1] Monterey One Water was formerly known as Monterey Regional Water Pollution Control Agency (MRWPCA).
[2] The permitted design flow of the SVRP is 29.6 mgd (approximately 33,000 AFY), which can accommodate the supplementary flow for treatment. The tertiary recycled water is provided to 12,000 acres of farmland in the Salinas Valley primarily during the growing season (typically April through November). This aspect of the project is subject to (1) Water Recycling Requirements issued to MRWPCA (Order 94-82) and (2) Recycled Water User Requirements (Order No. 97-52) issued to Monterey County Water Resources Agency by the Central Coast Regional Water Quality Control Board.

conditions, the Project could provide up to 5,900 AFY for crop irrigation.

The Project will also include a drought reserve component to support greater use of the new supply for crop irrigation during dry years. The Project will provide an additional 200 AFY of product water that will be injected in the Seaside Basin in wet and normal years for up to five consecutive years. This will result in a "banked" drought reserve totaling up to 1,000 acre-feet (AF). During dry years, the Project will provide less than 3,500 AF of water to the Seaside Basin; however, CalAm will be able to extract the banked water to make up the difference to its supplies, such that its extractions and deliveries will not fall below 3,500 AFY. The source waters that are not sent to the AWP Facility during these dry years when water from the drought bank is being used by CalAm will be sent to the SVRP to increase supplies for CSIP.

The Project components include: conveyance of three types of source waters to the RTP for treatment; the new AWP Facility and other improvements to the RTP; a treated water conveyance system, including pipeline, a pump station, a reservoir, and connections to the pipeline for landscape irrigation; groundwater injection and monitoring wells; and potable water distribution system improvements. Construction of the Project is anticipated to require approximately 18 months, plus three months of testing and start-up.

The new source waters that will supplement the existing incoming wastewater flows are the following: (1) water from the City of Salinas industrial waste water system which is referred to as the agricultural wash water system, (2) storm water flows from the southern part of Salinas, (3) surface water and agricultural tile drain water that is captured in the Reclamation Ditch, and (4) surface water and agricultural tile drain water that flows in the Blanco Drain. Most of these new source waters will be combined within the existing wastewater collection system before arriving at the RTP; water from Blanco Drain will be conveyed directly to the headworks of the RTP. As part of the California Environmental Quality Act (CEQA) adopted Environmental Impact Report (EIR) for the Project, the assessment included these new sources as well as agricultural drainage water from Tembladero Slough and storm water diversions from the Lake El Estero facility in Monterey. Neither grant, loan financing, design, engineering, or permitting are currently being pursued for Tembladero Slough, but may be reconsidered in the future. The Lake El Estero source is not planned for diversion for the Project, but may be reassessed in the future.

The Project will require modifications to existing facilities and construction of new physical facilities, briefly listed below.

- **Source water diversion and storage**. New facilities will be required to divert and convey the new source waters into and through the existing municipal wastewater collection system to the RTP.

- **Treatment facilities at the RTP**. A new AWP Facility will be constructed at the RTP site. This facility will include a full advanced treatment system that meets the requirements in Title 22. California Code of Regulations (CCR), Division 4. Environmental Health, Chapter 3. Water Recycling Criteria, Article 5.2. Indirect Potable Reuse: Groundwater Replenishment – Subsurface Application, amendments to Article 1 definitions, and amendments to Article 7 – Engineering Report and Operational Requirements. The terms "Title 22 Criteria," as used in this report, refer to the State Water Resources Control Board Division of Drinking Water (DDW) Water Recycling Criteria. Treatment at the AWP Facility will consist of ozone pre-treatment, low-pressure membrane filtration, reverse osmosis treatment, advanced oxidation, and product water stabilization. There will also be modifications to the existing SVRP to optimize and enhance the delivery of recycled water to growers.

- **Product water conveyance**. A new pipeline, pump station, reservoir and appurtenant facilities will be constructed to transport the product water from the RTP to the Seaside Groundwater Basin for injection. The new pipeline will include connections to provide purified product water to MCWD for landscape irrigation.

- **Injection well facilities**. The injection facilities will include new injection and monitoring wells (in the shallow and deep aquifers), back-flush facilities, pipelines, electricity/power distribution facilities, and electrical/motor control buildings.

- **Distribution of groundwater from Seaside Basin**. CalAm water distribution system improvements will be needed to deliver the full yield of extracted groundwater to CalAm customers.

This Engineering Report addresses the replenishment of the Seaside Basin by injection of product water from the AWP Facility. This Engineering Report is an update to the September 2016 Pure Water Monterey Engineering Report, which was approved by the Division of Drinking Water (DDW) on November 7, 2016. Since September 2016, M1W has entered into an agreement with MCWD to provide 600 AFY of purified water from the product water conveyance pipeline. In order to provide the additional production, the capacity of the AWP Facility has been revised from 4 MGD to 5 MGD. Accordingly, the Engineering Report is being revised to describe the AWP Facility capacity of 5 MGD. The treatment train remains the same as described in the September 2016 Engineering Report, except that its capacity has been increased from 4 MGD to 5 MGD. The injection system design and modeling remain the same as described in the September 2016 Engineering Report since the additional 1 MGD of capacity will be withdrawn from the conveyance pipeline prior to injection. After completion of the September 2016 Engineering Report, M1W entered into the water purchase agreement with MCWD, the AWP Facility design was completed for the 5 MGD facility, and the Project received Waste Discharge Requirements and Water Recycling Requirements (WDRs/WRR) from the Central Coast RWQCB (Order No. R3-2017-0003) (Appendix L). In addition to describing the increased AWP Facility capacity in this Engineering Report update, the material has been updated to reflect the final design, and to include requirements from the WDRs/WRRs. A separate Engineering Report will be submitted by MCWD to address the distribution, program administration, and uses of product water from the AWP Facility for landscape irrigation. A regional map showing the location of project components is presented as **Figure 1-1**.[3]

---

[3] This Engineering Report does not address Regional Water Quality Control Board Order No. 94-82, Water Reclamation Requirements for MRWPCA for use of recycled water for agricultural irrigation. Order No. 94-82 includes reclamation specifications for the amount of recycled water use (average daily flow over each month not to exceed 29.6 million gallons. *See* Reclamation Specifications B.1). The supplemental tertiary recycled water intended for irrigation as part of the Project does not exceed this requirement. Additional information on any potential changes in tertiary recycled water quality as a result of the source waters was provided in the EIR and is also addressed in this report in terms of secondary effluent quality.

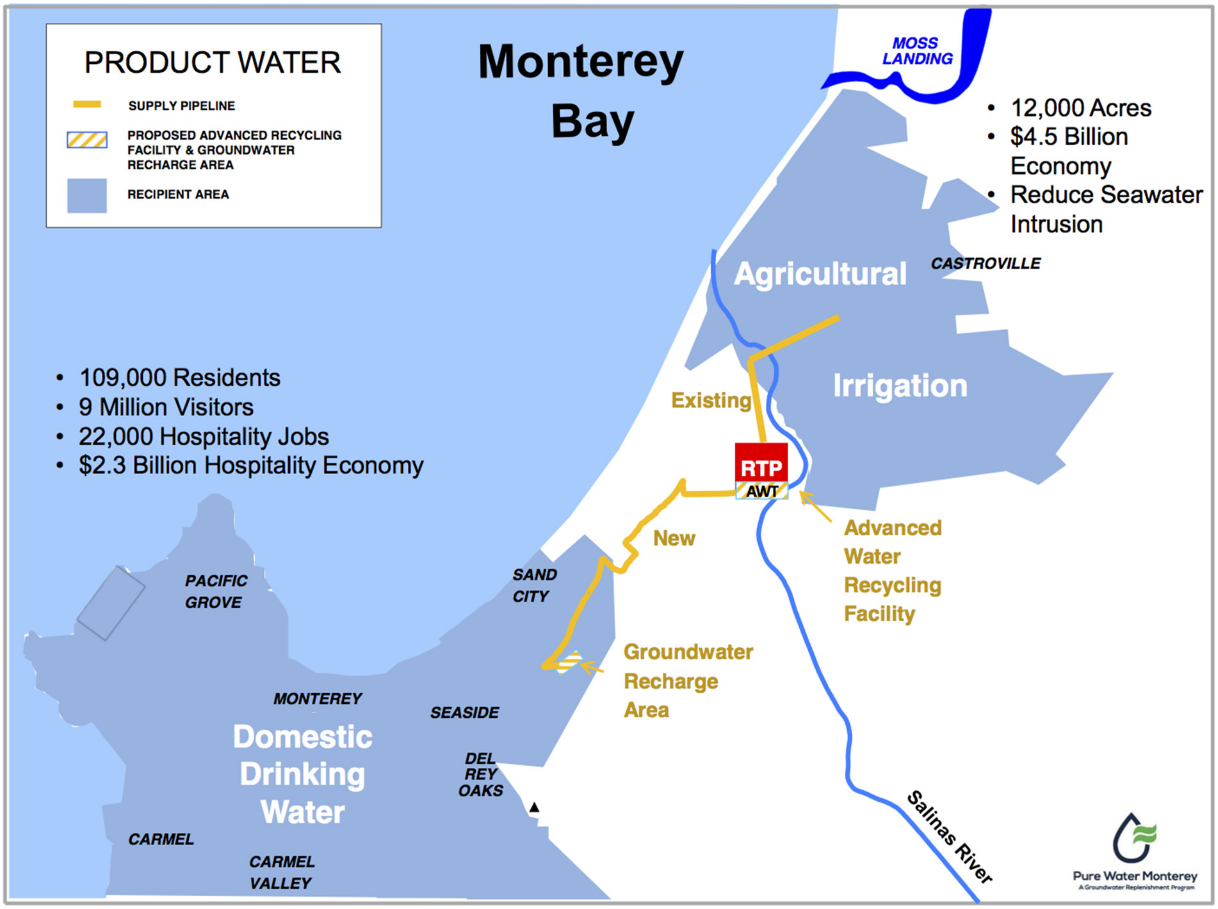


Figure 1-1. Project Facilities Overview

1.3. INDEPENDENT ADVISORY PANEL

M1W has contracted with the National Water Research Institute (NWRI) to form and coordinate the activities of an Independent Advisory Panel (IAP) to provide expert peer review of the technical, scientific, regulatory, policy, and outreach aspects of the Project.

The IAP is comprised of four experts in disciplines relevant to groundwater replenishment projects: engineering, regulatory criteria, public health, hydrogeology, risk assessment, and other relevant fields. The IAP members are:

- George Tchobanoglous, Ph.D., P.E., NAE; University of California, Davis (Davis, California),[4]
- Jean-François Debroux, Ph.D., Kennedy/Jenks Consultants (San Francisco, California),
- Martin B. Feeney, P.G. CHG, Consulting Hydrogeologist (Santa Barbara, California),[5] and
- Michael P. Wehner, MPA, REHS, OCWD (Fountain Valley, California).[6]

[4] Ph.D. – Doctor of Philosophy, P.E. – Professional Engineer, NAE – National Academy of Engineering.
[5] P.G. – Professional Geologist, CHG – Certified Hydrogeologist.
[6] MPA – Masters of Public Administration, REHS – Registered Environmental Health Specialist.

For the first 16-month contract with NWRI, the IAP was tasked with providing specific input on:

- Review of bench-scale testing of the source waters
- Review of source water quality sampling plan and results
- The proposed treatment technologies and operations, including the design and testing protocol for the pilot system.
- Review of the performance and operations of the pilot system.
- Review of water quality data from the pilot system.
- Feedback on the anticipated water quality of the full-scale AWP Facility based on pilot system results.
- Feedback on hydrodynamics, hydrology, and the fate and transport of constituents in the product water after subsurface application.
- Feedback on protection of public health and groundwater quality.
- Feedback on project planning, permitting, and public outreach.

The IAP held two meetings (October 2013 and May 2014) and provided two reports on their findings and recommendations (see **Appendix A**). Topics reviewed included source water characterization; the preliminary results of the pilot testing; information on groundwater quality, groundwater modeling, and the vadose zone leaching analysis; public outreach; water rights; and source control.

1.3.1. Concept Proposal

The IAP also reviewed and provided input on the conceptual project proposal submitted to DDW. In May 2014, M1W submitted a proposal, which was first reviewed by the IAP. IAP comments were included in the concept proposal that was submitted to DDW. On June 5, 2014, DDW submitted a letter to M1W that conditionally approved the Project proposal, subject to the following future submittal requirements:

- The Engineering Report, final design and Contingency Plan,
- The Operations Optimization Plan,
- The Response Plan,
- The Water Quality Monitoring Plan,
- Monitoring well program justification, and
- Information on M1W's technical and managerial capacity with a focus on treatment plant operators**.**

These topics are addressed in this Engineering Report. The Operations Optimization Plan is described in this report, but pursuant to the Title 22 Criteria, will be submitted prior to startup of operations. Copies of the proposal and DDW letter are presented in **Appendix B**.

1.3.2. Future IAP Activities

M1W plans to extend the contract with NWRI for future IAP involvement with the Project, including review and advice regarding finalizing the Engineering Report, any issues that may arise as part of design and construction of the AWP Facility, and review of full-scale operations.

1.4. ENVIRONMENTAL COMPLIANCE

M1W is the lead agency for purposes of environmental compliance. The CEQA process for the Project consisted of the following steps:

- September 2013: M1W issued the Notice of Preparation and conducted EIR scoping.
- December 2014: M1W issued the Supplemental Notice of Preparation.
- April 22, 2015: M1W issued the Draft EIR (see http://purewatermonterey.org/reports-docs/deir/).
- April 22 through June 5, 2015: M1W provided a 45-day public review period.
- September 25, 2015: M1W issued the Final EIR.
- October 8, 2015: The M1W Board of Directors certified the Final EIR (including Oct. 5, 2015 Errata to the Final EIR), adopted findings and approved mitigation measures, adopted a Statement of Overriding Considerations[7], and approved the Project.

The public outreach activities for the Draft and Final EIR are presented in **Section 1.3**.

The Final EIR, which was certified on October 8, 2015, consists of the written comments received on the Draft EIR, and presents responses to environmental issues raised in the comments. In addition to the responses to comments, the Final EIR contains revisions, updates, and clarifications in response to public comment on the Draft EIR. The Final EIR is available at the Project website (http://purewatermonterey.org/reports-docs/eir/).

An addendum to the certified Final EIR was prepared to include the capacity change from 4 MGD to 5 MGD. Adoption occurred at the October 30, 2017 M1W Board Hearing.

The U.S. Bureau of Reclamation has completed review of the PWM Project under the National Environment Policy Act (NEPA) for potential partial funding for the PWM Project. In addition, the SWRCB and the Environmental Protection Agency (EPA) have completed their environmental review (termed "CEQA-Plus"), including compliance with federal regulations through consultation with affected federal agencies (U.S. Fish and Wildlife Service, National Marine Fisheries Service, and the State Office of Historic Preservation).

The Project is being financed in part by a Clean Water State Revolving Fund (CWSRF or SRF) Loan, administered by the SWRCB, Division of Financial Assistance (DFA). As stated in the EIR and comments on the Draft EIR, the CWSRF Program is partially funded by the EPA, and is subject to federal environmental regulations. All applicants seeking CWSRF financing must comply with CEQA and provide sufficient information so that the SWRCB can document compliance with federal environmental laws. The SWRCB calls this federal compliance "CEQA-Plus." The EIR was prepared to meet the CEQA-Plus requirements in order to be eligible for CWSRF loan funds. An Environmental Package (a portion of the CWSRF loan application) was submitted to the DFA on October 9, 2015, which further documented compliance with the federal requirements.

[7] The Statement of Overriding Considerations was issued for two unavoidable impacts related to construction noise, which could not be mitigated.

1.5. GROUNDWATER REPLENISHMENT PROJECT GOALS

The goals of the Project are to enable CalAm to reduce its diversions from the Carmel River system by up to 3,500 AFY by injecting the same amount of product water produced by the AWP Facility into the Seaside Basin. CalAm is under a SWRCB Cease and Desist Order (SWRCB Order No. 2009-0060, as amended by Order No. 2016-0016) to secure replacement water supplies and cease over-pumping of the Carmel River by January 2022.

The Project will also include a drought reserve component by providing for an additional 200 AFY of product water that will be injected in the Seaside Basin in wet and normal years up to a total of 1,000 AF. Thus, the Project will inject up to 3,700 AF of product water into the Seaside Basin in some years, rather than the 3,500 AF needed for CalAm supplies. This will result in a "banked" drought reserve. During dry years, less than 3,500 AF of product water will be delivered to the Seaside Basin, and the source waters that are not sent to the AWP Facility will undergo tertiary treatment for agricultural irrigation when demand exists. CalAm will be able to extract the banked water to make up the difference to its supplies, such that its extractions and deliveries will not fall below 3,500 AFY.

1.6. MANAGERIAL AND TECHNICAL CAPABILITIES

As discussed in **Section 2**, one of the requirements of the Title 22 Criteria (Section 60320.200(f)), is that a project sponsor must demonstrate that it possesses adequate managerial and technical capability to comply with the regulations. DDW has developed a Technical Managerial and Financial Assessment (TMF) form in order to assess the managerial and technical capabilities of project sponsors for public drinking water supply systems. Portions of the requirements discussed in the TMF form apply to groundwater replenishment projects to satisfy the Title 22 Criteria for groundwater replenishment, including the requirements for information regarding the project operations including certified operators, training, and emergency response. The following sections of the Engineering Report address the TMF requirements applicable for the Project:

- **Section 13** – general operations.
- **Section 13.2** – training.
- **Section 13.3** – contingency plans for emergencies.

1.7. PURPOSE OF THIS REPORT

The purpose of this Engineering Report is to present detailed information on the Project and the overall plan for compliance with the Title 22 Criteria for groundwater replenishment by subsurface application.

This Page Intentionally Left Blank

2. PROJECT PARTICIPANTS AND REGULATIONS

2.1. PROJECT PARTICIPANTS

The project participant responsibilities have been defined by water purchase agreements between M1W, MPWMD, and CalAm that was approved by the California Public Utilities Commission. The agreements specify that M1W is responsible for the design, construction, operation, and ownership of facilities for the production of product water for the Project, including the RTP, AWP Facility, Transmission, and Injection Facilities. MPWMD will buy product water from M1W for the purpose of securing financing and paying for the operating costs of the Project. MPWMD will then sell the water to CalAm and MCWD.

M1W has entered into two separate agreements with the Monterey County Water Resources Agency (MCWRA) and the City of Salinas for source water from the jurisdictions of these two agencies. On March 17, 2017, SWRCB issued Water Rights Permits 21376 and Permit 21377 for the diversion of surface waters from Blanco Drain and Reclamation Ditch, respectively. Water Rights Permit 21376 limits the diversion from the Blanco Drain to no more than 6 cubic feet per second by direct diversion, totaling up to 3,000 AFY. Water Rights Permit 21377 limits the diversion from the Reclamation Ditch to 6 cubic feet per second by direct diversion, totaling up to 2,000 AFY. These permits include terms and conditions developed with the National Marine Fisheries Service (NMFS) and the California Department of Fish and Wildlife (CDFW) to reduce potential impacts to fisheries, including the South Central California Coast (S-CCC) steelhead.

The City of Salinas source water required a wastewater change petition from the SWRCB because this source water was previously disposed of in percolation ponds adjacent to the Salinas River at the Industrial Waste Treatment Facility (IWTF). Accordingly, the City of Salinas filed a wastewater change petition with the SWRCB on October 9, 2015. The City of Salinas’s petition was publicly noticed on November 3, 2015. Protests for the petition were due on November 18, 2015. No protests to the petition were submitted. The SWRCB issued an approval of this wastewater change petition on November 30, 2015.

Separate from the water purchase agreement, M1W will continue to administer the source control program for industrial and commercial businesses and the new source waters to be diverted to the RTP. Additional information on the source control program is presented in **Section 4**.

Implementation of the Project will be achieved through the cooperative efforts of the agencies listed in **Table 2-1**.

Table 2-1: Project Participants

Project Participants	Roles
Federal Agencies	
U.S. Environmental Protection Agency	Administration of the Clean Water State Revolving Fund Loan program; maintains inventory of Class V injection wells as part of the Underground Injection Program
U.S. Army Corps	Approval of Clean Water Act Section 404 permit for fill of Waters of the U.S. at Reclamation Ditch and Blanco Drain
U.S. Fish and Wildlife Service	Biological Opinion for Compliance with Federal Endangered Species Act, Section 7
National Oceanic and Atmospheric Administration -National Marine Fisheries Service and Monterey Bay National Marine Sanctuary	Biological Opinion or concurrence letter for Compliance with Federal Endangered Species Act, Section 7 and authorization of Regional Water Quality Control Board issued National Pollutant Discharge Elimination System Permit, respectively
State of California Agencies	
State Water Resources Control Board - Division of Water Rights	Approval of water rights permits for diversions of surface water and Clean Water Act Section 401 Water Quality Certification program
State Water Resources Control Board - Division of Financial Assistance	Approval of CWSRF loan and Recycled Water Project Grant; federal action agency (with US EPA) for compliance with Section 7 Endangered Species act and Section 106 National Historic Preservation Act
State Water Resources Control Board – Division of Drinking Water	Approval of Project and Engineering Report, recommendations to Regional Water Quality Control Board for Project Waste Discharge Requirements/Water Reclamation Requirements
State Office of Historic Preservation	Letter of Concurrence of National Historic Preservation Act Section 106 Compliance
Regional Water Quality Control Board – Central Coast	Multiple permits: Modified National Pollutant Discharge Elimination System for the RTP, Waste Discharge Requirements/Water Recycling Requirements for use of recycled water for groundwater replenishment, other General Permits – low threat discharges and construction storm water
Department of Fish and Wildlife	Approval of a Streambed Alteration Agreement (Fish and Game Code Section 1602)
State Lands Commission	Approval of land lease for Salinas River pipeline crossing needed for Blanco Drain diversion
Public Utilities Commission	Approval of Water Purchase Agreement for CalAm to purchase water produced and injected; State lead agency for the Monterey Peninsula Water Supply Project
California State University Monterey Bay	Approval of land lease, easement/right of way

Regional and Local Agencies/Districts	
Fort Ord Reuse Authority	Environmental Services Cooperative Agreement compliance and approval of easement/right of way for injection facilities
County of Monterey – Resource Management Agency/Planning Dept	Approval of use permit(s) and/or grading permit(s) for Reclamation Ditch, Blanco Drain, 33-inch industrial wastewater pipeline slip-lining RTP, AWPF, and product water conveyance system.
County of Monterey – Planning Department	Approval of use permit(s) and/or grading permit(s) for RTP, AWPF, and product water conveyance system.
County of Monterey – Environmental Health	Approval of hazardous materials, etc. Responsible for the permitting of the construction, destruction, and repairs/modification of a domestic, irrigation, agricultural, cathodic protection, monitoring, or heat exchange wells
County of Monterey – Water Resources Agency	Agreements and/or land lease/easements/right of way for surface water diversions Reclamation Ditch and Blanco Drain diversions
City of Marina	Approval of easement/right of way
City of Salinas	Agreements for construction of improvements to the Salinas Industrial Waste Water Treatment Facility site; use/easements to improve the 33-inch industrial wastewater pipeline; interruptible rate approval
City of Seaside	Approval of easement/right of way
Marina Coast Water District	Approval of easement/right of way; and Water Purchase Agreement; Operations and Maintenance Agreement(s) with MPWMD
Monterey Peninsula Water Management District	Approval of Water Distribution System Permit; Water Purchase Agreement and Operations and Maintenance Agreement(s) between M1W, Monterey Peninsula Water Management District and CalAm
Monterey Peninsula Regional Water Authority	Political support of Project and involvement in Settlement Agreement regarding the Monterey Peninsula Water Supply Project[a]
Seaside Basin Watermaster	Approval of storage agreement
Private Entities	
California American Water Company	Water Purchase Agreement; Operations and Maintenance Agreement(s) with MPWMD; Proponent of the Monterey Peninsula Water Supply Project[a]
Private Land Owners	Agreement for easement/right of way to access the Reclamation Ditch and Blanco Drain diversions sites; temporary use/access to the sites needed for slip-lining the 33-inch industrial pipelines

a. The Water Supply Project, which is being proposed by CalAm, would replace existing supplies that are constrained by legal decisions affecting the Carmel River and Seaside Basin water resources. The Water Supply Project would produce 9.6 million gallons per day of water from an ocean desalination facility; an alternative is to combine the Project with a smaller desalination facility (Variant Project) that would produce 6.4 million gallons per day of desalinated ocean water.

2.1.1. Division of Drinking Water: Groundwater Replenishment

Final regulations for subsurface application of recycled water for groundwater replenishment are contained in the Title 22 Criteria. The groundwater replenishment regulations, which became effective June 18, 2014, establish the requirements applicable for obtaining approval and permitting of planned Groundwater Replenishment Reuse Projects (GRRPs). The Project's WDRs/WRRs implement the requirements. A summary of the Title 22 Criteria is presented in the following subsections.

2.1.1.1. General Requirements

Per Section 60320.200, prior to GRRP operation, the Project Sponsor must obtain DDW approval of a plan to provide an alternative source of drinking water or a DDW-approved treatment system for wells impacted by the GRRP. Provision of the alternative drinking water supply or well treatment will be needed if operation of the GRRP impacts a drinking water well so that it violates drinking water standards, has been degraded so that it is no longer a safe source of drinking water, or fails to meet the pathogen control requirements in CCR Title 22 Section 60320.208.

The Project Sponsor must ensure that the GRRP continuously uses full advanced treatment, in accordance with Section 60310.201, to treat the entire volume of recycled water prior to subsurface application.

The applied recycled water must be retained underground to meet the more stringent of the retention times determined for pathogen control (Section 60320.208) or response retention time (RRT) per Section 60320.224. The GRRP must be designed and operated such that water beyond the boundary established by the zone of controlled drinking water well construction (defined below) meets the Recycled Municipal Wastewater Contribution (RWC) requirements in Section 60320.216.

The Project Sponsor must provide a map that shows the location of the GRRP, monitoring wells established pursuant to CCR Title 22 Section 60320.226, and potable wells within two years travel time of the GRRP based on groundwater flow directions and velocities expected under GRRP operating conditions, and two zones:

- The boundary representing a zone of controlled drinking water well construction - the greatest of the horizontal and vertical distances reflecting the retention time for virus removal credit or the RRT.
- A secondary boundary representing a zone of potential controlled drinking water well construction, depicting the zone within which a well would extend the boundary of controlled drinking water well construction to include existing or potential drinking water wells, thus requiring more study and potential mitigation prior to drinking water well construction.

Prior to operating a GRRP, the Project Sponsor must collect at least four samples (one sample each quarter) from each potentially affected aquifer. The samples must be analyzed for the chemicals, contaminants, and characteristics specified in Sections 60320.210 (nitrogen compounds), 60320.212

(regulated constituents and physical characteristics), 60320.218 (total organic carbon or TOC), and 60320.220 (additional chemicals).

The Project Sponsor must ensure that recycled water used for the GRRP is from a wastewater management agency that is not in violation of effluent limits pertaining to groundwater replenishment as established in the agency's RWQCB permit.

Prior to operations, the Project Sponsor must demonstrate adequate managerial and technical capability.

Prior to operations, the Project Sponsor must demonstrate that all treatment processes have been installed and can be operated to meet their intended function.

If a Project Sponsor is directed by DDW or the RWQCB to suspend recycled water application, it cannot resume without obtaining approval from DDW and the RWQCB.

2.1.1.2. Advanced Treatment Criteria

Per Section 60320.201, GRRPs that utilize subsurface application are required to use full advanced treatment (reverse osmosis [RO] and an advanced oxidation treatment process [AOP]) that, at a minimum, meets the criteria of CCR Title 22 Section 60320.201.

For RO, each membrane element must achieve a minimum sodium chloride (NaCl) rejection greater than or equal to 99.0% and an average (nominal) NaCl rejection greater than or equal to 99.2% using 2008 American Society for Testing and Materials International (ASTM) Method D4194-03 and the following substitute test conditions:

- Tests are operated at a recovery greater than or equal to 15%.
- NaCl rejection is based on three or more successive measurements.
- An influent pH between 6.5 and 8.0.
- An influent NaCl concentration less than or equal to 2,000 milligrams per liter (mg/L).

During the first 20 weeks of full-scale operation, the membrane must produce a permeate having no more than 5% of the sample results with TOC concentrations greater than 0.25 mg/L based on monitoring no less frequent than weekly.

To address when the integrity of RO process has been compromised, the Project Sponsor must propose for approval at least one form of continuous performance monitoring (for example, conductivity or TOC) as well as the associated surrogate and/or operational parameter limits and alarm settings.

To demonstrate that a sufficient oxidation process has been designed, the Title 22 Criteria allow two options for demonstration. Option 2 has been selected for the Project, which requires the Project Sponsor to conduct testing that includes challenge or spiking tests to demonstrate that the AOP process removes 0.5-log of 1,4-dioxane and establish surrogate or operational parameters that reflect whether the 0.5-log reduction of 1,4-dioxane is attained. The criteria specify that at least one surrogate or operational parameter must be capable of being monitored continuously.

The advanced treated recycled water must also meet drinking water maximum contaminant levels (MCLs).

2.1.1.3. Public Hearing

Per Section 60320.202, the Project Sponsor must hold a public hearing for a GRRP prior to DDW's submittal of its recommendations to the RWQCB for the GRRP's initial permit and any time an increase in maximum RWC has been proposed, but has not been addressed in a prior public hearing. The Project Sponsor must provide information it intends to present at the hearing to DDW for review and approval prior to the hearing and place the information on a website for public access 30 days prior to the hearing. The Project Sponsor must notify the downgradient potable water owners whose drinking water wells are within ten years of the GRRP based on groundwater flow directions and velocities.

2.1.1.4. Lab Analyses

Per Section 60320.204, analyses for contaminants with primary and secondary MCLs must be performed using drinking water methods.

2.1.1.5. Wastewater Source Control

Per Section 60320.206, entities that supply recycled water to a GRRP must administer a comprehensive source control program that includes: (1) an assessment of the fate of DDW and RWQCB-specified contaminants through the wastewater and recycled water treatment systems; (2) provisions for contaminant source investigations and contaminant monitoring that focus on DDW and RWQCB-specified contaminants; (3) an outreach program to industrial, commercial, and residential communities; and (4) an up-to-date inventory of contaminants.

2.1.1.6. Pathogenic Microorganism Control

Per Section 60320.208, the treatment system must achieve a 12-log enteric virus reduction, a 10-log *Giardia* cyst reduction, and a 10-log *Cryptosporidium* oocyst reduction using at least 3 treatment barriers. For each pathogen, a separate treatment process can only be credited up to a 6-log reduction and at least 3 processes must each achieve no less than a 1.0-log reduction. For each month retained underground as validated by a tracer test, the recycled water will be credited with a 1-log virus reduction.

To validate underground retention time, a tracer study must be conducted prior to the end of the third month of operation. The retention time represents the difference from when the water with the tracer is applied at the GRRP to when either 2% of the initially introduced tracer concentration has reached the downgradient monitoring point, or 10% of the peak tracer unit value is observed at the downgradient monitoring point. With DDW approval, an intrinsic tracer may be used in lieu of an added tracer with a credit of no more than 0.67-log per month provided.

If the effectiveness of a treatment train's ability to reduce enteric virus is less than 10-logs, or *Giardia* cyst or *Cryptosporidium* oocyst reduction is less than 8-logs, the Project Sponsor must immediately notify DDW and the RWQCB, and discontinue application of recycled water unless directed otherwise by DDW or the RWQCB.

2.1.1.7. Nitrogen Compounds Control

Per Section 60320.210, the Project Sponsor must collect at least two total nitrogen samples each week at least three days apart (grab or 24-hour composite) from the recycled water or recharge water[8] before or after subsurface application. The analytical laboratory must analyze the sample within 72 hours and report results greater than 10 mg/L to the Project Sponsor within the same 72 hours. If the average of two consecutive samples exceeds 10 mg/L, the Project Sponsor must collect a confirmation sample and notify DDW and RWQCB within 48 hours of being notified of the results by the laboratory. The Project Sponsor must also investigate the cause of the exceedance, take actions to reduce the total nitrogen concentrations, and initiate monitoring for additional nitrogen compounds at different locations in the groundwater basin. If the average of four consecutive samples exceeds 10 mg/L, injection of recycled water must be suspended and not resumed until corrective actions are implemented and at least two consecutive samples are less than 10 mg/L.

2.1.1.8. Regulated Contaminants and Physical Characteristics Control

Per Section 60320.212, the Project Sponsor must monitor recycled water quarterly and meet all primary MCLs and action levels (except nitrogen compounds which are addressed by special provisions). For disinfection byproducts, compliance can be determined in the recharge water in lieu of recycled water if the fraction of recycled water in the recharge water is equal to or greater than the average fraction of recycled water in the recharge water applied over the quarter.[9] Compliance is based on the running annual average of quarterly samples. If the running four-week average exceeds the contaminants' MCL for 16 consecutive weeks, the Project Sponsor must notify DDW and the RWQCB within 48 hours of knowledge of the exceedance, and if directed by DDW or the RWQCB, suspend application of recycled water. If four quarterly results for asbestos are below detection, monitoring may be reduced to one sample every three years.

For a contaminant whose compliance with its MCL or action level is not based on a running annual average, if the average of the initial and confirmation sample is greater than the MCL or action level, the Project Sponsor must notify DDW and the RWQCB and initiate weekly sampling until four consecutive weekly results are below the MCL. If the running four-week average exceeds the contaminant's MCL, the Project Sponsor must notify DDW and the RWQCB within 24 hours, and if directed by DDW or the RWQCB, suspend application of recycled water.

For constituents with secondary MCLs, the Project Sponsor must collect an annual recycled water sample. If the annual average exceeds a secondary MCL in California Health and Safety Code Table 64449-A or the upper limit in Table 64449-B, the Project Sponsor must initiate quarterly monitoring

---

[8] Recharge water is the combination of recycled water and credited diluent water. Based on the recycled water contribution of 100%, diluent water will not be used for the Project.
[9] *Ibid*.

of the recycled water for the contaminant. If the running annual average of quarterly averaged results exceeds an MCL, the Project Sponsor must describe the reasons and any corrective actions in a report submitted to the RWQCB and DDW no later than 45 days following the quarter when the exceedance occurred. Annual monitoring may resume when the running annual average of quarterly results does not exceed a secondary MCL.

2.1.1.9. Dilution Water Requirements

Per Section 60320.214, the Project Sponsor must ensure diluent water (non-recycled water) meets primary MCLs, secondary MCLs (upper limit), and Notification Levels (NLs) through implementation of the Project Sponsor's DDW-approved monitoring plan. The plan must include actions to take if an MCL or NL is exceeded. Note: the proposed RWC for the Project is 100%; use of diluent water is not proposed.

2.1.1.10. Recycled Municipal Wastewater Contribution Requirements

Per Sections 60301.705 and 60320.214, the RWC is defined as follows:

- The RWC means the fraction equal to the quantity of recycled water applied at the GRRP divided by the sum of the quantity of recycled water and credited diluent water. Each month, the Project Sponsor must calculate the running monthly average (RMA) RWC based on the total volume of the recycled municipal wastewater and credited diluent water for the preceding 120 months.
- The initial maximum RWC, which may be up to 1.0, will be determined by DDW based on, but not limited to, DDW's review of the Engineering Report, information obtained as a result of the public hearings, and a Project Sponsor's demonstration that the treatment processes will reliably achieve a TOC concentration no greater than 0.5 mg/L. A GRRP may increase its maximum RWC if (1) it is approved by DDW and the RWQCB; (2) for the previous 52 weeks, the TOC 20-week running average has not exceeded 0.5; and (3) the permit allows the increase.

If the RMA exceeds its maximum RWC, the Project Sponsor must notify DDW and the RWQCB within seven days of knowledge of the exceedance and within 60 days implement corrective actions that may be required by DDW or the RWQCB, and submit a report to the regulators describing the reasons for the exceedance and corrective actions to avoid future exceedances. Note: the Project Sponsor is proposing an initial maximum RWC of 1.0.

2.1.1.11. Total Organic Carbon Requirements

Per Section 60320.218, the Project Sponsor must monitor TOC weekly in the applied recycled water prior to replenishment. For subsurface application projects, the TOC cannot exceed 0.5 mg/L based on (1) the 20-week running average of all TOC results; and (2) the average of the last four TOC results. If the GRRP exceeds the 20-week running average, the Project Sponsor must suspend operations until at least two consecutive results (three days apart) are less than the limit, notify DDW and RWQCB within seven days of suspending operations, and submit a report to the regulators within 60 days describing the reasons for the exceedance and corrective actions. If the GRRP exceeds the TOC limit based on the average of the last four results, the Project Sponsor must notify DDW and RWQCB within 60 days and submit a report describing the reasons for the exceedance and corrective actions.

2.1.1.12. Additional Chemical and Contaminant Monitoring

Per Section 60320.220, the Project Sponsor must monitor recycled water and groundwater quarterly for Priority Pollutants, chemicals specified by DDW based on the Engineering Report, the affected groundwater basin, and the Project Sponsor's source control program. Each quarter, the Project Sponsor must monitor the recycled water for DDW-specified chemicals having NLs. Recharge water may be monitored instead if the fraction of recycled water in the recharge water is equal to or greater than the average fraction of recycled water in the recharge water applied over the quarter. If a result exceeds an NL, the Project Sponsor must collect a confirmation sample within 72 hours of notification of the result. If the average of the initial and confirmation sample is greater than the NL, the Project Sponsor must initiate weekly monitoring until the running 4-week average no longer exceeds the NL. If the running 4-week average is greater than the NL, the Project Sponsor must describe the reason and provide a schedule for corrective actions in a report submitted to the RWQCB and DDW no later than 45 days following the quarter in which the exceedance occurred. If the running 4-week average is greater than the NL for 16 consecutive weeks, the Project Sponsor must notify DDW and the RWQCB within 48 hours of receiving knowledge of the exceedance.

In addition, each year the Project Sponsor must monitor the recycled water for indicator compounds specified by DDW and RWQCB based on the review of the Engineering Report, the source control inventory, the affected groundwater basin(s), and an indicator compound's ability to characterize the presence of pharmaceuticals, endocrine disrupting chemicals, personal care projects, and the presence of wastewater, and the availability of analytical test methods.

Any detected compounds that are part of this additional contaminant monitoring program must be reported to DDW and RWQCB no later than the following quarter in which the results are received by the Project Sponsor.

2.1.1.13. Operation Optimization Plan

Per Section 60320.222, prior to operation, the Project Sponsor must submit an Operation Optimization Plan (OOP) to DDW and the RWQCB for review and approval. At a minimum, the OOP must identify the operations, maintenance, analytical methods, and monitoring necessary for the GRRP to meet regulatory requirements, as well as the reporting of monitoring results to DDW and the RWQCB. The OOP must be representative of current operations and updated as appropriate.

2.1.1.14. Response Retention Time

Per Section 60320.224, recycled water applied by a GRRP must be retained underground for a period of time necessary to allow a Project Sponsor sufficient response time to identify treatment failures and implement actions, including the plan to provide an alternative water supply or well-head treatment. The minimum allowable RRT is two months. To demonstrate that the actual retention time underground is no less than the required RRT, an added tracer or a DDW approved intrinsic tracer may be used. For each month of retention time estimated utilizing the approved intrinsic tracer, a project sponsor shall receive no more than 0.67 months credit. The actual retention time is the time representing the difference between when the water containing the tracer is applied at the GRRP and when either 2% of the initially introduced tracer concentration has reached the downgradient monitoring point, or 10% of the peak tracer unit value arrives at the downgradient monitoring point.

2.1.1.15. Monitoring Well Requirements

Per Section 60320.226, the Project Sponsor must site and construct at least two monitoring wells downgradient of the GRRP. One monitoring well must be located between two weeks to six months travel time and at least 30 days upgradient of the nearest drinking water well, and one monitoring well must be located between the GRRP and the nearest downgradient drinking water well. The monitoring wells must allow for samples to be obtained independently from each aquifer and validated as receiving recharge water from the GRRP. For new projects, the Project Sponsor must collect two samples prior to GRRP operation[10] and at least one sample each quarter after operations begin. Each sample must be analyzed for nitrogen, nitrate, nitrite, secondary MCLs, Priority Pollutants, contaminants specified by DDW or the RWQCB taking into consideration the groundwater basin quality, the source control inventory, and the results of the recycled water monitoring.

If a quarterly monitoring result exceeds 80% of a nitrate, nitrite, or nitrate plus nitrite MCL, the Project Sponsor must collect another sample within 48 hours of being notified of the result and have it analyzed. If the average of the initial and confirmation sample exceeds an MCL, the Project Sponsor must notify DDW and the RWQCB within 24 hours of being advised by the laboratory of the result and discontinue application of recycled water until corrective actions are taken or evidence is provided to DDW and RWQCB that the contamination is not the result of the GRRP.

For DDW-specified chemical analyses completed in a month, the Project Sponsor must ensure the laboratory electronically submits results to DDW no later than 45 days after the end of the month in which monitoring occurred, in a manner such that data is readily uploaded to the DDW database.

2.1.1.16. Reporting

Per Section 60320.228, no later than six months after the end of each calendar year, the Project Sponsor must submit a report to DDW and the RWQCB that provides information including the project compliance status, any corrective actions or suspensions of recycled water applications, monitoring data, the location of the recharged recycled water, changes in operations or treatment, and predictions of RWCs for the next calendar year. Public water systems and drinking water well owners with downgradient sources potentially affected by the GRRP and within ten years

[10] Note: Title 22 Section 60320.200(c) requires the Project Sponsor to conduct background monitoring consisting of least four samples (one sample each quarter) from each potentially affected aquifer before operations begin for nitrogen compounds, regulated constituents and physical characteristics, TOC, Priority Pollutants, and any contaminants specified by DDW or the RWQCB taking into consideration the groundwater basin quality and the source control inventory.

groundwater travel time from the GRRP must be notified by direct mail and/or electronic mail of the availability of the report.

Every five years from the date of the initial approval of the Engineering Report, the Project Sponsor must update the report to address any project changes and submit the report to DDW and the RWQCB. The update must address anticipated increases in RWC, compliance with retention time requirements, descriptions of inconsistencies between previous groundwater modeling predictions and the observed values, and how subsequent predictions will be determined.

2.1.1.17. Alternatives

Per Section 60320.230, alternatives to any of the Title 22 Criteria provisions are allowed if the Project Sponsor demonstrates that the alternative provides the same level of public health protection; the alternative has been approved by DDW; and if required by DDW or the RWQCB, conducts a public hearing on the alternative, disseminates information, and receives public comments. Unless otherwise specified by DDW, the demonstration of public health protection must include a review by an independent scientific advisory panel.

2.1.2. Division of Drinking Water: Disinfected Tertiary Recycled Water

Title 22 Criteria (Section 60304(a)) specify use of "disinfected tertiary recycled water" for surface irrigation of food crops, parks and playgrounds, school yards, residential landscaping, and unrestricted access golf courses. The recycled water quality required under these criteria is less strict than as required for groundwater replenishment and the Project's WDRs/WRRs include the requisite monitoring to ensure compliance with requirements for disinfected tertiary recycled water. A summary of the relevant Title 22 Criteria for production of disinfected tertiary recycled water is presented in the following sections.

2.1.2.1. Recycled Water for Irrigation

Per Section 60304(a), recycled water used for irrigation of food crops and areas with unrestricted access shall be disinfected tertiary recycled water. This quality of recycled water can also be used for cooling and all other non-potable purposes listed in the Title 22 Criteria. Use of disinfected tertiary recycled water for nonrestricted recreational impoundments that has not received conventional treatment requires additional pathogen monitoring.

2.1.2.2. Disinfected Tertiary Recycled Water

Per Section 60301.230, disinfected tertiary recycled water, as it relates to the Project, is filtered wastewater that is disinfected with a process that, combined with filtration, inactivates or removes 5 logs of MS2 bacteriophage or poliovirus, as well as achieves total coliform limits. The total coliform limits are a median of 2.2 MPN/100 mL for the last seven days of sampling results, 23 MPN/100 mL in no more than one sample in any 30-day period, and 240 MPN/100 mL all of the time.

2.1.2.3. Filtered Wastewater

Per Section 60301.320, filtered wastewater, as it relates to the Project, is oxidized wastewater that has been passed through microfiltration, ultrafiltration, or reverse osmosis such that the turbidity does not exceed 0.2 NTU more than 5% of the time within a 24-hour period and does not exceed 0.5 NTU at any time.

2.1.2.4. Reliability Requirements

Per Sections 60341 through 60355, reliability requirements, related to this Project, include redundancy and alarms, or long-term disposal options, for primary treatment, biological treatment, secondary sedimentation, filtration, and disinfection.

2.1.3. Regional Water Quality Control Board Requirements

The Central Coast RWQCB is responsible for regulating irrigation with recycled water and recycled water discharges to groundwater, which are subject to state water quality regulations and statutes.

Waste Discharge Requirements/Water Recycling Requirements (WDRs/WRRs) issued by the RWQCB are required to implement applicable state water quality control policies and plans, including water quality objectives and implementation policies established in the Water Quality Control Plan for the Central Coast Basin (Basin Plan).[11] The Basin Plan designates beneficial uses and surface water / groundwater quality objectives.

Groundwater throughout the Central Coast Basin (except for the Soda Lake Sub-basin) is suitable for agricultural water supply (AGR), municipal and domestic supply (MUN), and industrial use. The Basin Plan has:

- General narrative groundwater objectives that apply to all groundwaters for taste and odor and radioactivity.
- For MUN beneficial uses - groundwater criteria for bacteria and DDW primary and secondary MCLs.
- For AGR beneficial uses - objectives to protect soil productivity, irrigation, and livestock watering.

Permit limits for groundwater replenishment projects are set to ensure groundwater does not contain concentrations of chemicals in amounts that adversely affect beneficial uses or degrade water quality. For some specific groundwater sub-basins, the Basin Plan establishes specific mineral water quality objectives for total dissolved solids (TDS), chloride, sulfate, boron, sodium, and nitrogen. No specific numeric objectives have been established in the Basin Plan for the Seaside Basin for these constituents other than those with MCLs. The Central Coast issued Order No. R3-2017-0003 (WDRs/WRRs) on March 9, 2017 to regulate Project operations and impacts.

---

[11] See http://www.waterboards.ca.gov/rwqcb3/publications_forms/publications/basin_plan/.

2.2. State Water Resources Control Board Requirements

The California Water Code allows the SWRCB to adopt state policies for water quality control. There are two policies particularly relevant to groundwater replenishment projects: the Anti-degradation Policy and the Recycled Water Policy.

2.2.1. Anti-Degradation Policy

The state's Anti-degradation Policy is captured in Resolution No. 68-16, which is titled "Statement of Policy with Respect to Maintaining High Water Quality in California." It is also specifically cited in the Basin Plan. The first two sections of the Policy state that:

1. Whenever the existing quality of water is better than the quality established in policies as of the date on which such policies become effective, such existing high quality water will be maintained until it has been demonstrated to the state that any change will be consistent with maximum benefit to the people of the state, will not unreasonably affect present and anticipated beneficial use of such water, and will not result in water quality less than that prescribed in the policies.

2. Any activity which produces or may produce a waste or increased volume or concentration of waste and which discharges or proposes to discharge to existing high quality waters will be required to meet waste discharge requirements which will result in the best practicable treatment or control of the discharge necessary to ensure that (a) pollution or nuisance will not occur and (b) the highest water quality consistent with maximum benefit to the people of the State will be maintained.

2.2.2. Recycled Water Policy

The Recycled Water Policy was adopted by the SWRCB in February 2009. It was amended in 2013 to specify monitoring requirements for constituents of emerging concern (CECs and in 2018 to ensure consistent statewide permitting/reporting and to update CEC monitoring requirements based on recent research findings. The Recycled Water Policy created uniformity in how RWQCBs were individually interpreting and implementing Resolution 68-16 for water recycling projects, including groundwater replenishment projects. The critical provisions in the Policy related to groundwater replenishment projects are discussed in the following subsections.

2.2.2.1. Salt/Nutrient Management Plans

In recognition that some groundwater basins in the state contain salts and nutrients that exceed or threaten to exceed Basin Plan groundwater objectives, and that some Basin Plans do not have adequate implementation measures to achieve compliance, the Recycled Water Policy includes provisions for managing salts and nutrients on a regional or watershed basis through development of Salt/Nutrient Management Plans (SNMPs) rather than imposing requirements on individual recycled water projects (which had been the practice prior to adoption of the Recycled Water Policy). Unfavorable groundwater salt and nutrient conditions can be caused by natural soils, discharges of waste, irrigation using surface water, groundwater, or recycled water, and water supply augmentation using surface or recycled water. Regulation of recycled water alone will not address these conditions.

SNMPs were to be developed for every groundwater basin/sub-basin by May 2014 (May 2016 with a RWQCB-approved extension). This requirement was updated in the most recent amendment to include only basins that are identified by each regional water board in their evaluations. The SNMP must identify salt and nutrient sources; identify basin/sub-basin assimilative capacity and loading estimates; and evaluate the fate and transport of salts and nutrients. The SNMP must include implementation measures to manage salt and nutrient loadings in the basin on a sustainable basis and an anti-degradation analysis demonstrating that all recycling projects identified in the plan will collectively satisfy the requirements of Resolution No. 68-16. The SNMP must also include an appropriate cost effective network of monitoring locations to determine if salts, nutrients and other constituents of concern (as identified in the SNMPs) are consistent with applicable water quality objectives.

A SNMP has been prepared for the Seaside Basin to comply with the Recycled Water Policy (HydroMetrics, 2014a). The SNMP was developed with basin stakeholder input through the Seaside Basin Watermaster and was adopted by the MPWMD. The SNMP was submitted to the RWQCB on July 9, 2014. The RWQCB has deemed the submittal to be insufficient in terms of its anti-degradation findings and does not intend to adopt it as Basin Plan amendment.[12]

2.2.2.2. Groundwater Replenishment Provisions

The Recycled Water Policy includes specific provisions for approval of groundwater replenishment projects.

- Project must comply with the Title 22 Criteria for groundwater replenishment, including monitoring requirements for priority pollutants contained in California Code of Regulations, title 17 and California Code of Regulations, title 22 (including subsequent revisions), and recommendations by the State Water Board for the protection of public health pursuant to Water Code section 13523.
- Projects must implement a CEC monitoring program that is consistent with Attachment A of the Recycled Water Policy and any recommendations from the SWRCB.

Nothing in the Recycled Water Policy limits the authority of the RWQCB to protect beneficial uses provided any proposed limitations for protection of public health may only be imposed following consultation with DDW, consistent with SWRCB Orders WQ 2005-0007 and 2006-0001.

Nothing in the Recycled Water Policy limits a RWQCB from imposing additional requirements for a groundwater replenishment project that has a substantial adverse effect on the fate and transport of a contaminant plume or changes the geochemistry of an aquifer causing dissolution of constituents.

[12] *See* October 10, 2016 email from Harvey Packard, RWQCB to M1W staff.

2.2.2.3. Anti-degradation and Assimilative Capacity

The Recycled Water Policy states that until such time as an SNMP is in effect, compliance with SWRCB Resolution No. 68-16 can be demonstrated by evaluating two assimilative capacity thresholds. A groundwater replenishment project that utilizes less than 10% of the available assimilative capacity in a groundwater basin/sub-basin (or multiple projects utilizing less than 20% of the available assimilative capacity in a groundwater basin/sub-basin) are only required to conduct an anti-degradation analysis verifying the use of the assimilative capacity. In the event a project or multiple projects utilize more than the designated fraction of the assimilative capacity (e.g., 10% for a single project or 20% for multiple projects), the project proponent must conduct a RWQCB-deemed acceptable anti-degradation analysis. A RWQCB has the discretionary authority to allocate assimilative capacity to groundwater replenishment projects. A Project-specific antidegradation analysis was conducted as part of the permitting process. The analysis demonstrated use of less than 10% of the available assimilative capacity of constituents of concern.[13]

2.2.2.4. Constituents of Emerging Concern

When adopted in 2009, this provision in the Recycled Water Policy acknowledged the need for more scientific information and work with respect to test methods and more specific determinations as to how CECs may impact public health or the environment. The SWRCB convened an expert panel, in consultation with DDW, to make recommendations for monitoring CECs in recycled water. The first expert panel report was published in June 2010 with specific recommendations for CEC monitoring for groundwater replenishment projects.

The SWRCB amended the Recycled Water Policy in 2013 (Resolution No. 2013-0003) to include the Panel's recommended CEC monitoring program, including the a list of specific performance indicator and health-based CECs, and surrogates, , their respective monitoring, and procedures to evaluate the data and for responding to the monitoring results (see Section **12.6**). The Panel was reconvened in 2017 to review available data and update its 2010 recommendations. The Final Report was released in April 2018 and included revisions to the list of indicators and surrogates and recommendations to conduct bioanalytical screening. The Panel's findings were incorporated into Appendix A of the 2018 Recycled Water Policy Amendment.

2.3. FEDERAL REQUIREMENTS FOR GROUNDWATER REPLENISHMENT PROJECTS (UNDERGROUND INJECTION CONTROL)

At this time there are no Federal permitting requirements for surface application groundwater replenishment projects; the U.S. EPA's underground injection control (UIC) program does apply to injection wells but has no permitting consequences for the Project. The UIC program has categorized injection wells into five classes, only one of which (Class V) applies to groundwater replenishment projects. Under the existing Federal regulations, Class V injection wells are "authorized by rule" which

[13] November 18, 2016 Technical Memorandum prepared by Todd Groundwater for MRWPCA, "Antidegradation Analysis in Support of Proposed AWTF Recycled Water Concentration Limits, Pure Water Monterey Groundwater Replenishment Project (Project)"

means they do not require a Federal permit if they do not endanger underground sources of drinking water and comply with other UIC program requirements. For California, U.S. EPA Region 9 is the permitting administrator for Class V wells. Any injection project planned in California must meet the State Sources of Drinking Water Policy, which ensures protection of groundwater quality for drinking water supplies, and therefore a Federal permit would not be necessary.[14] All Class V injection well owners in California are required to submit information to U.S. EPA Region 9 on the well for U.S. EPA's inventory.[15]

[14] See http://water.epa.gov/type/groundwater/uic/class5/frequentquestions.cfm#do_i.
[15] http://www.epa.gov/region9/water/groundwater/uic-classv.html, and http://www.epa.gov/region9/water/groundwater/injection-wells-register.html.

3. PROJECT FACILITIES

This section summarizes information, including design criteria, on the M1W RTP and the AWP Facility unit processes and reliability features, product water transmission systems, and the Injection Facilities. The AWP Facility design information presented in this Engineering Report is based on the AWP Facility and Product Water Pump Station contract drawings that were completed in May 2017 for re-bidding the construction of the facilities.

3.1. REGIONAL TREATMENT PLANT

3.1.1. Overview of Monterey Regional Water Pollution Control Agency's System

M1W, which currently serves a population of approximately 250,000, was created in 1972. M1W consists of and provides regional wastewater treatment, disposal, and reclamation facilities for the cities of Monterey, Pacific Grove, Del Rey Oaks, Sand City, Marina, and Salinas; the Seaside County Sanitation District; the Castroville, Moss Landing, and Boronda Community Services Districts; and Fort Ord lands. Each member entity retains ownership and operating and maintenance responsibility for wastewater collection and transport systems up to the point of connection with interceptors owned and operated by M1W (some member entities contract with M1W for operation and maintenance services of their collection systems). Residential, commercial, and industrial wastewater and some dry weather urban runoff are conveyed to the RTP for treatment. M1W also accepts an average 6,400 gallons per day of brine by truck from businesses, which would otherwise discharge to the sanitary sewer system and into the RTP. These wastewaters include water softener regenerant waste and RO brines. Because irrigation uses of recycled water are sensitive to TDS, M1W has sought to keep elevated TDS wastewaters segregated from the influent flow to the RTP. Brine wastes are held in a lined holding pond and ultimately discharged directly to, or blended with, secondary treatment wastewater before being discharged through M1W's ocean outfall.

3.1.2. Regional Treatment Plant Facilities

The RTP is located in Marina, CA (see **Figure** 3-1). It has an average dry weather flow design treatment capacity of 29.6 million gallons per day (mgd) and a peak wet weather design capacity of 75.6 mgd, with an Outfall ultimate wet weather capacity of 81.2 mgd. It currently receives and treats approximately 16-17 mgd. An aerial image annotated with the key treatment facilities at the RTP is presented in **Figure 3-2**.

Figure 3-1. Regional Treatment Plant location

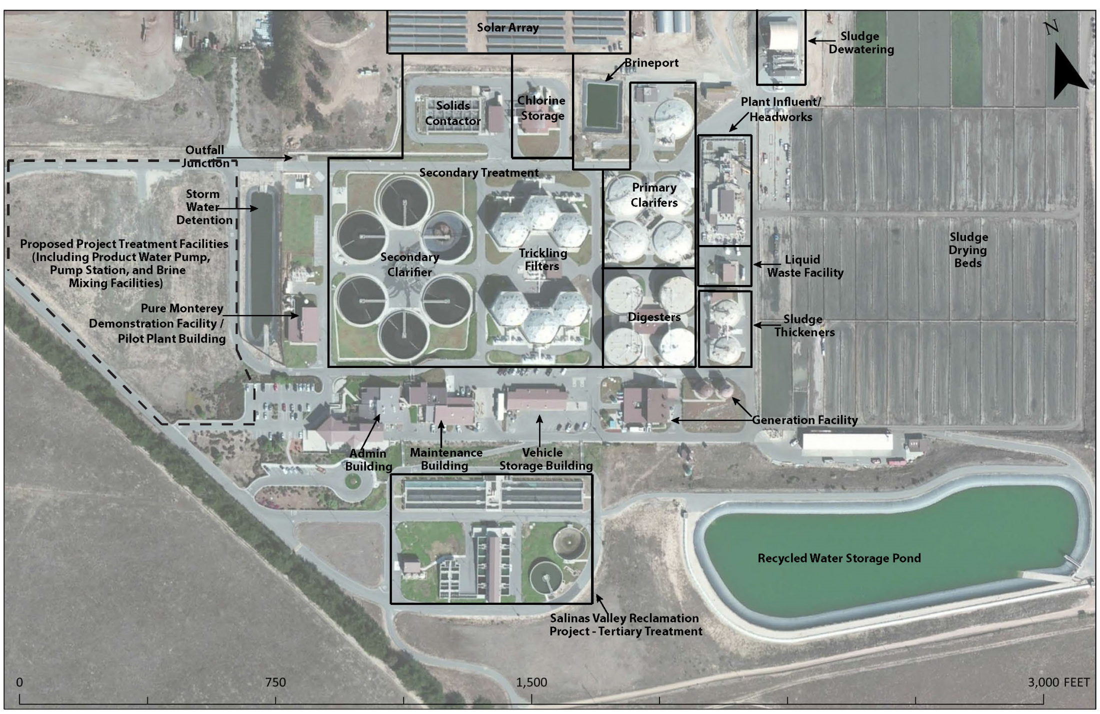


Figure 3-2. Existing Regional Treatment Plant facilities

Wastewater treatment at the RTP consists of aerated grit removal, primary clarifiers, trickling filters, solids contact, and secondary clarifiers. Undisinfected secondary clarifier effluent is (1) discharged to the ocean pursuant to National Pollutant Discharge Elimination System (NPDES) Permit (Order No. R3-2014-0013) or (2) used as influent for the co-located SVRP for production of disinfected tertiary recycled water.

In most winter months, secondary effluent is discharged to Monterey Bay through the ocean outfall, which includes a diffuser that extends 11,260 feet offshore at a depth of approximately 100 feet. The minimum initial dilution is 145 parts seawater to 1 part discharge water. The diffuser on the ocean outfall is designed to convey wet weather flows of up to 81.2 mgd.

In most months, tertiary recycled water is used for irrigation of 12,000 acres of farmland in the northern Salinas Valley pursuant to RWQCB Orders No. 94-82 (WRRs issued to M1W) and No. 97-52 (Recycled Water User Requirements for CSIP issued to the MCWRA). The existing facilities at the SVRP, including upstream treatment at the RTP, are designed to produce up to 29.6 mgd of tertiary recycled water; this volume of recycled water is authorized under Order No. 94-82. The SVRP includes an 80-AF storage pond that holds tertiary-treated wastewater and disinfected Salinas River water before it is distributed to farmland. The use of recycled water for irrigation reduces regional dependence on and use of local groundwater, which, in turn reduces groundwater pumping-related seawater intrusion into the Salinas Valley aquifers.

Sludge/biosolids are anaerobically digested and sent to two screw presses, which replaced a belt filter press and reduced the reliance on sludge drying beds. The holding lagoons and some of the drying beds may still be utilized in emergency situations. Dried solids are hauled to the Monterey Regional Waste Management District’s landfill, adjacent to the RTP, where it is mixed with wood products and used for slope cover.

3.1.3. Regional Treatment Plant Flow Projections

In support of the EIR, a study was conducted to evaluate future projected flows to the RTP (Brezack & Associates, Inc., 2014). The analysis found that municipal wastewater flow to the RTP is projected to decrease to a range of 19.2 to 17.1 mgd. Actual municipal wastewater flows to the RTP have decreased to approximately 16-17 mgd showing that the study underestimated conservation and the effects of a four-year drought. The study may reflect the general trends and says that after 2030, flows may increase to a range of highs between 22.7 and 24.3 mgd. The future increase is dependent upon whether urban growth projections assumed in the 2014 projections are realized, which may not occur. To ensure sufficient water for the Project and CSIP, new source waters will be diverted to the RTP as previously discussed in **Section 1**.

3.2. ADVANCED WATER PURIFICATION FACILITY

There are no existing advanced treatment facilities permanently installed at the site of the new AWP Facility other than the Demonstration Facility. The full-scale AWP Facility will consist of the following major components[16]:

- Secondary effluent diversion structure,
- AWP Facility influent pump station,
- Ozonation (membrane filtration pretreatment),
- Membrane filtration (MF) feed water pumps
- MF system,
- RO feed water pumps,
- RO system,
- Ultraviolet light (UV) with hydrogen peroxide AOP,
- Post treatment stabilization including decarbonation and lime addition,
- Product water pump station and transmission line,
- RO concentrate discharge facilities,
- Waste neutralization facilities

A simplified process flow diagram is shown in **Figure 3-3.**

[16] The optional upflow Biologically Active Filtration (BAF) system was included as a possible process in the 2014 Concept Proposal and was also addressed as part of the EIR; however, it was removed from the AWP Facility design through value engineering.

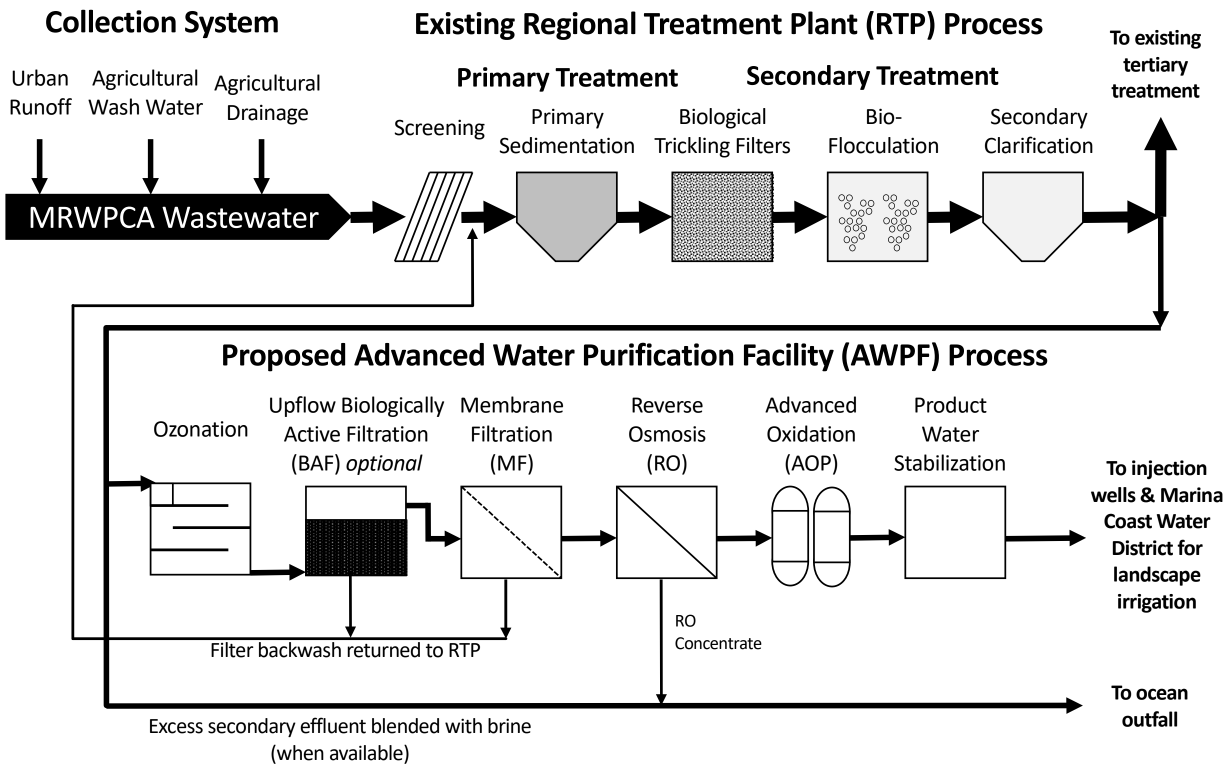


Figure 3-3. Simplified process flow diagram of existing M1W RTP primary and secondary treatment and the AWP Facility

The planned treatment capacity of the AWP Facility is 5.0 mgd (e.g., the amount of product water produced will be 5.0 mgd). A process flow summary for the major treatment processes of the AWP Facility is provided in **Table 3-1**.

Table 3-1: AWP Facility Process Flow Summary

Treatment Process	Design Flows (mgd)
Ozonation Influent and Effluent	6.85
MF Feed	6.85
MF Filtrate	6.17
RO Feed	6.17
RO Permeate	5.0
AOP Influent and Effluent	5.0
Post Treatment Influent and Effluent	5.0

3.2.1. Secondary Effluent Diversion Structure and AWP Facility Influent Pump Station

Secondary effluent, pulled from between the secondary effluent Rapid Mix facility of the RTP and the SVRP diversion facility, will be diverted to the AWP Facility via the secondary effluent diversion structure and the AWP Facility influent pump station.

3.2.2. Membrane Filtration Pretreatment

Sodium hypochlorite is injected ahead of the ozone system at a dose of 17 to 30 mg/L as Cl_2. The target combined chlorine residual ahead of the RO system is approximately 3 mg/L as Cl_2. Residual ammonia in the RTP secondary effluent is present at sufficient concentrations to react with the sodium hypochlorite to form chloramines. Design criteria for the system are provided in **Table 3-2**.

Table 3-2: Sodium Hypochlorite Addition System

Sodium Hypochlorite Addition System[a]	
Tank	
Solution strength, %	12.5
Number of Storage Tanks	2
Capacity, gal (each)	10,300
Material	HDLPE or XLPE with anti-oxidant liner
Pumps	
Number (Duty + Standby)	1+1
Type	Peristaltic
Maximum Capacity per Pump, gph	73.5
Rated Pressure, psig	60

a. HDLPE – High density linear polyethylene; XLPE – Cross-linked polyethylene.

3.2.3. Ozonation

The ozone treatment system will treat chloraminated secondary effluent from the RTP prior to filtration by the downstream MF system.

3.2.3.1. Ozone Pretreatment

Ozone pretreatment can provide a number of benefits to a potable reuse treatment system: (1) low-pressure membrane pretreatment, (2) CECs destruction, and (3) pathogen disinfection.

Ozonation prior to MF (also referred to as preozonation) can increase MF run times and flux for some waters. Non-nitrified secondary effluent, such as the RTP effluent, contain large organic molecules (defined here as greater than 10 kilodaltons [kDa]), which rapidly foul low-pressure membranes. Ozonation of these large organic molecules reduces their size to less than 1 kDa via oxidation, and allows them to pass through the MF system with minimal fouling (the organic molecules are then well-rejected by the downstream RO system). With the fouling potential of the water reduced by preozonation, the MF system run times are increased and the MF system can be designed for higher fluxes. Long run times allow for less chemical usage and a greater recovery, while designing the MF system for a higher flux reduces the number of membrane modules required.

Preozonation can also reduce the concentration of CECs in the RO feed, which can lead to a reduction in both the concentration of known health-significant CECs in the RO permeate and the concentration of CECs in the RO concentrate that is ultimately discharged to the ocean.

3.2.3.2. Ozone Piloting Summary

Piloting and water quality sampling were conducted from 2013 to 2014 at the M1W RTP to aid in the design of preozonation (see **Appendix C** for Pilot Report). Select key findings from that effort are summarized below:

- The downstream MF run time increased by approximately a factor of four with an ozone dose of 10 mg/L;
- The downstream MF run time was not adversely affected by higher ozone doses (e.g., 20 mg/L);
- Secondary effluent contained high concentrations of TOC (12 to 18 mg/L, typical for a non-nitrified secondary effluent), which exert significant ozone demand;
- Significant CEC removal was observed at an ozone dose of 10 mg/L (an ozone to TOC ratio [O_3:TOC] of about 0.4; see **Figure 3-4** for removal observed during pilot testing); and,
- Secondary effluent contained variable concentrations of nitrite (ranging from < 0.1 to 2.2 mg/L as Nitrogen [N]) due to partial nitrification in the RTP trickling filters, which exerts significant ozone demand (3.4 mg/L of ozone per 1 mg/L of nitrite as N); however, ozone dose control methods are available that automatically account for influent nitrite concentrations (*e.g.*, trimming to a dissolved ozone residual).

The key treatment objectives for including ozone pretreatment (i.e., improved MF performance and significant CEC destruction) were both successfully demonstrated at an ozone dose of 10 mg/L; therefore, this was selected as the design ozone dose for the full-scale facility.

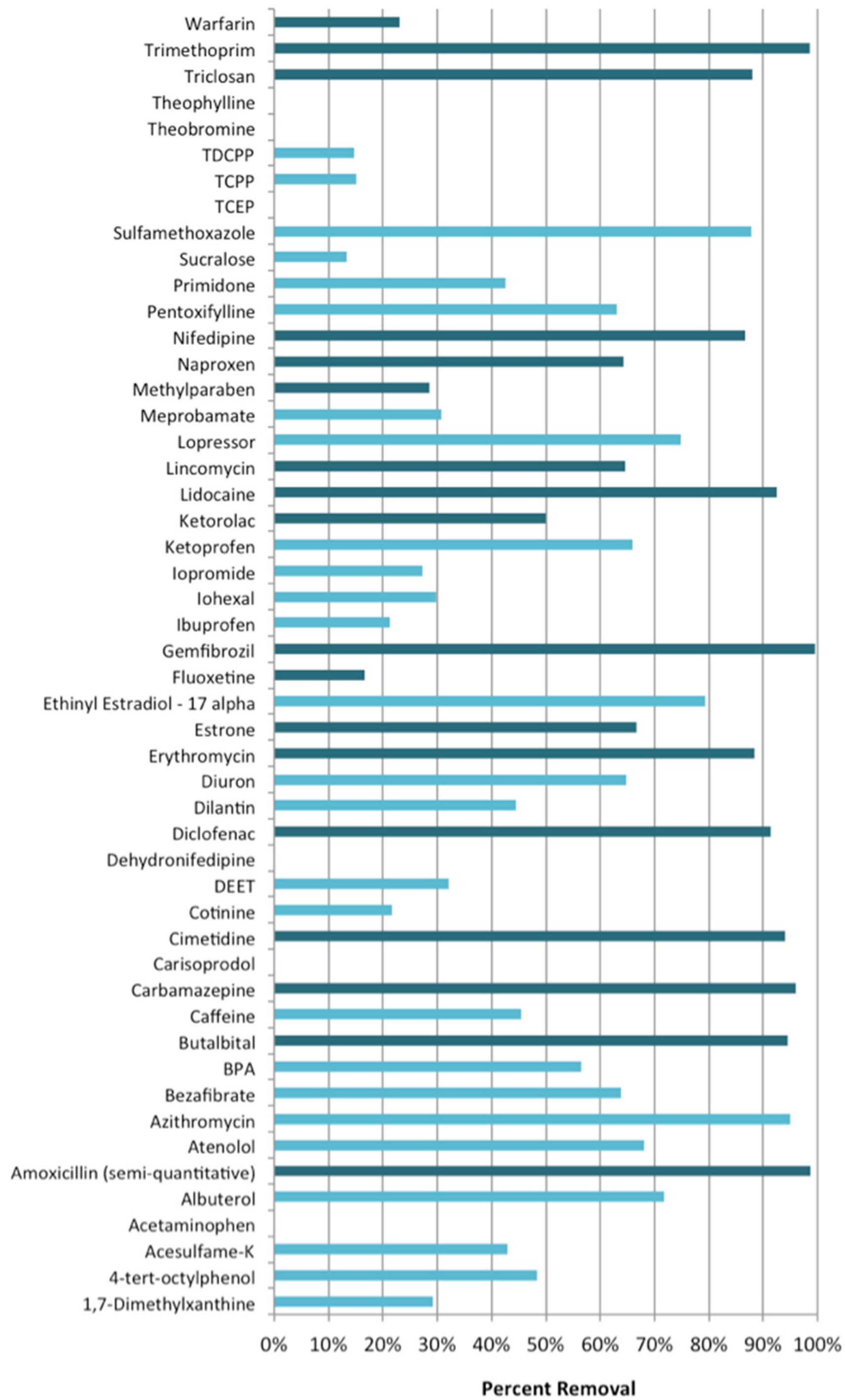


Figure 3-4. Median removal of CECs observed during piloting at an ozone dose of 10 mg/L, where dark bars indicate removal to below the detection limit. Constituents with no bars were not removed.

3.2.3.3. Design Ozone Dose

The ozone system was designed based on the ozone piloting, where an average applied ozone dose of 10 mg/L proved successful for MF pretreatment. From this average dose, a maximum and minimum design dose were selected, considering maximum and minimum design water qualities, average pilot water qualities, as well as full-scale and pilot-scale ozone transfer efficiencies. The following sections discuss the selection of the maximum and minimum design water quality and the full-scale design transfer efficiency.

3.2.3.3.1. Design Water Quality

Design water quality assumptions were developed from historical water quality data. Three years of dissolved organic carbon (DOC), total suspended solids (TSS), and nitrite data from January 2011 through May 2014 (24-hour composite samples)[17] were used to develop the design assumptions. TOC was estimated from the DOC and TSS data, and the 95th percentile values for TOC and nitrite were chosen as the maximum ozone design water qualities. The minimum values for both TOC and nitrite from these datasets were chosen as the minimum ozone design water qualities. These maximum and minimum design water qualities were compared to the average water quality conditions observed during the 10 mg/L phase of piloting to develop the design ozone doses, which were extracted from the same RTP 24-hour composite dataset (the development of the design ozone doses is discussed in the next section)[18]. A summary of the maximum and minimum design water qualities, and the average water qualities observed during piloting of the 10 mg/L applied ozone dose are shown in **Table 3-3**.

Table 3-3: Design and Pilot Water Quality

Parameter	Average piloting concentrations at 10 mg/L, applied	Max design concentration	Min design concentration
Nitrite, mg/L as N	0.63	2.2	0
Estimated TOC, mg/L	16	20	11

Nitrite exerts an immediate ozone demand on a 1:1 stoichiometric basis, thereby decreasing the concentration of ozone available for the oxidation of organics. When more nitrite is present, more ozone must be applied (e.g., an increase in nitrite concentration of 1 mg/L as N requires an increase of 3.4 mg/L transferred ozone). The design TOC concentration is factored into the design ozone dose by keeping the pilot O_3:TOC ratio constant. When the influent TOC increases, the ozone dose must also increase to maintain a sufficient O_3:TOC ratio to adequately reduce MF fouling; e.g., if the TOC concentration doubles, then the transferred ozone dose must also double. The maximum and minimum design ozone doses take into account the maximum and minimum nitrite and TOC concentrations accordingly (design ozone doses are presented in **Subsection 3.2.3.3.3**).

[17] Nitrite data was from January 2011 to July 2014.

[18] The 10 mg/L phase of testing occurred over the following date range: 1/16/14 - 2/17/14, 2/26/14 - 3/13/14, and 4/7/14 - 5/19/14.

3.2.3.3.2. Transfer Efficiency

In addition to design water qualities, the design ozone doses factor in the difference in ozone transfer efficiency that can be achieved at full-scale compared to pilot-scale. The pilot transfer efficiency ranged from 94% to 96%. The AWP Facility will utilize side stream ozone injection and is expected to achieve a minimum ozone transfer efficiency of 90%.

3.2.3.3.3. Design Doses

The design ozone doses were developed based on the design influent water quality, a conservative full-scale transfer efficiency (see **Table 3-4**). For context, these design ozone doses are higher than ozone doses required for drinking water disinfection (e.g., 1 to 4 mg/L) and higher than those required for sulfide removal in drinking water (e.g., 10 to 12 mg/L). The authors are aware of only one other utility that currently pretreats non-nitrified secondary effluent with ozone (the West Basin Municipal Water District); their design ozone dose of 16 mg/L is similar to the dose in this design.

Table 3-4: Design Applied Ozone Doses

Design Applied Ozone Dose	Value (mg/L)
Maximum	30
Average	14
Minimum	5

3.2.3.4. Design Flows

The design flows for the ozone system are a function of the recoveries of the downstream processes (**Table 3-5** summarizes the design flows for the ozone system). The minimum flow was based on producing 1.20 mgd of RO permeate (one small RO train online and operating a recovery of 81% to maintain minimum cross-flow velocity). Although the ozone system must be able to turndown to the minimum flow, the AWP Facility is expected to operate closer to the design flow most of the time. The maximum and minimum flows impact the ozone equipment sizing and number of sidestream injectors. Flow surges to the downstream MF system will be addressed through flow equalization (EQ) tanks upstream and downstream of the MF. Flow through the ozone system will only vary when the RO permeate production set point is lowered.

Table 3-5: Ozone Design Flows

Design Flow Rate	Value (mgd)
Maximum	6.85
Minimum	1.64

3.2.3.5. Ozone Generator

Based on the design flows and applied ozone doses, a design capacity of the ozone generator was developed (**Table 3-6**). An ozone concentration of 10% was used. Ozone generators of this scale typically have a power turndown of approximately 20:1 or greater, and the additional gas flow system turndown is typically 10:1. To meet the design maximum and minimum doses and flows, a turndown of 26:1 is required from the design ozone capacity. Ozone production may become less efficient when the turndown exceeds 10:1, as suboptimal gas flows will be required (i.e., the result is a lower ozone concentration than design); however, the ozone system is rarely expected to turndown 26:1. The 26:1 turndown represents the low flow condition (when the RO permeate is 1.2 mgd) at the minimum ozone dose (5 mg/L).

Ozone generators typically require minimal regular maintenance, and failure is typically infrequent. Modern generators include fuses for each dielectric tube, which allows the generator to continue production if a dielectric tube fails. A redundant generator has not been included for the Project for a number of reasons. The AWP Facility may operate for short periods of time without preozonation with more frequent MF cleaning as needed. Further, the AWP Facility has a planned offline factor of 10%.

Table 3-6: Ozone Generator Design Criteria

Parameter	Value
Number of generators (duty + standby)	2+0
Design ozone concentration, % by weight	10
Capacity at 10% by weight per generator, lbs/day	850
Ozone production turndown, of design capacity, min	26:1

The generator will come with a corresponding power supply unit (PSU) to supply power to the ozone generator. As discussed in the following subsection, the PSU and ozone generator will connect to the cooling water system to dissipate heat.

3.2.3.6. Cooling Water System

The ozone generator and PSU must be cooled to avoid overheating and dissipating excess heat into the surroundings. A closed loop cooling system with a plate and frame heat exchanger, interfacing with an open loop system are used (design criteria are summarized in **Table 3-7**). The open water source used for the cooling system is the MF filtrate, which is low in solids to reduce build up on the exchanger. A filter is included in the closed loop to ensure that particles are neither deposited in the ozone generator nor on the heat exchanger surface if particles accidently enter the closed loop system (e.g., particles from maintenance activities).

Table 3-7: Cooling System Design Criteria

Parameter	Value
Heat exchanger type	Plate and frame
No. of cooling systems (duty + standby)	1+1
Particle filter size, µm	0.1
Closed loop cooling water temperature (max.) °C	29.4

3.2.3.7. Oxygen System

High-purity oxygen gas is fed to the ozone generator to achieve a high concentration of ozone gas. For this size system, the oxygen feed is achieved through the use of offsite generation and delivery of LOX. A LOX system consists of a LOX storage tank, a pressure regulating system, vaporizers, and a nitrogen boost system, which is included to increase the efficiency of ozone generation.

3.2.3.7.1. LOX Delivery Scheduling

A level-sensor device in the LOX tank allows the LOX supplier to track usage. When the level reaches a predetermined capacity (e.g., 45%), a delivery truck is dispatched to refill the tank. Delivery trucks have a trailer capacity of 6,000 gallons, and deliveries can typically be made within 24 to 48 hours.

3.2.3.7.2. LOX Tank Size

The LOX tank is 13,000 gallons, which represents 7 days of LOX consumption at the maximum design dose and 16 days of LOX consumption at the average design dose. These storage times are conservative in case of difficulties with dispatching LOX deliveries.

3.2.3.7.3. Vaporizers

Vaporizers volatilize the LOX and are chilled in the process. While one vaporizer is in operation, the second warms in ambient air to prepare for operation.

Design criteria for the LOX storage and vaporizers are shown in **Table 3-8**. These design criteria are based on an ozone concentration of 10%.

Table 3-8: LOX Design Criteria

Parameter[a]	Value
LOX consumption, gal/day	822 (average dose) 1,790 (maximum dose)
Storage tank volume, gallons	13,000
Storage time days	16 (average dose) 7 (maximum dose)
Number of tanks	1
Configuration	Horizontal
Vaporizer type	Ambient air
Vaporizer size scfh, minimum, each	143
Number of vaporizers	2

a. Design criteria based on 10% ozone concentration

3.2.3.7.4. Pressure Regulating System

A pressure regulating system is installed to regulate the delivered oxygen pressure coming from the LOX system.

3.2.3.8. Nitrogen Boost System

Nitrogen addition (0.5 to 2% nitrogen) with the gaseous oxygen improves ozone generation performance. Nitrogen is present in sufficient quantities in air; however, the air must be conditioned to remove moisture before sending it through the ozone generator. The nitrogen boost system contains the following components:

- Air compressors
- Receiver tank
- Aftercooler
- Desiccant dryers
- Particulate and oil coalescing filters

3.2.3.9. Ozone Injection System

Sidestream injection with a venturi injector is used to inject ozone into the process water to mix the gaseous ozone with the sidestream flow. The sidestream injection system efficiency is a function of the gas to liquid (G:L) ratio. To achieve good mixing, the sidestream injection system is designed for a low G:L ratio (i.e., 0.35 or less). Low sidestream injection G:L ratios are necessary to avoid low ozone transfer efficiencies when treating secondary effluent (personal communication with Jim Jackson of Mazzei Injector and Kerwin Rakness).

The low G:L ratio necessitates a large sidestream flow, given the ozone doses. The sidestream system is designed for an ozone concentration of 10%. The large sidestream flow that comes with a G:L ratio of 0.35 or less is also necessary to avoid low ozone transfer efficiencies in secondary effluents (personal communication with Kerwin Rakness).

After injection, the sidestream flow is a combination of water, dissolved and gaseous ozone and oxygen, which is mixed with the bulk flow using flash reactors where additional dissolution of the gaseous ozone occurs.

Multiple sidestream pumps, and corresponding injectors, are installed to efficiently meet turndown requirements. After ozone comes in contact with the water, the system material is comprised of 316 stainless steel, until the ozone is removed in the contactor or the downstream quenching system. The injection system design criteria are summarized in **Table 3-9**.

Table 3-9: Injection System Design Criteria

Parameter	Value
Injection system type	Sidestream injection
Injector type	Venturi injector
Venturi injectors (duty + standby)	3+0
Venturi injector size, inches	6
Sidestream pumps (duty + standby)	3+0
Pump flow estimate (each), gpm	1,061
Sidestream injection G:L ratio, max	0.35
Mixers, minimum number	2
Mixer type	Flash Reactor
Transfer efficiency, minimum	90%

3.2.3.10. Ozone Contactor

The ozone contactor provides head to the upstream mixing structure, facilitates further ozone dissolution, provides contact time, and facilitates the removal of ozone off-gas. These features of the ozone contactor are described in more detail in the following subsections. Ozone contactor design criteria are provided in **Tables 3-10** and **3-11.**

3.2.3.10.1. Static Head

The upstream flash reactor requires backpressure to ensure that fine bubbles are created in the mixing process. Fine bubbles have a larger surface area to volume ratio than coarse bubbles, which increases ozone gas dissolution into the liquid stream. Increasing backpressure leads to finer bubbles and thus more efficient ozone gas dissolution (with diminishing returns at approximately 24 feet of pressure). The backpressure will be approximately 18.5 feet to the centerline of the contactor. The backpressure will primarily come from the MF feed tank inlet structure, and not primarily from a head loss device, such as a valve downstream of the flash mixer.

3.2.3.10.2. Contact Time

The ozone contactor also provides contact time for the dissolved ozone to react and dissipate. After gaseous ozone mixes with the secondary effluent, it dissolves into the liquid. Most of the dissolved ozone reacts rapidly (within seconds) with organics and other reduced chemicals, such as reduced iron, manganese, and nitrite; however, some organics require more time (multiple minutes). This reaction time must occur upstream of the membrane systems because membranes are sensitive to ozone, which may degrade their performance through the oxidation of the membrane surface. The ozone contactor gives time for the dissolved ozone to react with recalcitrant organics and time to dissipate before the ozonated effluent is discharged to the MF system.

The contact time at the pilot proved sufficient for dissipating the dissolved ozone residual for moderate ozone doses (hydraulic residence time [HRT] of 3 minutes, and assumed baffling efficiency of 90%: t_{10} of 2.7 minutes, where t_{10} is the time for 10% of an input concentration to be observed at the outlet of the contactor system). Given the imperative to not send a dissolved ozone residual downstream, the contact time was designed for equal to, or greater, than the contact time observed during piloting. This contact time acts as a redundant barrier to the quenching system for protecting downstream membrane equipment.

3.2.3.10.3. Ozone Off-gas

The ozone contactor traps the ozone off-gas and directs it to the ozone destruct units. Due to inefficiencies in mixing, limitations of ozone solubility, or variability in the ozone demand, not all of the injected ozone is dissolved into the liquid. Some of the applied ozone remains in the gaseous form, and some of the dissolved ozone may volatilize during contacting. This ozone gas is captured by the ozone destruct system (see description later).

3.2.3.10.4. Contactor Configuration

An serpentine pipeline contactor is used at the AWP Facility because it can achieve reasonable baffling efficiencies, facilitate additional ozone dissolution, and meets space constraints.

Table 3-10: General Ozone Contactor Design Criteria

Parameter	Value
Configuration	Serpentine pipeline contactor
Contact time HRT, min	3.9
Flash reactor backpressure feet	18.5 to contactor centerline

Table 3-11: Specific Ozone Contactor Design Criteria

Parameter	Value
Contactor Design	
Influent flow rate, mgd	6.85
Contact time, minutes	3.9
Liquid volume, gal	18,500
Dimensions:	
Diameter, feet	4.0
Length, feet	197

3.2.3.10.5. Foam

The water quality received during pilot testing did not create excessive foam. It is expected that foam will not be generated within the serpentine pipeline contactor.

3.2.3.11. Ozone Destruct System

Un-dissolved ozone that off-gases inside of the ozone contactor is piped to the ozone destruct system. The design criteria for the ozone destruct system are shown in **Table 3-12**.

Large concentrations of ozone may be sent to the ozone destruct system when the ozone system is shut down and the generator is purged of gas with a high ozone concentration. In normal operation, the ozone destruct only receives the gaseous ozone that did not dissolve into the bulk flow. The fraction of excess ozone should be low, as the specified transfer efficiency is greater than 90%. Gaseous ozone sensors are located prior to and after the ozone destruct. The sensors upstream of the destruct will be used to calculate the ozone transfer efficiency, while the downstream sensors will be used to ensure ozone destruction.

Table 3-12: Ozone Destruct Design Criteria

Parameter	Value
Number of destructs	3
Maximum ozone concentration in ozone vent-gas, ppm[a]	0.05

a. Occupational Safety & Health Administration heavy work, 8-hour limit; parts per million – ppm.

3.2.3.12. Instrumentation

3.2.3.12.1. Sample Taps

Sample taps are included : (1) immediately before the contactor; (2) immediately downstream of ozone injection, (3) at the end of the ozone contactor; and (4) after the quenching system (the quenching system is used, if needed, to quench residual dissolved ozone). The sample lines are directed to instrumentation manifolds. Redundant instrumentation is installed to maintain ozone control during instrumentation maintenance. The ozone effluent and quenching effluent sample times lead to dedicated instruments to keep sample-piping length to a minimum, which allows for a representative dissolved ozone concentration and an accurate dosing of the quenching chemical.

3.2.3.12.2. Instrumentation & Control

Instrumentation is required to monitor the ozone influent and effluent water quality, to control the ozone dose, and to control the ozone residual quenching system. Instruments are provided for each contactor to help diagnose operational issues. The instrument locations are summarized in **Table 3-13**.

The ozone dose is controlled by trimming to a dissolved ozone residual. This method of control leads to an automatic adjustment of ozone dose based on changes in ozone demand (e.g., caused by changes in nitrite or TOC concentrations), thereby maintaining the O_3:TOC ratio close to the O_3:TOC ratio associated with the design ozone dose and water quality. For example, if the nitrite or TOC concentrations in the ozone feed increase, and correspondingly increase the ozone demand, the ozone residual will decrease, which would cause the control system to respond by increasing the ozone dose until that the ozone residual reaches the ozone residual setpoint. This method of control (feed back) does not require online nitrite or TOC analyzers (feed forward) or grab samples, and bromate formation is minimized by maintaining the O_3:TOC ratio close to the design O_3:TOC ratio.

Table 3-13: Sensors for Ozone Control

Sensor[a]	Number of sensors	Locations
Dissolved ozone	2	Immediately after injection (2)
ORP	7	Before ozone contactor (1) Immediately after injection (2) After ozone contactor (1+1)[b] After quenching (1+1)[b]

a. Ultraviolet light transmittance – UVT; Oxidation-reduction potential – ORP; sensors should be applicable to ozonated secondary effluents.

b. (Duty+standby)

3.2.3.13. Quenching System

An ozone quenching system is included to increase operational flexibility. The system consists of two ORP sensors (one duty and one standby) before quenching, and two ORP sensors (one duty and one standby) after quenching. Quenching will be achieved with sodium bisulfite.

The system is sized to dose 1.1 mg/L sodium bisulfite (enough chemical to quench a maximum of 0.5 mg/L of DO_3). Mixing is provided immediately downstream of the quenching chemical addition. Rapid mixing allows the quenching agent to react more readily with the stronger oxidant, ozone, instead of consuming chloramines. The quenching system design criteria are shown in **Table 3-14**.

Table 3-14: Quenching System Design Criteria

Parameter	Value
Quenching chemical	Sodium bisulfite
Solution strength, %	25
Tank Volume, gal	2,500
Design dose, mg/L sodium bisulfite	1.1
Metering Pumps	
Number (duty + standby)	1+1
Maximum capacity per pump, gph	1

3.2.3.14. Layout and Materials

3.2.3.14.1. Layout

The following equipment will be placed indoors:

- Ozone generator
- Cooling water systems
- Power supply units
- Nitrogen boost system

The following equipment will be placed outside, if necessary:

- LOX equipment
- Injection system (under a roof is recommended)
- Ozone destruct units

3.2.3.14.2. Materials

Wetted parts that may contact an ozone residual will be made out of one of the following materials:

- Stainless steel 316 or 316 L grade piping
- Concrete contactor
- Teflon gaskets
- PVC sample piping

3.2.4. Membrane Filtration Treatment System

The MF treatment system will process water pretreated by the ozone system to condition it further for downstream treatment by the RO system. The MF system is proficient at removing particulate matter from the RO feed water that will otherwise foul the RO process membranes. The system includes the following components:

- MF feed tank and pumps
- Feed strainers
- MF membrane process units
- MF filtrate tank

- Membrane backwash/reverse flush pumps
- Compressed air system
- Clean in place (CIP) system
- Enhanced flux maintenance (EFM) system
- Reverse filtration (RF) system

The system has an installed capacity of 6.85 mgd, sufficient to support an RO system capacity of 5.0 mgd operating at 81% recovery. Individual subsystem components of the MF system are discussed in the following subsections.

3.2.4.1. Raw Water Characteristics

Assumed secondary effluent quality related to the MF and RO systems is shown in **Table 3-15**.

Table 3-15: Design Typical Influent Quality

Assumed MF Influent Water Quality[a, b]		
Alkalinity (in $CaCO_3$ units)	mg/L	306
Ammonia as N	mg/L	28
Bromide	mg/L	0.3
Calcium	mg/L	66
Chloride	mg/L	222
Conductivity (Specific Conductance)	µS/cm	1661
Iron	mg/L	0.4
Magnesium	mg/L	31
Manganese	mg/L	0.06
Nitrate (as NO_3)	mg/L	38
Nitrite (as N)	mg /L	1.2
Nitrate + Nitrite as N	mg /L	9.8
pH	pH	7.5
Phosphate (Orthophosphate as P)	mg/L	4
Potassium	mg/L	21
Silica	mg/L	40
Sodium	mg/L	167
Sulfate	mg/L	123
Sulfide	mg/L	--
Temperature	°C	22
TDS	mg/L	914
Total hardness as $CaCO_3$	mg/L	291
Total Kjeldahl Nitrogen	mg/L	33
Total N	mg/L	44
Turbidity	NTU	3

a. Assumed MF influent water quality based on source water sampling, expected source flows, historical RTP performance, and pilot testing.
b. Calcium carbonate - $CaCO_3$; Nitrate - NO_3; Phosphorus - P; Microsiemens per centimeter - µS/cm; Nephelometric turbidity units – NTU.

3.2.4.2. Membrane Filtration Feed Tank and Pumps

The MF feed tank and pumps receive project source water pretreated by the ozone system and the addition of sodium hypochlorite upstream of the ozone system. The MF feed tank has a hydraulic residence time of 25 minutes. The volume is sufficient to equalize variable flows into the MF membrane units during normal cycles of filtration and backwash, allowing a steady flow through the upstream ozone system. The feed pumps are horizontal, split case type, configured in a 3 x 50%

arrangement. The pumps are equipped with variable speed drives to allow operation at variable flow and pressure conditions related to operating sequences of the MF units and auto-strainers. The variable speed drives also operate when pressure fluctuations occur due to changes in permeability of the MF process membranes between CIP sequences. Design criteria for the MF feed pump station are provided in **Table 3-16**.

Table 3-16: MF Feed Tank and Pumps

MF Feed Tank and Pumps	
MF Feed Tank	
Type	Above grade, welded steel
Dimensions, D x SWD, ft x ft[a]	30 x 25
Capacity, gal	132,2000
Hydraulic residence time, min	25
MF Feed Pumps	
Number of pumps (duty + standby)	2+1
Operating configuration	3 x 50%
Pump type	Horizontal Split Case
Pump capacity, gpm	2,745
Pump head, feet	105
Pump motor size, hp	100
Pump drive	Variable Speed

a. D x SWD – diameter by side water depth

3.2.4.3. Automatic Strainers

The automatic strainers provide particulate removal prior to the MF units and also protect the hollow fiber membranes. The strainers are an automatic backwashing type, which can continue to filter water during the backwash process, which is a cyclical process that lasts for roughly 30 seconds. The process can be triggered by time, differential pressure loss, or remote-manual initiation. The anticipated recovery of the automatic strainers is greater than 98%. Design criteria are presented in **Table 3-17**.

Table 3-17: Automatic Strainers

Automatic Strainers[a]	
Number of strainers (Duty + Standby)	2+1
Operating configuration	3 x 50%
Type	Automatic, Self-Cleaning
Rated capacity, gpm	3,300
Maximum pressure drop at rated flow, psid	7
Screen size (rating), microns	300
Screen type	Weave wire
Recovery, %	>98
Motor Size, hp	1/2

3.2.4.4. Membrane Filtration System

The piloting program revealed that the outside-in filtration path outperformed the inside-out alternative; and that the polyvinylidene difluoride (PVDF) membranes formed by thermally induced polymerization exhibited stable permeability at a flux rate of 30 gallons per day per square foot (gfd). Therefore, this type of MF system was selected for the AWP Facility (see design criteria in Table 3-18).

The core of a typical MF system is the MF block, or unit. Each unit incorporates the following, which will be mounted on a coated steel frame:

- Hollow fiber MF membrane modules mounted vertically on high density polyethylene manifolds,
- Process flow piping and valves,
- Instruments, and
- Electrical and pneumatic panels.

Individual units are connected via a manifold from one common feed, and a set of feed pumps operating on variable frequency drives provides the influent flow (MF Feed Pumps described previously). The speed of these pumps is adjusted to attain a desired filtrate flow rate, with modulating valves on each unit controlling its respective flow. The individual units are all equipped with cleaning and enhanced flux maintenance capabilities, process and control air, drains, scrub air connections and reverse flush headers to achieve the desired rate of system production.

During operation, MF system feed water enters the bottom of a module and travels through large holes to the exterior of the fibers in the main body of the module. The feed water within the module housing permeates through the hollow fiber membranes into the interior lumens. The filtered water then exits through the top of the module and continues to the permeate connection.

Aside from normal operation, the two other automatic operating modes include:

1. Reverse filtration/air scrubbing (RF/AS): removes accumulated particulates from the membranes, and

2. EFM: restores permeability.

The RF/AS sequence occurs automatically after 28 minutes of filtration time and takes approximately 120 seconds to complete. The MF system continuously cycles between filtration and RF/AS cycles with the exception of the daily EFM. Once every few days, the modules are cleaned via an EFM cycle, which takes approximately 60 minutes to complete. Residuals from the RF/AS and EFM are sent to the RTP headworks, after quenching or pH neutralization, as necessary.

Table 3-18: Membrane Filtration System

Membrane Filtration System	
System rated capacity, mgd	6.17
Number of MF skids (Duty + Standby)	4+1
Number of MF modules per skid	102
Maximum design instantaneous flux, gfd	25
Membrane type	0.1 micron PVDF
Module model number	SMT600-P72
Membrane area per nodule, square feet	775
Maximum flow per unit, gpm	1,372
RF/AS cycle interval, min	28
RF flux, gfd	30-70
AS Air Flow (scfm/module)	3.1-7.5
EFM Frequency (hours)	24
Minimum Recovery (%)	92

3.2.4.5. Compressed Air System

The main components of the compressed air system are listed in **Table 3-19**. Compressed air is used in the MF system as process air during the periodic air scrub sequence and as control and valve operating air throughout the system. The air used is dry and oil-free, per the Instrument Society of America Standard S7.3.

Table 3-19: Compressed Air System

Compressed Air System	
Air Compressors[a]	
Number (Duty + Standby)	1+1
Operating Configuration	2 x 100%
Capacity, scfm	30
Minimum Design Pressure, psig	145
Motor Size, hp	15
Air Receiver	
Number (duty + standby)	1+0
Volume, gallons	200
Design Pressure, psig	150

3.2.4.6. Clean-in-Place System

The function of the CIP system is to regenerate the membranes when they become fouled with constituents that are not removed by the periodic RF/AS and EFM sequences. The main components of the CIP system are summarized in **Table 3-20**, and the chemical transfer systems are detailed in **Table 3-21**. During the cleaning of a unit, the remaining units, including the dedicated spare unit, maintain the maximum required system production level.

Table 3-20: Clean-in-Place System

CIP System[a]	
MF CIP Tanks	
Number	2
Type	FRP
Capacity, gal	3,000
MF CIP Heater	
Number	2
Size, kw	75
Strainer	
Number (duty + standby)	2+1
MF CIP Pump	
Number (duty + standby)	1+1
Materials	FRP
Design flow per pump, gpm	1,020
Drive	Variable speed
Motor size, hp	25
Maximum motor speed (rpm/enclosure)	1,800

Table 3-21: Chemical Transfer Systems

Chemical Transfer Systems	
Sulfuric Acid	
Sulfuric Acid Tank	1
Solution strength, %	93
Number	1
Capacity, gal	3,000
Sulfuric Acid Pump	
Capacity per pump, gph	300
Sodium Hydroxide	
Sodium Hydroxide Tank	
Solution strength, %	25
Number	1
Capacity, gal	3,000
Sodium Hydroxide Pump	
Capacity per pump, gph	300
Sodium Hypochlorite	
Sodium Hypochlorite Tank	
Solution strength, %	12.5
Number	2
Capacity per tank, gal	10,300 (operating); 8,755 (nominal)
Sodium Hypochlorite Pump	
Materials	PVC
Capacity per pump, gph	300

3.2.4.7. Enhanced Flux Maintenance System

The EFM system uses the main CIP system for daily cleans. The most frequently used solution, sodium hydroxide (NaOH), is stored in a tank fitted with two immersion heaters. This is to account for the number of units in the system and the shorter heating times between required cleanings.

3.2.4.8. Reverse Filtration System

The RF system is provided to perform routine regeneration of the membrane fibers (components are summarized in **Table 3-22**). The system reverses the flow of the MF system, moving filtrate from the inside of the fibers, through the membrane and to drain. The RF pumps are equipped with variable speed drives to maintain the target flow over variable trans- membrane pressure losses through the MF modules based on the degree of fouling. The pumps draw off the main filtrate manifold and route to the filtrate clear well.

Table 3-22: Reverse Filtration System

Reverse Filtration System	
Number of pumps (duty + standby)	1+1
Operating Configuration	2 x 100%
Primary design capacity per pump (gpm)	2,200
Drive	Variable speed
Motor size, hp	100
Max. motor speed, rpm	1,800

3.2.5. Reverse Osmosis Membrane Criteria

The RO process is used to remove dissolved constituents such as dissolved salts, pathogens, pesticides, organics, pharmaceutical compounds, and other CECs. The RO system includes:

- Cartridge filters,
- RO membrane trains,
- RO CIP system, and
- RO membrane flush system.

The rated permeate flow capacity is from 1.2 to 5.0 mgd with an 81% recovery.

3.2.5.1. Reverse Osmosis Wet Well and Transfer Pump Station

Filtrate from the MF system flows to a MF filtrate tank for intermediate storage and pumping ahead of the RO system. The MF filtrate tank provides equalization storage between variable rates of MF filtrate flow (due to backwash and cleaning cycles) and the continuous, stable flow required to the RO system. The target hydraulic residence time is 27 minutes. The pumps are low-pressure, providing flow through the pretreatment cartridge filters and chemical addition systems ahead of the inline high-pressure booster pumps feeding the RO membrane trains. Design criteria for the RO feed pump station are provided in **Table 3-23**.

Table 3-23: RO Feed Pump Station

RO Feed Pump Station	
MF Filtrate Storage Tank	
Type	Abovegrade, Welded Steel
Hydraulic residence time, min	27
Dimensions, DxSWD[a], ft x ft	30 x 25
Capacity (gallons)	114,200 (operational) 132,200 (nominal)
RO Transfer Pumps	
Number of pumps (duty + standby)	3+1
Operating configuration	4 x 33%
Pump type	End suction centrifugal
Pump capacity, gpm	1,400
Pump head, ft	92
Pump motor size, hp	50
Pump drive	Variable Speed

a. D x SWD – Diameter x Side Water Depth

3.2.5.2. Pretreatment Facilities

RO pretreatment facilities include cartridge filtration and the addition of sulfuric acid and a scale inhibitor (see **Table 3-24**). The cartridge filters remove any large particles in the MF filtrate that could interfere with RO filtration. Sulfuric acid is used to lower the feed pH to the RO system and help prevent mineral scaling with the assistance of the scale inhibitor (see **Table 3-25**). The primary scalants of concern are calcium phosphate and silica; pH adjustment (down to a set point as low as 6.0) is the primary control of calcium phosphate scale, while the scale inhibitor is relied on to prevent the scaling of silica. The above approach worked well in keeping scaling at a minimum during the six-month pilot test period and was successful in the Demonstration Facility.

Table 3-24: RO Cartridge Filters

RO Cartridge Filters	
Number (Duty + Standby)	2+1
Operating configuration	3 x 50%
Rated capacity of housing mgd	3.85
Max. loading rate, gpm/10-inch equivalent	4.0
Cartridge element rating (microns)	5

The cartridge filter vessels are horizontal type to facilitate the loading and unloading of filter elements.

Table 3-25: Reverse Osmosis Chemical Systems

RO Chemical Systems	
Scale Inhibitor	
Scale Inhibitor Tank	
Number	1
Type	Cross-linked polyethylene
Capacity, gal	9,000
Scale Inhibitor Pumps	
Number (duty + standby)	1+1
Capacity, gph	1.5
Sulfuric Acid	
Sulfuric Acid Tank	
Solution strength, %	93
Number	2
Type	Lined steel
Capacity, gal	9,000
Sulfuric Acid Pumps	
Number (duty + standby)	1+1
Capacity, gph	56
Rated Pressure, psi	100

3.2.5.3. Reverse Osmosis Trains

The main RO system equipment includes one small train and two large trains. The small train is sized for 1.5 mgd of permeate production, and the large trains are sized for 2.0 mgd of permeate production. The two large trains contain 60 pressure vessels in a 40:20 array, and the small train consists of 45 pressure vessels in a 30:15 array. Each vessel contains seven 8-inch diameter RO membrane elements.

The trains are connected to common feed, permeate, concentrate, flush feed, flush waste, and cleaning system headers. Product water from each train is combined and piped to the UV system reactors. Concentrate from the trains is combined and sent to the existing RTP outfall for disposal. Cleaning and flushing residuals are neutralized and sent to the plant waste equalization basin prior to return to the RTP headworks. Design criteria are provided in **Table 3-26**.

Table 3-26: Reverse Osmosis System

RO System	
RO Feed Pumps	
Number	3 (2 large, 1 small)
Type	Vertical Turbine
Materials	316 SS
Primary design operating flow per pump, gpm	1,300 (small train) 1,750 (large train)
Head at design point, ft	150 - 580
Drive	Variable Speed
Motor size, hp	250 (small train) 350 (large train)
Max. motor speed, rpm	1,800
RO Membrane Trains	
Number	1 (small train) 2 (large trains)
Permeate capacity (each), mgd	1.5 (small train) 2.0 (large trains)
Recovery (%)	81
Pressure vessel array	40:20 (large trains) 30:15 (small train)
Pressure Vessels	
Type	FRP, feed/concentrate side port configuration
Design operating pressure, psig	450
Size	To contain seven 40-inch x 8- inch diameter elements
Membrane Elements	
Number (total)	840
Element type	Spiral Wound
Membrane type	High rejection, polyamide composite
Element length, in	40
Element diameter, in	8
Membrane element area, square feet	400
Average rejection, %	99.6
Average flux at rated capacity, gfd	12

3.2.5.4. Clean-in-Place System

The CIP system is an ancillary facility provided for in-situ chemical cleaning of the RO membranes. This permanently piped system is used to prepare and recirculate a chemical cleaning solution independently through each stage of the RO membrane trains. The CIP system is operated from a local control panel. See **Table 3-27** for system components.

Cleaning chemicals are loaded into the CIP tank using a bag loader or eductor for batching of dry fed chemicals directly to the tank, which are diluted with RO permeate. The CIP pump draws from the CIP tank and, to mix the contents, is capable of circulating the solution to either the RO train or back to the CIP tank. The cleaning tank is fitted with a pair of flanged immersion heaters to achieve the required temperature of the cleaning solution. A small liquid chemical addition system is provided to adjust the cleaning solution pH if necessary. Two process lines are provided to the RO train; one pipeline is used to convey the cleaning solution to the membranes while the other is to return the cleaning solution to the CIP tank. Piping connections at each RO train allow for each membrane stage to be cleaned independently. Piping and valving at the CIP tank allow the cleaning solution to be for (1) recirculated back to the tank, (2) sent to the MF system neutralization tank, or (3) sent directly to the plant waste equalization tank for return to the RTP.

A utility water service connection that meets DDW cross connection control requirements is provided to allow use of potable water for preparation of the cleaning solution when RO permeate is not available. The CIP tank heaters are monitored and controlled by a tank-mounted thermocouple that is part of the heater unit.

Table 3-27: RO Clean-in-Place System

RO CIP	
CIP Tank	
Number	1
Type	FRP
Capacity, gal	7,600
CIP Pump	
Capacity at design point, gpm	1,500
Drive	Variable speed
Motor size, hp	75
Max. motor speed, rpm	1,800
CIP Tank Heater	
Number	2
Size, kW	75

3.2.5.5. Reverse Osmosis Membrane Flush System

The flush system is an ancillary facility provided for periodic *in-situ* flushing of the RO membranes. This permanently piped system is used to displace residual feed and concentrate from the RO membranes on train shutdown. It can also be used to periodically displace stagnated solution during extended train shutdowns.

Source water for flushing is RO permeate stored in an above grade storage tank. The tank is continually filled and pumped into the UV system influent header to ensure it does not stagnate. A dedicated flush pump drawing from the tank provides flow to the inlet side of the RO membrane feed pumps, which pumps the solution through the membrane pressure vessels. The majority of the flush supply remains on the feed/concentrate side of the membrane elements due to the relatively low delivery pressure. A waste valve on the final concentrate line is opened during flushing to discharge displaced waters to waste. To avoid the creation of backpressure during flushing, the permeate dump valve also opens to discharge accumulated permeate to waste.

A separate set of pumps draws from the tank to maintain a clean flush supply between intermittent flushing. The solution is pumped into the UV system feed header, or routed to the MF and RO cleaning systems for solution makeup and/or flushing. Design criteria for components of the flush system are provided in **Table 3-28**.

Table 3-28: RO Flush System

RO Flush System	
Flush Tank	
Number	1
Capacity, gal	15,230
Flush Pump	
Number (duty + standby)	1+0
Capacity at design point, gpm	500
Drive	Variable speed
Motor size, hp	30
Flush Transfer Pumps	
Number (duty + standby)	1+1
Operating configuration	2 x 100%
Capacity at design point, gpm	250
Drive	Fixed speed
Motor size, hp	7.5

3.2.6. Advanced Oxidation Process Design

AOPs are those in which hydroxyl radicals are generated at ambient temperature and pressure in order to facilitate oxidation of organic compounds. Hydroxyl radicals react rapidly with organics, making AOP an effective strategy for reducing the concentration of specific trace organic compounds and recalcitrant compounds. Advantages of AOPs include their ability to significantly reduce the concentrations of many CECs to acceptable levels, and the relatively short hydraulic residence time required. An AOP is also able to provide a high level of pathogen inactivation.

The AOP chosen for the Project is low pressure UV with hydrogen peroxide (UV/H_2O_2). It was selected for two reasons: (1) ozone is already used in the process train as an oxidant (it also provides disinfection), and (2) H_2O_2 is used as part of AOP systems in existing groundwater replenishment projects using full advanced treatment, and thus has a proven track record (for example, the Orange County Sanitation District's GWRS). The principle behind this process is that H_2O_2 reacts with UV light to form hydroxyl radicals, which then oxidize the target compounds.

3.2.6.1. Reduce Recalcitrant Compounds

In full advanced treatment, an AOP follows RO, which is capable of reducing the concentration of many organic and inorganic compounds to very low levels. However, some particularly recalcitrant, low molecular weight compounds are removed less effectively, e.g., NDMA and 1,4-dioxane. During the pilot testing, NDMA removal through RO was approximately 40%. The Title 22 Criteria require a specific 0.5-log reduction for 1,4-dioxane. Thus, AOPs are designed to achieve a certain level of removal of preselected recalcitrant compounds, 1,4-dioxane and NDMA. DDW has established NLs for 1,4-dioxane (1 μg/L) and NDMA (10 nanograms per liter or ng/L).[19]

This concept of AOP as a treatment barrier is illustrated in Figure 3-5, which shows the log removal of various CECs based on an AOP dose required to achieve 0.5-log removal of 1,4-dioxane. If 0.5-log removal of 1,4-dioxane is achieved, 0.5-log or greater removal of CECs that appear in **Figure 3-5** to the left of 1,4-dioxane will be accomplished. This is important because it demonstrates that the UV/ H_2O_2 process provides an effective barrier against CECs in potable reuse applications.

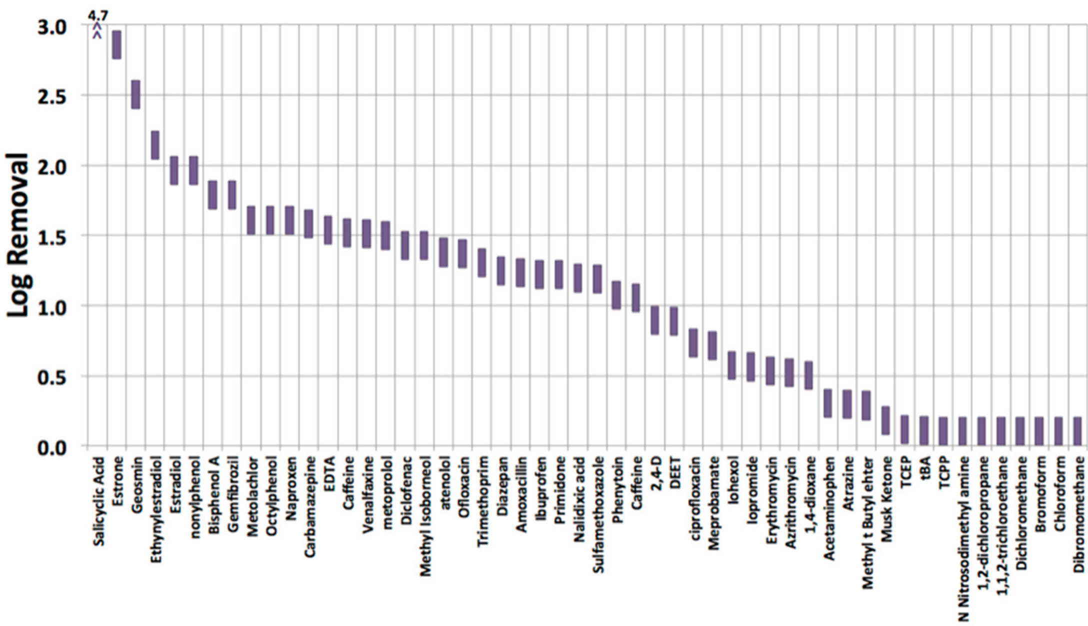


Figure 3-5. Log removal of CECs achieved when AOP dose removes 0.5-log 1,4-dioxane

3.2.6.2. Factors Affecting Advanced Oxidation Processes

Several factors affect the performance of AOPs by interfering with the production of hydroxyl radicals or by reacting with them. While these factors are of limited concern for the Project based on the high quality of RO permeate, additional information is provided in the following subsections for background.

[19] Effective date February 4, 2015; see http://www.waterboards.ca.gov/drinking_water/certlic/drinkingwater/NotificationLevels.shtml.

3.2.6.2.1. *Presence of Hydroxyl Radical Scavengers*

The presence of bicarbonate and carbonate ions can reduce the efficacy of AOPs because these species are reactive with hydroxyl radicals. Although they react much slower than many organic compounds, the concentrations of these hydroxyl radical scavengers are often orders of magnitude higher than those of the target compounds. Natural organic matter (NOM) also reacts with hydroxyl radicals, and can have a more detrimental impact on AOP performance than the carbonate species for some waters. Because bicarbonate, carbonate, and NOM are removed through the RO to a high degree, these are not a concern when performing AOP on RO permeate, making UV/AOP a very effective process for such applications.

3.2.6.2.2. *Photolysis of Hydrogen Peroxide*

In a UV/H_2O_2 process, oxidation is driven by the absorption of photons by H_2O_2 and the subsequent release of energy. The effectiveness of this process is dependent on the extent to which H_2O_2 undergoes photolysis. The presence of chemicals or organic molecules that absorb UV light can reduce the quantity of photons available to react with H_2O_2 and thus reduce the extent of oxidation. These constituents include NOM, NO_3, and iron, as well as the target compounds to a smaller degree (*e.g.*, CECs, 1,4-dioxane). While these compounds undergo photolysis due to UV exposure, the reduction of their concentrations is often more efficient via hydroxyl radicals generated by H_2O_2 photolysis, as many compounds are not amenable to UV photolysis alone in the absence of hydroxyl radicals. Hydroxyl radicals react rapidly with organics, and their second-order $^{\bullet}OH$ rate constants are generally several orders of magnitude faster than the rate constants for any conventional oxidant (Crittenden et al., 2012).

3.2.6.3. *UV Lamp Technology*

Two types of lamps were considered for this application: low pressure, high intensity (LPUV) lamps, and medium pressure, high intensity (MPUV) lamps. LPUV lamp technology was selected for the AOP system based on the following considerations:

- LPUV emits energy at one specific wavelength of 254 nanometers (nm), which is a wavelength that has been shown to be highly effective for NDMA destruction, and
- MPUV lamps have been shown to require higher energy inputs to achieve the same level of NDMA destruction as LPUV lamps.

MPUV lamps emit energy in the UV spectrum from 200 to 400 nm. Since H_2O_2 only absorbs photons in the 200-300 nm wavelength range, a portion of the energy emitted in the UV spectrum from 300 to 400 nm cannot be used to generate hydroxyl radicals.

3.2.6.4. *Advanced Oxidation Process Design*

The AWP Facility UV AOP system is designed to handle 5 mgd flows and for specific log reductions of recalcitrant compounds, as defined in the following subsections.

3.2.6.4.1. 1,4-Dioxane Design Target

Based on the pilot testing, the concentration of 1,4-dioxane measured in the RO permeate was below the MRL of 1 µg/L, the same concentration as the NL. The 1,4-dioxane concentration target for the AOP system is set to ½ the NL (0.5 µg/L).

3.2.6.4.2. NDMA Design Target

The NDMA design goal for the Project was set at 1 ng/L. Based on levels observed during piloting (a maximum NDMA concentration of 32 ng/L was observed in the RO permeate), the design removal for NDMA is 1.5-log to achieve the goal of 1 ng/L.

3.2.6.5. Feed Water Quality

Based on the pilot testing results, the feed water quality for the UV/H_2O_2 AOP system is provided in **Table 3-29**.

Table 3-29: Advanced Oxidation Feed Water Quality

UV Peroxide AOP Feed Water Quality	
NDMA, ng/L	≤ 50
1,4-dioxane, µg/L	≤ 3
Temperature, °C	16-24
UV transmittance at 254 nm	≥ 95%
Alkalinity, mg/L as $CaCO_3$	≤ 20
TOC, mg/L	≤ 0.5
TDS, mg/L	≤ 60
TSS, mg/L	< 1
pH	5-6.5
Calcium hardness, mg/L as $CaCO_3$	≤ 5
Iron, mg/L	< 0.1
Manganese, mg/L	< 0.02

3.2.6.6. General UV Design Criteria

General design criteria for the UV/H_2O_2 system are defined in **Table 3-30**. A collimated beam study was conducted to determine the UV dose for the NDMA and 1,4-dioxane reduction requirements. This testing indicated that the UV system would have to deliver a UV dose of 1,600 MJ/cm^2 to meet both the NDMA and 1,4-dioxane goals. The dose required to meet the NDMA goal was larger than the dose required to meet the 1,4-dioxane goal. The dose required for 0.5 log removal of 1,4-dioxane will be further explored during start-up testing and commissioning of the AWP Facility, as the AWP Facility may operate at the 1,4-dioxane dose during operation if the effluent NDMA levels are below the Notification Level.

Table 3-30: UV AOP System General Design Criteria

Parameter	Value
Flow rate, mgd	5.0
UV reactors (standby + duty)	4+1
H_2O_2 dose, mg/L as H_2O_2	3.5 to 6
UVT, % at 254 nm	≥ 95
NDMA reduction requirement	≥ 1.5-log
NDMA concentration in UV AOP treated water, ng/L	≤ 1
1,4-Dioxane reduction requirement	≥ 0.5-log
1,4-Dioxane concentration in UV AOP treated water, µg/L	≤ 0.5
UV dose, mJ/cm^2	1,600

3.2.6.7. Ultraviolet System

The UV system is designed for a maximum flow rate of 5.0 mgd. Four duty reactors will be provided, along with one standby reactor. Each reactor contains 60 290-W lamps (300 lamps total, 87 kW total lamp power). Design criteria are provided in **Table 3-31**.

Table 3-31: Design Criteria for the UV system

Parameter	Value
UV system manufacturer	WEDECO/Xylem
UV reactor model	LBX 1500e
Reactors (duty + standby)	4+1
Reactors (duty)	4
Operating configuration	In parallel
Design operating flow rate, mgd	5.0
Influent UVT at 253.7 nm, %	≥ 95
Influent temperature, °C	14-27
Lamps, total (duty + standby)	300
Lamps, total (duty)	240
Lamps per reactor	60
Pressure drop through reactor at 5 mgd, inches	19
Power per lamp, W	290
Total lamp power, P_L (duty + standby), kW	87
Total lamp power, P_L (duty), kW	69.6
Total lamp power, P_L, per reactor, kW	17.4
UV Intensity Sensors per reactor	1
UV Intensity Sensors, total (duty + standby)	5
UV Intensity Sensors, total (duty)	4

3.2.6.8. Hydrogen Peroxide Feed System

H_2O_2 will be dosed upstream of the UV reactors, with a design dose range from 3.5 to 6 mg/L, as shown in Table 3-32. The H_2O_2 system will consist of two metering pumps (duty + standby), a 1,600-gallon chemical storage tank, chemical containment system, and an in-line static mixer. Hydrogen peroxide addition will be flow-paced at a dose controlled by the UV/AOP system. The design criteria for the H_2O_2 dosing system are summarized in **Table 3-32**.

Table 3-32: Design Criteria for Hydrogen Peroxide Dosing System

Parameter	Value
H_2O_2 dose range, mg/L as H_2O_2	3.5-6
Static mixer type	In-line
H_2O_2 solution strength, %	50
H_2O_2 storage tank volume, gal	1,600
Maximum H_2O_2 dosing rate (at 6 mg/L), gph	2.1
Storage at average use	42

3.2.7. Product Water Stabilization

Several issues arise as a result of the softness and low alkalinity of RO permeate product water, including conveyance pipe corrosion, the potential for groundwater aquifer leaching and mineral mobilization, as well as changes in taste or smell that affect consumer acceptance. For these reasons, most advanced treatment facilities producing RO permeate practice pH and/or alkalinity adjustment as a control strategy for mitigating corrosion, leaching, and undesirable taste and odor (T&O).

3.2.7.1. Purpose

3.2.7.1.1. Minimize Corrosion in Conveyance Pipeline

The conveyance pipeline will transport water from the AWP Facility to the injection wells. Without post-treatment stabilization, corrosion may occur in the conveyance pipeline. Corrosion degrades the integrity of the pipeline and can lead to formation of corrosion by-products. These corrosion by-products may contribute to plugging of the injection site and may impact downstream T&O.

3.2.7.1.2. Minimize Leaching in Groundwater Aquifer

Another issue with RO permeate is the potential for leaching of minerals and other chemicals present within the aquifer of the Seaside Basin. Leaching could impact the water quality by increasing dissolved solids or mobilizing unwanted compounds such as arsenic.

3.2.7.1.3. Consumer Acceptance

Consumer acceptance is important for the overall success of the project. Minimizing changes in water quality associated with T&O and appearance can help maintain positive customer perception. For the Project, minimizing water quality changes that cause public concern is less of an issue because the RO product water from the AWP Facility will be blended with existing groundwater before it reaches consumers.

3.2.7.2. Post-treatment Parameters

The Langelier Saturation Index (LSI), Calcium Carbonate Precipitation Potential (CCPP), and the Aggressive Index all indicate the ability of a solution to dissolve or precipitate calcium carbonate mineral. Waters that tend to precipitate calcium carbonate (LSI > 0) may form a protective layer of calcium carbonate in the conveyance piping. Waters that tend to dissolve calcium carbonate can erode these protective layers, eventually exposing iron or steel. The ability of a solution to dissolve calcium carbonate is a function of pH, calcium concentration (related to hardness), carbonate concentration (related to alkalinity), temperature and TDS. The following is a description of the other water quality parameters that make up the post-treatment water quality goals:

- The chloride concentration relates to the corrosivity of the water with respect to iron and steel;
- The Modified Fouling Index (MFI) and turbidity are measurements of the particulate and colloidal make-up of the water, which relate to the particle loading of the water and may indicate the presence of pathogenic bacteria; and
- A chlorine residual is used to control biofilm growth in the conveyance pipeline and injection wellhead.

3.2.7.2.1. Post-Treatment Design Goals for AWP Facility

The post-treatment system will be designed to treat the entire 5 mgd flow from the RO system, including a turndown to 1.2 mgd. To minimize corrosion and control leaching in the aquifer, the post-treatment system will produce water with the characteristics shown in **Table 3-33**.

Table 3-33: Post Treatment Design Criteria

Parameter	Post Stabilization WQ Goals
Temperature, °C	16 - 24
Alkalinity, mg/L as $CaCO_3$	40-80
pH	7.5-8.5
Calcium hardness, mg/L as $CaCO_3$	40-80
LSI	0.15-0.2
CCPP, mg/L	2-6
Turbidity, NTU	< 0.2
TOC, mg/L	< 10
Total Cl_2, mg/L	2-4
Total nitrogen, mg/L as N	< 10

3.2.7.3. Decarbonation

Decarbonation of the UV/AOP product water is achieved through air stripping, which promotes the transfer of CO_2 out of the product water and into the atmosphere. By reducing CO_2 levels, the decarbonated water can more easily be manipulated to achieve the post-treatment water quality goals. The primary benefit is a reduction in the amount of chemicals needed to achieve the water quality targets. Modeling suggests that a range of flows between 70-100% of the 5 mgd flow may require decarbonation prior to stabilization. To meet this range and provide added flexibility, the air stripping process has been designed to treat the entire 5 mgd flow from the UV/AOP process. A bypass line will be included to adjust the fraction of flow passing through the air stripper. The system will include one duty and one standby air stripper designed to treat the full flow (5 mgd). This stripper will have a weir influent flow structure to increase the turndown of the stripper (typically 10:1 with the influent weir structure). Below a turndown of 10:1, the media may not fully wet and CO_2 removal becomes unreliable.

A redundant blower will be provided for continuous operation during blower maintenance. Stripper maintenance is typically negligible unless fouling occurs, or the media is damaged. Media damage may occur if operations or maintenance staff walk on the media. This damage is not expected to occur during normal operation; however, if the media must be accessed, the manufacturer recommendation will be followed to avoid damage. Fouling is not typically a concern when using RO permeate.

Table 3-34: Decarbonation Design Criteria

Parameter	Value
Free CO_2 removal efficiency (minimum)	94%
Number of decarbonator towers	1
Diameter of decarbonator tower, ft	14
Inlet structure type	Weir
Packing depth, ft	10
Air to water ratio, ft^3:ft^3	25
Fraction of flow through bypass, %	0-30
Max flow through decarbonator, mgd	5
Min flow through decarbonator, mgd	1.2
Tower loading rate at design flow, gpm/sf	22.6
Blowers (duty + standby)	1+1
Blower capacity, each, scfm	12,200
Blower motor size, each, hp	15
Blower motor speed, each, rpm	1,280
Blower motor type	Centrifugal fan

3.2.7.4. Alkalinity, pH, and Hardness Adjustment

After air stripping, chemicals will be added to adjust the alkalinity, pH, and hardness of the decarbonated water.

3.2.7.4.1. Design Criteria for Cal-Flo Hydrated Lime Addition System

The Cal-Flo system provides a stable slurry of pre-prepared $Ca(OH)_2$ that can be used to directly adjust the pH, alkalinity, and calcium hardness of the process water. The system includes a continuously mixed, $Ca(OH)_2$ storage silo that maintains a slurry that can be injected directly into the process stream. The main advantages of the Cal-Flo system over conventional $Ca(OH)_2$ systems are that it greatly reduces equipment needs (eliminates dry lime storage, lime feed and slaking systems, and lime saturators) while providing significantly simplified operation. The high-quality slurry can be added directly to the process water while maintaining the water within specifications for turbidity and other particulate water quality goals. **Table 3-35** summarizes the post-treatment lime addition design criteria for the Cal-Flo $Ca(OH)_2$ addition system.

Table 3-35: Cal-Flo Hydrated Lime Addition Design Criteria

Parameter	Value
Design capacity, mgd	5
Available strength, %	30
Diluted strength, %	25
Average hydrated lime dose, mg/L as $Ca(OH)_2$	45
Average lime consumption (at 25%), gal/d	577
Lime storage tanks	1
Storage volume provided, gal	20,000
Diameter, ft	12
Mixer	2
Horsepower, hp	1
Type	In-line

3.2.7.5. Secondary Disinfection

Ammonium sulfate and sodium hypochlorite are added during product water stabilization for secondary disinfection to prevent regrowth in the product water conveyance pipeline. The target total chlorine residual is 2-4 mg/L as Cl_2, and will rapidly decay in the aquifer prior to the water reaching the monitoring wells. Likewise, the residual ammonia will be rapidly oxidized. The design criteria for secondary chlorination (without ammonia addition) are shown in **Table 3-36**.

Table 3-36: Secondary Disinfection Design Criteria

Parameter	Value
Design capacity, mgd	5
Sodium Hypochlorite	
Dose, mg/L as Cl_2	2-4
Feed rate, gph	2.76-5.51
Number of metering pumps (duty + standby)	1+1
Metering pump capacity, gph	7.2
Ammonium Sulfate	
Solution strength, %	40
Tank Capacity, gal	900
Dose, mg/L as N	2.5-5
Feed rate, gph	1.07-2.14
Number of metering pumps (duty + standby)	1+1
Metering pump capacity, gph	2.7

3.2.8. Waste Collection and Disposal

Ozone injection strainer waste, MF strainer backwash, MF reverse flow waste, MF enhanced flux maintenance waste, MF CIP waste, RO CIP waste, and RO flush waste travel to a Waste Equalization Pump Station for neutralization. The Waste Equalization Pump Station is a below-ground wet-well type. The combined waste stream is treated with sulfuric acid, sodium hydroxide, sodium bisulfite, and Ferric chloride, as needed. The neutralized waste is subsequently returned to headworks of the RTP. Criteria for the Waste Equalization Pump Station are provided in **Table 3-37**.

Table 3-37: Waste Equalization Pump Station

Waste Equalization Pump Station	
Waste Equalization Wetwell	
Number	1
Length, ft	30
Width, ft	15
Max water level elevation, ft	94
Min water level elevation, ft	83
Operational water depth, ft	11
Total operational volume, gal	37,026
Average operational hydraulic residence time, min	72
Waste Transfer Pumps	
Number of pumps (duty + standby)	1+1
Type	Vertical turbine
Rated flow per pump, gpm	765
Primary design operating point, gpm @ ft	765 @ 60
Motor size, hp	20
Drive	Variable speed
Maximum motor speed, rpm	900
Ferric Chloride System	
Solution strength, %	40
Design dose, mg/L	15
Tank	1
Tank type	Cross-linked polyethylene
Tank nominal capacity, gal	900
Metering pump (duty + standby)	1+1
Maximum capacity per pump, gph	2
Neutralization Chemical Transfer Systems	
Sulfuric Acid	
Solution strength, %	93
MF transfer pump	1
Rated capacity per pump, gph	300
Sodium hydroxide	
Solution strength, %	25
MF transfer pump	1
Rated capacity per pump, gph	300
Sodium bisulfite	
Solution strength, %	25
MF transfer pump	1
Rated capacity per pump, gph	300

3.3. PREVENTIVE MAINTENANCE PROGRAM FOR TREATMENT FACILITIES

The M1W Maintenance Department's mission is to effectively and efficiently maintain all equipment so that it remains in a safe, reliable, and well maintained condition for its internal and external customers.

3.3.1. Graduated Preventative Maintenance Program

The emphasis of the maintenance program is preventive rather than reactive maintenance. A strong preventive maintenance program effectively reduces overall maintenance costs by decreasing the number of, and the high cost of unpredictable repairs caused by reactive maintenance. M1W uses a graduated preventative maintenance (PM) program that is based on the manufacturer's recommendations and modified based on their experience and their local environment. These PM practices maximize useful life, are cost efficient over the life of the asset, and ensures that their assets remain in serviceable operating condition.

Maintenance schedules are developed for each asset, based upon usage and manufacturer's recommendations. Each asset has PM tasks categorized as Weekly, Monthly, Semi-Annual or Annual, which include regular inspections. In addition, many assets also have "real-time" supervisory control and data acquisition (SCADA) condition monitoring installed and are subject to daily physical operational checks. All of this data will be monitored and tracked within the Agency Computerized Maintenance Management System program.

To assure optimum benefits, M1W will continually review its maintenance practices to identify potential improvements to the program.

3.4. RECYCLED WATER TRANSMISSION FACILITIES

The transmission facilities consist of the AWP Facility Product Water Pump Station (PWPS), the Purified Water Reservoir, and the Product Water Pipeline.

The PWPS will be located within the site of the AWP Facility to be constructed within the current boundary of the RTP. The PWPS will pump product water into the Product Water Pipeline and into the Purified Water Reservoir. The pipeline will include connections to supply purified recycled water for landscape irrigation by MCWD. The reservoir will be used to balance out diurnal demands from landscape irrigation. M1W and MCWD ownership of the transmission system components is described below. M1W will be responsible for operations and maintenance of its facilities as described in this Engineering Report. MCWD will be responsible for operations and maintenance of the MCWD-owned transmission facilities and distribution facilities downstream of the transmission main as described in the MCWD Title 22 Engineering Report.

M1W Facilities

- The Product Water Pump Station is owned and operated by M1W.

- Transmission main pipeline located on the RTP site and at the injection well site is owned and operated by M1W. (M1W ownership at the injection well site includes all land east of the General Jim Moore Blvd. right-of-way.)

MCWD Facilities

- Transmission main pipeline consisting of approximately 50,000 linear feet (9.5 miles) of 16 to 24-inch diameter transmission main is owned and operated by MCWD. (MCWD ownership extends from the southern boundary of the RTP site to the east edge of General Jim Blvd Moore boundary at the injection well site.)
- The 2.0 MG operational storage tank (Blackhorse reservoir) is owned and operated by MCWD. (The reservoir is located at the site of MCWD's potable water storage tanks supplying zones D and E.)

3.4.1. Product Water Pipeline

A pipeline will be constructed to convey product water from the AWP Facility to the Seaside Basin for groundwater replenishment (see **Figure 3-6)**. The alignment will generally follow the Regional Urban Water Augmentation Project (RUWAP) through the City of Marina and the middle of the Ft Ord area, now in the jurisdictions of the City of Marina, Fort Ord Reuse Authority (FORA) and the City of Seaside.

The annual average volume of product water will be 3,200 to 4,300 AFY (see **Section 2** for discussion of drought reserve injection). On a constant basis this annual amount would be about 2.9 to 3.8 mgd. Several factors will affect the actual daily flow rates through the conveyance system. These factors include: seasonal variations; source water supply variations; down-time for maintenance of mechanical equipment of pumping systems and the AWP Facility; maintenance of the injection wells; and MCWD demands. Hence, it was necessary and prudent to size facilities, particularly the conveyance pipeline, to handle these flow variations so as to result in the annual average recharge target volume of 4,300 AFY. Based on the best available data and reasonable projections, the estimated maximum future amount of source water for the Project may provide for a total peak product water delivery flow rate of approximately 5 mgd.

Taking into consideration these factors, it was determined that the design flow for the product water pipeline was 5 mgd. Using this design flow criterion, the pipeline size was to be between 16 and 24 inches in diameter. Based on current availability of source water for the AWP Facility, operation of the Project indicates that the maximum daily flow will be about 5.0 mgd. This design flow rate compensates for AWP Facility shut-down periods for routine maintenance purposes, thus resulting in the Project being able to meet the maximum design annual average recharge volume of 3,700 AFY and the MCWD volume of 600 AFY. This flow rate was used in the design of the pump station.

The pipeline will include flow control valves, isolation valves, blow down structures for maintenance, air and vacuum release valves, and other appurtenant facilities. Other general design features include standby pumping units for pump stations; in-line isolation valves on the pipeline approximately every 2,000 feet, in case an unforeseen leak occurs, or subsequent construction activities result in damage to the pipeline; and compliance with DDW pipeline separation requirements.

3.4.2. AWP Facility Product Water Supply Pump Station

3.4.2.1. Background Information

The PWPS will receive flow from the AWP Facility. The product water will flow by gravity to the clearwell of the PWPS. The PWPS will pump the product water into the product water conveyance pipeline, and ultimately to the Injection Facilities area. There is a tee off of the conveyance pipeline to the purified water reservoir at the Blackhorse site which is used for flow equalization to balance diurnal demands from MCWD’s landscape irrigation, in order to maintain a nearly constant injection rate. Design and operation of the purified water reservoir is discussed in **Section 3.4.3**.

3.4.2.2. Physical Description

The PWPS will be located within the site of the AWP Facility. The PWPS will be cast-in-place, concrete-type structure. The pumps will be vertical-turbine type. Pumps will be mounted outdoors on a concrete deck over an intake clear well reservoir. Electrical and control equipment for the pumps will be housed in a small, electrical enclosure, located adjacent to the pump station. All electrical and control equipment within the enclosure will be located with easy access for maintenance.

Pump motors, discharge piping and valves, and monitoring and sampling equipment will be located on the deck area over the clear well. The PWPS will be rectangular in shape with the plan dimensions being determined based on pump and other equipment space requirements in the pump deck area and to a secondary extent, storage volume in the clear well. A physical footprint of approximately 30 feet by 40 feet is being provided for the pump station within the AWP Facility. The depth from the top of the deck to the invert of the clearwell will be approximately 15 feet. (The exact physical size (footprint) of the PWPS and clearwell capacity will be determined during final design.)

The PWPS was designed for a maximum flow of 5.0 mgd.

3.4.2.3. Pump Station Discharge Pipeline

Sizing of the discharge pipeline (forcemain) and selecting the type and size of the pumps present certain challenges. The ground elevation at the PWPS site is about at Elevation 100. There are intermediate high points along the route. Also, friction loss in the pipeline was one of the factors in the determination of the amount of horsepower required. Backflow prevention to the PWPS will be provided by the combination of a check valve on each pump discharge and MCWD's transmission main will have a CCR Title 17 compliant backflow prevention device on each pipeline connecting to the MCWD distribution system.

3.4.2.4. Pump Selection

Pump selection was based on the pipeline size of 24-inch diameter, ground profiles and static lifts (difference in ground elevations between pump station elevation and discharge elevation).

3.4.2.5. Mechanical Design Considerations

3.4.2.5.1. Surge Control

A surge tank will be provided. Detailed hydraulic transient analyses were performed during the final design.

3.4.2.5.2. Valves and Appurtenances

Each pump discharge will have a manual isolation butterfly valve and a check valve. Due to the high discharge head and potential surge conditions, it is anticipated that the check valve will be the double-door, fast-acting, silent type. A manual isolation butterfly valve will also be provided on the discharge header downstream of the flow meter to isolate the meter from the transmission line.

Each pump discharge will also have an air release valve to release air on pump start-up. Air release valves will also be provided on the pump discharge header at high points where air may accumulate.

3.4.2.5.3. Electrical Design Considerations

Power supply to the motors will be 480-Volt, 3-phase, 60-Hertz power fed from a motor control center (MCC) located within an electrical equipment enclosure. A new additional power supply is required for the AWP Facility and PWPS. The Pacific Gas and Electric Company (PG&E) or the Monterey Regional Waste Management District will provide this new service.

3.4.2.6. Instrumentation, Monitoring and Control Design Considerations

3.4.2.6.1. Pump Control

The PWPS pumps will be automatically controlled by the water level in the clear well. In that way, the pumps will match the combined water supply rate from the AWP Facility. Manual pump start and stop and speed control will also be provided at the AWP Facility by the Programmable Logic Controller (PLC).

Control interlocks with other systems will be as follows:

- All of the PWPS pumps will be automatically stopped on high pressure in the product water conveyance pipeline, or low level in the pump station clearwell.
- All of the PWPS pumps will be automatically stopped on detection of critical alarm conditions at any of the upstream or downstream conveyance systems.

Under any of the hydraulic or process performance alarm conditions that would shut down the pumps, the product water would be routed to M1W’s ocean outfall, headworks, or SVRP storage pond until the alarm conditions have been addressed and cleared.

3.4.2.6.2. Monitoring

The following monitoring tasks were considered:

- The water level in the clearwell will be continuously monitored using an ultrasonic level sensor, with separate float switches for high and low level alarms in the event of failure of the level sensor. The water level signal will be used for pump control as described above.
- A magnetic flow meter will be provided on the PWPS discharge header to measure pump flow rate. The flow signal will be used for regulatory and product water inventory record keeping, for PWPS monitoring, and for pump control as described above.
- A pressure transducer will be provided on the PWPS discharge header to continuously measure header pressure for the purposes of monitoring pump operation and head conditions in the transmission system.
- A locally indicating pressure gauge will be provided on the discharge header and on each pump discharge.

3.4.2.6.3. Equipment Protection

The following equipment protection measures will be considered in the final design:

- Monitoring of motor winding and bearing temperature with automatic pump shutdown on high temperature condition.
- Due to the relatively high operating pressures, providing pump vibration monitoring with automatic pump shut down on high vibration condition.

3.4.2.7. Design Criteria

Design criteria for the PWPS are presented in **Table 3-38**.

3.4.3. Reliability centered maintenance

M1W is currently conducting a failure modes effects analysis in order to develop a condition based maintenance monitoring plan, which will be tied into their process plan, for reliability centered maintenance. This asset management plan will prioritize maintenance based on maintaining reliability in the system, and will take into account cascading effects that lack of maintenance could have on process performance.

Table 3-38: Product Water Pump Station Design Criteria

Parameter	Units	RUWAP Alignment
Pump Units		
Type	---	Vertical Turbine
Total/Duty/Standby	Number	4/3/1
Design capacity per pump	gpm	1,160
Pump operation	---	Variable
Pump Motors		
Size, each unit	hp	200
Drive type	---	Variable Frequency Drive
Synchronous speed	rpm	1,800

3.4.4. Purified Water Reservoir

The purified recycled water reservoir is owned by MCWD but shared with M1W, and located at the shared Blackhorse site, which is east of General Jim Moore Boulevard and approximately 8 miles from the AWP Facility's PWPS (**Figure 3-6**). In M1W's AWP Facility design drawings, the reservoir is referenced as the Purified Water Reservoir, while in MCWD's Title 22 Engineering Report, it is called the Blackhorse Reservoir. The Reservoir is connected to the Project's Conveyance Pipeline and provides pressure control and flow equalization for the overall purified water system. Purified recycled water from the AWP Facility is pumped into the conveyance pipeline and flows to the Blackhorse Reservoir and to the Project's Seaside Basin Injection Facilities. Purified water flows by gravity from the Blackhorse Reservoir to the injection facilities. A schematic showing the location of the shared Blackhorse Reservoir site relative to the AWP Facility Product Water Pump Station (PWPS) and the Injection Facilities is shown in **Figure 3-6**.

In addition to providing purified recycled water for groundwater replenishment, the Project will provide purified recycled water to MCWD for landscape irrigation through MCWD's Recycled Water Project (RWP). The purified water from the AWP Facility will share a single Conveyance Pipeline system, from which water is used for groundwater injection and irrigation. MCWD is responsible for conveyance and distribution of recycled water for non-potable purposes (more information can be found in MCWD's Title 22 Report). The shared facilities between the Project and the RWP are approximately 50,000 feet of 16 to 24-inch diameter transmission mains and one 2.0 million-gallon storage tank (i.e., the Blackhorse Reservoir). Initially, the RWP will receive up to 600 AFY of purified water for irrigation demands.

MCWD is responsible its RWP system design to deliver purified recycled water to irrigation customers. CCR Title 17 compliant backflow prevention devices will be installed at each connection to the transmission main. Where distribution mains (8-inch to 12-inch diameter) connect to the transmission main, a Double Check Valve Backflow Prevention Assembly (per AWWA Standard C510), will be installed. Where 1-inch diameter irrigation services connect directly to the transmission main, a Reduced-Pressure Principle Backflow Prevention Assembly (per AWWA Standard C511) will be installed.

3.4.4.1. Reservoir Description

The 2.0 MG Blackhorse Reservoir is a covered welded steel reservoir which provides pressure control, flow equalization and operational storage for the Project. The reservoir is designed in accordance with American Water Works Association (AWWA) Manual of Practices M42 for Steel Water Storage Tanks and constructed in accordance with AWWA Standard D100 for Welded Carbon Steel Tanks for Water Storage. The tank diameter is 104.5-feet, with an outside wall height of 35-feet. The operational storage capacity of the Reservoir is 1.8 MG.

The reservoir has one common 24-inch diameter inlet/outlet pipe connecting the reservoir to the conveyance pipeline and within the reservoir there is a Tidelfex mixing system consisting of multiple inlets and outlets. The direction of flow into or out of the reservoir is controlled by the difference between the supply from the AWPF and the demands from the Injection Facilities and the MCWD RWP.

The Blackhorse Reservoir has an emergency water supply through an air gap from a nearby potable water tank and booster pump but is only needed for construction testing of MCWD's conveyance facilities. This emergency potable water supply, which can only be manually operated, will not be used once M1W's AWP Facility starts up. To prevent unintentional use, a steel flange plate with padlocks will be installed at the emergency water supply air gap, requiring it to be manually unlocked. If future use of this emergency water supply at the reservoir is needed by M1W, approval to add this potable supply into the reservoir will first be obtained from DDW and the Regional Water Board through submittal of revisions.

3.4.4.2. Reservoir Operational Strategy

The Blackhorse Reservoir "floats" on the system, meaning the water level is based on flow rate from the AWP Facility PWPS, injection well demand flow rate, and MCWD customer irrigation demand flow rate. M1W operates and controls flow rates of the AWP Facility pump station and injection wells. Adjustments in M1W's operation allow the reservoir elevation to increase or decrease, causing flow to go into and out of the reservoir.

As discussed with the Reservoir design criteria (**Section 3.4.3.1**), the Blackhorse Reservoir has one common inlet and outlet pipe connecting the reservoir to the conveyance pipeline. To encourage mixing within the reservoir, a Tideflex mixing system that provides separate inlet/outlet locations within the reservoir is included to ensure mixing during each drain/fill cycle, thereby preventing temperature and water quality stratification.

The detention time of water in the Reservoir will be managed through increasing and decreasing production at the AWP Facility to provide turnover in the Reservoir and to regulate the average detention time in the reservoir to 3 to 5 days. The initial injection well demand will be relatively constant at approximately 3 mgd. On a weekly basis, the AWP Facility will operate at reduced production rates (~1.5 mgd) that are lower than the injection rates, to reduce the level in the Purified Water Reservoir to the low level setpoint. Following drawdown of the Reservoir, AWP Facility operators will increase AWP Facility production to rates (~4.5 mgd) that are higher than the injection well demands to increase the water level in the Reservoir to the high level setpoint. Flows from the AWP Facility will be then adjusted to lower the Reservoir level back down for steady state, automatic operation. This operation will reduce water age in the Reservoir.

In automatic Reservoir operation, the water level in the reservoir is allowed to vary within operational range setpoints. Through feedback control, the SCADA system communicates the water level in the reservoir to the AWP Facility source water pump station, which automatically adjusts AWP Facility production rate. If the level rises too high, the AWP Facility production rate is reduced or shutdown. If the reservoir level drops too low, AWP Facility production rate is increased.

As discussed in **Section 3.2.7.2.1**, a combined chlorine residual will be maintained in the product water leaving the AWP Facility to control biofilm growth in the conveyance pipeline and injection wellhead. The target chlorine residual concentration at the injection wellhead is 2-4 mg/L as Cl_2. If the chlorine residual at the injection wellhead drops below this target due to low chlorine residual in the water from the Blackhorse Reservoir, the detention time in the reservoir can be reduced by decreasing production at the AWP Facility and/or increasing the chlorine dose at the PWPS. Chlorine residual at the injection wellfield will be measured continuously with two amperometric analyzers, and recorded through the AWP Facility's SCADA system.

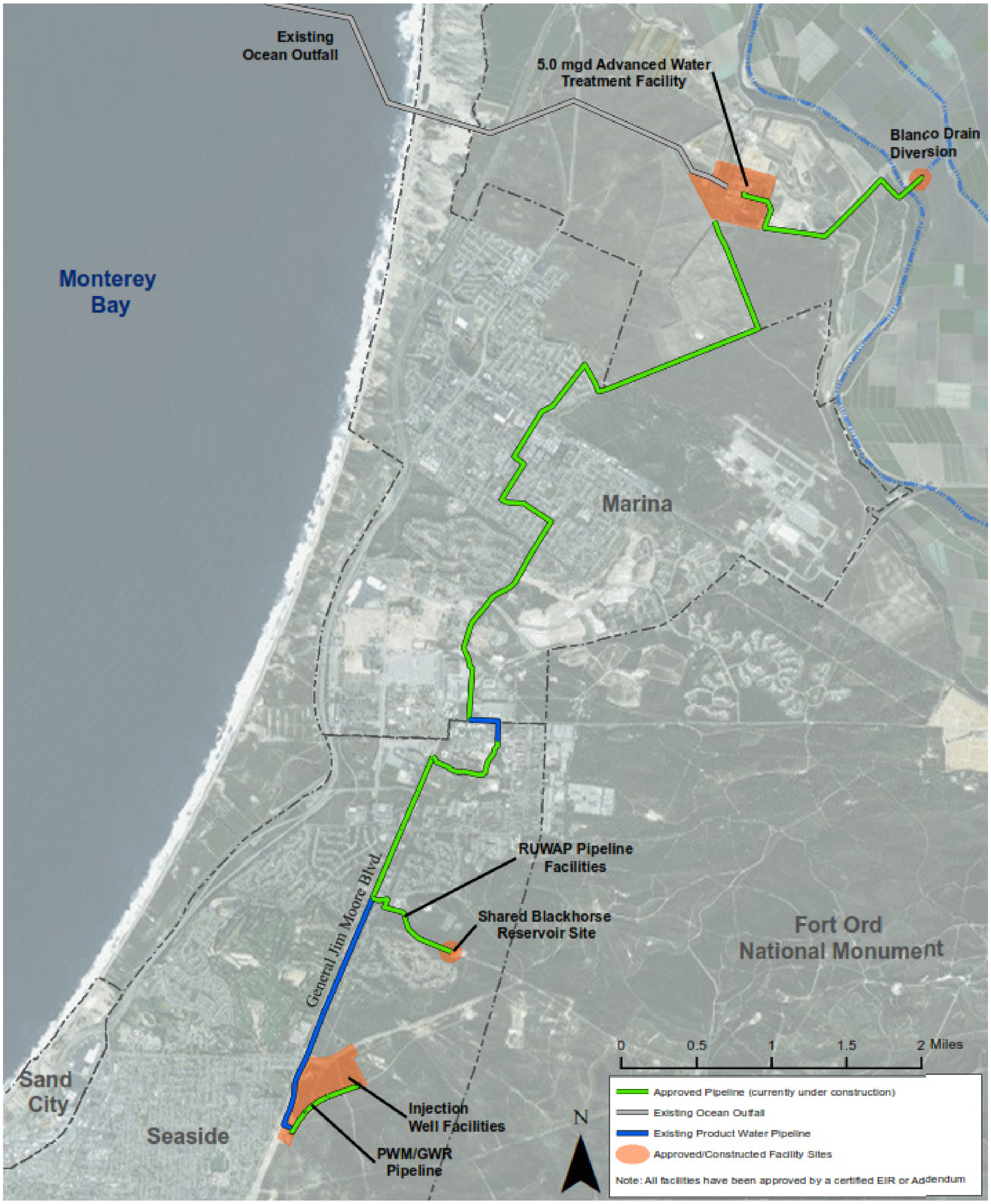


Figure 3-6. Product Water Transmission Facilities

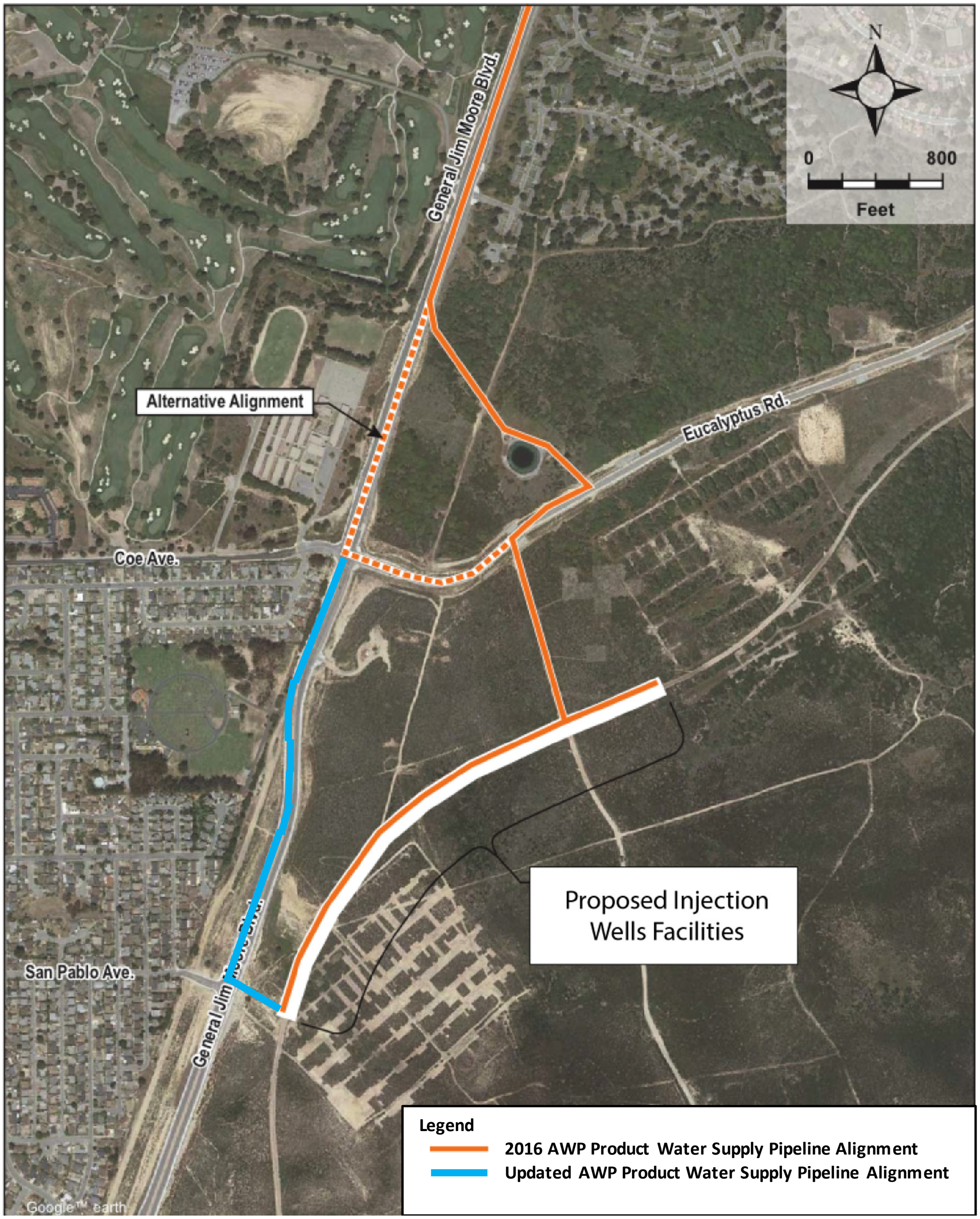


Figure 3-7. Map of AWP Facility Product Water Supply Pipeline to Proposed Injection Well Facilities

3.5. INJECTION FACILITIES

The Injection Facilities are constructed along a strip of land on the eastern boundary of the City of Seaside, about 1.5 miles inland from Monterey Bay (**Figures 3-6** and **3-7**). As discussed in more detail in **Section 9**, the area is located within the Northern Inland Subarea of the Seaside Basin. Facilities are located within an approximate 150-foot-wide corridor of land about 3,000 feet long, as shown by blue highlighting on **Figure 3-8**. This corridor is referred to herein as the Injection Facilities area or site.

The southwestern edge of the Injection Facilities area is approximately east 500 feet of General Jim Moore Boulevard, near the intersection with San Pablo Avenue (**Figure 3-8**). From that point, the area curves northeastward and upslope approximately 3,000 feet along two parcel boundaries, generally following existing unimproved roads of former Fort Ord lands. The northeastern edge of the site is approximately 2,200 feet east of General Jim Moore Boulevard and 1,200 feet south of Eucalyptus Road (**Figure 3-8**).

The Injection Facilities area covers a narrow strip of land within two larger parcels that are currently under the control of FORA. These parcels are scheduled to be conveyed to the City of Seaside for redevelopment upon completion of all remedial activities. Injection facilities have been located along parcel boundaries to minimize interference with future land use plans.

Injection Facilities include the following components (**Figure 3-8**):

- Two deep injection wells (DIW-1 and DIW-2).
- Two vadose zone injection wells (VZW-1 and VZW-2).
- Four monitoring well clusters (MW-1S/1D, MW-2S/2D, MW-1AS/1AD, MW-2AS/2AD).
- A shallow basin for discharge of well back-flushing water (back-flush basin).
- Water supply lines, electrical facilities, and other supporting appurtenances.

The PWM Project includes a total of four injection wells. Two DIWs (DIW-1 and DIW-2) will inject approximately 70 percent of the purified recycled water directly into the Santa Margarita Aquifer. Two VZWs (VZW-1A[20] and VWZ-2) will inject approximately 30 percent of purified recycled water in the unsaturated Aromas Sand Formation for percolation to the underlying Paso Robles Aquifer[21]. DIW-1 was installed and tested in 2017 during the first phase of construction (Phase 1). DIW-2 and VZW-2 were installed and tested in 2018/2019 during the second phase of construction (Phase 2). VZW-1A will be installed under Phase 2 construction in April 2019. Water supply lines, electrical facilities, and other supporting appurtenances are being installed during Phase 2 construction scheduled to be completed in May 2019.

---

[20] The original VZW-1 was not successfully drilled to target depth using the auger method, and the borehole was abandoned. VZW-1A will be drilled using the reverse rotary method (similar to VZW-2) adjacent to the abandoned VZW-1 borehole.

[21] Approximate distribution of purified recycled water between DIWs and VZWs reflects the Project goal of recharging 70 percent into the Santa Margarita Aquifer and 30 percent into the Paso Robles Aquifer.

Article 5.2 Section 60320.226 (Monitoring Well Requirements) of the Recycled Water Regulations states that at least two monitoring wells must be constructed downgradient of the Project for each aquifer receiving Project recharge water. The first monitoring well shall be located between 2 weeks and 6 months travel time from the Project; the second well shall be located between the first monitoring well and nearest drinking water well, and at least 30 days upgradient of the drinking water well. To comply with the recycled water recharge regulations and account for anticipated variable flowpaths to the nearest drinking water wells, M1W has installed four groundwater monitoring well clusters to monitor the two aquifers receiving injection. As shown on **Figure 3-8**, the monitoring wells are located between the injection wells (DIWs and VZWs) and the nearest drinking water wells to the west and northwest of the Injection Facilities Area. Each monitoring well cluster consists of a shallow monitoring well screened in the Paso Robles Aquifer (designated with the letter "S") and a deep monitoring well screened in the Santa Margarita Aquifer (designated by the letter "D"), for a total of eight (8) monitoring wells. Monitoring Well Cluster 1 (i.e., MW-1S and MW-1D) was installed in 2017 during Phase 1 construction, while the three other monitoring well clusters (MW-2S/2D, MW-1AS/1AD, and MW-2AS/2AD) were installed and developed in 2018/2019 during Phase 2 construction.

Additional wells may be required for Project operation in the future, depending on the operational efficiency of the injection wells over time. Well installation has been conducted using a phased approach. Additional operational considerations are discussed in **Section 8**.

In addition to land use considerations, the Injection Facilities area was selected using the following hydrogeologic criteria for injection into Seaside Basin aquifers:

- Upgradient of existing CalAm production wells for efficient recovery of recharged product water that has comingled with both native groundwater and Monterey Peninsula Aquifer Storage Recovery (ASR)-injected water from the Carmel River system.
- Within areas of favorable aquifer properties for replenishment and groundwater production, such as relatively high transmissivity and sufficient aquifer thickness.
- Sufficiently deep water table to provide a large local storage volume.
- Close to pumping depressions[22] to provide replenishment water to areas of declining water levels.

The design criteria for the 4.0 mgd injection system remains the same, as the additional 1.0 mgd of capacity added to the AWP Facility will be diverted from the conveyance pipeline to MCWD prior to the injection system.

[22] Groundwater elevation contour maps illustrating areas of pumping depressions are presented in **Section 9** of this report.

Figure 3-8
GWR Project Wells
Injection Facilities Area

3.5.1. Injection Wells

The conceptual layout and preliminary design for the Project injection wells are based, in part, on the amount of product water available for replenishment and the local hydrogeology. In general, the Project proposes to inject an annual average of 3,500 AFY into two aquifers, the shallower Paso Robles Aquifer and the deeper Santa Margarita Aquifer, both of which provide water supply from existing extraction wells. Vadose zone wells will be used for injection into the relatively shallow unconfined Paso Robles Aquifer. Deep injection wells will be used for injection into the deeper semi-confined to confined Santa Margarita Aquifer. **Figure 3-8** shows the proposed locations for four vadose zone wells and four deep injection wells within the Injection Facilities area.

The average annual injection amount of 3,500 AFY will be allocated between the two aquifers in a manner consistent with the estimated amount of local extraction from each aquifer, taking into consideration anticipated underground retention times (and pathogen reduction credits) of recycled water to the nearest drinking water wells in each aquifer. The target allocation includes approximately 30% (1,050 AFY) into the unconfined Paso Robles Aquifer and approximately 70% (2,450 AFY) into the Santa Margarita Aquifer. **Section 8** provides more information on the total injection amounts and how the amounts vary with Project operation. **Section 9** describes the hydrogeologic framework and provides more detail on the two targeted aquifer systems. General injection well specifications are summarized in **Table 3-39** as follows.

Table 3-39: Injection Well Specifications

Project Specification[a]	Paso Robles Aquifer	Santa Margarita Aquifer
Recharge Method	Vadose Zone Well	Deep Injection Well
Groundwater Occurrence	Unconfined	Semi-Confined to Confined
Transmissivity	659 to 1,524 ft^2/day	11,377 to 21,878 ft^2/day
Hydraulic Conductivity	20 ft/day	63 ft/day
Number of Wells	2	2
Injection Capacity per Well	500 gpm	1,000 gpm
Total Injection Capacity	1,000 gpm	2,000 gpm
Extraction Capacity per well (for well maintenance)	N/A	2,000 gpm

a. Square feet per day - ft^2/day; Feet per day – ft/day.

The injection well locations are shown on **Figure 3-8** along with other project components including the back-flush basin and monitoring wells. Ground surface elevations, depth to water and aquifer depths are summarized in **Table 3-40** below.

Table 3-40: Project Injection Wells

Project Injection Well	Ground Elevation ft-msl[d]	Groundwater Elevation[a,b] ft-bgs[e]	Depth to Water[b] ft-bgs[e]	Paso Robles[c] Depth to Top ft-bgs[e]	Paso Robles[c] Depth to Base ft-bgs[e]	Santa Margarita[c] Depth to Top ft-bgs[e]	Santa Margarita[c] Depth to Base ft-bgs[e]	Well Depth ft-bgs[e]
Santa Margarita Deep Injection Wells (DIW)								
DIW-1	401	-24	425	345	525	525	725	830
DIW-2	361	-15	376	290	420	420	625	635
Paso Robles Vados Zone Wells (VZW)								
VZW-1A	401	-24	425	345	525	525	725	200
VZW-2	361	-15	376	290	420	420	625	100

a. Water Levels measured during aquifer testing.
b. Groundwater elevation and depth to water represents the water table for VZW and the Santa Margarita potentiometric surface for DIWs.
c. Aquifer geometry based on lithologic samples and geophysical logs from drilling of DIW-1/MW-1D and DIW-2/MW-2D
d. feet-msl=feet above mean sea level
e. feet-bgs=feet below ground surface

3.5.1.1. Deep Injection Wells

Key considerations for the design of the deep injection wells include:

- Sufficient capacity to accommodate delivered product water from the AWP Facility.
- Sufficient number of wells to allow for offline well maintenance and repairs.
- Adequate well spacing to minimize hydraulic mounding interference with adjacent deep injection wells or nearby ASR wells.
- Located close enough to existing production wells to allow for the efficient recovery of injected water.
- Located ample distance from downgradient production wells to comply with regulatory requirements regarding underground retention times for pathogen removal credit and response retention time (see **Sections 5 and 6**).

The manner in which these design considerations were incorporated into the Project is summarized in the following subsections.

3.5.1.1.1. Deep Injection Well Capacity

MPWMD has installed four successful deep injection (and recovery) wells (ASR-1 to ASR-4 on **Figure 3-8**) at the nearby ASR project that are capable of sustained injection rates of about 1,500 gpm. Unlike ASR wells, the Project's deep injection wells will receive product water on a more continuous basis, will require a more consistent injection rate over time, and will not be used for recovery of injected water (although some pumping will occur for well maintenance), which will be accomplished through existing downgradient production wells.

In consideration of these factors, a design injection rate of 1,000 gpm – lower than the ASR rate of 1,500 gpm – was selected to accommodate planned injection volumes for the Santa Margarita Aquifer . This rate minimizes local mounding and long-term stress on the wells. Wells were constructed using a phased approach (see **Section 8**).

3.5.1.1.2. Number of Deep Injection Wells

As discussed in more detail in **Section 8**, there will be some time periods when a maximum of 3,700 AFY of recycled water may be available for Seaside Basin recharge (more than the average of 3,500 AFY). The collective capacity of the deep injection wells must be capable of accepting the maximum daily injection rate for the Santa Margarita Aquifer, estimated at 1,821 gpm (based on 70 percent recharge goal for the Santa Margarita Aquifer and back-flushing). With a design injection capacity of 1,000 gpm/well, two deep injection wells with a total design capacity of 2,000 gpm are required. Based on aquifer pumping tests of DIW-1 and DIW-2 performed to date, the two injection wells are expected to have injection capacities well in excess of 1,000 gpm each (for a total injection capacity exceeding 2,000 gpm). The extra injection capacity is desirable to account for well maintenance/down time and potential decreases in well capacity over time.

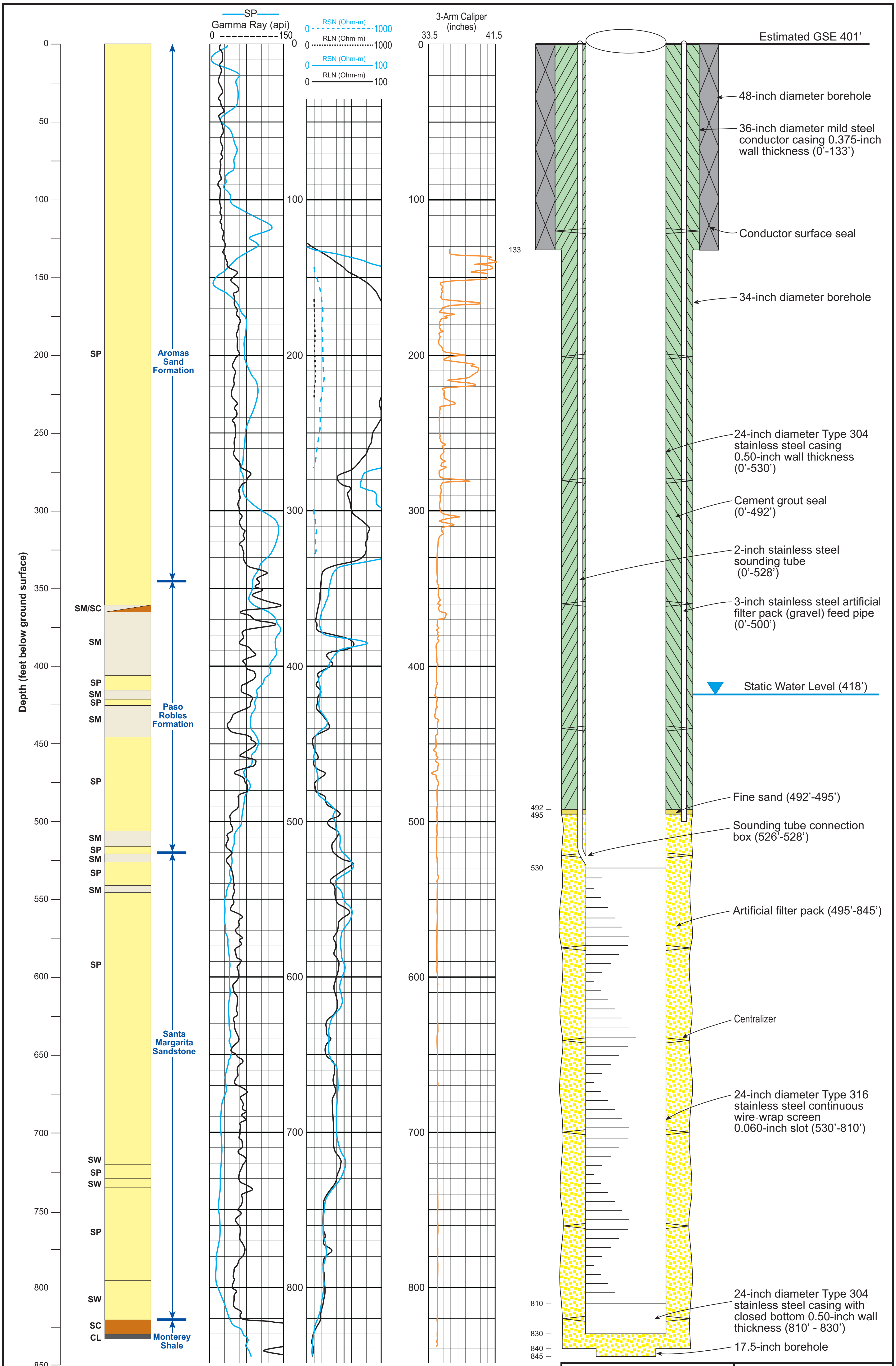
3.5.1.1.3. Location and Spacing of Deep Injection Wells

The location and spacing of the deep injection wells were selected based on both technical and regulatory considerations. As shown on **Figure 3-8**, the spacing between the deep injection wells is 1,085 feet. Similar spacing is also maintained between the deep injection wells and the closest downgradient production wells (ASR-1/2). Because the injection wells will be operated continuously (except during routine maintenance), water levels are expected to rise or "mound" around the injection wells, which expands over time until steady state conditions are reached. As these groundwater mounds overlap in the subsurface, hydraulic gradients increase and injection rates may decrease as the well becomes less efficient. Increased spacing between wells (based on the aquifer's hydraulic properties) can minimize the impacts of this hydraulic interference. In addition, the spacing between the injection wells and downgradient production wells is considered to balance the timely recovery of product water with underground retention times as required by the Title 22 Criteria (see **Sections 5 and 6**).

3.5.1.1.4. Deep Injection Well Design

Well designs for both Project deep injection wells were developed based on lithologic and geophysical logs collected during drilling of adjacent deep monitoring wells (MW-1D and MW-2D). Final designs for DIW-1 and DIW-2 are shown on **Figures 3-9** and **3-10**, respectively.

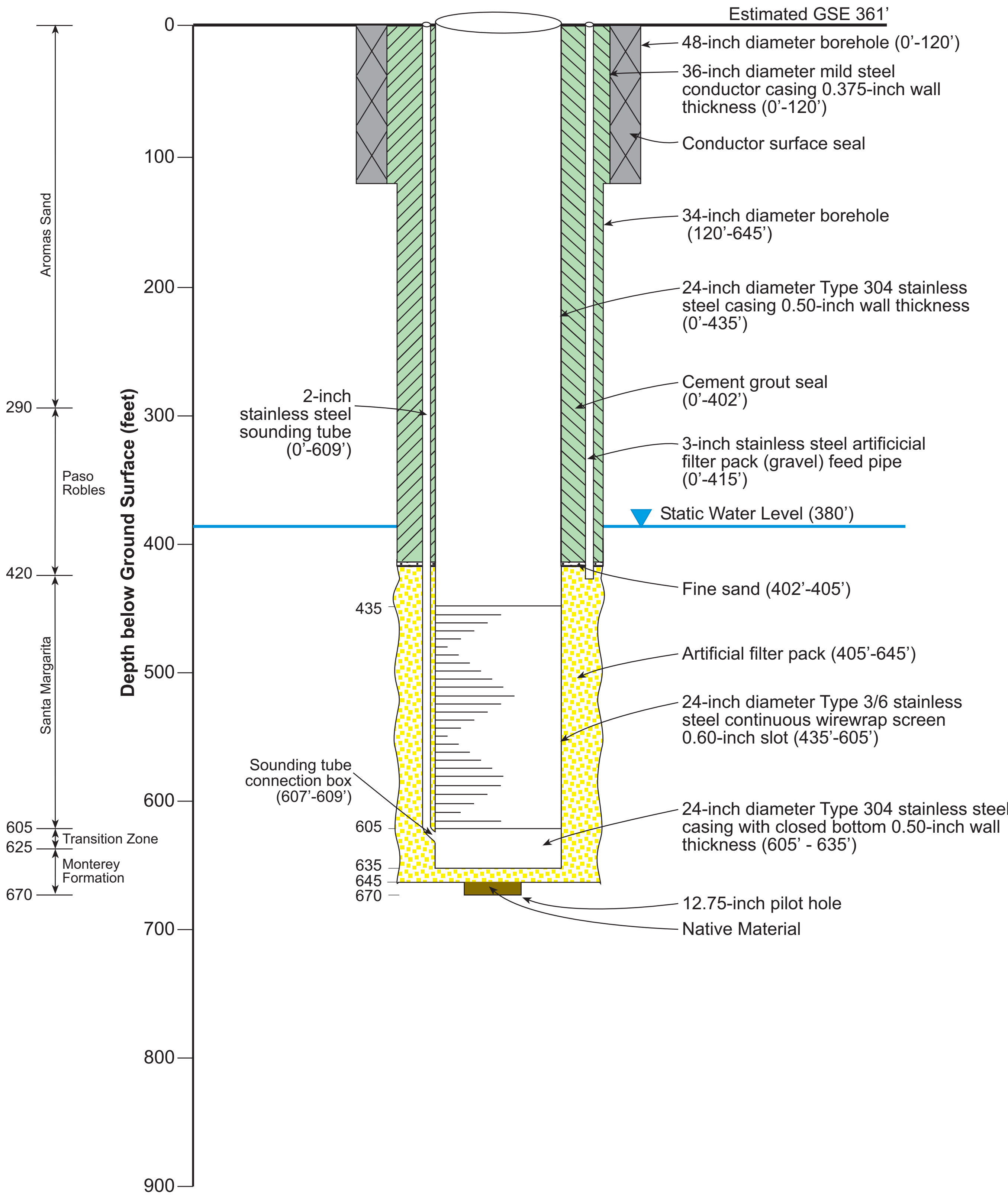
Wells will be equipped with a downhole flow control valve to allow both injection and extraction to occur in each well. Each well will have a pump and motor to allow pumping for well maintenance at a projected rate of up to 2,500 gpm. Pumped water will be discharged to a separate backflush pipeline to transmit water to the backflush basin, described in more detail in the following subsections.



January 2018

TODD GROUNDWATER

Figure 3-9
Lithologic Log, Geophysical Log, and Well Profile DIW-1



TODD GROUNDWATER

Figure 3-10
Final Design
DIW-2

3.5.1.2. Vadose Zone Wells

Similar to deep injection wells, well capacity and well spacing are also key considerations for vadose zone wellfield design. However, pathways and transport of the product water to the water table and to subsequent downgradient extraction wells are also considered. Recent data from a M1W field program were used to analyze a preliminary vadose zone well design and operational parameters for the Project. Complete results of the field program are presented in a separate report, attached to this Engineering Report as **Appendix I** (Todd Groundwater, 2015b). The locations of the two vadose zone wells (VW-1A and VZW-2) are shown on **Figure 3-8** and discussed in more detail below.

3.5.1.2.1. Well Capacity

M1W collected site-specific data during a 2013-2014 field program to better assess potential injection capacity and optimize vadose zone well design for recharging the Paso Robles Aquifer. Based on core samples and geologic logging in monitoring well M1W MW-1, the vadose zone appears more homogeneous and permeable than the underlying saturated zone of the Paso Robles Aquifer. Hydraulic conductivity data from core samples indicate the potential for high injection rates.

3.5.1.2.2. Number of Vadose Zone Wells

Vadose zone wells must accommodate the maximum delivery of product water into the Paso Robles Aquifer, estimated at 638 gpm (based on 30 percent recharge goal for the Paso Robles Aquifer, incorporating backflushing of DIWs). With a design injection capacity of 500 gpm/well, two vadose zone wells with a total design capacity of 1,000 gpm are required.

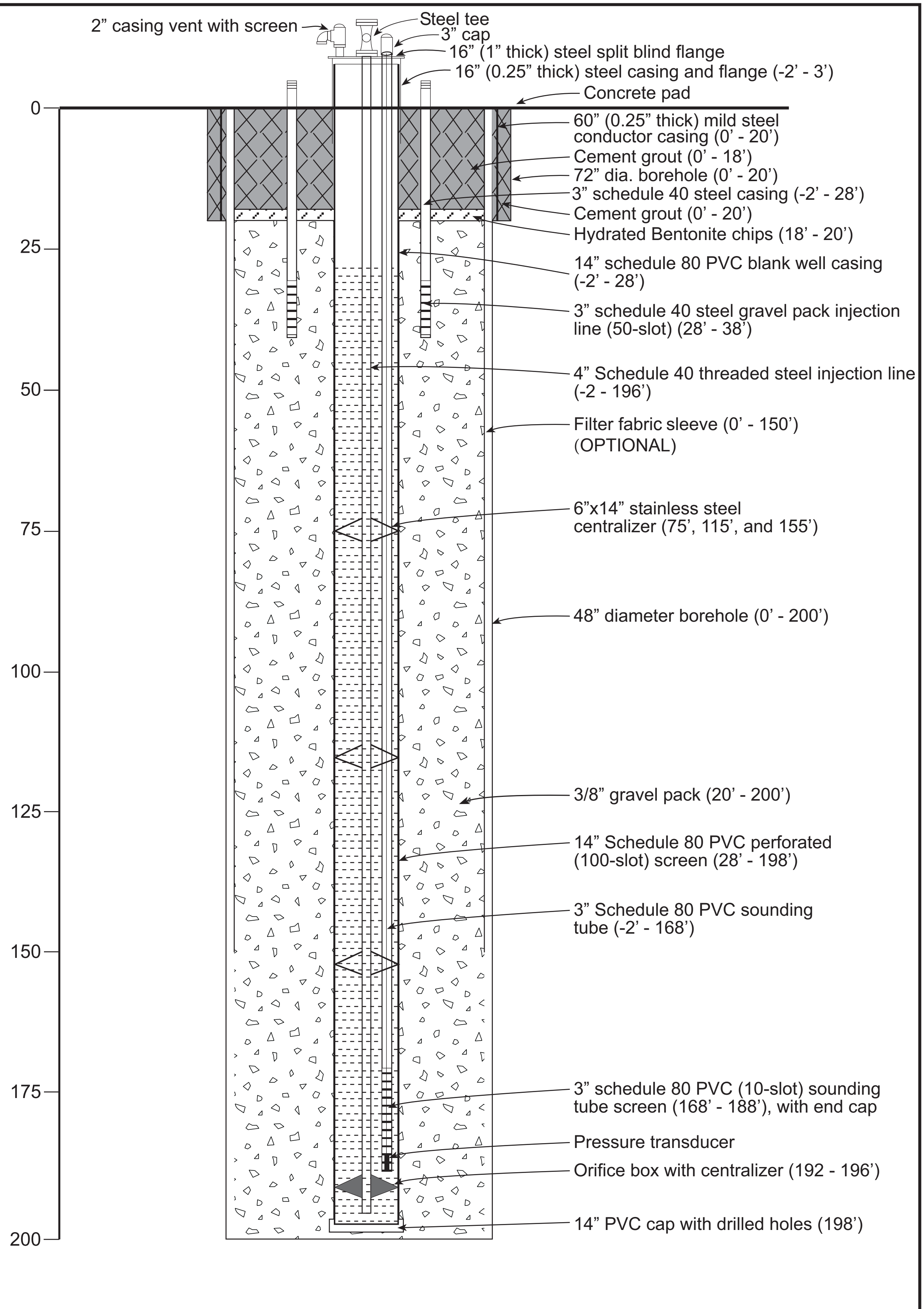
3.5.1.2.3. Spacing and Location of Vadose Zone Wells

Similar to the deep injection wells, the vadose zone wells are spaced approximately 1,000 feet apart (**Figure 3-8**). The locations of the vadose zone wells along the 3,000-foot Injection Facilities area are less sensitive to the spacing criteria for deep injection wells. Travel time from vadose zone wells to downgradient production wells is much slower than from the deep injection wells. This is due to the increased travel time associated with vadose zone transport and slower average linear groundwater velocities in the Paso Robles Aquifer (due to lower permeability). In addition, the relatively low recharge volumes reduce the potential for significant well interference among closely-spaced wells. Additional information on travel time is provided in **Section 5**. Additional information on recharge volumes is provided in **Section 8**.

3.5.1.2.1. Vadose Zone Well Design

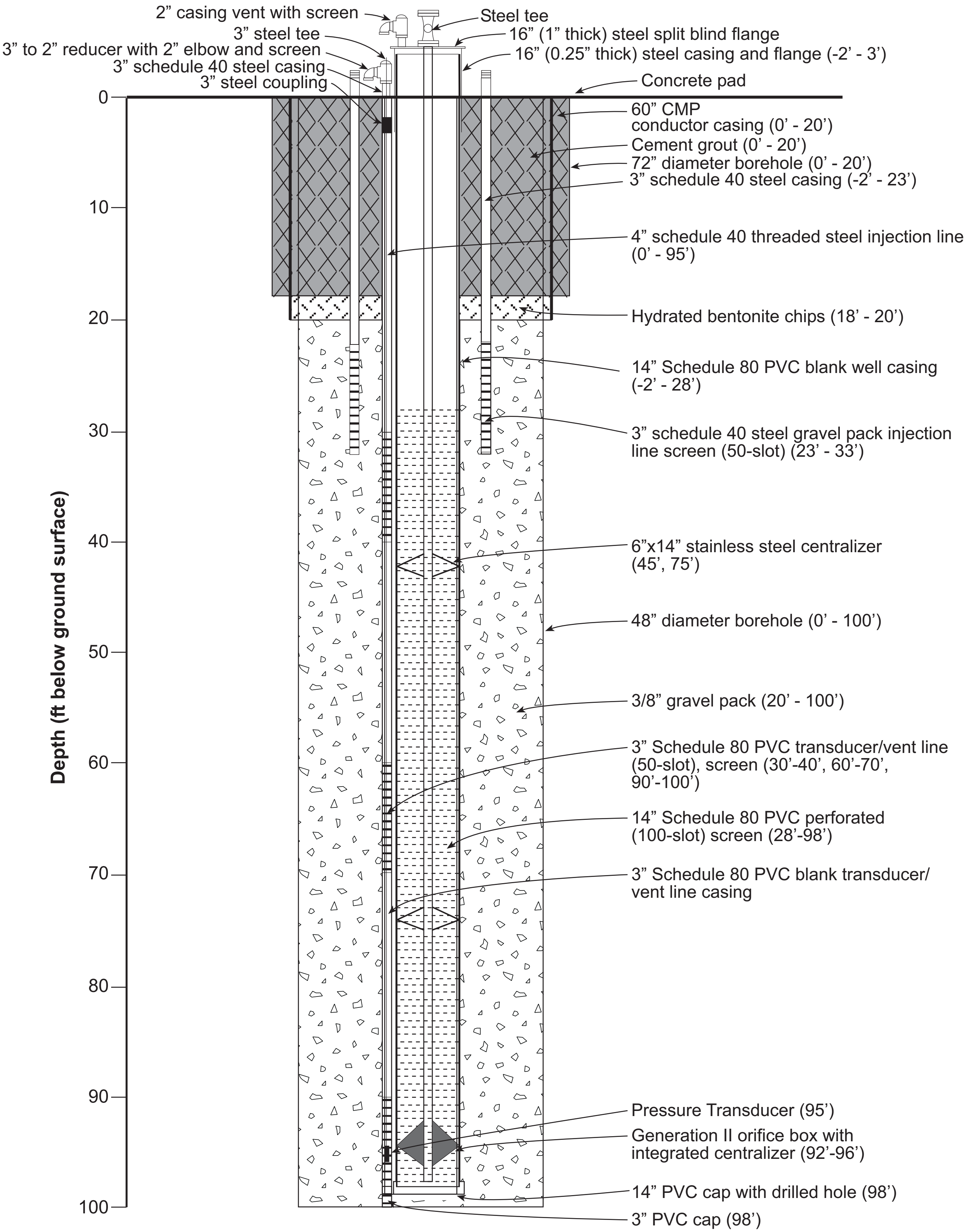
Well designs for both Project vadose injection wells are shown on **Figures 3-11 and 3-12** were developed based on VZW designs at the City of Scottsdale (Arizona) Water Campus and the lithologic and geophysical logs collected during drilling of adjacent monitoring wells (MW-1D and MW-2D). Wells have been designed to accept recycled water via a 4-inch PVC casing referred to as an eductor line installed to the bottom of the well to prevent cascading water and air entrainment. The well design also incorporates transducer tubes, ventilation lines, and lines to access the gravel pack.

VZW-2 was successfully installed in 2019 to a depth of 100 feet and successfully tested at 350 gpm. VZW-1A will be installed in April/May 2019 to a target depth of 200 feet to provide additional well injection capacity.



TODD GROUNDWATER

Figure 3-11
VZW-1A
Recharge
Well Design



TODD GROUNDWATER

Figure 3-12
VZW-2
Recharge Well Design

3.5.2. Back-Flush Basin

Deep injection wells will need to be pumped periodically to mitigate well clogging and to maintain injection capacity, a process known as back-flushing. To provide a location and mechanism to discharge the pumped water, a shallow basin will be constructed at the southern end of the Injection Facilities area. Water will be piped to the basin from the deep injection wells, allowed to infiltrate the permeable sediments on the open basin bottom, and percolate down to the water table. By allowing the water to recharge, pumped water will be conserved. Vadose zone wells do not penetrate the saturated zone and are not involved in the back-flushing process.

The proposed basin has been sited southwest of DIW-2 (**Figure 3-8**) to take advantage of a natural depression east of General Jim Moore Boulevard north of San Pablo Avenue. **Figures 3-13** and **3-14** shows the Site, Grading, and Drainage Plan. The basin covers a footprint of approximately 150 feet by 120 feet and is approximately 12 feet deep. The back-flush basin has a storage volume of 2.1 AF. Discharge water will be pumped from each deep injection well to a 16-inch backflush pipeline.

3.5.2.1. Back-flush Basin Design Criteria

The basin will be constructed on the Aromas Sand, which comprises the upper 300- to 400-feet of vadose zone beneath the Injection Facilities area. This geologic unit was recently evaluated during drilling of the nearby monitoring well M1W MW-1 (**Figure 3-8**). Core samples throughout the vadose zone were collected and analyzed for vertical permeability. Laboratory permeability values vary widely from more than 100 feet per day in the most permeable sand zones to less than 0.01 feet per day in silty clay intervals. However, samples above about 295 feet (about 100 feet above the current water table) contain very little fine-grained sediment (silt or clay). The lowest permeability value measured in this section is about 14 inches per hour (or 28 feet per day). MPWMD corroborated this laboratory infiltration rate with observed infiltration rates of about one foot/hour during the first hour of discharge at the existing ASR back-flush basin (located between ASR-1 and ASR-2 and about 1,000 feet from the Project's proposed back-flush basin location, see **Figure 3-8**).

Relatively rapid infiltration rates indicate that the basins will drain sufficiently between discharge events, allowing for drying and periodic tilling to break up any surficial clogging. For planning purposes, a design infiltration rate of six feet per day is assumed. That rate is judged reasonable, given that it is only about 20% of the lowest permeability value recorded in the upper 277 feet of the vadose zone.

3.5.2.2. Back-flushing Rates and Schedule

Back-flushing is typically conducted at pumping rates higher than injection rates. At the nearby ASR wellfield, MPWMD back-flushes the wells at about twice the injection rate. For planning purposes, it is assumed that the Project will also back-flush the deep injection wells at 2,000 gpm – twice the planned injection rate of 1,000 gpm. It is anticipated that each deep injection well will be backflushed for 4 hours per week.

The optimal back-flushing schedule and required pumping volumes will be determined once the injection wells are operational. The nearby MPWMD ASR wellfield site contains a small back-flush basin that holds approximately 240,000 gallons of water to accommodate several hours of weekly pumping. Because the Project recycled water will contain relatively low TSS or TDS, clogging rates of the deep injection wells may be lower than observed at nearby ASR wells.

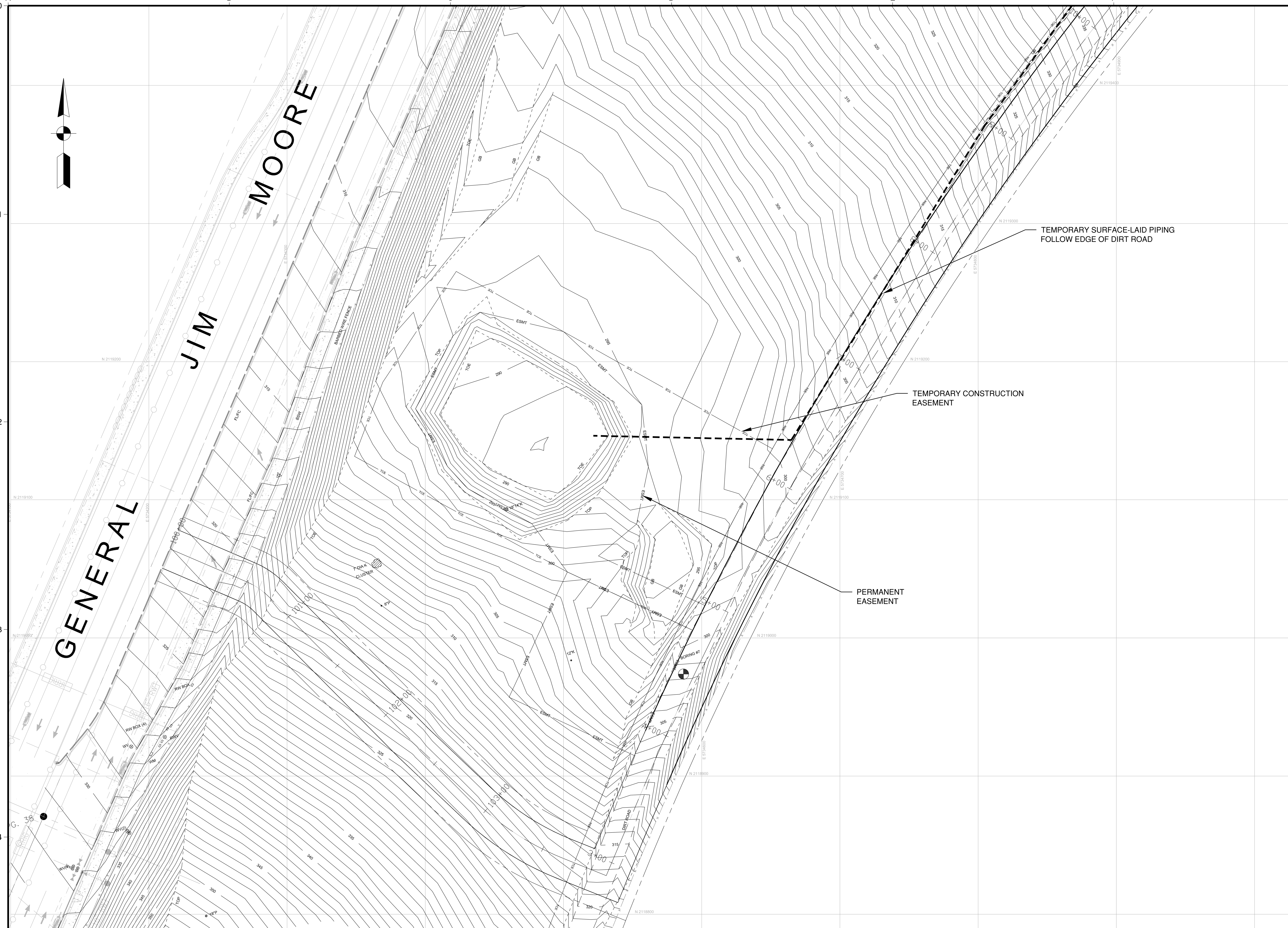
However, because the Project wells are being completed in the same aquifer as the ASR wells, and because the injectate for the ASR project is also relatively low in solids content, weekly pumping for each well at a rate of 2,000 gpm is being assumed for planning purposes. If a well requires four hours of pumping at 2,000 gpm, approximately 480,000 gallons of water will need to be discharged per well per week. This schedule is conservative and may be modified once wells are in operation.

E2 Consulting Engineers developed a preliminary design of the project back-flush basin including an analysis of inflow and outflow to assure sufficient basin capacity (See Table 3-3 in E2, 2014). The basin design may be modified once injection well testing has been completed.

3.5.3. Water Supply Pipelines and Additional Support Facilities

Figures 3-15 through **3-18** shows the Process Flow Diagram, Typical Yard Piping Plan (for original DIW-1 and VZW-1 site; known as Well Site 2), Typical DIW (and VZW-2 Specific) Plan and Sections. Together, the figures illustrate the following water supply pipeline and additional support facility features:

- A 16-inch back-flush pipeline will be connected to the deep injection wells for conveyance to the back-flushing basin. Wells will also be tied into a 18- to 20-inch product water supply pipeline by 12-inch and 6-inch feed lines for deep injection wells and vadose zone wells, respectively. Additional facilities include electrical connections, transformer, and electrical building.
- The 16-inch AWP Facility product water pipeline will be tied to the 20-inch Product Water Distribution Line. The deep injection wells will be connected with a 16-inch backflush pipeline that conveys pumped water to the backflushing basin.
- A well access pad for a vadose zone well and a deep injection well is included with connection to the 18-inch water distribution line and the 16-inch backflush pipeline (deep injection well only). Electrical lines including two power conduits and two instrument conduits are also shown on the diagram. Electrical power connections, as well as a Control and Instrumentation panel will be included at each well site.
- An AC-access road will be constructed from Eucalyptus Road across the Injection Facilities area to allow for service, operation, and well maintenance. Monitoring wells will be constructed both along the Injection Facilities road and downgradient within the proposed City of Seaside redevelopment area. Temporary access roads will be constructed to the monitoring wells. Access to monitoring wells may be modified as development proceeds across the area.



PERMANENT EASEMENT	
NORTHING	EASTING
2119005.58	5734593.47
2119047.76	5734502.80
2119082.80	5734477.00
2119108.06	5734430.92
2119124.22	5734416.04
2119165.88	5734392.97
2119218.79	5734420.14
2119235.79	5734439.72
2119221.76	5734500.01
2119168.78	5734556.70
2119123.74	5734561.42
2119082.40	5734552.85
2119059.37	5734525.26
2119023.51	5734602.34

TEMPORARY CONSTRUCTION EASEMENT	
NORTHING	EASTING
2119005.58	5734593.47
2119047.76	5734502.80
2119131.42	5734348.80
2119185.16	5734369.30
2119265.29	5734422.43
2119132.05	5734659.84

EASEMENT NOTES:
1. PERMANENT EASEMENT IS 20-FT WIDE ENTERING THE SITE
2. PERMANENT EASEMENT FOLLOWS 295-FT ELEVATION CONTOUR.

Figure 3-13

SCALE: 1 INCH = 40 FEET

Schaaf & Wheeler
CONSULTING CIVIL ENGINEERS
3 Quail Run Circle, Suite 101
Salinas, CA 93907-2348
(831) 883-4848

UNDERGROUND SERVICE ALERT
CALL: TOLL FREE
1-800
227-2600
TWO WORKING DAYS BEFORE YOU DIG

NO.	REVISION	DATE	BY
	CONFORMED	4/6/2018	AAS

SCALES
0 — 1"
0 — 25mm
IF THIS BAR IS NOT DIMENSION SHOWN, ADJUST SCALES ACCORDINGLY.

REGISTERED PROFESSIONAL ENGINEER ANDREW A. STERBENZ No. 69703 CIVIL STATE OF CALIFORNIA
12/1/2017

DESIGNED AAS
DRAWN JCT
CHECKED AAS

MONTEREY REGIONAL WATER POLLUTION CONTROL AGENCY
MONTEREY, CA
PURE WATER MONTEREY
GROUNDWATER REPLENISHMENT PROJECT

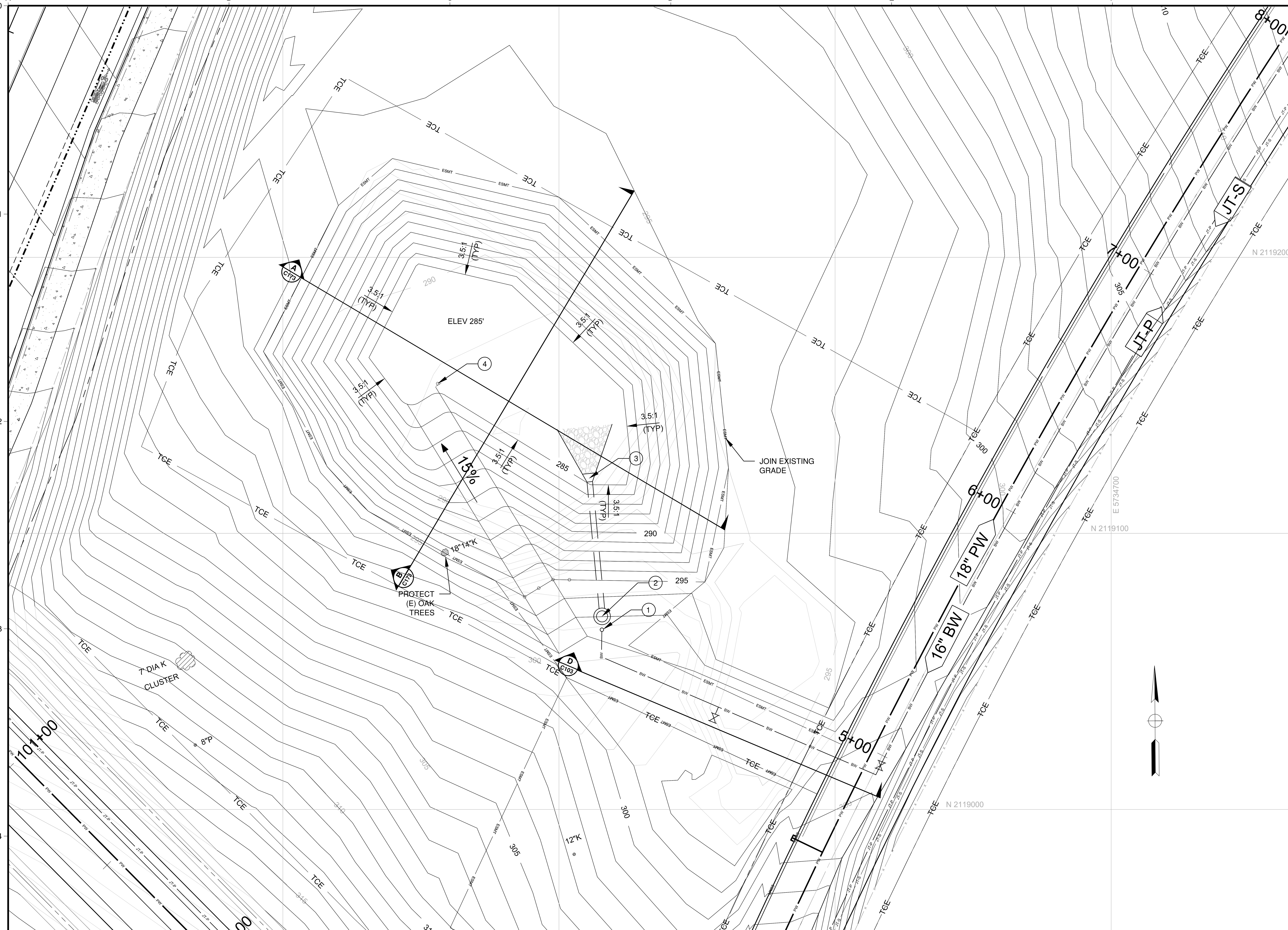
Kennedy/Jenks Consultants
200 Fourth Street, Suite 210, Santa Rosa, CA 95401-8534

INJECTION WELL FACILITIES
PHASE 2

PERCOLATION BASIN
HORIZONTAL CONTROL AND SITE PLAN

FILE NAME 166801202-C-170.DWG
JOB NO. 1668012*02
DATE DECEMBER 2017
SHEET C-170

S:\KJC\01-GWR_Wellfield\Drawings\Phase 2\166801202-C-170.dwg CMURPHY 11/21/2017 5:53 PM



GRADING NOTES

1. DISPOSE OF EXCESS CUT MATERIAL AT WELL SITE 3 (SEE SHEET C-131)
2. PROTECT EXISTING OAK TREES IN-PLACE (SHOWN ON SHEET C-170).
3. DO NOT DISTURB ROADWAY EMBANKMENT SLOPE FOR GENERAL JIM MOORE BLVD.
4. CLEAR ALL SHRUBS AND REMOVE ROOTS WITHIN PERMANENT EASEMENT LIMITS. STOCKPILE BRUSH AND BRANCHES AND CHIP ON-SITE.
5. COMPACT MAINTENANCE RAMP AND ACCESS DRIVEWAY TO 95% MODIFIED PROCTOR.
6. HYDROSEED ALL TCE AREAS FOLLOWING FINAL GRADING.
7. GRADING OF DETENTION BASIN SHALL OCCUR PRIOR TO WELL DEVELOPMENT PUMPING AND TESTING.
8. CONTRACTOR SHALL REMOVED ACCUMULATED FINES AND SCARIFY BASIN INVERT FOLLOWING WELL TESTING. MULTIPLE CLEANING CYCLES MAY BE REQUIRED.

KEY NOTES

1. 16-IN BACK-FLUSH PIPELINE SEE DETAIL 1/C-174.
   CENTER COORD: N: 2119065.2 E: 5734516.0
2. 60-IN INLET MANHOLE, RIM ELEV 298.0', SEE DETAIL 1/C-174.
   CENTER COORD: N: 2119069.9 E: 5734515.6
3. 24-IN HDPE PIPELINE W/ FLARED END SECTION. SEE DETAIL 1/C-174.
   CENTER COORD: N: 2119121.7 E: 5734510.8
4. DEPTH GAUGE SEE DETAIL 1/C-173
   CENTER COORD: N: 2119154.2 E: 5734456.1

PERCOLATION BASIN DESIGN DATA

1. BOTTOM ELEVATION: 285 FT
2. FULL ELEVATION: 295 FT
3. POND VOLUME AT 294 FT: 94,400 CU-FT (2.1 AC-FT)
4. DESIGN INFLOW RATE: 2,624 GPM
5. DESIGN INFLOW DURATION: 4 HOURS
6. DESIGN INFLOW VOLUME: 84,200 CU-FT (1.9 AC-FT)
7. DESIGN PERCOLATION RATE: 6 INCHES PER HOUR
8. TIME TO DRAIN: 18 HOURS

BASIN BOTTOM CORNERS	
NORTHING	EASTING
2119197.65	5734449.18
2119189.80	5734482.94
2119152.12	5734523.25
2119125.50	5734526.04
2119117.55	5734524.39
2119117.67	5734511.43
2119163.68	5734431.18

Figure 3-14

SCALE: 1 INCH = 20 FEET

Schaaf & Wheeler
CONSULTING CIVIL ENGINEERS
3 Quail Run Circle, Suite 101
Salinas, CA 93907-2348
(831) 883-4848

UNDERGROUND SERVICE ALERT
CALL: TOLL FREE
1-800
227-2600
TWO WORKING DAYS BEFORE YOU DIG

USE OF DOCUMENTS

NO.	REVISION	DATE	BY
	CONFORMED	4/6/2018	AAS

SCALES
IF THIS BAR IS NOT DIMENSION SHOWN, ADJUST SCALES ACCORDINGLY.

REGISTERED PROFESSIONAL ENGINEER ANDREW A. STERBENZ No. 69703 CIVIL STATE OF CALIFORNIA 12/1/2017

DESIGNED AAS
DRAWN AAS
CHECKED AAS

MONTEREY REGIONAL WATER POLLUTION CONTROL AGENCY
MONTEREY, CA
PURE WATER MONTEREY
GROUNDWATER REPLENISHMENT PROJECT

Kennedy/Jenks Consultants
200 Fourth Street, Suite 210, Santa Rosa, CA 95401-8534

INJECTION WELL FACILITIES
PHASE 2

PERCOLATION BASIN
GRADING AND DRAINAGE PLAN

FILE NAME 166801202-C-171.DWG
JOB NO. 1668012*02
DATE DECEMBER 2017
SHEET C-171

S:\KJC\01-GWR_Wellfield\Drawings\Phase 2\CONFORMED DRAWINGS\166801202-C-171.dwg CMURPHY 4/2/2018 10:00 AM

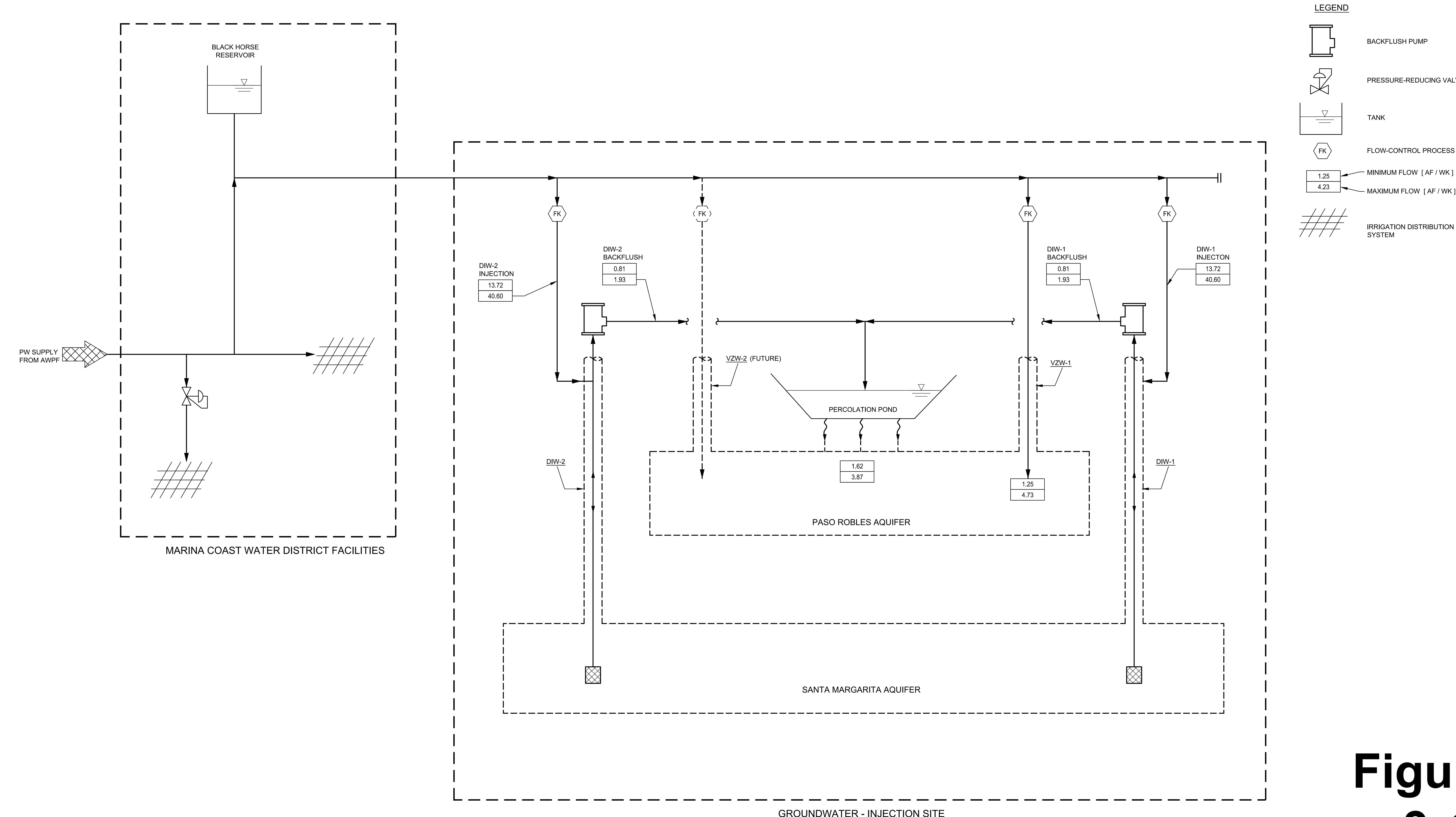


Figure 3-15

USE OF DOCUMENTS

THIS DOCUMENT, INCLUDING THE INCORPORATED DESIGNS, IS AN INSTRUMENT OF SERVICE FOR THIS PROJECT AND SHALL NOT BE USED FOR ANY OTHER PROJECT WITHOUT THE WRITTEN AUTHORIZATION OF KENNEDY/JENKS CONSULTANTS.

NO.	REVISION	DATE	BY
	CONFORMED	4/6/2018	RRH

SCALES

0 — 1"

0 — 25mm

IF THIS BAR IS NOT DIMENSION SHOWN, ADJUST SCALES ACCORDINGLY.

REGISTERED PROFESSIONAL ENGINEER RODMAN R. HOUSER No. C54215 Exp. 12/31/18 CIVIL STATE OF CALIFORNIA

12/1/17

DESIGNED RRH

DRAWN JL

CHECKED RRH

MRWPCA

MONTEREY REGIONAL WATER POLLUTION CONTROL AGENCY
MONTEREY, CA

PURE WATER MONTEREY
GROUNDWATER REPLENISHMENT PROJECT

Kennedy/Jenks Consultants
200 Fourth Street, Suite 210, Santa Rosa, CA 95401-8534

INJECTION WELL FACILITIES
PHASE 2

OVERALL GWR INJECTION FACILITES
PROCESS FLOW DIAGRAM

FILE NAME 1668012_00-G-007.dwg

JOB NO. 1668012*02

DATE DECEMBER 2017

SHEET G-007

pw:\\kjce-pw.bentley.com:kjce-pw\Documents\Clients\Monterey Regional Water Pollution Control Agency\Projects\GWR Injection Well Facilities_1668012.00\10-Design\10.06-Drawings\General\1668012_00-G-007.dwg

Figure 3-16

USE OF DOCUMENTS

NO.	REVISION	DATE	BY
2	DESIGN CLARIFICATION NO 23	3/2019	MJS/MJR
1	DESIGN CLARIFICATION NO 17	10/2018	SLG/MJR
	CONFORMED	4/6/2018	RRH

SCALES
0 — 1"
0 — 25mm
IF THIS BAR IS NOT DIMENSION SHOWN, ADJUST SCALES ACCORDINGLY.

REGISTERED PROFESSIONAL ENGINEER — RODMAN R. HOUSER — No. C54215 — Exp. 12/31/18 — CIVIL — STATE OF CALIFORNIA
12/1/17

DESIGNED: RRH
DRAWN: DWM
CHECKED: -

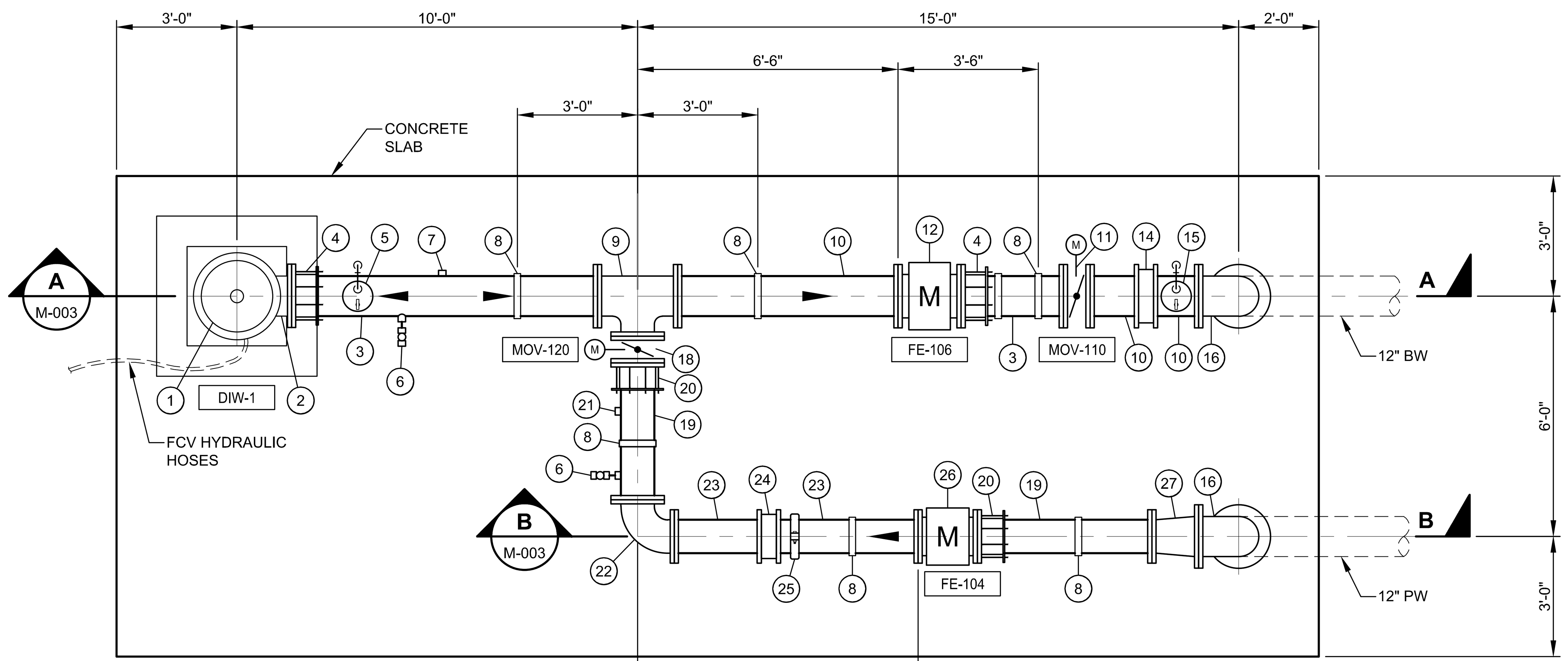
MRWPCA
MONTEREY REGIONAL WATER POLLUTION CONTROL AGENCY
MONTEREY, CA
PURE WATER MONTEREY GROUNDWATER REPLENISHMENT PROJECT

Kennedy/Jenks Consultants
200 Fourth Street, Suite 210, Santa Rosa, CA 95401-8534

INJECTION WELL FACILITIES PHASE 2

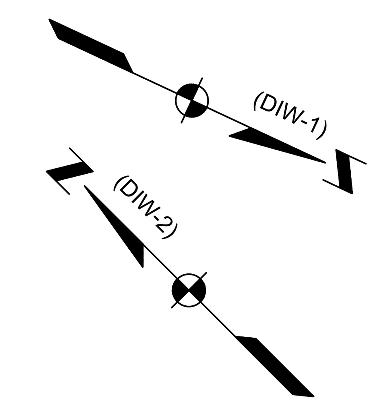
WELL SITE NO. 2 YARD PIPING PLAN

FILE NAME: 166801202-C-123.dwg
JOB NO.: 1668012*02
DATE: DECEMBER 2017
SHEET: C-123



TYPICAL DIW PLAN 1 C-123, C-133

0 2 4
3/8"=1'-0"



GENERAL NOTES:

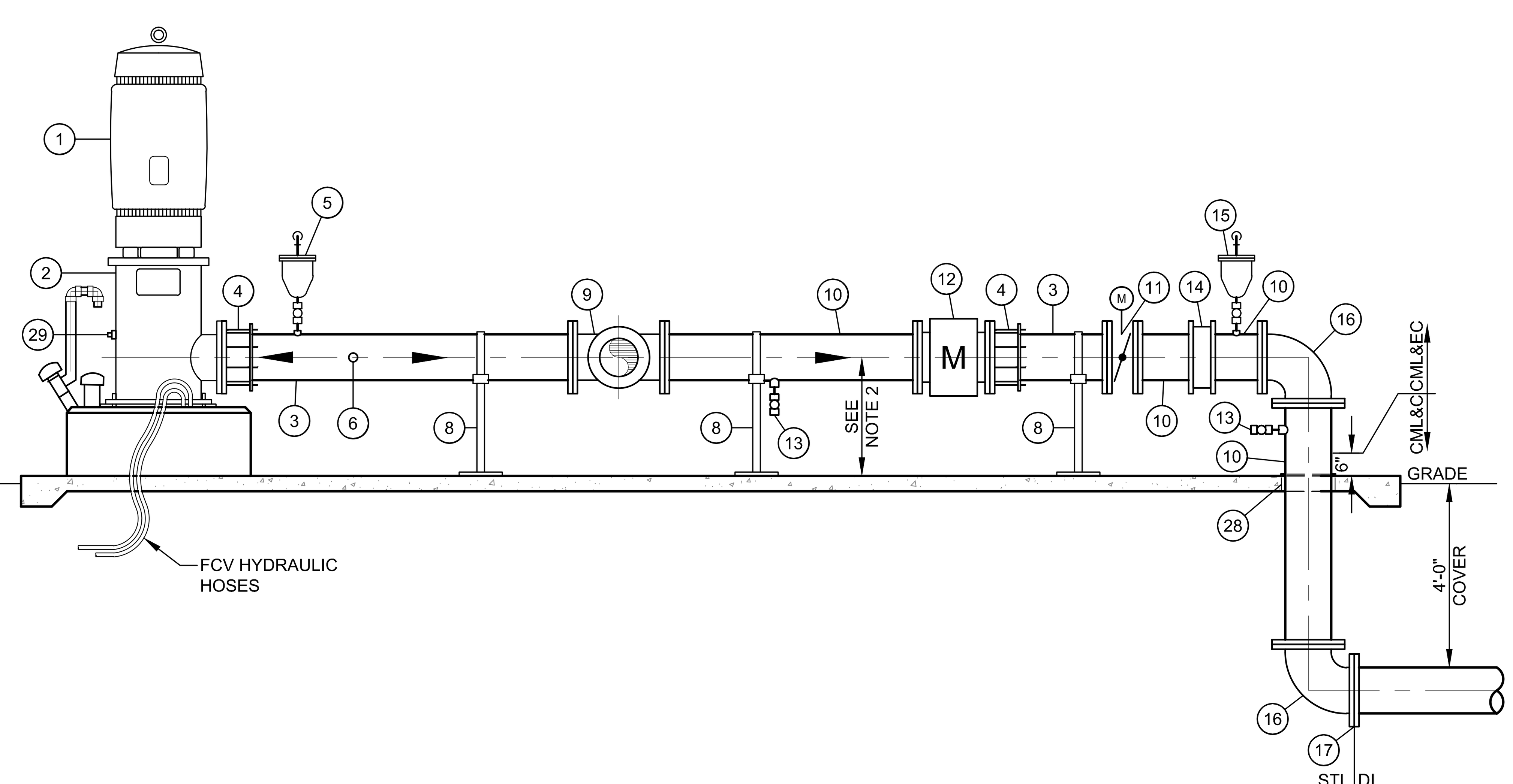
1. EQUIPMENT TAGS SHOWN FOR DIW-1. FOR DIW-2, SEE TABLE BELOW.

	WELL SITE NO. 2	WELL SITE NO. 3
PUMP	DIW-1	DIW-2
BW VALVE	MOV-110	MOV-210
BW METER	FE-106	FE-206
PW VALVE	MOV-120	MOV-220
PW METER	FE-104	FE-204

2. HEIGHT OF PIPING TO BE COORDINATED WITH WELL HEAD TEE. NOT TO EXCEED 3' IN HEIGHT.

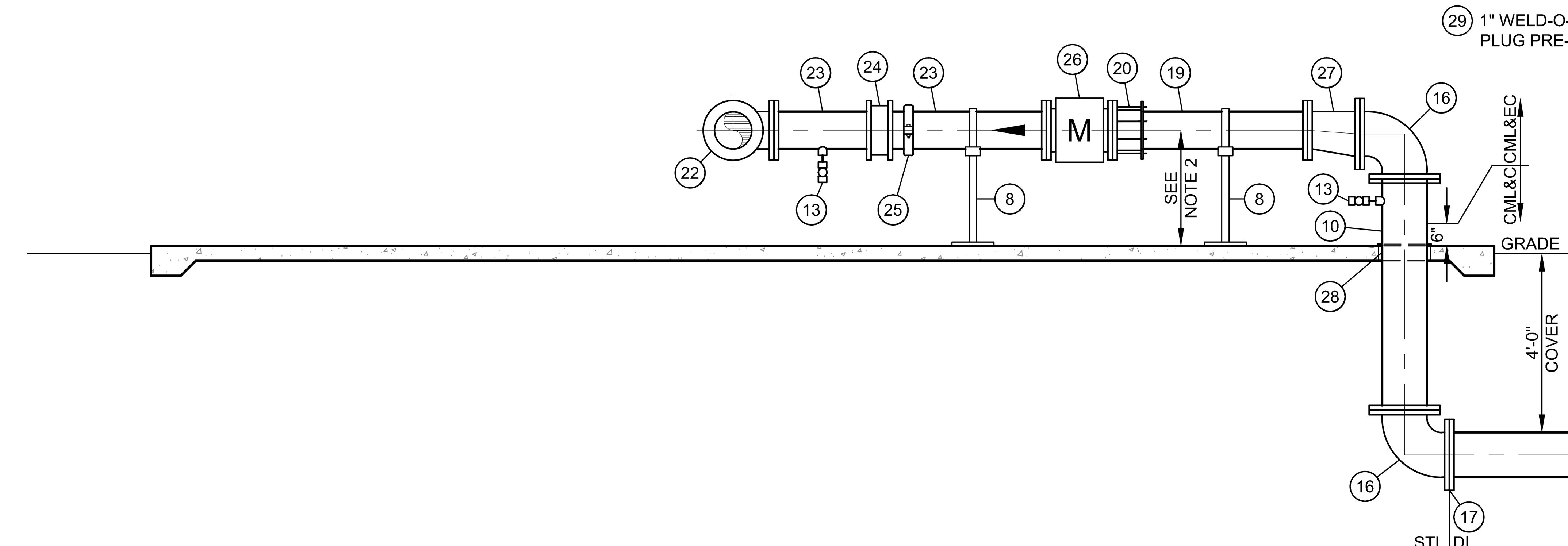
KEY NOTES:

1. MOTOR
2. FABRICATED STL PUMP DISCHARGE HEAD
3. 12" STL PIPE, PE X FLG
4. 12" FLANGE COUPLING ADAPTER WITH RESTRAINED HARNESS
5. 2" DEEP WELL AIR RELEASE/VACUUM VALVE (1 / M-002)
6. 1" SAMPLE TAP (3 / M-002)
7. PRESSURE INDICATING TRANSMITTER/PRESSURE SWITCH HIGH (2 / M-002)
8. PIPE SUPPORT (4 / M-002)
9. 12" X 12" X 10" STL TEE, FLG ENDS
10. 12" STL PIPE, FLG X FLG
11. 12" MOTOR ACTUATED BUTTERFLY VALVE, FLG ENDS
12. 12" MAGNETIC FLOW METER, FLG ENDS
13. 3/4" DRAIN WITH BALL VALVE
14. 12" SPLIT-DISK CHECK VALVE, WAFER ENDS
15. 2" COMBO AIR RELEASE VALVE (5 / M-002)
16. 12" 90 DEGREE STL ELBOW, FLG X FLG
17. 12" INSULATING FLANGE KIT (7 / M-002)
18. 10" MOTOR ACTUATED BUTTERFLY VALVE, FLG ENDS
19. 10" STL PIPE, PE X FLG
20. 10" FLANGE COUPLING ADAPTER WITH RESTRAINED HARNESS
21. 1" THREAD-O-LET WITH DIELECTRIC BUSHING AND CORSTOP
22. 10" 90 DEGREE STL ELBOW, FLG X FLG
23. 10" STL PIPE, FLG X FLG
24. 10" SPLIT-DISK CHECK VALVE, WAFER ENDS
25. VICTAULIC COUPLING
26. 10" MAGNETIC FLOW METER, FLG ENDS
27. 10" X 12" ECCENTRIC REDUCER
28. FLOOR SLEEVE (6 / M-002)
29. 1" WELD-O-LET WITH GALV STL THREADED PLUG PRE-LUBE PORT



TYPICAL DIW SECTION 1 A M-003

0 2 4
3/8"=1'-0"



TYPICAL DIW SECTION 2 B M-003

0 2 4
3/8"=1'-0"

Figure 3-17

USE OF DOCUMENTS

THIS DOCUMENT, INCLUDING THE INCORPORATED DESIGNS, IS AN INSTRUMENT OF SERVICE FOR THIS PROJECT AND SHALL NOT BE USED FOR ANY OTHER PROJECT WITHOUT THE WRITTEN AUTHORIZATION OF KENNEDY/JENKS CONSULTANTS.

NO.	REVISION	DATE	BY
	CONFORMED	4/6/2018	DWF

SCALES: 0 — 1" ; 0 — 25mm. IF THIS BAR IS NOT DIMENSION SHOWN, ADJUST SCALES ACCORDINGLY.

REGISTERED PROFESSIONAL ENGINEER DAVID W. FERGUSON No. CE34626 Exp. 09/30/19 STATE OF CALIFORNIA — 12/1/17

DESIGNED RRH
DRAWN BBH
CHECKED -

MRWPCA

MONTEREY REGIONAL WATER POLLUTION CONTROL AGENCY
MONTEREY, CA
PURE WATER MONTEREY
GROUNDWATER REPLENISHMENT PROJECT

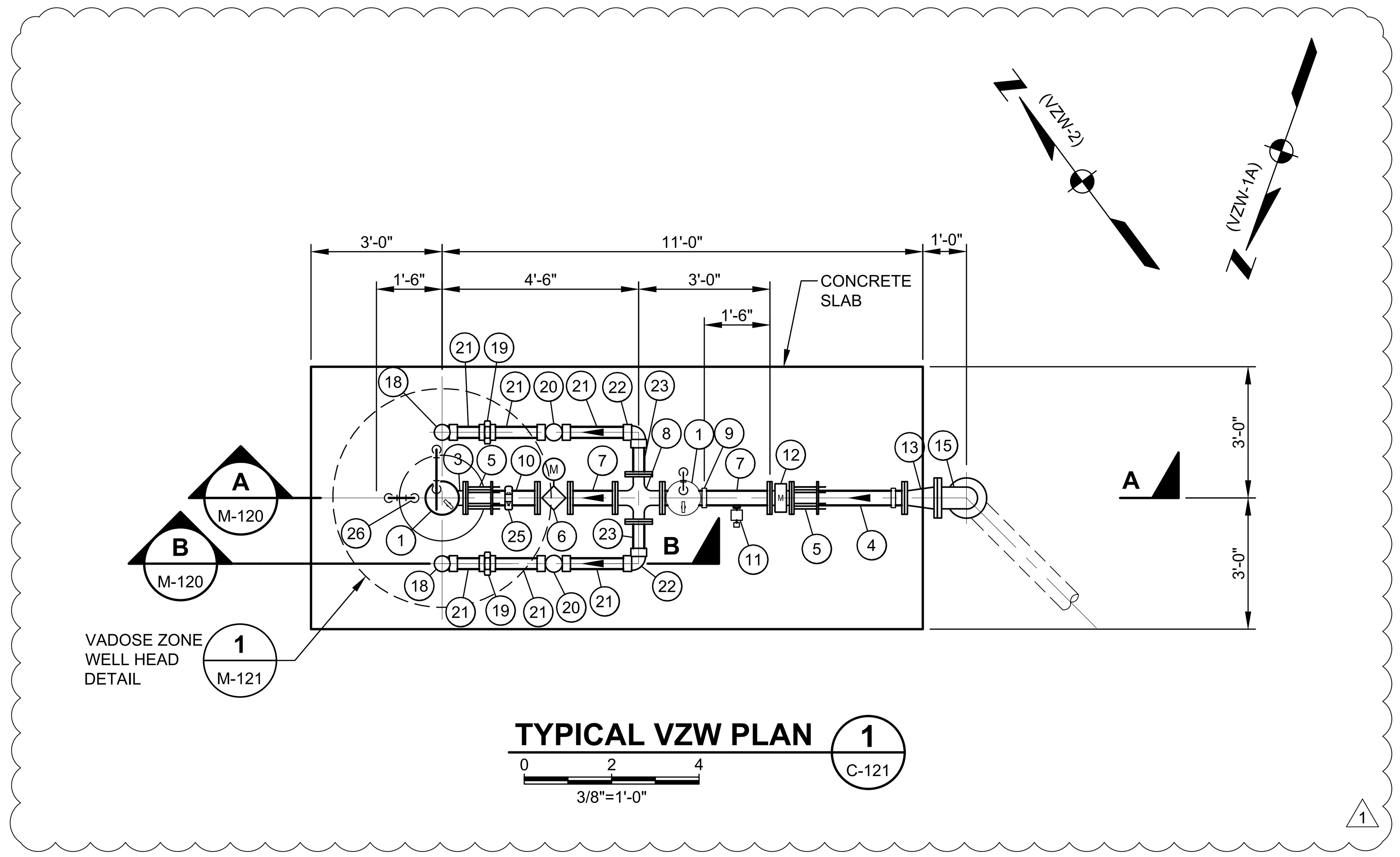
Kennedy/Jenks Consultants
200 Fourth Street, Suite 210, Santa Rosa, CA 95401-8534

INJECTION WELL FACILITIES
PHASE 2

TYPICAL DIW PLAN AND SECTIONS

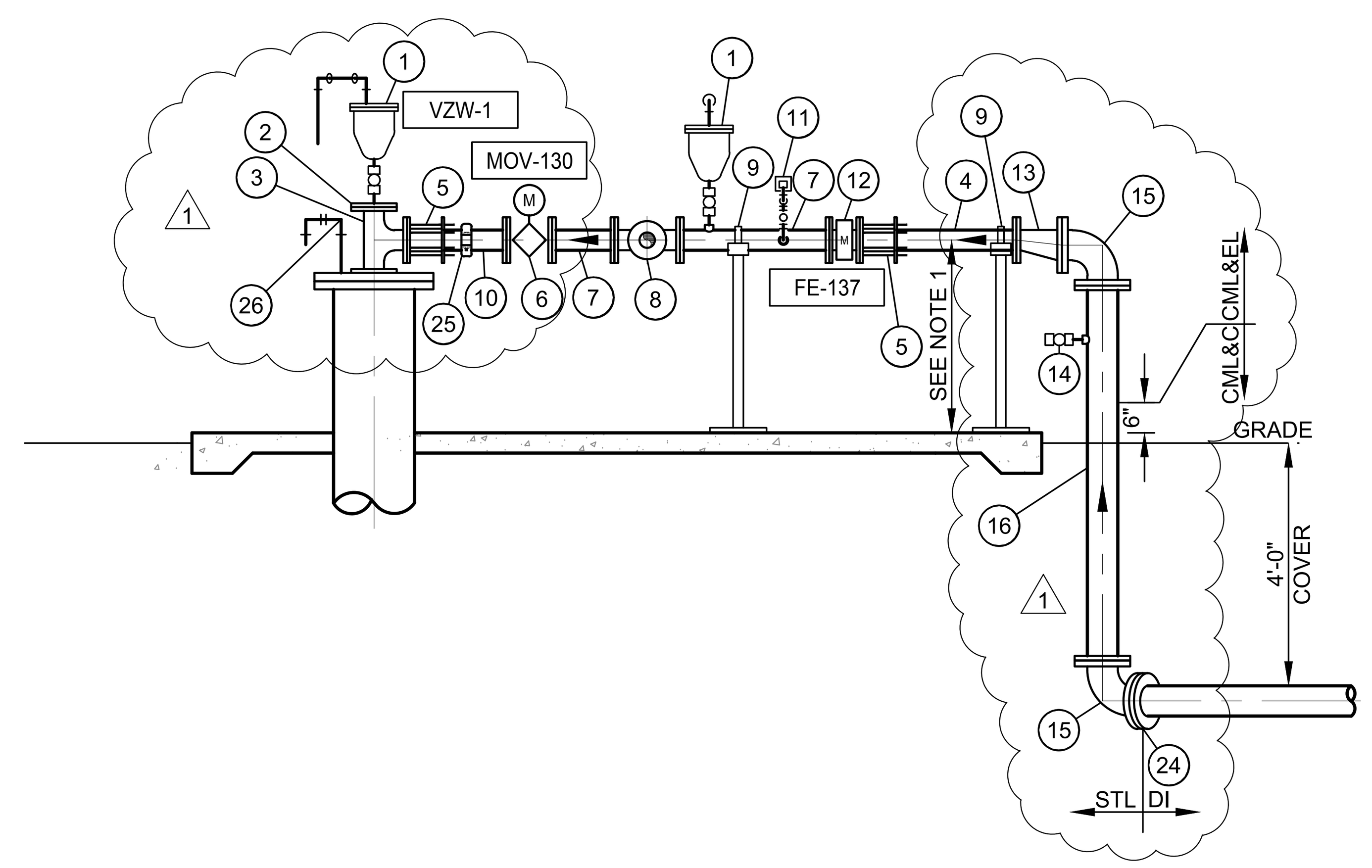
FILE NAME 166801202-M-003.dwg
JOB NO. 1668012*02
DATE DECEMBER 2017
SHEET M-003

pw:\\kjce-pw.bentley.com:kjce-pw\Documents\Clients\Monterey Regional Water Pollution Control Agency\Projects\GWR Injection Well Facilities_1668012.00\10-Design\10.06-Drawings\Mechanical-Building\166801202-M-003



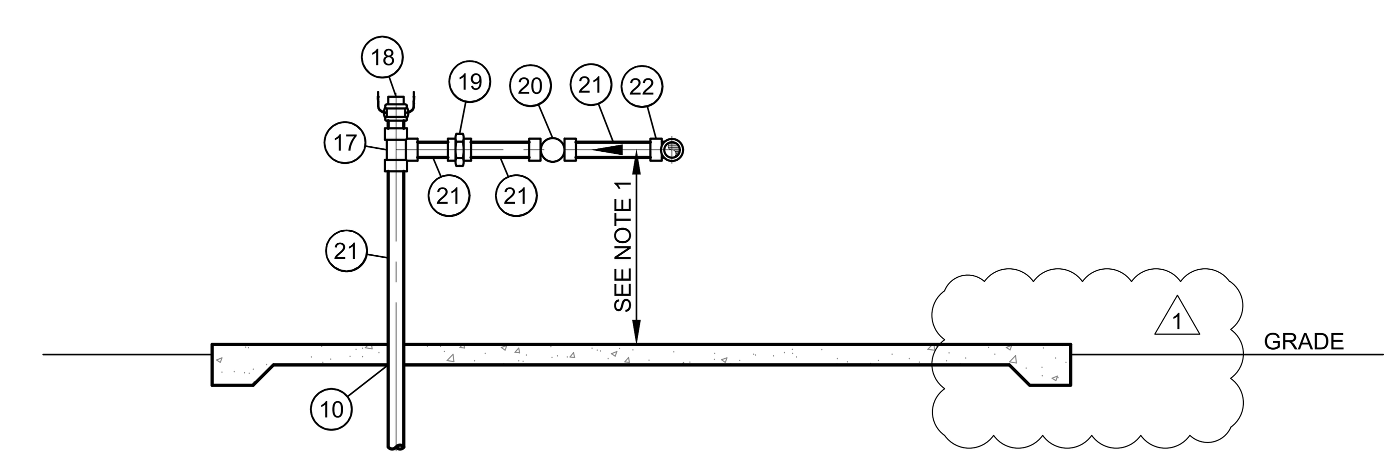
TYPICAL VZW PLAN 1 C-121

3/8"=1'-0"



TYPICAL VZW SECTION A M-120

3/8"=1'-0"



TYPICAL VZW SECTION B M-120

3/8"=1'-0"

GENERAL NOTES:

1. HEIGHT OF PIPING TO BE COORDINATED WITH WELL HEAD TEE. NOT TO EXCEED 3' IN HEIGHT.

KEY NOTES:

1. 2" COMBINATION AIR VALVE (5 / M-002)
2. 4" BLIND FLANGE
3. 4" X 4" X 4" STL TEE
4. 4" STL PIPE, PE X FLG
5. 4" FLANGE COUPLING ADAPTER WITH RESTRAINED HARNESS
6. 4" MOTOR ACTUATED PLUG VALVE
7. 4" STL PIPE, FLG X FLG
8. STL CROSS 4" X 4" MAIN LINE, 3" X 3" BRANCHES
9. PIPE SUPPORT (4 / M-002)
10. 4" STEEL PIPE, FLG X GROOVED
11. PRESSURE INDICATING TRANSMITTER/PRESSURE SWITCH HIGH (2 / M-002)
12. 4" MAGNETIC FLOW METER
13. 4" X 6" ECCENTRIC REDUCER
14. 3/4" DRAIN WITH BALL VALVE
15. 6" 90 DEGREE STL ELBOW, FLG X FLG
16. 6" STL PIPE, FLG X FLG
17. 3" X 3" X 3" STL TEE
18. 3" CAM & GROOVE WITH CAP
19. 3" STL UNION
20. 3" BALL VALVE
21. 3" STL PIPE, THD X THD
22. 3" 90 DEGREE STL ELBOW, THD X THD
23. 3" STL PIPE, THD X FLG
24. 6" INSULATING FLANGE KIT (7 / M-002)
25. VICTAULIC COUPLING
26. TRANSDUCER AND VENT

Figure 3-18

USE OF DOCUMENTS

THIS DOCUMENT, INCLUDING THE INCORPORATED DESIGNS, IS AN INSTRUMENT OF SERVICE FOR THIS PROJECT AND SHALL NOT BE USED FOR ANY OTHER PROJECT WITHOUT THE WRITTEN AUTHORIZATION OF KENNEDY/JENKS CONSULTANTS.

NO.	REVISION	DATE	BY
1	DESIGN CLARIFICATION NO 23	3/2019	MJS/MJR
	CONFORMED	4/6/2018	DWF

SCALES
0 — 1"
0 — 25mm
IF THIS BAR IS NOT DIMENSION SHOWN, ADJUST SCALES ACCORDINGLY.

REGISTERED PROFESSIONAL ENGINEER, DAVID W. FERGUSON, No. CE34626, Exp. 09/30/19, STATE OF CALIFORNIA
12/1/17

DESIGNED RRH
DRAWN DWM
CHECKED -

MRWPCA
MONTEREY REGIONAL WATER POLLUTION CONTROL AGENCY
MONTEREY, CA
PURE WATER MONTEREY
GROUNDWATER REPLENISHMENT PROJECT
Kennedy/Jenks Consultants
200 Fourth Street, Suite 210, Santa Rosa, CA 95401-8534

INJECTION WELL FACILITIES
PHASE 2

WELL SITE NO. 2 - VZW PLAN AND SECTIONS

FILE NAME 166801202-M-120.dwg
JOB NO. 1668012*02
DATE DECEMBER 2017
SHEET M-120

This Page Intentionally Left Blank

4. SOURCE WASTEWATER

This section describes M1W pretreatment/source control program and information on the characteristics of secondary effluent produced at the RTP that serves as feed water to the AWP Facility.

4.1. INDUSTRIAL PRETREATMENT AND SOURCE CONTROL PROGRAM

4.1.1. Legal Authority

M1W administers an approved pretreatment program under NPDES Permit Order No. R3-2014-0013. The objectives of the program are: (1) to enhance M1W'sability to comply with effluent discharge requirements and any other discharge criteria, which are required or authorized by state or federal law; (2) to derive the maximum public benefit by regulating the quality and quantity of wastewater discharged into the sewerage system; (3) to protect the public, the environment, M1W personnel and facilities from potentially harmful industrial wastes; and (4) to ensure that industrial users pay their fair share of treatment operations and maintenance costs.

Activities to achieve these objectives are conducted in accordance with M1W Ordinance No. 2008-01 (*An Ordinance Establishing Regulations for the Interception, Treatment and Disposal of Sewage and Wastewater; Providing for and Requiring Charges and Fees Therefore; and Fixing Penalties for Violation of Said Regulations* [Wastewater Discharge Ordinance]); Ordinance No. 2015-01 (*An Ordinance Establishing Rule and Regulations Regulating the Discharge of Hauled Wastes* [Hauled Waste Ordinance]), and federal pretreatment regulations pursuant to 40 Code of Federal Regulations Part 403 (40 Code of Federal Regulations [CFR] Part 403) and Sections 307 and 402 of the Clean Water Act (CWA). On October 26, 2015, M1W adopted a new Interruptible Rate Structure that includes provisions that will address control measures for the new source waters for the Project.

4.1.2. Program Description

M1W's program maintains a staff of 3 full-time positions (a Source Control Supervisor and two Source Control Inspectors) that provide permitting, inspection, sample collection, sample analysis, review of data, response to incidents of noncompliance by industries or issues at the RTP, enforcement, development of program requirements, and administration (including record keeping and data management). The staff also provides contractual support for regulation of dischargers to the Salinas Industrial Waste Treatment Facility (IWTF) (referred to as "agricultural wash water") and member entity contract inspection services for the 2012 NPDES storm water permit and Grease WDR Programs.

M1W has a small industrial base. The number and type of industries at of the end of November 2017 are summarized below in **Table 4-1**.

Table 4-1: M1W Industrial Inventory

Classification[a]	Number	Type of Industry/Discharge
Significant Industrial Users (SIUs)		
Categorical Industrial Users (CIUs)	**0**	
Non-significant CIUs	**0**	
Non-categorical SIUs	**4**	
Mission Linen Supply #0300		Industrial laundry
Mission Linen Supply #2100		Industrial laundry
Sabor Farms, LLC		Agricultural wash water
Ocean Mist Farms		Ag Wash Water
Other Regulated IUs	**11**	
Chevron Corp.		Groundwater
City of Pacific Grove		Urban Runoff
City of Pacific Grove		Effluent from Water Recycling Facility
Community Hospital of the Monterey Peninsula		Sanitary waste[b]
Culligan Water Conditioning		Regeneration of water softener resins
Encore Oils, LLC		Biodiesel Facility
Monterey Bay Aquarium		Saline and sanitary waste
Natividad Medical Center		Sanitary waste[b]
Performance Agriculture		Groundwater
Pure Etch Co.		Groundwater
Salinas Valley Memorial Hospital		Sanitary waste[b]
Total	**15**	

a. The USEPA defines significant industrial user in three ways: (a) an industrial user subject to Categorical Pretreatment Standards under 40 CFR Part 403.6 and 40 CFR, Chapter I, subchapter N. Any industry that falls under these categories is considered a SIU whether it has process discharge to the sewer or not. These industries are Categorical Industrial Users (CIUs); (b) Any industry which discharges an average of 25,000 gallons per day or more of process wastewater to the sewer system (excluding sanitary, non-contact cooling and boiler blowdown wastewater) or contributes a process wastestream which makes up 5 percent or more of the average dry weather hydraulic or organic capacity of the treatment plant; and (c) any industry which is designated as such by the wastewater management agency on the basis that the industrial user has a reasonable potential for adversely affecting the operation of the collection system or treatment plant, or violating any pretreatment requirement.

M1W has pretreatment standards for photo processors, x-ray developers, and printers that generate spent fixer solutions, including sizing specific silver recovery systems or hauling spent fixer solutions. For hospitals specifically, M1W requires hospitals to implement a program for waste management and reduction based on the USEPA *Guidance Manual for Controlling Waste from Hospitals and Medical Facilities*. Hospitals are required to submit annual reports that list accomplishments from the past year and goals for the new year. M1W maintains its industrial inventory by reviewing the phone book and online telephone information sites; referrals from the M1W Customer Service Department for new or expanded sewer connections; building permit sign-offs from all member entity building inspection departments; and service area canvassing.

M1W's industrial users are required to obtain a permit in order to discharge to the sewerage system. The permit includes discharge limits, prohibitions, monitoring requirements, and reporting, and other provisions pursuant to the Wastewater Discharge Ordinance and/or federal regulations.

M1W maintains an active monitoring program to ensure continued compliance by its industrial users. M1W can, if needed, perform surveillance monitoring aimed at facilitating the detection of actual and potential problems caused by the illegal discharge of prohibited materials.

M1W conducts a field inspection program, which includes visiting industrial facilities to investigate their compliance status, identifying industrial sources responsible for treatment plant upsets or incidents, and disseminating information on the pretreatment program to industrial users.

Industrial users that are found through inspection or monitoring to be out of compliance are subject to enforcement action by M1W. Standardized enforcement procedures have been developed in M1W's Enforcement Response Plan to achieve timely and effective compliance.

All waste haulers that dispose hauled wastes at the RTP must have and show proof of (1) registration as a septage or chemical toilet hauler with the County of Monterey Department of Public Health and (2) an M1W Liquid Waste Hauler Discharge Permit in accordance with the Hauled Waste Ordinance. Limitations and prohibitions are contained in the Hauled Waste Ordinance. Prior to discharge to a receiving location, each load is tested for pH and a sample is collected for storage. When the receiving location is full, M1W operations staff collects a sample and conduct a respirometer test. If it passes, the contents are pumped to the RTP. If the test fails, a respirometer test will be conducted on every stored sample to determine which hauler discharged the problem load and appropriate actions are taken against the hauling company. If the waste in the receiving location cannot be pumped into the RTP, the hauler is required to return to the RTP and pump out the waste for treatment or hauling to an appropriate disposal site.

M1W has established local limits that apply to all discharges per **Section 2.10.1** in the Wastewater Discharge Ordinance as shown in **Table 4-2**.

Table 4-2: M1W Local Limits

Constituent	Local Limit mg/L
Arsenic	0.42
Cadmium	3.4
Copper	4.3
Cyanide	0.73
Lead	3.0
Mercury	0.018
Nickel	3.5
Silver	2.3
Total Chromium	2.7
Zinc	2.6
pH	6.0-10.5
Temp	<150 °F
Phenol	8.1

M1W has adopted narrative prohibitions related to toxic inorganic pollutants, toxic organic chemicals, oil and grease, ammonia, biochemical oxygen demand, and TSS. M1W has also developed pretreatment standards (e.g., local limits) for silver for photo processors, x-ray developers and printers.

Prior to operation of the Project, the local limits will be evaluated for constituents relevant to potable reuse, including MCLs, NLs, CECs, and other pollutants of concern.

On August 29 and 30, 2017, PG Environmental conducted a Pretreatment Compliance Audit (PCA) on behalf of the Central Coast RWQCB. A PCA Summary Report was sent to MRWPCA in February 2018. The PCA Summary Report identified several requirements for Pretreatment Program modification including issuing a wastewater discharge permit for the Salinas Industrial Wastewater System, modifying the Wastewater Discharge Ordinance, and modifying several implementation procedures.

MRWPCA is currently in the process of completing an update of its local limits to reflect the anticipated changes in the wastewater characteristics associated with new water sources to the Regional Treatment Plant (see **Section 4.1.3**). Subsequent to the local limits update, MRWPCA will modify its Wastewater Discharge Ordinance and Enforcement Response Plan to reflect the revisions to the local limits and the findings of the PCA Summary Report.

M1W's community outreach activities, which include source control information, were summarized in **Section 1.2**. Additional activities directly related to the source control program include:

- M1W's Got Drugs Program, which provides information to residents about proper disposal of medications and a list of pharmacies with take-back programs.
- Commercials and advertising for controlling fats, oils, and grease.
- Participation in the Monterey County Oil Recycling Program.
- Dissemination of information on Monterey County's household hazardous waste program and an on-line household hazardous waste disposal chart.

4.1.3. New Water Sources for the Regional Treatment Plant

The new source waters that will supplement the existing incoming wastewater flows are the following: (1) water from the City of Salinas agricultural wash water system (Salinas IWTF), (2) storm water flows from the southern part of Salinas, (3) surface water and agricultural tile drain water that is captured in the Reclamation Ditch and Tembladero Slough, and (4) surface water and agricultural tile drain water that flows in the Blanco Drain. Most of these new source waters will be combined within the existing wastewater collection system before arriving at the RTP; water from Blanco Drain will be conveyed directly to the RTP. As part of the EIR, the assessment included these new sources as well as storm water diversions from the Lake El Estero facility in Monterey. Grant/loan financing, design, engineering nor permitting are being pursued for Tembladero Slough, but may be reconsidered in the future. The Lake El Estero source is not planned for diversion for the Project but may be reassessed in the future.

The M1W's source control plans and programs are currently being reviewed and updated to address new water sources including (a) permitting the agricultural wash water and other industries that discharge to the Salinas IWTF; and (b) a new interruptible rate program that includes control mechanisms and prohibitions as described below.

4.1.3.1. Agricultural Washwater

The City of Salinas collects and treats wastewater from approximately 25 agricultural process and related businesses that heretofore were conveyed to the Salinas IWTF for biological treatment and discharge via percolation ponds. Prior to completion of the Pure Water Monterey AWP Facility, these industrial facilities will be permitted as IUs by M1W. Over 80% of the collected flows are from vegetable packers, with the remainder originating from seafood processing, refrigerated warehousing, and manufacturing of ice and corrugated paper boxes.

4.1.3.2. Blanco Drain

The Blanco Drain is a man-made reclamation ditch draining approximately 6,400 acres of agricultural lands east of the City of Salinas. The watershed for the Blanco Drain is between the Salinas River and Alisal Slough, and discharges to the Salinas River. The Blanco Drain is separated from the Salinas River by a flap gate, which prevents high-water conditions in the Salinas River from migrating up the Blanco Drain channel. Summer flows in the Blanco Drain are generally tile drainage and runoff from irrigated agriculture. Winter flows include storm water runoff, although some fields remain in production and are irrigated year-round. The Project would include improvements that would enable water in the Blanco Drain to be diverted and conveyed to the RTP for treatment. The Monterey County Water Resources Agency has flood control responsibility for the natural and man-made storm water channels within the County, including the Blanco Drain and the Reclamation Ditch system in northern Monterey County.

4.1.3.3. Salinas Storm Water Collection System

Currently, storm water from urban areas in southern portions of the City of Salinas is collected and released to the Salinas River through an outfall near Davis Road. The runoff system currently drains an area of about 2.5 square miles and eventually flows to the Salinas River through a 66-inch gravity pipeline. The drainage area is virtually all within the developed portion of Salinas and does not appear to intercept water from non-urban areas. Therefore, flows are likely to be almost entirely from urban runoff. The climate of Salinas is semiarid, with the rainy season occurring from November through March. The Project would include improvements that would enable Salinas storm water to be conveyed to the RTP for treatment.

4.1.3.4. Reclamation Ditch

The Reclamation Ditch, created between 1917 and 1920, is a network of excavated earthen channels used to drain natural, urban, and agricultural runoff and agricultural tile drainage. The Reclamation Ditch watershed is approximately 157 square miles that includes headlands, agricultural areas, the City of Salinas and portions of Castroville and Prunedale. It collects water from Alisal Creek at Smith Lake southeast of the City of Salinas, Gabilan and Natividad Creeks within Salinas at Carr Lake, and Santa Rita Creek west of Salinas. The Reclamation Ditch is a major drainage channel that flows from east to west through Salinas and continues west where it drains into Tembladero Slough, thence to the Old Salinas River Channel, and ultimately into Moss Landing Harbor through the Potrero Road Tide Gates. Alisal, Gabilan and Natividad Creeks are seasonal in their upper reaches. The Reclamation Ditch is perennial downstream of agricultural and urban development. However, the presence of dry-season flow is a consequence of dry-season urban discharges and agricultural runoff and tile drain water. The Project would include improvements that would enable water from the Reclamation Ditch watershed to be diverted from the Reclamation Ditch at Davis Road Salinas to be conveyed to the RTP for treatment.

4.1.3.5. Interruptible Rate Program

On October 26, 2015, M1W adopted a new Interruptible Rate Program for acceptance of the Project new water sources into the sewerage system on a seasonal or interruptible basis, and the program was updated as of April 2017. M1W has developed eligibility criteria and conditions to qualify for this rate that include the following source control mechanisms:

- The applicable discharger will be required to obtain and comply with a wastewater discharge permit issued by M1W that includes discharge limits, prohibitions, self-monitoring, spill control, reporting and other provisions in accordance with the Wastewater Discharge Ordinance.[23]

- The water source cannot contain domestic sewage as verified by M1W's Source Control Division.

- The water source cannot be from a groundwater remediation site.

- The discharger must provide water quality data for the proposed discharge so that M1W can determine if the discharge requirements per the Wastewater Discharge Ordinance, including compliance with M1W's permits and protection of recycled water can be achieved. The permit application clarifies the number of samples, analyses, reporting levels, etc. The discharger will be responsible for the costs related to developing and implementing M1W water quality objectives, including prohibitions that will allow M1W to shut off the flow of source water.

- The discharger must allow M1W to control the amount, timing, and duration of the discharge through motorized valves using a SCADA connection with M1W's RTP and continuous flow metering. M1W has the authority and access to reduce or terminate the discharge. The discharger, if needed, shall have pre-treatment for the removal of trash and/or other unacceptable discharges as identified in the newly created discharge permit.

- The discharger must have an alternative legal means of disposing of the wastewater should M1W discontinue the diversion. M1W will reduce or shut off flow when needed so that existing flow capacities of M1W facilities will not be exceeded.

- The discharger will not be allowed to exceed the existing capacity of M1W infrastructure, and will not be given an allocation or right to existing capacity.

- The discharger must agree to pay the appropriate fees associated with diverting and treating the water in accordance with the proposed Interruptible rate formula. These fees may include

[23] The agency is currently in negotiations with the City of Salinas to enter into an agreement that will address the permitting requirements of the City and the relevant dischargers to the City's industrial wastewater conveyance system. In addition, the agency is intended to revise its Wastewater Discharge Ordinance in 2018 to cover numerous wastewater collection system changes currently in design or construction.

billing, source control and other administrative costs relating to this rate. Fees for M1W to operate and maintain the diversion facilities will also be included in the rate.

- M1W will inspect and monitor the discharge, and if necessary take enforcement action for permit violations in accordance with the Wastewater Discharge Ordinance and Enforcement Response Plan.

4.1.4. Compliance with Title 22 Source Control Requirements

While M1W's Source Control Program to date has focused on protecting the RTP, ocean receiving water quality, and tertiary recycled water quality, the source control program will meet the Title 22 Criteria for groundwater replenishment as follows:

- **Contaminant Assessment.** The Project's pilot testing evaluated the fate of chemicals and contaminants through the RTP and treatment systems for the AWP Facility (*see* **Section 7**). The list of chemicals and contaminants evaluated included Priority Pollutants, constituents with MCLs and NLs, and CECs, and pesticides of local interest. Future studies will be conducted at the request of DDW and RWQCB or based on monitoring data collected by M1W.

- **Contaminant Source Investigation.** M1W will conduct investigations and monitoring (a) in the event of interference or pass through[24] at the RTP or AWP Facility, (b) at the request of DDW or RWQCB, or (c) based on monitoring data collected by M1W.

- **Outreach:** M1W currently administers an effective outreach program that consists of RTP facility tours, classroom presentations, information on the Project, information on pharmacies offering drug take-back programs, participation/exhibits in community events, school outreach (presentations, materials, teacher curriculum training and workshops), RTP tours, commercials and advertising for controlling fats, oil and grease, participation in the Monterey County Oil Recycling Program, and tours of the new AWP demonstration facility. These outreach efforts are similar to programs implemented by other agencies involved with potable reuse.

- **Contaminant Inventory.** M1W's source control program tracks and identifies industrial users and discharges, including contaminants discharged through industrial monitoring. M1W maintains its industrial inventory by reviewing the phone book and online telephone information sites, referrals from the M1W Customer Service Department for new or expanded sewer connections, building permit sign-offs from all member entity building inspection departments, and service area canvassing. The inventory will also address the new source waters based on the results of the source water monitoring and subsequent monitoring when the source waters and any related industrial contributions are delivered to the RTP.

---

[24] Interference is defined as an industrial discharge which alone or in combination with a discharge or discharges from other sources (1) inhibits or disrupts the RTP or AWP Facility, their treatment processes or operations, the RTPs sludge processes, uses or disposal, or the use of recycled water and (2) is therefore a cause of a permit violation. Pass is defined as a discharge that exits the RTP or AWP Facility in quantities or concentrations, which, alone or in conjunction with a discharge or discharges from other sources, is a cause of a permit violation.

- **Annual Reporting.** M1W currently prepares an annual report on the pretreatment program. Future reports will address compliance with the Title 22 source control provisions upon operation of the Project.

4.2. RAW WASTEWATER CHARACTERISTICS

4.2.1. Flows

In November 2015, M1W analyzed the future monthly and annual availability of potential source waters not currently part of the M1W system, including the Blanco Drain, Reclamation Ditch and agricultural wash water[25]. The predicted RTP flows are presented in **Figure 4-1** and **Table 4-3**. Flows were also predicted for three different rainfall/water year types and management scenarios:

- **Normal/Wet – Building Reserve** considers flows when normal to above average rainfall is experienced, but AWP water is being stored in the Seaside Groundwater Basin to build a reserve supply;
- **Normal/Wet – Full Reserve** considers flows when normal to above average rainfall is experienced and the reserve supply is full; and
- **Drought** considers flows when below normal rainfall is experienced and there are higher demands for tertiary treated recycled water.

The total flows entering the RTP are relevant because some predictions regarding the water quality entering the AWP Facility are based on the blending that will occur with raw wastewater entering the RTP. In the summer, historical flows of secondary effluent will undergo tertiary treatment for delivery to CSIP recycled water customers. The AWP Facility will be able to utilize secondary effluent that is not directed to the CSIP recycled water customers. The predicted composition of source water flows available to the AWP Facility are shown in **Figure 4-2**.

[25] Flow predictions of diverted new source waters were based on estimated availability of the source waters, wastewater flows (based on average monthly municipal wastewater flows from 2012 through 2016), AWP Facility production levels, CSIP demands, and the RTP capacity.

Table 4-3: Predicted Availabilities for Source Waters entering the RTP (units in acre-ft)

	Month	Jan[a]	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Normal/Wet - Building Reserve	Municipal WW	1624	1481	1636	1612	1686	1630	1646	1647	1591	1685	1572	1621
	Ag Wash	0	0	0	355	413	563	435	444	369	0	0	0
	Blanco Drain	0	0	0	252	225	274	277	244	184	0	0	0
	Rec Ditch	0	0	0	106	79	99	113	109	72	0	0	0
Normal/Wet - Full Reserve	Municipal WW	1624	1481	1636	1612	1686	1630	1646	1647	1591	1685	1572	1621
	Ag Wash	0	0	0	355	413	563	435	444	369	0	0	0
	Blanco Drain	0	0	0	252	225	274	277	244	184	0	0	0
	Rec Ditch	0	0	0	106	79	99	113	109	72	0	0	0
Drought	Municipal WW	1566	1404	1557	1372	1507	1438	1502	1468	1424	1768	1487	1484
	Ag Wash	0	0	0	312	412	391	435	444	368	0	0	0
	Blanco Drain	0	0	246	113	102	155	154	121	65	45	133	0
	Rec Ditch	0	0	70	106	79	99	113	109	72	65	89	0

a. Based on average municipal wastewater flows from 2012 through 2016

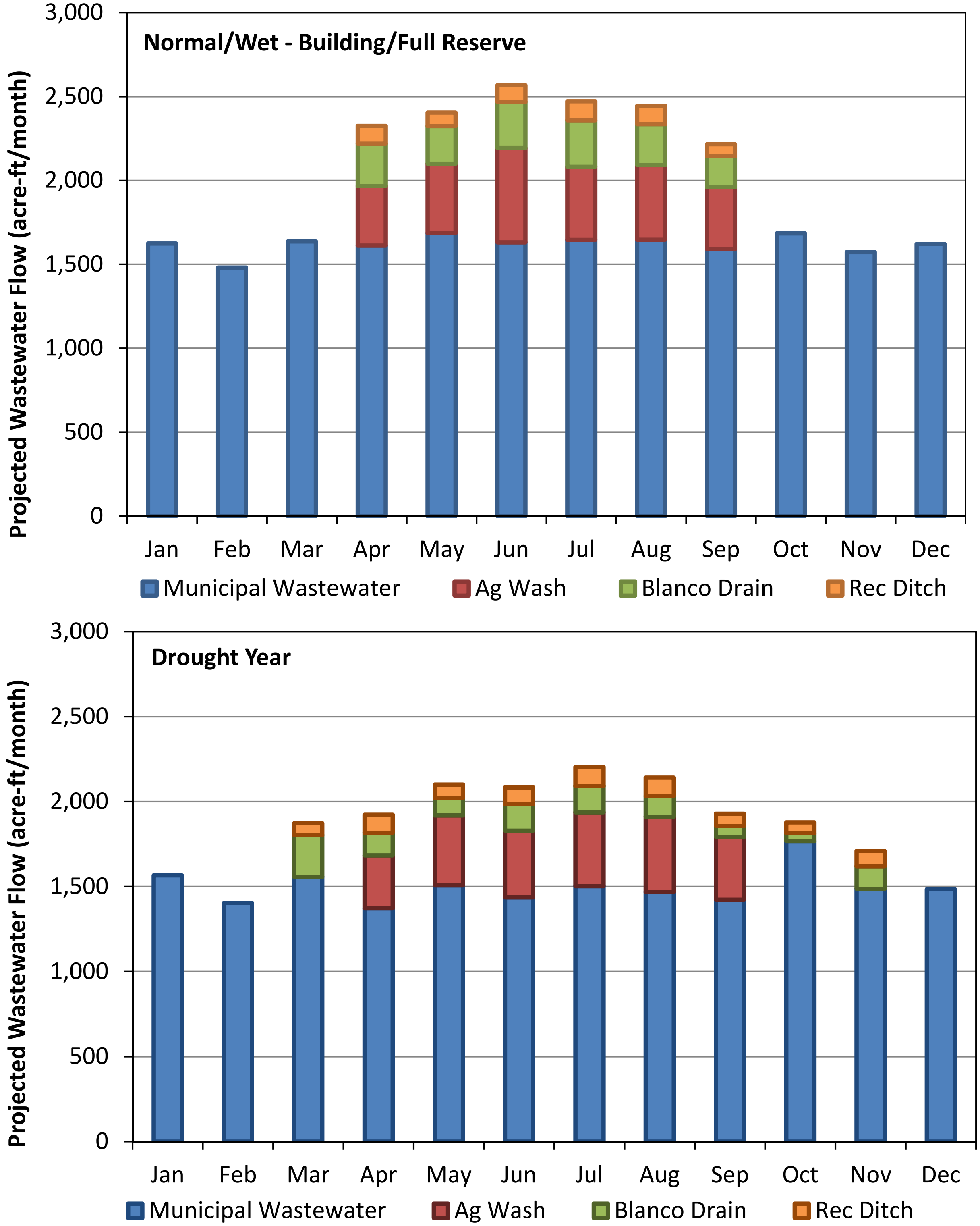


Figure 4-1. Estimated Availabilities for Source Waters entering the RTP during (top) Normal/Wet – Building Reserve and (bottom) Drought, with Average Wastewater Flow Rates from 2012 through 2016.

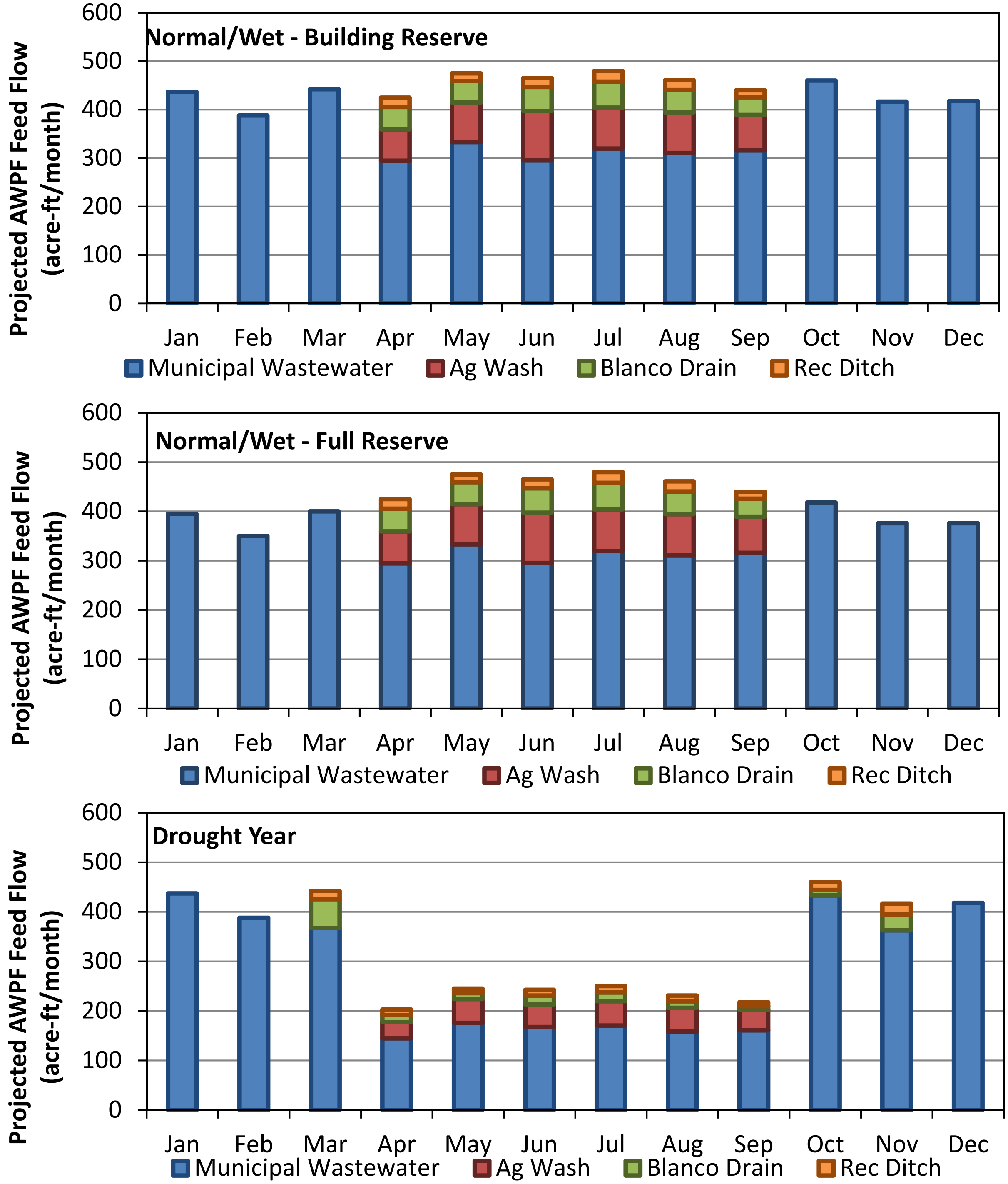


Figure 4-2. Predicted AWP Facility source water flows for use in the project during (top) Normal/Wet – Building Reserve, (middle) Normal/Wet – Full Reserve and (bottom) Drought with average Wastewater Flow Rates from 2012 through 2016.

4.2.2. Water Quality

A monitoring program was conducted from July 2013 to June 2014 for five of the potential source waters (Trussell Technologies 2014b). Regular monthly and quarterly sampling was carried out for the RTP secondary effluent, agricultural wash water, and Blanco Drain drainage water. Limited sampling of stormwater from Lake El Estero was performed due to seasonal availability, and there was one sampling event for the Tembladero Slough drainage water.[26] The Reclamation Ditch was not sampled during the monitoring program. At the time the samples were collected, both Lake El Estero and Tembladero Slough were considered as potential sources waters for the Project. At this time neither source is planned to be used for the Project; however, the results of these sources have been included for historical context, and for use in estimating the Reclamation Ditch water quality.

4.2.2.1. Pathogenic Microorganisms

To protect public health, groundwater replenishment projects must inactivate or remove pathogenic microorganisms from the wastewater. The Title 22 Criteria for groundwater replenishment require minimum pathogenic log reductions of 12, 10, and 10 for viruses, *Giardia* cysts, and *Cryptosporidium* oocysts, respectively (i.e., 99.9999999999%, 99.99999999%, and 99.99999999% inactivation or removal, respectively).

During the 2013 to 2014 monitoring program, source waters were monitored for *Cryptosporidium* oocysts, *Giardia* cysts, total coliform, and *E. coli*. The source waters were not monitored for viruses based on the low number of indigenous virus expected to be present in runoff (Rajal et al., 2007) and RTP secondary effluent (Rose et al., 2004). Instead, indicator bacteria (total coliform and E. *coli*) were used as surrogates for virus. A summary of the concentrations of pathogens and indicator organisms measured in the source waters is presented in **Table 4-4**. In this context, untreated means the following:

- For the RTP effluent, prior to the AWP Facility treatment.
- For the other source waters, prior to treatment at the RTP/AWP Facility.

The concentrations of pathogens and indicator organisms are typical of an undisinfected secondary effluent.

[26] A Salinas stormwater sample was collected on December 2, 2014 and analyzed for an abridged set of chemical parameters, but these data were not included in this assessment.

Table 4-4: Summary of Pathogens Measured in Source Waters

Parameter [a]	Undisinfected RTP Secondary Effluent N = 4-11[b]	Agricultural Wash Water N = 3	Blanco Drain N = 4	Lake El Estero N = 1	Tembladero Slough N = 1
Cryptosporidium[c] (oocysts/L)	0.38 (<0.10 – 0.9)	<0.33 *(<0.2 – <0.38)*	0.185 (<0.18 – 0.2)	<0.3	<0.09
Giardia[c] (cysts/L)	<0.1 (<0.1 – 0.2)	<0.33 *(<0.2 – <0.38)*	<0.18 *(<0.09 – <0.19)*	<0.3	<0.09
Total coliform[d] (MPN/100 mL)	$7.1x10^5$ ($1.9x10^5$ – $1.6x10^6$)	$7.7x10^6$ ($6.2x10^5$ –$9.6x10^7$)	$4.3x10^4$ ($8.4x10^3$ –$2.0x10^6$)	$3.5x10^3$	$1.7x10^5$
E. coli[d] (MPN/100 mL)	$1.8x10^5$ ($2.9x10^4$ –$5.8x10^5$)	<20 (<20 – 18)	$2.4x10^2$ (75 – $2x10^3$)	<100	$7.5x10^2$

a. N is the number of samples; total coliform and *E. Coli* were sampled more frequently when range is shown.
b. Three of the total coliform and *E. Coli* samples and one of the *Cryptosporidium* and *Giardia* samples included diversion of agricultural wash water mixed with sewage and treated at the RTP.
c. Values are median values and data range (minimum concentration to maximum concentration) where applicable. Recoveries from one matrix spike test ranged from 19% to 51% for *Cryptosporidium* oocysts for the RTP secondary effluent, agricultural wash water and the Blanco Drain, and ranged from 27% to 48% for *Giardia* cysts for the agricultural wash water and the Blanco Drain, and was less than 0.092% for *Giardia* cysts for the RTP Secondary effluent.
d. Values are geometric means with the observed range (minimum concentration to maximum concentration) where applicable.

The source waters that were sampled are all expected to have a lower pathogenic microorganism counts than raw municipal wastewater. Therefore, adding the new source waters will not increase the concentrations of these organisms; the RTP and AWP Facility treatment technologies typical for groundwater replenishment projects will remove these organisms as demonstrated by existing groundwater replenishment projects elsewhere, and as discussed later in the report based on the pilot testing (*see* **Section 7)**.

4.2.2.2. Water Quality Constituents

The 2013 to 2014 source water sampling included a detailed characterization of the source waters. The source water sampling was designed to assess the full list of water quality parameters, including many that are not required to be monitored for groundwater replenishment projects. The types of constituents that were included in the source water monitoring program were:

- General water quality parameters, including total nitrogen and TOC;
- Constituents with California Primary and Secondary MCLs, namely
  - Inorganic chemicals,
  - Organic chemicals,
  - Disinfection by-products (DBPs), and
  - Radionuclides;
- Constituents with California action levels for lead and copper;
- Constituents with California NLs, namely

- Current NLs as of December 14, 2010, and
- Archived Advisory Levels (AALs)[27];

- Priority Pollutants;
- Constituents included in the USEPA Unregulated Contaminant Monitoring Rule (UCMR) Lists 1, 2 and 3 (excluding pathogenic organisms);
- Pesticides of local interest (PoLi) based on the agricultural activity/usage in the area[28]; and
- CECs.

As previously noted, the Title 22 Criteria include numeric water quality criteria for primary and secondary MCLs, total nitrogen and TOC, and action levels for lead and copper. The Title 22 Criteria also include requirements for numeric NLs based on the results of monitoring recycled water. For purposes of this project, the numeric NLs were used as compliance goals. Therefore, the source waters were analyzed for the constituents (also referred to as analytes) with regulatory criteria and goals.

The Title 22 Criteria require that the recycled water be monitored for additional constituents, but do not specify numeric criteria for the following: Priority Pollutants; chemicals specified by DDW based on the Engineering Report, affected groundwater basin, and source control program; and indicator chemicals to characterize the presence of CECs. Although the regulations do not require monitoring for AALs, contaminants included in the UCMR, PoLi, or all of the CECs sampled in the source waters, they were included in the source water sampling program to provide a comprehensive data set to evaluate source water quality and the performance of the pilot system.

During source water sampling and pilot testing programs, the sampling program evaluated a total of 435 analytes, including constituents with and without regulatory criteria/goals. Of these, 194 analytes were detected in at least one sample, and 241 were below detection limits in all of the source waters. The median concentration and concentration range of each analyte, as well as number of samples with positive detections, are provided in **Appendix E**. Some analytes are listed more than once in the appendix because different analytical techniques were used to determine their concentrations.

As previously noted, the Project includes the collection of a variety of new source waters that will be combined with existing incoming wastewater flows for conveyance to and treatment at the RTP. Constituent concentration reduction prior to use of the purified water for replenishment will occur in three ways.

1. In many cases, the blending of waters prior to treatment at the RTP will reduce concentrations of some constituents in each source water. Based on the predicted average monthly flows, the new source waters will comprise 0% to 36% of the RTP influent, depending on the month of the year and water type (building reserve or drought scenario). When additional source waters are being brought in to the RTP, they will receive dilution with municipal wastewater ranging from 16 parts wastewater and 1 part new source water to 2 parts wastewater and 1 part new source water.

2. The concentration of some constituents in the new source waters will be reduced prior to reaching the AWP Facility through the RTP primary and secondary treatment.

3. The secondary treated wastewater that is not sent to the SVRP tertiary treatment plant for agricultural irrigation will be treated at the AWP Facility, which will include ozonation, MF, RO,

[27] Per the H&S Code, advisory levels were renamed as NLs.
[28] Many of these constituents had applicable MCLs or AALs, and thus are addressed under those regulatory requirements/goals.

UV/AOP, and post treatment stabilization. These treatment technologies are typical for groundwater replenishment projects and will effectively remove these constituents as demonstrated by existing groundwater replenishment projects elsewhere and as discussed in the following sections of this report.

4.2.2.3. Constituents with Maximum Contaminant Levels and Notification Levels

Two monitoring frequencies were used for source water monitoring: (1) quarterly monitoring of all parameters to understand occurrence of the various constituents, and (2) monthly monitoring of a select list of constituents for understanding the variability of key design parameters. The quarterly sampling list for constituents/parameters with primary MCLs, secondary MCLs, and NLs are listed in **Table 4-5**, **4-6**, and **4-7**, respectively.

Table 4-5: Constituents with Primary Maximum Contaminant Levels Included in the Source Water Monitoring

1,1-Dichloroethane	Carbofuran	Monochlorobenzene
1,1-Dichloroethylene	Carbon Tetrachloride	Nickel
1,1,1-Trichloroethane	Chlordane	Nitrate[a]
1,1,2-Trichloro-1,2,2-Trifluoroethane	Chlorite	Nitrate+Nitrite[a]
1,1,2-Trichloroethane	Chromium	Nitrite (as N)[a]
1,1,2,2-Tetrachloroethane	cis-1,2-Dichloroethylene	Oxamyl
1,2-Dichlorobenzene	Cyanide	Pentachlorophenol
1,2-Dichloroethane	Dalapon	Perchlorate
1,2-Dichloropropane	Di(2-ethylhexyl)adipate	Picloram
1,2,3-Trichloropropane	Di(2-ethylhexyl)phthalate	Polychlorinated Biphenyls
1,2,4-Trichlorobenzene	Dibromochloropropane	Radium-226
1,3-Dichloropropene	Dichloromethane	Radium-228
1,4-Dichlorobenzene	Dinoseb	Selenium
2,3,7,8-TCDD	Diquat	Simazine
2,4-D	Endothall	Strontium-90
2,4,5-TP	Endrin	Styrene
Alachlor	Ethylbenzene	Tetrachloroethylene
Aluminum	Ethylene Dibromide	Thallium
Antimony	Fluoride	Thiobencarb
Arsenic	Glyphosate	Toluene
Asbestos	Gross Alpha Particle	Total Haloacetic acids
Atrazine	Heptachlor	Toxaphene
Barium	Heptachlor Epoxide	Total trihalomethanes
Bentazon	Hexachlorobenzene	trans-1,2-Dichloroethylene
Benzene	Lindane	Trichloroethylene
Benzo(a)pyrene	Hexachlorocyclopentadiene	Trichlorofluoromethane
Beryllium	Mercury	Tritium
Beta/photon emitters (K40 adjusted)	Methoxychlor	Uranium
Bromate	Methyl-tert-butyl ether	Vinyl Chloride
Cadmium	Molinate	Xylenes

a. The Title 22 Criteria for groundwater replenishment do not require that the MCLs for nitrate, nitrite, and nitrate + nitrite be met in recycled water. Regulations require that the total nitrogen concentration in the recycled water not exceed 10 mg/L as N. However, see later discussion in the report regarding compliance with Basin Plan MCL-based groundwater objectives, which include nitrate, nitrite, and nitrate + nitrite.

Table 4-6: Constituents with Secondary Maximum Contaminant Levels Included in the Source Water Monitoring

Aluminum	Iron	Thiobencarb
Chloride	Manganese	Total Dissolved Solids
Color	Methyl-tert-butyl ether	Turbidity
Conductivity	Odor-Threshold	Zinc
Copper	Silver	
Foaming Agents	Sulfate	

Table 4-7: Constituents with Notification Levels in the Source Water Monitoring

	Nitrosamines (List of 9)[a]
1,2,4-Trimethylbenzene	N-nitrosodi-n-propylamine
1,3,5-Trimethylbenzene	N-nitrosodiethyamine
1,4-Dioxane	NDMA
2-Chlorotoluene	N-nitroso-di-n-butylamine
2,4,6-Trinitrotoluene	N-nitrosodiphenylamine
4-Chlorotoluene	N-nitrosomorpholine
Perfluorooctane sulfonate (PFOS)	N-nitrosopiperidine
Perfluorooctanoic acid (PFOA)	N-nitroso-methylethylamine
Boron	N-nitrosopyrrolidine
Carbon disulfide	Naphthalene
Chlorate	n-Propylbenzene
Diazinon	Propachlor
Dichlorodifluoromethane (Freon 12)	RDX (Hexahydro-1,3,5-trinitro-1,3,5-triazine)
Ethylene glycol	sec-Butylbenzene
Formaldehyde	tert-Butylbenzene
HMX (or Octogen)	Tertiary butyl alcohol
Isopropylbenzene	Vanadium
Manganese	
Methyl isobutyl ketone	
n-Butylbenzene	

a. The current list of NLs includes only three nitrosamines: N-nitrosodiethyamine, NDMA, and N-nitrosodi-n-propylamine; the source water monitoring included a total of nine nitrosamine compounds.

A summary of the numbers of constituents/parameters with MCLs, NLs, and AALs detected[29] in each of the "untreated" source waters is presented in **Table 4-8**. In this context, untreated means the following:

- For the RTP effluent, after secondary treatment but prior to AWP Facility treatment.
- For the other source waters, prior to any treatment at the RTP/AWP Facility.

Table 4-8 also includes the numbers of constituents above their relevant regulatory limits, NLs or AALs.

[29] Detected means that the concentration was above the MRL. The MRL represents an estimate of the lowest concentration of a compound that can be detected in a sample for which the concentration can be quantified and reported with a reasonable degree of accuracy and precision.

Table 4-8: Number of Constituents with Maximum Contaminant Levels and Notification Levels Detected in Untreated Source Waters

Source Water	Number of Constituents Detected			
	Primary MCLs	Secondary MCLs	NLs	AALs
RTP Effluent	12 (1)[a]	12 (6)	9 (1)	3 (0)
Agricultural Wash Water	20 (5)	12 (8)	9 (2)	2 (0)
Blanco Drain	15 (2)	12 (9)	6 (0)	3 (1)
Lake El Estero	12 (0)	11 (7)	5 (0)	0 (0)
Tembladero Sough	13 (2)	9 (8)	3 (0)	1 (0)

a. Numbers in parentheses are the number of constituents detected (at least once) above a regulatory limit or advisory level.

Table 4-9 provides a comparison between the results of the untreated source water monitoring and the concentrations of constituents with primary and secondary MCLs that were determined to be above their regulatory limits in at least one sample in any of the untreated source waters. Very few constituents were above primary or secondary MCLs in the various untreated source waters. For the NLs, only two constituents were found in two of the five untreated source waters (RTP effluent and agricultural wash water) above the current NLs as shown in **Table 4-9**. For the AALs, only three constituents were detected with one above the advisory level (see **Table 4-10**). Treatment will occur through the primary and secondary processes at the RTP and AWP Facility. These treatment technologies are typical for groundwater replenishment projects and will remove these constituents to below regulatory levels and goals as demonstrated by existing groundwater replenishment projects elsewhere and as discussed later in the report.

Table 4-9: Constituents with Maximum Contaminant Levels above Regulatory Limits in at Least One Sample of any of the Untreated Source Waters

Source Water	Comparison to Primary MCLs			Comparison to Secondary MCLs		
	Constituent	Primary MCL	Highest Concentration	Constituent	Secondary MCL	Highest Concentration
RTP Effluent	Di-(2-ethylhexyl) phthalate	4 µg/L	78 µg/L	Color	15 units	75 units
				Conductivity	900 µS/cm[a]	1623 µS/cm
				Iron	0.3 mg/L	0.537 mg/L
				Odor-Threshold	3 units	200 units
				TDS	500 mg/L[b]	803 mg/L
				Aluminum	0.2 mg/L	0.256 mg/L
Agricultural Wash Water	Fluoride	2 mg/L	31.9 mg/L	Chloride	250 mg/L[c]	292 mg/L
	1,3-Dichloropropene	0.5 µg/L	0.7 µg/L	Color	15 units	175 units
	Di(2-ethylhexyl)phthalate	4 µg/L	16 µg/L	Conductivity	900 µS/cm[a]	1830 µS/cm
	Haloacetic acids (HAA5)	60 µg/L	390 µg/L	Iron	0.3 mg/L	0.875 mg/L
	Total trihalomethanes	80 µg/L	160 µg/L	Odor-Threshold	3 units	350 units
				TDS	500 mg/L[b]	1594 mg/L
				Turbidity	5 NTU	72 NTU
				Aluminum	0.2 mg/L	0.598 mg/L
Blanco Drain	Aluminum	1 mg/L	2.04 mg/L	Chloride	250 mg/L[c]	307 mg/L
	1,3-Dichloropropene	0.5 µg/L	0.62 µg/L	Color	15 units	85 units
				Conductivity	900 µS/cm[a]	2929 µS/cm
				Iron	0.3 mg/L	3.891 mg/L
				Odor-Threshold	3 units	40 units
				Sulfate	250 mg/L[c]	530 mg/L
				TDS	500 mg/L[b]	2066 mg/L
				Turbidity	5 NTU	150 NTU
				Aluminum	0.2 mg/L	2.04 mg/L

Source Water	Comparison to Primary MCLs			Comparison to Secondary MCLs		
	Constituent	Primary MCL	Highest Concentration	Constituent	Secondary MCL	Highest Concentration
Lake El Estero	None		--	Chloride	250 mg/L[c]	514 mg/L
				Color	15 units	75 units
				Conductivity	900 µS/cm[a]	2559 µS/cm
				Iron	0.3 mg/L	0.508 mg/L
				TDS	500 mg/L[b]	1506 mg/L
				Turbidity	5 NTU	18 NTU
				Aluminum	0.2 mg/L	0.402 mg/L
Tembladero Slough	Aluminum	1 mg/L	1.54 mg/L	Chloride	250 mg/L[c]	394 mg/L
	Di(2-ethylhexyl)phthalate	4 µg/L	78 µg/L	Color	15 units	175 units
				Conductivity	900	2939 µS/cm
				Iron	0.3 mg/L	2.962 mg/L
				Sulfate	250 mg/L[c]	412 mg/L
				TDS	500 mg/L[b]	1968 mg/L
				Turbidity	5 NTU	50 NTU
				Aluminum	0.2 mg/L	1.54 mg/L

a. Recommended consumer acceptance level; upper range 1600 µS/cm.
b. Recommended consumer acceptance level; upper range 1000 mg/L.
c. Recommended consumer acceptance level; upper range 500 mg/L.

Table 4-10: Constituents with Concentrations above Notification Levels or Archived Action Levels in at Least One Sample in any of the Untreated Source Waters

Source Water	Comparison to NLs			Comparison to AALs		
	Constituent	NL	Highest Levels Detected	Constituent	AAL	Highest Levels Detected
RTP Effluent	NDMA	10 ng/L	16 ng/L	None	---	---
Agricultural Wash Water	Formaldehyde NDMA	100 µg/L 10 ng/L	120 µg/L 340 ng/L	None	---	---
Blanco Drain	None	---		Dieldrin	0.002 µg/L	0.028 µg/L
Lake El Estero	None	---	--	None	---	---
Tembladero Slough	None	---	--	None	---	---

4.2.2.4. Lead and Copper Action Levels

The Title 22 Criteria require that recycled water used for groundwater replenishment not exceed the action levels for lead and copper, which are 0.015 mg/L and 1.3 mg/L, respectively. The maximum concentrations of lead and copper measured in any of the untreated source waters were 0.0018 mg/L, and 0.073 mg/L, respectively. Thus, the source water sampling program found that lead and copper were below their respective action levels in all of the untreated source waters sampled. Further, the Project includes post-treatment water stabilization, which controls corrosion and dissolution of minerals in the groundwater. The decarbonation process reduces the inorganic carbon concentration and raises the pH, both of which decrease copper corrosion.

4.2.2.5. Total Organic Carbon

The Title 22 Criteria require that, prior to injection, the TOC concentration in recycled water not exceed 0.5 mg/L, based on the 20-week running average of all TOC results and the average of the last four TOC results. As shown in **Table 4-11**, the median concentration and range of TOC in the various untreated source waters are similar except for the agricultural wash water, which has a significantly higher TOC concentration. However, all of the untreated source waters will undergo treatment through the primary and secondary processes at the RTP and advanced treatment at the AWP Facility. These treatment technologies are typical for groundwater replenishment projects using subsurface application and will result in TOC concentrations at or below 0.5 mg/L. The RTP and the RO membranes are the primary barriers for TOC removal. The RTP will reduce the TOC concentration in the agricultural wash water through primary and secondary treatment. During the piloting program (described in **Section 7**), the TOC concentration in the RO permeate consistently was less than 0.5 mg/L when the system was operated in a manner consistent with how the full-scale system will be operated, even when the RTP was treating the agricultural wash water.

Table 4-11: Summary of Total Organic Carbon Concentrations Measured in Untreated Source Waters

Parameter[a]	RTP Effluent	Agricultural Wash Water	Blanco Drain	Lake El Estero	Tembladero Slough
TOC (mg/L)	15 (12-17)	295 (66-340)	3 (2.5-11)	14	8.8

a. Median values and data range (minimum concentration to maximum concentration) where applicable.

4.2.2.6. Total Nitrogen

The Title 22 Criteria require that the applied recycled water not exceed a total nitrogen concentration of 10 mg/L. Samples may be collected before or after subsurface application. As indicated in **Table 4-12**, the total nitrogen concentration in untreated Lake El Estero water meets the requirement, while the other untreated source waters do not. However, after treatment at the AWP Facility, all of the source waters will meet the total nitrogen requirement based on the treatment technologies to be provided that are typical for groundwater replenishment projects. The average total nitrogen removal observed through the piloting program (*see* **Section 7**) was 94.3%, which is sufficient to reduce these concentrations to levels below 10 mg/L. The principal AWP Facility nitrogen removal mechanism will be reduction through the RO membranes.

Table 4-12: Summary of Total Nitrogen Concentrations in Untreated Source Waters

Parameter[a]	RTP Effluent	Agricultural Wash Water	Blanco Drain	Lake El Estero	Tembladero Slough
Total nitrogen (mg/L as N)	44.2 (35.7-50.5)	25.3 (19-51.1)	70.1 (63-77.3)	1.3	58

a. Median values and data range (minimum concentration to maximum concentration) where applicable.

4.2.2.7. Priority Pollutants

The Title 22 Criteria require that recycled water and groundwater (from downgradient monitoring wells) be monitored for Priority Pollutants (chemicals listed in 40 CFR Part 131.38, "Establishment of numeric criteria for priority toxic pollutants for the State of California") specified by DDW, based on the DDW's review of a project's engineering report. A total of 32 of the 126 Priority Pollutants were detected in the source waters sampling. Of the 32 chemicals detected, 19 were chemicals with either MCLs or NLs. As described later, 16 Priority Pollutants were found in the RO permeate after the pilot testing, all of which also had concomitant MCLs or NLs with permeate concentrations less than the MCLs or NLs.

4.2.2.8. Constituents of Emerging Concern

Constituents of emerging concern were evaluated using the Eurofins Eaton Analytical Liquid Chromatography Tandem Mass Spectrometry method that specifically addresses 92 constituents. The highest occurrence of CECs was in the RTP secondary effluent. This was expected, as these compounds are common in wastewater and are often not significantly removed by conventional primary and secondary wastewater treatment (see **Figure 4-3**). For the 92 CECs that were included in the Eurofins method, 59 were detected in at least one source water, with the maximum concentrations being observed in the RTP secondary effluent for 50 of the 59 constituents. Of the nine other constituents, five were seen at the highest concentration in the agricultural wash water, and the other four maximum concentrations were detected in the drainage waters. It should be noted that for the new source waters, the concentrations presented in **Figure 4-3** are raw water concentrations that do not take into account blending with the other waters and treatment reduction through the RTP primary and secondary treatment processes, nor treatment through the pilot test facility or full scale AWP Facility. CEC data collected for the untreated source waters are presented in **Appendix E**, and are further discussed with regard to the pilot testing in **Section 7**.

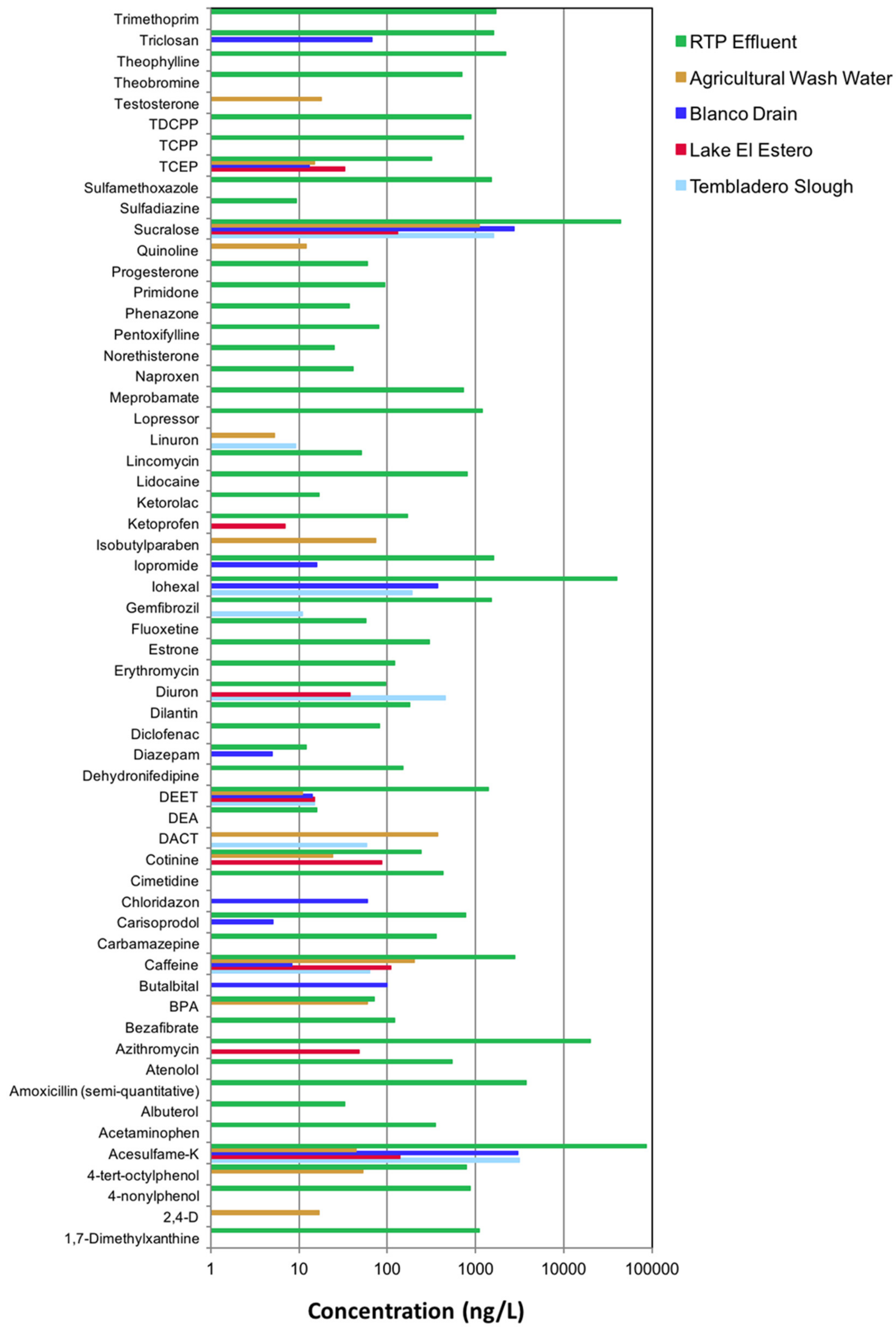


Figure 4-3. Constituents of Emerging Concern – Maximum Values Detected in the Waters included in the Source Water Sampling Program

4.2.2.9. NPDES Ocean Discharge Monitoring

The Monitoring and Reporting Program for the M1W NPDES Permit R3-2014-0013 requires semi-annual monitoring of the effluent discharged to the ocean (see **Appendix F**). The water quality data from January 2010 to February 2015 is shown in **Table 4-13**.

Table 4-13: Water Quality Summary for the Ocean Outfall Discharge Water, January 2010 through February 2015 and NPDES Limits

Contaminant	Unit	Limit[a]	Median	Minimum	Maximum
Objectives for protection of marine aquatic life					
Cadmium (6-mo median)	µg/l	150	ND	ND	ND
Chromium (Hex) (6-mo median)	µg/l	290	25	0.03	49
Lead (6-mo median)	µg/l	290	ND	ND	ND
Selenium (6-mo median)	µg/l	2200	1.1	0.74	43
Silver (6-mo median)	µg/l	79	ND	ND	ND
Cyanide (6-mo median)	µg/l	150	41	3.2	65
Total Chlorine Residual (6-mo median)	µg/l	290	200	200	200
Acute Toxicity (daily maximum)	TUa	4.7	0.4	0	2.3
Chronic Toxicity (daily maximum)	TUc	150	40	40	80
Phenolic Compounds (non-Chlorinated) (6-mo median)	µg/l	4500	2.1	1.6	2.6
Endosulfan (6-mo median)	µg/l	1.3	ND	ND	ND
Endrin (6-mo median)	µg/l	0.29	ND	ND	ND
HCH (Hexachlorocyclohexane) (6-mo median)	µg/l	0.58	20	5.8	34
Radioactivity (Gross Beta)	pCi/L	[b]	10.1	3.32	79.3
Radioactivity (Gross Alpha)	pCi/L	[b]	6.23	2.82	457
Objectives for protection of human health - noncarcinogens					
Acrolein	µg/l	32000	ND	ND	ND
Antimony	mg/l	180	0.38	0.38	0.38
Bis (2-chloroethoxy) methane	µg/l	640	ND	ND	ND
Bis (2-chloroisopropyl) ether	mg/l	180	ND	ND	ND
Chlorobenzene	µg/l	83000	ND	ND	ND
Di-n-butyl phthalate	mg/l	510	ND	ND	ND
Dichlorobenzenes	mg/l	740	0.074	0.074	0.074
Diethyl phthalate	mg/l	4800	ND	ND	ND
Dimethyl phthalate	mg/l	20000	ND	ND	ND
4,6-dinitro-2-methylphenol	µg/l	32000	ND	ND	ND
2,4-Dinitrophenol	µg/l	580	ND	ND	ND
Ethylbenzene	mg/l	600	ND	ND	ND

Contaminant	Unit	Limit[a]	Median	Minimum	Maximum
Objectives for protection of marine aquatic life					
Fluoranthene	mg/l	2200	0.0032	0.0032	0.0032
Hexachlorocyclopentadiene	µg/l	8500	ND	ND	ND
Nitrobenzene	µg/l	720	ND	ND	ND
Thallium	µg/l	290	ND	ND	ND
Toluene	mg/l	12000	0.11	0.056	0.16
Tributyltin	ng/l	200	ND	ND	ND
1,1,1-Trichloroethane	mg/l	79000	ND	ND	ND
Objectives for protection of human health - carcinogens					
Acrylonitrile	µg/l	15	ND	ND	ND
Aldrin	ng/l	3.2	ND	ND	ND
Benzene	µg/l	860	ND	ND	ND
Benzidine	µg/l	0.010	ND	ND	ND
Beryllium	ng/l	4800	ND	ND	ND
Bis(2-chloroethyl)ether	µg/l	6.6	ND	ND	ND
Bis(2-ethyl-hexyl)phthalate	µg/l	510	1.1	0.36	28
Carbon tetrachloride	µg/l	130	ND	ND	ND
Chlordane	ng/l	3.4	ND	ND	ND
Chlorodibromomethane	µg/l	1300	ND	ND	ND
Chloroform	mg/l	19	0.22	0.22	0.22
1,4-Dichlorobenzene	µg/l	2600	ND	ND	ND
3,3-Dichlorobenzidine	ng/l	1200	ND	ND	ND
1,2-Dichloroethane	µg/l	4,100	ND	ND	ND
1,1-Dichloroethylene	µg/l	130	ND	ND	ND
Dichlorobromomethane	µg/L	910	ND	ND	ND
Dichloromethane (methylenechloride)	mg/l	66	0.075	0.075	0.075
1,3-dichloropropene	µg/l	1300	ND	ND	ND
Dieldrin	ng/l	5.8	ND	ND	ND
2,4-Dinitrotoluene	µg/l	380	ND	ND	ND
1,2-Diphenylhydrazine (azobenzene)	µg/l	23	ND	ND	ND
Halomethanes	mg/l	19	0.00073	0.00073	0.00073
Heptachlor	µg/l	0.0073	ND	ND	ND
Heptachlor Epoxide	µg/L	0.0029	ND	ND	ND
Hexachlorobenzene	ng/l	32	ND	ND	ND
Hexachlorobutadiene	µg/l	2000	ND	ND	ND
Hexachloroethane	µg/l	370	ND	ND	ND
Isophorone	µg/l	110000	ND	ND	ND

Contaminant	Unit	Limit[a]	Median	Minimum	Maximum
Objectives for protection of marine aquatic life					
N-Nitrosodimethylamine	µg/l	1100	ND	ND	ND
N-Nitrosodi-N-Propylamine	µg/L	55	ND	ND	ND
N-Nitrosodiphenylamine	µg/l	370	ND	ND	ND
PAHs	ng/l	1300	0.0116	0.0045	0.0186
PCBs	ng/l	2.8	ND	ND	ND
TCDD Equivalents	pg/l	0.57	2.9E-09	5.0E-12	2.8E-08
1,1,2,2-Tetrachloroethane	µg/l	340	ND	ND	ND
Tetrachloroethylene	µg/l	290	ND	ND	ND
Toxaphene	ng/l	31	ND	ND	ND
Trichloroethylene	µg/l	3900	ND	ND	ND
1,1,2-Trichloroethane	µg/l	1400	ND	ND	ND
2,4,6-Trichlorophenol	µg/l	42	ND	ND	ND
Vinyl chloride	µg/l	5300	ND	ND	ND

[a] Limit value represents the 30-day average limitation unless otherwise noted.

[b] Not to exceed limits specified in California Code of Regulations, Title 22, Division 4, Chapter 15, Article 5, Section 64443

This Page Intentionally Left Blank

5. PATHOGENIC MICROORGANISM CONTROL

As required by the Title 22 Criteria, the pathogen reduction requirements for groundwater replenishment projects are 12-log, 10-log, and 10-log reduction for viruses, *Giardia* cysts, and *Cryptosporidium* oocysts, respectively ("12/10/10"). In order to achieve these 12/10/10 pathogen log reduction values (LRVs), M1W must utilize at least three separate treatment processes. Each treatment process can only receive up to 6-log reduction credit, and at least three processes must achieve at least 1.0-log reduction credit. Additionally, 1-log of virus credit can be earned for each month the water is retained underground. The pathogen removal assumed for each treatment process is discussed in the sections below. The combined LRVs for the Project will meet the Title 22 Criteria. The monitoring to ensure safety for groundwater replenishment will all ensure that the AWP Facility meets the less stringent Water Recycling Criteria for disinfected tertiary recycled water.

5.1. PRIMARY AND SECONDARY TREATMENT

M1W's RTP secondary treatment consists of bar screens, grit removal, primary clarification, biological trickling filters, bio-flocculation (solids contact), and secondary clarification with optional Chemically Enhanced Phosphorous Removal (CEPT) facilities. The solids contact process is an aeration basin that operates a short solids retention time (SRT), which is used to improve the trickling filter effluent water quality. At this time, no credits for primary or secondary treatment are being pursued because of limited data from the RTP. This is conservative, though, as some degree of pathogen removal does occur during primary and secondary treatment. Rose, et al. (2004) reported that pathogen removals through secondary treatment were 96% - 99.9% for viruses and bacteria, 97.7% - 99.8% for *Giardia* cysts, and 0% - 99.4% for *Cryptosporidium* oocysts. None of the treatment facilities included in the 2004 Rose study employed the trickling filters-solid contact secondary process and only one facility included primary treatment, where particle-associated pathogens may be removed through sedimentation. The one treatment facility that had primary clarification also had a short SRT aeration basin for the secondary process. At this facility, pathogen removals through primary and secondary treatment were 96% - 99.9% for viruses and bacteria, 99.1% for *Giardia* cysts, and 94% for *Cryptosporidium* oocysts.

The limited sampling that was conducted for Giardia cysts and Cryptosporidium oocyst during the pilot sampling campaign is reported in **Table 5-1**, which summarizes results from the RTP influent the RTP secondary effluent.

Aerobic secondary treatment at the RTP provides an effluent that meets the Water Recycling Criteria for an oxidized wastewater, which is a prerequisite to producing a disinfected tertiary recycled water for irrigation.

Table 5-1: Pathogen and Pathogen Indicator Removal Observed through RTP, Ozone, MF, and RO during Pilot Testing

Parameter[a]	RTP Influent[c] N=6	Undisinfected RTP Secondary Effluent N=6-22[d]	Ozone Effluent N=6-25[d]	MF Effluent N=6-25[d]	RO Permeate N=27
Cryptosporidium (oocysts/L) Recovery[b]	<2 (1 - 8) *23%*	<0.35 *(<0.09 - 0.9)* *30%*	2.65[e] (0.3 – 23.3) 92%	*<0.09* *(<0.09 - <0.1)* *26%*	-- --
Giardia (cysts/L) Recovery[b]	8847 (1634 - 13626)[b]	<0.15 (<0.09 – 1.1) <0.092%	<0.2 (<0.09 – 4.4) 76%	*<0.09* *(<0.09 - <0.1)* *50%*	-- --
Total coliform (MPN/100 mL)	-- --	2.8×10^5 (2.4×10^3 – 1.6×10^6)	6.3×10^2 (5.5×10^1 - 3.1×10^3)	<1 (<1 – 71)[f]	<1 (<1 - <1)
E. Coli (MPN/100 mL)	-- --	6.0×10^4 (4.9×10^2 – 3.3×10^5)	2.7x101 (<1 – 5.5×10^2)	<1 (<1 - <1)	<1 (<1 -<1)

a. N is the number of samples; median values shown, with ranges in parentheses. Two of the protozoa samples and approximately ten of the bacteria samples included diversion of agricultural wash water mixed with sewage and treated at the RTP.
b. Recovery measured in one sample. ColorSeed not used on RTP influent matrix spike; thus, native giardia interfered (recovery of 658%).
c. Draft EPA method 1693, which omits the filtration step of EPA method 1623a, used for analysis.
d. Greater sampling frequency for total coliform and *E. Coli*
e. There were consistently higher concentrations of *Cryptosporidium* oocysts measured in the ozone effluent compared to the secondary effluent. This effect appears to be an artifact of the analysis in part, where the ozonation of the water seems to have dramatically improved method recovery.
f. The two total coliform detections in the MF effluent samples (71 and 2) are suspected to be due to sample contamination

5.2. AWP Facility

The AWP Facility treatment train includes ozone, MF, RO, and UV/H_2O_2 AOP. A discussion of the pathogen LRVs for each unit process is presented below.

5.2.1. Ozone

Ozonation is the first treatment process in the AWP Facility treatment train. Its primary purpose is to reduce the size of the large organic molecules in the secondary effluent, which improves performance of the downstream MF system. Ozone also oxidizes CECs and pesticides, and provides pathogen inactivation. Although ozone has disinfection capability, no pathogen LRV credit is being pursued for the ozone process at this time. At the design ozone dose (10 mg/L) for the AWP Facility, the ozone demand of the water is high enough such that a measurable ozone residual cannot typically be carried through a significant length of time in the ozone contactor. A higher ozone dose and more ozone residual monitors would be required in order to achieve significant ozone CT (concentration multiplied by the contact time) credit.

If additional pathogen inactivation credit is needed for redundancy, ozone CT credit may be pursued in the future. CT values for inactivation by ozone are provided in the USEPA drinking water Surface Water

Treatment Rule (SWTR) Guidance Manual (U.S. EPA, 1990) for *Giardia* cysts and virus, and in the USEPA Long Term 2 Enhanced Surface Water Treatment Rule (LT2ESWTR) Toolbox Guidance Manual for *Cryptosporidium* oocysts. Equations derived from these CT tables are the following (U.S. EPA, 2010):

- *Cryptosporidium* oocyst log credit = 0.0397 x $(1.09757)^{Temperature(ºC)}$ x CT
- *Giardia* cyst log credit = 1.038 x $(1.0741)^{Temperature(ºC)}$ x CT
- Virus log credit = 2.1744 x $(1.0726)^{Temperature(ºC)}$ x CT

Substantially more ozone is required for *Cryptosporidium* oocyst inactivation than for either *Giardia* cysts or virus. For example, to receive 2-log virus inactivation credit at 25°C, a CT of only 0.160 mg/L-minute would be required, which would concurrently provide 1-log *Giardia* cyst inactivation but only 0.06-log *Cryptosporidium* oocyst inactivation.

This CT approach can be challenging for secondary and tertiary wastewater matrices for two key reasons. The first challenge is that ozone demand in wastewater is high, so it can be difficult to sustain the dissolved ozone residuals that are necessary for CT calculations. The second challenge is that the high ozone doses necessary to generate sufficient residuals can form disinfection by-products (e.g., bromate, NDMA, formaldehyde). Several ozone system suppliers have recently conducted disinfection validation studies based on an applied O_3:TOC ratio, rather than the achieved CT, and it was confirmed that significant virus inactivation occurs rapidly, before generating a measurable CT. In the future, M1W may pursue additional virus inactivation credit based on applied O_3:TOC ratio. More information is provided in Appendix M of this Engineering Report.

5.2.2. Membrane Filtration

MF follows ozone in the AWP Facility process train. MF is used as a physical barrier for removal of pathogens. The membranes that were pilot tested had nominal pore size of 0.01 microns. For this project, 4-log removal credit for *Giardia* cysts and 4-log removal credit for *Cryptosporidium* oocysts have been established, but no virus removal credit is being sought even though some particulate-associated viruses would be removed through MF. These LRVs are based on product-specific performance challenge tests conducted by the membrane manufacturer. Daily pressure decay tests (PDTs) will be conducted to confirm no broken fibers or other breach of membrane integrity, based on product-specific minimum test pressure and maximum allowable pressure decay. The membranes will be required to have passed the required challenge tests to demonstrate the desired 4-log *Giardia* cyst and *Cryptosporidium* oocyst removal.

Drinking water regulations provide a framework for Microfiltration/Ultrafiltration (MF/UF) to receive log removal credit for virus, *Giardia* cysts, and *Cryptosporidium* oocysts. Specifically, the California SWTR allows the use of MF/UF as an alternative filtration technology, provided the technology demonstrates at least 2-log *Giardia* cyst removal, 1-log virus removal, and 2-log *Cryptosporidium* oocyst removal and meets certain turbidity performance standards, per CCR, Title 22, Division 4, Environmental Health Chapter 17, Article 2, Section 64653(e). The State and Federal LT2ESWTR include additional regulations and guidance on achieving additional removal credit for *Cryptosporidium* oocysts. The LT2ESWTR Toolbox Guidance Manual (U.S. EPA, 2010) and Membrane Filtration Guidance Manual (U.S. EPA, 2005) provide detailed guidelines for performing the pathogen removal challenge tests on MF and UF to determine log removal credits (U.S. EPA, 2010). The daily PDT is performed to confirm the integrity of the membranes. A product specific minimum test pressure and a maximum allowable decay rate are used for the PDT, which is able to detect a 3-micron hole (i.e., the resolution of the test is 3-microns).

Given the pore size of the MF, 4-log removal credit for *Giardia* cysts and 4-log removal credit for *Cryptosporidium* oocysts are expected. Although the challenge tests confirm virus removal (0.5 to 1 LRV is typical), no credit is being pursued for virus removal for the Project. To receive pathogen reduction credit for the MF process, continuous monitoring of the system using online turbidimeters (i.e., indirect integrity monitoring) and daily PDTs (i.e., direct integrity monitoring) is necessary to ensure proper MF performance.

The WDR/WRR requires that the MF filtrate turbidity not exceed 0.2 NTU more than 5% of the time within a 24-hour period and 0.5 NTU at any time, which is equivalent to the Water Recycling Criteria for filtered wastewater through membrane filtration. Thus, in addition to providing sufficient pathogen control for groundwater replenishment, the Project will meet the Water Recycling Criteria for filtered wastewater, which, after disinfection, will allow the product water to be used for irrigation.

5.2.3. Reverse Osmosis

Additional pathogen removal credits for virus, *Giardia* cysts and *Cryptosporidium* oocysts will be credited through the RO membranes. RO process performance for pathogen removal will be confirmed by measuring a surrogate parameter (i.e., conductivity, or TDS) that demonstrates the RO membrane integrity. LRVs of these parameters are used as a conservative estimate of pathogen removal.

Most potable reuse advanced treatment facilities measure TOC or electrical conductivity (EC) reduction across the RO membranes as surrogates for pathogen log reduction. However, recent studies at the City of San Diego's North City Demonstration Pure Water Facility have shown that rejection of naturally occurring strontium is another effective surrogate. The San Diego demonstration testing showed that strontium rejection across the RO membranes (the same membranes installed in the PWM's RO system) provided a conservative assessment of MS2 virus rejection under both intact and compromised conditions, while providing higher log removal values (LRVs) than the typical surrogates EC and TOC. At the PWM AWP Demonstration Facility, M1W has conducted parallel sampling of EC, TOC, and strontium rejection across the ESPA2 LD RO membranes for the past 8 months, which are the same RO membranes installed in the full-scale AWP Facility. Results are presented in **Figure 5-1**. As shown, strontium LRVs were consistently greater than 2.5-log, TOC LRVs were consistently greater than 1.5-log, and EC LRVs were consistently greater than 1.0-log.

PWM will monitor rejection of all three surrogate parameters—strontium, TOC and conductivity—across the RO membranes, and apply a three-tiered approach for calculating applicable virus, *Giardia* cyst, and *Cryptosporidium* oocyst log reduction for the RO system. The first tier of pathogen credit will be based on strontium rejection as measured once daily in the RO feed and the combined permeate of each RO train. The second tier of pathogen credit will be based on TOC rejection calculated from continuous online monitoring of the RO feed and the combined RO permeate. The third and last tier for pathogen credit will be based on continuous on-line EC monitoring of the RO feed, combined RO permeate of each RO train, and combined RO permeate. Log reduction will be reported to DDW for all three surrogates, unless data is not available for the other surrogate(s), and the surrogate that provides the largest log reduction will be used for calculating pathogen LRV. For strontium, the lowest per train LRV will be reported. The expected minimum pathogen LRV for each surrogate is (1) at least 2.5 log for strontium rejection, (2) 1.5 log for TOC rejection, and (3) 1.0 log for EC rejection. Justification for this approach is provided in Appendix M of this Engineering Report.

The RO process provides an additional barrier to MF treatment by ensuring that the RO permeate turbidity will not exceed 0.2 NTU more than 5% of the time within a 24-hour period and that the RO permeate turbidity will not exceed 0.5 NTU at any time, which helps ensure that the treatment process will meet the Water Recycling Criteria requirements for filtered wastewater, prior to disinfection and irrigation use.

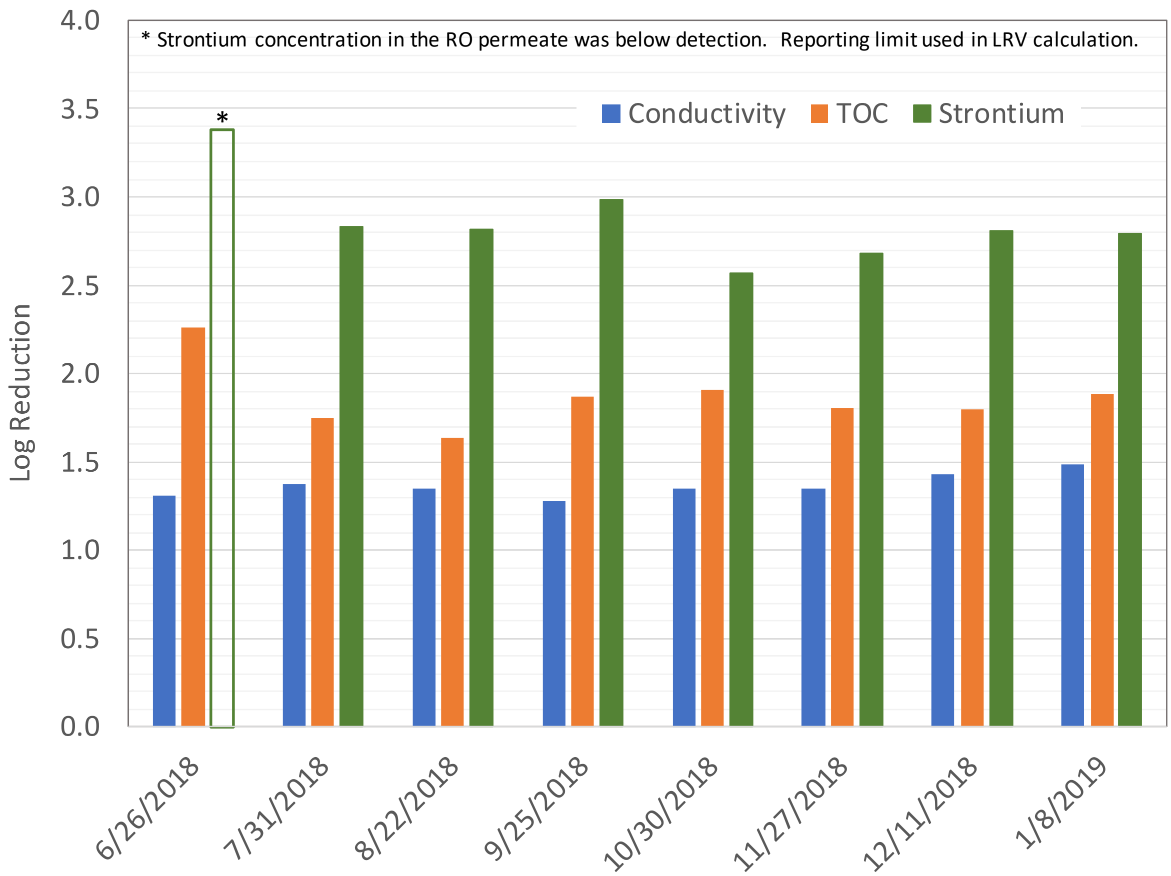


Figure 5-1. Log Removals for EC, TOC and Strontium Measured at the PWM Demonstration Facility

5.2.4. Advanced Oxidation

The next treatment process is AOP using UV/H_2O_2 with a UV dose of 1,600 mJ/cm^2, which was determined through collimated beam testing to meet the NDMA removal target. Pathogen inactivation credits being pursued through the UV/AOP system are 6-log each for *Cryptosporidium* oocysts, *Giardia* cysts and virus. The design dose is based on what is needed to achieve the required 0.5-log 1,4-dioxane reduction as well as other AOP goals (*e.g.*, 1.5-log reduction of NDMA), as discussed in **Section 3**.

For pathogen inactivation with UV/AOP, the USEPA's UV Disinfection Guidance Manual (U.S. EPA, 2006b) specifies the UV dose requirements for achieving up to 4-log *Cryptosporidium* oocyst, *Giardia* cysts, and virus credit with UV disinfection. The UV doses are shown in the **Table 5-2** below. With a dose of 1,600 mJ/cm^2 greater than 6-log inactivation of these pathogens is expected. Virus inactivation requires a higher UV dose than *Cryptosporidium* oocyst or *Giardia* cyst inactivation. Extrapolating the data in **Table 5-2**, a dose of 236 mJ/cm^2 is needed for 6-log virus inactivation, which is more than 6 times lower than the design UV dose. During start-up and commissioning of the AWP Facility, the UV doses required for 0.5 log removal of 1,4-dioxane will be determined. This dose is expected to be lower than the design dose, which was developed around the NDMA goal. If the UV dose required for 1,4-dioxane removal is sufficient to meet pathogen removal requirements, then M1W may operate at the 1,4-dioxane UV dose if NDMA levels are below the notification level.

Table 5-2: UV Dose Required for Pathogen Inactivation

Target Pathogens	Log Inactivation[a]							
	0.5	**1.0**	**1.5**	**2.0**	**2.5**	**3.0**	**3.5**	**4.0**
Cryptosporidium	1.6	2.5	3.9	5.8	8.5	12	15	22
Giardia	1.5	2.1	3.0	5.2	7.7	11	15	22
Virus	39	58	79	100	121	143	163	186

a. Source USEPA, 2006b.

Given the high dose of UV, it is not anticipated that small variability in process performance will have an impact on the ability of the system to meet the pathogen reduction targets for this system. To ensure the design dose is delivered, several parameters will be continuously measured—UV intensity (UVI), power, and UV transmittance (UVT)—to provide information about proper functioning of the system.

In order to meet the disinfected tertiary recycled water requirements in the Water Recycling Criteria, the disinfection process must, along with filtration, inactive or remove 5 logs of MS2 or poliovirus. The NWRI UV Disinfection Guidelines for Drinking Water and Water Reuse suggest a UV dose of at least 50 mJ/cm^2 for RO permeates with a turbidity equal to or less than 0.2 NTU 95% of the time and not to exceed 5 NTU and a UVT of 90% or greater. The guidelines state that at least 2 logs of viruses will be removed through the RO process, and that three-log inactivation of poliovirus can be achieved with a UV dose of about 30 mJ/cm^2. The design dose of 50 mJ/cm^2 is suggested in the guidelines to account for variability in the effluent quality. The guidelines include MS2 inactivation data that suggests 5 log removal can be achieved with a UV dose of 110 to 150 mJ/cm^2. Assuming no removal through RO, using the more conservative virus surrogate (MS2), and taking the upper range, 150 mJ/cm^2 is a conservative requirement for the Project to meet the Water Recycling Criteria for disinfected tertiary recycled water based on the NWRI UV Guidelines. This UV dose is less than the UV dose required for groundwater replenishment; accordingly, the AWP Facility will meet the Water Recycling Criteria for disinfected tertiary recycled water by meeting the requirements for groundwater replenishment.

5.2.5. Chlorine Disinfection

Chloramines are used for post-stabilization secondary disinfection. The treatment goal is a total chlorine concentration of 2 to 4 mg/L as Cl_2 entering the conveyance pipeline and at the injection wellhead. Any residual chloramines and ammonia in the water will have degraded prior to any of the monitoring wells, so water extracted from the ARS wells will not contain chloramines.

At 20°C, a CT of 370 mg/L-min is needed for 1-log *Giardia* inactivation with chloramines, and a CT of 109 mg/L-min is needed for 1-log virus inactivation. These CT values with chloramines assume that chlorine is applied ahead of ammonia, providing some (un-defined) amount of free chlorine disinfection (U.S. EPA, 1990). Disinfection capabilities of free chlorine are superior to chloramines. With free chlorine, a CT of only 22 mg/L-min is needed for 1-log *Giardia* inactivation (pH of 7.5, temperature of 20ºC), and a CT of only 0.5 mg/L-min is needed for the same log virus inactivation.

At this time, no pathogen inactivation credit for final disinfection with chlorine is being pursued. However, M1W may pursue disinfection credit in the future by considering either (1) using chlorine addition to breakpoint chloramines in the product water at the PWPS, and then adding ammonia after the PWPS discharge to reform chloramines, thereby allowing use of the chloramine CT tables in the drinking water regulations (U.S. EPA, 1990) or (2) conducting a virus inactivation study using preformed chloramines to demonstrate virus inactivation credit that could be achieved in the 8-mile conveyance pipeline. Chlorine residual at the injection wellfield will be measured continuously with two amperometric analyzers and recorded through the AWPF's SCADA system. More information is provided in Appendix M of this Engineering Report.

5.3. Subsurface Pathogen Reduction Credit

The Project qualifies for a pathogen (virus) reduction credit associated with the time that product water remains underground (from injection to extraction). The Title 22 Criteria for groundwater replenishment by subsurface application allow for a 1-log virus reduction credit for each month underground. This allowance applies only when underground retention times are confirmed with an added tracer study. Other methods of estimating underground retention times are assigned less than 1-log reduction credit per month, with the actual reduction credit differing among various methodologies (see Table 60320.208, Title 22 Criteria).

Preliminary analytical estimates of local groundwater velocity suggest that product water injected into the Santa Margarita Aquifer (via deep injection wells) will remain underground for at least one year prior to extraction. Product water injected into the Paso Robles Aquifer (via vadose zone wells) will remain underground even longer due to vadose zone transport, lower permeability in the shallow aquifer, and farther to extraction wells.

Although this analytical estimate of at least one year provides a useful average for planning purposes, it does not represent the variability in underground retention times resulting from the highly dynamic local flow conditions. Groundwater flow beneath and downgradient of the injection facilities area is controlled in part by operation of the nearby ASR facilities; these wells inject, rest, and pump at intermittent time intervals depending on the availability of injectate from the Carmel River system, time since an injection cycle ended, demand by CalAm, and pumping from other production wells in the Seaside Basin. In order to evaluate the underground retention time under the full range of dynamic hydraulic conditions at the Injection Facilities area, a groundwater flow model was applied to the analysis.

The underground retention time did not change when the AWP Facility capacity was increased from 4 mgd to 5 mgd, as the additional 1 mgd of capacity will be used for irrigation and withdrawn from the conveyance pipeline prior to injection.

5.3.1. Numerical Modeling of Underground Retention Time

The numerical model used to estimate underground retention times – referred to herein as the Watermaster Model – was developed, calibrated, and documented by the Seaside Basin Watermaster in 2009 (Hydrometrics, 2009). The Watermaster Model is a transient five–layer model built on the MODFLOW platform and calibrated over a 22-year period from January 1987 through December 2008. The model has been widely applied for numerous basin-wide groundwater management assessments and represents a technically-credible and accepted tool for simulating groundwater scenarios in the Seaside Basin (Hydrometrics, 2014a). Additional details of the Watermaster Model are summarized in **Section 9.1.3.2**.

For the Project, the Watermaster Model was used to simulate underground retention time (travel time) between each of the four injection wells and the closest production well under varying hydrologic and pumping conditions. The modeling was conducted using the predictive model setup developed previously by the Watermaster for analyzing future conditions in the Seaside Basin. The predictive model covers a 33-year period from 2009 through 2041. The injection wells are currently anticipated to commence operations in 2019. For purposes of the modeling analysis, the injection was simulated as beginning in October 2016 to cover the entire Water Year (WY)[30] 2017 and allow for a 25-year analysis of the Project.

Modeling incorporated recharge volumes and a monthly delivery schedule of product water to the four injection wells, including a drought reserve account as described in more detail in **Section 8**. The delivery schedule was varied based on hydrology and the balance of the drought reserve account for every year of the simulation (see **Table 8-1** and **Sections 8.1** through **8.3** for more information on the product water delivery schedule).

Modeling also incorporated reasonable assumptions of future operation of production wells in the Seaside Basin. Production wells were assumed to be pumping in the model based on court-allocated pumping and agreements associated with the Seaside Basin adjudication. CalAm production wells (and the ASR wells) were assumed to be the recovery (extraction) wells for the product water based on existing well capacity and water demand at any given time.

A quantitative assessment of future operations of the ASR Project was developed by MPWMD for the modeling. MPWMD operates the ASR facilities under cooperative agreements with CalAm. The ASR future operations assessment was based on historical hydrologic conditions on the Carmel River between 1987 and 2008 and approved rules of ASR operation. These criteria allowed MPWMD to predict both injection and recovery schedules at each ASR well over time. By incorporating this assessment into the model setup, the Project could be evaluated over a full range of ASR injection and recovery (pumping) conditions.

Particle tracking, a modeling process used to track the movement of product water in the groundwater system, was used to evaluate travel times. For the particle tracking analysis, “particles” (acting as simulated tracers of the recharged water) were released at each of the eight proposed injection well sites (four deep injection wells and four vadose zone wells) in every month of the 25-year simulation of the Project. This provided a comprehensive assessment of various travel times that could occur under

[30] A WY is defined as October 1 through September 30, and is based on the annual precipitation pattern in California. The Water Year is designated by the calendar year in which it ends.

numerous combinations of pumping and ASR operations. Particles were simulated as being released around the edges of each model cell that contained an injection well and were tracked as they flowed downgradient in the aquifers. Particles were tracked until they reached a cell containing a production well, where they were extracted from the system. Tracking from the edges of model cells (rather than at a well location within the cell) allows for a thorough examination of particle transport, but is also conservative in that it eliminates the additional distance a particle will travel between the actual well and the edge of a cell.

Documentation of model set-up and results were presented in technical memoranda prepared by Montgomery & Asssociates [formerly HydroMetrics Water Resources Inc. (HydroMetrics)], the firm that developed and ran the Watermaster model in support of the Project. The complete technical memorandums are included as **Appendix D** to this Engineering Report.

When a numerical model, such as the Watermaster Model, is used to demonstrate the underground retention time, the Title 22 Criteria require that the reduction credit be reduced to only 0.5 log per month to account for uncertainty in the method of analysis (Table 60320.208 in the regulations). For example, the model would need to demonstrate a travel time of one year to allow for a 6-log virus reduction credit.

5.3.2. Underground Retention Time Modeling Results

The results of the particle tracking analysis confirmed that travel time from PWM injection wells to drinking water wells was greater than one year during most of the 25-year simulation period. Travel time from the deep injection wells (DIW-1 and DIW-2) to nearest drinking water well (ASR 1/2) was greater than 12 months in 287 months of the 300 months for which the PWM project was simulated (96 percent occurrence). Travel times of recycled water from the vadose zone wells to the nearest drinking water well was greater than 3.8 years throughout the simulated PWM injection period.

High-velocity conditions in the Santa Margarita Aquifer occurred during simulated drought years when basin production was at its maximum and ASR wells were extracting stored water rather than injecting Carmel River water. Although these faster travel times occurred only during 4 percent of the period when PWM was injecting, the fastest travel time is the focus of the analysis, consistent with a conservative approach.

Particle tracking results for the fastest travel time period are illustrated on **Figures 5-2** and **5-3** for the deep injection wells and vadose zone wells, respectively. Paths are colored separately for each well. As indicated by the jagged nature of some of the particle paths on **Figure 5-2**, groundwater flow in the Santa Margarita Aquifer is being influenced by the dynamic system created by changes in pumping and injection in both production and ASR wells. ASR wells repel the particles when injecting and attract the particles when pumping. Because the injection rates (about 1,500 gpm) and pumping rates (up to 3,000 gpm) at the ASR wells represent some of the highest rates for Seaside Basin wells, these wells significantly influence local hydraulic gradients.

As shown on **Figure 5-3**, simulated flow paths from vadose zone wells are not impacted by ASR operation. Product water injected in the vadose zone wells flows downgradient unimpeded until arrival at wells that are at least partially screened in the Paso Robles Aquifer (e.g., Paralta, Luzern). Many of the particles do not reach extraction wells during the model simulation period and are not a factor in calculating the underground retention time. If all of the product water were injected into the vadose zone wells only, a 6-log virus reduction credit (or more) would be readily demonstrated. The fastest travel times to a downgradient extraction well for each of the injection wells were tabulated from the model as summarized in **Table 5-3**.

The fastest travel times to a downgradient extraction well for each of the injection wells were tabulated from the model as summarized in **Table 5-3**. **Table 5-3** documents the fastest travel time from injection to extraction in days.

Table 5-3: Simulated Fastest Travel Times between Injection and Extraction Wells

Extraction Well	Recharge Well of Origin			
	DIW-1	DIW-2	VZW-1A	VZW-2
	Travel Time (Days)			
ASR 1&2	344	328	—	—
ASR 3&4	—	—	—	—
City Seaside #3	—	—	—	—
Luzern	—	—	—	1,394
Ord Grove **#2**	—	657	8,422	7,719
Paralta	520	757	1,399	—

a. – no particle arrives at wells during the 25-year simulation period

A minimum underground retention time in the Santa Margarita Aquifer (from DIW-2 to ASR 1&2) of 328 days (10.8 months) was simulated. The minimum travel time from DIW-1 to ASR 1&2 was similar (344 days; 11.3 months). Particles from DIW-2 are also transported to the Ord Grove #2 and Paralta production wells, while particles from DIW-1 are captured by the Paralta production well.

A minimum underground retention time in the Paso Robles Aquifer (from VZW-2 to the Luzern well) of 1,394 days (44.3 months; 3.7 years) was simulated. It is noted that the travel time from VZW-2 to the Ord Grove #2 well is slower (21.1 years) than the travel time to the more distant Luzern well. This is because the Luzern well is screened in the shallow aquifers, whereas the Ord Grove #2 well is screened in the deeper Santa Margarita Aquifer, and the horizontal water velocities are much higher than the vertical velocities between aquifers. The Paralta well is screened in both the Paso Robles and the Santa Margarita Aquifers and thus receives particles from VZW-2 within similar time scale as the Luzern well.

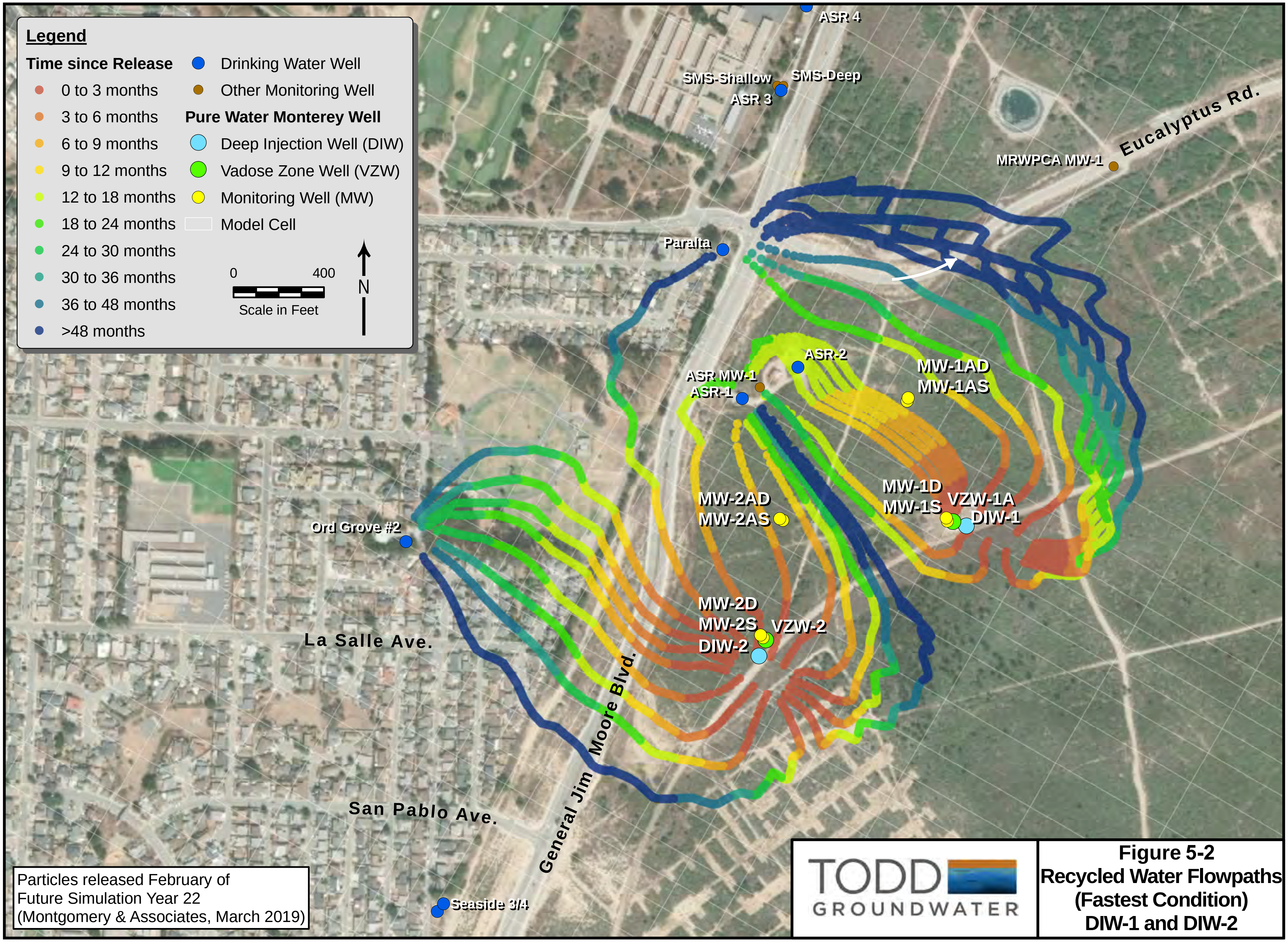


Figure 5-2
Recycled Water Flowpaths
(Fastest Condition)
DIW-1 and DIW-2

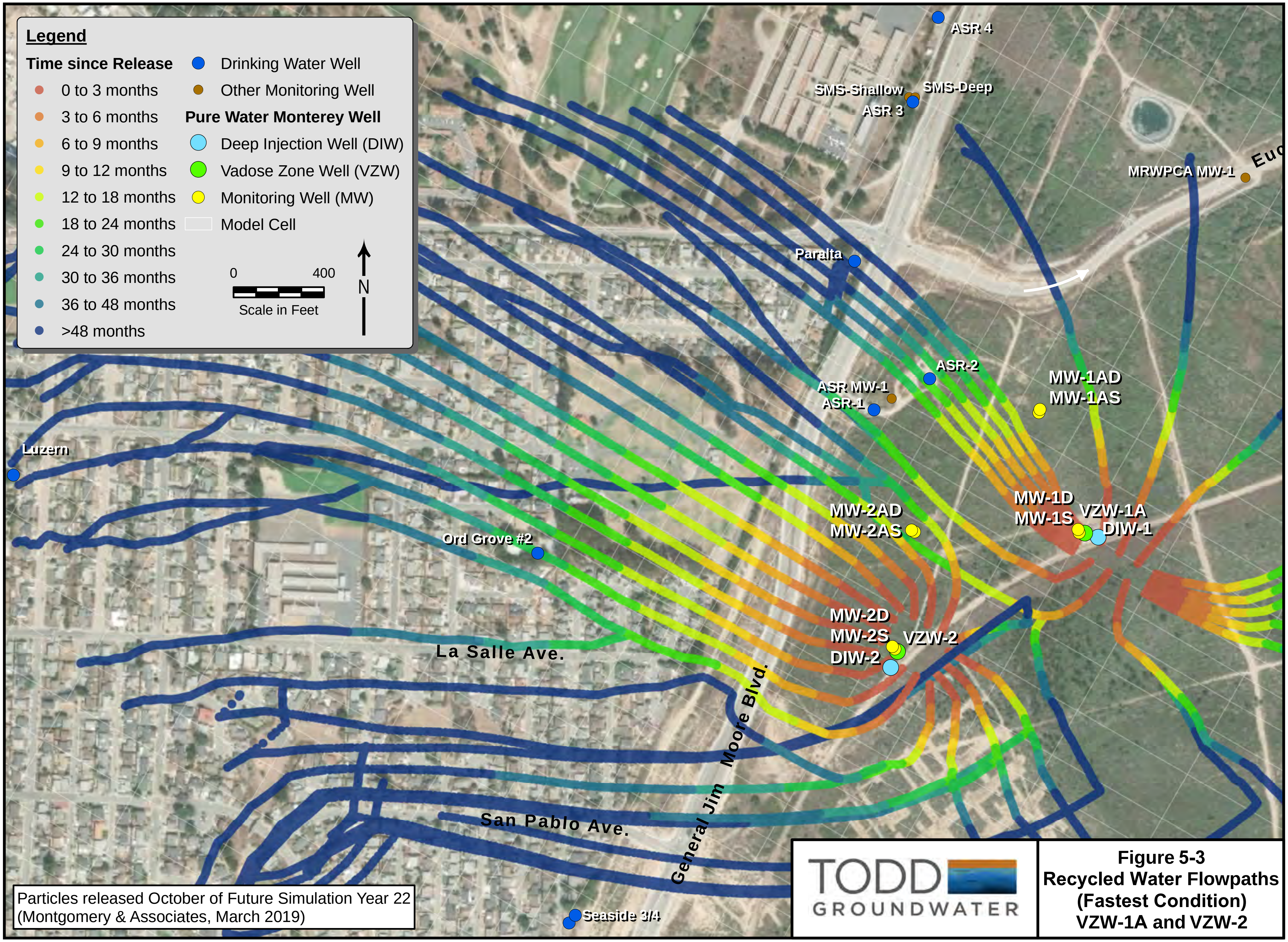


Figure 5-3
Recycled Water Flowpaths
(Fastest Condition)
VZW-1A and VZW-2

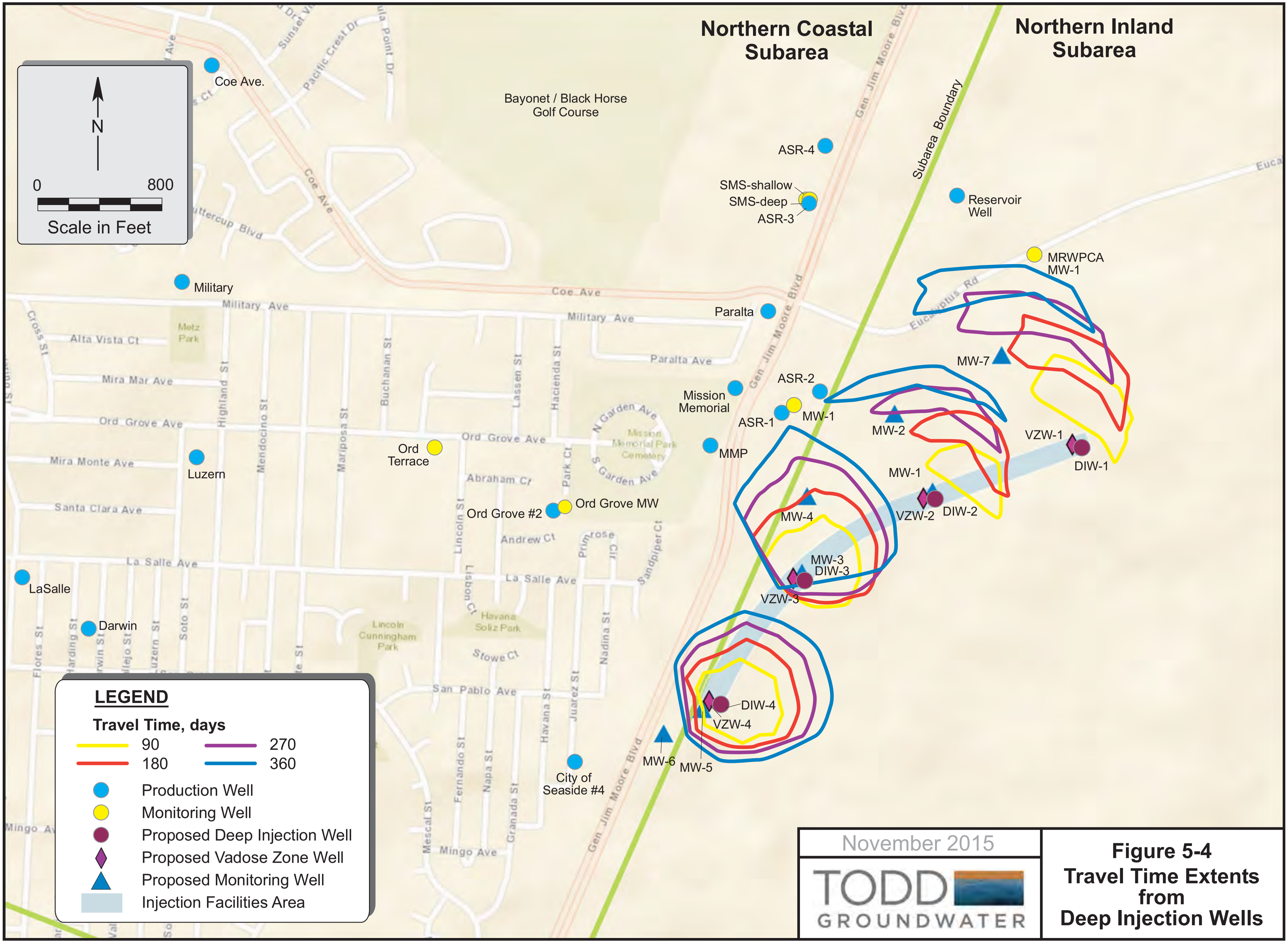
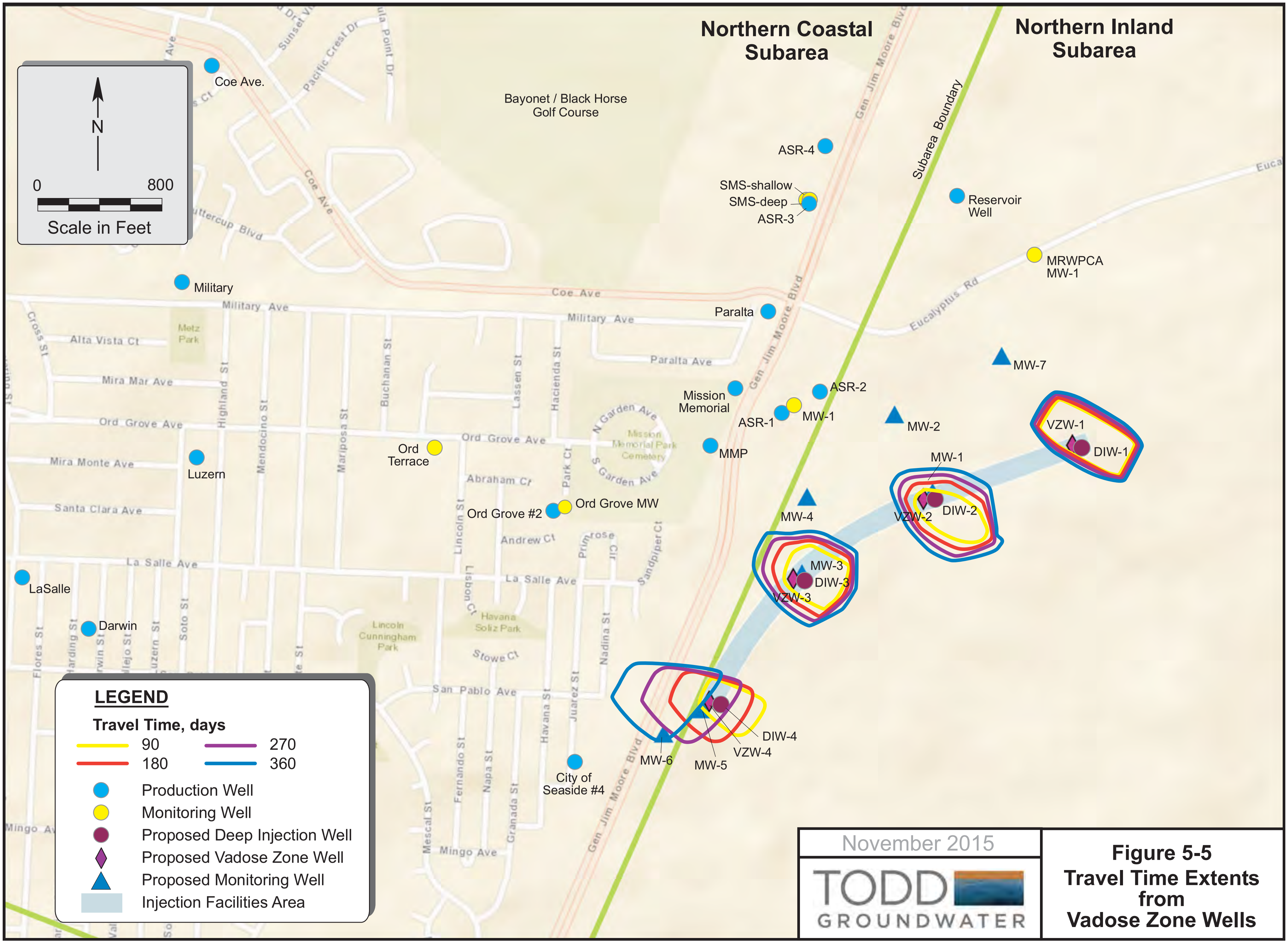


Figure 5-4
Travel Time Extents from Deep Injection Wells



November 2015

TODD GROUNDWATER

Figure 5-5
Travel Time Extents from Vadose Zone Wells

5.3.3. Pathogen Reduction Credit Requested

Based on the results of the modeling, it appears that injected water will remain in the groundwater system for at least six months, which will meet the requirements for a 6-log virus reduction credit if demonstrated by added tracer testing (or with a safety factor for intrinsic tracer testing). But because the demonstration of underground retention time with groundwater modeling requires a one-year travel time for conditional approval of the a 6-log reduction credit, a lower reduction credit is proposed. As described above, DIW-2 is approximately 37 days short of the one-year requirement under certain pumping conditions during five years of the 25-year simulation period. The underground retention time of 328 days from DIW-2 to the downgradient ASR wells is the controlling factor in the log reduction credit request.

Accordingly, a 5.4-log virus reduction credit is requested for the underground retention time portion of the Project treatment process. The fastest travel time of 328 days represents approximately 10.8 months. With a virus reduction credit of 0.5-log per month, a 5.4-log reduction credit is derived.

5.3.4. Potential Modification of Virus Reduction Credit

The analysis that supports the 5.4-log virus reduction credit is highly conservative. As mentioned previously, the modeling releases and extracts the particle at the edges of the model cell rather than at the actual well location. Furthermore, only particles released in 13 months out of 300 months exhibit the slightly less than one-year travel time. The water injected during the months associated with fast travel times will mix with ambient groundwater and previously-injected water to mitigate the amount of low residence-time water at the production well. Finally, average underground retention times for all wells exceed the one-year minimum requirement as demonstrated by groundwater modeling. Given the conservative nature of the analysis and the conservative assumptions built into the Title 22 Criteria regarding travel times from modeling, actual underground retention times are likely to exceed the six-month minimum under all flow conditions.

In order to validate a 6-log virus reduction credit, a tracer test, rather than modeling alone, is needed to demonstrate that the Project can meet a six-month underground retention time. Within the first three months after Project start-up, the underground retention time will be confirmed through tracer testing (see tracer test planning information in **Section 12.8** of this report). If tracer testing is successful, a 6-log reduction credit may be requested at that time.

5.4. Pathogenic Microorganism Control Summary

The expected pathogen log removal credits for the Project are summarized in **Table 5-4**. Total pathogen removal credits for the Project meet and are expected to exceed the requirements set forth by the Title 22 Criteria of 12-log, 10-log, and 10-log for virus, *Giardia* cysts, and *Cryptosporidium* oocysts, respectively. The pathogen control methods required for groundwater replenishment are also sufficient to meet the Water Recycling Criteria for disinfected tertiary recycled water used for landscape irrigation.

Table 5-4: Pathogen Log Removal Expectations and Requirements

Process	Treatment Confirmation	Log Reduction Credits		
		Virus	*Giardia*	*Crypto*
RTP Primary & Secondary[a]	Credit not pursued at this time	0	0	0
Ozone[a]	Credit not pursued at this time	0	0	0
MF	Daily PDT and turbidity monitoring	0	4	4
RO	Daily grab samples (strontium) and online monitoring (TOC and conductivity)	2.5	2.5	2.5
AOP (UV/H_2O_2)	UV dose monitoring[b]	6	6	6
Final Disinfection-Chlorine[a]	Credit not pursued at this time	0	0	0
Underground Residence Time in Aquifer	6-month underground retention time[c]	5.4	0	0
Total Expected Credit		**13.9**	**12.5**	**12.5**
Required Credit		**12**	**10**	**10**

a. May be included if additional credit for redundancy is needed.

b. The UV dose will be determined through online monitoring of the UVT, UV intensity, and flowrate.

c. Actual residence time is expected to exceed 6 months. When the tracer test (using an intrinsic tracer) confirms the modeled underground retention time of 10.8 months, the Project would be credited with virus removal of 7.2-log (applying the 0.67 log safety factor for an intrinsic tracer listed in the California Recycled Water Regulations).

This Page Intentionally Left Blank

6. RESPONSE RETENTION TIME

In accordance with Title 22 Section 60320.224, a project sponsor must propose an RRT. The criteria state that the RRT can be no less than two months. The intent of the RRT is to allow ample time to identify any treatment failure so that inadequately treated recycled water does not enter a potable water system. The RRT also allows time, if necessary, to provide an alternative water supply or well head treatment in the event that a GRRP impacts a well, preventing it from being used as a potable water supply. This is accomplished by retaining recycled water underground while the issue is diagnosed, and a resolution is implemented.

For planning purposes, a numerical model was used to predict the fastest travel times from recharge wells to downgradient production wells using the applicable safety factors in Title 22 Section 60320.224(d) to account for uncertainty in the method of analysis (discussed in **Sections 5.3 and 6.3**). This analysis demonstrated that an underground retention time of at least 5.4 months can be documented (10.8 month travel time corrected by the safety factor of 0.5 for modeling). To demonstrate that the actual retention time underground an added tracer or a DDW approved intrinsic tracer with a safety factor (0.67 month credit per month of time estimated using the intrinsic tracer) can be used. The tracer testing must be conducted prior to the third month of operation (see **Section 12.8**).

The response measure components of the RRT (5.25 months) are presented and justified in **Section 6.2**. The RRT is based on the following hypothetical worst-case scenario: immediately after a routine sample is taken for acutely toxic constituents, "off-specification" product water from the AWP Facility is inadvertently injected into the groundwater system. The RRT of 5.25 months is composed of the following response measure components:

- Time to Identify Water Quality Problem and Complete Confirmation Sampling (see **Section 6.1.2**):
    - Identify: Time elapsed before product water exceedance is discovered is the sum of the (1) longest time elapsed between sample collection, and (2) longest time elapsed before laboratory results are shared with M1W.
    - Confirm: Time needed to confirm (1) problem exists through additional sampling at AWP Facility and nearest monitoring well and (2) potential problem no longer exists by demonstrating four consecutive samples are below the MCL.
- Time to Assess Results with DDW and RWQCB (see **Section 6.1.3**):
    - Time needed to share findings and make decision regarding the appropriate response(s).
- Time to Procure Safe Interim Drinking Water Supply (see **Section 6.1.4**):
    - Time necessary to provide an interim water groundwater supply should DDW determine that the Project has impacted a drinking water well so that it can no longer be used as a drinking water supply.

The following subsections expand on these response components and provide the basis for the RRT.

The response retention time does not change with the increase in AWP Facility capacity from 4 mgd to 5 mgd because the additional 1 mgd capacity is for irrigation which will be withdrawn from the product water conveyance pipeline prior to injection.

6.1. Response Retention Time Components

6.1.1. RRT Concept

The RRT aims to protect public health by allowing for an interim safe drinking water source to be secured in the unlikely event that "off-specification" recycled water is injected into the ground with an emphasis on constituents that pose acute (short-term) health risks. Most chemical contaminants monitored in drinking water pose chronic (long-term) health risks (i.e., short-term exceedances of a limit would not result in adverse health consequences). Thus, the RRT is based on microbial pathogens (using total coliform organisms as the indicator organism), nitrogen compounds (nitrate and nitrite), and perchlorate, because they represent acute risks (i.e., short-term health risks to the water consumers) that require immediate attention. These contaminants posing acute risks are similar to RRTs derived for other groundwater replenishment projects. If any of these constituents are measured above acceptable levels in the product water (see **Table 6-1**), DDW will be informed and the response outlined within this section will be initiated.

Table 6-1: Acute Contaminants and Concentrations at which RRT Response is Initiated

Acute Parameters	Concentration	Units
Total coliform	2.2 (7-day median) 23 (in more than 1 sample in any 30-day period) 240 (any sample)	MPN/100mL
Nitrate (as N)	10.0	mg/L
Nitrite (as N)	1.0	mg/L
Perchlorate	0.006	mg/L

It is noteworthy that the exceedance of these acute parameters is highly unlikely as M1W will incorporate the following safety features that are part of the Project: (1) continuous online monitoring of RO treatment with real-time results reviewed by the AWP Facility operators; (2) multiple levels of critical control points for AWP Facility operations, alarms, and unit process redundancy; and (3) the ability to shut down the AWP Facility at a moment's notice. Additionally, piloting results for the AWP Facility support the reliability of the AWP Facility product water (see **Table 6-2**).

Table 6-2: Summary of Results from AWP Piloting – RO Permeate

Acute Parameters[a]	Number of Detects/ Total Number of Samples	Median (Range)	Units
Coliform	0/26	<1 (all non-detects)	MPN/100mL
Nitrate (as N)	17/26	<0.2 (<0.2 – 0.7)	mg/L
Nitrite (as N)	20/26	<0.1 (<0.1 – 0.4)	mg/L
Perchlorate	0/1	<0.002 (only 1 sample taken)	mg/L

[a] All of these constituents would be further reduced through UV/AOP treatment (UV/AOP was not included in the pilot testing)

6.1.2. Time to Identify Water Quality Problem and Complete Confirmation Sampling

Real-time tracking of critical control points at the AWP Facility serves to identify early signs of any treatment performance issues. The RRT however is based on the worst-case hypothetical scenario – discovering the problem based on water quality results of an acutely toxic parameter that (1) is measured infrequently and (2) requires substantial time for the laboratory to analyze and notify M1W of the results. The maximum time that could pass before a problem is identified is the sum of (1) time between sampling events and (2) time estimated by the contracted laboratory to analyze and report the results to M1W. The time passed before a problem is identified varies depending on the acute water quality parameters, which may have different monitoring frequencies and different times for completion of analyses (see **Table 6-3**).

Table 6-3: Routine Monitoring Details for Acute Contaminants in AWP Effluent

Acute Parameters	Monitoring Frequency	Sample Delivery [a]	Analysis Time	Estimated Notification Time	Total Time to Identify Water Quality Problem[b,c]
Coliform	1/day	n/a	1 day	1 days	3 days
Nitrate	1/week	n/a	8 hours	2 days	10 days
Nitrite	1/week	n/a	8 hours	2 days	10 days
Perchlorate	1/month[d]	1 day	1 day	10 days	40 days

a. Coliform, nitrate, and nitrite to be completed by MRWCPA in their in-house laboratory. Perchlorate to be sent to Monterey Bay Analytical Services, who subcontracts either with McCampbell Analytical, Inc. or BSK Analytical Laboratories.
b. Total Time = Frequency + Sample Delivery + Analysis Time + Estimated Notification Time.
c. Total Time is rounded up to nearest whole day.
d. Because perchlorate is effectively removed by RO, a treatment step provided at the AWP Facility, the following is proposed: collect quarterly RTP secondary samples and monthly product water samples for 1 year. If the product water results are below detection and no perchlorate appears to be coming from the RTP, M1W will request that the product water perchlorate sampling frequency be increased to quarterly without impacting the RRT.

The laboratory turnaround estimates in **Table 6-3** are conservative (i.e., longer than anticipated), and may be expedited by M1W during time-sensitive situations. Based on **Table 6-3**, the greatest amount of time (40 days) is associated with the assessment of perchlorate.

If there is an exceedance in concentration of an acute parameter, M1W will concurrently initiate confirmation sampling at the AWP Facility and the nearest down-gradient monitoring well. To the extent possible, the results for the confirmation samples will be expedited from the contracted laboratory. See **Table 6-4** for timing of expedited turnarounds.

As part of the confirmation sampling efforts, M1W will launch weekly monitoring of acute contaminants at two locations: (1) the AWP Facility product water and (2) the nearest monitoring well to the injection well. Both sites will be sampled weekly ahead of and during the theoretical arrival of the "off-specification" water at the monitoring well, as well as four weeks after the theoretical arrival at the monitoring well. The monitoring well provides early warning for the down-gradient potable production wells. Based on modeling results, travel time to the monitoring well (this monitoring well also serves as the monitoring well for the tracer test) is between 2 weeks to 1 month. The duration used for the RRT calculation is twice that predicted by the model to account of uncertainties, as set forth in Title 22 Section 60320.224(d). Pursuant to Title 22 Section 60320.212(d)(1), product water and monitoring well samples will be collected until four consecutive weekly results are below the contaminant's MCL.

Table 6-4: Estimated Turnarounds for Expedited Assessment of Acute Contaminants

Acute Parameters	Sample Delivery [a]	Analysis Time	Estimated Notification Time	Total Time to Process Expedited Sample[b,c]
Coliform	N/A	1 day	1 day	2 days
Nitrate	N/A	8 hours	8 hours	1 days
Nitrite	N/A	8 hours	8 hours	1 days
Perchlorate	1 day	1 day	2 days	4 days

a. Coliform, nitrate, and nitrite to be completed by MRWCPA in their in-house laboratory. Perchlorate to be sent to Monterey Bay Analytical Services, who subcontracts with McCampbell Analytical.

b. Total Time = Sample Delivery + Analysis Time + Estimated Notification Time.

c. Total Time is rounded up to nearest whole day.

As part of the confirmation sampling efforts, M1W will launch weekly monitoring of acute contaminants at two locations: (1) the AWP Facility product water and (2) the nearest monitoring well to the injection well. Both sites will be sampled weekly ahead of and during the theoretical arrival of the "off-specification" water at the monitoring well, as well as four weeks after the theoretical arrival at the monitoring well. The monitoring well provides early warning for the down-gradient potable production wells. Based on modeling results, travel time to the monitoring well (this monitoring well also serves as the monitoring well for the tracer test) is between 2 weeks to 1 month. The duration used for the RRT calculation is twice that predicted by the model to account of uncertainties, as set forth in Title 22 Section 60320.224(d). Pursuant to Title 22 Section 60320.212(d)(1), product water and monitoring well samples will be collected until four consecutive weekly results are below the contaminant's MCL.

The total time to identify water quality problem and complete confirmation sampling is 19 weeks and is the sum of:

- Longest time elapsed between sample collection (1 month);
- Longest turnaround for routine results (12 days);
- Travel time to monitoring well, doubled to account for uncertainty in numerical model (4 weeks x 2 = 8 weeks);
- Four consecutive weekly samples after passage of "off-specification" water at monitoring well to demonstrate all four concentrations are below contaminant's MCL (4 weeks); and
- Longest turnaround for expedited results (4 days).

6.1.3. Time to Assess Water Quality Results with DDW and RWQCB

M1W will inform DDW and RWQCB if RRT response is initiated and will keep the regulators abreast of the findings. After the last set of results are available, the time required for MRWPACA, DDW, and RWQCB to assess the sample results and make decisions regarding the appropriate response(s) is estimated to be 1 week.

6.1.4. Time to Procure Safe Interim Drinking Water Supply

As discussed in previous sections, M1W has a response plan with remedial actions for plant operators if the product water cannot meet reuse or discharge standards, including immediate shutdown of recycled water deliveries. M1W also has contingency plans for disposal of "off-specification" recycled water via the ocean outfall (this water will meet NPDES permit effluent limitations). In this section, M1W presents an additional response plan for procuring a safe interim drinking water supply (plan) in the unlikely event that a water quality problem by-passes the multiple fail-safe measures associated with the AWP and injection facilities. The eight steps of the plan, discussed in this section, provide a systematic and comprehensive approach for addressing a water quality issue in the Seaside Basin on both a short-term and long-term basis.

The time required for M1W to notify and coordinate with regulatory agencies and stakeholders on a water quality problem and initiate steps of this plan is estimated to take one week.

In addition to actions at the AWP Facility, M1W will immediately implement appropriate steps in the plan outlined below to mitigate any potential impacts to the drinking water supply. Explanation and assumptions for each step of the plan are also provided.

The plan focuses on potential impacts to the downgradient drinking water wells associated with the fastest subsurface arrival time of Project water; these two wells, ASR-1 and ASR-2[31], are located about 1,000 feet from the injection wellfield. However, the plan also applies to other potentially impacted downgradient wells, including the City of Seaside Well No. 4, located southwest of the injection wellfield. Although this well is also located about 1,000 feet from the wellfield, it is not directly downgradient and is associated with much longer travel times from the injection wells. For all other downgradient wells, the actions associated with the plan remain the same, but even more time would be available to mitigate impacts (given the longer travel times to other wells). Although the plan provides protection for both aquifers receiving injectate, actions target the Santa Margarita Aquifer first due to faster travel times, closer drinking water wells, and higher reliance on the deeper aquifer for water supply. Injection can also be transferred from one aquifer to the other, if appropriate.

Because the AWP Facility will be shut down if the water quality problem cannot be immediately remedied, any potential impacts to the groundwater supply are anticipated to be of relatively short duration. However, the plan also covers the potential for long-term impacts through wellhead treatment and other actions (Steps 7 and 8).

1. **Notify Well Owners and Key Stakeholders, and Coordinate Appropriate Actions**

Once a water quality issue is identified, downgradient well owners will be notified immediately. The downgradient drinking water wells with the fastest travel times, ASR-1 and ASR-2, are operated by MPWMD for injection on behalf of CalAm. Both of these entitities are also involved in the Project as Project Participants (see **Table 2-1**). Because the most likely affected well owners and operators are Project partners, selection and implementation of effective actions will be more easily coordinated. In

[31] Although this well has not yet been permitted for use as a drinking water supply, it assumed that permitting will be completed prior to Project start up.

addition, the City of Seaside will be included in all notifications and planning steps; the City operates a downgradient drinking water supply well and has been cooperating with M1W on Project development and implementation for several years. Finally, the Seaside Basin Watermaster will also be included in the notification process and subsequent response actions. Although the Watermaster is not a well owner, it has groundwater basin management responsibilities and the Watermaster Technical Advisory Committee has closely tracked and supported the Project.

It is noted that ASR-1 is operated by CalAm for production of drinking water into their distribution system. Well ASR-2 is not yet permitted for drinking water production, but when that occurs, it will also be operated by CalAm through their water system permit. In the event that a problem is identified that could impact the quality of produced water from ASR-1 or ASR-2, M1W will notify CalAm as soon as possible.

2. Confirmation Sampling in Monitoring Wells Adjacent to Injection Well Field

Monitoring wells adjacent to impacted Project injection wells will be sampled for the constituent(s) of concern. Recognizing that these monitoring wells are located within about a one-month travel time from injection, these wells function as sentry wells, allowing early detection of water quality problems. They provide a lead-time of about one year before injected product water would reasonably be assumed to arrive downgradient at a Santa Margarita Aquifer drinking water well (with even longer travel times for the Paso Robles Aquifer). This underground travel time will provide time for planning the necessary actions to prevent impacted groundwater from entering the drinking water supply.

3. Initiate Accelerated Groundwater Quality Sampling in Downgradient Monitoring Wells and Water Supply Wells; Anticipate Downgradient Water Supply Wells that may be Impacted

Additional downgradient monitoring wells, along with the closest water supply wells, will also be analyzed for the constituent(s) of concern. Depending on the circumstances associated with the impact, wells will be monitored at an appropriate frequency – weekly to monthly – until impacts are fully addressed. Detections at these monitoring wells would be expected to occur within about five months of the sentry wells and approximately six months prior to the anticipated arrival of impacted water at ASR-1 or ASR-2 (under fastest hydraulic conditions). Again, travel times will be much longer for other downgradient drinking water wells, especially those in the Paso Robles Aquifer. Also, any recent injection at the ASR wells will likely increase this lead time. Depending on the constituent and concentrations, this lead time would be sufficient for potential remedies such as taking preparatory actions to shut down a well, arrange for blending options, or secure wellhead treatment. Analyses for these constituents will also be conducted at other nearby monitoring wells, as appropriate (e.g., ASR-MW-1).

4. Suspend Operation of the Drinking Water Well if Impacted

Well production will be suspended if constituents of concern are detected in the drinking water well or adjacent monitoring well at concentrations deemed by DDW to make the well unsuitable as a drinking water source as a result of the Project. The drinking water well will be taken offline and sampled periodically (likely weekly, depending on concentrations) to examine changes over time and to determine if concentrations are returning to acceptable levels. For impacts to ASR wells, the well will be pumped to the adjacent backflushing basin, which has been shown to readily accommodate several hours of pumping (as is conducted periodically for backflushing the ASR well). The backflushing basin at the ASR-1 well site holds about 245,000 gallons of water and infiltrates at rates of more than 0.5 feet per hour. In addition, there are plans to expand the basin to more than 700,000 gallons. This capacity is more than sufficient for ongoing weekly sampling of the well as needed. While these actions are occurring, production will be shifted among other wells as described in Step 6.

5. **Consider Blending Options**

Depending on concentrations, blending is a potentially viable option that would allow the water supply to be quickly restored. This approach has been used throughout the state as a solution to dealing with groundwater contamination. Water quality sampling of the impacted well, in addition to previous and ongoing groundwater quality analyses at upgradient monitoring wells, will provide data to assess whether concentrations have been sufficiently diluted in the groundwater system. Data will also be used to determine when concentrations are reasonably expected to rise or dissipate and to determine if the blending (and the blending ratio) would allow for a well to be used for drinking water. Sampling will occur at a frequency selected in consultation with DDW in any well selected for blending to ensure that impacts are not seen in the blending well. For example, if ASR-1 (the closest drinking water supply well) is impacted, concentrations may be sufficiently low at nearby ASR-2 to consider blending to meet water quality goals. ASR-2 well could be pumped for blending without significantly spreading the impacted groundwater. By capturing the impacted groundwater locally at the ASR-1/ASR-2 well site, problematic constituents could be contained in a manner that prevents additional downgradient wells from being impacted, while meeting drinking water standards in the CalAm distribution system.

6. **Shift Production from Impacted Well to other Existing Wells**

A review of existing well capacities in the vicinity of the Project indicates that some excess capacity is likely available at any given time to shift production to a non-impacted well. This was the result of an analysis conducted in support of the Project EIR. That analysis considered specific capacities of existing wells along with reasonable assumptions for CalAm demand requirements from the Seaside Basin. The analysis also considered times when existing ASR wells would be required for ASR injection or recovery. Results of the analysis indicated that existing wells provide excess capacity under almost all of the recharge and recovery scenarios over a 32-year simulation period.

Data provided by CalAm to support the EIR analysis indicated that a total minimum capacity of 3,653 gpm is available from the five existing CalAm wells in coastal subareas: Luzern #2, Ord Grove #2, Paralta, Playa #3, and Plumas #4 (not including capacities of two low-capacity wells planned for abandonment by CalAm). Additional capacity is available from four existing ASR wells drilled at two well sites: ASR-1 and ASR-2 at the Santa Margarita well site; and ASR-3 and ASR-4 at the Seaside Middle School well site. It is recognized that only one ASR well (ASR-1) is permitted currently for drinking water supply, but additional permitting is anticipated to occur prior to Project operation. ASR wells are capable of pumping up to about 3,000 gpm each for backflushing purposes. However, both wells at each well site would not be pumped simultaneously due to hydraulic interference associated with the relatively close well spacing. Further, well capacities decrease with ongoing injection. As a conservative assumption, an ASR capacity of 1,750 gpm is assumed for each ASR well site (total 3,500 gpm for the two sites). Even with these reduced rates, existing CalAm basin wells and ASR wells are capable of more than 7,153 gpm, a rate more than sufficient to meet anticipated future CalAm demand in the Seaside Basin of approximately 9,100 AFY (about 5,642 gpm).

Further, it is noted that ASR wells are not operated full time. For example, the ASR wells were not operated in 2014 for either injection or recovery. If the closest downgradient wells (ASR-1 and ASR-2) were impacted during these time periods, no additional capacity within the system would be required until ASR injection and recovery began again. This would provide additional time for planning and remediation if such an impact occurred in the future.

Potential use of an existing intertie between the CalAm system and the City of Seaside water system is also incorporated into this step. The intertie provides additional flexibility for the plan, allowing the ability to suspend production from an impacted City well and provide access to the CalAm system. This intertie, located near the intersection of LaSalle Avenue and Lincoln Street in Seaside, has been used recently while a City well was offline for maintenance. M1W will coordinate plan implementation steps with the City, CalAm, and MPWMD so that all parties are informed of any water quality issue in advance of potential impacts to any drinking water well.

Finally, several additional wells in the Seaside Basin are capable of providing potable water if permitted and re-commissioned to do so. These wells represent a potential emergency backup water supply to accommodate demand if a drinking water well is offline temporarily. Several of these wells include the Reservoir Well, the MMP well, and the PRTIW well (among others). Most of these wells are screened in the Paso Robles Aquifer, where travel times from injection wells to drinking water wells are orders of magnitude longer (more than 8 years as indicated by groundwater modeling (see **Table 5-3**) and represent much lower amounts of Product water injectate. Although the capacity of these wells is relatively low, collectively, they could combine with other steps in the plan to shift production away from an impacted well while not exacerbating groundwater quality conditions.

7. **Initiate Wellhead Treatment Planning and Secure Wellhead Treatment as Appropriate**

Ongoing remedial actions by the U.S. Army in the former Fort Ord area demonstrate the ability for granular activated carbon or air stripping to remediate volatile organic chemicals (VOC) contamination. Such treatment facilities are commonplace and can be secured within several weeks on an emergency basis if needed. Permitting and re-routing of lines can be accomplished within a few months at the affected well site. Ion exchange and other technologies such as RO are also avilable within similar time frames. The type of treatment needed will be known approximately one year in advance, providing sufficient time for planning and implementation.

8. **Continue Well Suspension, Provide Bottled Water, and/or Consider Additional Wells**

It is unlikely that a water quality failure could not be remediated in a relatively short time frame (within months of detection) using the steps described above. Nonetheless, in the event that the options described above cannot be sufficiently implemented in the desired time frame, M1W will work with project partners to secure bottled water, install additional wells, and/or replace the potable water supply in some other manner to ensure that drinking water demands can be met.

6.2. Response Retention Time

The RRT is 5. 25 months and consists of the time necessary to (1) identify water quality problems and complete confirmation sampling; (2) assess results and make decisions for appropriate responses based on DDW and RWQCB input; and (3) procure safe interim drinking water supply solution (including wellhead treatment), if needed (see **Table 6-5**).

The RRT of 5.25 months is conservative and protects drinking water wells. The RRT will be validated and potentially refined after the tracer test is completed and recycled water travel times are computed (described in **Section 6.3**).

Table 6-5: Summary of Response Retention Time

Factors Contributing to RRT	Duration in days[a]	Duration in weeks[b]	Duration in months[c]
#1: Time to identify water quality problem and complete confirmation sampling	**128**	**19**	**4.75**
Longest time between routine sampling frequency [d,e]	*28*	*4*	*1.0*
Longest turnaround routine sample results [f]	*12*	*2*	*0.5*
Travel time to nearest monitoring well [g]	*56*	*8*	*2.0*
Four consecutive samples less than MCL[h]	*28*	*4*	*1.0*
Longest turnaround for last expedited sample result [f]	*4*	*1*	*0.25*
#2: Time to assess results and make decisions for appropriate responses based on DDW and RWQCB input	**7**	**1**	**0.25**
#3: Time to procure safe interim drinking water supply	**7**	**1**	**0.25**
RRT [i]	**142**	**21**	**5. 25**

a. All durations rounded up to nearest whole day.
b. All durations rounded up to nearest whole week.
c. All durations rounded up to nearest 100th of a month.
d. Of the acute parameters, perchlorate is sampled least frequently. Quarterly perchlorate monitoring is specified within Title 22 Section 60320.212(a), however monthly was selected for RRT determination to reduce the response time.
e. Because perchlorate is effectively removed by RO (a treatment step provided at the AWP Facility), the following is proposed: collect quarterly RTP secondary samples and monthly product water samples for 1 year. If product water results are non-detect and no perchlorate appears to be coming from the RTP secondary effluent, M1W will request that the perchlorate product water frequency be increased to quarterly without impacting the RRT.
f. Perchlorate has the longest laboratory turnaround for both regular and expedited samples.
g. Per Title 22 Section 60320.224(d), the travel time to the monitoring well is doubled to account for the uncertainty of numerical model (4 weeks travel time x 2 safety factor = 8 weeks).
h. Pursuant to Title 22 Section 60320.212(d)(1), product water and monitoring well samples will be collected after passage of "off-specification" water at monitoring well until four consecutive weekly results are below the contaminant's MCL.
i. RRT = [Time to identify water quality problem and complete confirmation sampling] + [Time to assess results and make decisions for appropriate responses based on DDW and RWQCB input] + [Time to procure safe interim drinking water supply].

6.3. UNDERGROUND RETENTION TIME ANALYSIS

As described in **Section 5.3**, the underground retention time before injected water reaches a drinking water well varies considerably with the dynamic nature of the local groundwater system. Local hydraulic gradients are highly variable, controlled by intermittent injection and recovery operations of the downgradient ASR wellfields and other downgradient production wells. Numerical modeling was used to evaluate the travel time from each injection well to the closest downgradient extraction well over a 25-year simulation period, incorporating the full range of potential ASR operations. Modeling results indicate that the shortest travel time to the closest production well is about 327 days (about 10.8 months) and represent groundwater transport from deep injection well DIW-2 to extraction well ASR-1 (see **Section 5.3** for modeling details; see Section **9.1.3.2** for details on the Watermaster Model used in the analysis. Full model results are included in **Appendix D**).

The shortest travel time of 10.8 months was associated with drought conditions when the ASR wellfield was being operated for maximum recovery of stored water (see **Sections 5.3.1 and 5.3.2**). These conditions only occurred during five years of the 25-year simulation period and represent a conservative estimate to apply to the Project (see discussion in **Section 5.3.3**). A tracer test conducted after Project start-up is anticipated to confirm that representative travel times are longer.

Due to the uncertainty associated with numerical modeling, the Title 22 Criteria only allow for 0.5 months to be credited to the underground retention time for every month indicated by the modeling (Table in Section 60320.224(d)). With the shortest travel time of 10.8 months to the nearest extraction well, the underground retention time for the Project is 5.4 months, as summarized in **Table 6-6**.

Table 6-6: Underground Retention Time for Project

Analysis	Time
Shortest Travel Time in 25-year simulation period (DIW-3 to ASR-1; see **Table 5-3**)	10.8 months
Underground Retention Time Factor (numerical modeling)	0.5 month/model month
Underground Retention Time for Virus Reduction Credit	5.4 months
Application of the Underground Retention Time to the RRT	RRT $\leq$ 5.4 months

As shown above, the RRT of 5.25 months is shorter than the underground retention time to allow for response actions prior to potential water quality impacts at a drinking water well. To further inform the RRT derivation, the estimated travel time from injection wells to proposed downgradient monitoring wells, as indicated from the numerical modeling, is summarized in the following subsection.

6.3.1. Travel Times to Monitoring Wells

In compliance with the Title 22 Criteria, monitoring wells are proposed for the Project to detect short-term travel times (between two weeks and six months) and intermediate travel times between injection and extraction. **Figure 3-8** shows the locations of the Project compliance monitoring wells associated with the four project injection wells. **Section 12** provides a more detailed description of the proposed groundwater monitoring program and proposed phasing of monitoring wells. The particle tracking results presented in **Section 5.3.2** can be used to estimate the shortest travel time from any injection well to downgradient monitoring wells.

Table 6-7 lists the estimated travel time from each injection well to the closest monitoring wells, using the fastest simulated travel times from the particle tracking analysis. As indicated in the table, the monitoring wells proposed adjacent to the injection wells have a short estimated travel time of about 1 month in the Santa Margarita Aquifer. While vadose zone travel times are not addressed directly by groundwater modeling, it is anticipated travel time of recycled water to Paso Robles Aquifer monitoring wells adjacent to the two vadose zone injection wells will be less than six months (per the Title 22 Criteria monitoring well requirements that at least one well is located between two weeks and six months). Travel times to the downgradient monitoring well are expected to vary from about six months (180 days) to one year (365 days).

Table 6-7: Simulated Fastest Travel Times between Injection and Monitoring Wells

Injection Well	Adjacent Monitoring Well		Downgradient Monitoring Well	
	Well Number	Estimated Travel Time (days)	Well Number	Estimated Travel Time (days)
DIW-1	MW-1D	<30	MW-1AD	180
DIW-2	MW-2D	<30	MW-2AD	270
VZW-1A	MW-1S	<180	MW-1AS	365
VZW-2	N/A[a]	N/A[a]	MW-2AS	270

a. Development of MW-2S has not been successful due to the thin occurrence of the Paso Robles Aquifer at this location and limited saturated thickness. No water quality samples have been collected from this MW-2S to-date. Based on predicted underground flowpaths of injected purified recycled water, monitoring well requirements for the Paso Robles Aquifer are satisfied by the three other shallow monitoring wells (MW-1S, MW-1AS, and MW-2AS).

6.3.2. Tracer Study Requirements

Title 22 criteria require that a tracer study be used to demonstrate the underground retention times estimated in the above analysis. Details of the tracer testing will be based, in part, on groundwater quality data scheduled to be collected in Project monitoring wells prior to startup. In compliance with regulations, the tracer study shall be initiated prior to the third month of Project operation. Preliminary considerations for tracer test planning are discussed in **Section 12.8**.

This Page Intentionally Left Blank

7. AWP FACILITY RECYCLED WATER QUALITY

A pilot-testing program was conducted between mid-October 2013 and mid-July 2014, with extensive sampling conducted between December 2013 and June 2014 (Trussell Technologies 2014a, attached as **Appendix C**). The pilot facility treated a flow of 30 gpm of undisinfected RTP secondary effluent with the goals of (1) evaluating the performance of the ozone-MF-RO portion of the AWP Facility processes, and (2) developing design criteria for each unit process. Although AOP is included in the AWP Facility, it was not included in the pilot testing and sampling program. Design of an AOP system typically does not typically require a pilot demonstration and sufficient information on treatment efficacy is available from existing groundwater replenishment projects. During the pilot testing and the source water sampling campaign, Salinas agricultural wash water (Salinas IWTF influent) was diverted to the RTP collection system where it mixed with untreated municipal wastewater from April 1, 2014 through the end of the sampling program. Data from this period are reflective of the blended water quality of these two sources. The results and details of the pilot testing are included in **Appendix C.**

The pilot facility treated the RTP secondary effluent with sodium hypochlorite (to form chloramines), ozone, MF, and RO. Water quality sampling during piloting included general water quality parameters, pathogens and pathogen indicators, disinfection byproducts, pesticides of local interest, priority pollutants, CECs, constituents with MCLs (inorganics, synthetic organic contaminants), NLs, AALs, and constituents on the UCMR lists (1 through 3) to determine the presence and removal of the constituents (also see **Section 4.2.4.2**).

Pilot water quality sampling results indicated that the AWP Facility product water is expected to meet all applicable regulations, including the Title 22 Criteria for groundwater replenishment, RWQCB Basin Plan objectives, MCLs, NLs, and AALs. The RO permeate met all requirements except NDMA, where concentrations were higher than the NL (e.g., 20-32 ng/L). However, the UV/AOP system will be designed to reduce NDMA by at least 1.5-log to achieve the target goal of 1 ng/L.

Two pesticides—dieldrin and DDE (a breakdown product of the legacy pesticide DDT)—were detected in low concentrations in the new source waters. Bench tests were conducted in February 2016 evaluating the removal of these two contaminants through the RTP, membrane filtration and ozonation in order to ensure compliance with the California Ocean Plan water quality objectives for these two contaminants when discharging the RO concentrate through the ocean outfall. Results of these bench tests are summarized in **Section 7.5.4** and the complete bench test report is provided in **Appendix K**.

7.1. TOTAL NITROGEN

The Title 22 Criteria include a total nitrogen limit of 10 mg/L in the recycled water or recharge water (before or after injection), where the limit applies to the average of the results of two consecutive samples collected at least three days apart for each week. During the pilot study, the final pilot effluent consistently met the total nitrogen limit, where the total nitrogen ranged from 1.5 mg/L to 2.9 mg/L, significantly lower than the 10 mg/L regulatory limit (**Figure 7-1**). After the addition of the agricultural wash water to the RTP in April 2014, the average pilot influent (RTP secondary effluent) total nitrogen decreased from 43.7 mg N/L to 34.8 mg N/L. This was expected because the wash water has a lower total nitrogen concentration compared to the typical RTP effluent.

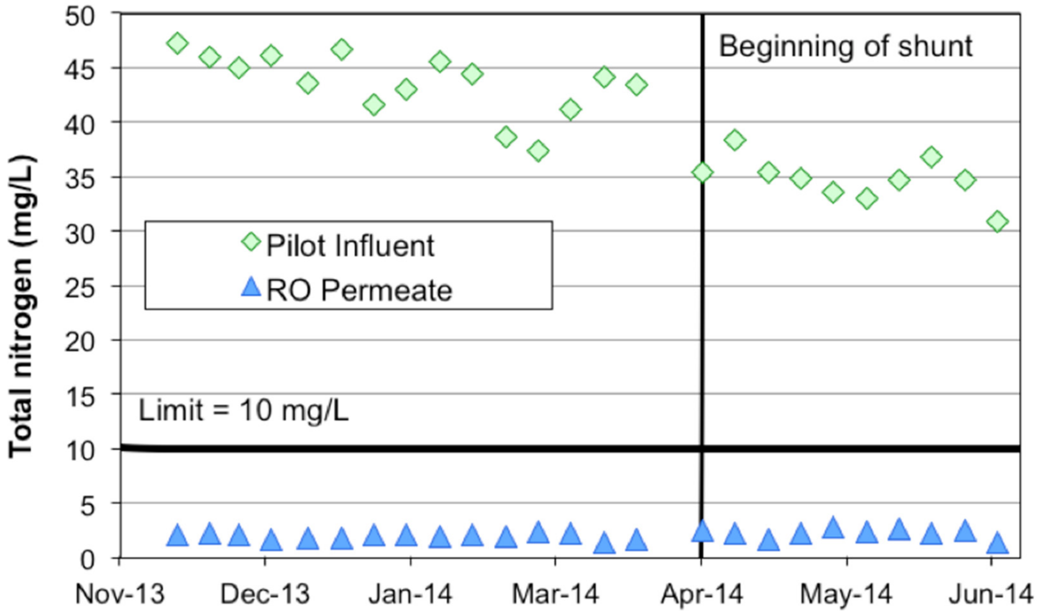


Figure 7-1. Removal of total nitrogen through the pilot

The Blanco Drain has elevated levels of nitrate – the median concentration observed during source water sampling was 68 mg N/L. These elevated nitrate concentrations contribute to the elevated total nitrogen concentration observed in the Blanco Drain (median of 70 mg/L), compared to the RTP effluent (median of 44 mg/L, where the RTP effluent total nitrogen is mostly comprised of ammonia). The Reclamation Ditch may also have elevated total nitrogen concentrations as it also receives agricultural tile drainage, in addition to runoff. The impact of the Blanco Drain, the Reclamation Ditch, and the agricultural wash water on the RTP effluent total nitrogen concentration can be conservatively estimated if it is assumed that nitrogen removal is not obtained in the RTP (actual total nitrogen removal in the RTP was 21% to 43% during a two-week study in October 2015 using composite samples). Using the projected monthly flows, total nitrogen concentrations through the year were predicted. The results of the analysis are summarized in **Table 7-1**, including the highest monthly total nitrogen based on the median observed values and the maximum observed values. Despite the higher nitrate levels in the Blanco Drain, the maximum predicted total nitrogen under median conditions is about 10% higher than what has already been observed in the RTP effluent. The maximum predicted value, based on the maximum observed values, is 9% higher than the observed maximum in the RTP effluent (without Blanco Drain blending).

Table 7-1: Observed and Predicted Total Nitrogen Concentrations Calculated using Median and Maximum Values

Total N	RTP Effluent[a], mg/L	Blended Source Waters[a], mg/L
Median	44	49
Maximum	51	55

a. Blended concentrations based on predicted source water flows presented in **Section 4.2** and including RTP effluent, agricultural wash water, Blanco Drain, and Reclamation Ditch, where the Reclamation Ditch total nitrogen concentrations were assumed to be the greater of the Blanco drain or Tembladero Slough median and maximum concentrations as the Reclamation Ditch was not included in the source water sampling campaign.

The average total nitrogen removal through the pilot was 94.3%. Assuming this removal, a blended source water total nitrogen concentration of 49 mg/L would be reduced to 2.8 mg/L and total nitrogen of 55 mg/L will be reduced to 3.1 mg/L. Both of these concentrations are well below the Title 22 limit of 10 mg/L. Therefore, despite higher nitrate levels (and corresponding higher total nitrogen levels) in the Blanco Drain and potentially elevated total nitrogen concentrations in the Reclamation Ditch, the AWP Facility should readily meet the 10-mg/L total nitrogen effluent limit.

7.2. TOTAL ORGANIC CARBON

Section 60320.218 of the Title 22 Criteria specifies that the TOC concentration in the product water cannot exceed 0.5 mg/L based on:

- The 20-week running average of all TOC results; and
- The average of the last four TOC results.

As discussed in **Section 4.2.4.5**, the median concentration and range of TOC in the various untreated source waters are similar except for the agricultural wash water, which has a significantly higher TOC concentration. However, all of the untreated source waters will undergo treatment through the primary and secondary processes at the RTP and advanced treatment at the AWP Facility. In fact, a significant decrease in the RTP effluent TOC was observed during the time period of the agricultural wash water shunt (Salinas IWTF influent shunt), compared with values observed before the shunt: 14.8 ± 0.7 mg/L and 13.0 ± 0.7 mg/L (mean ± 95% confidence interval), for before and after the shunt testing, respectively (see **Figure 7-2**Figure 7-2.), indicating that the TOC concentration in the agricultural wash water is significantly reduced through primary and secondary treatment. It is expected that the addition of low-TOC waters (e.g., Blanco Drain, and potentially in the future, Tembladero Slough, Lake El Estero) would only further decrease the TOC in the feed water to the AWP Facility via blending.

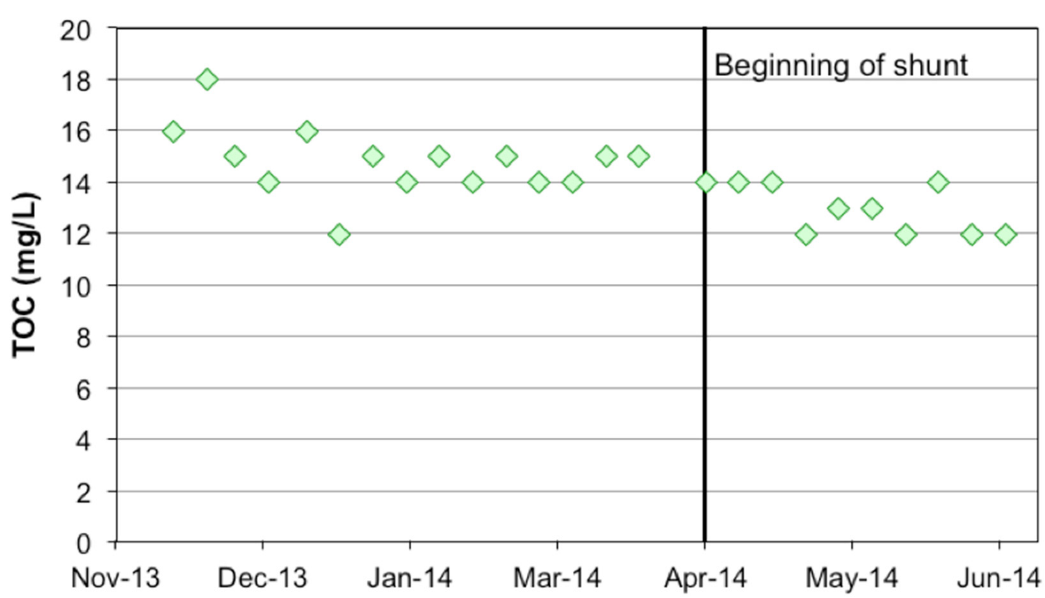


Figure 7-2. TOC concentrations entering the pilot

The key unit process in the AWP Facility that further reduces TOC is the RO system. The TOC concentrations in the RO permeate are impacted by the ozone dose used in the ozone pretreatment unit process. The TOC concentrations in the RO permeate at a time when ozone dose was 10 mg/L were consistently below 0.5 mg/L, ranging from 0.27 mg/L to 0.42 mg/L, including the period when the agricultural wash water was added to the municipal wastewater for treatment at the RTP (**Figure 7-3**). However, when the ozone dose was increased to approximately 20 mg/L, the TOC concentration in some of the RO permeate samples exceeded 0.5 mg/L. This information helped in the selection of the design ozone dose chosen for the full-scale AWP Facility; namely, the lower dose of 10 mg/L, which, coupled with the expected reduction in TOC from blending with other low-TOC source waters, RTP primary and secondary treatment, and treatment through the other AWP Facility unit processes, will consistently produce product that meets the Title 22 TOC requirements.

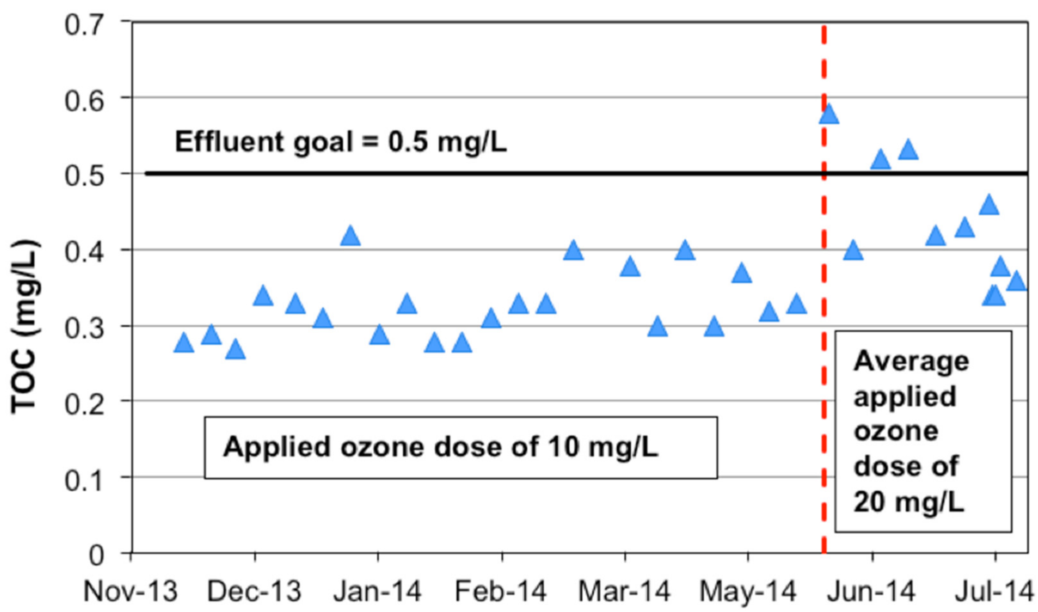


Figure 7-3. TOC concentrations in the pilot RO permeate. Increase in ozone dose started 5/20/14 and continued through the end of piloting

7.3. REGULATED CONSTITUENTS

In accordance with Title 22, the product water must meet primary and secondary drinking water MCLs. Results from the pilot testing indicate that the AWP Facility should produce water in compliance with all primary and secondary MCLs. A summary of the constituents detected in the RO permeate with primary and secondary MCLs is presented in **Table 7-2**. Fourteen constituents with MCLs were detected in the RO permeate at least once, as shown in **Table 7-2**, and with the exception of the odor threshold secondary MCL, none of them exceeded their regulatory limit. For the full-scale AWP Facility, odor will be reduced to levels below the MCL after UV/ H_2O AOP treatment (Agus et al., 2011). Thus, results of the pilot testing based on the ozone-MF-RO portion of the AWP Facility and the expected benefit from full-scale treatment with AOP show that the product water from the full-scale AWP Facility would comply with all of the MCLs that are required to be met for groundwater replenishment of recycled water. Based on the pilot performance for these constituents, source water quality data, RTP performance during pilot testing, and source water flows, the inclusion of the additional source waters not used/treated by the pilot testing will also be able to be treated to meet the MCLs.

Although bromate formed during ozonation (from less than 1 µg/L to up to 9 µg/L; median 3.35 µg/L), RO effectively removed bromate and bromate was not detected in the RO permeate during the pilot plant sampling program. Pilot testing included a wide range of O_3:TOC ratios, including O_3:TOC ratios approximately two times larger than the O_3:TOC ratio associated with the design ozone dose and water quality. During pilot testing of these O_3:TOC ratios, the maximum bromate concentration in the ozone effluent was less than the MCL (maximum of 9 µg/L, compared to the MCL of 10 µg/L). Based on these piloting data, the bromate concentration in the AWP Facility ozone effluent is expected to be approximately 3 to 4 µg/L at the design O_3:TOC ratio.

Downstream of ozone, bromate removal through RO was observed to be as high as greater than 88.9% during piloting (similar, and greater, levels of removal were observed at West Basin Municipal Water District piloting, where pre-ozonation is also practiced). Conservatively assuming a removal of 88.9% through RO, the bromate concentration in the ozone effluent would have to be greater than 90 µg/L for bromate levels in the RO permeate to be at the MCL. Such levels in the ozone effluent are not expected given that they are ten times higher than the maximum concentration observed during piloting that included O_3:TOC ratios approximately twice as high as the design O_3:TOC ratio.

There were several constituents that were measured above or close to their MCL in the untreated source waters; however, based on predicted treatment through the RTP and AWP Facility, none of these constituents are expected to impact the ability of the product water to meet the Title 22 Criteria for compliance with MCLs.

Hexavalent chromium was not included in the pilot water quality sampling as an MCL had not yet been established. Total chromium (hexavalent chromium plus trivalent chromium) was sampled twice during piloting. One sample was collected from the RO permeate; the other sample was collected from the bench-scale stabilized RO permeate. The total chromium results were 5 µg/L and less than 0.5 µg/L, respectively. Both results are less than the MCL for hexavalent chromium, which is 10 µg/L. These samples are also less than the total chromium MCL of 50 µg/L.

Additionally, samples from the source waters were analyzed for hexavalent chromium during the source water quality sampling campaign. The maximum concentration among the source waters was 4.9 µg/L, which was detected in the Salinas IWTF. The RTP effluent, which contributes the majority of the flow to the AWPF, had a maximum concentration of less than 0.02 µg/L. The maximum blended source water concentration is estimated to be less than 1.2 µg/L, which is less than the MCL. Further, the maximum total chromium concentration measured in the source waters was 19 µg/L - measured in the Blanco Drain and the Tembladero Slough - whereas the maximum concentration measured in the RTP effluent was 3 µg/L. The maximum blended total chromium concentration is estimated to be 7 µg/L, which is less than the hexavalent chromium as well as the total chromium MCL.

Table 7-2: Constituents with MCLs Detected in RO Permeate

Constituent	Unit	MCL	Median (Range)[a]
Secondary MCL Consumer Acceptance			
Chloride	mg/L	250	3 (<1 - 6)
Conductivity	µS/cm	900	38 (32 - 46)
Sulfate	mg/L	250	<1 (<1 – 1)
TDS	mg/L	500	<10 (<10 – 26)
Turbidity	NTU	5	<0.05 (<0.05 – 0.1)
Primary MCL Inorganics			
Aluminum	mg/L	0.2	<0.01 (<0.01 – 0.045)
Arsenic	mg/L	0.01	<0.001 (<0.001 – 0.002)
Chromium	mg/L	0.05	0.005
Cyanide	mg/L	0.15	<0.005 (<0.005 – 0.007)
Fluoride	mg/L	2	<0.1 (<0.1 – 0.2)
Nitrate	mg/L as N	10	<0.2 (<0.2 – 0.7)
Nitrite	mg/L as N	1	<0.1 (<0.1 – 0.4)
Nitrate + Nitrite	mg/L as N	10	0.55 (0.1 - 1.6)
Selenium	mg/L	0.1	<0.002 (<0.002 – 0.01)
Primary MCL Synthetic Organic Compounds			
Total trihalomethanes	µg/L	80	1.85 (0.68 – 5)
Primary MCL Radionuclides			
Radium-226	pCi/L[b]	5	0.298 ± 0.327

a. Parameters with no range were only sampled during one complete MCL sampling event.
b. Picocuries per liter - pCi/L.

7.4. BASIN PLAN OBJECTIVES

For the Seaside Basin, the Basin Plan includes general narrative groundwater objectives for taste and odor and radioactivity, and numeric objectives for:

- Bacteria - the median concentration of coliform organisms (*i.e.*, total coliform) over any seven-day period must be less than 2.2/100 mL; and
- Chemical constituents - groundwater shall not contain chemical concentrations in excess of primary and secondary MCLs.

As previously discussed, the RO permeate followed by AOP will meet all MCLs, the bacterial objective, and the narrative objectives. Based on the pilot testing, source water quality data, RTP performance during pilot testing, and source water flows, the inclusion of the additional source waters not diverted to the RTP and treated by the pilot testing will also be treated to meet the Basin Plan objectives.[32]

The Basin Plan also includes guidelines to protect soil productivity, irrigation, and livestock watering. With regard to salinity and chloride, the RO permeate concentrations from the pilot testing were below the guidelines. One of the Basin Plan guidelines is the Sodium Adsorption Ratio (SAR), which is used to determine if irrigation water affects the rate of water infiltration. It is not a constituent, but a calculated value based on the square root of the ratio of sodium to the average quantity of calcium plus magnesium, on an equivalence basis, adjusted for tendency precipitate or dissolve lime (RWQCB, 2011). The cations (calcium, magnesium, and sodium) used to derive an SAR will be removed by RO as part of the full-scale AWP Facility. Calcium will be dosed into the UV/AOP effluent (downstream of the RO permeate), which will lead to a favorably low SAR. SAR values in the pilot RO permeate ranged from 1.0 to 1.4, compared to strictest the SAR guideline of <3. The addition of calcium during product water stabilization would bring the SAR values to approximately 0.2 to 0.3. The potential addition of sodium hypochlorite for secondary disinfection would have no noticeable impact on the SAR values (0.2 to 0.3 would still be expected).

As discussed earlier, even considering the effects of blending all of the source waters prior to treatment, the predicted total nitrogen concentration after secondary treatment at the RTP and treatment through the full-scale AWP Facility will result in a maximum product water concentration of 3.2 mg/L. This concentration is below the individual guidelines for ammonia and nitrate.

---

[32] With regard to permitting the Project, it is important to acknowledge what a RWQCB must consider when establishing waste discharge requirements. Per California Water Code Section 13263(a), "[t]he requirements shall implement any relevant water quality control plans that have been adopted, and shall take into consideration the beneficial uses to be protected, the water quality objectives reasonably required for that purpose, other waste discharges, the need to prevent nuisance, and the provisions of Section 13241." WDR requirements should not be performance-based as a means of interpreting Best Practicable Treatment or Control (BPTC) per Resolution 68-16, the Anti-degradation Policy. The application of BPTC does not dictate the application of performance-based limits. As noted in SWRCB Order WQ 2014-090-DWQ-Corrected (General Waste Discharge Requirements for Recycled Water), BPTC is defined as "a combination of Title 22 and the Regional Water Board Water Quality Control Plans (Basin Plans)." See Finding 24, pg. 7.

The chemical stabilization process following AOP in the full-scale AWP Facility will influence bicarbonate and pH concentrations in the purified water. These concentrations will be within the Basin Plan Guidelines as demonstrated by existing groundwater replenishment projects elsewhere.

The Basin Plan includes water quality objectives for agricultural use for irrigation supply and livestock watering. The following demonstrates how the Project AWP product water would comply with those Basin Plan objectives:

- Of the 21 constituents with objectives, 14 have MCLs (aluminum, arsenic, beryllium, cadmium, chromium, fluoride, iron, manganese, mercury, nickel, nitrate+nitrite, nitrite, selenium, and zinc). All of the agricultural objectives are set at higher concentrations than the MCLs with the exception of zinc, fluoride and selenium; however, RO permeate test results from the pilot testing indicate the AWP Facility will achieve adequate removal of these constituents. In addition, the RO permeate for the MCL-based constituents either meets MCLs or meets the less stringent Basin Plan agricultural objectives. Lastly, the maximum zinc and selenium concentrations measured in the source waters were below the objectives, prior to treatment; the maximum predicted fluoride concentrations in the source waters, accounting for source water blending and based on measured values in the source waters, will be reduced to levels below the objective based on median removals of fluoride through RO observed during pilot testing.
- The Basin Plan also includes agricultural objectives for copper and lead. In the case of copper, the objectives for irrigation supply (0.2 mg/L) and livestock watering (0.5 mg/L) are more stringent than the drinking water action level (1.3 mg/L). The maximum concentrations of copper measured in any of the untreated source waters was 0.073 mg/L, which is below the agricultural objectives prior to advanced treatment. For lead, the Basin Plan objectives for irrigation supply (5.0 mg/L) and livestock watering (0.1 mg/L) are less stringent than the drinking water action level (0.015 mg/L). The maximum concentration of lead measured in any of the untreated source waters was 0.0018 mg/L, which is well below the agricultural objectives prior to advanced treatment. Thus, the source water sampling program found that lead and copper were below their respective agricultural basin plan objectives in all of the untreated source waters sampled.
- The Basin Plan includes agricultural objectives for two constituents with NLs: boron and vanadium. In the case of boron, the agricultural objective for irrigation supply (0.75 mg/L) is more stringent than the NL of 1 mg/L. Vanadium was not detected in the RO permeate from the pilot testing. The median boron concentration in the RO permeate was 0.18 mg/L (range 0.16 to 0.23 mg/L). Thus, the piloting testing found that boron and vanadium were below their respective agricultural basin plan objective in the RO permeate. Additionally, the maximum boron and vanadium concentrations measured in the source waters were below the objectives.
- The three remaining agricultural objectives do not have regulatory standards or goals: cobalt, lithium, and molybdenum. Studies of RO treatment have shown that it is effective in removing metals such as these from secondary wastewater. Cobalt and molybdenum were removed to below detection levels, and lithium was removed by 68% with a median concentration of 0.01 mg/L, which is below agricultural objectives for irrigation supply ranging from 0.075 to 2.5 mg/L (Department of Health, Western Australia, 2009).

The concentration of dissolved solids on the feed and permeate side of the RO membrane were measured to determine their removal during the RO process. Select results from this effort are summarized in **Table 7-3**. The concentration of these dissolved solids in the RO permeate were typically below the detection limit, and thus the removal is often reported as greater than the indicated value. These data show robust removal of dissolved solids through the RO process, including a dramatic reduction in TDS. Based on this expected removal, the Project will comply with all Basin Plan standards, objectives, and guidelines.

Table 7-3: Removal of Select Dissolved Solids

Constituent	Average Removal
TDS	>98.6%
Chloride	>98.8%
Sulfate	>98.9%
Phosphate	>96.7%
Nitrate	>94.4%
Calcium	>99.1%
Magnesium	>97.8%
Sodium	97.2%
Potassium	>96.3%

7.5. Other Relevant Constituents

7.5.1. Endocrine Disrupting Compounds, Pharmaceuticals and Other Chemicals

The panel list of CECs measured by the Eurofins Eaton Analytical Liquid Chromatography Tandem Mass Spectrometry (LC-MS-MS) method (92 constituents) was measured monthly in the pilot influent, ozone effluent, and RO permeate during pilot testing. Ozonation consistently reduced the concentrations of many of the CECs to levels below detection (*e.g.*, bisphenol A (BPA) and several of the pharmaceuticals); on average, there were approximately 40 CECs detected in the pilot influent and 26 detected in the ozone effluent. With a few exceptions described below, the RO removed the remaining CECs to below detection. In addition, the AWP Facility will include UV/AOP, which provides an additional barrier to destroy chemicals and pathogens (UV/AOP was not piloted, and therefore no grab samples were collected on UV/AOP effluent). The CEC removals observed across the pilot treatment system are shown in **Figure 7-4**.

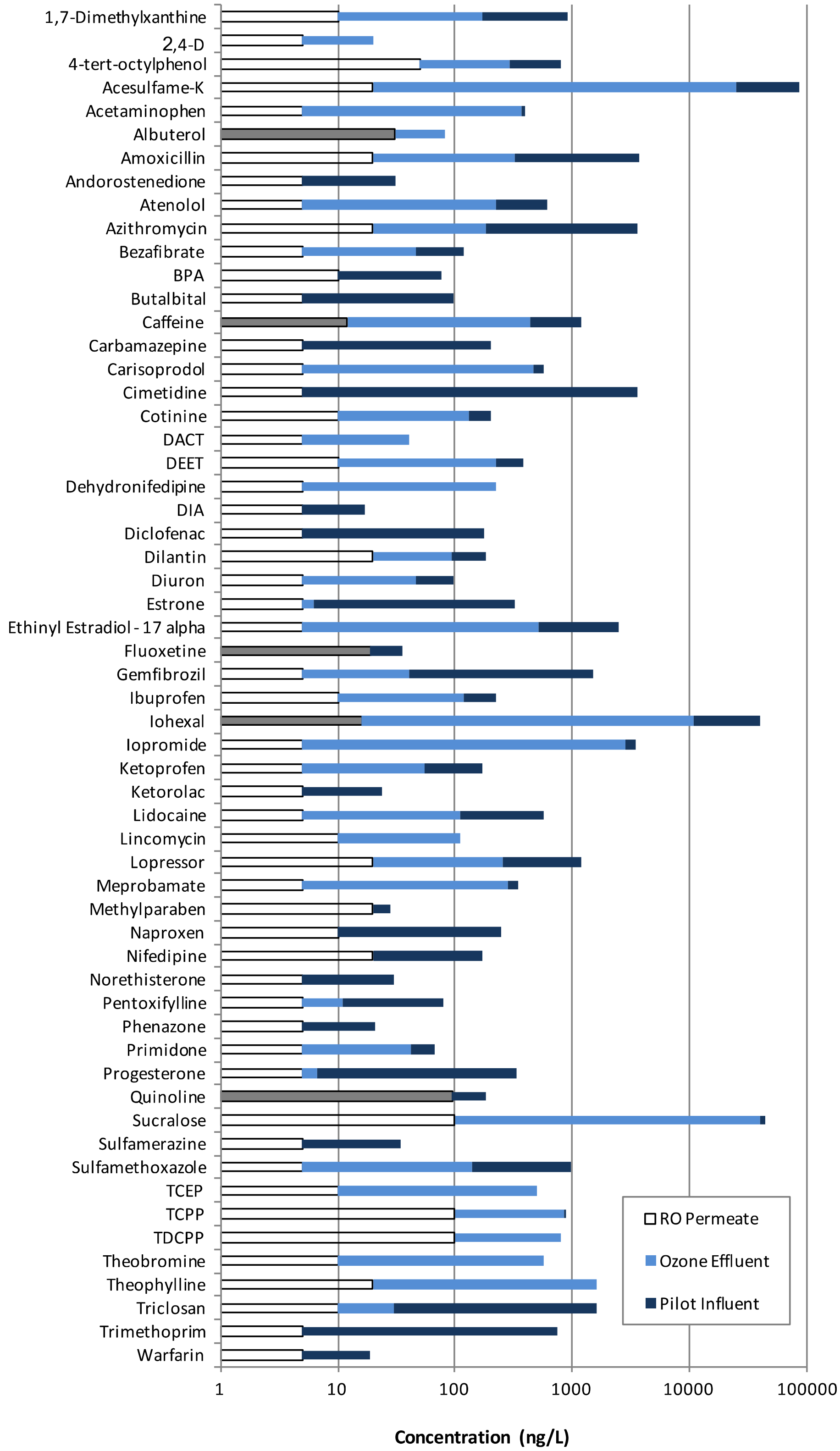


Figure 7-4. CEC Removal Demonstrated during Pilot Testing through Ozonation and Reverse Osmosis. Unfilled sections indicate results were below detection limit. All values shown are maximum detected values.

In three of the seven monthly sampling events, there were a few CECs detected in the RO permeate (not including previously discussed NDMA). These compounds were erythromycin, caffeine, iohexal, albuterol, carbadox, fluoxetine, and quinolone. In all cases, these compounds were detected in only one sample, and it is likely that several of the detections were actually false positives due to contamination. Specifically, erythromycin and carbadox (both antibiotics) were not detected in either the pilot influent or the ozone effluent, and thus the RO permeate detection is considered an anomaly. For quinoline (a chemical that has ubiquitous sources such as cigarette smoke and automobile exhaust, and is used in the production of dyes, paints, pharmaceuticals, and fragrances) and fluoxetine (an antidepressant), the RO permeate values exceeded the ozone effluent value, and it is strongly suspected that this is a false positive as well. The remaining compounds detected in the RO permeate, caffeine (a simulant), iohexal (a contrast agent), and albuterol (an asthma medication), were detected at concentrations near the detection limit and it is unclear whether or not they are actual values. For all of these compounds, it is important to keep in mind that (1) the concentrations detected were many orders of magnitude below any demonstrated health related levels, and (2) these compounds have all been shown to be effectively removed by UV/AOP (i.e., exceeding 90% for these compounds). It is expected that all of these compounds will be below current detection limits in the full-scale AWPF UV/AOP effluent and product water.

7.5.2. Constituents with Notification Levels

During pilot testing, the only constituent measured in the RO permeate above its NL or AAL was NDMA (see **Table 7-4**). However, the UV/AOP process is specifically designed to achieve 1.5-log removal (i.e., 96.8% removal) of NDMA. This level of removal will reduce the NDMA concentration to a range of approximately 0.63 to 1.0 ng/L (from the measured range of 20 to 32 ng/L present in the RO permeate), which is well below the NL. The detection limit for 1,4-dioxane makes it difficult to ascertain where the concentration in the RO permeate is in comparison to the NL (since the NL is equal to the detection limit). In addition to 1.5 log NDMA removal, the UV/AOP system will also be designed to achieve a minimum of 0.5 log removal of 1,4-dioxane, and thus providing assurance that the product water 1,4-dioxane concentration will be below the NL in the full-scale AWP facility product water.

Table 7-4: Constituents with NLs or AALs Detected in RO Permeate

Constituent	Unit	Limit	Median (Range)[a]
Boron	mg/L	1 (NL)	0.18 (0.16 – 0.23)
Formaldehyde	mg/L	0.1 (NL)	0.050 (0.028 – 0.071)
NDMA	ng/L	10 (NL)	27 (20 – 32)
N-Nitrosodi-n-Propylamine	ng/L	10 (NL)	<2 (<2 – 2.9)
Chloropicrin	µg/L	50 (AAL)	3.5
2,3,5,6-Tetrachloroterephthalate	mg/L	3.5 (AAL)	0.0001

a. Parameters with no range were sampled once during a complete NL/AAL sampling event.

7.5.3. Remaining Priority Pollutants

The Title 22 Criteria require that recycled water and groundwater (from down gradient monitoring wells) be monitored for Priority Pollutants (chemicals listed in 40 CFR Part 131.38, "Establishment of numeric criteria for priority toxic pollutants for the State of California") specified by DDW, based on DDW's review of the project's engineering report. Sixty-four Priority Pollutants were sampled and analyzed during the pilot plant sampling program. Of these constituents, a total of 16 Priority Pollutants were found in the RO permeate after the pilot testing, all of which had MCLs or NLs that are addressed elsewhere in this section. It is noted that of the 16 Priority Pollutants detected, only NDMA was found above its NL. As previously noted, the UV/AOP process, which will follow the RO process in the full-scale AWP Facility, will be designed to reduce the NDMA concentration to below the NL of 10 ng/L.

7.5.4. Bench Tests for Pesticide Removal

Two persistent legacy pesticides that have been banned for decades but were detected in low concentrations in samples of Blanco Drain water are dieldrin and DDE (a breakdown product of DDT). The median detected concentration of dieldrin was 17 ng/L, with a range of less than 10 ng/L (below the method detection limit) to 31 ng/L; DDE was detected only once at a concentration of 21 ng/L. Bench tests were conducted in February 2016 evaluating the removal of these two contaminants through the RTP, membrane filtration and ozonation in order to ensure compliance with the California Ocean Plan water quality objectives when discharging the RO concentrate through the ocean outfall.

Bench test results showed significant dieldrin and DDx (congeners of DDT, DDE, DDD were all tested) removal through the RTP, ozonation and membrane filtration. For dieldrin, 84% removal was seen through the RTP, 44% - 63% removal (depending on ozone dose) was seen through ozonation, and 97% - 98% removal was seen through membrane filtration. For DDx, 93% removal was seen through the RTP, 36% - 48% removal was seen through ozonation, and 92% - 94% removal was seen through membrane filtration. Overall, 91% to 99.9% dieldrin removal and 96% to 99.8% DDx removal was observed through the RTP, ozonation and filtration. Additional removal of these contaminants through the RO and UV/AOP processes was not evaluated as part of this bench testing.

Conclusions of these tests were that removal of these contaminants through the RTP alone was sufficient to meet the California Ocean Plan water quality objectives. Removal through the advanced treatment processes in the AWP Facility offers additional layers or redundancy and robustness to treatment of these contaminants. The complete bench test report is provided in **Appendix K**.

7.6. CONSTITUENTS MONITORED FOR DISINFECTED TERTIARY RECYCLED WATER PRODUCTION

The Water Recycling Criteria for disinfected tertiary recycled water requires monitoring of turbidity and total coliform for irrigation with disinfected tertiary recycled water. During pilot testing, total coliform levels were less than 1 MPN/100 mL in all 27 RO permeate samples, and less than 1 MPN/100 mL in 23 of 25 MF filtrate samples (the two MF filtrate samples with detections were suspected to be due to sample contamination). Thus, total coliform levels in the RO permeate, prior to disinfection, were below the Water Recycling Criteria for disinfected tertiary recycled water (requirements are that the median of daily results over the last seven days not exceed 2.2 MPN/100 mL, that the 23 MPN/100 mL not be exceed more than once a month, and that 240 MPN/100 mL never be exceeded).

The MF filtrate turbidity was measured to be less than 0.05 NTU 99.8% of the time with the online turbidimeter. Grab samples from the MF filtrate and RO permeate confirmed the low turbidity values, with results always equal to or less than 0.1 NTU, and with the median sample result in the RO permeate being less 0.05 NTU. Thus, the MF filtrate was able to meet the Water Recycling Criteria for filtered wastewater, a prerequisite to producing disinfected tertiary recycled for irrigation, with additional redundancy provided by the RO system (the requirements are that the effluent turbidity be less than or equal 0.2 NTU 95% of the time within a 24-hour period and the turbidity not exceed 0.5 NTU when membranes are used for filtration).

8. INJECTION OPERATIONS AND MAINTENANCE

The preliminary operation plan for injection into the Seaside Basin is summarized in this section. Prior to operation, a more detailed Operation Optimization Plan (OOP) will be prepared and submitted to DDW and the RWQCB for review and approval prior to Project startup. The OOP will contain more specifics on the operation and maintenance of the injection facilities, as well as final approved protocols for groundwater sampling.

The preliminary injection operation and maintenance plan is not affected by the increase in capacity of the AWP Facility from 4 mgd to 5 mgd since the additional 1 mgd is for irrigation and will be diverted from the product water conveyance pipeline prior to injection.

8.1. DELIVERY/CONVEYANCE OF PRODUCT WATER TO SEASIDE BASIN

M1W has evaluated the amounts and availability of the Project source waters and has developed estimates of monthly deliveries of product water to the Seasisde Basin. An average of 3,500 AFY is planned for delivery, but monthly amounts will vary based on hydrologic conditions.

Specifically, the Project will incorporate the concept of a drought reserve account. During wet and normal years, the project will convey an extra 200 AFY of advanced treated water (primarily during October-March) to the Seaside Basin for credit in the drought reserve account, up to a cumulative total of 1,000 AF. During dry conditions, the Project could reduce its deliveries to the Seaside Basin by as much water as had accumulated in the drought reserve. This amount of water will be treated to a tertiary level and delivered instead to CSIP for supplemental irrigation supply. During these reduced deliveries to the Seaside Basin, CalAm will continue to extract 3,500 AFY for municipal supply by using the water stored in the drought reserve account.

For further analysis, these operational guidelines have been translated into potential monthly delivery amounts to the Seaside Basin based on actual hydrologic conditions as discussed in more detail below.

8.2. DELIVERY SCHEDULES AND OPERATION OF THE DROUGHT RESERVE ACCOUNT

M1W has considered the availability and amounts of source waters, capacity of the AWP Facility, minimum delivery targets, and operational guidelines discussed above in order to develop potential delivery schedules for recharge to the Seaside Basin. This analysis has identified six potential delivery schedules that could occur, based on two water management decision points made in each year of Project operation. These delivery schedules are presented in **Table 8-1**. The two management decisions that determine appropriate deliveries to the Seaside Basin are described below.

Table 8-1: Product Water Available for Injection

Purified Water Delivery Schedule for Injection (AF)		Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Total
Before drought reserve complete	**Wet/normal year**	331	321	331	331	299	331	288	297	288	297	297	288	3,700
After drought reserve complete	**Wet/normal year**	297	288	297	297	268	297	288	297	288	297	297	288	3,500
Before drought reserve complete	**Drought year (1,000 AF to CSIP)**	331	321	331	331	299	331	124	128	124	128	128	124	2,700
Before drought reserve complete	**Drought year (400 AF to CSIP)**	331	321	331	331	299	331	222	230	222	230	230	222	3,300
Before drought reserve complete	**Drought year (200 AF to CSIP)**	331	321	331	331	299	331	255	263	255	263	263	255	3,500
After drought reserve complete	**Drought year (1,000 AF to CSIP)**	297	288	297	297	268	297	124	128	124	128	128	124	2,500
		Maximum Net Recharge Rates (AF)												
Santa Margarita Aquifer (70%)		232	224	232	232	209	232	201	208	201	208	208	201	2,590
Paso Robles Aquifer (30%)		99	96	99	99	90	99	86	89	86	89	89	86	1,110
Total (100%)		331	321	331	331	299	331	288	297	288	297	297	288	3,700

The first management decision will be made by October 1, the beginning of the Water Year (WY), and will dictate which of two delivery schedules is followed during October through March of that WY. The decision will be based on whether or not the drought reserve account is full (1,000 AF). If the account is full, the Project will deliver monthly amounts from October through March based on average annual deliveries. The two delivery schedules with a full reserve account are highlighted in purple in **Table 8-1** and labeled Schedule 2 and Schedule 8). If the account balance is less than 1,000 AF on October 1, then an additional 200 AF will be delivered from October through March (highlighted in **Table 8-1** in blue; for example, see October through March delivery schedules 1, and 3 through 7). For wet or normal years, these two recharge schedules will produce a total of 3,700 AFY (Schedule 1) or a total of 3,500 AFY (Schedule 2) (**Table 8-1**).

The second management decision will be made in early spring as to which schedule will be followed for deliveries in April through September. This decision will be based on whether or not the previous 6 months of precipitation has indicated a drought year and whether supplemental irrigation water is needed and available from the drought reserve account. This decision will be made by MCWRA. If it is a wet/normal year, the delivery will follow the April through September delivery schedule shown for both Schedule 1 and Schedule 2 (highlighted in orange in **Table 8-1**). However, if MCWRA requests water from the drought reserve account during a drought year, the delivery schedule for April through September will follow one of the drought delivery schedules shown in green in **Table 8-1**. The selection of the drought schedule will be based on the then-current balance in the drought reserve account (as of April 1 – see last column in **Table 8-1**).

8.3. MAXIMUM DELIVERY FOR RECHARGE

The maximum monthly amount of product water available from any of the eight potential delivery schedules in **Table 8-1** can be converted to a maximum monthly injection rate in gpm for each aquifer. These rates are summarized in the lower portion of **Table 8-1**. The total maximum injection rate for any of the delivery schedules is 2,459 gpm[33]. Assuming 70% recharge into the Santa Margarita Aquifer, deep injection wells will need to accommodate an estimated peak flow of 1,821 gpm[34]. Assuming 30% recharge into the Paso Robles Aquifer, the vadose zone wells will need to be capable of a collective injection rate of 638 gpm.

Injection wells have been designed and constructed to accommodate these maximum rates allowing for down-time associated with well operation and maintenance and expected losses in well efficiency over time.

8.4. INJECTION WELL OPERATION

The PWM Project includes a total of four injection wells (see **Figure 3-8**). Two DIWs (DIW-1 and DIW-2) will inject approximately 70 percent of the purified recycled water directly into the Santa Margarita

[33] Planned routine back-flushing of deep injection wells of 4 hours per week per well and corresponding recharge of percolating back-flush water to the Paso Robles Aquifer are considered in this calculation to ensure 70% Santa Margarita Aquifer / 30% Paso Robles Aquifer final recharge allocation.
[34] Planned routine back-flushing of deep injection wells of 4 hours per week per well and corresponding recharge of percolating back-flush water to the Paso Robles Aquifer are considered in this calculation to ensure 70% Santa Margarita Aquifer / 30% Paso Robles Aquifer final recharge allocation.

Aquifer. Two VZWs (VZW-1A[35] and VWZ-2) will inject approximately 30 percent of purified recycled water in the unsaturated Aromas Sand Formation for percolation to the underlying Paso Robles Aquifer[36].

8.4.1. Deep Injection Wells Installation and Operation

DIW-1 was installed and tested in 2017 during the first phase of construction (Phase 1). Variable-discharge and constant-discharge pumping tests were performed on DIW-1 to assess well performance and local aquifer hydraulic properties of the Santa Margarita Aquifer. Results indicate that DIW-1 can be pumped up to 3,200 gallons per minute (gpm) without a significant decrease in specific capacity. Based on a pumping rate of 3,161 gpm and an ending water level drawdown of 49.9 feet, the 10-hour specific capacity of DIW-1 is 63.4 gpm per foot of drawdown (gpm/ft of dd). A flow profile developed from the spinner log survey of DIW-1 indicates that intermediate screen perforations between 600 and 735 feet-bgs contribute 90 percent of the water to DIW-1. While injection testing has not yet been performed, the pumping test results indicate that DIW-1 can meet the design pumping capacity of 2,000 gpm, assuming a design injection rate of 1,000 gpm per DIW and design pumping/backflushing rate equal to twice the injection rate.

DIW-2 was installed and tested in 2018/2019 during the second phase of construction (Phase 2). Variable-discharge and constant-discharge pumping test results indicate that DIW-2 can be pumped up to 2,700 gallons per minute (gpm) without a significant decrease in specific capacity. Based on a pumping rate of 2,010 gpm and an ending water level drawdown of 92.0 feet, an 8-hour specific capacity of DIW-2 is 21.85 gpm per foot of drawdown (gpm/ft of dd). A flow profile developed from the spinner log survey of DIW-2 indicates that intermediate screen perforations between 490 and 550 feet-bgs contribute 50 percent of the water to DIW-2, with 25 percent split evenly above and below this intermediate section. While injection testing has not yet been performed, the pumping test results indicate that DIW-2 can meet the design pumping capacity of approximately 2,000 gpm, assuming a design injection rate of 1,000 gpm per DIW and design pumping/backflushing rate equal to twice the injection rate.

[35] The original VZW-1 was not successfully drilled to target depth using the auger method, and the borehole was abandoned. VZW-1A will be drilled using the reverse rotary method (similar to VZW-2) adjacent to the abandoned VZW-1 borehole.

[36] Approximate distribution of purified recycled water between DIWs and VZWs reflects the Project goal of recharging 70 percent into the Santa Margarita Aquifer and 30 percent into the Paso Robles Aquifer.

8.4.2. Vadose Zone Wells Installation and Operation

VZW-2 was installed and tested in 2018/2019 during the second phase of construction (Phase 2). VZW-1A will be installed under Phase 2 construction in April 2019 (see **Figure 3-8** for well locations).

Variable-discharge injection testing of the 100-foot VZW-2 demonstrated an injection capacity of about 380 gpm, slightly below the 500-gpm design rate. Accordingly, VZW-1A will be constructed to a depth of 200 feet and, together with VZW-2, is expected to accommodate the total design maximum flow rate of 638 gpm to the vadose zone wells.

8.5. INJECTION SUPPORT FACILITIES

Injection support facilities are described in **Section 3.5**. Information is summarized below with additional components relating to system operation.

8.5.1. Product Water Supply Pipelines and Electrical Service

As previously discussed in **Sections 3.4** and **3.5**, the product water will be transmitted via the AWP product water pipeline to the Injection Facilities area. There, the pipeline will connect to a local 18-inch diameter product water supply line to deliver water to the injection wells. This local water supply line will be constructed along the length of the Injection Facilities area, but may be constructed in phases, to support the phasing of injection wells. Deep injection wells will be tied into the local water supply line by a 12-inch diameter feed line and will also be connected to a 16-inch diameter backflush pipeline to transmit water pumped for maintenance to a backflush basin. Injection and discharge will be controlled downhole by a flow-control valve. The vadose zone wells will be connected to the 18-inch water supply line by an 6-inch diameter feed line. Vadose zone wells will not be connected to the backflush line.

An electrical duct bank will be connected to an electrical cabinet, which will be constructed at each well site. The electrical equipment will include a main electrical power supply cabinet required for PG&E power supply, a transformer and motor controls. Power supply will be needed to drive only one injection pump motor at a time.

E2 Consulting Engineers evaluated the electrical requirements of the Injection Facilities (E2, 2014). PG&E has two circuits in the vicinity of the new wells. Connection to the circuits will be an underground feed from poles along General Jim Moore Boulevard. The electrical connection could be medium service depending on the points of service. The well motors will be operated with a variable frequency drive (VFD). The voltage of the motor will be based on the distance from the VFD to each respective well pump.

8.5.2. Backflush Basin

The back-flush basin has a storage volume of 2.1 AF. Discharge water will be pumped from each deep injection well to a 16-inch backflush pipeline. It is anticipated that each deep injection well will be backflushed for 4 hours per week.

8.6. OPERATIONS PLAN

Injection will occur in the Project wells on a mostly continual basis, controlled by the operations and maintenance schedules of the AWPF. An average of 3,500 AFY will be injected into the basin for downgradient recovery using existing extraction wells. During normal and wet periods, up to 3,700 AFY may be injected depending on the then-current reserve account balance. Extraction will be maintained at 3,500 AFY. This amount will already be injected into the Seaside Basin prior to extraction. In this manner, adverse impacts to the basin will be avoided, a reliable water supply will be provided to CalAm, and the yield from the Seaside Basin will be significantly increased.

A detailed description of the plans to operate and maintain the injection facilities is presented in the OOP. A draft version of the OOP was submitted to DDW for review on February 4, 2019[37].

[37] "Draft Operation Optimization Plan, Pure Water Monterey Advanced Water Treatment Facility and Groundwater Replenishment Project," Trussell Technologies, February 2019.

This Page Intentionally Left Blank

9. HYDROGEOLOGIC SETTING

The Injection Facilities are located on the coastal plain of Monterey Bay south of the Salinas River (**Figure 9-1**). As shown on **Figure 9-1**, the area overlies a portion of the Seaside Area Subbasin of the larger Salinas Valley Groundwater Basin (DWR, 2004). The Salinas Valley is an elongate intermountain valley that extends to the southwest of the area shown on **Figure 9-1** for approximately 80 miles. The Seaside Area Subbasin as defined by the Department of Water Resources (DWR) includes the coastal communities of Seaside and Marina and a portion of the former Fort Ord military facility. The area is bounded by other subbasins of the Salinas Valley Groundwater basin including the 180/400 Aquifer Subbasin to the north and the Corral de Tierra Subbasin to the south. The western boundary is the Monterey Bay shoreline, although the aquifer system continues offshore (**Figure 9-1**).

For the purposes of local groundwater management and generally consistent with a court-appointed adjudication boundary, the local groundwater basin has been re-defined as a smaller area than the DWR-defined Seaside Area Subbasin. For consistency with jurisdictional and local agency terminology, this portion of the Seaside Area Subbasin is referred to as the Seaside Groundwater Basin, or simply Seaside Basin, in this report.

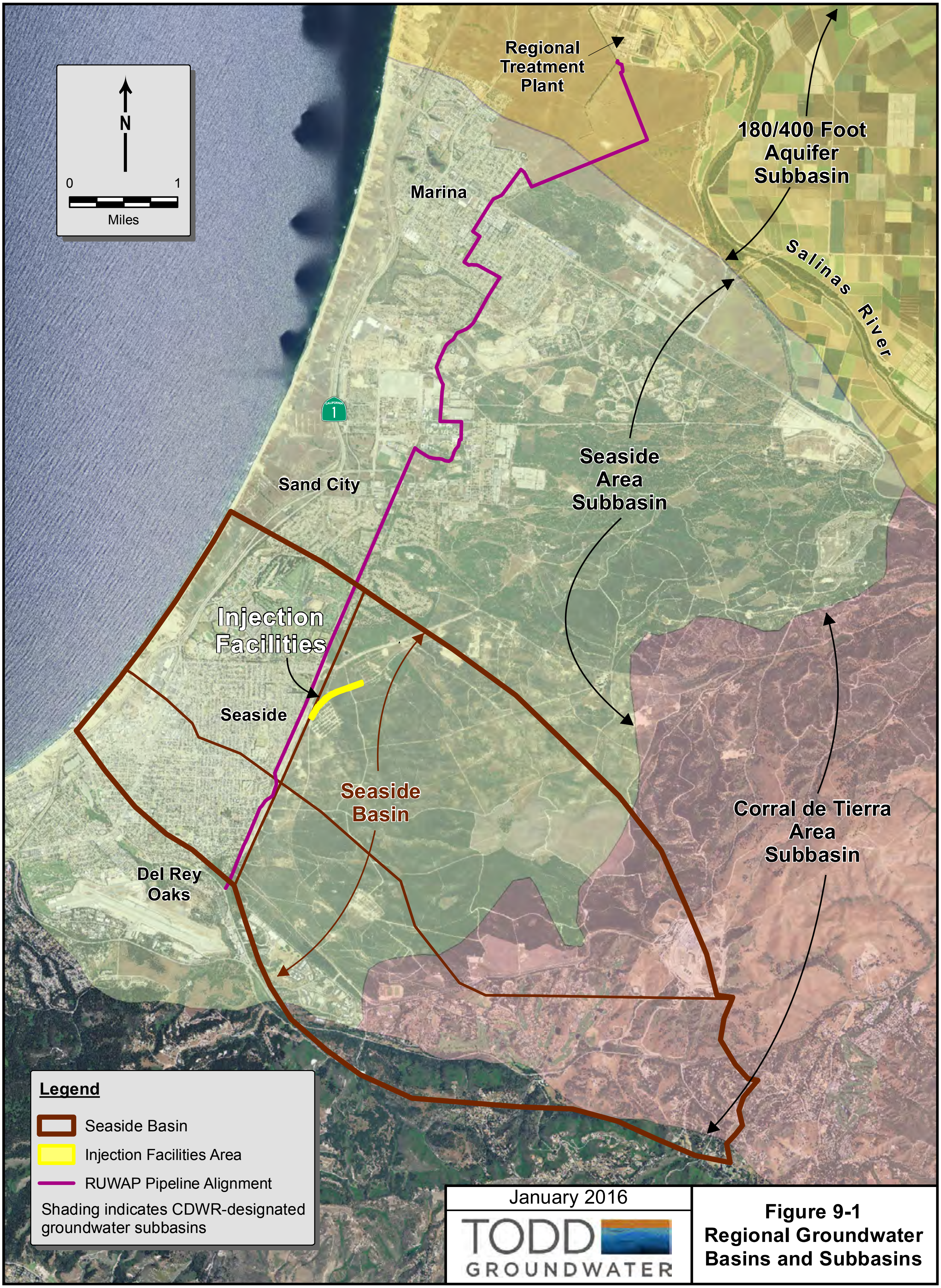
Groundwater conditions in the Seaside Basin were documented in a basin-wide study conducted for MPWMD (Yates, et al., 2005). As part of that study, investigators presented updated basin boundaries with four subareas that are generally aligned with hydrogeologic features such as the occurrence of bedrock, extent of aquifer systems, geologic faulting, and groundwater divides. Specifically, four subareas were delineated: Northern Coastal Subarea, Northern Inland Subarea, Southern Coastal Subarea, and Laguna Seca Subarea. The updated basin boundaries and four subarea boundaries are shown on **Figures 9-1** and **9-2**.

The northern boundary of the Seaside Basin is a groundwater divide and shifts somewhat over time. In addition, the northern boundary also differs somewhat from the boundary defined in the basin adjudication by the courts. However, all of these boundaries' differences are minor and do not affect the project analysis. For consistency, the boundaries shown on all of the maps for this report are the updated boundaries from Yates (et al., 2005).

The discussion of the hydrogeologic setting is not impacted by the increase in capacity of the AWP Facility from 4 mgd to 5 mgd since the additional 1 mgd is for irrigation and will be diverted from the product water conveyance pipeline prior to injection.

9.1. SEASIDE BASIN AND REGIONAL HYDROGEOLOGY

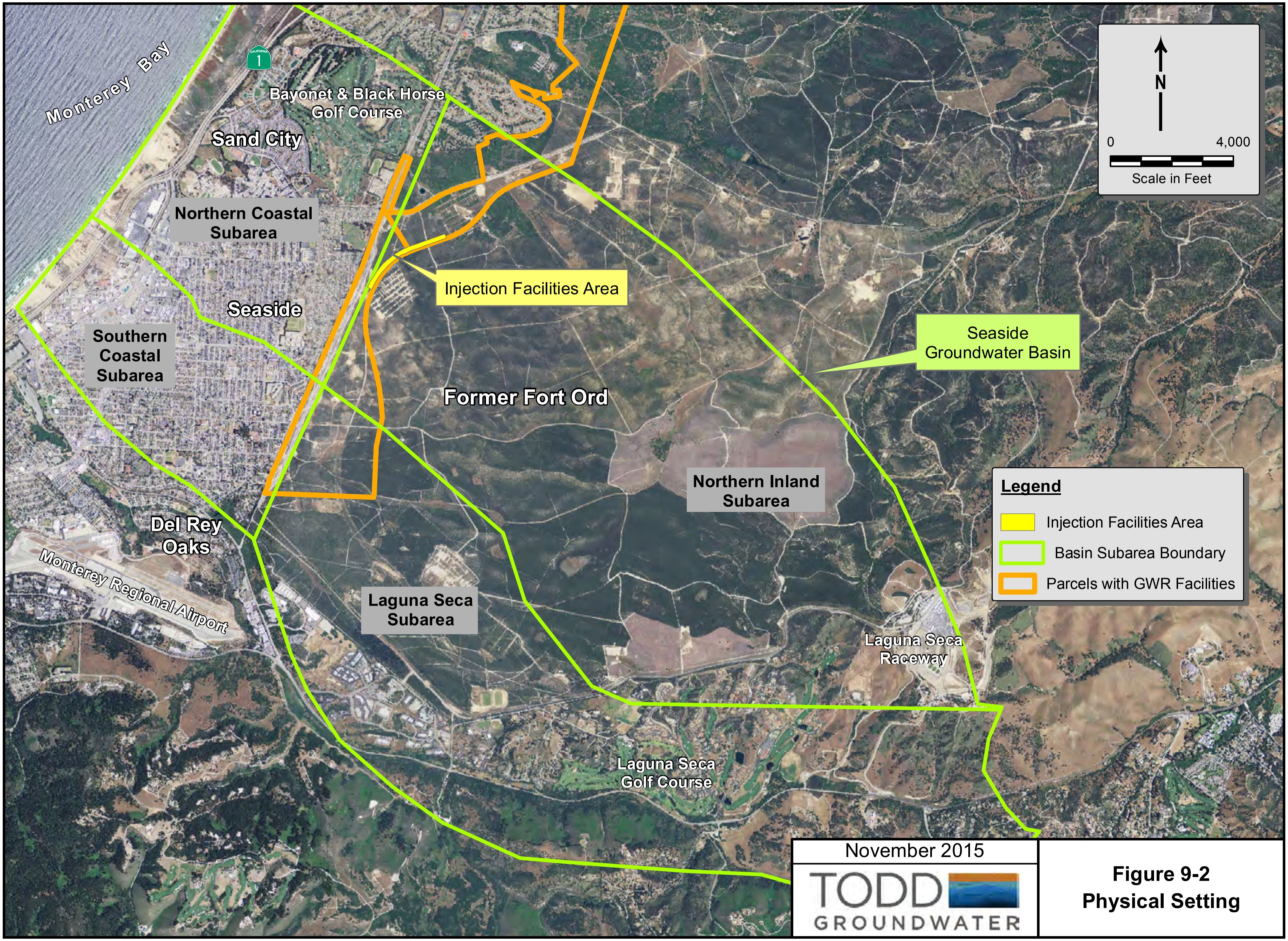
As shown by the aerial photograph on **Figure 9-2**, the coastal subareas of the Seaside Basin are urbanized and intersect portions of the Cities of Seaside, Monterey, Del Rey Oaks, and Sand City. The Bayonet & Black Horse Golf Courses are located in the northern portion of the Northern Coastal Subarea. Highway 1 crosses the coastal subareas near the coast. The Northern Inland Subarea is largely undeveloped and contains lands from the former Fort Ord facility. These lands extend into the northern portions of the Laguna Seca Subarea, bounded by development in Del Rey Oaks in the southwestern subarea and by Laguna Seca development and golf courses in the eastern subarea. The Injection Facilities area is located in northwestern portion of the Northern Inland Subarea near the boundary with the Northern Coastal Subarea, as highlighted on **Figure 9-2**.



January 2016

TODD GROUNDWATER

Figure 9-1
Regional Groundwater Basins and Subbasins



November 2015

TODD GROUNDWATER

Figure 9-2
Physical Setting

9.1.1. Physical Setting

The ground surface elevation rises across the groundwater basin from sea level at the coast to more than 850 feet above mean sea level (msl) in the southeastern portions of the basin. Surface elevations in the western portion of the Northern Inland Subarea, including the Injection Facilities area, are generally between 300 feet msl and 500 feet msl.

The average annual precipitation for the Seaside Basin is approximately 15 inches per year (inland) to 17 inches per year (coastal). Much of the surface drainage in the Seaside Basin is internal with runoff pooling in small depressions between surficial sand dune deposits. There are no major drainageways in the Northern Inland Subarea. Runoff from precipitation at the Injection Facilities area flows overland generally to the west-southwest, consistent with ground surface elevations.

9.1.2. Geologic and Hydrogeologic Setting

The Seaside Basin consists of semi-consolidated to consolidated sedimentary units overlying relatively low permeability rocks of the Miocene Monterey Formation and older crystalline rocks. These low permeability units are generally used to define the base of the groundwater basin. The sedimentary units consist of marine sandstones of Tertiary age overlain by a complex Quaternary-age sequence of continental deposits and shallow Quaternary-age dune deposits. In general, the sedimentary units dip northward and thicken into the Salinas Valley.

The Seaside Basin has been structurally deformed by geologic folding and faulting. In particular, sedimentary units in the southern portion of the basin have been uplifted and displaced along the Ord Terrace and Seaside faults, which create some hydraulic separation, or compartmentalization, within the basin. Both faults are generally south of the Injection Facilities. However, one interpretation of the Ord Terrace fault trace (Yates, et al., 2005) indicates that the fault trends relatively close (within 1,000 feet) to the southern-most extent of the Injection Facilities area and could potentially result in some hydraulic separation between the injection wells and the closest municipal well to the southwest, City of Seaside #4 (see wells on **Figure 3-8**) (see also information on nearby production wells in **Section 10**). This uncertainty will not affect the Project operations. As a conservative assumption, the hydrogeologic investigation assumes that the wells are hydraulically connected.

Two main sedimentary units provide groundwater supply to existing pumping wells in the Seaside Basin: the continental Quaternary-age (Pleistocene) Paso Robles Formation and the underlying Tertiary-age (Miocene) Santa Margarita Sandstone. Permeable units in these two geologic formations are referred to herein as the Paso Robles and the Santa Margarita Aquifers. Although the Santa Margarita Aquifer is more homogeneous than the Paso Robles Aquifer, both are defined by a series of stratified layers rather than a single continuous sand unit.

The two aquifers are overlain by Quaternary-age units including undifferentiated sediments, eolian sand deposits, and the consolidated Aromas Formation (DWR, February 2004; Yates et al., 2005). Although these shallow units are highly permeable in most areas, the deposits occur generally above the water table and are only saturated in coastal areas. As such, these shallow units do not contribute substantially to the basin's water supply.

Over-pumping of these two aquifers over time has resulted in declining water levels near the coast, increasing the potential for seawater intrusion. These conditions led to a court-administered groundwater basin adjudication. Details regarding the adjudication and historical and current groundwater use are described in the following sections.

9.1.3. Seaside Basin Adjudication and Watermaster Activities

The Seaside Basin was adjudicated by the California Superior Court on March 27, 2006, establishing groundwater extraction rights in the basin. A court-appointed Watermaster has been formed to execute the requirements of the adjudication. The court decision requires a decrease in pumping after three years from the effective date of the adjudication and additional pumping reductions over time unless the Watermaster has secured additional outside sources of water for basin replenishment.

9.1.3.1. Seaside Basin Watermaster Groundwater Monitoring and Reporting

The Watermaster prepares annual reports to the court documenting annual groundwater extractions, groundwater storage, groundwater replenishment (if any) and other information on groundwater conditions including levels and quality. In cooperation with MPWMD, the Watermaster conducts a groundwater monitoring program to support these reporting requirements. For WY 2015, the monitoring program included water quality data from 12 basin monitoring wells, water levels in 76 monitoring and inactive production wells, and precipitation and streamflow data (Arroyo Del Rey) (MPWMD, 2015). Groundwater quality samples are analyzed for general minerals and certain parameters and constituents required for the annual seawater intrusion analysis.

In addition to these monitoring and reporting programs, the Seaside Basin Watermaster also conducts technical groundwater studies and analyses for groundwater basin management. For example, the Watermaster developed target water levels for key coastal wells to protect against seawater intrusion, referred to as protective levels (HydroMetrics, 2009). HydroMetrics produces annual reports analyzing water level and quality data to determine the potential for seawater intrusion (HydroMetrics, 2014). These Seawater Intrusion Analysis Reports also compare water levels to protective levels and report any indications of seawater intrusion. Although the potential for seawater intrusion remains a threat to basin water quality, no seawater intrusion has been observed as of the most recent analysis in December 2014 (HydroMetrics, 2014b).

9.1.3.2. Seaside Basin Watermaster Groundwater Model

In 2009, the Seaside Basin Watermaster completed construction of a numerical groundwater flow computer model for the basin using the model code MODFLOW 2005 (HydroMetrics, 2009). The Watermaster Model provides a basin-wide tool for determining protective water levels to prevent seawater intrusion and for evaluating various groundwater management strategies.

The Watermaster Model covers approximately 76 square miles of the Salinas Valley Groundwater Basin including the Seaside Basin. In order to represent the hydrostratigraphy and simulate three-dimensional flow in the basin, the model was constructed with five layers. Model layers generally correspond to observed hydrostratigraphic units[38] as follows:

- Layer 1 - Older Dune deposits and Aromas Red Sand,

[38] A hydrostratigraphic unit can be defined as a formation, part of a formation, or groups of formations in which there are similar hydraulic characteristics allowing for grouping into aquifers or confining layers (aquitards).

- Layers 2 and 3 - Upper and Middle Paso Robles Aquifer,
- Layer 4 - Basal clay layers (approximately 80 feet thick) typically observed in the Lower Paso Robles Formation, where present, and
- Layer 5 - Santa Margarita Aquifer (including the Purisima Formation where present).

The Watermaster Model is a transient model that has been calibrated over a 22-year period from January 1987 through December 2008 and is capable of simulating groundwater levels over a wide variety of hydrologic conditions. The model includes conditions that occurred during the drought period of the early 1990s and relatively wet periods such as 1998 and 2005. Boundary conditions and additional details on the Watermaster Model are documented in a report on model construction and calibration (HydroMetrics, 2009).

In 2014, the Watermaster Model was updated to include groundwater conditions through December 2013. Details and documentation of the model update were provided in a technical memorandum included as an attachment to the Seaside Basin Watermaster 2014 Annual Report (see Attachment 10 in Seaside Basin Watermaster, 2014).

The model provides a valuable quantitative tool for the evaluation of the Project and potential impacts to basin water levels and wells. HydroMetrics (now Montgomery & Associates), consultant to the Watermaster and author of the Watermaster Model, was contracted by MRWPCA to apply the model to simulate aquifer response to injection associated with the Project. Modeling results pertaining to Project injection impacts to groundwater quality are summarized in **Section 11**. The model was also applied to simulate the underground retention time in order to support the pathogen (i.e., virus) reduction credit requested in this report as well as the estimated response retention time provided prior to extraction of the recycled water. Modeling results for the underground retention time analysis are provided in **Section 5.3**.

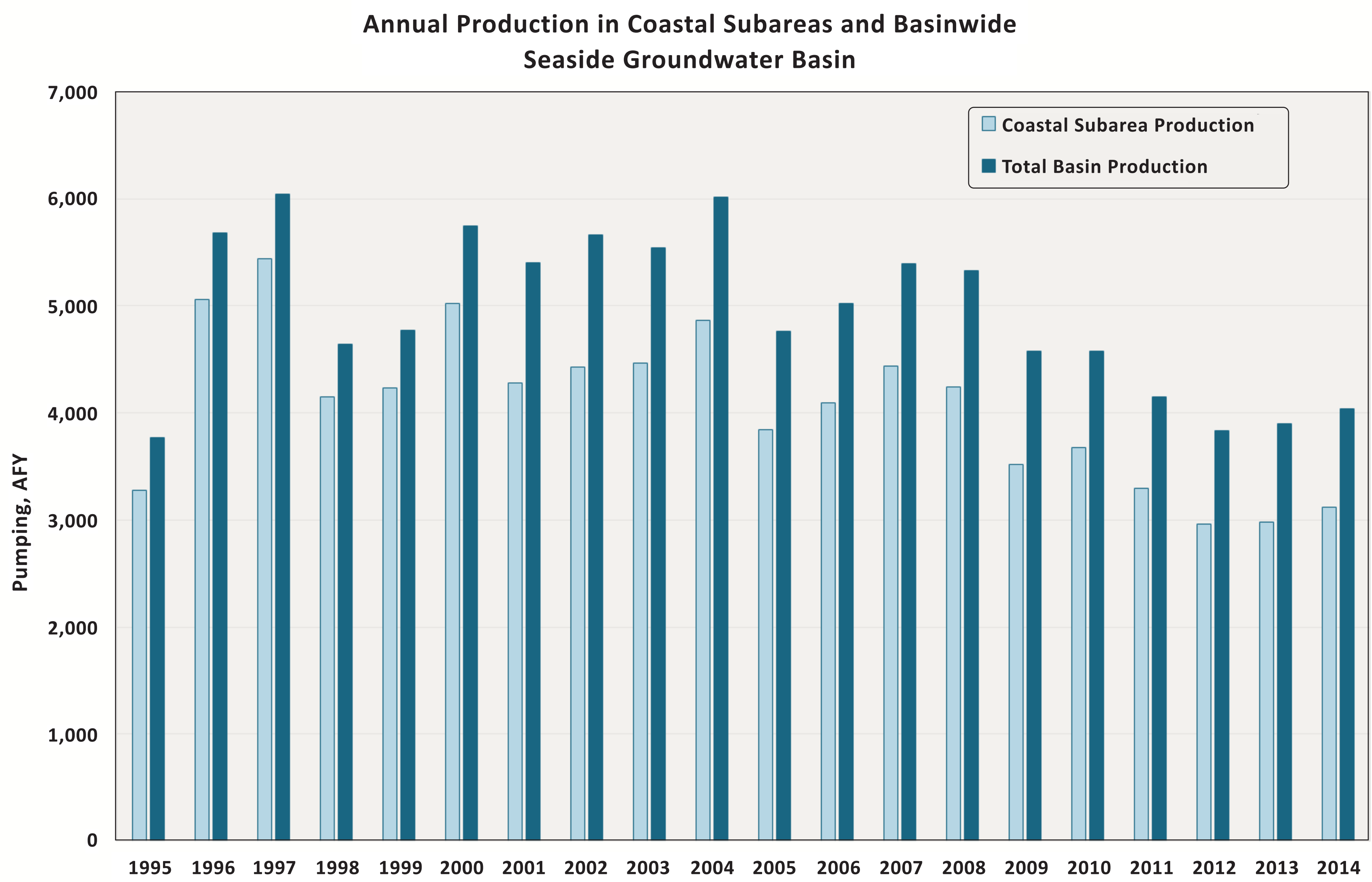
9.1.4. Groundwater Use

Groundwater pumping in the Seaside Basin provides water supply for municipal, irrigation (primarily golf courses), and industrial uses. Historically, about 70 to 80% of the pumping has occurred in the Northern Coastal Subarea, with additional pumping occurring in the Laguna Seca Subarea supplemented by small amounts in the Southern Coastal Subarea. CalAm is the largest pumper in the basin accounting for about 80% of the groundwater pumped in WY 2014 (Seaside Basin Watermaster, 2014). Production wells in the Northern Coastal Subarea are shown on **Figure 9-3**.

Annual pumping in the Coastal subareas and total basin production over the last 20 years are shown on **Figure 9-4**. Over this time period, production in the Coastal subareas has averaged about 4,070 AFY and total basin production has averaged about 4,950 AFY.

Prior to basin adjudication in 2006, pumping exceeded sustainable yield and contributed to significant basin-wide water level declines. Over-pumping in the coastal subareas resulted in water levels declining below sea level at the coast, placing aquifers at risk of seawater intrusion. In particular, basin pumping increased after a 1995 order by the SWRCB placed constraints on out-of-basin supplies (**Figure 9-4**).

Figure 9-3
Production Wells near Injection Facilities



Notes: 1995 - 2001 data by Reporting Period (July 1 - June 30). 2001 - 2014 data by Water Year (October 1 - September 30).
Pumping data do not include ASR injection or recovery amounts.

November 2015

TODD GROUNDWATER

Figure 9-4
Coastal and Basin-wide Groundwater Production

Since 2008, groundwater pumping has declined. Pumping in coastal subareas averaged about 4,505 AFY from 1996 through 2008 but has decreased to about 3,260 AFY from 2009 through 2014 (Seaside Basin Watermaster production records). For comparison purposes, the court established a natural safe yield for the coastal subareas of between 1,973 AFY to 2,305 AFY during the Seaside Basin adjudication (California Superior Court, 2006).

The data in **Figure 9-4** do not include production data from the nearby ASR Project where about 2,870 AF have been injected and recovered from 2010 through 2015. Although the ASR Project uses basin storage capacity, the water produced from ASR wells has been imported into the Seaside Basin and injected into the wells, resulting in no net basin production. Production wells in the vicinity of the Injection Facilities, including the ASR wells are the focus of the discussion in **Section 10**.

9.2. PROJECT AREA HYDROGEOLOGY

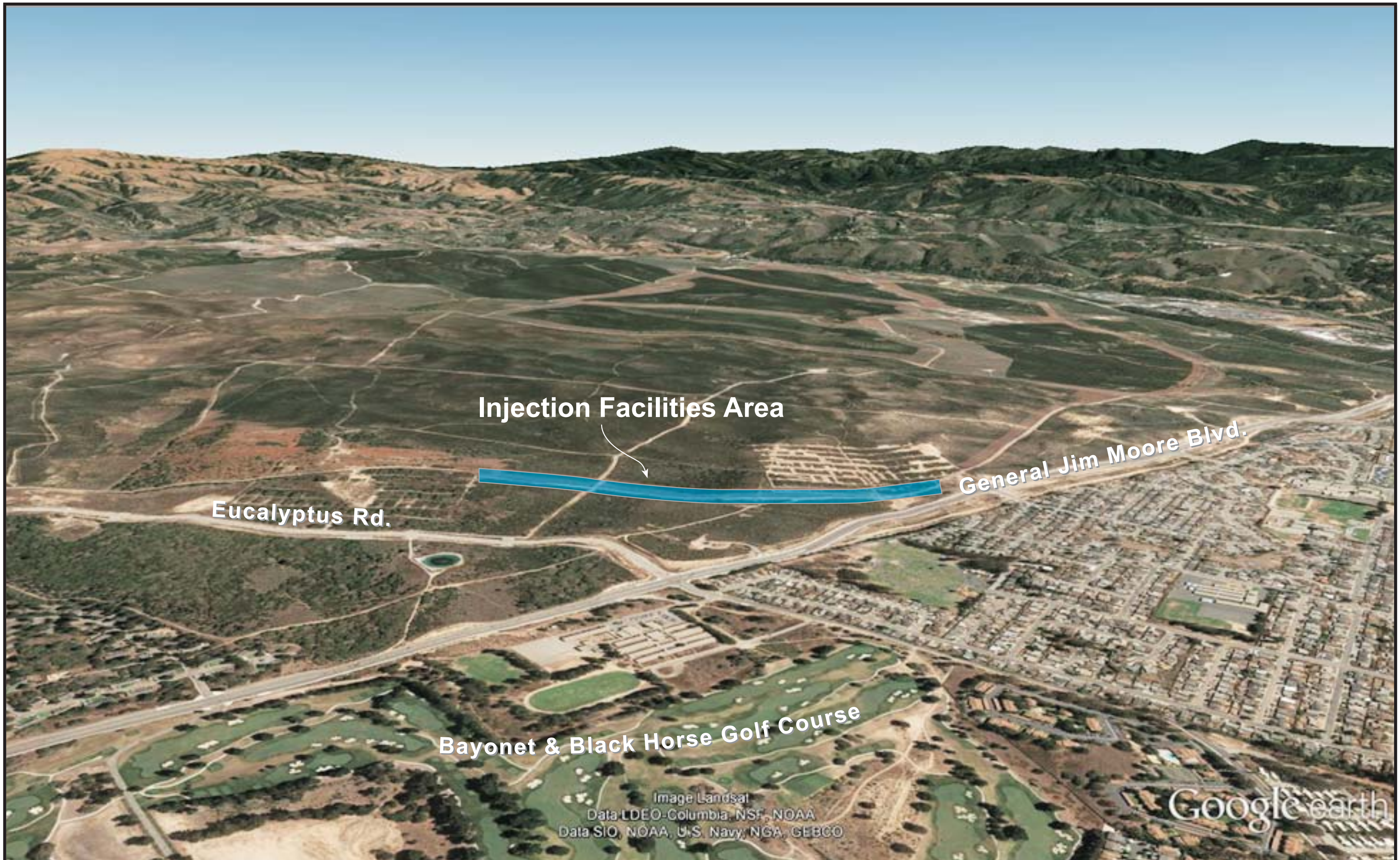
The proposed Injection Facilities are located within the Northern Inland Subarea but adjacent to the Northern Coastal Subarea where most of the basin's groundwater pumping occurs (see production wells on **Figure 9-3**).

9.2.1. Physical Setting of the Injection Facilities Area

The Injection Facilities are located on inland mature sand dunes that slope westward toward Monterey Bay (**Figure 9-2**). The site is characterized by rolling hills and closed depressions. An oblique view of the Injection Facilities area illustrates the hummocky nature of the surrounding topography (**Figure 9-5**). The area is currently undeveloped and is cross-cut by unimproved roads and trails associated with former military activities (**Figure 9-5**). An access road to a small water reservoir is across Eucalyptus Road from the northern-portion of the proposed Injection Facilities area. This reservoir and adjacent groundwater well have been used historically for irrigation at the Bayonet and Black Horse golf courses west of General Jim Moore Boulevard (**Figure 9-5**).

Ground surface elevations along the Injection Facilities area vary from about 455 feet msl in the northeast to about 300 feet msl in the southwest. Elevations between DIW-1 and DIW-2 range from about 400 to 360 feet msl with elevations at the proposed back-flush basin of approximately 300 feet msl.

The Injection Facilities area receives about 14.5 inches of annual rainfall (Yates, et al., 2005). Runoff on the rolling hills collects in low areas and provides recharge to the Seaside Basin. Recharge from deep percolation of rainfall (and minor amounts of irrigation) in the Northern Inland Subarea has averaged about 1,080 AFY from 2003 through 2007 (HydroMetrics, 2009). This amount represents 99% of the total recharge estimated for this undeveloped subarea (HydroMetrics, 2009).



View looking southeast.

November 2015

TODD GROUNDWATER

Figure 9-5
Oblique View Injection Facilities Area

9.2.2. Land Use in the Injection Facilities Area

The Injection Facilities will be located on a portion of the former Fort Ord military base, which provided training and staging for U.S. troops from 1917 to 1994. The Project wells are located in the northwestern portion of a large upland area referred to as the Inland Ranges (HLA, 1994). As shown on Figure 9-6, the Inland Ranges consist of about 8,000 acres bounded by Eucalyptus Road to the north, Barloy Canyon Road to the east, South Boundary Road to the south, and General Jim Moore Boulevard to the west. For environmental investigation and remediation purposes on former Fort Ord lands, a portion of the area is also referred to as Site 39. The general area of the Inland Ranges, the Site 39 boundary, and the proposed injection wells are shown on **Figure 9-6**.

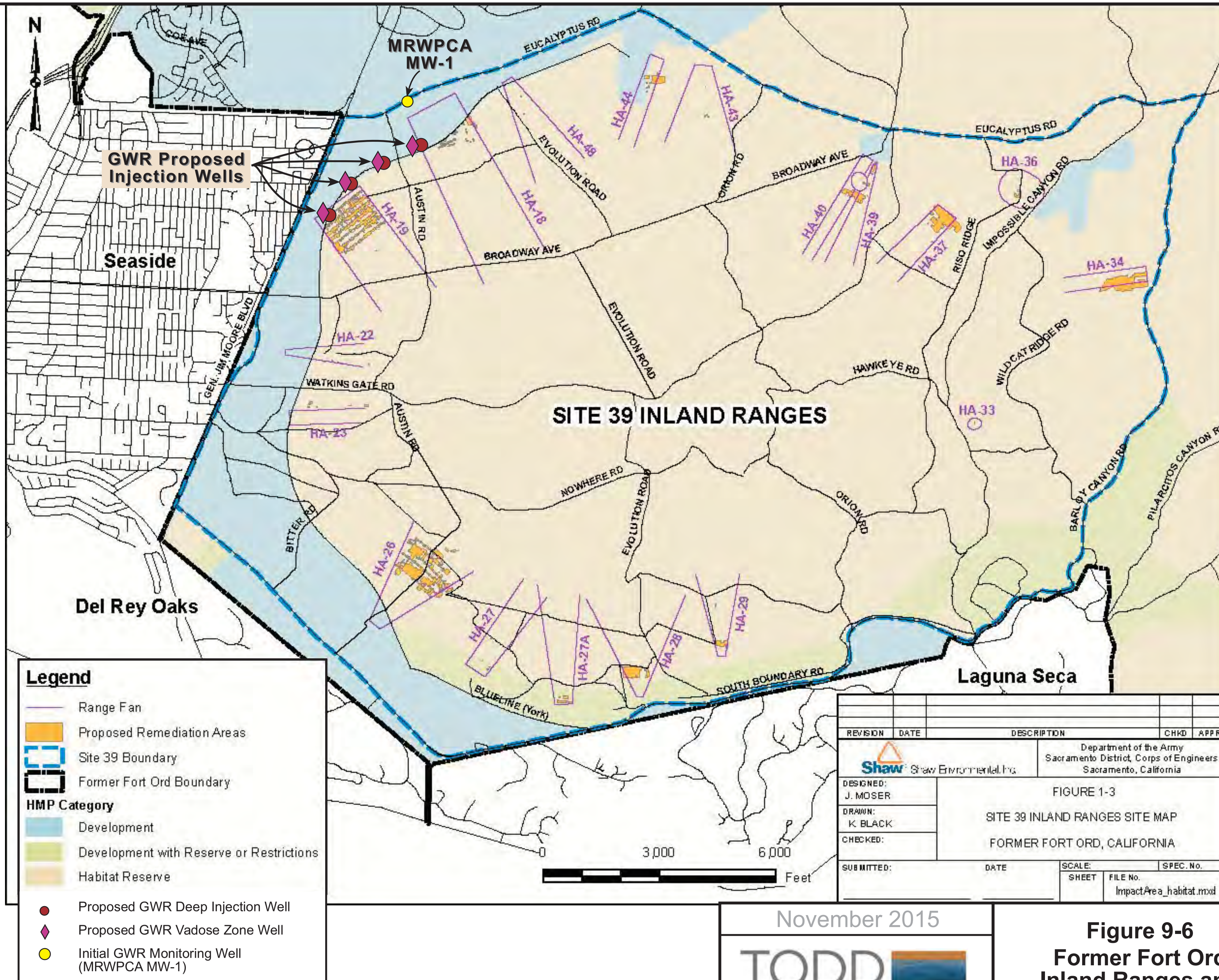
Site 39 contained at least 28 firing ranges that were used for small arms and high explosive ordnance training using rockets, artillery, mortars and grenades. Range 18 (HA-18) and Range 19 (HA-19) are the closest ranges to the Injection Facilities area (**Figure 9-6**).

Considerable expended and unexploded ordnance have been documented in various areas of Site 39. The specific ordnance types include rounds from shotguns, mortars, M74 rockets, recoilless rifles, aircraft, grenades, artillery, howitzers, mines, anti-tank weapons (bazookas), bombs, naval ordnance, Bangalore torpedoes, C-4, TNT, military dynamite, and shaped charges. Functions for these items included high explosives plus heat generating, armor piercing, white phosphorous, smoke tracer, illumination, incendiary, and photo flash devices.

Beginning in 1984, numerous environmental investigation and remediation activities have occurred on Site 39. During these investigations, metals and various compounds associated with explosives have been detected in soil. Remediation has been more extensive in areas targeted for redevelopment, an area that includes the Injection Facilities area. As shown on **Figure 9-6**, the Injection Facilities area is within and along the edge of areas targeted for development without restrictions (blue shaded area on **Figure 9-6**).

Most of these lands are now controlled by FORA, the organization responsible for the planning, financing, and implementing the conversion of former Fort Ord military lands to civilian activities. FORA has signed an Environmental Services Cooperative Agreement (ESCA) with the U. S. Army to allow transfer of approximately nine parcels (3,340 acres) to FORA that were associated with military munitions (e.g., unexploded ordnance or munitions and explosives of concern). Under ESCA, FORA is responsible for addressing munitions response actions. FORA and their contractors are working with regulatory agencies including the California Department of Toxic Substances Control and the U.S. EPA to complete munitions remediation activities.

The two ESCA parcels containing the Injection Facilities area, APN 031-151-048-000 and APN 031-211-001-000, are outlined on **Figure 9-2**. These two parcels will ultimately be transferred to the City of Seaside for redevelopment. Parcels adjacent to and south-southeast of the proposed Injection Facilities area will remain under the control of the U.S. Bureau of Land Management.



Modified from: Shaw Environmental, 2009.

November 2015

TODD GROUNDWATER

Figure 9-6
Former Fort Ord Inland Ranges and Proposed Injection Wells

The ESCA parcels that contain the Injection Facilities were less impacted by former Fort Ord activities than other parcels associated with Site 39 and have already been cleared of munitions and explosives of concern and approved for future development. The City of Seaside has an ordinance applicable to these and other former Fort Ord parcels, which requires a soil management plan for any soil disturbance and other parcel restrictions.

The Injection Facilities are purposefully located along the southern-southeastern edge of the parcels and are not expected to interfere with future re-development by the City of Seaside (**Figure 9-2**). By spacing the wells along the parcel boundary, it is anticipated that any visual or noise concerns will also be minimized.

9.2.3. Local Subsurface Conditions

Aquifer units and subsurface conditions in the vicinity of the Injection Facilities area are illustrated on a geologic Cross Section A-A' (**Figure 9-3**). The cross section location and corresponding wells are shown on **Figure 9-3**. Subsurface conditions and aquifer parameters near the Injection Facilities area are also summarized in **Table 9-1** and discussed in the following sections.

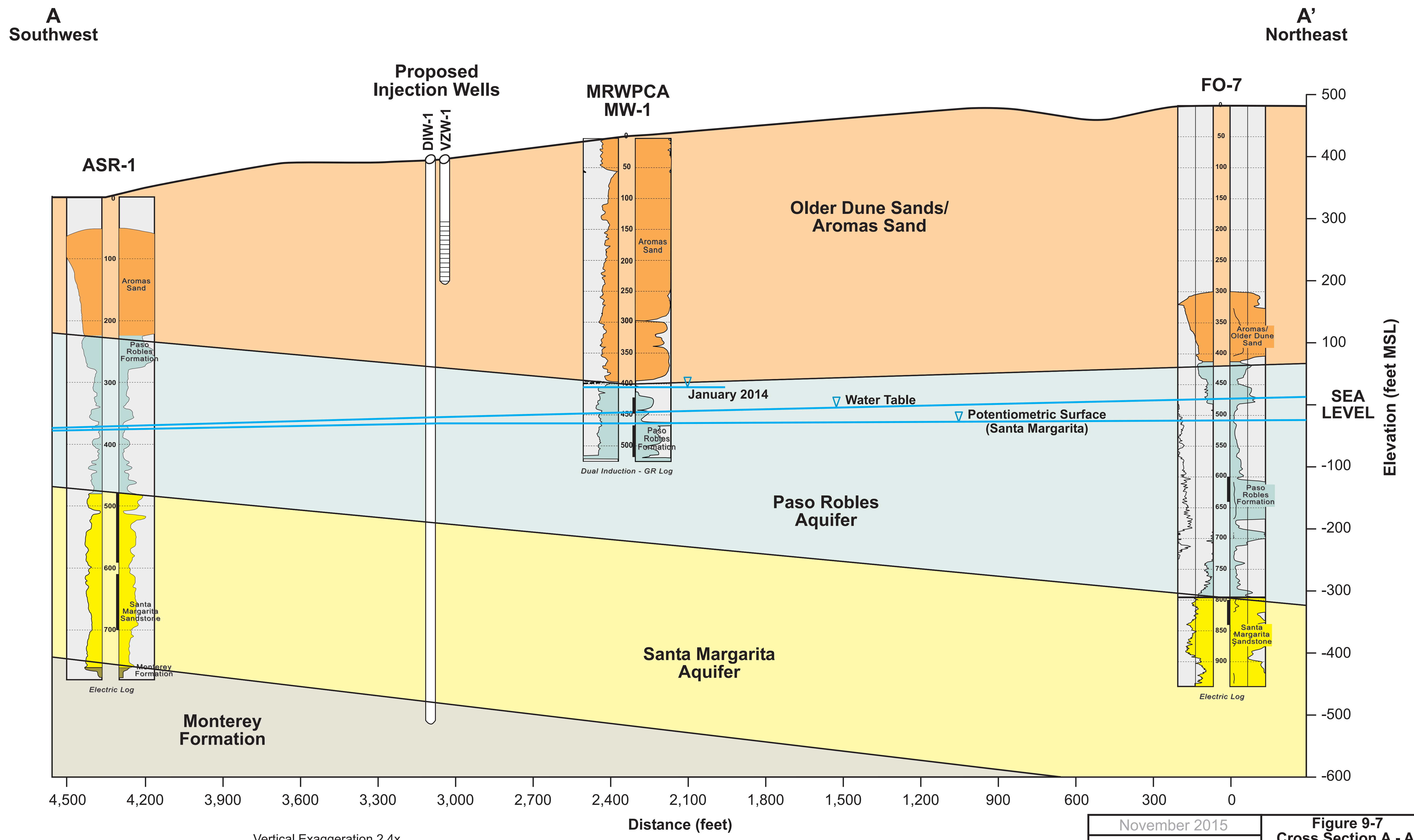
Table 9-1: Anticipated Subsurface Conditions in the Injection Facilities Area

	Aromas Sand / Older Dune Deposits	Paso Robles Aquifer	Santa Margarita Aquifer	Data Sources[a]
Lithology	Fine brown sand, silty sand, some medium to coarse sand, minor silt and clay.	Heterogeneous package of interbeds of sand, silt, and clay mixtures. Average bed thickness of 25 feet.	Fine- to medium-grained well sorted sand to silty sand; sandy silt in lower portions of formation; minor clay.	1, 2, 3
Interval Thickness	400 feet	250 feet	280 feet	1, 2
Percent Sand	92%	52%	74%	2
Depth	Surface sediments	356 feet	609 feet	Figure 5; Ground surface elev.
Groundwater Conditions	unsaturated	unconfined	semi-confined	4, 5
Aquifer Parameters ***Transmissivity (T)***	Not applicable; unsaturated locally	659 ft^2/day to 1,524 ft^2/day	11,377 to 13,947 ft^2/day 24,003 ft^2/day	1, 5, 6, 7, 8, 9
Horiz. Hydraulic Conductivity (K_h)	350 ft/day	20 ft/day	63 ft/day	2, 6
Vertical Hydraulic Conductivity (K_v)	70 ft/day	0.66 ft/day to 16 ft/day	0.63 ft/day	1, 3, 7
Storativity (S)	0.24 to 0.40 (sand); 0.04 to 0.09 (silt; silty sand)	0.12	0.0018 0.00258	1, 4, 5
Average Coastal Subarea Production	Not applicable; unsaturated locally	Est. 500 AFY (15% of total coastal production)	Est. 2,500 AFY (85% of total coastal production)	9, 10
Area Water Levels Below Sea Level	Not applicable; unsaturated locally	900 acres	>2,000 acres	9

[a] Data Sources: 1.Todd Groundwater, 2015; 2.Padre, 2002; 3. HydroMetrics, 2006; 4. ASR Systems, 2005; 5. MPWMD, 2002; 6. Yates et al., 2005; 7. Fugro, 1998. 8. HydroMetrics, 2009; 9. Hydrometrics, 2013; 10. MPWMD, 2014.

9.2.4. Older Dune Sands/Aromas Sand

The shallowest geologic deposits in the Injection Facilities area are composed of recent and older eolian sands and older continental deposits of Pleistocene age. This undifferentiated sequence is referred to herein as Older Dune Sands/ Aromas Sand or Aromas Sand. The unit has been described as also including fluvial and coastal terrace deposits, as well as flood-plain and other basin deposits (Yates, et al., 2005; HydroMetrics, 2009).



November 2015

TODD GROUNDWATER

Figure 9-7
Cross Section A - A'
Subsurface Conditions near Proposed Injection Wells

The entire thickness of the Aromas Sand was cored in a boring for a recently-installed monitoring well by Todd Groundwater adjacent to the Injection Facilities area (see M1W MW-1 on **Figure 9-3**). The unit was described on a geologic log and selected core samples were analyzed at various laboratories to evaluate lithology and mineralogy, porosity and permeability, infiltration rates, leaching potential, and other factors. Complete laboratory results are documented and analyzed in a separate report (**Appendix D**).

Geologic core descriptions from M1W MW-1 indicate that the Aromas Sand is approximately 400 feet thick adjacent to the Injection Facilities area and is composed primarily of fine-grain sand (about 92% sand) with minor amounts of silt and clay. The upper 300 feet is the most homogeneous with generally higher permeability values. As shown on **Table 9-1** , the unit is associated with relatively high horizontal hydraulic conductivity (350 ft/day) and vertical hydraulic conductivity (70 ft/day) as estimated from laboratory core data.

The geologic unit is illustrated on the cross section on **Figure 9-7** and ranges from about 225 feet at ASR-1 to about 400 feet thick at M1W MW-1 and monitoring well FO-7. Also shown on the cross section are geophysical logs (Dual Induction-GR log and Electric logs) for three existing wells. These logs provide readings of electrical (resistivity) measurements throughout the borehole. Although the logs are provided for illustrative purposes only (without ohm-meter or other electrical scales), log curves show relatively high readings in the Aromas Sand (shaded in orange)[39], generally indicative of higher permeability sediments (and, in this case, unsaturated conditions). The Aromas Sand is unsaturated in the Injection Facilities area as illustrated by the water levels shown on the cross section (water table and potentiometric surface, **Figure 9-7**).

Also projected onto the cross section are schematic diagrams of two injection wells, including a vadose zone well (VZW-1) and a deep injection well (DIW-1) (**Figure 9-7**). Details of the injection wells, including final designs for all four injection wells, are provided in **Section 3.5**.

9.2.5. Paso Robles Aquifer

Beneath the Aromas Sand is the Paso Robles Formation (**Figure 9-7**). The formation is heterogeneous and contains interbeds of sand, silt, and clay mixtures (Yates et al., 2005). Silt and clay layers are characterized by a variety of colors including yellow-brown, reddish brown, whitish gray, and dark bluish gray, indicating a variety of depositional and geochemical environments. These continentally-derived deposits are discontinuous and difficult to correlate from well to well in the basin. The formation is expected to average approximately 240 feet thick in the Injection Facilities area. Beneath this area, the water table occurs in the upper portion of the aquifer (**Figure 9-7**). The top of the Paso Robles is anticipated to be encountered at an average depth of about 370 feet beneath the Injection Facilities area.

The heterogeneous nature of the aquifer in the Injection Facilities area is illustrated on the resistivity logs on **Figure 9-7**. As shown from the logs, resistivity readings (right of the depth columns) are highly variable throughout the Paso Robles Aquifer, indicating interbeds of varying thicknesses. The upper 50 to 100 feet of the aquifer appear to contain a higher percentage of sand, indicating relatively higher

[39] Logs were unavailable in the upper portions of ASR-1 and FO-7 due to shallow surface casings. Log in MRWPCA MW-1 is a cased-hole induction log. For all three logs, resistivity measurements are shown to the right of the depth column and increase to the right.

permeability. These sands are screened in M1W MW-1. Below the upper sand unit, the formation becomes more heterogeneous and generally more fine-grained. A lower, more permeable layer in the Paso Robles Aquifer is screened in FO-7 at about 600 feet deep (about -125 feet msl). Using an approximate sand/silt boundary indicator of 25 ohm-meters on the electric log of a nearby Paso Robles test well, the overall Paso Robles Aquifer is estimated to contain about 52% sand (**Table 9-1**).

The ability of an aquifer to transmit, store, and yield reasonable quantities of water is reflected in aquifer parameters including transmissivity (T), horizontal hydraulic conductivity (K or K_h), and storativity (S). These parameters for the Paso Robles Aquifer have been compiled and reviewed by previous investigators in the basin (Fugro, 1997; Yates et al., 2005; HydroMetrics, 2009). In the Injection Facilities area, representative aquifer parameters include a T value of about 659 ft^2/day to 1,524 ft^2/day, a K value of 20 ft/day and an S value of 0.12 (dimensionless), reflecting an effective porosity of 12%. These parameters for the Paso Robles Aquifer are listed in **Table 9-1** .

9.2.6. Santa Margarita Aquifer

The Santa Margarita Sandstone of Pliocene/Miocene age underlies the Paso Robles Aquifer throughout most of the Seaside Basin. The aquifer consists of a poorly-consolidated marine sandstone approximately 250 feet thick in the Northern Coastal subarea of the basin. The unit has apparently been eroded near the southern basin boundary due to uplift from folding and faulting along the Seaside and Chupines faults (Yates et al., 2005).

The Miocene/Pliocene Purisima Formation overlies the Santa Margarita Sandstone in some areas. This unit has been described in more detail along the coast and has been grouped with the Santa Margarita Aquifer in Layer 5 of the basin groundwater model (HydroMetrics, 2009). The Purisima Formation is difficult to delineate using subsurface data and is either thin or not present beneath the Injection Facilities area.

The Santa Margarita Aquifer is shown on the cross section on **Figure 9-7**. The more homogeneous nature of the Santa Margarita Aquifer is illustrated on the geophysical logs for ASR-1 and FO-7. The aquifer is approximately 280 feet thick in the Injection Facilities area and contains about 74% sand (with the remainder containing sandy silt and minor clay). The aquifer is about 600 feet deep in the Injection Facilities area as indicated on **Figure 9-7**.

A review of Santa Margarita Aquifer parameters near the Injection Facilities area and in adjacent coastal areas indicated an average T value of 11,377 ft^2/day (Fugro, 1997; Padre, 2002). More recent aquifer tests in ASR-1 indicated a similar, but slightly higher, T value of 13,947 ft^2/day (Padre, 2002). The Watermaster Model has a T value of about 24,000 ft^2/day in the Injection Facilities area.

S values have been estimated at 0.0018 and 0.00258 (dimensionless) for the Santa Margarita Aquifer, indicating semi-confined to confined conditions. The confined nature of the aquifer suggests that groundwater replenishment can raise water levels more quickly and to higher levels than an equivalent amount of recharge in an unconfined aquifer. Parameters for the Santa Margarita Aquifer are summarized in **Table 9-1** .

9.2.7. Water Levels and Groundwater Flow Directions

Water levels have been monitored in the Seaside Basin for at least 25 years. These data document the decline of water levels from the mid-1990s into the 2000s with a recent partial recovery of water levels in some areas since the adjudication of the basin. In general, changes in water levels have occurred in response to changes in groundwater production and ASR operation. Long-term water level trends and fluctuations are indicated by three hydrographs presented on **Figure 9-8** (PCA-West well) and **Figure 9-9** (wells FO-7 and Paralta Test Well). These well locations can be found on **Figure 9-10**. PCA-West is a cluster of two monitoring wells (one in each aquifer) located just west of Highway 1 in the central portion of the Northern Coastal Subarea. FO-7 is also a cluster of two monitoring wells located on Eucalyptus Blvd. on the eastern edge of the map on **Figure 9-10**. The Paralta Test Well is a monitoring well adjacent to the Paralta production well, located near the intersection of Coe Avenue and General Jim Moore Blvd. on **Figure 9-10**.

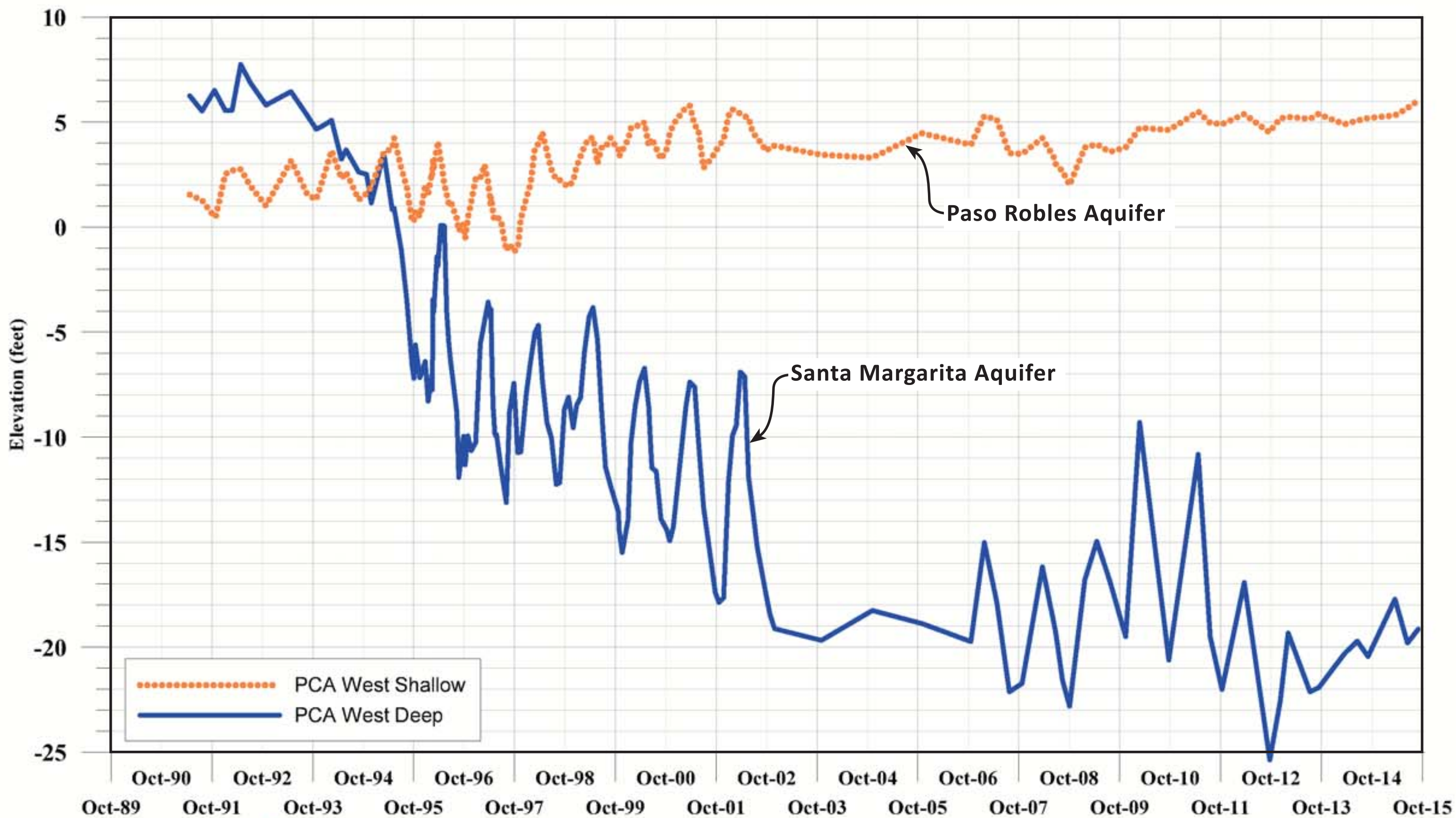
Figure 9-8 shows a long-term hydrograph of a well in the Northern Coastal Subarea, the PCA West well, to illustrate water level trends and fluctuations since 1989 in coastal areas of the basin. The curve highlighted in orange on **Figure 9-9** represents water levels in the Paso Robles Aquifer and the lower curve represents water levels in the Santa Margarita Aquifer. **Figure 9-9** shows hydrographs in two monitoring wells close to the Injection Facilities area, FO-7 and Paralta Test Well (located adjacent to the Paralta production well). Note that data for these wells are displayed from 1994 to 2013, a shorter time interval than shown for the PCA West Well on **Figure 9-8**. Similar to the PCA West well, FO-7 also consists of two monitoring points: a shallow well screened in the Paso Robles Aquifer, and a deep well screened in the Santa Margarita Aquifer. The Paralta Test well is screened in both aquifers and represents average water levels, although most of the water appears to be coming from the Santa Margarita Aquifer.

Seasonal fluctuations are readily seen on all of the hydrographs, resulting from changes in pumping throughout the basin. For the Paso Robles Aquifer, seasonal fluctuations of about 3 to 5 feet per year are typical with the highest water levels in the spring and lower water levels in the fall (**Figures 9-8** and **9-9**). Fluctuations are more pronounced in the Santa Margarita Aquifer and vary from about 6 to 15 feet per year in the PCA West well (**Figure 9-8**) and in monitoring well FO-7 (top of **Figure 9-9**). The Paralta Test Well (bottom of **Figure 9-9**) is adjacent to large pumping centers and indicates much large seasonal fluctuations up to about 20 to 30 feet.

Prior to groundwater development, groundwater flow directions were generally from inland areas toward the coast. Currently, groundwater flow patterns are controlled by local groundwater pumping and subarea pumping depressions. In addition, groundwater flow patterns are altered near certain subarea boundaries where geologic faulting and other discontinuities have compartmentalized groundwater. In particular, the boundary between northern and southern subareas appears to impede groundwater flow.

The Santa Margarita Aquifer is semi-confined by low permeability units in the basal sediments of the Paso Robles Aquifer. Although some leakage occurs, water levels are different in the two aquifers. Differences are less near wells that are pumping from both aquifers.

Water level contour maps for July/August 2014 are presented for the Paso Robles Aquifer and the Santa Margarita Aquifer on **Figures 9-10** and **9-11**, respectively. Hydrographs, water levels, and groundwater flow for each of aquifers are discussed in more detail below.



MONTEREY PENINSULA WATER MANAGEMENT DISTRICT

PCA West (Deep) (15S/1E-15F2)

Screened from 825-875 in the Santa Margarita Sandstone (Tsm)
Wellhead Elevation 65.18 MSL
DWR Driller Log No. 338401
Datasource: MPWMD

PCA West (Shallow) (15S/1E-15F1)

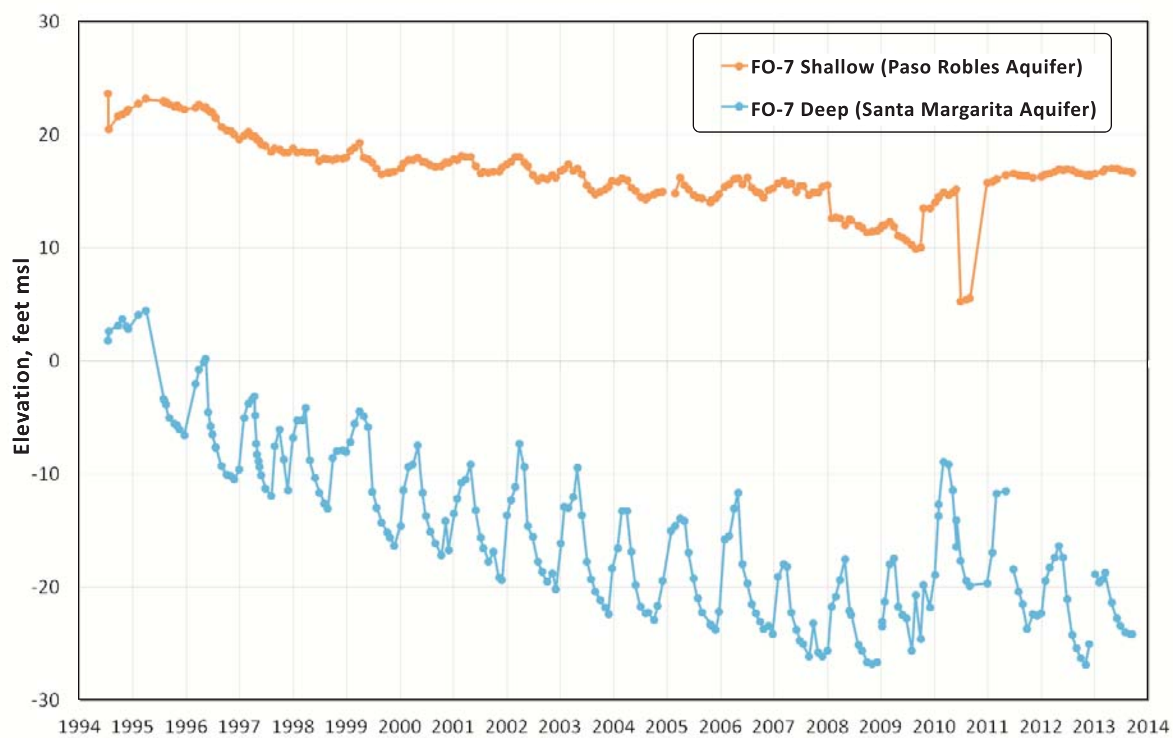
Screened from 525-575 in the Paso Robles Formation (QTp)
Wellhead Elevation 64.22 MSL
DWR Driller Log No. 338400
Datasource: MPWMD

November 2015

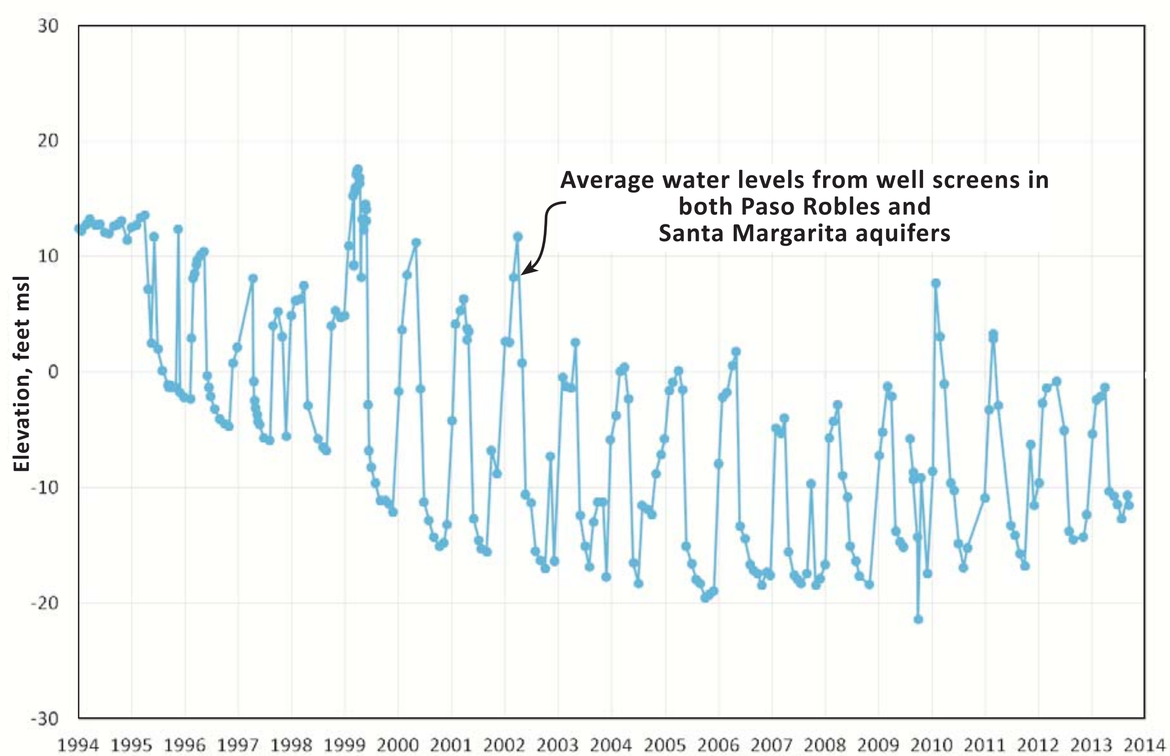
TODD GROUNDWATER

Figure 9-8
Long-term Hydrograph
Northern
Coastal Subarea

Water Levels in F0-7



Water Levels in Paralta Test Well



November 2015

TODD GROUNDWATER

Figure 9-9
Hydrographs near Injection Facilities Area

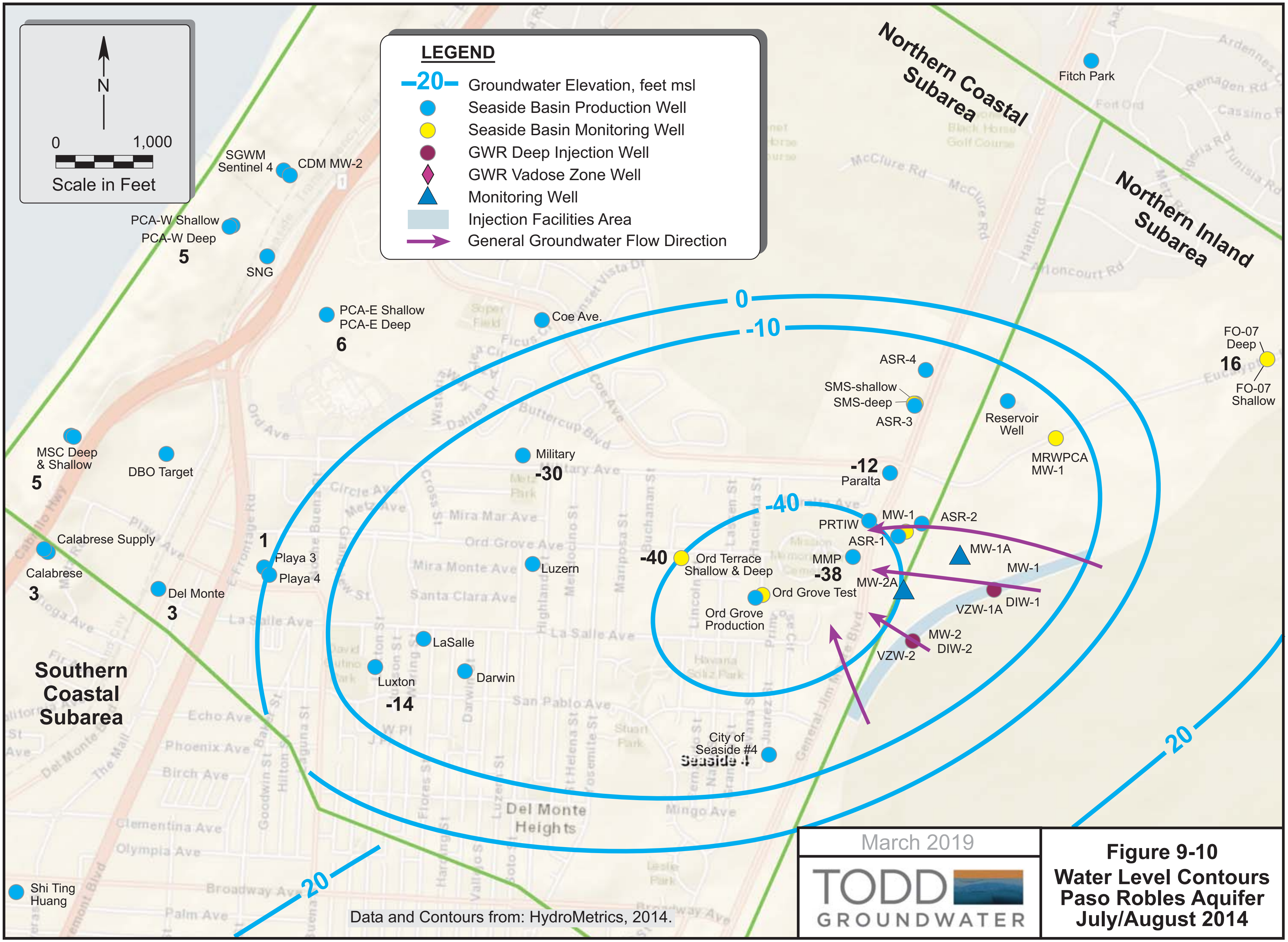


Figure 9-10
Water Level Contours
Paso Robles Aquifer
July/August 2014

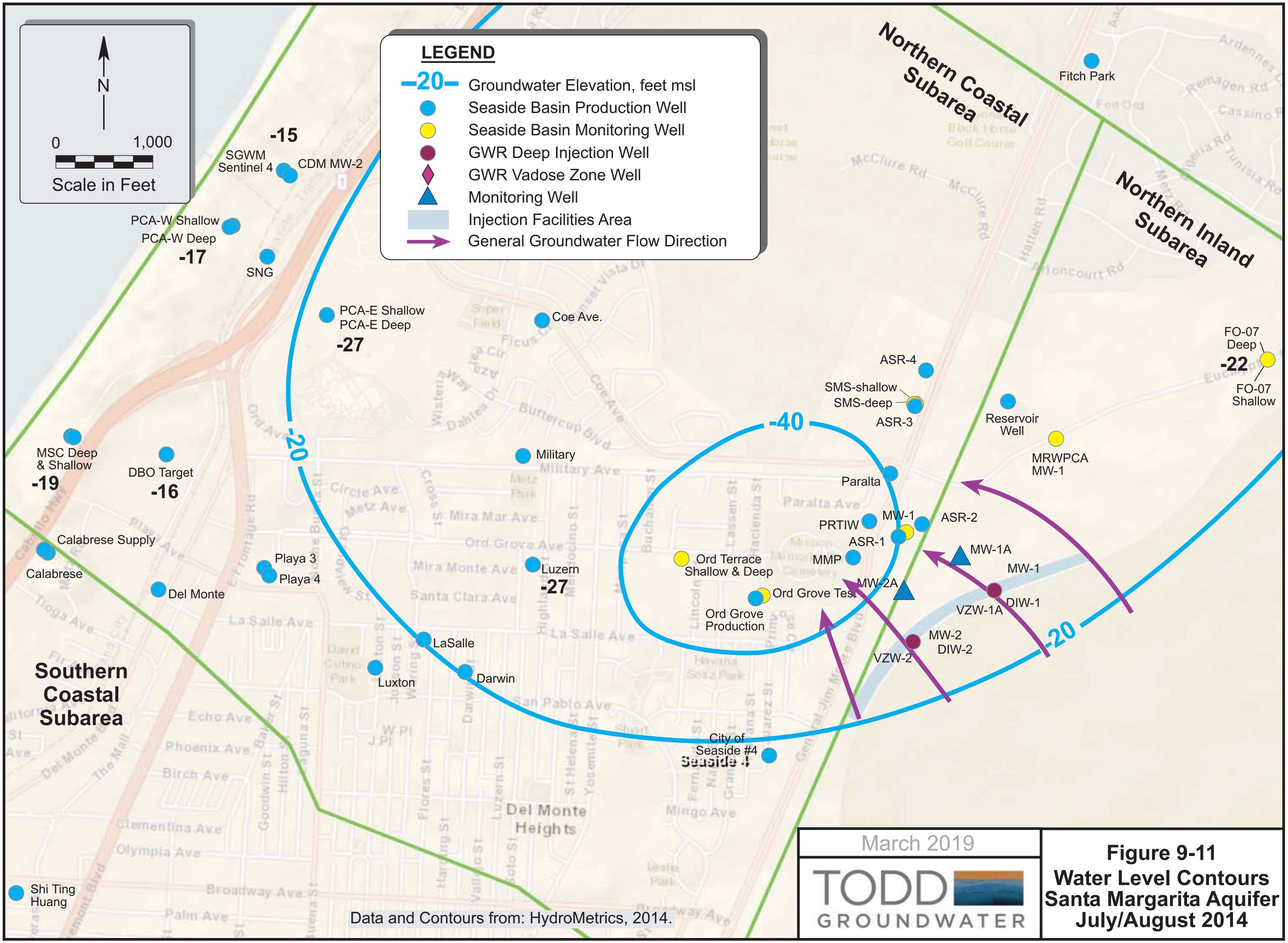


Figure 9-11
Water Level Contours
Santa Margarita Aquifer
July/August 2014

9.2.7.1. Water Levels and Groundwater Flow in the Paso Robles Aquifer

As shown on **Figure 9-8**, water levels in the Paso Robles Aquifer (PCA West – Shallow) have fluctuated between about minus 1 foot below msl to about 7 feet above msl over the last 24 years. Water levels declined below sea level in the mid-1990s in response to increases in groundwater production. Most of the subsequent groundwater production occurred in the deeper Santa Margarita Aquifer and water levels in the Paso Robles Aquifer rose near the coast. Since that time, water levels in the PCA well have stabilized at about two to seven feet above msl. Water levels in FO-7 (orange curve on top graph on **Figure 9-9**) illustrate water table conditions about 3,000 feet north of the Injection Facilities. Since 1994, the water table in FO-7 has declined from elevations above 20 feet msl in the mid-1990s to about 15 feet msl and have averaged 14.5 feet since 2006 (**Figure 9-9**). This decline is consistent with downgradient pumping in both aquifers that has created a localized pumping depression in the Northern Coastal Subarea.

Groundwater occurs as unconfined in the Paso Robles Aquifer and represents the water table throughout most of the northern subareas. **Figure 9-10** shows a water level contour map for summer 2014 and indicates that water levels in the Paso Robles Aquifer are below sea level over much of the Northern Coastal Subarea and beneath the Injection Facilities area. A large pumping depression is indicated by the closed contour of 0 feet msl (sea level) on the water level contour map (contours from HydroMetrics, 2014b). This map, representing water levels measured in July and August 2014, shows water levels below msl covering an area of almost 1,000 acres (also covering about one-half of the Northern Coastal Subarea).

Groundwater flow in both the Northern Coastal and Northern Inland subareas is controlled by the depression. Shallow groundwater beneath the Injection Facilities area flows west/northwest toward the center of the depression where water levels are lower than - 40 feet below msl (see flow arrows on **Figure 9-10**). The anonymously low water level of -161 feet posted for the Ord Grove production well likely indicates local pumping impacts and is not representative of the local water levels in the aquifer. Based on the groundwater contours shown on **Figure 9-10**, hydraulic gradients in the vicinity of the Injection Facilities area are estimated at 0.025 feet/feet in the Paso Robles Aquifer.

Previous water level contour maps indicate that water levels have been relatively stable over the past year. Similar water level contour maps for the Paso Robles Aquifer during January/March 2014 and July/August 2013 are shown in **Figures 9-12** and **9-13**, respectively. For July/August 2013, a different scale allows for a more basin-wide view of water levels.

9.2.7.2. Water Levels and Groundwater Flow in the Santa Margarita Aquifer

Water levels have declined in the Santa Margarita Aquifer at a much faster rate than in the Paso Robles Aquifer. As shown on **Figure 9-8**, the potentiometric surface of the Santa Margarita Aquifer indicates a long-term decline in the PCA West (Deep) well since the mid-1990s with only seasonal recovery. In general, the rate of decline has been less since about 2006 as a result of the adjudication of the Seaside Basin and subsequent changes in pumping rates. Nonetheless, water levels have remained below sea level in the coastal PCA West (Deep) well since 1995, increasing the risk of seawater intrusion. The high rate of decline is likely related to both the increase in Santa Margarita Aquifer pumping as well as the lower S value of the semi-confined aquifer.

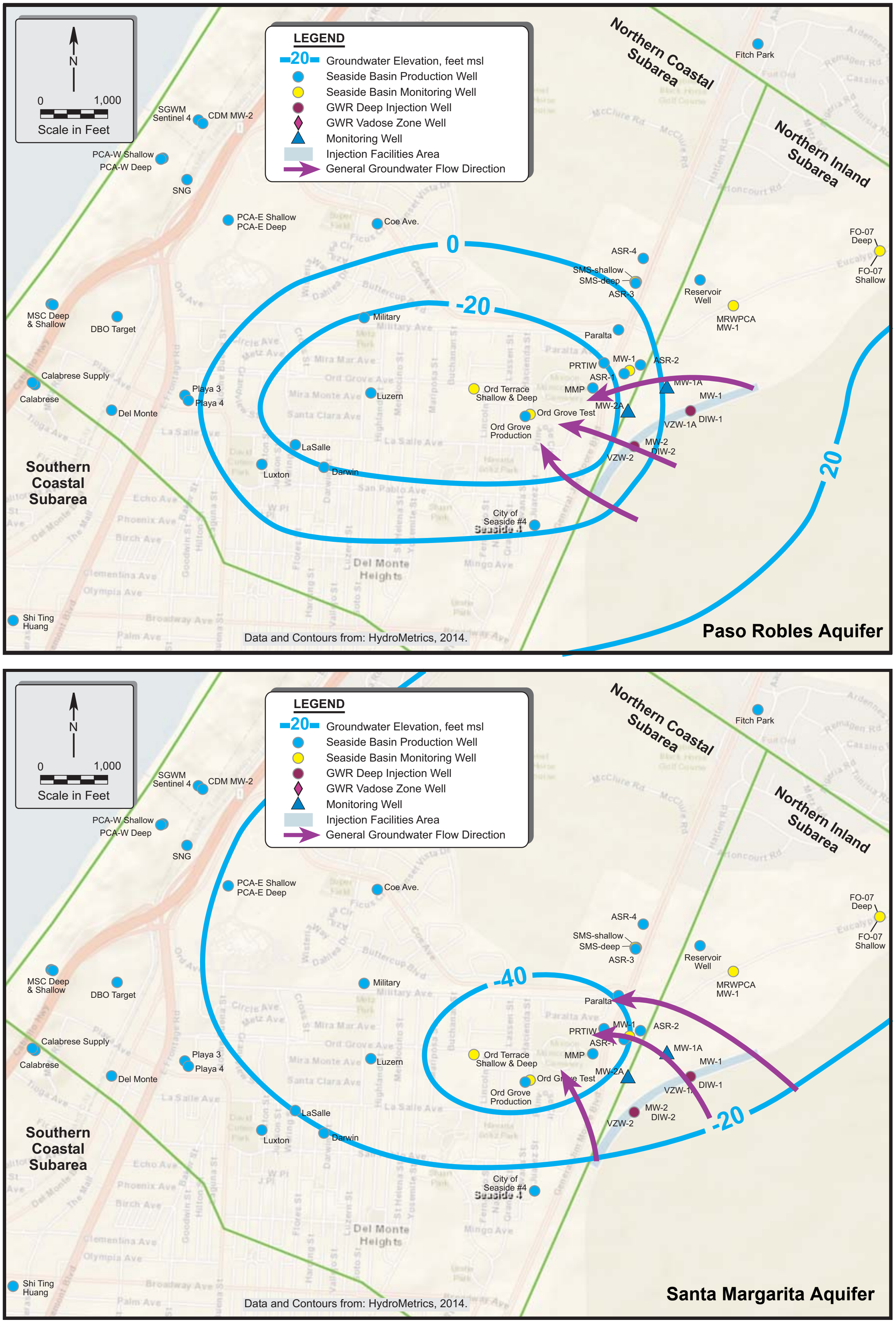
Figure 9-9 shows similar trends and fluctuations on two hydrographs from Santa Margarita wells closer to the Injection Facilities area (FO-7 is about 3,000 feet north and Paralta Test Well is about 1,300 feet to the northwest, see **Figure 9-11** for well locations). Water levels in the Paralta Test Well are generally higher than in FO-7 (Deep), likely due to the well screens installed in both the Paso Robles and the Santa Margarita aquifers. Although the trends and fluctuations are more similar to the Santa Margarita water levels, the contribution from the Paso Robles Aquifer results in higher water levels overall. Water levels in the Paralta Test Well show greater seasonal fluctuations than observed in FO-7 due to its proximity to large pumping wells including the adjacent Paralta production well and nearby ASR wells.

Figure 9-11 shows the widespread area of water level declines on a recent water level contour map for the Santa Margarita Aquifer (contours from HydroMetrics, 2014b). The map shows that water levels are below msl over almost all of the Northern Coastal Subarea and a portion of the Northern Inland Subarea. The lowest water levels are below -40 feet msl, similar to the low levels in the Paso Robles Aquifer (**Figure 9-10**). Water levels beneath the Injection Facilities area range from about -20 feet msl to about -30 feet msl.

The water level contour map also indicates that the pumping depression extends beyond the northern basin boundary but does not extend into the Southern Coastal subarea. Similar to conditions in the Paso Robles Aquifer, groundwater in the Santa Margarita Aquifer in the Southern Coastal Subarea appears to be compartmentalized by geologic faulting and relatively unaffected by pumping to the north.

Beneath the Injection Facilities area, groundwater flows west/northwest (see arrows on **Figure 9-11**). Flow directions are similar to groundwater flow directions in the Paso Robles Aquifer, but exhibit a slightly more northerly trajectory due to the additional pumping in the Santa Margarita Aquifer in the Paralta, ASR-3, and ASR-4 wells north of the Injection Facilities. The potentiometric surface for the Santa Margarita Aquifer is slightly lower than the water table in this area (typically about 5 to 10 feet), resulting in a downward vertical gradient. The average horizontal hydraulic gradient between the Injection Facilities area and the center of the pumping depression is estimated at 0.017 feet/feet to the west-northwest.

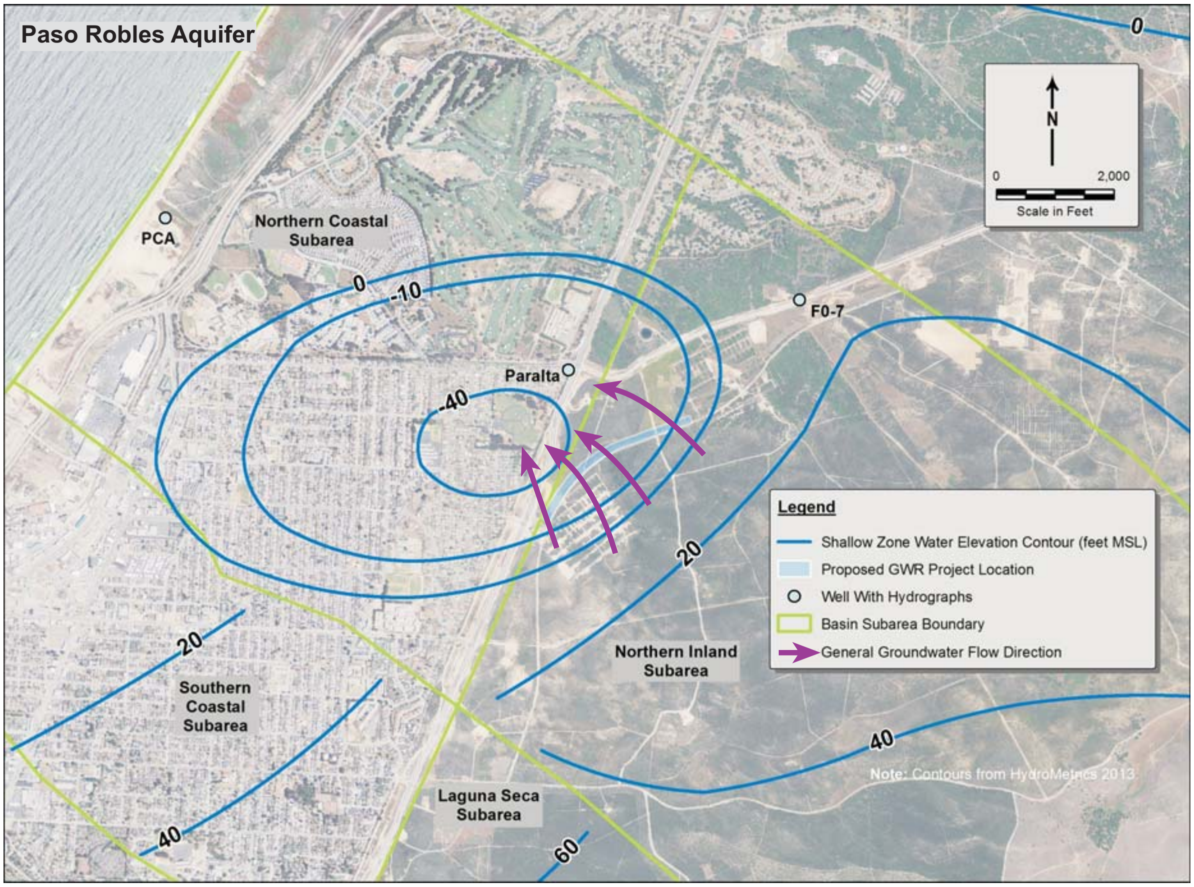
Previous water level contour maps over the past year indicate similar groundwater levels and flow directions. Water level contour maps for the Santa Margarita Aquifer during January/March 2014 and July/August 2013 are shown on the bottom graphs of **Figures 9-12** and **9-13**, respectively. For July/August 2013, a different scale allows for a more basin-wide view of water levels.

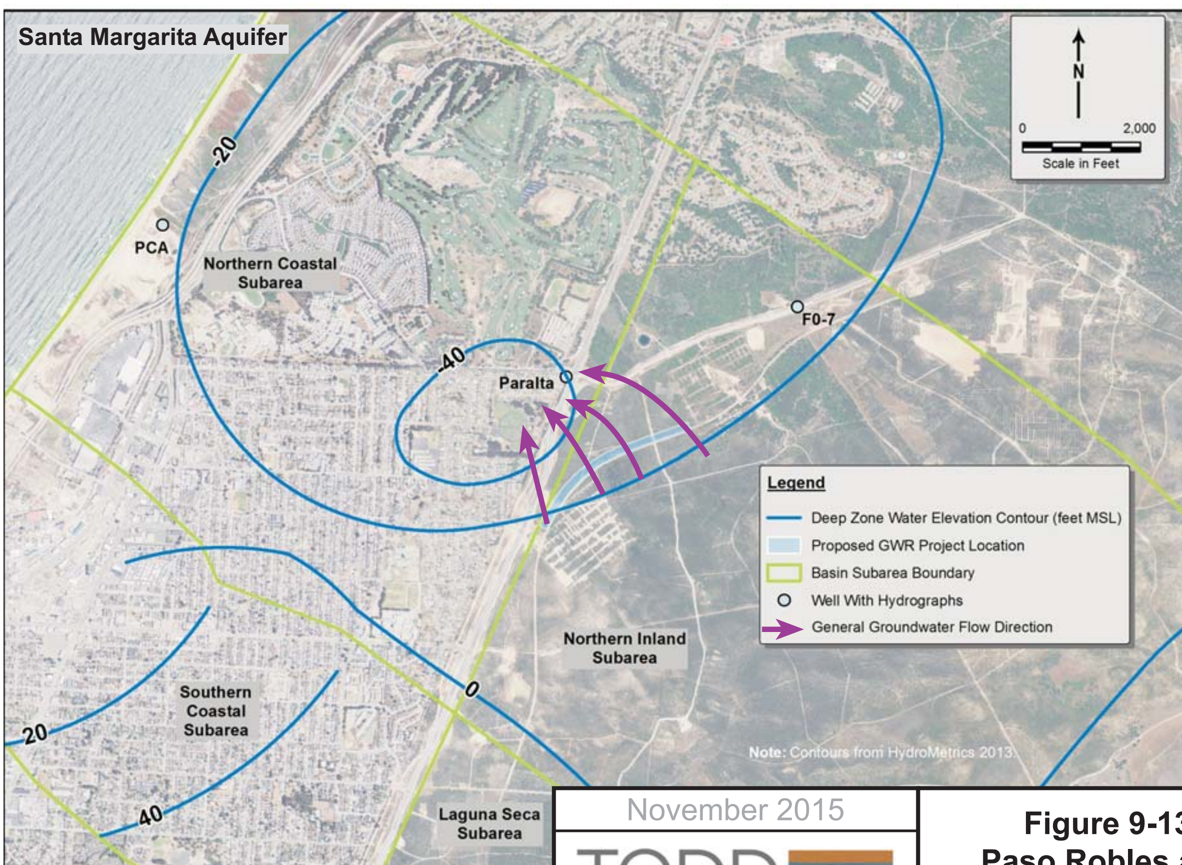


March 2019

TODD GROUNDWATER

Figure 9-12
Water Level Contours Santa Margarita Aquifer and Paso Robles Aquifer January/March 2014





November 2015

TODD GROUNDWATER

Figure 9-13
Paso Robles and Santa Margarita Water Levels July/August 2013

9.3. GROUNDWATER BUDGET

Conceptually, the groundwater budget for the Seaside Basin is controlled primarily by surface recharge of the aquifer systems (and vertical leakage between aquifers), pumping from the aquifers, and subsurface inflows and outflows across subarea/basin boundaries. Additional smaller components of the groundwater budget have also been documented. Quantitative assessments of the various inflows and outflows were estimated by Yates (et al., 2005) and developed further by HydroMetrics (2009) for the construction of the Watermaster Model. In preparation of the SNMP for MPWMD, HydroMetrics incorporated additional groundwater budget components for the Seaside Basin and updated basin outflows including pumping (HydroMetrics, 2014a). Inflows and outflows from the SNMP groundwater budget are discussed below. The Seaside Basin groundwater budget is summarized at the end of the discussion in **Table 9-2**.

9.3.1. Inflows

The primary inflows into the groundwater basin considered in the MPWMD SNMP are listed below:

- Deep percolation of rainfall.
- Subsurface inflow from adjacent onshore areas.
- Subsurface inflow from offshore areas (where coastal water levels are below sea level).
- Imported water recharged into the basin (including ASR).
- Losses from water distribution systems.
- Losses from sewer system.
- Septic system return flows (primarily Laguna Seca Subarea).
- Irrigation return flows (landscaping and golf courses).
- Infiltration from stormwater ponds (coastal subareas).

The Paso Robles Aquifer is recharged primarily from surface infiltration of precipitation, as wells as surficial inflow from additional sources listed above (HydroMetrics, 2009). The primary area of recharge occurs in the eastern portion of the basin where the Paso Robles formation crops out at the surface, allowing rainfall to infiltrate directly into the aquifer units (Yates, et al., 2005). In the Injection Facilities area, recharge occurs by percolation through the surficial deposits of the Aromas Sand. In these undeveloped areas of the Northern Inland Subarea, inflows other than from rainfall are insignificant.

Most of the recharge to the Santa Margarita Aquifer is assumed to occur by leakage from the overlying Paso Robles Formation, especially in areas where the lower Paso Robles is relatively permeable (Yates, et al., 2005; HydroMetrics, 2009). Recharge also enters the Santa Margarita Aquifer from subsurface inflow from other subareas and north of the basin boundary. Although the Santa Margarita crops out east of the Seaside Groundwater Basin, recharge occurring in the outcrop area has been interpreted to flow with groundwater toward the Salinas Valley away from the Seaside Groundwater Basin.

9.3.2. Outflows

The primary outflows from the groundwater basin are listed below:

- Groundwater pumping.
- Subsurface outflow to onshore areas.
- Subsurface outflow to offshore areas.

The groundwater budget presented in the 2014 SNMP is reproduced in **Table 9-2** below. The budget combines annual averages from selected recent time periods with the most representative data for each component. Almost all of the inflows represent average annual data from 2008 – 2012. Subsurface inflows and outflows were averaged from 2003 – 2007. Pumping (including ASR wells) and system losses are average annual amounts from 2011 - 2012.

Table 9-2: Seaside Basin Groundwater Budget

Water Balance Component	Northern Coastal	Northern Inland	Southern Coastal	Laguna Seca	Basin Total
INFLOWS (AFY)					
Precipitation	78	1,450	30	700	2,258
Groundwater Underflow					
From Onshore	2,850	0	450	180	180[a]
From Offshore	100	0	0	0	100
ASR Wells (Injection)	625	0	0	0	625
Water Distribution System Losses	411	0	21	46	478
Sewer Distribution System Losses	77	0	9	19	105
Septic Systems	0	0	5	22	27
Irrigation Infiltration					
Golf Courses	85	0	0	88	173
Landscaping	461	0	52	114	627
Recycled Water Irrigation	0	0	0	9	9
Storm Water	68	0	37	0	105
Total Inflow	***4,754***	***1,450***	***604***	***1,177***	***7,985***
OUTFLOWS (AFY)					
Groundwater Pumping	4,278	0	227	869	5,374
Groundwater Underflow					
To Onshore	0	2,060	790	450	N/A [a]
To Offshore	70	0	30	0	100
Total Outflow	***4,348***	***2,060***	***1,047***	***1,319***	***8,774***
Storage Change (Inflow – Outflow)	**406**	**-610**	**-443**	**-142**	**-789**

a. Values represent subsurface movement among subareas; basin total represents net value rather than a sum of the subareas.
Source: HydroMetrics, 2014a.

9.4. GROUNDWATER QUALITY

Groundwater in both the Paso Robles and Santa Margarita aquifers is used for drinking water supply and generally meets drinking water quality standards including primary MCLs. Elevated concentrations of manganese and hydrogen sulfide have been identified as exceeding secondary MCLs in some Santa Margarita Aquifer wells (Jones & Stokes, 2006). Groundwater chemistry varies throughout the basin and also varies between aquifer systems (HydroMetrics, 2014a). For the Project, the groundwater quality characterization focuses on the Northern Inland and Northern Coastal subareas. In these areas, groundwater is characterized as a sodium-bicarbonate type water. In general, mineral content and salinity, represented by TDS and chloride, are higher in the Santa Margarita Aquifer than in the Paso Robles Aquifer.

Groundwater quality data are available from several monitoring programs. Over the last 25 years, MPWMD has installed and sampled monitoring wells throughout the basin. The Seaside Basin Watermaster, through a cooperative agreement with MPWMD, conducts water quality monitoring with a focus on coastal wells and data needed for an annual analysis of potential sea water intrusion. In addition, MPWMD conducts a separate water quality monitoring program for the ASR Project as documented in the DDW-approved Sampling and Analysis Plan (Pueblo Water Resources, December 2012). Samples for this program include both local groundwater and injectate imported from the Carmel River basin. Finally, as part of its drinking water permit, CalAm monitors water quality from drinking water wells and its water distribution system. Except for the CalAm monitoring, other programs do not routinely monitor groundwater for constituents included in drinking water analyses as provided in CCR Title 22. None of the programs include all constituents required for monitoring a GRRP.

Data from these monitoring programs have been supplemented with analyses from six wells in the vicinity of the Injection Facilities area, which were sampled in January/February 2014. This sampling event was part of a field program conducted by M1W to support the Project. Samples were analyzed for an expanded list of more than 275 separate constituents and parameters including those required by the Title 22 Criteria for groundwater replenishment. Additional analyses were included to investigate the potential presence of constituents of concern from former Fort Ord activities and to support hydrogeologic and geochemical evaluations. Additional details from the M1W field program are presented more fully in a separate report, attached as **Appendix I** (Todd Groundwater, 2015b).

To provide some indication of future water quality for the product water, Trussell Technologies prepared a stabilized bench-scale sample of RO permeate from the pilot treatment facility. Although this sample does not reflect all of the source waters that will be part of the Project, the sample provides a useful surrogate to compare to groundwater quality and to support an analysis of potential impacts from the Project (**Section 11**).

9.4.1. Data Sources

In 2013, groundwater quality data were compiled from the monitoring programs described above to support the EIR for the Project. MPWMD provided an electronic database in Access© format that included groundwater quality data dating back to 1990. Data from 14 wells located relatively close to the Injection Facilities area were incorporated in the water quality characterization. CalAm provided groundwater quality data from eight nearby production wells in Excel© format from 2010 through 2013. These data were combined into a project database with data from the 2014 M1W field program. The types of analyses, time periods, and formats for the groundwater quality data are summarized in **Table 9-3**.

Table 9-3: Source of Groundwater Quality Data

Water Quality Database	Data Source		
	MPWMD	Cal-Am	MRWPCA
# Wells	14	8	6
Time Period	1990-2012	2010 - 2013	2014
Anions	x	x	x
Metals (including major cations)	x	x	x
Conventional Chemistry Parameters	x	x	x
Chlorinated Pesticides and PCBs	x	x	x
Nitrogen and Phosphorus Pesticides	x	x	x
Organic Analytes[a]	x	x	x
Chlorinated Acids	x	x	x
Carbamates[b]		x	x
Volatile Organic Compounds (VOCs)	x	x	x
Semivolatile Organic Compounds		x	x
Haloacetic Acids		x	x
Herbicides		x	x
Nitroaromatics and Nitramines (Explosives)			x
Other (e.g., isotopes)			x

a. Organic Analytes – including 1,2-Dibromo-3-chloropropane, 1,2-Dibromoethane (EDB), diquat, endothall, glyphosate.
b. Carbamates – organic compounds derived from carbamic acids.

As indicated in the table above, the M1W field program expanded the list of available analytes for six wells surrounding the Injection Facilities area, providing groundwater quality data for both the Paso Robles and the Santa Margarita aquifers. In addition, these analyses provide the only water quality data available for several wells, including an upgradient monitoring well for each aquifer (FO-7 shallow and FO-7 Deep) and a newly-installed monitoring well, M1W MW-1, located about 1,200 feet north of the Injection Facilities area on Eucalyptus Road (see **Figure 9-3**). The wells sampled during the M1W field program are summarized in **Table 9-4** as follows.

Table 9-4: Wells Sampled in M1W Field Program

Well[a]	Well Type	Screened Aquifer	Well Depth (feet, bgs)	Screen Interval (feet, bgs)[b]
M1W MW-1	Monitoring	Paso Robles	521	421 - 446; 466 - 516
FO-7 Shallow	Monitoring	Paso Robles	650	600 - 640
FO-7 Deep	Monitoring	Santa Margarita	850	800 - 840
PRTIW	Irrigation	Paso Robles	460	345 - 445
ASR MW-1	Monitoring	Santa Margarita	740	480 - 590; 610 - 700
Seaside Muni 4	Production	Santa Margarita	560	330 - 350; 380 - 420; 430 - 470; 490 - 550

a. All wells sampled January/February 2014.
b. bgs = below ground surface.

Laboratory analyses of groundwater samples collected at these six wells are presented in **Appendix I**.

9.4.2. Pilot Water Quality

Trussell Technologies, Inc. (Williams, et al., 2014) provided an advanced treated recycled water sample to Todd Groundwater in support of the M1W field program. The sample was developed to represent the product water quality for comparison to groundwater quality and to support geochemical modeling. The sample of RO permeate was collected from the M1W pilot advanced water treatment plant. Trussell Technologies stabilized the RO permeate using a bench-scale post-treatment stabilization unit to better approximate the water quality anticipated for the product water from the AWP Facility.

To develop the bench-scale water sample, Trussell Technologies conducted several stabilization steps to mimic goals established for the OCWD's GWRS, a similar project that uses advanced treatment to meet regulatory requirements. The first chemical stabilization step involved the addition of $CaCl_2$ and NaOH to increase alkalinity. Then, CO_2 gas was bubbled into the sample to decrease the pH to a target goal. This process produced approximately 32 L of product water for incorporation into the field program analyses.

The sample – referred to herein as stabilized pilot water sample – closely represents the final product water quality for the purposes of the field program objectives. The primary objective was to use representative recycled water samples to conduct laboratory leaching tests on vadose zone cores. These data have supported geochemical modeling (summarized in **Section 11**). Details of the leaching tests and geochemical modeling results are presented in a separate report on the field program, attached to this report as **Appendix I** (Todd Groundwater, 2015b).

The stabilized pilot water sample was analyzed for general minerals, physical characteristics, and metals by McCampbell Analytical Laboratory. The analytical methods and sample results are presented in **Table 9-5**.

Table 9-5: Stabilized Pilot Water Analysis

Analyte	Method	Units	MRL	Results	MCL or NL	Basin Plan Objective or Guideline[e]
Inorganics:						
Alkalinity (total)	SM 2320B	mg/L	0.10	37.4	---	---
Ammonia ((total as N)	EPA 350.1	mg/L	0.10	1.3	---	<5
Bicarbonate	SM 2320B	mg/L	1.00	37.4	---	<90
Carbonate	SM 2320B	mg/L	1.00	ND	---	---
Chloride	EPA 300.15	mg/L	1.00	21.0	250[b]	<106
Chlorine	SM 4500-Cl DE	mg/L	0.40	2.9	---	---
Dissolved oxygen @ 21.8 °C	SM 4500 OG	mg DO/L	1.00	8.94	---	---
Hydroxide	SM 2320B	mg/L	1.00	ND	---	---
Sulfate		mg/L	0.5	ND	250[b]	---
Physical Parameters:						
LSI @ 21.8 °C	calculated	–	–	–1.6	---	---
ORP @22.3 °C	SM 2580B	mV	10.0	629.0	---	---
pH @ 25 °C	SM 4500H+B	pH units	0.05	7.45	---	Normal Range
Specific conductivity @ 25 °C	SM 2510B	µmohs/cm or µS/cm	10.0	127.0	900[b]	<750
TDS	SM 2540C	mg/L	10.0	74.0	500[b]	480
Metals (cations):						
Antimony	EPA 200.8	µg/L	0.50	ND	6[c]	---
Arsenic	EPA 200.8	µg/L	0.50	ND	10[c]	100
Barium	EPA 200.8	µg/L	5.0	ND	1,000[c]	---
Beryllium	EPA 200.8	µg/L	0.50	ND	4[c]	100
Cadmium	EPA 200.8	µg/L	0.25	ND	5[c]	10
Calcium	EPA 200.8	µg/L	1,000	9,200	---	---
Chromium	EPA 200.8	µg/L	0.50	ND	50[c]	100
Cobalt	EPA 200.8	µg/L	0.50	ND	---	50
Copper	EPA 200.8	µg/L	0.50	ND	1,000[a]	200
Iron	EPA 200.8	µg/L	20.0	ND	300[a]	5,000
Lead	EPA 200.8	µg/L	0.50	ND	15[c]	5,000
Magnesium	EPA 200.8	µg/L	20.0	ND	---	---
Manganese	EPA 200.8	µg/L	20.0	ND	50[a]	200
Mercury	EPA 200.8	µg/L	0.025	0.032	2[c]	10
Molybdenum	EPA 200.8	µg/L	0.50	ND	---	10
Nickel	EPA 200.8	µg/L	0.50	ND	100[c]	200
Selenium	EPA 200.8	µg/L	0.50	ND	50[c]	20
Silver	EPA 200.8	µg/L	0.19	ND	100[a]	---
Sodium	EPA 200.8	µg/L	1,000	18,000	---	<69,000
Thallium	EPA 200.8	µg/L	0.50	ND	2[c]	---
Vanadium	EPA 200.8	µg/L	0.50	ND	50[d]	100
Zinc	EPA 200.8	µg/L	5.0	5.5	5,000[a]	

Pilot plant water provided by Trussell Technologies, Oakland, CA to Todd Groundwater on February 12, 2014. Laboratory analyses by McCampbell Analytical, Inc., Pittsburg, CA on February 13-26, 2014. Sulfate analysis proved by Trussell Technologies.

a. Secondary MCL.
b. Secondary MCL recommended range.
c. Primary MCL.
d. NL.
e. Basin Plan objectives for the protection of groundwater for municipal and domestic supply use are MCLs and not repeated in this column. The numbers in the column are the more stringent of the guidelines for irrigation or objectives for agricultural water use.
f. Part of SAR determination.

As shown in the table above, the stabilized pilot water meets all MCLs, NLs, and Basin Plan objectives for the analysis conducted.

9.4.3. Groundwater Quality Characterization

Existing data representing general groundwater chemistry were checked for accuracy and evaluated using various geochemical plotting techniques, as summarized in this subsection and provided on **Figure 9-14** through **9-18**. In addition, the geochemical signature of the pilot water is compared to the signature of ambient groundwater.

9.4.3.1. *Geochemical Analysis and Methodology*

Major cation (calcium, magnesium, sodium, potassium) and anion (chloride, sulfate, bicarbonate and carbonate) analyses were plotted on standard Stiff, Trilinear (Piper), Schoeller diagrams (Hem, 1989), and Brine Differentiation (BDP) plots. Analyses reported in milligrams per liter (mg/L) were recalculated to milliequivalents per liter (meq/L) to evaluate water chemistry and possible sources of groundwater recharge. In the absence of total bicarbonate data, reported $CaCO_3$ concentrations were recalculated to bicarbonate (HCO_3^-) using a conversion factor from Hounslow (1995). To validate the general mineral data, a cation-anion balance error analysis was conducted using the groundwater data. The cation-anion balance indicated that most data were adequate to incorporate into the geochemical analysis. Where data were outside of acceptable balance criteria, the errors appeared to be associated with elevated metal concentrations resulting from anomalous high turbidity in the samples.

For geochemical plotting purposes, the most recent available data were used for wells near the Injection Facilities. The six wells included in the M1W field program contained the most recent sampling (January or February 2014). Data from July 2012 through November 2013 were used for all other wells except the Ord Terrace well, which contained a more complete data set from September 2009.

9.4.3.2. Water Source Geochemical/Fingerprinting Diagrams

Stiff Diagrams are straight-line plots of cation and anion concentrations in meq/L. Data points are plotted along four parallel horizontal axes on each side of a vertical axis. Individual points are then connected to produce a polygonal pattern. The patterns or shapes of the polygons can be compared to typical standard patterns for groundwater or seawater or compared to polygons from other wells to identify samples of similar water chemistry.

The most recent water quality samples (2009 – 2014) were plotted as Stiff diagrams as shown on **Figure 9-14**. Diagrams are color-coded to indicate the aquifer represented by the polygons. Yellow and green Stiff diagrams indicate a well screened in the Paso Robles Aquifer or the Santa Margarita Aquifer, respectively, while the orange Stiff diagrams indicate groundwater contribution from both aquifers. Also shown on the map are Stiff diagrams for the treated Carmel River Basin injectate for the ASR wellfields (labeled ASR injectate) and the bench-scale stabilized sample of pilot water.

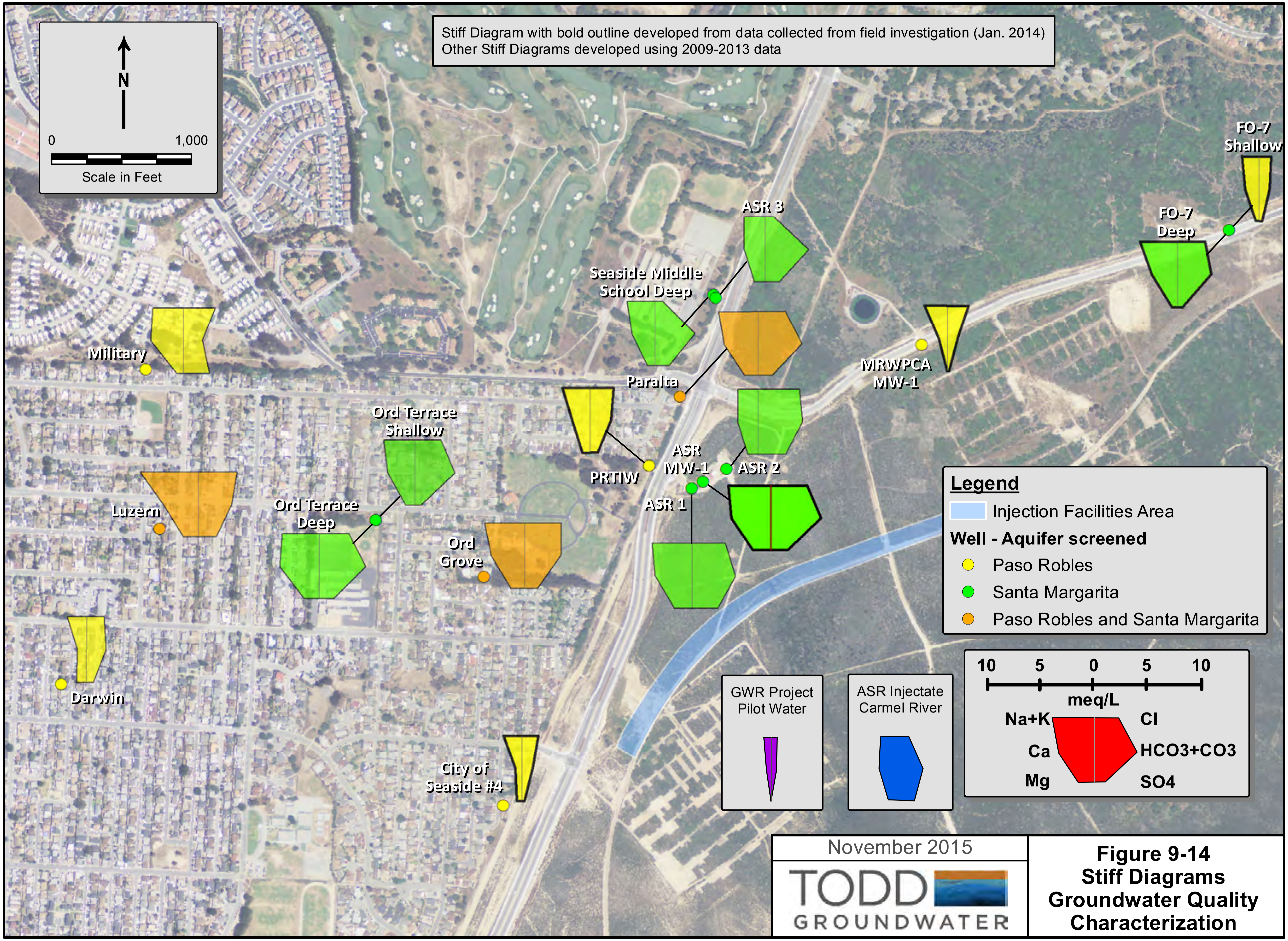


Figure 9-14
Stiff Diagrams
Groundwater Quality Characterization

The stiff diagrams on **Figure 9-14** show differences in the groundwater signatures between the shallow (Paso Robles) and deep (Santa Margarita) aquifers. In general, wells screened in the Paso Robles Aquifer show lower concentrations for all of the major ions plotted, especially calcium, chloride, HCO_3^-, magnesium, and sulfate. Concentrations of these ions are consistently higher in the deeper Santa Margarita Aquifer. Wells that are screened in both aquifers show a signature more similar to the deeper Santa Margarita water signature, indicating that the Santa Margarita Aquifer is contributing more water to the well than the Paso Robles Aquifer.

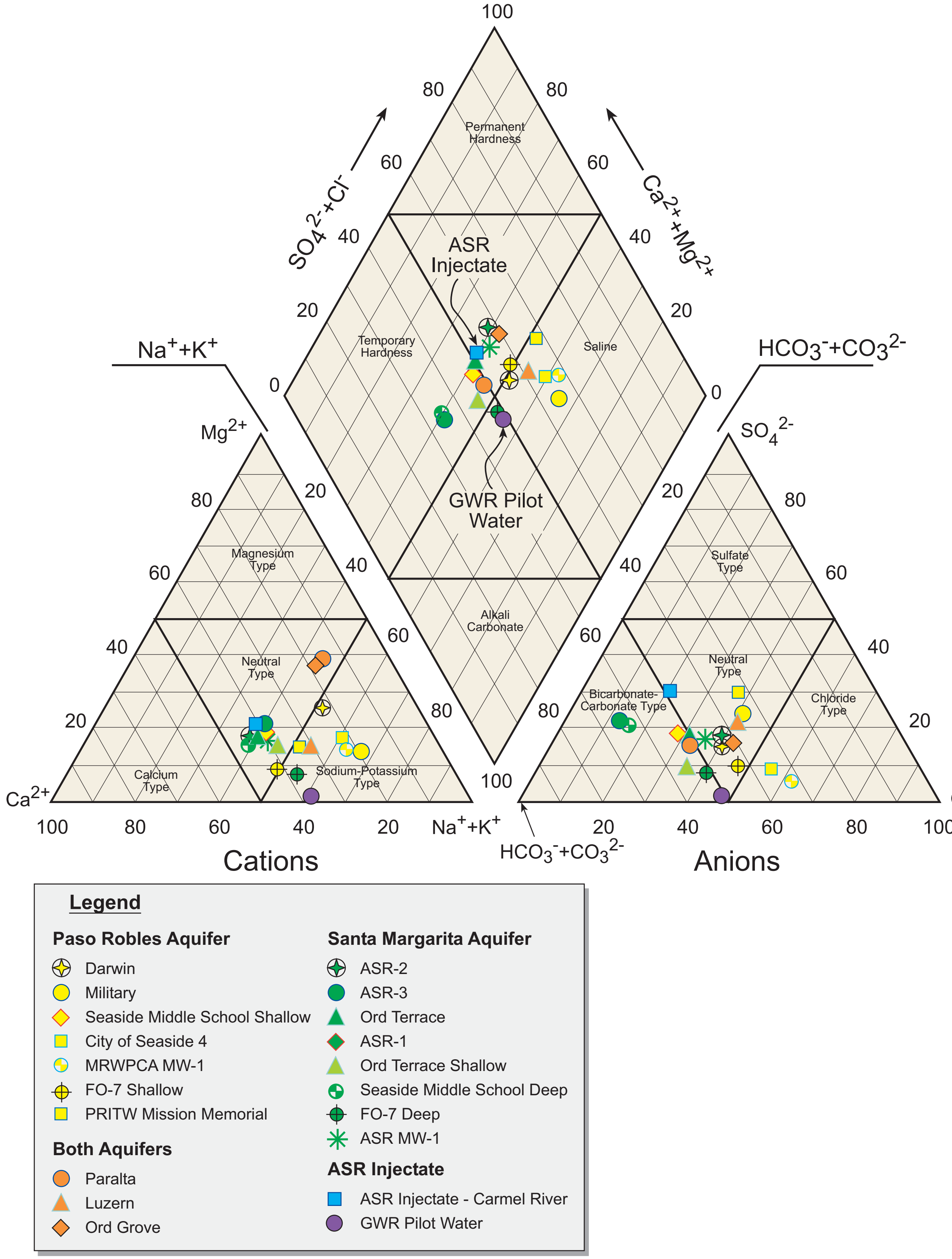
The ASR injectate has a geochemical signature that is different from most of the aquifer signatures in the Seaside Basin. Because the injectate is sourced from surface water (i.e., the Carmel River system water), the water chemistry is less mineralized than the Seaside Basin ambient groundwater. Overall ionic concentrations for the ASR injectate are lower than in the Santa Margarita Aquifer and the injectate appears to have slightly higher magnesium and sulfate than most wells in the Paso Robles Aquifer. Although not clearly demonstrated by the Stiff diagrams on **Figure 9-14**, the geochemical signature in the ASR wells vary considerably with ASR operation. As expected, wells exhibit signatures similar to ASR injectate during periods of injection (with chloride concentrations of about 30 mg/L) and return to signatures in the ambient groundwater during relatively long periods of non-injection or pumping (with chloride concentrations from about 120 mg/L to 140 mg/L)

The AWP pilot water has even lower relative mineral content than the ASR injectate. The signature is very distinct form other groundwater quality signatures and should be identifiable in groundwater samples from the Project's proposed monitoring wells.

Trilinear (Piper) Diagrams allow characterization of water chemistry and comparison of water quality analyses. Cation (calcium, magnesium, and sodium + potassium) concentrations in meq/L are expressed or normalized as a percentage of the total cations, which are plotted on a triangle in the lower left portion of the diagram. Total anions (CO_3^{2-}+HCO_3^-, sulfate, and chloride) are plotted on a triangle in the lower right portion of the diagram. The cation-anion plots are then projected onto a central diamond-shaped area, combining both cation and anion distributions. Groundwater with similar geochemistry will generally plot together in similar locations; therefore, groundwater from different sources may be identified by their bulk or intrinsic chemical compositions, which also may be classified as to water type.

The water quality analytical data from wells shown on **Figure 9-14** are plotted on the Trilinear diagram on **Figure 9-15**. Similar to the color coding on **Figure 9-14**, **Figure 9-15** presents data from wells screened in the Paso Robles Aquifer with yellow symbols; wells in the Santa Margarita Aquifer are shown with green symbols; and wells screened in both aquifers are shown with orange symbols. Data from an ASR injectate sample (blue) and the bench-scale sample from the pilot plant (purple) are also included for comparison.

The Trilinear diagram (**Figure 9-15**) shows that groundwater in both aquifers range from neutral-type to sodium-potassium-type (for cations) and bicarbonate-carbonate-type, to neutral-type, to chloride-type (for anions). In the diamond portion of the diagram, the groundwater samples from both shallow and deep aquifers are generally clustered together toward the center, suggesting relatively similar water chemistry. There is some slight differentiation among the two aquifers. Most of the groundwater samples from the Paso Robles wells (yellow) group toward a more sodium-chloride (saline) signature (**Figure 9-15**).



November 2015

TODD GROUNDWATER

Figure 9-15
Trilinear Diagram
Groundwater Chemistry near Injection Facilities

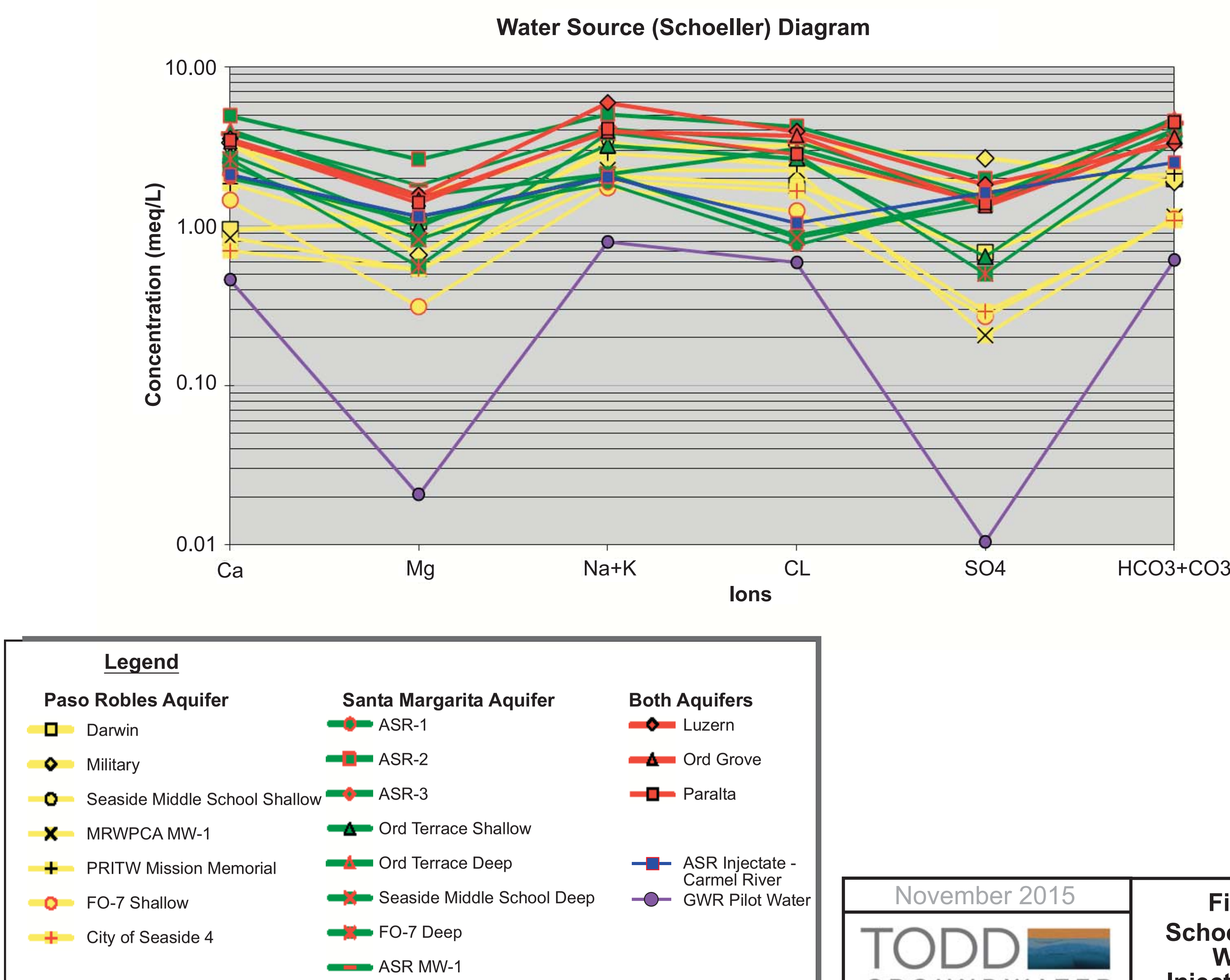
The ASR injectate appears slightly different than the groundwater signature, especially with respect to bicarbonate (lower) and sulfate (slightly higher). Several samples from ASR wells plot close to the ASR injectate sample, indicating mixing of the two waters.

The pilot water plots as sodium-potassium-type and bicarbonate-carbonate-type mostly because of the added calcium carbonate, $CaCl_2$ and CO_2 gas used to stabilize the AWP pilot water in this sample. The pilot water plots at the edge of other data points, mostly due to lower chloride and sulfate concentrations. Because the final full scale AWP Facility water will contain less calcium than the pilot water sample because the full-scale stabilization will not require the addition of calcium carbonate and $CaCl_2$ as was done for the bench-scale method of stabilization, the actual Trilinear signature of product water will likely be even more distinct from other samples.

Schoeller (Water Source/Fingerprint) Diagrams. Although the Trilinear diagram may be used to differentiate between overall water chemistry types, differences are often indistinguishable except in percentage amounts. Schoeller diagrams plot the meq/L of specific cations and anions and can offer a more detailed and different view of water chemistry. Schoeller diagrams are often used in conjunction with Trilinear diagrams for typing or fingerprinting different water sources. In general, water from similar sources (e.g., sources may include surface water, groundwater influenced by surface recharge, regional older groundwater) will often plot in a similar pattern on a Schoeller diagram.

Figure 9-16 shows a Schoeller diagram analysis for wells near the Injection Facilities. Samples are color-coded similar to the other diagrams to facilitate analysis. ASR injectate and pilot plant water analyses are also shown for comparison purposes.

The Schoeller diagram confirms the interpretation from the Stiff diagrams in that the Paso Robles Aquifer (yellow) contains groundwater at lower ionic concentrations than the Santa Margarita Aquifer (green). For wells screened in both aquifers (i.e., Paralta, Luzern, and Ord Grove – shown in orange), the Schoeller signature is more similar to the Santa Margarita Aquifer, indicating more contribution from that aquifer to the sample. However, because there is some overlap in the signatures, it also appears that there is infiltration/mixing of groundwater from the upper to lower aquifer. The ASR injectate (blue) also appears to be influencing the Santa Margarita Aquifer. The pilot plant water, shown for future comparison purposes only, has a unique signature with lower concentrations of magnesium and sulfate.



November 2015

TODD GROUNDWATER

Figure 9-16
Schoeller Diagram Wells near Injection Facilities

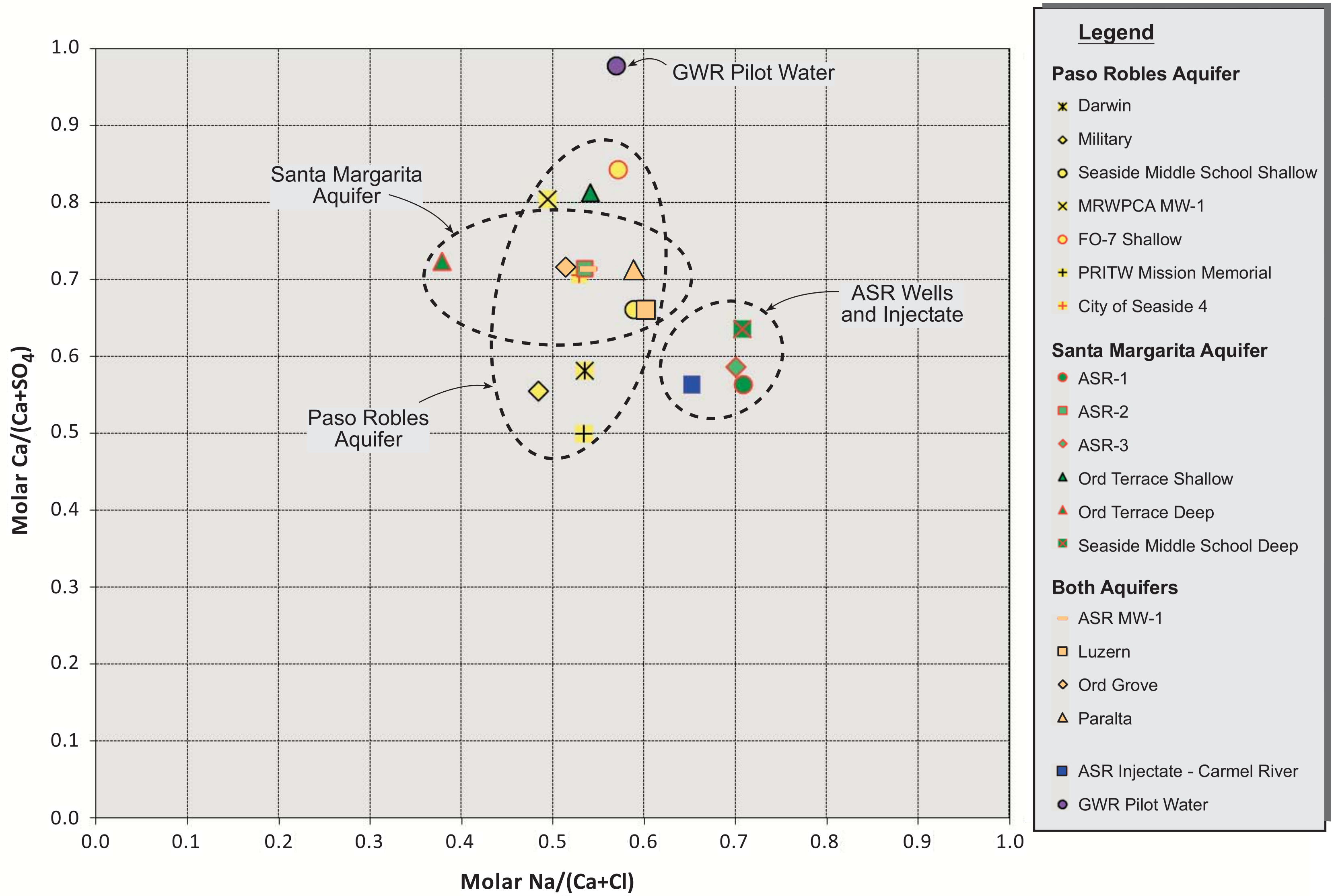
Brine Differentiation Plots. The BDP was developed by Hounslow (1995) to differentiate brine-contaminated waters from waters of other origins using major constituents commonly available in a water quality analysis. However, it has been widely used as another fingerprinting tool for differentiation of various groundwater chemistry. Molar concentrations of calcium divided by calcium plus sulfate on the vertical axis and sodium divided by sodium plus chloride on the horizontal axis are plotted on this type of diagram. Fields and mixing lines for brines, evaporates (i.e., precipitated salts), and seawater can be delineated, if applicable. One of the advantages of the BDP is that straight- and curved-line mixing ratios can be shown, particularly if end member concentrations (such seawater or brackish water) are known.[40]

The BDP on **Figure 9-17** shows scattered analytical data for the wells near the Injection Facilities. Fields of various well groupings are delineated on the plot for ease of use. As shown, the ASR injectate and ASR wells plot in a distinct area compared to other wells. The BDP appears to be a better indicator than the other plots of the mixing of injectate with groundwater in the ASR wells where most of the injection has occurred (ASR-1 and ASR-2). Fields for the two aquifers appear to overlap. Wells screened in both aquifers plot within the central overlapping area, consistent with mixing of the two water chemistries.

Similar to the other geochemical plots, the BDP shows that the pilot water sample signature is quite distinctive and separate. This signature indicates that a similar BDP analysis conducted during and following a field tracer test with AWP injectate will be useful for identifying actual travel times of injected water. However, because the analysis is based on relative concentrations of cations in the water samples, BDP signatures can be altered during groundwater transport through cation exchange and other geochemical interactions in the groundwater system. Although the BDP plot appears useful for differentiating wells influenced by pilot water, it should not be relied upon alone for the tracer test analysis. But when combined with other geochemical analyses, the BDP is expected to yield useful information.

Collectively, the geochemical plots indicate that product water will likely be sufficiently distinct from groundwater to allow for use as an intrinsic tracer in tracking the injected recycled water in the subsurface. More information on the proposed tracer testing approach is provided in **Section 6**.

[40] End members are waters having two distinct isotopic or chemical compositions with other samples ranging between the two.



November 2015

TODD GROUNDWATER

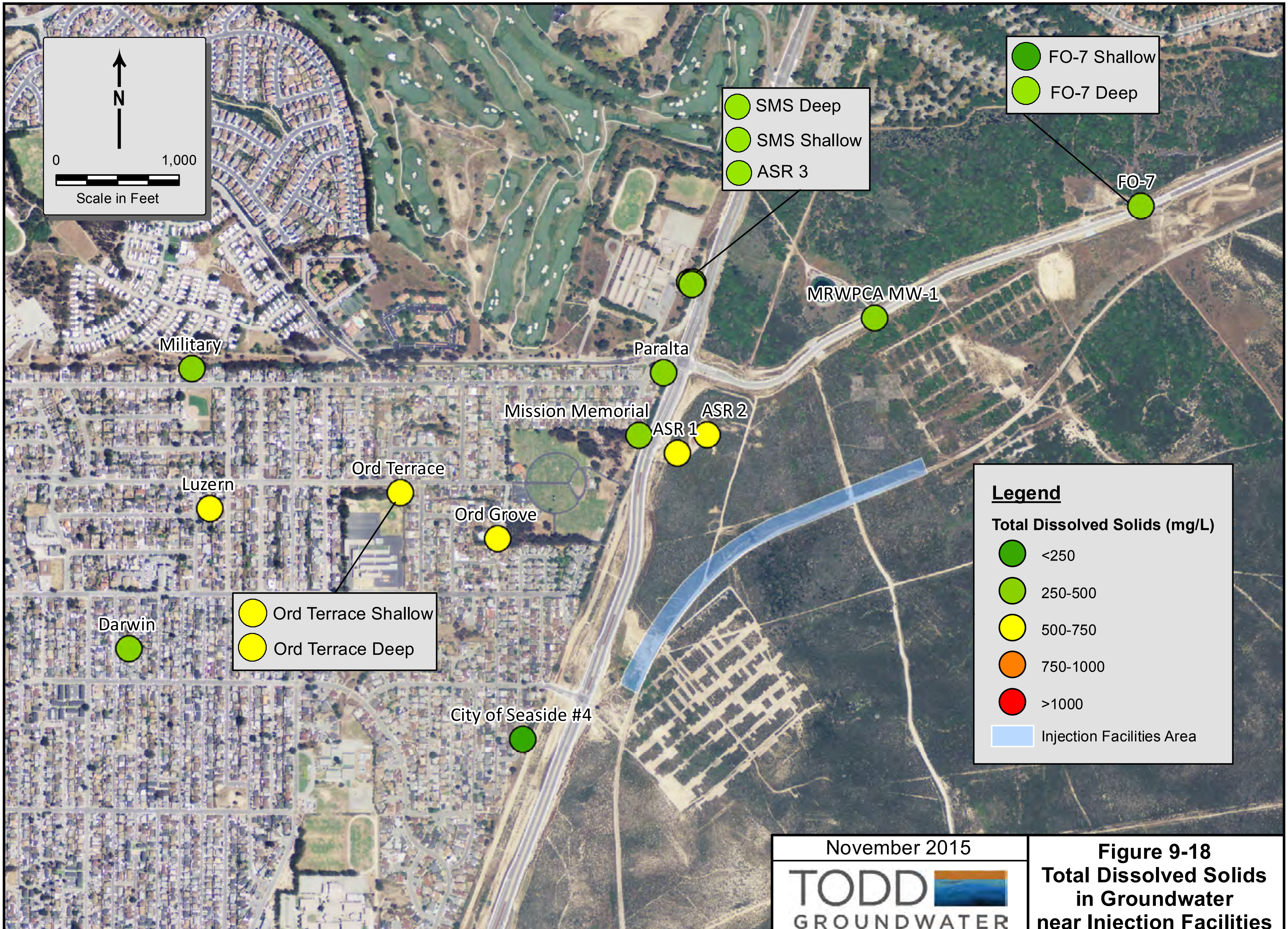
Figure 9-17
Brine Differentiation Plot Wells near Injection Facilities

9.4.3.3. Concentrations of TDS in Groundwater

As indicated from the geochemical analysis, the ionic concentrations and water chemistry signatures for the Paso Robles Aquifer are slightly different than for the Santa Margarita Aquifer. This interpretation is also reflected in the concentrations of TDS in groundwater near the Injection Facilities area. **Figure 9-18** includes recent (2012 - 2014) TDS concentration ranges for the samples used in the analysis.

Using the data ranges in the legend, **Figure 9-18** indicates that all of the TDS measurements in the wells were below the California secondary MCL Upper Consumer Acceptance Contaminant Level Range of 1,000 mg/L, although some were above the Recommended Consumer Acceptance Contaminant Level Range of 500 mg/L. TDS levels ranged from 190 mg/L in FO-7 Shallow (Paso Robles Aquifer) to 668 mg/L in ASR-2 (Santa Margarita Aquifer during a period of recovery with only small amounts of prior injection).

In general, wells screened in the Paso Robles Aquifer have lower TDS concentrations than in the Santa Margarita Aquifer with the 500 mg/L level serving as a reasonable dividing concentration for comparative purposes. For example, all wells screened only in the Paso Robles Aquifer are below 500 mg/L (green on **Figure 9-18**). Most of the Santa Margarita wells have recent concentrations above 500 mg/L (yellow on **Figure 9-18**), except Paralta (screened in both aquifers), SMS Deep, ASR-3, and FO-7 Deep. Wells not affected by ASR injection do not show a wide variation in TDS concentrations over time.



November 2015

TODD GROUNDWATER

Figure 9-18
Total Dissolved Solids in Groundwater near Injection Facilities

Figure 9-18. Total Dissolved Solids in Groundwater near Injection Facilities

9.4.4. Potential Constituents of Concern and Other Groundwater Analyses

To supplement the characterization of general groundwater chemistry, the water quality database was reviewed for potential constituents of concern including regulated constituents (those with MCLs). For the Project, additional potential constituents of concern also include those associated with former military activities at Fort Ord. Some of these constituents had not been analyzed previously in groundwater near the Injection Facilities area. To address this data gap, groundwater from the six wells sampled in the field program (**Table 9-4** above) were analyzed for more than 275 constituents/parameters. In addition to regulated constituents and former Fort Ord constituents, the six groundwater samples were also analyzed for CECs as defined in the SWRCB Recycled Water Policy and other constituents not previously monitored routinely in local groundwater.

9.4.4.1. Constituents Exceeding California Primary MCLs

For the more than 275 constituents and parameters analyzed in each of the six wells for this monitoring event, only two wells, FO-7 Shallow and M1W MW-1, detected any constituents that did not meet the California primary MCLs. These detections, along with turbidity values, are summarized in **Table 9-6** below.

Table 9-6: Constituents Exceeding California Primary MCLs

Analyte	Method	Units	MDL	FO-7 Shallow	M1W MW-1	California Primary MCL
Turbidity	SM2130B	NTU	0.040	550	71	5[a]
Aluminum (Al)	EPA 200.8	µg/L	8.0	3,700	2,700	1,000
Arsenic (As)	EPA 200.8	µg/L	0.28	210		10
Barium (Ba)	EPA 200.8	µg/L	0.12	1,200		1,000
Chromium (Cr) Total	EPA 200.8	µg/L	0.32	790		50
Lead (Pb) Total	EPA 200.8	µg/L	0.080	42		15
Gross Alpha	7110B	pCi/L	3.00	125 ±5		15
Gross Beta	7110B	pCi/L	4.0	114 ±2		50
Combined Radium	calculated	pCi/L	1.00	38.3 ±2.4		5

a. 5 NTU is a secondary MCL and is included on the table for comparison purposes as discussed in the text.

As shown in **Table 9-6**, the only constituents that were detected at concentrations above primary MCLs were five metals and several radiogenic parameters. These constituents are the ones most affected by elevated turbidity in groundwater samples; as shown on the table, the well with the most exceedances (FO-7 Shallow) is the well with the highest turbidity value (550 NTU). Further, the only other well with an exceedance (M1W MW-1) also detected elevated turbidity (71 NTU). FO-7 Deep (data not shown in **Table 9-6**) did not detect any constituents above primary MCLs, but the slightly elevated turbidity value of 10 NTU correlated to slightly elevated detections in other metals. No exceedances of primary MCLs were recorded in any of the wells with turbidity values of 10 NTU or less. Complete laboratory analyses for the sampling event in the six wells are presented in **Appendix I**.

Due to the relatively slow velocities within groundwater systems and the natural filtering associated with aquifer materials, groundwater does not typically contain solids that will result in the elevated turbidity values shown above. Rather, it is more likely that aquifer particles or other solids are being entrained in the groundwater samples and interfering with the laboratory analysis. Collectively, these data indicate that suspended small particles of aquifer material or pre-development solids are being analyzed by the laboratory methods (i.e., causing analysis interference) rather than dissolved constituents on which water quality standards are based. Therefore, the concentrations of certain metals and radiogenic parameters are not considered representative of actual concentrations in groundwater.

FO-7 and M1W MW-1 are constructed with small-diameter casings that cannot accommodate large pumps; the deep water table has limited the ability to develop these three monitoring wells sufficiently in order to produce a turbid-free groundwater sample for analysis. In addition, FO-7 is a relatively older monitoring well (drilled in 1994) that has never been previously sampled for groundwater quality and may not be capable of producing turbid free water. As such, future sampling programs will incorporate techniques such as field filtering to minimize the effects of turbidity.

9.4.4.2. Former Fort Ord Constituents

Given the historical land use of the former Fort Ord lands, the M1W field program included groundwater analyses for chemicals of concern associated with former Fort Ord activities. The six groundwater samples from the M1W field program were analyzed for 17 explosive compounds (nitroaromatics and nitramines) by U.S. EPA Method 8330B. In addition, two metals associated with explosive compounds (beryllium and lead) were also analyzed. These data were compared to available California primary MCLs and NLs and are summarized in **Table 9-7**.

As shown in **Table 9-7**, the only explosive constituent detected in groundwater samples was 2,6-DNT (dinitrotoluene). This constituent was also detected in laboratory blank samples, which are samples of laboratory water (not groundwater) analyzed for quality assurance/quality control (QA/QC) purposes. Detections of this constituent at similar levels in the laboratory blank sample indicate that 2,6-DNT is likely a laboratory contaminant and not actually present in groundwater. Although the constituent may be present in several groundwater *samples*, the laboratory blank data suggest that it was introduced into the samples in the laboratory. Further, detections of 2,6-DNT in FO-7 Shallow, FO-7 Deep, and ASR MW-1 were below the laboratory reporting level (RL), meaning that the concentration of 2,6-DNT in samples is too low to be quantified. Given the laboratory QA/QC data for 2,6-DNT, the low levels of the detections, and the absence of additional explosives in groundwater, data indicate that groundwater has not been impacted locally from explosives associated with former Fort Ord activities.

Table 9-7: Groundwater Analyses for Explosives and Associated Metals

Constituent	Wells with Detections	MRL (µg/L)	Detected or Reported Concentration (µg/L)	Primary MCL (µg/L)	NL (µg/L)	Comments
Explosives[a]						
HMX	None	0.099-0.12	ND	None	350	
RDX	None	0.099-0.12	ND	None	0.3	
1,3,5- Trinitrobenzene	None	0.20-0.22	ND	None	None	
1,3-dinitobenzene	None	0.098-0.12	ND	None	None	
3,5-dinitoaniline	None	0.098-0.30	ND	None	None	
2,4,6 Trinitro-phenylmethyl-nitramine	None	0.10-0.12	ND	None	None	
Nitrobenzene	None	0.099-0.12	ND	None	None	
4-Amino-2,6-dinitrotoluene	None	0.098-0.11	ND	None	None	
2-amino-4,6-dinotrotoluene	None	0.098-0.11	ND	None	None	
TNT	None	0.098-0.11	ND	None	1	
2,6-DNT	FO-7 Shallow	0.20	0.070[c]	None	None	high turbidity
	FO-7 Deep	0.23	0.064[c]	None	None	slightly turbid
	ASR MW-1	0.10	0.037[c]	None	None	
2,4-DNT	None	0.10	ND	None	None	
2-nitrotoluene	None	0.11	ND	None	None	
4-nitrotoluene	None	0.098-0.12	ND	None	None	
3-nitrotoluene	None	0.098-0.12	ND	None	None	
Nitroglycerine	None	0.99-1.2	ND	None	None	
Pentaerythritol tetranitrate	None	0.49-0.56	ND	None	None	
Metals[b]						
Beryllium	ASR-2	0.050	0.7	4.0		
	FO-7 Shallow	0.020	0.68			high turbidity
	M1W MW-1	0.020	0.044			turbid
Lead	ASR-1	0.020	0.78	15.0		
	ASR-2	0.010	3.0			
	FO-7 Shallow	0.020	**42.0**			high turbidity
	FO-7 Deep	0.080	1.3			slightly turbid
	PRTIW: Mission Memorial	0.020	0.061			
	M1W MW-1	0.020	1.3			turbid
	Paralta	0.001	3.0			

a. Nitroaromatics and nitramines by U.S. EPA Method 8330B: Samples received and submitted by Alpha Analytical Laboratory, Ukiah, CA to ALS Environmental (ALS), Kelso, WA on February 5, 2014; analyzed by ALS on February 8, 2014.
b. Metals by U.S. EPA Method 200.8 analyzed by Alpha Analytical Laboratory, Ukiah, CA, February 5-11, 2014.
c. Constituent also detected in laboratory blank indicating a laboratory contaminant that may not be present in groundwater. All detections were below MRLs and are not quantifiable.

For the metals analysis in **Table 9-7**, both beryllium and lead – as naturally occurring substances – were detected in several groundwater wells above the reporting limits. Beryllium was detected in groundwater collected from ASR-2, FO-7 Shallow, and M1W MW-1, although all of the detections met the California Primary MCL. Other wells in the database did not detect beryllium above the laboratory reporting limits.

Lead was also detected in groundwater collected from ASR-1, ASR-2, FO-7 Shallow, FO-7 Deep, Mission Memorial PRTIW, M1W MW-1, and Paralta. The detection in FO-7 Shallow (42 µg/L) was above the MCL (15 µg/L) but appears anomalous with respect to other detections of lead in the database. The concentration of 42 µg/L is the highest concentration in the database by an order of magnitude, which included lead analyses from 13 wells sampled from 2011 through 2014. The second highest concentration was detected in ASR-2 at 3.0 µg/L (also included on **Table 9-7**). Except for FO-7 Shallow, all of the detections were below the MCL for lead.

As previously mentioned, the 2014 sampling of FO-7 Shallow was the first time that this small-diameter monitoring well had been sampled for water quality since its original sampling upon well completion. Sampling produced a highly turbid sample (550 NTU), likely relating to the inability to properly develop the well for water quality when installed in 1994 as a water level monitoring well. As such, the metals analytical data are likely the result of particle interference and are not likely representative of dissolved lead concentrations in groundwater.

Given the absence of explosives and the relatively low levels of beryllium and lead (with the exception of FO-7 Shallow where data appear to be inaccurate as explained above), the data do not indicate that former Fort Ord activities have impacted groundwater in the existing wells near the Injection Facilities area.

9.4.4.3. Constituents of Emerging Concern

As defined in the Recycled Water Policy, CECs are chemicals in personal care products, pharmaceuticals including antibiotics, antimicrobials, agricultural and household chemicals, hormones, food additives, transformation products and inorganic constituents. These chemicals have been detected in trace amounts in surface water, wastewater, recycled water, and groundwater and have been added to the monitoring requirements for any project involving groundwater replenishment using recycled water.

The SWRCB Recycled Water Policy CEC monitoring requirements were based on the recommendations of an expert panel and will be included in the monitoring program for the Project's permit (see **Section 12**). For injection projects that produce recycled water using RO and AOP, the monitoring requirements in the Recycled Water Policy only apply to recycled water prior to and after treatment (no groundwater sampling). As part of the Title 22 Criteria for injection projects, a project sponsor must in the Engineering report recommend CECs for monitoring in product water and groundwater (see **Section 12**).

The following Recycled Water Policy CECs are health-based indicators, treatment/performance based indicators, or both as shown below:

- 17-*β*-estradiol - steroid hormone (health-based indicator)
- Caffeine – stimulant (health-based and performance-based indicator)
- NDMA – disinfection byproduct (health-based and performance-based indicator)
- Triclosan – antimicrobial (health-based indicator)

- DEET – personal care product (performance-based indicator)
- Sucralose – food additive (performance-based indicator)

None of the CECs currently have either primary MCLs for drinking water. For NDMA, the current NL is 10 ng/L.

To provide baseline conditions for these CECs in the Seaside Basin, the six wells sampled in the recent M1W field program were analyzed for the six CECs and other pharmaceuticals/personal care products included in U.S. EPA Laboratory Methods 1625M and 1694 (APCI and ESI+). Groundwater samples were analyzed from ASR MW-1, City of Seaside 4, FO-7 Shallow, FO-7 Deep, PRTIW Mission Memorial, and M1W MW-1. Full results are provided in **Appendix D**. Detections of the six CECs are summarized in **Table 9-8**.

Table 9-8: Groundwater Sample Analyses for CECs

Constituent[a]	Wells with Detections[b]	Minimum Reporting Limit (RL)	Detected or Reported Concentration	Comments
		µg/L[c]		
NDMA	PRTIW (Mission Memorial)	0.002	0.0054	NL =0.01
17-β-estradiol	None	0.001	ND	
Triclosan	None	0.002	ND	
Caffeine	FO-7 Deep	0.001	0.0027	
	M1W MW-1		0.0068	
DEET	FO-7 Deep	0.001	0.0023	
	M1W MW-1		0.0060	
Sucralose	None	0.005	ND	

a. NDMA by U.S. EPA Method 1625M; 17-β-estradiol and triclosan by U.S. EPA Method 1694-APCI**;** caffeine, DEET, and sucralose by U.S. EPA 1694-ESI+.
b. Groundwater analyzed from wells ASR-1, City of Seaside 4, FO-7 Shallow, FO-7 Deep, PRTIW Mission Memorial, and M1W MW-1.
c. Analyses reported on laboratory analytical data sheets in ng/L or parts per trillion. Converted to µg/L or parts per billion. Samples received by Alpha Analytical Laboratory, Ukiah, CA; submitted to Weck Laboratories, Inc. (Weck), City of Industry, CA, on February 5, 2014; analyzed by Weck from February 11 to February 19, 2014.

As indicated in **Table 9-8**, NDMA was detected in groundwater collected from the PRTIW well at 0.0054 µg/L (below the NL); caffeine was detected in FO-7 Deep and M1W MW-1 at 0.0027 and 0.0068 µg/L, respectively (below the Drinking Water Equivalent Level [DWEL] of 0.35 µg/L per Anderson et al., 2010).[41] DEET was detected in FO-7 Deep and M1W MW-1 at 0.0023 and 0.0060 µg/L, respectively (below the DWEL of 81 µg/L per Intertox, 2009). Estradiol (17-β), triclosan, and sucralose were not detected above reporting limits in groundwater collected from any of the six wells.

These data represent the first time that CECs have been analyzed in the Seaside Basin and serve as initial background data. The data will be confirmed through future groundwater sampling events that will

[41] The DWEL is the amount of a substance in drinking water that can be ingested daily over a lifetime without appreciable risk.

support the monitoring program in this Engineering Report. Nonetheless, only a few constituents were detected at very low levels (all less than 0.01 µg/L) and meet advisory or safe health concentrations.

9.4.4.4. Salts and Nutrients

A SNMP has been prepared for the Seaside Basin to comply with requirements in the SWRCB's Recycled Water Policy (HydroMetrics, 2014a). As documented in the SNMP and confirmed herein, ambient groundwater generally exceeds Basin Plan objectives for TDS in many areas of the basin, while nitrate and chloride concentrations generally meet Basin Plan objectives. TDS, nitrate, and chloride concentrations in the product water are expected to meet all Basin Plan objectives. Additional information on potential Project impacts to groundwater quality and details from the SNMP are provided in **Section 11.4**.

This Page Intentionally Left Blank

10. PRODUCTION AND MONITORING WELLS

Seaside Basin wells downgradient of the Injection Facilities area provide water supply for municipal, industrial, and irrigation purposes. There are also numerous monitoring wells upgradient and downgradient of the area. Most of these monitoring wells are part of either the ASR monitoring program or the basin-wide monitoring program, both of which are conducted by MPWMD in cooperation with Cal Am and the Seaside Basin Watermaster, respectively. Local production and monitoring wells are shown on **Figure 10-1**.

Most wells near the Injection Facilities are located in the adjacent Northern Coastal Subarea. The closest water supply wells include Seaside No. 4 (operated by the City of Seaside) and two ASR wells, ASR-1 and ASR-2, (operated by the MPWMD for CalAm). Each of these wells is located about 1,000 feet or more downgradient from a Project injection well (**Figure 10-1**).

Wells within the Northern Inland Subarea include the Reservoir Well (an inactive irrigation well), and the recently-installed M1W MW-1 monitoring well; both wells are screened in the upper Paso Robles Aquifer and monitor the local water table (**Figure 10-1**). An additional monitoring well cluster (FO-7 Shallow and FO-7 Deep) is located about 2,800 feet to the northeast of the Injection Facilities area along Eucalyptus Road (just west of the area shown on **Figure 10-1**).

The production and monitoring wells are not impacted by the increase in capacity of the AWP Facility from 4 mgd to 5 mgd since the additional 1 mgd is for irrigation and will be diverted from the product water conveyance pipeline prior to injection.

10.1. PRODUCTION FROM EACH AQUIFER SYSTEM

Both aquifers are screened in downgradient production wells. The Paso Robles Aquifer is less productive than the Santa Margarita Aquifer and is often screened in a well that is also screened in the Santa Margarita Aquifer. Near the Injection Facilities area, the Paso Robles is screened in production wells Paralta (which is also screened in the Santa Margarita Aquifer), PRTIW, MMP, and Seaside 4, all located within about 1,000 feet west of General Jim Moore Boulevard. The Paralta and Seaside 4 are drinking water wells. PRTIW and MMP are irrigation wells and are not used for drinking water supply.

Screened intervals in downgradient drinking water wells are shown on Cross Section B-B’ on **Figure 10-2**. The cross section is oriented along General Jim Moore Boulevard from the Seaside 4 well in the southwest to ASR-4 in the northeast, as shown on **Figure 10-1**. In addition to the downgradient ASR wellfields, Paralta, and Seaside 4, the next closest downgradient drinking water well, Ord Grove 2, is also projected onto the section (**Figure 10-2**). The cross section shows the Older Dune Sands/Aromas Sand at the surface and extending to an approximate depth of 300 feet. The Paso Robles Aquifer and underlying Santa Margarita Aquifer are screened in the various wells as shown (**Figure 10-2**).

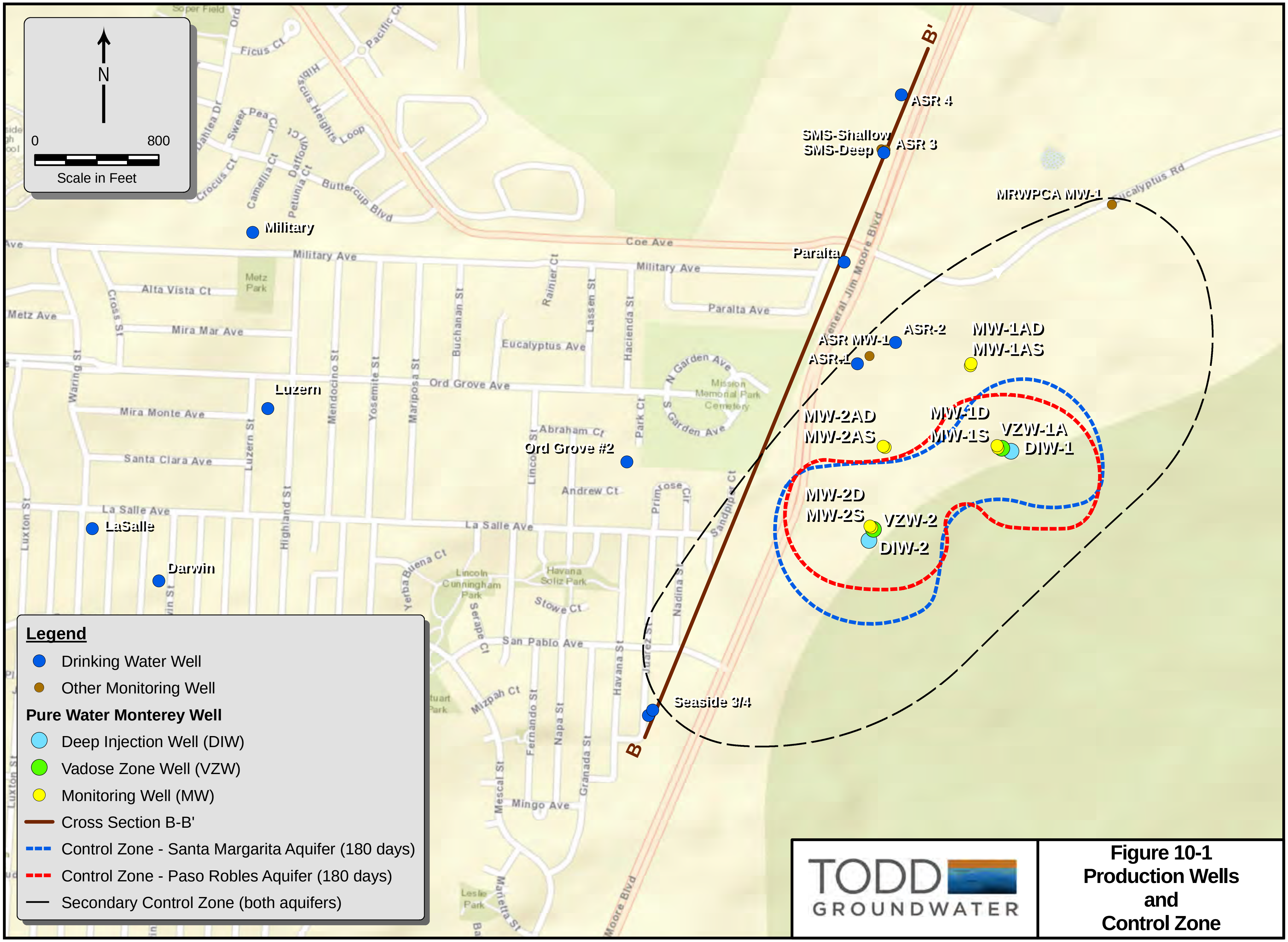
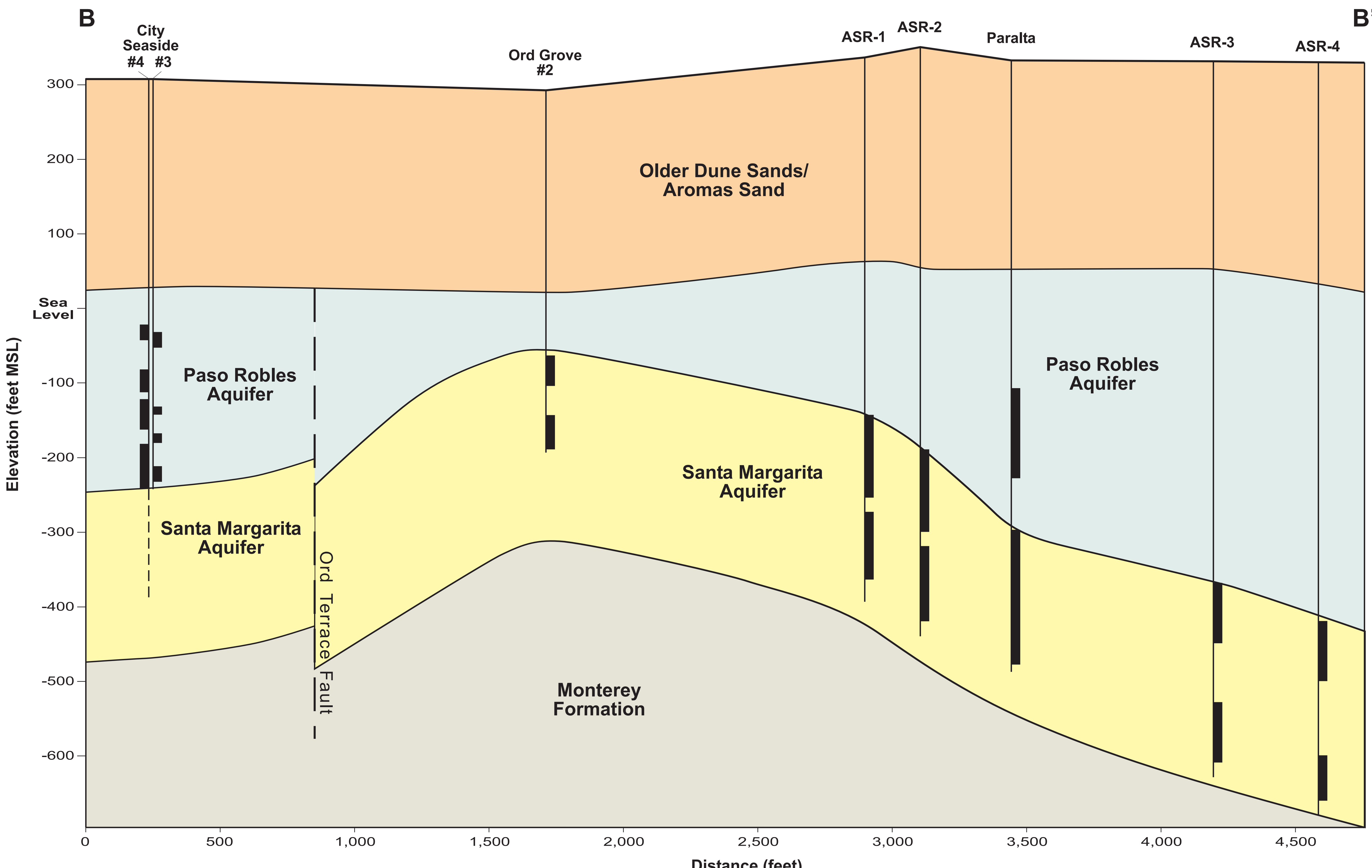


Figure 10-1
Production Wells and Control Zone



November 2015

TODD GROUNDWATER

Figure 10-2
Cross Section B - B'
Closest Downgradient Drinking Water Wells

All of the ASR wells are screened in the Santa Margarita Aquifer (**Figure 10-2**). As mentioned above, the Paralta well is also screened in the Paso Robles Aquifer. The Ord Grove #2 production well appears to be screened in the Santa Margarita Aquifer only, but the gravel pack allows some connection in the well to overlying sand layers in the Paso Robles Aquifer. As such, the Paso Robles Aquifer has been estimated to contribute a small amount of production to this well (also evidenced by groundwater quality data). Seaside 4 appears to be screened in the Paso Robles Aquifer only, although there is some uncertainty with the aquifer interpretation (**Figure 10-2**). Previous wells at this site extended down into the Santa Margarita Aquifer and flow from the deeper aquifer may also contribute some flow to wells at this location. The Watermaster Model simulates this well as pumping from both aquifers.

As shown on **Figure 10-1**, additional drinking water production wells are located within about one mile of the Injection Facilities area, including Military, Luzern, Darwin, and LaSalle wells. All of these wells are screened in the Paso Robles Aquifer; Luzern is also screened in the Santa Margarita Aquifer.

Because many wells are screened in both the Paso Robles Aquifer and the Santa Margarita Aquifer, the contribution of the Paso Robles Aquifer to basin production is not known with certainty. Estimates by previous investigators (Yates et al., 2005) indicate that an average of about 40% of the coastal area production was from the Paso Robles Aquifer in 2000 through 2003. However, with additional wells in the Santa Margarita Aquifer and changes in production over time, the current contribution from the Paso Robles Aquifer is estimated to be only about 20% of the basin pumping.

It is expected that this declining trend in Paso Robles Aquifer production will continue into the future. CalAm, the primary producer in the Coastal Subareas, has been shifting production from older wells that were primarily Paso Robles Aquifer wells, to the newer (and higher capacity) wells (i.e., Ord Grove, Paralta, ASR wells), which are primarily Santa Margarita Aquifer wells. This transition is the basis for allocating 90% of the product water to be injected into the Santa Margarita Aquifer and only 10% to the Paso Robles Aquifer (see **Table 8-1** for a quantitative delivery schedule).

10.2. ASR Operation

The Monterey Peninsula ASR Project consists of four ASR wells and associated monitoring wells drilled at two locations along General Jim Moore Boulevard downgradient of the Injection Facilities area. ASR-1 and ASR-2 are the closest wells to the Injection Facilities, both located about 1,000 feet downgradient. ASR-3 and ASR-4 are located about 2,000 feet and 2,300 feet from the Injection Facilities, respectively. The wellfields are operated by MPWMD through an agreement with CalAm. As mentioned previously, the ASR wells inject treated imported water from the Carmel River Basin for seasonal storage and subsequent recovery for drinking water supply.

Currently, Carmel River Basin water (extracted from riverbank wells) is treated to drinking water standards and conveyed to the ASR wells for recharge when excess water is available (e.g., periods when flows in the Carmel River exceed fisheries bypass flow requirements). Two potential future ASR wells further to the north are also planned for injection of water from a proposed ocean desalination plant to be developed by CalAm.

ASR injection amounts vary from year to year depending on surface water availability; specifically, diversions from the Carmel River for ASR injection are limited to certain times of the year and are allowed only when minimum flows are present at certain gages on the Carmel River (i.e., to provide adequate fish passage). A regulatory order requires that the injected Carmel River water be extracted to meet water demands; thus, the project is not operated for the long-term replenishment of basin aquifers (Seaside Basin Watermaster, 2012).

Table 10-1 summarizes annual ASR injection and recovery from 2011 to 2018.

Table 10-1: Injection and Recovery Volumes, ASR Project

Water Year	ASR Injection (AFY)	ASR Recovery (AFY)
2010	1,111	1,111
2011	1,117	1,117
2012	131	131
2013	294	513
2014	0	0
2015	215	0
2016	699	493
2017	2,345	1,182
2018	530	1,499
Total	6,444	6,046

10.3. Closest Drinking Water Supply Well

The closest drinking water well to each of the Project's proposed injection wells (and producing from the target aquifer) is listed in **Table 10-2**. Distances between the Project wells and production wells are measured on a surface map and do not reflect simulated travel times within the aquifer.

Table 10-2: Closest Drinking Water Wells to Injection Wells

Project Wells	Target Aquifer	Closest Downgradient Production Well	Approximate Distance (feet)
DIW-1	Santa Margarita	ASR-2	1,141
DIW-2	Santa Margarita	ASR-1	1,142
VZW-1A	Paso Robles	Ord Grove #2	2,412
VZW-2	Paso Robles	Ord Grove #2	1,626

10.4. Production Wells Within a Two-Year Travel Time

All downgradient drinking water wells that could potentially be reached by water injected into the Project injection wells within a two-year travel time have been analyzed in more detail pursuant to Title 22 Section 60320.200(e)(4). Because of the dynamic nature of the groundwater system resulting from intermittent ASR operation and variable downgradient pumping patterns with time, the two-year travel time is not a fixed downgradient boundary. Rather, groundwater modeling indicates that the two-year travel time varies significantly throughout the 25-year simulation period. To ensure that wells within a two-year travel time window are included in the analysis, the distances associated with the fastest one-year travel rates are doubled, providing an area of maximum extent within which to identify drinking water wells.

This approach is highly conservative in that the local hydraulic gradients are highest when ASR wells are in full operation, yet the wells will have to be non-operational to allow the injected product water to continue on a two-year travel path without being extracted. In other words, the conditions associated with the fastest travel times will result in extraction of the product water before a two-year travel time is complete. Conceptually, the two-year travel time used in this analysis will apply only if ASR-1 and ASR-2 wells were in full operation up to the time that product water arrived near the wells and then pumps were shut off such that product water will continue to migrate past the wells. The approach is even more conservative with respect to the vadose zone wells. Groundwater modeling indicates that none of the product water injected into the Paso Robles Aquifer intersects a Paso Robles-screened drinking water well within a two-year time frame (see **Table 5-3**). Nonetheless, this conservative approach accounts for a full range of potential of operations that will result in the fastest two-year travel times and includes the maximum number of production wells in the analysis.

The fastest approximate one-year travel time is estimated at approximately 1,000 feet (DIW-3 to ASR-1; see **Table 5-3**); therefore, a zone downgradient of approximately 2,000 feet is applied. The drinking water wells are tabulated in **Table 10-3**.

Table 10-3: Drinking Water Wells within a Two-Year Travel Time

Drinking Water Well	Estimated Travel Time (years)	Producing Aquifer	Injection Well(s)
ASR-1 / ASR-2	0.9 years	Santa Margarita	DIW-1, DIW-2
Paralta	2.0 years	Santa Margarita / Paso Robles	DIW-1, DIW-2
Ord Grove #2	1.8 years	Santa Margarita	DIW-2

10.5. Control Zone

As required by Title 22 Section 60320.200(e)(2), a zone of controlled well construction (control zone) must be delineated around the Project injection wells based on the longest of the travel times for pathogen control or RRT:

- Per **Section 5.4**, the proposed underground retention time for pathogenic microorganism control is 5.4 months.
- Per **Section 6.3**, the RRT is 5.6 months.

Thus, the RRT of 5.6 months is the factor that will control how the control zone derivation is proposed. Because the travel times vary with changing downgradient wellfield operations, the shortest travel time periods described in **Section 5.3** are used. Specifically, a zone representing the longest distance covered in six months (180 days) for each injection well is used to delineate the control zone for each aquifer.

As described previously, **Figures 5-3** and **5-4** show the extents of groundwater transport for deep injection wells and vadose zone wells, respectively, for various time periods from 90 days to 360 days. These represent the shortest travel times (and associated longest distances) represented by groundwater conditions over a 25-year simulation period.

The areas representing the 180-day travel time for Project injection wells shown on **Figure 5-2** (6 months) were combined to delineate a control zone for the Santa Margarita Aquifer. A control zone was developed by connecting the outer limits – upgradient and downgradient – from well to well. The resulting control zone for the Santa Margarita Aquifer is shown on **Figure 10-1** (blue dashed line). The Santa Margarita control zone includes all of the monitoring wells adjacent to the deep injection wells, but is just short of MW-1AD and MW-2AD (between the deep injection wells and ASR-1&2 to the north).

A similar methodology was used to delineate a control zone for the Paso Robles Aquifer. Connecting the outer portions of the 180-day (6 months) travel time extents from **Figure 5-3**, results in the control zone shown on **Figure 10-1** (dashed red line). The Paso Robles control zone includes all of the monitoring wells adjacent to the vadose zone wells.

M1W will work with the City of Seaside and the Monterey County Health Department, and FORA, if appropriate, to ensure that no production wells are constructed within these two control zones.

10.6. Secondary Control Zone Boundary

As required by Title 22 Section 60320.200(e)(3), a secondary boundary must be delineated around the injection wells representing a zone of potential controlled drinking water well construction requiring further study prior to a production well being installed. A generalized secondary control zone is proposed as shown on **Figure 10-1**. This zone is defined by the closest downgradient wells and extends approximately 1,000 feet downgradient (northwest, west, and southwest) from the injection wells (with estimated underground retention times of generally one year or more, depending on well operation). The secondary control zone is extended approximately 1,200 feet to Eucalyptus Road in order to include the M1W MW-1 monitoring well. The upgradient secondary control zone extends onto BLM lands where no future production wells would be expected to be drilled.

This Page Intentionally Left Blank

11. GROUNDWATER RECHARGE IMPACTS

Potential impacts to groundwater quality resulting from the Project were analyzed in a project-level EIR, certified in October 2015. With respect to groundwater storage, no impacts were identified; extractions associated with the Project will not exceed amounts of injection. The groundwater recharge impacts are not impacted by the increase in capacity of the AWP Facility from 4 mgd to 5 mgd since the additional 1 mgd is for irrigation and will be diverted from the product water conveyance pipeline prior to injection.

The objectives, assumptions, methodology, and results of the groundwater quality impacts analysis were presented in *Recharge Impacts Assessment Report* (Todd Groundwater, 2015a), provided as **Appendix D**. The groundwater quality analysis also incorporated results from geochemical modeling conducted for the MRWPCA field program. This modeling evaluated the potential for constituents in the vadose zone to be leached by percolating injectate, thereby impacting groundwater quality. The geochemical modeling also included the potential for adverse geochemical interactions between product water and groundwater. The groundwater quality impacts analysis provided for the EIR is summarized in the following sections.

11.1. POTENTIAL IMPACTS TO GROUNDWATER QUALITY

As described in the previous sections, the recycled water will be treated and stabilized to meet all drinking water quality objectives. Also discussed previously and shown in **Table 9-5**, concentrations of constituents in the pilot water sample, including TDS (74 mg/L) and nitrogen (1.3 mg/L as total N) all meet Basin Plan objectives (**Table 9-5**). Further, the product water is expected to be higher quality water than ambient groundwater with respect to TDS, chloride, nitrate, and other constituents (see analysis in **Section 9.4**). Accordingly, the Project will not result in groundwater failing to meet groundwater objectives or beneficial uses (including municipal water supply). Rather, the product water will have a beneficial effect on local groundwater quality.

11.2. RECYCLED WATER CONTRIBUTION

M1W is proposing a 100% RWC in conformance with Title 22 Section 60320.216 with no diluent water needed. Although product water will be mixing with groundwater, the impacts analysis shows that groundwater quality will not be adversely impacted. In addition, product water is of higher quality than groundwater with respect to mineral content and will actually improve overall groundwater quality locally.

11.3. ANTI-DEGRADATION ASSESSMENT

As discussed in **Section 2.3.1**, the State Anti-degradation Policy was adopted to maintain high quality water resources to the maximum extent possible, especially when the quality of the water is higher than established by adopted policies (Resolution 68-16). As described in **Section 9.4.2**, groundwater in the Seaside Basin is highly mineralized, with elevated TDS and chloride concentrations throughout the basin compared to the product water.

A SNMP has been prepared for the Seaside Basin to comply with the Recycled Water Policy (HydroMetrics, 2014a). The SNMP was developed with basin stakeholder input through the Seaside Basin Watermaster and was adopted by the MPWMD. The SNMP was submitted to the RWQCB on July

9, 2014. The RWQCB has deemed the submittal to be insufficient in terms of its anti-degradation findings and does not intend to adopt it as Basin Plan amendment.[42] A Project-specific anti-degradation analysis was conducted during development of the WDRs/WRRs. The analysis demonstrated use of less than 10% of the available assimilative capacity for constituents of concern.[43]

Existing groundwater quality and assimilative capacity for the Northern Inland Subarea as presented in the SNMP are summarized in **Table 11-1.** Also included in the table are assimilative capacity values for the groundwater basin.

Table 11-1: Groundwater Quality and Assimilative Capacity, Northern Inland Subarea

Northern Inland Subarea	Paso Robles Aquifer	Santa Margarita Aquifer	Combined Aquifers	Water Quality Objectives	Subarea Assimilative Capacity	Basin-wide Assimilative Capacity
TDS, mg/L	344	327	336	500	164	-40
Chloride, mg/L	63	61	62	250	188	110
Nitrate (as N) mg/L	0.43	0.53	0.48	10	9.5	9.3

Source: modified from SNMP data (HydroMetrics, 2014a)

11.4. IMPACTS TO EXISTING GROUNDWATER CONTAMINATION

As previously described in **Section 9.4.3.2**, the Injection Facilities are located on former Fort Ord lands. The area, now under FORA control, has been cleared of munitions and explosives of concern and remedial actions have been completed. Analyses of vadose zone core and groundwater as part of the M1W field program indicated that local groundwater adjacent to the Injection Facilities area had not been impacted by Fort Ord legacy constituents (see also Todd Groundwater, 2015). No known groundwater contamination exists beneath the Injection Facilities area.

A search of the surrounding area including the downgradient Northern Coastal Subarea was conducted on the California Department of Toxic Substances Control (DTSC) *EnviroStor* web site (www.envirostor.dtsc.ca.gov) and the SWRCB *Geotracker* web site (http://geotracker.waterboards.ca.gov). The goal of the search was to identify any potential industrial sites or activities that could contribute to groundwater contamination from previous site uses, spills, and/or chemical releases. The focus was on downgradient areas where injection from the Project might mix, redirect, spread, or otherwise interfere with existing areas of groundwater contamination.

Both *EnviroStor* and *Geotracker* listed the 28,016-acre Fort Ord Military Reservation as an active Federal Superfund site and listed munitions as the contaminant of primary concern. Additionally, *Geotracker* identified two adjacent sites on the former Fort Ord lands as gasoline contamination sites: (1) the 14th Engineers Motor Pool and (2) Building 511. These are active sites currently undergoing investigations

[42] *See* October 10, 2016 email from Harvey Packard, RWQCB to MRWPCA staff.

[43] November 18, 2016 Technical Memorandum prepared by Todd Groundwater for MRWPCA, "Antidegradation Analysis in Support of Proposed AWTF Recycled Water Concentration Limits, Pure Water Monterey Groundwater Replenishment Project (Project)"

and are located about 1.8 miles to the northeast. However, both sites are outside of the Seaside Basin and are not a threat to groundwater in the Injection Facilities area.

Other environmental sites have been identified in the Seaside Basin, including numerous leaking underground storage tank sites, but none were in the Injection Facilities area or in areas expected to be impacted by the Project. Specifically, there were no environmental contaminant sites identified in the area between injection and downgradient extraction wells. The Project operation would not be expected to impact any contaminant plumes, if any, located outside of this area.

11.5. Dissolution of Existing Contaminants

As mentioned in **Section 9.4**, a field program conducted by M1W in 2013-2014 included sampling and analysis of sediment cores, pilot water, and groundwater to support geochemical modeling. Specifically, the analysis involved the following:

- solid core extraction and leaching test analyses,
- development and analysis of a bench-scale stabilized product water sample,
- solid core mineralogical analysis (x-ray diffraction and x-ray fluorescence),
- core bulk chemical analysis,
- cation exchange capacity,
- geochemical modeling of vadose zone leaching using PHREEQC geochemical models developed by USGS (Parkhurst and Appelo, 2-013) and
- groundwater quality impacts analyzed through groundwater sampling, geochemical plotting techniques, and PHAST, a Windows based reactive transport groundwater model.

The purpose of the modeling was to evaluate the potential for dissolution (leaching) of existing constituents in the vadose zone (beneath vadose zone wells) that could impact groundwater quality. The geochemical compatibility of the product water and groundwater was also evaluated.

Geochemical modeling was conducted with a series of PHREEQC and PHAST geochemical model codes by Mahoney Geochemical Consulting LLC, Lakewood, CO (See *Appendix G in* Todd Groundwater, February 2015); this report is provided as **Appendix D**. The modeling was used to analyze the potential for leaching of chromium, arsenic, and lead from the vadose zone sediments (including samples from the Aromas Sand and Paso Robles Aquifer).

Chemical analyses identified chromium present in vadose zone sands in trace amounts as part of the hydrous ferric oxide coating of the quartz sand grains. Geochemical modeling predicted that these trace amounts of chromium could de-sorb into solution. However, this leaching was concluded to be a transient initial effect due to the low amounts of chromium present in the formation and would not persistent on a long-term basis. Conservative geochmical modeling indicated that groundwater concentrations may reach a maximum of 4 ug/L prior to depletion of the chromium source and that drinking water standards would not be violated. Predicted concentrations were substantially below the total chromium MCL of 50 µg/L and the hexavalent chromium MCL of 10 µg/L.

Although arsenic and lead were also determined to be present in vadose zone sediments, those constituents were more strongly adsorbed to the oxides than chromium. Consequently, only small amounts are predicted to be released into solution as the injected water flows through the Aromas

Sand, resulting in sustained but low concentrations of about 4 µg/L for arsenic and approximately 0.7 µg/L for lead. Concentrations in the zone of saturation meet water quality standards. None of the analyses indicated that groundwater concentrations would exceed regulatory standards for any of the leached constituents.

Additional geochemical analyses indicated that aquifer clogging from calcite precipitation will be unlikely due to the low concentrations of calcium and bicarbonate. Extensive biofouling of injection wells was also evaluated and determined to be unlikely given that the low concentrations of nitrogen and phosphorus in the AWP Facility product water will not tend to stimulate microbial growth.

In addition to impacts from the vadose zone wells, the analysis examined the potential for impacts to the Santa Margarita Aquifer from recharge into deep injection wells. Results indicated that the potential for such impacts were unlikely. Risk of trace metal desorption during injection of recycled water into the Santa Margarita Formation was inferred from previous studies of injected Carmel River water. The two injected water types have similar pH and oxidation-reduction potential, and are therefore, expected to have similar effects with respect to adsorption/desorption processes. Previous studies found no indications that significant metal concentrations will be released into solution, and those results can reasonably be extended to injection of recycled water. Further, biofouling will not likely pose a problem for the injection wells because the injected water is very low in nitrogen and phosphorus and will not tend to stimulate microbial growth

None of the modeling results indicated that groundwater will be geochemically incompatible with product water or that the Project would have a significant impact on groundwater quality. Complete results of the geochemical analyses and modeling are presented in the draft report on the M1W field program (Todd Groundwater, 2015b) and also attached to this report as **Appendix I**.

11.6. Conclusions of the Project Impacts Assessment

Based on the groundwater characterization and pilot water quality presented in **Section 9.4**, and results from the M1W field program including geochemical modeling (described above), no significant impacts to quality are anticipated from the Project. Summary conclusions are offered below:

- Stabilized pilot plant water samples and projected AWP Facility product water meet Title 22 Criteria for groundwater replenishment projects and Basin Plan groundwater quality standards, including drinking water MCLs. Further, the treatment processes to be incorporated into the AWP Facility will be selected and operated to ensure that all water quality standards will be met in both the product water and groundwater. A monitoring program will document project performance.
- The product water will be stabilized at the AWP Facility to ensure no adverse geochemical impacts. Geochemical modeling associated with the M1W field program indicated that no adverse groundwater quality impacts are expected from leaching or other geochemical reactions.
- No documented groundwater contamination or contaminant plumes have been identified in the Injection Facilities area or downgradient between injection and groundwater extraction wells. Therefore, injection associated with the Project will not exacerbate existing groundwater contamination or cause plumes of contaminants to migrate.

Stabilized pilot plant water samples and projected AWP Facility product water exhibit much lower concentrations of TDS and chloride than in ambient groundwater and will be expected to provide a localized benefit to groundwater quality. Such a benefit will expand over time with continuous injection from the Project wells.

This Page Intentionally Left Blank

12. MONITORING AND REPORTING PROGRAM

The monitoring and reporting program (MRP) in this section will be used to demonstrate compliance with Title 22 Criteria, the Project's WDRs/WRRs (Order No. R3-2017-0003), and other regulations that apply to the use of product water for groundwater replenishment. This section has the following structure:

- General Provisions
- AWP Facility Influent Quality
- RO Performance
- AOP Performance
- Pathogenic Microorganism Reduction
- Recycled Water Policy Advanced Treatment Requirements
- Product Water Quality
- Groundwater Quality
- Project Reports

12.1. GENERAL MONITORING PROVISIONS

The MRP includes the following monitoring locations:

- AWP Facility influent (RTP secondary effluent)
- MF system
- RO feed
- RO permeate
- AOP feed
- AOP effluent
- AWP Facility effluent (product water) prior to injection
- Receiving groundwater

The Project Sponsor will ensure proper sampling and analyses by:

- Use of a laboratory that is DDW-approved, RWQCB-approved, SWRCB-approved or Environmental Laboratory Accreditation Program (ELAP)-certified for analyses of regulated constituents.
- Use of drinking water analytical methods for constituents with MCLs that are DDW-approved, as described in 40 CFR Part 141:
    - Analytical methods will be selected with MRLs lower than prescribed limitations or goals when practicable and feasible.
    - Calibration curves will be developed that include the MRL (or equivalent if there is a different treatment of samples relative to calibration standards) to avoid extrapolation beyond the lowest point of the calibration curve.
    - Allowable hold time limits as specified in 40 CFR Part 141 will be observed.
    - All QA/QC analyses will be completed on the same day samples are analyzed.

- Selection of the best available method for chemicals specified in the Title 22 Criteria without primary and secondary MCLs (listed in order of preference):
    - Drinking water method or waste-water method.
    - DDW-recommended methods.
    - Most sensitive of the U.S. EPA approved methods.
    - Most sensitive of the methods available from scientific literature and commercial laboratory (requires DDW-approval and RWQCB notification).
    - A method developed by the laboratory (requires DDW review/approval and RWQCB notification).
- Use of sample dilution between 1 and 800 for bacteria analyses.
- Use of analytical methods that achieve SWRCB-specified MRLs for CEC monitoring required by the Recycled Water Policy.
- Prescribing the month in which routine monitoring occurs:
    - All quarterly monitoring in January-March, April-June, July-September, and October-December
    - All semi-annual monitoring of product water in January-June and July-December
    - All semi-annual monitoring of groundwater in January-June and July-December
    - Should M1W need to deviate from these specified months, the RWQCB will be notified of the deviation and reason for deviation.
- Providing analytical results in the monitoring report submitted in accordance with MRP for the Project.
- M1W will notify public water systems and drinking water well owners having downgradient source potentially affected by the Project and within a 10-year travel time from the Project of the availability of monitoring reports. Notification will be by direct mail and/or electronic mail. Other parties interested in receiving copies of the reports must notify M1W in writing to be notified when the reports are available.

Reports produced as a part of the MRP will at a minimum include:

- Analytical results for sampling locations and compliance with permit requirements or conditions.
- Location of each sampling station.
- A summary of sampling protocols and chain of custody procedures.
- Identification of laboratories conducting analyses.
- Copies of the laboratories' certifications.
- Analytical test methods and corresponding reporting limits (MRLs) and method detection limits (MDLs).
- A summary of QA/QC measures, including chain of custody.
- MCL, NL, response level, DDW condition, and Recycled Water Discharge Limit.

12.2. AWP Facility Influent Quality Monitoring

AWP Facility influent is secondary-treated effluent from the RTP. The AWP Facility influent meets Title 22 Section 60320.201 requirements that specify the use of oxidized wastewater (a term defined in Title 22 Section 60301.650). RTP effluent is currently monitored in accordance with RWQCB Order

No. R3-2014-0013 (see **Appendix F**) and one of the routinely measured parameters is $CBOD_5$, which can serve as an indication of oxidized effluent. To date, all samples have consistently met effluent limits for $CBOD_5$, and the highest reported daily maximum value was 42 mg/L in December 2016 (below the 85 mg/L daily maximum effluent limit), when the solids contact was bypassed for maintenance. The influent sampling station is located before secondary treated water enters the AWP Facility and prior to hypochlorite addition. Influent samples will be obtained on the same day that effluent samples from the RO system are obtained. The date and time of sampling will be reported with the analytical values determined. **Table 12-1** constitutes the influent monitoring program.

Table 12-1: AWP Facility Influent Monitoring

Constituents	Units	Type of Sample	Monitoring Frequency[a]
Ammonia-N	mg/L	Grab	Weekly
$CBOD_5$	mg/L	24-Hour Composite	Weekly
Boron	mg/L	Grab	Weekly
Chloride	mg/L	24-Hour Composite	Weekly
Nitrate-N	mg/L	24-Hour Composite	Weekly
Nitrite-N	mg/L	24-Hour Composite	Weekly
Nitrogen-Total	mg/L	Grab	Weekly
pH	pH Units	Metered	Continuous[b]
Sodium	mg/L	24-Hour Composite	Weekly
Sulfate	mg/L	Grab	Weekly
Total Suspended Solids (TSS)	mg/L	24-Hour Composite	Weekly
Total Coliform	MPN/ 100 mL	Grab	Weekly
Total Dissolved Solids (TDS)	mg/L	24-Hour Composite	Weekly
Total Flow	mgd	Metered	Continuous
Total Kjeldahl Nitrogen-N	mg/L	Grab	Weekly
Total Nitrogen	mg/L	Grab	Weekly
Total Organic Carbon (TOC)	mg/L	24-Hour Composite[c]	Weekly
Turbidity	NTU	Metered	Continuous
UV Transmittance	%	Grab	Weekly

Source: WDRs/WRRs

a. After the first full year of monitoring, M1W will compile results and submit a revised monitoring program to DDW and the Central Coast Water Board for review and approval.

b. For those constituents that are continuously monitored, M1W will report the monthly minimum and maximum, and daily average values.

c. May change to grab after MWRPCA demonstrates that grab sampling is adequate.

12.3. RO Performance Monitoring

Per Title 22 Criteria, M1W is required to use indicators and/or surrogates to evaluate AWP unit process performance. To satisfy Title 22 Section 60320.201(b), RO feed and permeate, including the permeate of each train and stage, will be monitored continuously for EC using online meters. EC LRV is a surrogate that serves to monitor performance of the RO treatment process and provides an early warning of compromised integrity. Example critical, alarm, and shutdown setpoints are <1.0, ≤1.1, ≤1.05 EC LRV, respectively (see **Section 13** for details).

Reporting the effectiveness of the RO process will be in accordance with Title 22 Sections 60320.201(g) and (h). Within 60 days after the initial twelve months of full-scale operations, M1W will submit a report to DDW and RWQCB regarding RO performance based on EC LRV and any accounts of process failure(s) based on critical, alarm, and shutdown setpoints and corresponding corrective action(s) taken. Additionally, each quarter for the duration of the replenishment operation, M1W will provide the percentage of results that did not meet the EC operational limits. Since monitoring will be continuous, daily averages will be used for computation. M1W will submit a report to DDW and RWQCB that explains the corrective action(s) planned or taken to reduce the percent to less than 10% and consult with DDW and if required comply with an alternative monitoring plan approved by DDW.

12.4. AOP Performance Monitoring

UV/H_2O_2 AOP has been piloted multiple times by various agencies, including City of Los Angeles, Water Replenishment District of Southern California, OCWD, West Basin Municipal Water District, and City of San Diego. Since the Project is utilizing a previously piloted AOP option, it is not necessary to complete another pilot study for the Project. To satisfy Title 22 Section 60320.201(d) that a sufficient oxidation process has been implemented, M1W will work with DDW to develop and implement a DDW-approved test plan during the commissioning phase. The testing will be conducted at a UVT of 95% and with hydrogen peroxide doses ranging from 3.5 to 6 mg/L. The testing will be used to demonstrate 0.5-log 1,4-dioxane concentration reduction and select surrogate(s) and/or operational parameter(s) that are capable of being monitored continuously, recorded, and have associated alarms that indicate treatment failure. Based on existing permitted subsurface application GRRPs (City of Los Angeles, Water Replenishment District of Southern California, and OCWD), the following surrogates and operational parameters may be considered:

- Total chlorine
- Free ammonia
- Total ammonia
- UV transmittance
- UV power usage
- UV intensity
- Electrical energy dose (EED)
- H_2O_2 dose
- Power per order of magnitude log removal (EE/O) based on UV dose
- UV dose

Reporting the effectiveness of the AOP process will be conducted in accordance with Title 22 Sections 60320.201(e) and (h). Within 60 days after the initial twelve months of full-scale operations, the M1W will submit a report to DDW and RWQCB regarding AOP performance based on selected surrogate(s) and/or operational parameter(s) during demonstration testing, as well as a description of any process failure(s) and corresponding corrective action(s) taken. Additionally, each quarter for the duration of the replenishment operation, M1W will calculate the percentage of results that did not meet the selected surrogate or operational parameter's operative limits to ensure AOP performance. If monitoring is continuous using online analyzers, daily averages will be used for computation. M1W will submit a report to DDW and RWQCB that explains the corrective action(s) planned or taken to reduce the percent to less than 10% and consult with DDW and if required, comply with an alternative monitoring plan approved by DDW.

12.5. Pathogenic Microorganism Reduction Monitoring

For the purpose of evaluating the performance of the treatment facilities/units with regards to pathogenic microorganism reduction (see **Section 5**), M1W will include the results of the monitoring specified in **Table 12-2** in its compliance monitoring reports.

Table 12-2: Pathogenic Microorganism Control Compliance Monitoring

Unit Process	Integrity Measure	Monitoring Frequency	Reporting	
			Pass	Assumption
MF	Pressure decay LRV and filtrate turbidity	Once every 24 hours of operation and continuous[c]	≥4.0[a] log ≤0.2 NTU[e]	MF is providing credited log reductions
RO	Strontium, TOC, or EC LRV reduction[b]	Grab and continuous[c]	≥1.0 log	RO is providing credited log reductions
AOP	Calculated UV dose[d]	Continuous[c]	≥300 mJ/cm^2	AOP is providing credited log reductions

a. Pressure decay rate value with an ending pressure that provides a resolution of 3 microns or less.
b. Daily EC reduction = -log($EC_{RO\ Permeate}$/$EC_{RO\ Feed}$). More information on the three-surrogate approach for integrity monitoring is provided in Section 5.
c. Since monitoring will be continuous using online analyzers, daily averages will be used for computation.
d. The UV reactor outputs a calculated UV Dose using online measurements of AOP feed flow rate, UV transmittance, and UV intensity. The dose equation or validation report will be provided after performance testing during start-up. A UV dose of 236 mJ/cm^2 is estimated for 6 log removal of enteric virus based on USEPA UV doses required for log removals of 4 and less; accordingly, 300 mJ/cm^2 is proposed as a conservative target for pathogen control.
e. Less than or equal to 0.2 NTU 95% of the time within a 24-hour period and less than 0.5 NTU all the time.

To satisfy on-going compliance of pathogenic microorganism control at the AWP Facility per Title 22 Section 60320.208(c), M1W will administer and monitor MF pressure decay tests, EC reduction through RO, and UV and H_2O_2 dose delivered through AOP. The log reduction achieved through the entire system will be determined each day and reported as "yes" if required log reductions were achieved or "no" if not achieved. If any of the three components (MF, RO, and AOP) do not pass, response measures specified in Title 22 Sections 60320.208(h) and (i) will be launched. Within 24 hours of becoming aware of the issue, M1W will immediately investigate potential cause(s) and take corrective action(s). The DDW and RWQCB will be notified immediately if the AWP Facility fails to meet pathogen reduction criteria longer than four consecutive hours, or more than a total of eight hours during any seven-day period. Failures of shorter duration will be reported to the RWQCB no later than ten days after the month in which failure occurred. If the calculated overall log reduction drops below 10-logs for enteric virus, or 8-logs for *Giardia* cysts or *Cryptosporidium* oocysts, M1W will immediately notify DDW and RWQCB, and discontinue application of product water for injection, unless directed otherwise by DDW or RWQCB.

12.6. Recycled Water Policy Advanced Treatment Requirements

The 2018 Recycled Water Policy Amendment requires monitoring for RO and AOP performance for subsurface application projects. These measures include bioanalytical screening and monitoring for CECs including performance indicators, surrogates, and health-based indicators. Monitoring shall be performed after treatment at a location prior to release into the aquifer. In addition, performance indicator CECs and surrogates shall be monitored prior to treatment by RO. The purpose of this is to evaluate performance and integrity of the RO and AOP processes, and to monitor CECs that are of toxicological relevance to human health. Monitoring must be conducted by a three-phased approach, which includes an initial assessment monitoring phase, followed by a baseline monitoring phase, and then a standard operation monitoring phase.

Prior to the initial assessment monitoring phase, M1W will develop and submit a Quality Assurance Project Plan (QAPP) for monitoring CECs using Guidance for Quality Assurance Project Plans, EPA QA/G-5 (EPA/240/R-2/009, 2002) to the SWRCB. QAPP will be updated annually if changes are made to the monitoring procedures. M1W will follow the Recycled Water Policy Amendment requirements for the selection of analytical methods and laboratories:

"Laboratories shall use analytical methods that have been validated and approved for the analytes in the applicable matrix and can achieve the reporting limits in Table 1 and Table 3 [of the Policy Amendment]. This includes methods that have been approved by U.S. EPA, the Standards Methods Committee, the American Society for Testing and Materials International, or other methods that have been validated and approved by the regional water boards or State Water Board for the analytes in the applicable matrix."

"A laboratory providing analyses of CECs and bioanalytical screening must hold a valid certificate of accreditation from the State of California Environmental Laboratory Accreditation Program (ELAP) for the analytical test methods or analytes selected, if such methods or analytes are accredited by ELAP at the time that monitoring is required to begin. If ELAP accreditation for analytical test methods or an analyte becomes available after monitoring is initiated, then the laboratory providing analysis of CECs shall be accredited by ELAP for those methods or analytes within one year of such accreditation becoming available. If ELAP accreditation is unavailable for a method or an analyte, the recycled water producer shall use a laboratory that has been accredited for a similar analytical method, instrumentation, or analyte until ELAP accreditation becomes available, unless otherwise approved by the regional water board or State Water Board for bioanalytical screening tools."

12.6.1. Initial Assessment Monitoring Phase

The Initial Assessment Monitoring phase will have a duration of one year. This phase is used to: (1) identify the occurrence of health-based CECs, performance indicator CECs, and surrogates in recycled water for groundwater recharge; (2) determine treatment effectiveness; (3) define the project specific performance indicator CECs and surrogates to monitor during the baseline monitoring phase; (4) specify the expected removal percentages for performance indicator CECs and surrogates; and (5) gather bioactivity data for ER-α and AhR bioanalytical screening tools to determine the range of responses for the bioassays for standardized water quality monitoring. During this phase, the Policy requires the bioanalytical screening and monitoring requirements shown in **Table 12-3**. M1W will use EC and TOC as performance surrogates.

Table 12-3: Initial Assessment Monitoring Phase Requirements

Analyte	Type of Sample	Minimum Frequency of Analysis[a]	Reporting Limit (µg/L)	Monitoring Locations	
				Prior to RO	Following Treatment Prior to Well Injection
Performance Indicator and Health-based CECs					
1,4-Dioxane	Grab	Quarterly	0.1		X
N-Nitrosodimethylamine (NDMA)	Grab	Quarterly	0.002	X	X
N-Nitrosomorpholine (NMOR)	Grab	Quarterly	0.002		X
Perfluorooctane sulfonate (PFOS)	Grab	Quarterly	0.0065		X
Perfluorooctanoic acid (PFOS)	Grab	Quarterly	0.007		X
Sucralose	Grab	Quarterly	0.1	X	
Sulfamethoxazole	Grab	Quarterly	0.01	X	X
Surrogates					
Electrical Conductivity	Online	Continuous	--	X	X
Total Organic Carbon (TOC)	24-hour composite	Weekly	--	X	X
Bioanalytical screening tools					
Estrogen reporter-α (ER-α)	--	Quarterly	0.5		X
Aryl hydrocarbon receptor (AhR)	--	Quarterly	0.5		X

a. More frequent monitoring may be required to respond to a concern per Attachment A. Section 4.1 of the Policy Amendment.

12.6.2. Baseline Monitoring Phase

Upon completion of the one-year Initial Assessment Phase, the Baseline Monitoring Phase will begin, which lasts one year for the bioanalytical screening tools and three years for all others. The purpose of the baseline monitoring phase is to: (1) gather occurrence data for health-based CECs; (2) evaluate performance indicator CECs and surrogates and determine treatment effectiveness; (3)

gather bioactivity data for ER-α and AhR bioanalytical screening tools and pilot test the framework for response actions; and (4) assess the list of health-based CECs, performance indicator CECs, surrogates, and bioanalytical screening tools and identify an appropriate list of constituents to monitor the removal of CECs and treatment system performance in the standard operation monitoring phase of a water recycling treatment plant.

Table 12-4: Baseline Monitoring Phase Requirements

Analyte	Type of Sample	Minimum Frequency of Analysis[a]	Reporting Limit (µg/L)	Monitoring Locations	
				Prior to RO	Following Treatment Prior to Well Injection
Performance Indicator and Health-based CECs					
1,4-Dioxane	Grab	Semi-Annually	0.1		X
N-Nitrosodimethylamine (NDMA)	Grab	Semi-Annually	0.002	X	X
N-Nitrosomorpholine (NMOR)	Grab	Semi-Annually	0.002		X
Perfluorooctane sulfonate (PFOS)	Grab	Semi-Annually	0.0065		X
Perfluorooctanoic acid (PFOS)	Grab	Semi-Annually	0.007		X
Sucralose	Grab	Semi-Annually	0.1	X	
Sulfamethoxazole	Grab	Semi-Annually	0.01	X	X
Surrogates					
Electrical Conductivity	Online	Continuous	--	X	X
Total Organic Carbon (TOC)	24-hour composite	Weekly	--	X	X
Bioanalytical screening tools					
Estrogen reporter-α (ER-α)	--	Quarterly	0.5		X
Aryl hydrocarbon receptor (AhR)	--	Quarterly	0.5		X

a. More frequent monitoring may be required to respond to a concern per Attachment A. Section 4.2 of the Policy Amendment.

12.6.3. Standard Operation Monitoring Phase

After the three-year Baseline Monitoring Phase, monitoring would shift to Standard Operating Monitoring, where per the Policy, the monitoring frequencies for the CEC indicators can be semi-annually or annually. The purpose of the standard operation monitoring phase is to monitor CECs under standard operating conditions at a water recycling treatment plant. For the Standard Operating period, the constituents and monitoring frequencies shown in **Table 12-5** will be used. For all monitoring phases, should a CEC indicator not be present at sufficient concentrations to use for performance assessments, M1W will consult with DDW and RWQCB on other potential options.

Table 12-5: Standard Operation Monitoring Phase Requirements

Analyte	Type of Sample	Minimum Frequency of Analysis[a]	Reporting Limit (µg/L)	Monitoring Locations	
				Prior to RO	Following Treatment Prior to Well Injection
Performance Indicator and Health-based CECs[b]					
1,4-Dioxane	Grab	Semi-Annually	0.1		X
N-Nitrosodimethylamine (NDMA)	Grab	Semi-Annually	0.002	X	X
N-Nitrosomorpholine (NMOR)	Grab	Semi-Annually	0.002		X
Perfluorooctane sulfonate (PFOS)	Grab	Semi-Annually	0.0065		X
Perfluorooctanoic acid (PFOS)	Grab	Semi-Annually	0.007		X
Sucralose	Grab	Semi-Annually	0.1	X	
Sulfamethoxazole	Grab	Semi-Annually	0.01	X	X
Surrogates					
Electrical Conductivity	Online	Continuous	--	X	X
Total Organic Carbon (TOC)	24-hour composite	Weekly	--	X	X
Bioanalytical screening tools					
Estrogen reporter-α (ER-α)	--	Semi-Annually	0.5		X
Aryl hydrocarbon receptor (AhR)	--	Semi-Annually	0.5		X

a. More frequent monitoring may be required to respond to a concern per Attachment A. Section 4.3.1.6 of the Policy Amendment.
b. If project demonstrates consistency in treatment effectiveness in removal of CECs, treatment operational performance, and appropriate recycled water quality, the monitoring can be conducted annually.

12.6.4. Evaluation of Bioanalytical Screening Tools and Monitoring Results for CECs

The effectiveness of the RO and RO/AOP processes using the surrogates and performance indicator CECs will be reported as percent removal of the measured parameter:

$$\text{Percent Removed} = ([X_{in} - X_{out}]/X_{in})\ (100)$$

During all phases, removal percentages for CEC indicators and the surrogates will be determined and will be included in the MRP monitoring reports. Should the percentages change significantly over time, M1W will evaluate any reasons for the change(s) and consult with DDW and RWQCB on response actions.

The measured environmental concentrations (MECs) of Health-based CECs will be compared to their respective monitoring trigger levels (MTLs) as shown in **Table 12-6** to determine MEC/MTL ratios. These ratios will be compared to the thresholds shown in **Table 12-7** to identify and implement appropriate responses.

Table 12-6: Monitoring Trigger Levels for Health-based CECs

Analyte	MTL (µg/L)
1,4-Dioxane	1
NDMA	0.010
NMOR	0.012
PFOS	0.013
PFOA	0.014

Table 12-7: MEC/MTL Thresholds and Response Actions for Health-based CECs

MEC/MTL Thresholds	Response Action[1]
If greater than 75% of the MEC/MTL ratio results for a CEC are less than or equal to 0.1 during the baseline monitoring phase and/or subsequent monitoring	A) After completion of the baseline monitoring phase, consider requesting removal of the CEC from the monitoring program.
If MEC/MTL ratio is greater than 0.1 and less than or equal to 1	B) Continue to monitor.
If MEC/MTL ratio is greater than 1 and less than or equal to 10	C) Check the data. Continue to monitor.
If MEC/MTL ratio is greater than 10 and less than or equal to 100	D) Check the data, resample within 72 hours of notification of the result and analyze to confirm CEC result. Continue to monitor.
If MEC/MTL ratio is greater than 100	E) Check the data, resample within 72 hours of notification of the result and analyze to confirm CEC result. Continue to monitor. Contact the regional water board and the State Water Board to discuss additional actions. (Additional actions may include, but are not limited to, additional monitoring, toxicological studies, engineering removal studies, modification of facility operation, implementation of a source identification program, and monitoring at additional locations.)

[1] If a CEC also has a notification level, additional follow-up monitoring may be required by the State Water Board or regional water board per requirements in California Code of Regulations, title 22.

Bioanalytical equivalent concentrations (BEQs) will be compared to their respective MTLs shown in **Table 12-8**. Resultant BEQ/MTL ratios will be compared to thresholds shown in **Table 12-9** and appropriate response actions will be implemented, accordingly.

Table 12-8: Monitoring Trigger Levels for Bioanalytical Screening Tools

Constituent/Parameter	MTL (ng/L)
Estrogen reporter-α (ER-α)	3.5
Aryl hydrocarbon receptor (AhR)	0.05

Table 12-9: MEC/MTL Thresholds and Response Actions for Bioanalytical Screening Tools

BEQ/MTL Threshold	Response Action
If BEQ/MTL ratio is consistently less than or equal to 0.15 for ER-α or 1.0 for AhR	A) After completion of the baseline monitoring phase, consider decreasing monitoring frequency or requesting removal of the endpoint from the monitoring program.
If BEQ/MTL ratio is greater than 0.15 and less than or equal to 10 for ER-α or greater than 1.0 and less than or equal to 10 for AhR	B) Continue to monitor.
If BEQ/MTL ratio is greater than 10 and less than or equal to 1000	C) Check the data, resample within 72 hours of notification of the result and analyze to confirm bioassay result. Continue to monitor. Contact the regional water board and State the Water Board to discuss additional actions, which may include, but are not limited to, targeted analytical chemistry monitoring, increased frequency of bioassay monitoring, and implementation of a source identification program.
If BEQ/MTL ratio is greater than 1000	D) Check the data, resample within 72 hours of notification of the result and analyze to confirm bioassay result. Continue to monitor. Contact the regional water board and the State Water Board to discuss additional actions, which may include, but are not limited to, targeted and/or non-targeted analytical chemistry monitoring, increased frequency of bioassay monitoring, toxicological studies, engineering removal studies, modification of facility operation, implementation of a source identification program, and monitoring at additional locations.

Results will be included in monitoring reports submitted to DDW and RWQCB. In accordance with Title 22 Section 60320.220(e), a chemical or contaminant detected as a result of this monitoring effort will be reported to DDW and RWQCB no later than the quarter following the quarter in which the results are received by M1W.

12.7. PRODUCT WATER – WATER QUALITY COMPLIANCE

Product water will be monitored for compliance purposes to ensure protection of public health and beneficial uses of groundwater. Process control parameters will also be monitored to facilitate operations of the AWP Facility (discussed in **Section 13**). For regulatory compliance, the product water will be monitored for:

- Compliance parameters defined in the Title 22 Criteria and WDR/WRR for:
    - Coliform bacteria
    - Total nitrogen
    - Regulated contaminants and physical characteristics
    - TOC
    - Additional monitoring requirements
        - Priority Pollutants
        - DDW-specified chemicals based on review of Engineering Report, affected groundwater basin, and source control assessments
- Recycled Water Policy health-based CECs
- Basin Plan water quality objectives
- Acutely toxic parameters monitored as a part of RRT response process (these are a subset of the regulated contaminants)

For each of the categories above, the monitoring frequency, sample type, and applicable regulations vary. The monitoring is presented in **Table 12-10**. After the first full year of monitoring, M1W will compile results and submit a revised monitoring program to DDW and the Central Coast Water Board for review and approval.

Table 12-10: Product Water Compliance Monitoring Program

Constituents[a]	Units	Type of Sample	Monitoring Frequency
Conductivity	µmho/cm	Metered	Continuous[b]
Total chlorine residual	mg/L	Metered	Continuous
Total recycled water flow	mgd	Metered	Continuous
UV dose for each reactor	mJ/cm^2	Metered	Continuous
UV transmittance at UV influent	%	Metered	Continuous
pH	pH units	Metered	Continuous
Arsenic	µg/L	Grab	Monthly
Boron	µg/L	Grab	Monthly
Chloride	mg/L	Grab	Monthly
Chromium – total	µg/L	Grab	Monthly
Total nitrogen[c]	mg/L	Grab	At least two samples per week at least 3 days apart
Nitrate-N	mg/L	Grab	Weekly
Total Kjeldahl nitrogen-N	mg/L	Grab	Weekly
Sodium	mg/L	Grab	Monthly
Sulfate	mg/L	Grab	Monthly
Total dissolved solids (TDS)	mg/L	Grab	Monthly
Total coliform	MPN/100 mL	Grab	Daily
Total organic carbon (TOC)	mg/L	24-hour composite[d]	Weekly
Turbidity	NTU	Metered	Continuous
Inorganics with primary MCLs	Varies	Grab	Monthly
Constituents/parameters with secondary MCLs	Varies	Grab	Monthly
Radioactivity	Varies	Grab	Monthly
Regulated organic chemicals	µg/L	Grab	Monthly
Disinfection byproducts	µg/L	Grab	Monthly
General physical	Varies	Grab	Quarterly
General minerals	µg/L	Grab	Quarterly
Constituents with notification levels	µg/L	Grab	Monthly
Remaining priority pollutants	µg/L	Grab	Quarterly
Constituents of Emerging Concern (CECs)	ng/L	Grab	Varies
Surrogates	Varies	Varies	Varies
Lead and copper	mg/L	Grab	Quarterly

Source: WDR/WRR

a. After the first full year of monitoring, M1W will compile results and submit a revised monitoring program to DDW and the Central Coast Water Board for review and approval.

b. For those constituents that are continuously monitored, the daily minimum, maximum, and average values will be reported.

c. If no problem is detected, analysis of nitrogen can be reduced to weekly after 12 months of data collection.

d. May change to grab after M1W demonstrates that grab sampling is adequate.

12.7.1. Nitrogen Compounds

To satisfy Title 22 Section 60320.210, M1W will collect grab samples from the product water prior to subsurface application for total nitrogen analysis. Total nitrogen is the sum of ammonia, nitrite, nitrate, and organic nitrogen concentrations. The sample will be collected semi-weekly with at least a 3-day gap between sampling events. The laboratory will be required to complete the analysis within 72 hours and report findings within 72 hours if the concentration exceeds 10 mg /L as N.

If the average of two consecutive measurements exceeds 10 mg /L as N, M1W will:

- Collect a confirmation sample
- Notify DDW and RWQCB within 48 hours of being notified of the results by the laboratory
- Investigate the cause of exceedance and take corrective action to avoid further exceedances
- Initiate additional monitoring as described in the OOP

If the average of four consecutive measurements exceeds 10 mg /L as N, M1W will suspend subsurface application of product water until corrective actions have been taken and at least two consecutive measurements are less than 10 mg /L as N.

The semi-weekly sampling frequency may be reduced if M1W, using the most recent twelve months of data, is able to show that (1) the average of all results does not exceed 5 mg /L as N and (2) the average of a result and its confirmation sample (taken within 24 hours of receipt of the initial result) did not exceed 10 mg /L as N. However, if both of these conditions are not maintained, M1W will revert to the original monitoring frequency and reduced frequency will not resume unless both conditions are met. M1W requests that when the Title 22 conditions are met, that the MRP allow for the RWQCB Executive Officer to reduce the monitoring frequency by letter, with the caveat that the original frequency must resume if the conditions are not met.

12.7.2. Regulated Contaminants and Physical Characteristics

To satisfy Title 22 Section 60320.201 and 60320.212 and the WDRs/WRRs, M1W will assess product water monthly for all constituents with MCLs and NLs (with the exception of nitrogen which is addressed by special provisions) to confirm that the product water meets regulatory levels (see **Table 12-11**, **12-12**, **12-13**, **12-14**, **12-15**, and **12-16**). After 12 consecutive months with no results exceeding an MCL or NL, M1W can apply for a reduced monitoring frequency, not less than quarterly. M1W will also sample for general physical and general minerals (see **Table 12-17**).

Table 12-11: Primary Maximum Contaminant Levels for Inorganic Chemicals

Analyte	Units	Primary MCL
Aluminum	mg/L	1.0
Antimony	mg/L	0.006
Arsenic	mg/L	0.01
Asbestos	MFL for fibers exceeding 10 microns in length	7
Barium	mg/L	1.0
Beryllium	mg/L	0.004
Cadmium	mg/L	0.005
Chromium	mg/L	0.05
Cyanide	mg/L	0.15
Fluoride	mg/L	2.0
Chromium (Total)	mg/L	0.05
Mercury	mg/L	0.002
Nickel	mg/L	0.1
Nitrate (as N)	mg/L	10
Nitrite (as N)	mg/L	1
Nitrate + Nitrite	mg/L	10
Perchlorate	mg/L	0.006
Selenium	mg/L	0.05
Thallium	mg/L	0.002

Source: Title 22 Section 64431 and the WDR/WRR

Table 12-12: Maximum Contaminant Levels for Radionuclides

Analyte	Unit	MCL
Radium-226 and Radium-228	pCi/L	5
Gross alpha particle activity (including radium-226 but excluding radon and uranium)	pCi/L	15
Uranium	pCi/L	20
Gross beta particle activity	**millirem/year**	**4**
Strontium-90	**pCi/L**	**8**
Tritium	**pCi/L**	**20,000**

Source: Title 22 Sections 64442 and 64443 and the WDR/WRR

Table 12-13: Maximum Contaminant Levels for Organic Chemicals

Analyte	Units	Primary MCL
a) Volatile Organic Chemicals		
Benzene	mg/L	0.001
Carbon Tetrachloride	mg/L	0.0005
1,2-Dichlorobenzene	mg/L	0.6
1,4-Dichlorobenzene	mg/L	0.005
1,1-Dichloroethane	mg/L	0.005
1,2-Dichloroethane	mg/L	0.0005
1,1-Dichloroethylene	mg/L	0.006
cis-1,2-Dichloroethylene	mg/L	0.006
trans-1,2-Dichloroethylene	mg/L	0.01
Dichloromethane	mg/L	0.005
1,2-Dichloropropane	mg/L	0.005
1,3-Dichloropropene	mg/L	0.0005
Ethylbenzene	mg/L	0.3
Methyl-*tert*-butyl ether	mg/L	0.013
Monochlorobenzene	mg/L	0.07
Styrene	mg/L	0.1
1,1,2,2-Tetrachloroethane	mg/L	0.001
Tetrachloroethylene	mg/L	0.005
Toluene	mg/L	0.15
1,2,4-Trichlorobenzene	mg/L	0.005
1,1,1-Trichloroethane	mg/L	0.200
1,1,2-Trichloroethane	mg/L	0.005
Trichloroethylene	mg/L	0.005
Trichlorofluoromethane	mg/L	0.15
1,1,2-Trichloro-1,2,2-Trifluoroethane	mg/L	1.2
Vinyl Chloride	mg/L	0.0005
Xylenes (m,p)	mg/L	1.750
b) Synthetic Organic Chemicals (SOCs)		
Alachlor	mg/L	0.002
Atrazine	mg/L	0.001
Bentazon	mg/L	0.018
Benzo(a)pyrene	mg/L	0.0002
Carbofuran	mg/L	0.018
Chlordane	mg/L	0.0001
Dalapon	mg/L	0.2
1,2-Dibromo-3-chloropropane (DBCP)	mg/L	0.0002
2,4-Dichlorophenoxyacetic acid (2,4-D)	mg/L	0.07
Di(2-ethylhexyl)adipate	mg/L	0.4
Di(2-ethylhexyl)phthalate	mg/L	0.004
Dinoseb	mg/L	0.007
Diquat	mg/L	0.02
Endothall	mg/L	0.1
Endrin	mg/L	0.002
Ethylene Dibromide	mg/L	0.00005
Glyphosate	mg/L	0.7
Heptachlor	mg/L	0.00001

Analyte	Units	Primary MCL
Heptachlor Epoxide	mg/L	0.00001
Hexachlorobenzene	mg/L	0.001
Hexachlorocyclopentadiene	mg/L	0.05
Lindane	mg/L	0.0002
Methoxychlor	mg/L	0.03
Molinate	mg/L	0.02
Oxamyl	mg/L	0.05
Pentachlorophenol	mg/L	0.001
Picloram	mg/L	0.5
Polychlorinated Biphenyls	mg/L	0.0005
Simazine	mg/L	0.004
Thiobencarb	mg/L	0.07
Toxaphene	mg/L	0.003
1,2,3-Trichloropropane	mg/L	0.000005
2,3,7,8-TCDD (Dioxin)	mg/L	$3x10^{-8}$
2,4,5-TP (Silvex)	mg/L	0.05

Source: Title 22 Section 64444 and the WDR/WRR

Table 12-14: Maximum Contaminant Levels for Disinfection Byproducts

Analyte	Units	MCL
Total trihalomethanes (TTHM)	mg/L	0.080
Bromodichloromethane		
Bromoform		
Chloroform		
Dibromochloromethane		
Haloacetic acids (five) (HAA5)	mg/L	0.060
Monochloroacetic Acid		
Dichloroacetic Acid		
Trichloroacetic Acid		
Monobromoacetic Acid		
Dibromoacetic Acid		
Bromate	mg/L	0.010
Chlorite	mg/L	1.0

Source: Title 22 Section 64533 and the WDR/WRR

Table 12-15: Action Levels for Lead and Copper

Analyte	Unit	Action Level
Lead	mg/L	0.015
Copper	mg/L	1.3

Source: Title 22 Section 64678 and the WDR/WRR

Table 12-16: Secondary Maximum Contaminant Levels and Upper Limits for Consumer Acceptance

Analyte	Units	MCL/Upper Limit
Secondary MCL		
Aluminum	mg/L	0.2
Color	Units	15
Copper	mg/L	1.0
Foaming Agents (MBAS)	mg/L	0.5
Iron	mg/L	0.3
Manganese	mg/L	0.05
Methyl-*tert*-butyl ether (MTBE)	mg/L	0.005
Odor - Threshold	Units	3
Silver	mg/L	0.1
Thiobencarb	mg/L	0.001
Turbidity	NTU	5
Zinc	mg/L	5.0
Upper Limit		
Total Dissolved Solids	mg/L	1,000
Specific Conductance	µS/cm	1,600
Chloride	mg/L	500
Sulfate	mg/L	500

Source: Title 22 Section 64449

Pursuant to Title 22 Section 60320.212(d), if parameters with primary MCLs or action levels exceed their corresponding MCL or action level, M1W will collect and submit a confirmation sample within 72 hours of being notified of results by the laboratory.

For a contaminant whose compliance with its MCL or action level is not based on a running annual average, if the average of the initial and confirmation sample exceeds the contaminant's MCL or action level, or the confirmation sample is not collected and analyzed, MWRPCA will notify DDW and RWQCB within 24 hours and initiate weekly monitoring until four consecutive weekly results are below the contaminant's MCL or action level. If the running four-week average exceeds the contaminant's MCL or action level, M1W will notify DDW and RWQCB within 24 hours and, if directed by DDW or RWQCB, suspend application of the product water for subsurface application.

For a contaminant whose compliance with its MCL is based on a running annual average, if the average of the initial and confirmation sample exceeds the contaminant's MCL, or a confirmation sample is not collected and analyzed, M1W will initiate weekly monitoring for the contaminant until the running four-week average no longer exceeds the contaminant's MCL. If the running four-week average exceeds the contaminant's MCL, M1W will describe the reason(s) for the exceedance and provide a schedule for completion of corrective actions in a report submitted to DDW and RWQCB no later than 45 days following the quarter in which the exceedance occurred. If the running four-week average exceeds the contaminant's MCL for sixteen consecutive weeks, M1W will notify DDW and RWQCB within 48 hours of knowledge of the exceedance and, if directed by DDW or RWQCB, suspend application of the product water for subsurface application.

Table 12-17: General Physical & General Minerals

Analyte		
Asbestos	Potassium	Foaming Agents
Calcium	Sodium	Odor
Chloride	Sulfate	Specific Conductance
Copper	Zinc	Total Dissolved Solids
Iron	Color	Total Hardness
Manganese	Corrosivity	-

Source: WDR/WRR

12.7.3. Total Organic Carbon

Pursuant to Title 22 Section 60320.218, M1W will sample the product water prior to subsurface application for TOC at least once a week. Twenty-four hour composite samples will be taken but grab samples may be used in lieu of 24-hour composite samples, if M1W demonstrates that a grab sample is representative of the water quality throughout a 24-hour period. The MRP allows for grab sampling to be effectuated pending DDW and RWQCB review if M1W demonstrates that a grab sample is representative for the purposes of demonstrating compliance with the Title 22 Criteria. The MRP allows for the change in sample type by written notification from the RWQCB Executive Officer.

TOC compliance is based on (1) a 20-week running average and (2) the average of the last four samples. These averages may not exceed 0.5 mg/L TOC.

If the 20-week running average exceeds 0.5 mg/L, M1W will:

- Immediately suspend replenishment operations until at least two consecutive samples taken three days apart are below 0.5 mg/L;
- Within seven days of suspension, notify the DDW and RWQCB; and
- Within 60 days of becoming aware of the original exceedance, submit a report to DDW and RWQCB with a description of the reason(s) for the exceedance and any corrective action(s) taken.

If the average of the last four samples exceeds 0.5 mg/L, M1W will:

- Within 60 days of becoming aware of the original exceedance, submit a report to DDW and RWQCB with a description of the reason(s) for the exceedance and any corrective action(s) taken.

Because the Project will be using a RWC of 1.0, meeting the TOC limits, as described above, will also serve as the method for evaluating RWC compliance.

12.7.4. Additional Chemicals and Contaminants

Pursuant to Title 22 Section 60320.220, additional monitoring requirements for the product water include:

- DDW-specified Priority Pollutants.

- DDW-specified chemicals based on a review of the Engineering Report, the affected groundwater basin, and any source control assessments.
- Contaminants with NLs.
- DDW- and RWQCB-specified indicator compounds.

These additional constituents to be monitored are shown in **Table 12-18** and **12-19**. If any parameters are detected as a part of this additional monitoring, M1W will notify the DDW and RWQCB no later than the quarter following the quarter in which results were obtained.

Some of the constituents in the list of Priority Pollutants are already monitored as part of the MCL monitoring effort. Thus, M1W will monitor the remaining Priority Pollutants shown in **Table 12-18** quarterly in the product water. For all of these constituents, M1W can reduce monitoring frequency to yearly based on DDW's review of the most recent two years of data. M1W requests that the MRP allow for the RWQCB Executive Officer to reduce the monitoring frequency by written notification, pending DDW review.

Table 12-18: Remaining Priority Pollutants

Analyte
Pesticides
Aldrin
Dieldrin
4,4'-DDT
4,4'-DDE
4,4'-DDD
Alpha-endosulfan
Beta-endosulfan
Endosulfan sulfate
Endrin aldehyde
Alpha-BHC
Beta-BHC
Delta-BHC
Acid Extractibles
2,4,6-trichlorophenol
P-chloro-m-cresol
2-chlorophenol
2,4-dichlorophenol
2,4-dimethylphenol
2-nitrophenol
4-nitrophenol
2,4-dinitrophenol
4,6-dinitro-o-cresol
Phenol
Metals
Chromium III
Base/Neutral Extractibles
Acenaphthene
Benzidine
Hexachloroethane

Analyte
Bis(2-chloroethyl)ether
2-chloronaphthalene
1,3-dichlorobenzene
3,3’-dichlorobenzidine
2,4-dinitrotoluene
2,6-dinitrotoluene
1,2-diphenylhydrazine
Fluoranthene
4-chlorophenyl phenyl ether
4-bromophenyl phenyl ether
Bis(2-chloroisopropyl)ether
Bis(2-chloroethoxyl)methane
Hexachlorobutadiene
Isophorone
Nitrobenzene
N-nitrosodi-n-propylamine
N-nitrosodiphenylamine
Bis(2-ethylhexyl)phthalate
Butyl benzyl phthalate
Di-n-butyl phthalate
Di-n-octyl phthalate
Diethyl phthalate
Dimethyl phthalate
Benzo(a)anthracene
Benzo(a)fluoranthene
Benzo(k)fluoranthene
Chrysene
Acenaphthylene
Anthracene
1,12-benzoperylene
Fluorene
Phenanthrene
1,2,5,6-dibenzanthracene
Indeno(1,2,3-cd)pyrene
Pyrene
Volatile Organics
Acrolein
Acrylonitrile
Chlorobenzene
Chloroethane
1,1-dichloroethylene
Methyl chloride
Methyl bromide
2-chloroethyl vinyl ether

Source: WDR/WRR

Table 12-19: Notification Levels

Analyte	Units	NL	Minimum Frequency of Analysis
Boron	mg/L	1	Monthly
n-Butylbenzene	mg/L	0.26	Monthly
sec-Butylbenzene	mg/L	0.26	Monthly
tert-Butylbenzene	mg/L	0.26	Monthly
Carbon disulfide	mg/L	0.16	Monthly
Chlorate	mg/L	0.8	Monthly
2-Chlorotoluene	mg/L	0.14	Monthly
4-Chlorotoluene	mg/L	0.14	Monthly
Diazinon	mg/L	0.0012	Monthly
Dichlorodifluoromethane (Freon 12)	mg/L	1	Monthly
1,4-Dioxane	mg/L	0.001	Monthly
Ethylene glycol	mg/L	14	Monthly
Formaldehyde	mg/L	0.1	Monthly
HMX	mg/L	0.35	Monthly
Isopropylbenzene	mg/L	0.77	Monthly
Manganese	mg/L	0.5	Monthly
Methyl isobutyl ketone (MIBK)	mg/L	0.12	Monthly
Naphthalene	mg/L	0.017	Monthly
N-Nitrosodiethylamine (NDEA)	mg/L	0.00001	Monthly
N-Nitrosodimethylamine (NDMA)	mg/L	0.00001	Monthly
N-Nitrosodi-n-propylamine (NDPA)	mg/L	0.00001	Monthly
Perfluorooctane sulfonate (PFOS)	mg/L	0.000013	Monthly
Perfluorooctanoic acid (PFOA)	mg/L	0.000014	Monthly
Propachlor	mg/L	0.09	Monthly
n-Propylbenzene	mg/L	0.26	Monthly
RDX	mg/L	0.0003	Monthly
Tertiary butyl alcohol (TBA)	mg/L	0.012	Monthly
1,2,4-Trimethylbenzene	mg/L	0.33	Monthly
1,3,5-Trimethylbenzene	mg/L	0.33	Monthly
2,4,6-Trinitrotoluene (TNT)	mg/L	0.001	Monthly
Vanadium	mg/L	0.05	Monthly

Source: WDR/WRR

If parameters with NLs exceed their corresponding NL, M1W will collect and submit a confirmation sample within 72 hours of being notified of results by the laboratory. If the average of the initial and confirmation sample exceeds the corresponding NL, M1W will initiate weekly monitoring until the running four-week average is below the NL. If the running four-week average exceeds the NL, M1W will submit a report to DDW and RWQCB no later than 45 days following the quarter in which exceedance occurred. The report will include a description of the reason(s) for exceedance and any corrective action(s) taken. If the running four-week average exceeds the NL for sixteen consecutive weeks, M1W will notify DDW and RWQCB within 48 hours of identifying this exceedance.

DDW and RWQCB may specify Indicator compounds that are monitored annually. The indicator compounds are selected based on the following:

- Review of the engineering report;
- Review of the inventory developed as a part of the wastewater source control program;
- Review of the groundwater basin;
- The ability of indicator compounds to characterize the presence of pharmaceuticals, endocrine disrupting chemicals, personal care products, and other indicators of the presence of municipal wastewater; and
- Availability analytical methodologies.

As previously discussed, the M1W industrial base is insignificant and there is no groundwater contamination in the Seaside Groundwater Basin. Per **Section 7.5.1**, the pilot testing looked at 92 CECs that were part of the analytical method used. Only a few CECs were detected in RO permeate as part of the pilot testing that were considered to be actual detections and not false positives: caffeine (a simulant), iohexal (a contrast agent), and albuterol (an asthma medication). All were detected at concentrations near the analytical method detection limit and it is unclear whether or not they were actual values. Moreover, all of these compounds are effectively removed by UV/AOP (i.e., exceeding 90% removal), and thus are very likely to be below levels of detection after UV/AOP. Thus, it is recommended that to satisfy Title 22 Section 60320.220(d) requirements for annual indicator monitoring, that the MRP focus on:

- The Recycled Water Policy performance-based and health-based CECs discussed in **Section 12.6**; and
- An annual scan of the product water using Eurofins Eaton Analytical Liquid Chromatography Tandem Mass Spectrometry method.

In accordance with Title 22 Section 60320.220(e), a chemical or contaminant detected as a result of this monitoring effort will be reported to DDW and RWQCB no later than the quarter following the quarter in which the results are received by M1W.

12.7.5. Basin Plan Specified Water Quality Objectives

The Central Coast RWQCB has designated beneficial uses of municipal and domestic supply, agricultural water supply, and industrial use for all groundwaters in the region including the Seaside Subbasin (covers the Seaside Groundwater Basin as used in this document). Water quality constituents include:

- Taste and odor (narrative objective)
- Radionuclides (Title 22, Chapter 15, Article 5, Section 64443 Table 4)
- Bacteria (coliform organisms)
- Organic Chemicals (Title 22, Chapter 15, Article 5.5, Section 64444.5, Table 5)
- Chemical Constituents (Title 22, Chapter 15, Article 4, Section 64435 Tables 2 and 3)
- Agricultural supply objectives (Basin Plan Tables 3-3 and 3-4)

Although the Central Coast RWQCB Basin Plan establishes specific mineral water quality objectives for some groundwater basins, no specific numeric objectives have been established in the Basin Plan for the Seaside Basin for these constituents other than those with primary and secondary MCLs, along with specific constituents for irrigation supply.

Routine and annual monitoring reports submitted to DDW and RWQCB will include any detections of the monitored chemicals or contaminants in the product water.

12.7.6. Disinfected Tertiary Recycled Water

The Project WDRs/WRRs (Order No. R3-2017-0003) includes monitoring requirements for MF filtrate turbidity and product water total coliform concentrations. The results will be reported to MCWD and recycled water delivery will be ceased if total coliform limits are exceeded or the operational specifications are exceeded for filter effluent turbidity.

12.8. GROUNDWATER MONITORING

New monitoring wells and a monitoring well program are incorporated into the Project to demonstrate ongoing project performance and to comply with the Title 22 Criteria. The objectives of the monitoring well program are to demonstrate compliance with the Title 22 and Basin Plan groundwater criteria and applicable state policies regarding protection of groundwater by:

- Siting one downgradient well with groundwater travel times (underground retention time) no less than two weeks and no more than six months from the injection wells (well also has to be greater than 30 days travel time from the nearest drinking water source).
- Siting an additional downgradient well between the Injection Facilities and the nearest downgradient potable water supply (in addition to the downgradient monitoring well used to demonstrate retention time).
- Monitoring groundwater levels and water quality; the well design will allow for sample collection from each aquifer receiving recycled water.
- Collecting baseline water quality samples prior to startup of the Project operation.

Monitoring wells will also be used to collect data as part of the tracer study (or studies) to demonstrate underground retention time for application to the pathogen reduction credit (**Section 5.3**) and the recommended RRT for the Project (**Section 6.5**).

12.8.1. Monitoring Well Locations and Design

Article 5.2 Section 60320.226 (Monitoring Well Requirements) of the Recycled Water Regulations states that at least two monitoring wells must be constructed downgradient of the Project for each aquifer receiving Project recharge water. The first monitoring well shall be located between 2 weeks and 6 months travel time from the Project; the second well shall be located between the first monitoring well and nearest drinking water well, and at least 30 days upgradient of the drinking water well. To comply with the recycled water recharge regulations and account for anticipated variable flowpaths to the nearest drinking water wells, M1W has installed four groundwater monitoring well clusters to monitor the two aquifers receiving injection. As shown on **Figure 12-1**, the monitoring wells are located between the injection wells (DIWs and VZWs) and the nearest drinking water wells to the west and northwest of the Injection Facilities Area. Each monitoring well cluster consists of a shallow monitoring well screened in the Paso Robles Aquifer (designated with the letter "S") and a deep monitoring well screened in the Santa Margarita Aquifer (designated by the letter "D"), for a total of eight (8) monitoring wells. Monitoring Well Cluster 1 (i.e., MW-1S and MW-1D) was installed in 2017 during Phase 1 construction, while the three other monitoring well clusters (MW-2S/2D, MW-1AS/1AD, and MW-2AS/2AD) were installed and developed in 2018/2019 during Phase 2 construction. Well construction details for the PWM injection and monitoring wells are provided in **Table 12-20**.

Figure 12-1
GWR Project
Monitoring Wells

Table 12-15 Summary of Pure Water Monterey Wells

Well Name	PWM Construction Phase	Well Type	Aquifer	Latitude	Longitude	Ground Elevation (feet msl)	Casing Diameter (inches)	Completion Date	Top of Screen (feet-bgs)	Bottom of Screen (feet-bgs)	Total Well Depth	Measurement Date	Depth to Water[1] (feet-bgs)	Static Water Level (feet-msl)
DIW-1	1	DIW	SM	36.618227	-121.814010	401	24	12/1/2017	530	810	830	12/4/2017	425	-24
DIW-2	2	DIW	SM	36.616571	-121.817082	361	24	1/21/2019	435	605	635	1/21/2019	376	-15
VZW-1A	2	VZW	Aromas	36.618229	-121.814298	398	14	to be constructed Mar-Apr 2019						
VZW-2	2	VZW	Aromas	36.616767	-121.816987	364	14	1/31/2019	28	98	98			
MW-1D	1	MW	SM	36.618315	-121.814318	398	4	6/1/2017	510	810	820	7/14/2017	421	-23
MW-2D	2	MW	SM	36.616824	-121.817066	362	4	7/1/2018	480	610	620	1/21/2019	373	-11
MW-1AD	2	MW	SM	36.619760	-121.814946	395	4	8/1/2018	610	870	880	9/20/2018	419	-24
MW-2AD	2	MW	SM	36.618247	-121.816827	365	4	7/1/2018	480	690	700	9/20/2018	390	-25
MW-1S	1	MW	PR	36.618276	-121.814298	398	4	6/1/2017	380	440	450	7/5/2017	399	-1
MW-2S	2	MW	PR	36.616796	-121.817027	363	4	7/1/2018	340	400	410	2/28/2019	374	-11
MW-1AS	2	MW	PR	36.619721	-121.814960	395	4	8/10/2018	380	460	470	9/20/2018	405	-10
MW-2AS	2	MW	PR	36.618228	-121.816782	365	4	8/24/2018	340	420	430	9/20/2018	375	-10

Notes:

Geographic coordinates are in North American Datum 1983

DIW = Deep Injection Well

VZW = Vadose Zone Well

MW = Monitoring Well

PR = Paso Robles Aquifer

SM = Santa Margarita Aquifer

Aromas = Aromas Sand Formation

feet-msl = feet above mean sea level

feet-bgs = feet below ground surface

Water quality samples from Project monitoring wells are being collected and analyzed for a comprehensive list of parameters to establish baseline (pre-injection) water quality conditions in the Paso Robles and San Margarita aquifers. The monitoring wells will continue to be sampled for the same comprehensive list of analytes at constituent-specific frequencies specified in the WDRs/WRRs. The proposed groundwater sampling plan for the intrinsic tracer test will be satisfied in part by the established Project groundwater monitoring requirements in the WDRs/WRRs.

Nearby Seaside Basin drinking water wells include MPWMD ASR-1 through ASR-4 (Santa Margarita Aquifer), Paralta (Paso Robles/Santa Margarita Aquifers), Ord Grove #2 (Paso Robles/Santa Margarita Aquifers), City of Seaside 3 and 4 (Paso Robles Aquifer), and Luzern (Paso Robles).

12.8.2. Monitoring Parameters and Sampling Frequency

A summary of the groundwater constituents and parameters incorporated into the MRP for groundwater monitoring is provided in **Table 12-21**. Details of specialized groundwater sampling protocols are also included in **Appendix G**.

As required by the regulations, monitoring wells will be sampled quarterly prior to project start-up. After one year of data collection, monitoring parameters will be re-assessed for inclusion in the groundwater quality monitoring program. Site-specific detections and concentrations in groundwater will be compared to other water quality data associated with product water and downgradient ambient groundwater. At that time, modifications to either parameters or the frequency of analysis may be requested for approval by DDW, as allowed by the regulations.

Table 12-21: Groundwater Monitoring Parameters

Constituents/Parameters[a]	Units	Type of Sample	Monitoring Frequency
Water level elevation[b]	Feet	Grab	Quarterly
Chlorine residual	mg/L	Grab	Quarterly
Chloride	mg/L	Grab	Quarterly
Nitrate-N	mg/L	Grab	Quarterly
Nitrite-N	mg/L	Grab	Quarterly
Nitrate plus Nitrite	mg/L	Grab	Quarterly
pH	pH units	Grab	Quarterly
Sodium	mg/L	Grab	Quarterly
Sulfate	mg/L	Grab	Quarterly
TOC	mg/L	Grab	Quarterly
Total Coliform	MPN/100 mL	Grab	Quarterly
BOD_5 20°C	mg/L	Grab	Semi-annually
Oil and Grease	mg/L	Grab	Quarterly
Total Nitrogen	mg/L	Grab	Quarterly
Total Suspended Solids	mg/L	Grab	Semi-annually
Turbidity	NTU	Grab	Quarterly
Inorganics with Primary MCLs[c]	Varies	Grab	Monthly
Constituents/parameters with Secondary MCLs[d]	Varies	Grab	Monthly
Fluoride	µg/L	Grab	Quarterly
Radioactivity[e]	Varies	Grab	Quarterly
Regulated Organics with MCLs[f]	µg/L	Grab	Quarterly
Disinfection By-Products[g]	µg/L	Grab	Quarterly
General Physical[h]	Varies	Grab	Monthly
General Minerals[h]	µg/L	Grab	Monthly
Chemicals with NLs[i]	µg/L	Grab	Quarterly
N-Nitrosopyrrolidine	µg/L	Grab	Annually
Remaining Priority Pollutants[j]	µg/L	Grab	Quarterly
Silver	mg/L	Grab	Quarterly

Source: WDR/WRR

a. After the first full year of monitoring, M1W will compile results and submit a revised monitoring program to DDW and the Central Coast Water Board for review and approval.
b. Water level elevations will be measured to the nearest 0.01 feet and referenced to mean sea level.
c. See constituents listed in **Table 12-11**.
d. See constituents listed in **Table 12-16.**
e. See constituents listed in **Table 12-12**.
f. See constituents listed in **Table 12-13**.
g. See constituents listed in **Table 12-14**.
h. See constituents listed in **Table 12-17**.
i. See constituents listed in **Table 12-19**.
j. See constituents listed in **Table 12-18**. The sampling frequency is quarterly with the exception of 4,4'-DDD, 4,4'-DDE, and 4,4-DDT, which are sampled annually.

12.8.3. Baseline Groundwater Quality Monitoring

As mentioned in **Section 2.1.1**, DDW requires baseline groundwater sampling prior to operating a GRRP with collection of at least four samples (one sample each quarter) from each potentially affected aquifer. These samples must be analyzed for the chemicals, contaminants, and characteristics specified in Sections 60320.210 (nitrogen compounds), 60320.212 (regulated constituents and physical characteristics), 60320.218 (total organic carbon or TOC), and 60320.220 (additional chemicals). The constituents are shown in **Table 12-22**. The baseline monitoring will address seasonal variability and sample all monitoring wells within 1-year travel time of the injection facilities twice to analyze for nitrogen compounds and secondary MCLs.

Table 12-22: Baseline Groundwater Monitoring Parameters

Constituents/Parameters[a]	Units	Type of Sample	Monitoring Frequency
Nitrate-N	mg/L	Grab	Quarterly
Nitrite-N	mg/L	Grab	Quarterly
Nitrate plus Nitrite	mg/L	Grab	Quarterly
TOC	mg/L	Grab	Quarterly
Total Nitrogen	mg/L	Grab	Quarterly
Lead	mg/L	Grab	Quarterly
Copper	mg/L	Grab	Quarterly
Inorganics with Primary MCLs[a]	Varies	Grab	Quarterly
Constituents/parameters with Secondary MCLs[b]	Varies	Grab	Quarterly
Radioactivity[c]	Varies	Grab	Quarterly
Regulated Organics with MCLs[d]	µg/L	Grab	Quarterly
Disinfection By-Products[e]	µg/L	Grab	Quarterly
General Physical[f]	Varies	Grab	Quarterly
Chemicals with NLs[g]	µg/L	Grab	Quarterly
Remaining Priority Pollutants[h]	µg/L	Grab	Quarterly

a. See constituents listed in **Table 12-11**.
b. See constituents listed in **Table 12-16.**
c. See constituents listed in **Table 12-12**.
d. See constituents listed in **Table 12-13**.
e. See constituents listed in **Table 12-14**.
f. See constituents listed in **Table 12-17**.
g. See constituents listed in **Table 12-19**.
h. See constituents listed in **Table 12-18**.

Baseline groundwater quality sampling has been ongoing since the third quarter of 2017 and will be continued through the second quarter of 2019 according to the schedule shown in **Table 12-23**.

Table 12-23: Baseline Groundwater Quality Sampling Schedule

Quarter		Santa Margarita DIW		Paso Robles Aquifer				Santa Margarita Aquifer			
				On-site Monitoring Wells		Off-site Monitoring Wells		On-site Monitoring Wells		Off-site Monitoring Wells	
		DIW-1	DIW-2	MW-1S	MW-2S	MW-1AS	MW-2AS	MW-1D	MW-2D	MW-1AD	MW-2AD
3rd	Jul-Sep 2017			X[a]				X[a]			
4th	Oct-Dec 2017	X[a]									
1st	Jan-Mar 2018										
2nd	Apr-Jun 2018			X[b]				X[b]			
3rd	Jul-Sep 2018					X[b,e]			X[b]	X[b,e]	X[b]
4th	Oct-Dec 2018		X[b]	X[c,e]			X[b,e]	X[c,e]		X[c,e]	X[c,e]
1st	Jan-Mar 2019			X[c,e]	[f]		X[d]	X[c,e]	X[d]	X[c,e]	X[c,e]
2nd	Apr-Jun 2019				[f]					X[c,e]	X[c,e]

a. Comprehensive analyte sampling as part of Phase 1 construction.

b. Comprehensive analyte sampling as part of Phase 2 construction.

c. Comprehensive sampling after Phase 2 Construction.

d. Additional sampling for Nitrogen compounds and secondary MCLs.

e. Includes PFOS and PFOA sampling.

f. Development of MW-2S has not been successful due to the thin occurrence of the Paso Robles Aquifer at this location and limited saturated thickness. No water quality samples have been collected from this MW-2S to-date. Based on predicted underground flowpaths of injected purified recycled water, monitoring well requirements for the Paso Robles Aquifer are satisfied by the three other shallow monitoring wells (MW-1S, MW-1AS, and MW-2AS). Additional discussion is provided in the "Anticipated Flowpaths/Travel Times of Recycled Water and ASR Influence in Project Monitoring Wells" section of the Draft Intrinsic Tracer Work Plan (Todd Groundwater, March 25, 2019).

12.9. PROJECT REPORTS

Routine and annual reports will be submitted in the appropriate electronic format using the SWRCB CIWQS program, and emailed to DDW as a PDF.[44] In addition, all groundwater monitoring data will be submitted to the GeoTracker database. The contents of the CIWQS and Geotracker Monitoring Reports will include a one-page summary of operational concerns that addresses changes in reporting conditions, including influent, recycled water, and groundwater monitoring results, since the last report. M1W will obtain Primary Station Codes (PSCodes), so all water quality results can be transmitted electronically to DDW via Electronic Data Transfer (EDT) as specified in **Table 12-24**. M1W will notify all downgradient public water systems and drinking water well owners of annual report availability by direct mail or electronic mail.[45]

Table 12-24: Timing for Obtaining PSCodes

Location	Timing to Obtain PSCodes from DDW
AWP Facility influent monitoring (secondary effluent from the RTP prior to the AWP Facility ozonation)	Once AWP Facility construction drawings are finalized
RO Feed	Once AWP Facility construction drawings are finalized
Combined RO permeate	Once AWP Facility construction drawings are finalized
UV/AOP system effluent	Once AWP Facility construction drawings are finalized
AWP Facility effluent (product water) prior to injection	Once AWP Facility construction drawings are finalized
Receiving groundwater (all wells)	Obtained from DDW in December 2018; all historical and new lab results transmitted via EDT

Reporting will be conducted as required by the Project WDRs/WRRs. Monthly reports will be submitted by the 15th day after the end of the month for which the monitoring occurred. Quarterly reports will be submitted on the 15th day of the second month following the end of each quarterly reporting monitoring period. Annual reports will be submitted by April 15th of each year.

Per Title 22 Section 60320.228(b), every five years from the date of approval of the Engineering Report, M1W must update the report and submit it to DDW and RWQCB. At a minimum, the update must include the following information:

- A description of how the RWC requirements will be met (in this case – TOC compliance);
- Evidence that the retention time for pathogen control and RRT have been met; and

[44] If the file exceeds one megabyte, a CD containing the file will be mailed to DDW.
[45] Public water systems and drinking water well owners with downgradient sources potentially affected by the recharge project and within ten years groundwater travel time from the Project injection wells.

- A description of any inconsistencies between previous groundwater model predictions and the observed and/or measured values, as well as a description of how subsequent predictions will be accurately determined.

In addition, M1W will provide an evaluation of the Project's ability to comply with all regulations and provisions over the previous five calendar years, and any changes to facilities, operations, or other pertinent Project elements/functions.

12.10. TRACER TEST PLANNING

Article 5.2 Section 60320.208(d) of the SWRCB Division of Drinking Water (DDW) Recycled Water Regulations states that a tracer test must be initiated prior to the end of the third month of Project operation to demonstrate the underground retention time of injected purified recycled water to the nearest drinking water well[46]. Results of the tracer test will serve as the basis for establishment of pathogen log reduction credits for underground retention time (and the response retention time) for the Project. The Recycled Water Regulations provide that for each month retained underground as validated by an added tracer test, the recycled water will be credited with a 1-log virus reduction, up to a maximum of 6-log reduction credits. The underground retention time from the tracer test shall be calculated based on the time from when the purified recycled water is injected to when either two percent (2%) of the initial tracer concentration has reached the downgradient monitoring point, or when ten percent (10%) of the peak tracer concentration observed in the downgradient monitoring point reaches the monitoring point[47]. With approval from the State Water Resources Control Board Division of Drinking Water (DDW), an intrinsic tracer may be used in lieu of an added tracer, with a credit of 0.67-log per month provided.

In March 2019, an Intrinsic Tracer Test Workplan[48] was submitted to DDW to implement an intrinsic tracer test for the Project in compliance with DDW Recycled Water Regulations (Tracer Work Plan). The tracer test will use a combination of intrinsic tracers, including specific conductance (SC), total dissolved solids (TDS), major inorganic ions, and temperature (heat) to differentiate purified recycled water from ambient groundwater as it moves downgradient through the groundwater system. The intrinsic tracer approach was selected based on the comprehensive evaluation of the following key factors:

1. Local hydrogeologic conditions, including basin geology, aquifer hydraulic properties, and groundwater occurrence and flow;
2. Water quality characteristics of Project purified recycled water and local ambient groundwater in the PR and Santa Margarita Aquifers; and

---

[46] The scheduled start date for PWM injection is June 22, 2019. Based on the intrinsic tracer approach proposed herein, the tracer test will by default begin at the onset of purified recycled water injection.

[47] Though not explicitly stated in the Recycled Water Regulations, underground retention time from the GRRP to the respective downgradient monitoring point provides the basis for determining the total underground retention time of recycled water from the GRRP to the nearest drinking water well using extrapolation of travel times or, as proposed in this Tracer Work Plan, groundwater flow modeling.

[48] Technical Memorandum, Draft Intrinsic Tracer Work Plan, Pure Water Monterey, Groundwater Replenishment Project, Todd Groundwater to Sherly Rosilela (DDW), March 25, 2019.

3. Potential influence from existing basin management programs, specifically the nearby MPWMD Aquifer Storage and Recovery (ASR) Project.
4. Results of groundwater model simulations used to predict aquifer hydraulic response to the Project under variable future hydraulic conditions (Montgomery & Associates [M&A], March 2019).

The technical basis for the intrinsic tracer test, proposed groundwater monitoring plan, and implementation schedule are presented in the Tracer Work Plan.

12.10.1. Combined Intrinsic Tracer Test and Groundwater Modeling Approach to Address Dynamic Local Hydraulic Conditions

Article 5.2 Section 60320.208(d) of the Recycled Water Regulations states that the proposed tracer test "shall be implemented under hydraulic conditions representative of normal GRRP operations". While the intrinsic tracer test will be implemented under normal Project operations, local hydraulic conditions (primarily in the Santa Margarita Aquifer) are also influenced by the MPWMD ASR Project, injection and extraction volumes for which are dependent on the climate/hydrology, all of which are beyond the control of the PWM Project. Currently, injection of treated Carmel River water for the MPWMD ASR Project occurs in four ASR wells (ASR-1 through ASR-4 on **Figure 3-8**) that are screened in the Santa Margarita Aquifer. The injection period for the ASR Project spans a 6-month period from December 1 to May 30; actual injection volumes are dependent on the timing and volume of excess flows in the Carmel River. Water production occurs using one ASR well (ASR-1); the water purveyor is in the process of obtaining certification to produce water using the other three ASR wells (ASR-2, ASR-3, and ASR-4). Groundwater modeling was based on production from all four ASR wells. The extraction period for the ASR Project spans an approximately 4-month period from August 1 to November 30[49]. Production volume depends on purveyor requirements.

It is important to recognize that the underground retention time that will be demonstrated by the tracer test represents one hydraulic condition. While Summer/Fall extractions in 2019 are unknown, ASR injections this winter (through February 28, 2019) have been above the historical average.[50] Additionally, the hydraulic gradient between the PWM injection facilities and nearest ASR wells (ASR-1 and ASR-2) at the start of Project injections will be relatively flat in comparison to mounded conditions expected beneath the Injection Facilities Area following the initial years of Project operation. For these reasons, the underground retention time identified from the tracer test is unlikely to demonstrate the minimum travel time for the Project.

To account for future variable hydraulic conditions, the results of the intrinsic tracer test (and an additional model simulation of actual hydraulic conditions and Project injection volumes during the tracer test) will be used to verify the accuracy of the groundwater model. Depending on the results, the groundwater model may be refined to match model-simulated and observed underground retention times from the tracer test. Upon successful re-calibration, the model will be used to simulate future variable operating and hydrologic conditions (as has been performed to-date) to

[49] Historical monthly ASR injection volumes are shown on the lower charts on Figures 3 and 4

[50] The volume of Carmel River water injected in WY 2018-19 through February 28, 2019 is 333 AF, more than double the average volume injected through February from WY 2000-01 through WY 2017-18 of 161 AF.

provide a refined minimum underground retention time. Because the refined minimum underground retention time will be predicted by a groundwater model that is calibrated to an intrinsic tracer demonstration test, it is requested that DDW apply a pathogen reduction credit of 0.67-log per month to the refined minimum underground retention time for the Project.

12.10.2. Evaluation of Purified Recycled Water, Groundwater, and Treated Carmel River Water

The technical basis for the intrinsic tracer test is based on the evaluation of water quality characteristics of the Project purified recycled water, local groundwater, and treated Carmel River water (associated with the MPWMD ASR Project). Data sources used for this evaluation include results from the Pilot-Scale Advanced Water Purification Plant (AWPF) (purified recycled water quality), ASR monitoring/operational data (ASR-related groundwater quality, treated Carmel River water quality, and ASR injection volumes since 2009), and results of baseline sampling of PWM monitoring wells (groundwater quality beneath the Injection Facilities Area and between the Injection Facilities Area and ASR wells). Key data and findings that support the tracer test design are discussed below.

- Treated Carmel River water (ASR injectate; green) is fresher (i.e., has lower ionic strength/salinity) than the ambient groundwater beneath the Injection Facilities Area (MW-1D and MW-2D) and to a slightly lesser degree in the vicinity of the offsite Project monitoring wells (MW-1AD and MW-2AD).
- During ASR injection, treated Carmel River water effectively displaces local groundwater, reducing TDS, SC and major ion concentrations in ASR-1, ASR-2, and ASR MW-1 to the same concentrations of ASR injectate. Extraction of groundwater via the ASR-1 and ASR-2 returns TDS, SC, and major ion concentrations in ASR-1, ASR-2, and ASR MW-1 to near-native groundwater quality. Some residual mixing between Carmel River water and native groundwater, presumably along the edges of the historical injected water plume is evident.
- TDS, SC, and major ion concentrations in MW-1AD and MW-2AD remained well above the respective concentrations for ASR injectate following the WY 2017-18 injection cycle and also during the current WY 2018-19 injection cycle. This indicates only partial influence/mixing of historically injected Carmel River water with native groundwater at these two monitoring well locations.
- In addition to time-concentration charts, geochemical plotting techniques reveal distinctive characteristics of the three source waters.

12.10.3. Intrinsic Tracer Properties and Selection

An intrinsic tracer test must have the ability to differentiate purified recycled water delivered from the Advanced Water Purification Facility (AWPF) to the Injection Facilities from ambient groundwater as it moves downgradient through the groundwater system. Desirable intrinsic tracers for the Project should have the following attributes:

- Consistently present (or absent) in purified recycled water with reliable concentrations
- Provides a sharp contrast with ambient groundwater quality

- Conservative in the groundwater system (neither sorbed or biologically and/or geochemically reactive and should have measurable and/or predictable physicochemical behavior), and
- Cost-effective to analyze

An intrinsic tracer can be an innate component or property of the recycled water or groundwater. An important consideration is that the tracer must be sufficiently different in the two waters to allow identification of the water source. An intrinsic tracer of the purified recycled water can also be the absence or lower concentrations of a certain component that is consistently present at higher concentrations in groundwater.

Because of the proposed advanced treatment process, ionic concentrations and other properties of purified recycled water are expected to be sufficiently distinct from ambient groundwater to allow for identification of its presence in Project monitoring wells. The proposed tracer test will use a combination of the following intrinsic tracers:

(1) Specific Conductance (SC) / Total Dissolved Solids (TDS)
(2) Major Inorganic Ions
    a. Calcium [Ca]
    b. Magnesium [Mg]
    c. Sodium [Na]
    d. Potassium [K]
    e. Chloride [Cl]
    f. Bicarbonate [HCO_3]
    g. Carbonate [CO_3]
    h. Sulfate [SO_4])
(3) Temperature (Heat) (supplemental)

SC/TDS: SC is a relatively inexpensive property to continuously measure in monitoring wells and has been used in many studies as an intrinsic tracer of recharge, surface-water/groundwater interactions, and groundwater flow. SC will be used as an intrinsic tracer, because the injected purified recycled water has a substantially lower ionic strength and, in turn, lower SC than the ambient groundwater. TDS concentrations from discrete samples will also be used as a complement to SC measurements.

Major Ions: While tracking of all major ions will be used to develop geochemical plots, chloride and sulfate will perhaps be most useful tracers in helping to track the injected purified recycled water. Chloride is an ideal intrinsic tracer of the purified recycled water because is relatively un-reactive in many common geochemical reactions in groundwater systems, such as oxidation-reduction, complexation, or sorption reactions. Chloride is also involved in a relatively limited number of biogeochemical processes and has very little retardation in groundwater systems. Most importantly, there are considerable differences in the chloride concentrations in the purified recycled water and ambient groundwater. Sulfate is also likely to be an excellent tracer, because of its distinctly different concentrations in the purified recycled water and ambient groundwater.

Temperature (Heat): Temperature (heat) has been used in many studies as an intrinsic tracer of recharge, surface-water/groundwater interactions, and groundwater flow. For this Project, heat will be used as a supplemental intrinsic tracer, because the injected purified recycled water is anticipated to be cooler than the ambient groundwater. This is based on data from preliminary groundwater quality sampling and the stabilized pilot water sample (RO Permeate) (Nellor, Trussell, and Todd, 2017). The stabilized pilot water sample has a median temperature of 22.2°C and range of 19.9 to 24.2°C. The groundwater temperature recorded in MW-1D during pumping tests of DIW-1 had relatively warmer temperature, ranging from 24 to 26°C.

Heat is not a conservative tracer, because it dissipates into the solid aquifer matrix during transport within the groundwater system. However, heat is a relatively inexpensive property to continuously measure in monitoring wells, and several recent managed aquifer recharge (MAR) studies have successfully used heat as a tracer of injected wastewater from a MAR system and to estimate residence time in the aquifer (Becker et al., 2015).

As an example, heat as a tracer was successfully used at the MAR facility for the Orange County Water District (Becker et al., 2015). In this study, the infiltrating recycled water averaged 25.6 to 28.9 °C, whereas the groundwater temperatures were between 17.9 and 25.0 °C. The study detected temperature changes associated with the injected wastewater in the monitoring wells that were as far as 557 feet from the MAR site and screened 68 feet below land surface. The data indicated that heat could be used to reliably determine residence times that ranged from 2 to 6 months. The heat tracer was detected at the furthest monitoring well, while extrinsic tracers (delta (11) Boron 11 [^{11}B] and Bromide [Br^-] became too dilute to detect above background concentrations. The Becker et al. (2015) study concluded that heat has good potential as an intrinsic tracer at MAR facilities.

The on-site Project monitoring wells MW-1D and MW-2D are located less than 100 feet from the nearest DIWs, and downgradient monitoring wells MW-1AD and MW-2AD are located approximately 620 feet from the nearest DIWs. Given that the Becker et al. (2015) study detected heat changes associated with the injected wastewater at about 560 feet from the MAR site, it is likely that the temperature signal from the injected purified recycled water for this Project will be detectable in onsite and downgradient monitoring wells. By continuously monitoring the temperature in the Project monitoring wells, a significant and sustained decrease in the water temperature will indicate the arrival of the purified recycled water at the monitoring well location.

12.10.4. Monitoring Plan and Analysis/Interpretation

Table 12-25 shows a preliminary monitoring plan and sampling schedule for the proposed intrinsic tracer test for the Project. **Table 12-25** is broken into pre-injection and post-injection periods with an anticipated PWM injection start date of June 22, 2019.

As shown in **Table 12-25**, discrete groundwater quality sampling will be complemented by sensors/dataloggers (InSitu® AquaTroll 200) installed in three of the four deep monitoring wells

(MW-2D, MW-1AD, and MW-2AD)[51]. The sensors will provide continuous measurement and recording of SC, temperature, and water levels. Continuous data will be used to detect the arrival of purified recycled water and develop a reliable concentration breakthrough curve of SC and temperature in the three monitoring wells. Dataloggers will be installed within the well screen at a depth corresponding to the portion of the SM Aquifer with the highest relative permeability. The sensors will be installed in MW-1AD and MW-2AD the week of March 18-24, 13 weeks prior the start of the injection of purified recycled water. This will allow for tracking of SC and temperature in the SM Aquifer at these locations over the last two months of the current ASR injection cycle (through May 30, 2019) and into the 2-month rest period (June 1 to July 31, 2019) prior to ASR extraction season and beyond. A sensor will also be installed in MW-2D prior to the start of the Project injection (tentatively scheduled for the week of May 20-26) to track baseline SC and temperature prior to and following initial Project injection.

12.10.5. Water Quality Sampling

As shown in **Table 12-25**, discrete groundwater quality samples will be collected from seven of the eight Project monitoring wells (with the exception of MW-2S) and analyzed for selected tracers (major ions, TDS). Field measurement of SC, pH, and temperature will also be recorded. Field-measured SC values under pumping conditions will be correlated to SC values from the sensors in MW-2D, MW-1AD, and MW-2AD. Sampling frequency for each well is variable and dependent on the expected arrival of purified recycled water and duration for the breakthrough curve to be completed. For MW-1D, more frequent sampling is proposed following initial injection, given its close proximity to DIW-1 and because it will not be equipped with a SC and temperature sensor.

The preliminary sampling schedule assumes that the underground time of purified recycled water to onsite deep monitoring wells (MW-1D and MW-2D) will be relatively short (approximately 3-4 weeks; assuming an average subsurface velocity of 3-4 feet per day) due to the short distance between the onsite monitoring wells and the nearest respective DIW (less than 100 feet). Increased sampling frequency from every four weeks to every two weeks in all offsite monitoring wells (MW-1AD, MW-2AD, MW-1AS, and MW-2AS) starting in Week 40 assumes detection of lower SC purified recycled water starting Week 40 by SC sensors and discrete samples installed in MW-1AD and MW-2AD and by discrete samples only in MW-1AS and MW-2AS. In reality, the sampling frequency for each well will increase to every two weeks following the initial detection of recycled water until the concentration breakthrough curve is complete. It is noted that the proposed Post-Injection sampling for the tracer test will be mostly satisfied by the required monthly groundwater monitoring and analysis of general mineral and physical parameters for the first year of Project operation as specified in the existing Project WDR.

The sampling schedule is summarized in **Table 12-26** below to show the anticipated sampling frequencies for each well and number of samples over an assumed tracer test period of approximately one year. Not shown in **Table 12-26** are initial and quarterly sampling since 2017 already completed to comply with Project baseline groundwater monitoring requirements.

---

[51] The sounding tube and test pump in MW-1D does not extend to the well screen, so does not allow for installation of a sensor for continuous tracking of SC and temperature.

Table 12-25. PWM Intrinsic Tracer Test Monitoring / Sampling and Analysis Plan

Pre-Injection (2019)		2019												
		Mar 18 Mar 24	Mar 25 Mar 31	Apr 1 Apr 7	Apr 8 Apr 14	Apr 15 Apr 21	Apr 22 Apr 28	Apr 29 May 5	May 6 May 12	May 13 May 19	May 20 May 26	May 27 Jun 2	Jun 3 Jun 9	Jun 10 Jun 16
		Week -13	Week -12	Week -11	Week -10	Week -9	Week -8	Week -7	Week -6	Week -5	Week -4	Week -3	Week -2	Week -1
MW-1D	Sample (TDS/SC/Major Ions/pH/temperature)			1		2		3		4		5		6
MW-2D	Continuous SC/Temp/WL Monitoring										Install**--------------------->---------------			
	Sample (TDS/SC/Major Ions/pH)			1		2		3		4		5		6
MW-1AD	Continuous SC/Temp/WL Monitoring	Install* --------->------------------->------------------->------------------->------------------->------------------->--------------												
	Sample (TDS/SC/Major Ions/pH)			1		2		3		4		5		6
MW-2AD	Continuous SC/Temp/WL Monitoring	Install* --------->------------------->------------------->------------------->------------------->------------------->--------------												
	Sample (TDS/SC/Major Ions/pH)			1		2		3		4		5		6
MW-1S	Sample (TDS/SC/Major Ions/pH)			1		2		3		4		5		6
MW-2S														
MW-1AS	Sample (TDS/SC/Major Ions/pH)			1		2		3		4		5		6
MW-2AS	Sample (TDS/SC/Major Ions/pH)			1		2		3		4		5		6

Post-Injection (2019)		2019																												
		Jun 17 Jun 23	Jun 24 Jun 30	Jul 1 Jul 7	Jul 8 Jul 14	Jul 15 Jul 21	Jul 22 Jul 28	Jul 29 Aug 4	Aug 5 Aug 11	Aug 12 Aug 18	Aug 19 Aug 25	Aug 26 Sep 1	Sep 2 Sep 8	Sep 9 Sep 15	Sep 16 Sep 22	Sep 23 Sep 29	Sep 30 Oct 6	Oct 7 Oct 13	Oct 14 Oct 20	Oct 21 Oct 27	Oct 28 Nov 3	Nov 4 Nov 10	Nov 11 Nov 17	Nov 18 Nov 24	Nov 25 Dec 1	Dec 2 Dec 8	Dec 9 Dec 15	Dec 16 Dec 22	Dec 23 Dec 29	Dec 30 Jan 5
		Week 0	Week 1	Week 2	Week 3	Week 4	Week 5	Week 6	Week 7	Week 8	Week 9	Week 10	Week 11	Week 12	Week 13	Week 14	Week 15	Week 16	Week 17	Week 18	Week 19	Week 20	Week 21	Week 22	Week 23	Week 24	Week 25	Week 26	Week 27	Week 28
MW-1D	Sample (TDS/SC/Major Ions/pH)	7	8	9	10	11	12			13				14				15				16				17				18
MW-2D	Continuous SC/Temp/WL Monitoring	---->--------------->--------------->--------------->--------------->--------------->--------------->--------------->-------------->																												
	Sample (TDS/SC/Major Ions/pH)	7		8		9				10				11				12				13				14				15
MW-1AD	Continuous SC/Temp/WL Monitoring	---->--------------->--------------->--------------->--------------->--------------->--------------->--------------->-------------->																												
	Sample (TDS/SC/Major Ions/pH)	7				8				9				10				11				12				13				14
MW-2AD	Continuous SC/Temp/WL Monitoring	---->--------------->--------------->--------------->--------------->--------------->--------------->--------------->-------------->																												
	Sample (TDS/SC/Major Ions/pH)	7				8				9				10				11				12				13				14
MW-1S	Sample (TDS/SC/Major Ions/pH)	7				8				9				10				11				12				13				14
MW-2S																														
MW-1AS	Sample (TDS/SC/Major Ions/pH)	7				8				9				10				11				12				13				14
MW-2AS	Sample (TDS/SC/Major Ions/pH)	7				8				9				10				11				12				13				14

Post-Injection (2020)		2020																												
		Jan 6 Jan 12	Jan 13 Jan 19	Jan 20 Jan 26	Jan 27 Feb 2	Feb 3 Feb 9	Feb 10 Feb 16	Feb 17 Feb 23	Feb 24 Mar 1	Mar 2 Mar 8	Mar 9 Mar 15	Mar 16 Mar 22	Mar 23 Mar 29	Mar 30 Apr 5	Apr 6 Apr 12	Apr 13 Apr 19	Apr 20 Apr 26	Apr 27 May 3	May 4 May 10	May 11 May 17	May 18 May 24	May 25 May 31	Jun 1 Jun 7	Jun 8 Jun 14	Jun 15 Jun 21	Jun 22 Jun 28	Jun 29 Jul 4	Jun 15 Jun 22	Jun 22 Jun 29	Jun 29 Jul 5
		Week 29	Week 30	Week 31	Week 32	Week 33	Week 34	Week 35	Week 36	Week 37	Week 38	Week 39	Week 40	Week 41	Week 42	Week 43	Week 44	Week 45	Week 46	Week 47	Week 48	Week 49	Week 50	Week 51	Week 52	Week 53	Week 54	Week 55	Week 56	Week 57
MW-1D	Sample (TDS/SC/Major Ions/pH)				19				20				21				22				23				24				25	
MW-2D	Continuous SC/Temp/WL Monitoring	------------------->------------------->------------------->------------------->------------------->------------------->------->																												
	Sample (TDS/SC/Major Ions/pH)				16				17				18				19				20				21				22	
MW-1AD	Continuous SC/Temp/WL Monitoring	------------------->------------------->------------------->------------------->------------------->------------------->------->																												
	Sample (TDS/SC/Major Ions/pH)				15				16				17		18		19		20		21		22		23		24		25	
MW-2AD	Continuous SC/Temp/WL Monitoring	------------------->------------------->------------------->------------------->------------------->------------------->------->																												
	Sample (TDS/SC/Major Ions/pH)				15				16				17		18		19		20		21		22		23		24		25	
MW-1S	Sample (TDS/SC/Major Ions/pH)				15				16				17				18				19				20				22	
MW-2S																														
MW-1AS	Sample (TDS/SC/Major Ions/pH)				15				16				17		18		19		20		21		22		23		24		25	
MW-2AS	Sample (TDS/SC/Major Ions/pH)				15				16				17		18		19		20		21		22		23		24		25	

Notes:
SC = Specific Conductance
TDS = Total Dissolved Solids
* = In-Situ Aquatroll 200 Datalogger to be installed in MW-1AD and MW-2AD week of March 18-24
** = In-Situ Aquatroll 200 Datalogger to be installed in MW-2D week of May 20-26
Baseline and Post-Injection Schedule is based on anticipated PWM injection start of June 22, 2019
[orange] = Weekly sampling in MW-1D assumes hypothetical arrival of PWM purified recycled water arrival by Week 3 or 4. Recycled water arrival and breakthrough in MW-2D will rely on SC and temperature sensor and bi-weekly sampling
[yellow] = Start of increased sampling frequency in Week 40 in MW-1AD, MW-2AD, MW-1AS, and MW-2AS from every 4 weeks to every 2 weeks assumes hypothetical arrival of PWM purified recycled water in Week 40.
Actual change to increaesd sampling frequency will be based on SC value decline based on SC sensor and dicrete samples of MW-1AD and MW-2AD and discrete samples of MW-1AS and MW-2AS
No sampling is proposed for MW-2S due to inability to successfully develop the well; MW-1S, MW-1AS, and MW-2AS satisfy the monitoring well requirements of the recycled water recharge regulations for the Paso Robles Aquifer

Table 12-26: Summary of Tracer Test Sampling and Analysis Plan

Period	Monitoring Wells	Sampling Frequency	Number of Samples/Well
Pre-Injection (Weeks -13 to -1)	MW-1D, MW-2D, MW-1AD, MW-2AD, MW-1S, MW-1AS, MW-2AS	Bi-Weekly (2 weeks)	6 samples
Post-Injection (Weeks 1 to 5)	MW-1D	Weekly	6 samples
	MW-2D	Bi-Weekly (2 weeks)	3 samples
	MW-1AD, MW-2AD, MW-1AS, MW-2AS	Monthly (4 weeks)	2 samples
Post-Injection (Weeks 6 to 39 estimated)	MW-1D, MW-2D, MW-1AD, MW-2AD, MW-1S, MW-1AS, MW-2AS	Monthly (4 weeks)	8 samples
Post-Injection (Weeks 40 to 57 estimated)	MW-1D, MW-2D, MW-1S	Monthly (4 weeks)	5 samples
	MW-1AD, MW-2AD, MW-1S, MW-1AS, MW-2AS	Bi-Weekly (2 weeks)	9 samples

Notes:

(a) Samples analyzed for TDS, Ca^{2+}, Mg^{2+}, Na^{+}, K^{+}, Cl^{-}, CO_3^{2-}, HCO_3^{-}, and SO_4^{2-}; field temperature, pH, and SC will also be recorded.

(b) Sampling schedule assume hypothetical detection of leading edge by Week 3 in onsite deep monitoring wells MW-1D and MW-2D) and by Week 40 in offsite monitoring wells (MW-1AD, MW-2AD, MW-1AS, and MW-2AS).

12.10.6. Data Analysis and Interpretation

The proposed intrinsic tracers will be used in combination to demonstrate the underground retention time of the injected purified recycled water to Project monitoring wells. Time-concentration plots of SC, TDS, and individual ions and ion ratios will be used in combination with sequential Stiff and Radial Plots to identify when the leading edge of injected purified recycled water reaches each Project monitoring well.

It is anticipated that SC, TDS, and major ion concentrations and temperature in Project monitoring wells will decline to the levels of injected purified recycled water as the injected purified recycled water breakthrough curve passes through each Project monitoring well. Similarly, the size and shape of Stiff and Radial plots of groundwater samples in Project monitoring wells will more closely resemble purified recycled water over the course of the breakthrough curve.

This Page Intentionally Left Blank

13. GENERAL OPERATIONS PLAN

The AWP Facility will be equipped with modern control and monitoring equipment, which will facilitate operation of the facility by highly trained operations staff to produce a water supply that is reliably protective of public health. Standby equipment will be included, as needed, to facilitate both planned and unplanned service of equipment. An Operations Optimization Plan (OOP) will be developed for the facility that details Standard Operating Procedures (SOPs). An overview of the AWP Facility operations plan features is described in this section. If the product water does not meet permit requirements, pathogen performance, or advanced treatment criteria based on online monitoring parameters (*e.g.*, conductivity removal through RO, UV dose) and other critical control points (*e.g.,* MF DIT), the product water will be discharged to the M1W outfall, returned to the RTP headworks, or pumped to SVRP, with the latter two options preferred to preserve the low-TDS water

In accordance with Title 22 Section 60320.200(g) and the WDR/WRR, prior to operations, M1W will demonstrate that all treatment processes have been installed and can be operated to meet their intended function by undertaking actions including, but not limited to, the following:

- Develop a Startup/Commissioning Plan to verify the correct installation of equipment and document proper performance for equipment,
- Collect manufacturers' standard factory tests and results (*e.g.*, MF membrane pathogen removal testing, RO conductivity removal testing),
- Perform tests of all equipment to verify proper installations and functionalities,
- Perform partial and complete startups and shutdowns of partial process treatment trains and whole AWP Facility,
- Perform complete simulations of major and critical alarms, and
- Conduct startup and performance evaluation, including validation of the advanced oxidation process.

13.1. RTP AND AWP FACILITY SYSTEM CONTROLS AND RELIABILITY

13.1.1. Controls

MWRPCA employs a virtualized server/client SCADA system. The AWP Facility will be integrated into this system to allow for control and monitoring by M1W. The SCADA system is under one Factorytalk Directory and is part of a Microsoft domain. Redundant Human-machine Interface (HMI) servers and FactoryTalk Alarm and Event (FTAE) servers, where the operators interface with the system, share a pair of redundant RSLinx data servers. The RSLinx data servers provide PLC data and alarms to the HMI servers and Factorytalk Historian, which records and saves the data.

Each process area (RTP, Pump Stations, SVRP, and CSIP) has a master ControlLogix PLC and the RTP includes a redundant PLC. These master PLCs act as gateways between other PLCs and remote input and output (I/O) to the SCADA system and Historian (MRWPCA 2015).

The local PLCs at the AWP Facility will control the unit processes to meet operational setpoints, to trigger alarms when thresholds are passed that require operator intervention, and to shutdown down unit processes that threaten the safety of equipment, operators, or public health. These local PLCs will feed into a master Project PLC, which will feed into the existing SCADA network.

13.1.2. Redundancy

A 10% offline factor was assumed in selecting the AWP Facility design flow to meet production requirements (i.e., the AWP Facility only needs to be in production 90% of the time in order to meet production requirements). OCWD's GWRS, which has similar facilities, has an operating offline factor of approximately 6%. The offline factor allows for planned and unplanned downtime, such as preventative maintenance or RO train cleans.

The AWP Facility design criteria were developed to meet the 10% offline factor. These design criteria include MF pre-treatment (via ozonation), sustainable MF fluxes (with respect to cleaning needs), sustainable RO recoveries, and the incorporation of stand-by equipment for key processes. The AWP Facility design criteria are summarized in **Section 3**.

Ozone system. The ozone system is included in the AWP Facility process train to reduce MF fouling and to reduce the concentration of CECs and pesticides in product water and RO concentrate discharged to the ocean. The ozone system will inactivate pathogens; however, no regulatory credit will be sought for this inactivation as it is not required to meet the Title 22 pathogen LRVs (i.e., the AWP Facility can produce a product that is protective of public health when the ozone system is offline, as sufficient pathogen inactivation is obtained in downstream processes: MF, RO, UV/AOP, and travel time in the aquifer). MF fouling will temporarily increase when the ozone is offline; however, fouling will return to low levels when the ozone system is brought back online and cleans will be used to remove foulants from extended ozone system downtime. Accordingly, the ozone system has not been designed with same level of redundancy as the other treatment processes that are required for pathogen removal credits.

Standby LOX tanks, vaporizers, ozone generators, nitrogen boost systems, and ozone destructs rarely fail and due to the permissible ozone system downtime, they are not included. Spare parts will be held onsite to facilitate rapid repair of systems that require service. Three sidestream injection lines are included in the design, which will allow for continued ozone injection if an injection line requires service, albeit at a lower transfer efficiency.

The design ozone dose was selected after pilot testing ozone pre-treatment for a thermally induced phase separation (TIPS) PVDF low-pressure membrane. The design ozone dose accounts for differences in water quality and transfer efficiency between pilot testing and the AWP Facility. Given that the ozone dose was conservatively selected for poor water quality (high in nitrite and TOC) and the maximum expected flow, the ozone system will be able to address a wide spectrum of feed water conditions.

MF system. The MF system design allows for one standby block of membranes at peak flow while maintaining the design flux. This standby block can be brought online when one of the other blocks is removed from service for maintenance or a CIP. The design flux was based on the pilot testing and it is the flux that could be sustained for approximately one month prior to needing a CIP. Blocks of MF modules may be periodically removed from service for routine backflushes (e.g., every 15 minutes) and daily cleans; the MF system includes flow equalization upstream (MF feed tank) and downstream (MF filtrate tank) to allow the upstream and downstream processes (ozone and RO, respectively) to operate at constant flow during these regular backflushes and daily cleans, and the MF system flux was designed to meet the target, average MF system flowrate, despite temporarily suspensions in production during the regular backflushes and daily cleans. A standby automatic pre-strainer and a duplex compressed air system are also included to reduce downtime associated with automatic strainer and air compressor maintenance. The alarms and standby block of membranes meet in the Water Recycling Criteria reliability requirements for filtration.

RO system. The RO system does not explicitly include a standby train for CIP events; rather, the offline time associated with RO CIP events was incorporated into the AWP Facility design offline factor and 5.5 mgd of RO capacity is provided, whereas only 5 mgd is needed. The CIP interval was demonstrated during the pilot test program at the design RO recovery with the secondary effluent during which time the agricultural washwater source water was shunted to the RTP for treatment. A standby cartridge filter is included to reduce downtime associated with cartridge filter maintenance. The excess capacity will allow for flexibility in operational fluxes, and will equate to less lost production when a train is offline for cleaning.

UV/AOP system. The UV/AOP system includes a redundant reactor, which will be brought online if a duty reactor alarms out of service or if one is taken offline for service. The design UV fluence ("UV dose") is based on conservative 1,4-dioxane removal requirements and a conservative effluent NDMA goal. The NDMA removal goal was based on observed RO permeate NDMA concentrations during pilot testing. The UV fluence required to meet these goals will achieve significantly greater pathogen inactivation than the process is granted credit. The alarms and the standby train meet the reliability guidelines provided in the NWRI UV Guidelines.

Product water stabilization. Product water stabilization consists of decarbonation and chemical addition. Lime (calcium hydroxide) will be injected to add alkalinity and calcium. The decarbonator will include a redundant blower to minimize downtime associated with regular blower maintenance. A standby decarbonator is not required, as they rarely require removal from service for maintenance.

Chemical feed systems and pumps. Standby chemical feed metering pumps and water pumps are provided to minimize downtown and to ensure reliability of disinfection systems (e.g., UV/AOP).

Power supply. The RTP has a 21 kilovolt (kV) primary service. The 21 kV medium voltage switchgear has a main breaker and 2 x knife disconnect switches that supply a redundant set of 21 kV to 480 volts alternating current (VAC) transformers. During normal operation the A or B side transformer is selected. The A and B transformers feed 2 x 4000 ampere (A) 480 VAC main breakers. A 1500 kW emergency standby transformer supplies power to the RTP during a PG&E power loss. There are 3 x 580 kW 480 VAC cogeneration units powered by a biogas and natural gas blend. During normal operations 2 x 580 kW cogeneration units are in operation. The RTP administration building has a critical load emergency generator on an Automatic Transfer Switch (ATS) to supply power to the control room and server room if the RTP 1500 kW generator fails. The SVRP has a separate 21 kV service that is not connected to the RTP (MRWPCA 2015).

The AWP Facility power will be supplied through a new PG&E utility connection to the RTP and through connection with the Monterey Regional Waste Management District power generation facilities. The system components would include a utility service, transformers, and switchgear. The major electrical loads will be from the new influent pumping, ozone generator, MF and RO feed water pumping, UV reactors, and product water pumping. The AWP Facility will not be able to utilize 480 VAC service from the RTP or the RTP cogeneration facility. The AWP Facility will require its own 21 kV service along with its own emergency generator.

RTP. The upstream RTP process includes bar screens (1/4 inch), aerated grit removal, primary clarification (5 clarifiers, with scum removal), CEPT facilities (ferric chloride), trickling filters towers (6 towers, 4 currently used; synthetic media), bioflocculation basins (also known as solids contact basins), and secondary clarification (6 clarifiers with scum removal), as well as solids handling facilities (gravity thickener, dissolve air flotation thickener, anaerobic digesters, screw presses, sludge drying beds, and sludge lagoons), all with an average dry weather and ultimate peak wet weather flow of 29.6 and 81 mgd, respectively. The average dry weather flow to the RTP will not exceed the permitted capacity of the RTP with the addition of the new source waters (the predicted flows range from 19 to 29.6 mgd, with an average flow of 24 mgd and a maximum flow of 29.6 mgd, where capacity is only reached for the month of June). Unused secondary effluent is discharged through an ocean outfall. The reliability features of the RTP meet the Water Recycling Criteria reliability requirements for primary treatment, biological treatment, and secondary sedimentation by having alarms and multiple treatment units capable of treating the entire flow with one unit not in operation. In addition, a long-term disposal option is available through the ocean outfall.

Flow control and residuals. Operation of the AWP Facility benefits from diverting a constant flow of secondary effluent from the larger secondary effluent flow that goes to either the SVRP or the ocean outfall, thereby avoiding the operational challenges associated with variable flowrates. The AWP Facility will divert secondary effluent from a diversion structure located downstream of the secondary clarifier effluent channel and upstream of SVRP influent pump station diversion. Operation of the AWP Facility also benefits from being able to discharge waste flows (also known as recycle streams) back to the RTP headworks, thus decreasing the potential negative impact that could occur from recycled streams being handled at the AWP Facility. Recycle streams will be returned to the RTP headworks.

13.1.3. Robustness

Several treatment processes are included in the AWP Facility and these processes, as well as the travel time in the aquifer, provide treatment through a variety of mechanisms. Given that contaminant removal efficiency is largely impacted by the treatment mechanism (*e.g.*, some contaminants are readily removed through RO, such as bromate, while others require UV/AOP to meet product water quality goals and requirements, such as NDMA), including a variety of treatment mechanisms facilitates the removal of a wide range of constituents.

AWP trains have evolved since the first potable reuse projects in California. One component that has changed over time is the robustness of potable reuse treatment trains. OCWD originally practiced groundwater injection of RO permeate; however, measurement of NDMA in the RO permeate lead to the inclusion of UV following RO. Later, measurement of 1,4-dioxane in the UV effluent lead to the addition of constituents that form hydroxyl radicals when exposed to UV light (e.g., H_2O_2), thereby achieving a UV/AOP process. The addition of ozone upstream of MF not only reduces MF fouling, but also provides additional robustness by adding a new oxidation step into the treatment train, which can both inactivate pathogens and oxidize CECs. **Table 13-1** summarizes the treatment mechanisms achieved through the AWP Facility and the groundwater aquifer. **Table 13-2** summarizes the impact of the major processes on constituents of concern.

Table 13-1: AWP Facility and Aquifer Treatment Process Robustness through Multiple Treatment Mechanisms

Process	Biological oxidation	Sorption	Chemical oxidation	Physical removal	Physical degradation
RTP (primary & secondary)	✓	✓		✓ (Sed[a])	
Chloramination			✓		
Ozone			✓		
MF				✓	
RO				✓	
UV/AOP			✓		✓ (Photolysis)
Decarbonator				✓ (Stripping)	
Aquifer	✓	✓		✓	✓ (Hydrolysis)

a. Sedimentation.

Table 13-2: AWP Facility and Aquifer Treatment Barriers

Process	Chemical constituents					Pathogenic microorganisms		
	Nitrogen	TOC	DPBs	Inorganics	CECs	Bacteria	Viruses	Protozoa
RTP (primary & secondary)	✓	✓		✓	✓	✓	✓	✓
Ozone					✓	✓	✓	✓
MF		✓		✓[a]		✓	✓	✓
RO	✓	✓	✓	✓	✓	✓	✓	✓
UV/AOP	✓		✓		✓	✓	✓	✓
Aquifer						✓	✓	✓

a. Particulate inorganics (*e.g.*, iron and manganese)

13.1.4. Resiliency and Integrity Monitoring

The Project has multiple resiliency elements beginning with its source control program and efficacy of the RTP treatment processes to protect the feed water coming into the AWP Facility. Other features include monitoring of the AWP Facility treatment processes and AWP Facility product water quality to ensure that unit processes are performing as expected and that the AWP Facility is reliably producing a water that is protective of public health. Monitoring will consist of grab samples, composite samples, and online instrumentation as discussed in **Section 12**. The treatment processes will have alarm setpoints, which will alert the attention of M1W staff and shutdown processes when necessary. M1W staff will also regularly review monitoring results and verify instrument readings. When monitoring results pass thresholds or alarm setpoints, staff will respond according to the OOP and SOPs.

Monitoring of the AWP Facility performance requires monitoring of surrogates that indicate the removal of pathogenic microorganisms and that demonstrate AOP performance. Pathogen microorganism removal credit will be claimed for three treatment processes: MF, RO, and UV/AOP. In addition, pathogen credit will be claimed for time spent in the aquifer following treatment in the AWP Facility. The AOP requirement to remove 1,4-dioxane and the M1W goal to achieve 1.5 log removal of NDMA will result in a UV/AOP process that achieves significantly greater log removal than the maximum credited unit process removal of 6 logs per pathogen or pathogen class (enteric virus, *Cryptosporidium* oocysts, *Giardia* cysts). Thus, ensuring that the AOP requirements are met ensures that the UV/AOP process meets its log removal requirements. Preliminary surrogates, critical control point target setpoints, example low and high alarm setpoints, and corrective actions are shown in **Table 13-3**. These setpoints are preliminary and may be modified, as needed, in the OOP.

If any critical failure occurs, the SCADA system will alarm and immediately reduce AWPF production to the setpoint of 2 MGD and place the AWP Facility into recirculation mode, which stops delivery of purified water to the AWP Facility product water conveyance pipeline. Once in recirculation mode, UV/AOP product water is diverted back to the MF feed tank, where the water circulates through the MF system, RO system, UV/AOP system, and back to the MF feed tank. Soon after recirculation mode is initiated, the feed flow into the AWP Facility Source Water Pump Station is automatically reduced to maintain the appropriate operating range in the MF feed tank. This allows the M1W Operators the opportunity to investigate and repair the cause of the critical failure. If system repair requires too much time, the AWP Facility can be placed into Standby or Offline Mode. Should any off-specification water flow past the recirculation point (just prior to the post treatment decarbonator) and into the PWPS, the off-specification water can be pumped to the SVRP Pond bypassing the conveyance pipeline. Depending on the nature of the failure, M1W must immediately notify DDW and the RWQCB, in accordance with Title 22 Criteria.

As discussed previously, TOC, total nitrogen, constituents with MCLs, lead, copper, Priority Pollutants, constituents with NLs, and indicator compounds indicative of pharmaceuticals, endocrine disrupting chemicals, personal care products, constituents regulated through source control, and other indicators of municipal wastewater will be monitored in the RO permeate or a downstream location prior to injection into the aquifer to verify product water quality and will also be monitored upstream as necessary to verify removal performance. M1W staff will review results and take corrective actions as necessary, which may include modifying treatment processes, removing units from service, or other actions as needed to improve performance.

In addition to the monitoring described above and in **Section 12**, other process and water quality parameters will be regularly monitored to support operation of the AWP Facility. These parameters will include levels (*e.g.*, chemical levels), flow rates, pressures, speeds (*e.g.*, pump motor speeds), residuals, concentrations, setpoints, and positions (*e.g.*, valve positions) for both the treatment processes and support systems. Parameters will be monitored through manual readings, on-line data, and laboratory analysis. Example water quality parameters include chloramine residual, ambient ozone concentration, ozone gas concentration, dissolved ozone residual, nitrite, ORP, pH, turbidity, and temperature. A final list of parameters that support operation of the AWP Facility will be detailed in the O&Ms and SOPs. Responses, based on monitoring results, may include the removal of processes from service, investigation of unusual results, and modification of treatment process setpoints to adapt to changing conditions.

Table 13-3: Preliminary Treatment Surrogates, Alarms and Example Corrective Actions in Response to Treatment Failures

Process	Parameter(s)	Monitoring frequency	Target Setpoint	Alarm Low	Alarm High	Example Corrective actions
MF	Pressure decay LRV and turbidity	Minimum of 1 per day and continuous	LRV = N/A[a] Turb = N/A	LRV = 4 log Turb = N/A	LRV = N/A Instant. Turb = 0.5 [b] Avg Turb = 0.2 [b]	Confirm results. Remove modules from service upon failure. Assess fiber breakage. Isolate, repair or replace module.
RO	Surrogate LRV[c]	Strontium = Grab samples once every 24 hours TOC and Conductivity = Continuous (at least 1 measurement every 15 minutes)	N/A[a]	1 log	--	Monitor individual RO trains. Verify analyzer accuracy. Remove train(s) from service upon failure. Conduct vessel probing.
UV/AOP	Calculated UV dose[d] H_2O_2 dose	Continuous (at least 1 measurement every 15 minutes)	UV = 1600 mJ/cm^2 H_2O_2 = 3.0 mg/L	UV = 1500 mJ/cm^2 H_2O_2 = 2.5 mg/L	UV = 1800 mJ/cm^2 H_2O_2 = 4.0 mg/L	Remove reactor from service. Check and replace lamps or ballasts as needed. Check and recalibrate sensors as needed. Check H_2O_2 dosing system.

a. If the overall AWPF pathogen reduction falls below 12/10/10, the SCADA system will alarm and notify the Operators to investigate potential causes and take corrective actions. If the AWPF fails to meet the pathogen reduction requirement for a period longer than 4 consecutive hours, or more than 8 hours in any 7-day period, then M1W shall notify DDW and the Regional Water Quality Control Board (RWQCB) immediately. If the overall AWPF pathogen reduction falls below 10/8/8, the system will immediately and automatically enter recirculation mode.

b. Less than or equal to 0.2 NTU 95% of the time within a 24-hour time period and less than 0.5 NTU all the time

c. Surrogate parameters used for determining pathogen LRV are strontium, TOC, and conductivity.

d. The UV reactor outputs a calculated UV Dose using online measurements of AOP feed flow rate, UV transmittance, and UV intensity. The dose equation or validation report will be provided after performance testing and optimization during start-up.

Pathogenic microorganism concentration reduction failure. As discussed in **Section 12**, the log reductions achieved through the entire system will be determined each day and reported as "yes" if required log reductions were achieved or "no" if not achieved. If all three components (MF, RO, and AOP) do not pass, response measures specified in Title 22 Sections 60320.208(h) and (i) will be launched. Within 24 hours of becoming aware of the issue, M1W will immediately investigate potential cause(s) and take corrective action(s). DDW and RWQCB will be notified immediately if the AWP Facility fails to meet pathogen reduction criteria longer than four consecutive hours, or more than a total of eight hours during any seven-day period. Failures of shorter duration will be reported to the RWQCB no later than ten days after the month in which failure occurred. If the calculated overall log reduction drops below 10-logs for enteric virus, or 8-logs for *Giardia* cysts or *Cryptosporidium* oocysts, M1W will immediately notify DDW and RWQCB, and discontinue application of product water for injection, unless directed otherwise by DDW or RWQCB.

Nitrogen Compounds, Regulated Contaminants and Action Levels, NLs, TOC, Additional Chemicals, and CECs. Information on response actions including monitoring, investigations, and suspension of product water for injection for each of these contaminant categories is presented in **Section 12**. Regular water quality sample collection and online monitoring is conducted at the RTP for process control, which includes turbidity, TSS, BOD (soluble and total $CBOD_5$, and BOD_5), dissolved organic carbon, TSS, volatile suspended solids, ammonia, pH, temperature, dissolved oxygen and flow at various locations in the RTP. This regular monitoring facilitates control of RTP treatment processes.

The RTP has alarms to indicate issues with the primary and secondary facilities, including power failure, unusual water quality, and mechanical failures. The alarm devices are connected to uninterruptible power supplies (UPSs) so that they continue to work in a power failure. All alarms result in an audible alarm in the control room. The control room operator is a Grade III operator or higher or is being supervised by a Grade III or higher operator on site. The control room is staffed 24 hours per day every day. Depending on the nature of the alarm, the control room operator can deal with the issue individually, call in on-call personnel to deal with issue; or call the Chief Operator and/or managers. All alarms are recorded and printed, and those records are maintained on paper and electronically. Alarms for the AWP Facility will also be routed to the control room.

13.2. TRAINING

13.2.1. O&M Manuals and SOPs

Training and O&M manuals will be provided by the engineering firm responsible for the 100% design of the AWP Facility, which will include training by the Original Equipment Manufacturers (OEMs) that provide equipment for the AWP Facility (for example, ozonation training will be conducted by the ozone system supplier). O&M manuals will be included in the M1W Electronic O&M Manual, which is currently in production for all facilities located at the RTP site. The O&M manuals will include process descriptions, control descriptions, design criteria, routine duties, start-up and shut-down SOPs, alarms, an emergency response plan, operation and maintenance staffing plans, contact information, water quality sampling and testing plans, and equipment specifications for each section of the facility.

Training will include hands-on training for each component of the facility. M1W staff will generate additional, internal SOPs to facilitate routine tasks, as needed. A select group of operators will initially be assigned to AWP Facility to quickly develop expertise on the AWP unit processes. Additionally, operators will be cycled through the AWP Facility to both ensure a broad range of expertise is available to support the AWP Facility and to facilitate an understanding of how the RTP treatment and the AWP Facility performance are interlinked. In addition to operating the RTP to meet ocean discharge requirements and provide a suitable influent to the SVRP, M1W will operate the RTP to provide a suitable influent to the AWP Facility.

M1W has developed a web-based O&M manual for the RTP, which provides easy access to graphics, photos, safety considerations, design criteria, general descriptions, major equipment, control strategies, alarms, P&IDs, SOPs, daily checklists, maintenance schedules, and troubleshooting information for each of the processes (*e.g.*, headworks, primary clarification). General information is also included, such as SCADA screens, reports, organizational charts, and emergency SOPs. A screenshot of an example page on the website is shown in **Figure 13-1**.

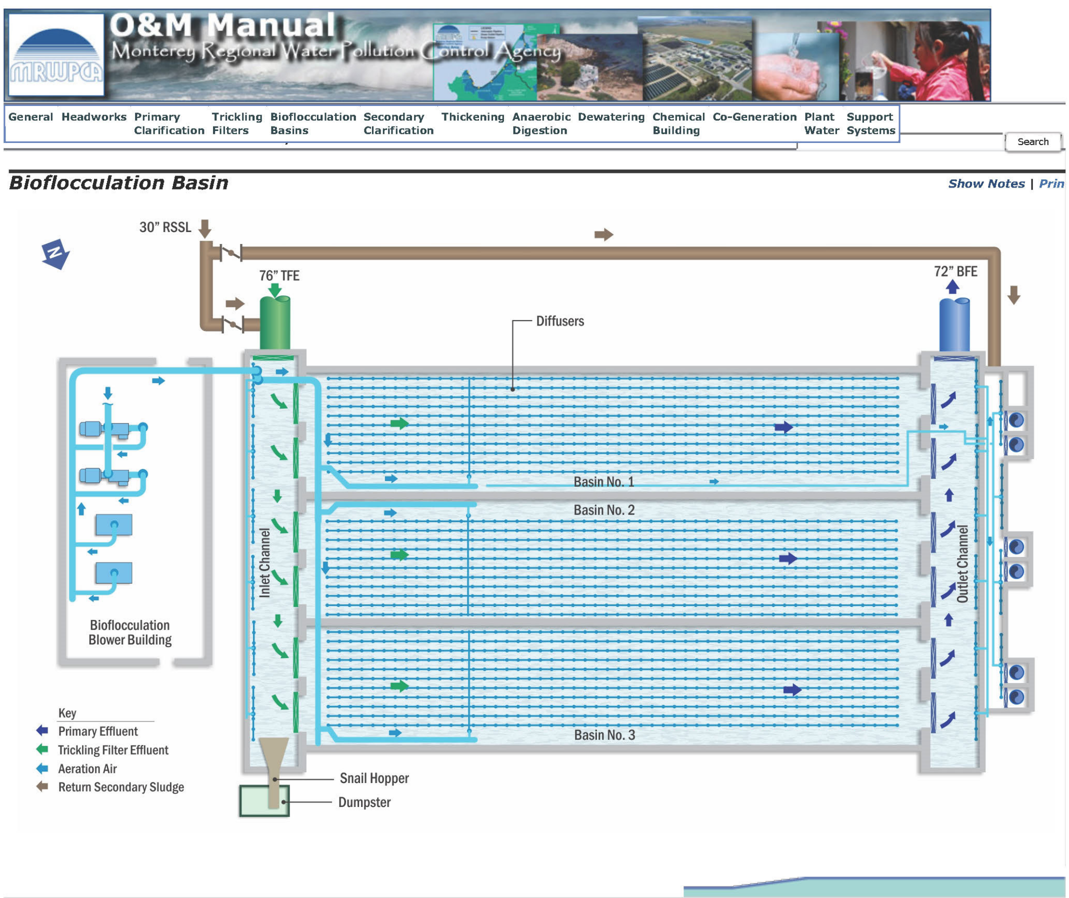


Figure 13-1. Screenshot of M1W's web-based RTP O&M manual. Bioflocculation graphic shown; clicking on components opens windows with photos and equipment lists.

Operator certification for potable reuse treatment facilities is currently in development. Recently a white paper on potable reuse operator training and certification frameworks was published by the California Urban Water Agencies (see **Appendix J** for the white paper). A potable reuse certification program supplement to existing wastewater and water treatment operator certification programs was recommended in the White Paper. In the supplemental program, operators could be trained on multi-barrier advanced water treatment technologies, regulations, advanced monitoring, and emergency response. The operators of the AWP Facility will be certified through the Wastewater Operator Certification Program of the SWRCB Office of Operator Certification. As the SRWCB continues with the development of advanced water treatment certification programs, M1W will follow the certification requirements. M1W intends to have operators of the Project participate in the voluntary reuse operator training and certification program once it is developed.

13.2.2. Demonstration Facility

M1W currently maintains and operates an AWP Demonstration Facility. This facility has pilot-scale treatment equipment that represent the full-scale AWP Facility equipment. The demonstration facility treatment steps are pre-straining, chloramination, ozonation, MF, RO, UV/AOP, and product water stabilization. The demonstration facility has a UV/AOP effluent flow rate of 15 gpm, with a product water stabilization sidestream flowrate of approximately 1 gpm.

The demonstration facility receives secondary effluent from a submerged pump in the secondary clarifier effluent channel. Coarse strainers are used at the demonstration facility to remove snails that could clog pilot-scale equipment. Following straining, sodium hypochlorite is dosed to form chloramines. Following chloramination, the water travels through the ozone, MF, RO, and UV/AOP treatment process skids. After the skids, a sidestream flows through the product water tasting equipment, which includes chemical stabilization via a calcite filter, a cartridge filter, a small UV reactor, and a chiller. The ozone, MF, RO, and UV/AOP treatment skids are automated with PLC control and alarms. These skids, pretreatment equipment (chloramination) and post-treatment equipment are integrated through a master PLC, with interlocks.

In the operating the Demonstration facility, the operators measure several water quality parameters, including critical control points, critical operating points, and constituents in the product water (see **Appendix H** for draft Demonstration facility water quality monitoring schedules and operator checklists). Critical control point monitoring includes MF DIT LRV, RO electrical conductivity LRV, estimated UV/AOP 1,4-dioxane and NDMA removal calculations (based on UVT, UV intensity, and H_2O_2 pump speed), UV/AOP H_2O_2 residual, UVT, and UV power. Critical operating points include secondary effluent nitrite and TOC, ozone system dissolved ozone residual, chloramine residual, MF transmembrane pressure and total coliform removal, RO feed pH and anti-scalant flow, and stabilized pH and conductivity, as well as chemical levels, flows, pressures and meter verification. Product water quality monitoring includes TOC and total nitrogen.

The demonstration facility equipment and the control system mirror the design for the full-scale AWP Facility. M1W staff are developing expertise through operation of the demonstration facility equipment, which will be invaluable for operation and control of the full-scale AWP Facility.

13.3. Operational Strategies and Contingency Plans

M1W staff will follow the SOPs, O&M manuals, and the OOP for operation of the AWP Facility. The SOPs, O&M manuals, and OOP will include plans for normal operation, maintenance, cleanings, equipment failures, power outages, source water control upsets, RTP upsets or changes in performance, AWP Facility upsets or changes in performance, and challenges with conveyance, injection and extraction.

The RTP includes a biological secondary process, comprised of non-nitrifying trickling filters, bioflocculation (solids contact), and clarification. While the secondary process is typically stable, unforeseen upsets may occur which could impact the quality of feed water to the AWP Facility. Occasionally an upset or change in raw water quality requires elevated coagulant doses at the SVRP to reach filter effluent turbidity goals. If needed, coagulant is added to the RTP bioflocculation effluent to improve settleability in the secondary clarifiers. A similar strategy may be employed for the feed water to the AWP Facility, if beneficial (however, the MF system will be able to reliably produce a filtrate water quality significantly lower in solids and colloids over a wider range of feed water qualities compared to the SVRP dual-media granular media filters). The ozone system will further provide pre-treatment to improve MF filterability during poor water quality events.

The RTP trickling filters are operated for carbon removal; however, partial nitrification can occur in the trickling filters under certain conditions. This partial nitrification can result in a nitrite residual in the secondary effluent, which exerts an ozone demand. The ozone system is designed for an elevated concentration of nitrite, and RTP operation may be adjusted to minimize nitrite formation, if necessary.

In the event of a power failure, a backup power system will be used to properly shutdown the AWP Facility and maintain power to key facilities, such as PLCs. If the AWP Facility shuts down (*e.g.*, water quality shutdown alarm, power failure), secondary effluent that would otherwise go to the AWP Facility will be diverted to the SVRP facilities, if sufficient capacity and demand is available, or the ocean outfall. In the event that the AWP Facility product water quality fails to meet regulatory requirements, M1W will respond as described above (see Chapter 12) and in accordance with the Title 22 Criteria. These responses may include repeat sampling, notification to DDW and the RWQCB, and suspension of production. If production is suspended, the AWP Facility will either be placed into recirculation mode while Operators investigate the source of the critical failure and make necessary adjustments or repairs, or the off-specification water will be returned to the RTP headworks or pumped to SVRP. In recirculation mode, AWP Facility production is reduced and the UV/AOP system effluent is diverted back to the MF feed tank for repeat treatment through the MF, RO and UV systems; water from the MF feed tank can be diverted (as needed) to the Waste Equalization Pump Station, where water is returned to the RTP headworks. If off-specification water is sent to the aquifer before production can be suspended, then the steps described in **Section 6** will be followed to ensure a safe interim drinking water supply (*e.g.*, monitoring, management, well-head treatment). An extensive Contingency Plan will be developed and included in the OOP for the PWM AWP Facility.

14. REFERENCES

Agus, E., Lim, MH, Zhang, L, and Sedlak D.L. (2011). *Odorous compounds in municipal wastewater effluent and potable water reuse systems*. Environmental Science & Technology. v 45, pp 9347-9355.

Anderson, P., Denslow, N., Drewes, J.E., Olivieri, A., Schlenk, D., and Snyder, S. (2010). *Monitoring Strategies for Chemicals of Emerging Concern (CECs) in Recycled Water; Recommendations of A Science Advisory Panel*. State Water Resources Control Board, Sacramento, CA, 85 p. with appendices.

Baldwin, J.A. and Cook, M.J. (2003, revised 2004). *Environmental Isotope Studies of Wastewater and Ground Water at Wastewater Land Treatment Sites in Idaho.* Technical Services Division, Idaho Department of Environmental Quality, Boise, ID, 34 p.

Black & Veatch Corporation (B&V). (2010). White's Handbook of Chlorination and Alternative Disinfectants, 5th Ed, Hoboken, NJ: John Wiley & Sons, Inc.

Brezack & Associates, Inc. (2014). *Monterey Regional Water Pollution Control Agency 40-Year Wastewater Flow Projections Report 2014 – 2054*. Prepared for the Monterey Regional Water Pollution Control Agency. June 2014.

California Air Resources Board (CARB). (2009). *State of California Air Resources Board Resolution 09-23, February 26, 2009*: CARB, Sacramento, CA, http://www.arb.ca.gov/regact/2009/nonsemi09/res0923.pdf, 3 p. with attachment.

California Department of Water Resources (DWR). (2004). *Salinas Valley Groundwater Basin, Seaside Area Subbasin, Central Coast Hydrologic Region, Salinas Valley Groundwater Basin*. California's Groundwater, Bulletin 118, last update February 27, 2004.

California Regional Water Quality Control Board, Central Coast Region (RWQCB). (2011). Water Quality Control Plan for the Central Coast Basin June 2011.

California State Water Resources Control Board (SWRCB). (2014). *Water Recycling Criteria*. Title 22, Division 4, Chapter 3, California Code of Regulations.

California Superior Court. (2006). California American Water, Plaintiff, vs. City of Seaside et al., Case No. M66343, Decision, Hon. Roger D. Randall, Ret., Filed March 27, 2006.

City of Scottsdale. (2007). Personal communication with Mr. Maurice Tatlow, July 27, 2007.

Clark, J.F. (2007). *Tracing Recharge Water from Spreading Ponds: A Decade of Studies*, in P. Fox (editor) *Management of Aquifer Recharge for Sustainability*: Proceedings of the 6th International Symposium on Management of Artificial Recharge of Groundwater, ISMAR6, Phoenix AZ USA, October 28th – November 2, 2007: ACACIA Publishing Inc., Phoenix, AZ, pp. 285-295.

Cole, T. Gerald, Consulting Engineer. (2014). *Administrative Draft Memorandum, MRWPCA Groundwater Replenishment Project, AWP Product Water Conveyance Facilities, Project Description and Conceptual Design*. Prepared for Monterey Regional Water Pollution Control Agency. Prepared by G. Gerald Cole, P.E., Consulting Engineer, January 31, 2014, revised Jun 1, 2014.

Coplen, T.B., Hopple, J.K., Bohlke, J.K., Peiser, H.S., Rieder, S.E., Krouse, H.R., Rosman, K.J.R., Ding, T., Cocke, R.D., Jr., Revesz, K.M., Lamberty, K.M., Taylor, P., and De Bievre, P. (2002, revised 2006). *Compilation of Minimum and Maximum Isotope Ratios of Selected Elements in Naturally Occurring Terrestrial Materials and Reagents.* U.S. Geological Survey (USGS) Water Investigations Report 01-4222, USGS, Reston, VA, 98 p.

Crittenden, J. C., R. R. Trussell, D. W. Hand, K. J. Howe, and G. Tchobanoglous. (2012). Water Treatment: Principles and Design, 3rd ed., MWH, John Wiley & Sons, Hoboken, NJ, 1901.

Davis, S.N., Campbell, D.J., Bentley, H.W., and Flynn, T.J. (1996). Ground Water Tracers. National Ground Water Association, Westerville, OH, 200 p.

Davisson, M.L., Hudson, G.B., Clark, J.F., Woodside, G., and Herndon, R. (2004). *Final Report on Isotope Tracer Investigations in the Forebay of the Orange County Groundwater Basin.* Lawrence Livermore National Laboratory (LLNL) Report No. UCRL-TR-201735, LLNL, Livermore, CA, 116 p.

E2 Consulting Engineers, Inc. (2014). *Technical Memorandum, Groundwater Replenishment (GWR) Project, Well Back-Flush Water Pumping, Conveyance and Storage Facilities*. Prepared for Monterey Regional Water Pollution Control Agency, August 7, 2014.

Fugro West, Inc. (Fugro). (1997). *Hydrogeologic Assessment, Seaside Coastal Groundwater Subareas, Phase III Update, Monterey County, California*. Prepared for Monterey Peninsula Water Management District, September 1997.

Gamlin, J.D., Clark, J.F., Woodside, G., Herndon, R. (2001). *Large-scale Tracing of Ground Water with Sulfur Hexafluoride*. Journal of Environmental Engineering, v. 127, pp. 170-174.

Harding Lawson Associates (HLA). (1994). *Draft Final Data Summary and Work Plan, Site 39 – Inland Ranges, Fort Ord, California*. Prepared for Department of the Army, Corps of Engineers, Sacramento, California, May 17, 1994.

Hem, J. D. (1989). *Study and Interpretation of the Chemical Characteristics of Natural Water*. USGS Water Supply Paper 2254, 263 p., 1989.

Henderson, P. (1982). *Inorganic Geochemistry.* Pergamon Press, New York, NY, 353 p.

Hounslow, A.W. (1995). *Water Quality Data: Analysis and Interpretation*. Lewis Publishers, Boca Raton, FL, 397 p.

HydroMetrics, WRI (HydroMetrics). (2015). Technical Memorandum, GWR Project EIR: Project Modeling Results, To: Bob Holden/MRWPCA, January 12, 2015.

HydroMetrics, WRI (HydroMetrics). (2014a). Seaside Groundwater Basin, Salt & Nutrient Management Plan, Prepared for Monterey Peninsula Water Management District, June 2014.

HydroMetrics, WRI. (HydroMetrics). (2014b). Water Year 2014, Seawater Intrusion Analysis Report, Seaside Basin, Monterey County, California, Prepared for Seaside Basin Watermaster, December 2014.

HydroMetrics, LLC. (HydroMetrics). (2009). Seaside Groundwater Basin Modeling and Protective Groundwater Elevations, Prepared for Seaside Basin Watermaster, November 6, 2009.

Jones & Stokes. (2006). Draft Monterey Peninsula Water Management District Aquifer Storage and Recovery Project, Environmental Impact Report/Environmental Assessment. Prepared for Monterey Peninsula Water Management District, SCH #2004121065, March 2006.

Kendall, C., and Krabbenhoft, D.P. (1995). Applications of Isotopes to Tracing Sources of Solutes and Water in Shallow Systems. IN *Groundwater Management: Proceedings of the Symposium Sponsored by the Water Resources Engineering Division, American Society of Civil Engineers*, editor R. J. Charbenau, 390 – 395. New York: American Society of Civil Engineers, 1995.

Kendall, C., Sklash, M.G, and Bullen, T.B. (1995). Isotope Tracers of Water and Solute Sources in Catchments. IN *Solute Modeling I: Catchment Systems*, editor T.E. Trudgill, 261 – 303. New York: Wiley, 1995.

Kendall, C., Young, M.B., and Silva, S.R. (2010). *Applications of Stable Isotopes for Regional to National-Scale Water Quality and Environmental Monitoring Programs*: in J.B. West, G.J. Bowen, T.E. Dawson, and K.P. Tu (editors), *Isoscapes: Understanding Movement, Pattern, and Process on Earth through Isotope Mapping*. Springer, New York, NY, pp. 89-111.

Kloppmann, W., Chikurel, H., Picot, G., Guttman, J., Pettenati, M., Aharoni, A., Guerrot, C., Millot, R., Gaus, I., and Wintgens, T. (2009). *B and Li Isotopes as Intrinsic Tracers for Injection Tests in Aquifer Storage and Recovery Systems*. Applied Geochemistry, v. 24, pp. 1214-1223.

Kloppmann, W., Vengosh, A., Guerrott, C., Millot, R., and Pankratov, I. (2008a). *Isotope and Ion Selectivity in Reverse Osmosis Desalination: Geochemical Tracers for Man-made Freshwater*. Environmental Science & Technology, v. 42, pp. 4723-4731.

Kloppmann, W., Van Houtte, Picot, G., Vandenbohede, A., Lebbe, I., Guerrot, C., Millot., Gaus, I., and Wintgens, T. (2008b). Monitoring Reverse Osmosis Treated Wastewater Recharge into a Coastal Aquifer by Environmental Isotopes (B, Li, O, H). Environmental Science & Technology, v. 42, pp. 8759-8765.

Lawrence Livermore National Laboratory. (2016) Draft *Final Report: Tracer Alternative Research Project*. LLNL-TR- 686918, March 2016.

Lee, W. (2009). *Selection and Testing of Tracers for Measuring Travel Times in Groundwater Aquifers Augmented with Reclaimed Water*. WateReuse Foundation, Alexandria, 74 p.

Monterey Peninsula Water Management District (MPWMD). (2015). *Seaside Basin Watermaster Memorandum 2015-02, Water Year 2015, Groundwater-Quality and Groundwater-Level Data Collected for the Seaside Groundwater Basin Watermaster*. November 6, 2015.

Monterey Regional Water Pollution Control Agency (MRWPCA). (2015). *MRWPCA SCADA and Power Overview*. November 8, 2015.

Padre Associates, Inc. (2002). *Summary of Operations, Well Construction and Testing, Santa Margarita Test Injection Well*. Prepared for Monterey Peninsula Water Management District (MPWMD), May 2002.

Panno, S.V., Hackley, K.C., Hwang, H.H., Greenberg, S., Krapac, I.G., Landsberger, S., and O'Kelly, D.J. (2002). *Source Identification of Sodium and Chloride Contamination in Natural Waters: Preliminary Results*. Southern Illinois University, Carbondale, IL, www.siu.edu/orda/igc/proceedings/02/panno.pdf, 25 p.

Panno, S.V., Hackley, K.C., Hwang, H.H., Greenberg, S.E., Krapac, I.G., and O'Kelly, D.J. (2005). *Characterization and Identification of Na-Cl Sources in Ground Water*: Ground Water, v. 44, n. 2, pp. 176-187.

Pueblo Water Resources (Pueblo). (2012). *Summary of Operations, Well Construction and Testing, Seaside Middle School Test Well*. Prepared for Monterey Peninsula Water Management District, March 2012.

Rajal, V.B, McSwain, B.S., Thompson, D.E., Leutenegger, C.M., Wuertz, S. (2007). *Molecular quantitative analysis of human viruses in California stormwater*. Water Research, 41: 19, pg. 4287-4298.

Rose, J.B., Farrah, S.R., Harwood, V.J., Levine, A.D., Lukasik, J., Menendez, P. and Scott, T.M. (2004). *Reduction of Pathogens, Indicator Bacteria, and Alternative Indicators by Wastewater Treatment and Reclamation Processes*. WERF 00-PUM-2T. Water Environment Research Foundation, Alexandria, VA.

Santella, N., Ho, D.T., Schlosser, P., and Stute, M. (2007). *Widespread Elevated Atmospheric SF_6 Mixing Ratios in the Northeastern United States: Implications for Groundwater Dating*: Journal of Hydrology, v. 349, issues 1-2, pp. 139-146.

Scheehle, E. (2008). *Sulfur Hexafluoride (SF_6) Use in Non-Utility and Non-Semiconductor Applications*: Draft Concept Paper, California Air Resources Board, Sacramento, CA, 9 p., http://www.arb.ca.gov/cc/sf6nonelec/sf6-draft-concept-paper.pdf.

Schladow, S.G. and Clark, J.F. (2008). *Use of Tracers to Quantify Subsurface Flow Through a Mining Pit*: Ecological Applications, v. 18, n. 8, pp. A55-A71.

Seaside Basin Watermaster. (2014). *Seaside Basin Watermaster Annual Report – 2014*, December 3, 2014.

Silva, S.R., Ging, P.B., Lee, R.W., Ebbert, J.C., Tesoriero, A.J., and Inkpen, E.L. (2002). *Forensic Application of Nitrogen and Oxygen Isotopes in Tracing Nitrate Sources in Urban Environments*. Environmental Forensics, v. 3, pp 125-130.

Snyder, S. (2007). Endocrine disruptors & pharmaceuticals: implications for the water industry. Presentation at the California State Water Resources Control Board, Sacramento, California: May.

Todd Groundwater. (2015a). *Recharge Impacts Assessment Report*, GWR Project, Prepared for Monterey Regional Water Pollution Control Agency, March 2015.

Todd Groundwater. (2015b). Draft *Hydrogeologic Field Investigation: MRWPCA Monitoring Well 1 (MW-1) Installation, Groundwater Quality Characterization, and Geochemical Assessment*, Monterey Peninsula Groundwater Replenishment (GWR) Project, Prepared for Monterey Regional Water Pollution Control Agency, February 28, 2015.

Trussell, R.R., Salveson, A., Snyder, S.A., Trussell, R.S., Gerrity, D., Pecson, B. (2013). *Potable Reuse: State of the Art Science Report and Equivalency Criteria for Treatment Trains*. WRRF Project 11-02, Alexandria, VA.

Trussell Technologies, Inc. (2014a). *Report: Pure Water Monterey Groundwater Recharge Project: Advanced Water Treatment Facility Piloting*, Prepared for MRWPCA, December 2014.

Trussell Technologies, Inc. (2014b). *Pure Water Monterey Groundwater Recharge Project: Source Water and Treated Water Quality*. Technical Memorandum. Prepared for the MRWPCA and MPWMD. September 2014.

Trussell Technologies, Inc. (2015). Technical Memorandum *Ocean Plan Compliance Assessment for the Pure Water Monterey Groundwater Replenishment Project*. Prepared for the MRWPCA, January 2015.

Trussell Technologies, Inc. (2004). *Using Anthropogenic Chemicals as Tracers in Groundwater*: A technical Memorandum. Prepared for the Los Angeles County Sanitation Districts, Whittier, CA, 9 p. with tables and figures.

U.S. Environmental Protection Agency U.S. EPA. (2010). Long Term 2 Enhanced Surface Water Treatment Rule Toolbox Guidance Manual, EPA 815-D-09-001, Washington, DC.

U.S. EPA. (2006a). National Primary Drinking Water Regulations: Long Term 2 Enhanced Surface Water Treatment Rule; Final Rule. 4 CFR Parts 9, 141, and 142.

U.S. EPA. (2006b). *Ultraviolet Disinfection Guidance Manual for the Final Long Term 2 Enhanced Surface Water Treatment Rule*. EPA 815-R-06-007. Washington, D.C.

U.S. EPA. (2006c). *High GWP Gases and Climate Change*: U.S. EPA, Washington, DC, 3 p., http://www.epa.gov/highgwp/scientific.html.

U.S. EPA. (2005). Membrane Filtration Guidance Manual, EPA 815-R-06-009, Washington, D.C.

U.S. EPA. (1998a). National Primary Drinking Water Regulations: Disinfectants and Disinfection Byproducts; Final Rule. 40 CFR Parts 9, 141, and 142

U.S. EPA. (1998b). National Primary Drinking Water Regulations: Interim Enhanced Surface Water Treatment. 40 CFR Parts 9, 141, and 142.

U.S. EPA. (1990). Guidance Manual for Compliance with the Filtration and Disinfection Requirements for Public Water Systems using Surface Water Sources, EPA/CN-68-01-6989, Washington, D.C.

Williams, G.J., Triolo, S., and Kenny, J. (2014). DRAFT – Communication MRWPCA – *Groundwater Replenishment (GWR) Project - Post-treatment Stabilization Bench-Top Protocol*. Memorandum from Trussell Technologies, Inc. to Todd Groundwater, 2 p., 2014.

Yates, Eugene B., Feeney, Martin B., Rosenberg, Lewis I. (2005). *Seaside Groundwater Basin: Update on Water Resource Conditions*. Prepared for Monterey Peninsula Water Management District, April 24, 2005.