

MRWPCA

TER

MANAGEMENT DISTRICT

Final Engineering Report

Volume II: Appendices for Engineering Report

Pure Water Monterey Groundwater Replenishment Project

Revised April 2019











FINAL ENGINEERING REPORT

VOLUME I: ENGINEERING REPORT

MONTEREY ONE WATER PURE WATER MONTEREY GROUNDWATER REPLENISHMENT PROJECT

April 2019



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National Water Research Institute Independent Advisory Panel Reports

NATIONAL WATER RESEARCH INSTITUTE

Draft Final Report

of the October 21-22, 2013, Meeting of the

Independent Advisory Panel

for

Monterey Peninsula Groundwater Replenishment Project

Prepared for:

Monterey Regional Water Pollution Control Agency 5 Harris Court, Building D Monterey, California 93940

January 7, 2014

DISCLAIMER

This report was prepared by an NWRI Independent Advisory Panel, which is administered by the National Water Research Institute (NWRI). Any opinions, findings, conclusions, or recommendations expressed in this report were prepared by the Panel. This report was published for informational purposes.

ABOUT NWRI

A 501c3 nonprofit organization, the National Water Research Institute (NWRI) was founded in 1991 by a group of California water agencies in partnership with the Joan Irvine Smith and Athalie R. Clarke Foundation to promote the protection, maintenance, and restoration of water supplies and to protect public health and improve the environment. NWRI's member agencies include Inland Empire Utilities Agency, Irvine Ranch Water District, Los Angeles Department of Water and Power, Orange County Sanitation District, Orange County Water District, and West Basin Municipal Water District.

For more information, please contact:

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Jeffrey J. Mosher, Executive Director Gina Melin Vartanian, Editor

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ACRONYMS

AF	Acre foot
AI	Aggressiveness Index
AOC	Assimilable organic carbon
AOP	Advanced oxidation processes
AWTP	Advanced water treatment plant
BAF	Biologically active filtration
Cal-Am	California American Water Company
ССРР	Calcium Carbonate Precipitation Potential
CDPH	California Department of Public Health
CEQA	California Environmental Quality Act
CPUC	California Public Utilities Commission
CSIP	Castroville Seawater Intrusion Project
EIR	Environmental Impact Report
GWR	Groundwater replenishment
LSI	Langlier Saturation Index
MF	Microfiltration
MPWMD	Monterey Peninsula Water Management District
MRWPCA	Monterey Regional Water Pollution Control Agency
NWRI	National Water Research Institute
RO	Reverse osmosis
TDS	Total dissolved solids
UV	Ultraviolet light
WPA	Water Purchase Agreement

1. PURPOSE AND HISTORY OF THE PANEL

In 2013, the National Water Research Institute (NWRI)¹ of Fountain Valley, California, a 501c3 nonprofit, appointed local and national water industry experts to an Independent Advisory Panel (Panel) to provide expert peer review of the proposed Monterey Peninsula Groundwater Replenishment (GWR) Project being considered by the Monterey Regional Water Pollution Control Agency (MRWPCA)² and its project partner, the Monterey Peninsula Water Management District (MPWMD).³

The GWR project is expected to create a sustainable source of water supply by using highlytreated water from a new advanced water treatment plant (AWTP) to augment local drinking water aquifers. Specifically, the project involves developing and conveying highly-treated water from the AWTP to the Seaside Basin using a series of shallow (i.e., vadose zone) and deep injection wells. Once injected into the Seaside Basin, the treated water would mix with the groundwater present in the aquifers and be stored for future use.

This additional supply would replenish the aquifers and increase the yield of the Seaside Basin for local pumpers, including the primary pumper, California American Water Company (Cal-Am). The GWR project will be designed to provide 3,500 acre-feet (AF) per year of high-quality replacement water to Cal-Am for delivery to its customers in the Monterey District service area, thereby enabling Cal-Am to reduce its diversions from the Carmel River system by the same amount.

The Panel is tasked with reviewing the proposed GWR project and providing findings and recommendations on project alternatives, alternative evaluation, and associated bench and pilot studies. Examples of issues that the Panel may address include public health and safety, advanced water treatment design issues, permitting and regulatory requirements, and public outreach and advocacy.

The Panel is made up of four experts in areas related to GWR projects, such as engineering, regulatory criteria, public health, hydrogeology, and other relevant fields. Panel members include:

- George Tchobanoglous, PH.D., P.E., NAE, University of California, Davis (Davis, CA)
- Jean-François Debroux, Ph.D., Kennedy/Jenks Consultants (San Francisco, CA)
- Martin B. Feeney, P.G., CHG, Consulting Hydrogeologist (Santa Barbara, California)
- Michael P. Wehner, MPA, REHS, Orange County Water District (Fountain Valley, California)

Background information about the NWRI Panel process can be found in Appendix A, and brief biographies of the Panel members can be found in Appendix B.

¹ <u>http://www.nwri-usa.org/</u>.

² <u>http://www.mrwpca.org/</u>.

³ <u>http://www.mpwmd.dst.ca.us/</u>.

2. PANEL MEETING

A 2-day meeting of the Panel was held on October 21-22, 2013, at the administrative offices of MRWPCA in Monterey, California. This meeting represents the first time the Panel has met to review the proposed GWR project.

2.1 Background Material

Prior to the meeting, the following background material and reports were provided to the Panel:

- a) Draft Memorandum dated May 7, 2013, from Phyllis Stanin, Principal Geologist/Vice President of Todd Engineers, to Bob Holden, Principal Engineer at MRWPCA, providing details on GWR project elements in support of the Environmental Impact Report (EIR) process.
- b) Document dated May 30, 2013, and titled "NOTICE OF PREPARATION: Monterey Peninsula Groundwater Replenishment Project Environmental Impact Report."
- c) Document dated August 21, 2013, that details the following from a bifurcation motion:
 - Findings Required for GWR Decision Pursuant to Settlement Agreement.
 - Procedural Schedule and Scope Pursuant to Settlement Agreement.
- d) Letter dated October 10, 2013, to Mayor Jason Burnett of the City of Monterey (California) from Keith Israel, General Manager of MRWPCA, providing a list of key impediments to the timely completion of GWR.
- e) Letter dated October 10, 2013, to Bob Holden, Principal Engineer at MRWPCA, from Derrik Williams, President of HydroMetrics Water Resources, Inc., that discusses the modeling completed in support of GWR project development efforts.
- f) A schedule of GWR project tasks and responsible parties from June 2014 to August 2014.

2.2 Meeting Agenda

Staff from NWRI and MRWPCA collaborated on the development of the agenda for the Panel meeting, which is included in Appendix C. The agenda was based on meeting the following specific objectives:

- Develop a working understanding of the proposed GWR project.
- Identify proposed project strengths and areas where more information is needed.
- After the meeting, prepare a brief summary of project questions and obstacles for use by the GWR project team.

The majority of the meeting was devoted to presentations made by MRWPCA staff and the project team. Time was provided for the Panel to ask questions and engage in discussion following each presentation. The presentations included:

- Panel Charge
- Overview of the Project Partners (MPWMD and MRWPCA)
- Overview of Related and Planned Projects
- GWR Project
- Bench Testing
- Pilot Testing and Sampling Plan
- Product Water Conveyance
- GWR Project Injection
- Public Outreach

Once the presentations were concluded, the Panel met in a closed session to discuss the information presented and address questions provided by MRWPCA and the project team. Before the meeting adjourned, the Panel prepared a report outline and drafted preliminary findings and recommendations, which have been expanded upon in this report.

2.3 Meeting Attendees

All Panel members attended this meeting with the exception of George Tchobanoglous. Other attendees included NWRI staff, MRWPCA staff, MPWMD staff, project team members, representatives from agency partners, and regulators. A complete list of Panel meeting attendees is included in Appendix D.

3. Observations and Findings

The principal observations and findings derived from the material presented and discussed during the meeting are provided below. They are organized under the following categories:

- General
- Project Goals and Outcomes
- Schedule
- GWR Source Waters
- Treatment
- Monitoring
- Pilot Study
- Conveyance
- California Environmental Quality Act (CEQA)
- Groundwater Items
- Brine
- Public Outreach

3.1 General

The Panel compliments MRWPCA and the project team for their excellent presentations, which were well-prepared and professional. The Panel also appreciated the background documents provided by MRWPCA.

3.2 **Project Goals and Outcomes**

• It is critical that MRWPCA understand all the criteria to allow the California Public Utilities Commission (CPUC) to approve the Water Purchase Agreement (WPA). The Panel requests that MRWPCA provide its interpretation of the criteria in the settlement agreement. The interpretation should be accompanied by a plan, including a schedule to meet each criterion. It is not appropriate for the Panel to develop this interpretation.

The Panel can evaluate MRWPCA's plan and progress in meeting these criteria. Once all the criteria are met, the Panel can provide a letter stating that the Panel believes MRWPCA has met the criteria as interpreted by MRWPCA.

- The Panel agrees that the GWR project is consistent with integrated water management planning as described in the California Water Plan.
- The Panel concurs that a draft engineer's report should be developed and incorporated into the schedule, as well as reviewed by the Panel. Allowing the California Department of Public Health (CDPH) to review the draft report would help in their conceptual approval of the project (which is necessary to satisfy CPUC's WPA approval).

- The Panel is concerned that the project (including conveyance and injection costs) could be greater than \$3,000 per AF. Preliminary estimates may be useful.
- The variability and sustainability of influent flows are of concern in light of additional conservation efforts, impacts of higher rates, inflow and infiltration, agricultural practices, and so on. Additional analysis, including seasonal flows, would be helpful in determining future flows. A breakdown between Salinas and the peninsula may be useful. Also, what is the likelihood of acquiring rights to the identified sources?
- In a time of shortage, how would water be allocated between the Castroville Seawater Intrusion Project (CSIP) and GWR obligations?
- The Panel requests information on flow consistency and justification between source water availability, treatment, conveyance, and injection (e.g., why is injection well capacity being doubled?). The Panel recognizes that some items are upsized. It is possible to upsize all the items by similar amounts or to present a plan for upsizing components and long-term usage.

3.3 Schedule

- The Panel is aware of the tight schedule that MRWPCA is trying to meet. MRWPCA should coordinate Panel meetings with the review of GWR project tasks and milestones to expedite this schedule.
- The Panel would find it useful to have a numbered list of tasks, with a paragraph describing each task and Gantt chart to better understand how elements tie together, what the milestones are, what review is needed, and so on. This format will facilitate the Panel's review of MRWPCA's efforts related to GWR project tasks.

3.4 GWR Source Waters

- Regarding the presentation on the Blanco Drain, the Panel does not see a clear use of this water resource. MRWPCA should develop a plan for how Blanco Drain, if needed, is incorporated into the GWR project. In addition, a clear use for the 1/4 Reclamation Ditch water is not apparent.
- Regarding wastewater flows, is there a projection on when the reduction in flows will flatten out? Flows may drop more with increased water rates.

3.5 Treatment

• The Panel believes that ozone-biologically active filtration (BAF)-microfiltration (MF)reverse osmosis (RO)-ultraviolet-based advanced oxidation processes (UV/AOP) to be appropriate to treat all sources that have gone through secondary treatment.

- To maintain appropriate levels of total dissolved solids (TDS) in the irrigation water, consider sending advanced treated water to the tertiary pond to control salinity if high TDS source water is sent to the plant headworks.
- MRWPCA should evaluate the possibility of the advanced treatment plant being larger than 3,500 AF. For example, a larger plant can treat water for the growers (rather than for economic growth) and could treat periods of high flows. Additional capacity in a larger advanced treatment plant could be used to offset the reduced availability of source water during dry years and droughts.
- Is the priority for source water treatment the following: Agricultural wash, Salinas stormwater, peninsula stormwater, 1/4 Reclamation Ditch, and Blanco Drain? A priority for the source waters should be established for the project.
- Is there a plan to stabilize the high-purity water before conveyance and injection? Is there a target finished water quality related to stability (e.g., Langlier Saturation Index [LSI], Aggressiveness Index [AI], and Calcium Carbonate Precipitation Potential [CCPP])? The appropriate stability index should be matched to the planned infrastructure materials and the prevention of metals mobilization in the aquifer.
- Is there an intent to maintain a chlorine residual in the finished water pipeline? The wells may perform better, especially if significant amounts of assimilable organic carbon (AOC) are present in the finished water.

3.6 Monitoring

- What is the rationale for quarterly monitoring of the source waters? Will the wet periods or specific crop washing be captured sufficiently?
- Regarding source water monitoring, the Panel recommends that MRWPCA provide a proposed list of constituents to change from quarterly monitoring to either annual monitoring or no monitoring. In addition, a brief narrative on the rationale to remove the constituents would be helpful for the Panel's review. The Panel would review the list and develop recommendations for submission to CDPH.
- Regarding monitoring for the pilot study, the Panel recommends that MRWPCA provide the proposed monitoring scheme for the pilot study, including constituents, locations, frequency, and related information. A brief narrative providing the project team's rationale would be helpful.

3.7 Pilot Study

- The Panel looks forward to seeing the early results from the pilot study.
- Will the pilot study results be used to determine if ozone and/or BAF are needed? Is this a goal of the pilot study?

3.8 Conveyance

• Due to the treatment employed, the stability of the water will need to be addressed with regards to pipeline material and corrosion. A stabilized water will be important for groundwater injection.

3.9 California Environmental Quality Act (CEQA)

• The Panel was impressed with the thoroughness of the CEQA efforts and encourages MRWPCA to continue these efforts as the project moves forward.

3.10 Groundwater Items

- The stability of the water will need to be evaluated for both aquifer systems (the Paso Robles and Santa Margarita formations).
- The groundwater sampling list will be forthcoming for Panel review. The Panel concurs that the list should include ordnance-related compounds, including perchlorate.
- The location analysis seems well handled in balancing all the components. The hydraulic modeling investigations (particle tracking) supported the analysis.
- Some sensitivity analysis on the modeling could be conducted on the reduced thickness of the Santa Margarita formation as the formation is not uniform.
- Costs for wells need to include costs for above-ground well facilities.
- The EIR should consider noise and visual impacts of the above-ground appurtenances.
- Is the use of one monitoring well in the Paso Robles because of the known heterogeneity? It would be helpful to justify the use of only one monitoring well.
- The well exploration program should include cased-hole geophysics, such as induction and gamma logging.
- Regarding the stability of RO source water quality: How will finished water quality impact wells? How will chemical reactions with aquifer materials be evaluated? Is there a need for geochemical modeling?

3.11 Brine

• MRWPCA should develop a brine management plan that includes discharge, seawater desalination brine, GWR brine, blending of brines, diffuser redesign, and so on.

3.12 Public Outreach

- The Panel recognizes that public outreach is a critical component of the project.
- Outreach to growers will be an important consideration as the project moves forward.
- It will be important to work with project partners and to understand the roles of each of the partners.
- Continued coordination between project proponents and tours of the Orange County Water District's Groundwater Replenishment System will be useful and beneficial.
- The communication plan should be finalized in coordination with project partners.
- There is a need to develop a consistent vocabulary and message for various agency representatives as they discuss the project at public meetings.
- As the timeline moves towards the completion of the project, the need for outreach efforts will intensify.
- There is a need to develop a visitor program for pilot facilities. The ability for visitors to view the pilot facilities would be useful, as observed in Orange County and San Diego.
- The use of a website and social media tools should be maintained throughout the effort.
- The Panel recommends that progress with the outreach program be reviewed at future Panel meetings.

APPENDIX A: PANEL BACKGROUND

About NWRI

For over 20 years, NWRI – a science-based 501c3 nonprofit located in Fountain Valley, California – has sponsored projects and programs to improve water quality, protect public health and the environment, and create safe, new sources of water. NWRI specializes in working with researchers across the country, such as laboratories at universities and water agencies, and are guided by a Research Advisory Board (representing national expertise in water, wastewater, and water reuse) and a six-member Board of Directors (representing water and wastewater agencies in Southern California).

Through NWRI's research program, NWRI supports multi-disciplinary research projects with partners and collaborators that pertain to treatment and monitoring, water quality assessment, knowledge management, and exploratory research. Altogether, NWRI's research program has produced over 300 publications and conference presentations.

NWRI also promotes better science and technology through extensive outreach and educational activities, which includes facilitating workshops and conferences and publishing White Papers, guidance manuals, and other informational material.

More information on NWRI can be found online at www.nwri-usa.org.

About NWRI Panels

NWRI also specializes in facilitating Independent Advisory Panels on behalf of water and wastewater utilities, as well as local, county, and state government agencies, to provide credible, objective review of scientific studies and projects in the water industry. NWRI Panels consist of academics, industry professionals, government representatives, and independent consultants who are experts in their fields.

The NWRI Panel process provides numerous benefits, including:

- Third-party review and evaluation.
- Scientific and technical advice by leading experts.
- Assistance with challenging scientific questions and regulatory requirements.
- Validation of proposed project objectives.
- Increased credibility with stakeholders and the public.
- Support of sound public-policy decisions.

NWRI has extensive experience in developing, coordinating, facilitating, and managing expert Panels. Efforts include:

- Selecting individuals with the appropriate expertise, background, credibility, and level of commitment to serve as Panel members.
- Facilitating hands-on Panel meetings held at the project's site or location.

• Providing written report(s) prepared by the Panel that focus on findings and recommendations of various technical, scientific, and public health aspects of the project or study.

Over the past 5 years, NWRI has coordinated the efforts of over 20 Panels for water and wastewater utilities, city and state agencies, and consulting firms. Many of these Panels have dealt with projects or policies involving groundwater replenishment and potable (indirect and direct) reuse. Specifically, these Panels have provided peer review of a wide range of scientific and technical areas related water quality and monitoring, constituents of emerging concern, treatment technologies and operations, public health, hydrogeology, water reuse criteria and regulatory requirements, and outreach, among others.

Examples of recent NWRI Panels include:

- Groundwater Recharge Scientific Study for the LOTT Clean Water Alliance (WA)
- Groundwater Replenishment System Program Review for the Orange County Water District (CA)
- **Examining the Criteria for Direct Potable Reuse** for Trussell Technologies (CA) and WateReuse Research Foundation (VA)
- Evaluating Potable Reuse for the Santa Clara Valley Water District (CA)
- Indirect Potable Reuse/Reservoir Augmentation Project Review for the City of San Diego (CA)
- **BDOC as a Surrogate for Organics Removal in Groundwater Recharge** for the California Department of Health Services (CA)
- Effluent Master Plan for Tucson Water (AZ)
- **Groundwater Replenishment Project Review** for the Los Angeles Department of Water and Power (CA)

More information about the NWRI Independent Advisory Panel Program can be found on the NWRI website at <u>http://nwri-usa.org/Panels.htm</u>.

APPENDIX B: PANEL BIOGRAPHIES

GEORGE TCHOBANOGLOUS, PH.D., P.E., NAE

Professor Emeritus University of California, Davis (Davis, CA)

For over 35 years, wastewater expert George Tchobanoglous has taught courses on water and wastewater treatment and solid waste management at the University of California, Davis, where he is Professor Emeritus in the Department of Civil and Environmental Engineering. He has authored or coauthored over 500 publications, including 22 textbooks and eight engineering reference books. Tchobanoglous has been past President of the Association of Environmental Engineering and Science Professors and currently serves as a national and international consultant to both government agencies and private concerns. Among his honors, he received the Athalie Richardson Irvine Clarke Prize from NWRI in 2003, was inducted to the National Academy of Engineers in 2004, and received an Honorary Doctor of Engineering degree from the Colorado School of Mines in 2005. In 2012, he received the first Excellence in Engineering Education Award from AAEE and AEESP. In 2013, he was selected as the AAEE and AEESP Kappe Lecturer. Tchobanoglous received a B.S. in Civil Engineering from the University of the Pacific, an M.S. in Sanitary Engineering from the University of California, Berkeley, and a Ph.D. in Environmental Engineering from Stanford University.

JEAN-FRANÇOIS DEBROUX, Ph.D.

Director, Advanced Technologies Group Kennedy/Jenks Consultants (San Francisco, CA)

At Kennedy/Jenks Consultants, Jean Debroux serves as Director of the Advanced Technologies Group, which was formed to solve technologically challenging problems. Part of this effort includes performing pilot and field studies for regulated and emerging contaminants and evaluates the cost impacts of complying with Safe Drinking Water Act regulations. A water quality expert, Debroux has extensive experience and expertise working with water utilities and research organizations in water treatment and water reuse issues, and is an active member of the WateReuse Foundation, where he serves on the Research Advisory Committee. Debroux received a B.S. in Chemical Engineering from the University of South Florida, and both an M.S. in Environmental Engineering and Ph.D. in Civil Engineering from the University of Colorado, Boulder. In addition, he attended the Environmental Management Institute at Tufts University and has served as a Post-Doctoral Research Fellow and Lecturer at Stanford University and as a Research Fellow at Université de Poitiers, France.

MARTIN B. FEENEY, P.G., CHG

Consulting Hydrogeologist (Santa Barbara, California)

Martin Feeney has been a consulting hydrogeologist since 1997, providing hydrogeologic consulting services to water agencies, private industry, and engineering firms. Prior to this, he served as hydrogeologist at various consulting firms such as Balanced Hydrologics, Inc. and Fugro West, Inc., where he provided analysis of groundwater basins, developed groundwater flow and transport, and developed saline groundwater source for desalination plants, injection wells/artificial recharge programs, and underground storage tank site assessment and remediation. He has also been involved in numerous groundwater resources and water well projects throughout California, working for groups such as Monterey County, Salinas Valley, Santa Clara Valley Water District, Ventura County, and various others. Feeney received a B.S. in Earth Sciences from the University of California, Santa Cruz and an M.S. in Environmental Planning (Groundwater) from California State University.

MICHAEL P. WEHNER, REHS, MPA

Assistant General Manager Orange County Water District (Fountain Valley, California)

Mike Wehner has over 40 years of experience in water quality control and water resources management. He has been with the Orange County Water District (OCWD) since 1991, currently serving as Assistant General Manager. Among his responsibilities, he directly manages the Water Quality and Technology Group, including Laboratory, Water Quality, Hydrogeology, Research and Development, and Health and Regulatory Affairs Departments. He is also involved with numerous aspects with the Groundwater Replenishment System (the nation's largest IPR project), including providing technical guidance on treatment and quality, as well as managing monitoring programs for the purification facility and receiving groundwater. He was also manager of OCWD's 8-year Santa Ana River Water Quality and Health Study, which evaluated the impact of using effluent-dominated river waters for groundwater recharge. Prior to joining OCWD, Wehner spent 20 years with the Orange County Health Care Agency, where he managed the Water Quality Control Section of Environmental Health. He is a Registered Environmental Health Specialist in California and is an internationally recognized expert in water quality, public health, and advanced water treatment processes, serving on expert panels in the United Kingdom, Australia, and Singapore, as well as for California and U.S. agencies and foundations. He received a Masters of Public Administration from California State University Long Beach and a B.S. in Biological Sciences from the University of California, Irvine.

NATIONAL WATER RESEARCH INSTITUTE

Independent Advisory Panel Meeting for Monterey Regional Water Pollution Control Agency on Monterey Peninsula Groundwater Replenishment Project

Preliminary Meeting Agenda October 21-22, 2013

Location

Monterey Regional Water Pollution Control Agency Administrative Offices 5 Harris Court, Bldg. D Monterey, CA 93940 (831) 372-3367 <u>On-Site Contacts:</u> Jeff Mosher (NWRI) Cell: (714) 705-3722 Mike McCullough (MRWPCA) Office: (831) 594-2597

Meeting Objectives:

- Develop a working understanding of the Proposed Groundwater Replenishment Project.
- Identify proposed project strengths and areas where more information is needed.
- After the meeting, prepare a brief summary of project questions and obstacles for use by the GWR team.

Monday, October 21, 2013

10:00 am	 Welcome and Introductions CDPH (Jan Sweigert) RWQCB (Harvey Packard) MPWMD (Dave Stoldt) MRWPCA (Keith Israel) 	Jeff Mosher, NWRI Mike Wehner, Panel
10:30 am	Panel Charge - Goals and Objectives - Panel Outcomes	Keith Israel, MRWPCA
10:45 am	Overview of Partners: MPWMD and MRWPCA	Larry Hampson, MPWMD and Bob Holden, MRWPCA
11:00 am	 Overview of Related and Planned Projects Monterey County Water Situation (Bob Holden) Water Solutions (Larry Hampson) 	Bob Holden and Larry Hampson

11:30 am	 Groundwater Replenishment Project (GWR) Source Water Characterization Quantities and Locations (Bob Holden) Qualities (Gordon Williams) Secondary, Tertiary, Ag Wash Water, Blanco Drain, Reclamation Ditch Sampling Plan 	Bob Holden
12:30 - 1:00 pm	WORKING LUNCH	
1:00 pm	Bench Testing - Secondary, Ag Wash water, Blanco Drain, and Secondary + Ag Wash water	Gordon Williams, Trussell
2:00 pm	Pilot Testing and Sampling Plan - Secondary and Advanced treatment	Kevin Alexander, SPI
2:45 pm	BREAK	
3:00 pm	Product Water Conveyance	Alison Imamura, DDA
3:50 pm	Panel Deliberations	Mike Wehner, Panel
5:00 pm	Adjourn	
Tuesday, October	22, 2013	
8:30 am	Summary of Day 1	Jeff Mosher, NWRI Mike Wehner, Panel
8:40 am	Groundwater Replenishment Project - Injection - Seaside Groundwater Basin - Injection Sites - Modeling - Monitoring Well - Injections Wells	Phyllis Stanin, Todd Engineers
9:45 am	BREAK	
10:00 am	Public Outreach	Keith Israel, MWRPCA
10:15 am	Questions and Discussions	
10:30 am	Panel Deliberations	Mike Wehner, Panel
12:00 noon	Working Lunch	
12:00 noon 1:30 pm	Working Lunch Debrief with MWRPCA	All

APPENDIX D: MEETING ATTENDEES

Panel Members:

- Jean-François Debroux, Ph.D., Kennedy/Jenks Consultants (San Francisco, CA)
- Martin B. Feeney, P.G., CHG, Consulting Hydrogeologist (Santa Barbara, California)
- Michael P. Wehner, REHS, MPA, Orange County Water District (Fountain Valley, California)

National Water Research Institute:

• Jeff Mosher, Executive Director

Monterey Regional Water Pollution Control Agency:

- Garrett Haertel, P.E., Compliance Engineer
- Brad Hagemann, Assistant General Manager
- Karen Harris, Community Relations Specialist
- Robert Holden, P.E., Principal Engineer
- Keith Israel, General Manager
- Mike McCullough, Recycled Water Project Assistant

Monterey Peninsula Water Management District

- Larry Hampson, District Engineer
- Jonathan Lear, PG, CHg, Senior Hydrogeologist.
- Joe Oliver, PG, CHg, Water Resources Division Manager
- David J. Stoldt, General Manager

Project Team Members:

- Jim Brezack, Brezack and Associates Planning
- Jerry Cole, Consultant
- James Crook, Environmental Engineering Consultant (Retired CDPH)
- Denise Duffy, Denise Duffy & Associates
- Alison Imamura, Denise Duffy & Associates
- Margie Nellor, Nellor Environmental Associates (on phone)
- Phyllis Stanin, Todd Engineers
- Alex Wesner, Separation Processes Inc.
- Valerie J. Young, AICP, Environmental Planning and Water Reuse Consultant

California Department of Public Health:

- Randy Barnard (on phone)
- Brian Bernados
- Eugene Leung (on phone)
- Jan Sweigert

Regional Water Quality Control Board, Central Coast Region

• Harvey Packard

Monterey County Health Department Cheryl Sandoval (on phone)

NATIONAL WATER RESEARCH INSTITUTE

Draft Final Report

of the May 1-2, 2014, Meeting of the

Independent Advisory Panel

for

Pure Water Monterey Peninsula Groundwater Replenishment Project

Prepared for:

Monterey Regional Water Pollution Control Agency 5 Harris Court, Building D Monterey, California 93940

June 23, 2014

DISCLAIMER

This report was prepared by an NWRI Independent Advisory Panel, which is administered by the National Water Research Institute (NWRI). Any opinions, findings, conclusions, or recommendations expressed in this report were prepared by the Panel. This report was published for informational purposes.

ABOUT NWRI

A 501c3 nonprofit organization, the National Water Research Institute (NWRI) was founded in 1991 by a group of California water agencies in partnership with the Joan Irvine Smith and Athalie R. Clarke Foundation to promote the protection, maintenance, and restoration of water supplies and to protect public health and improve the environment. NWRI's member agencies include Inland Empire Utilities Agency, Irvine Ranch Water District, Los Angeles Department of Water and Power, Orange County Sanitation District, Orange County Water District, and West Basin Municipal Water District.

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ACRONYMS

AF	Acre foot
ASR	Aquifer storage and recovery
AWTP	Advanced water treatment plant
BAF	Biologically active filtration
Cal-Am	California American Water
CDPH	California Department of Public Health
CEQA	California Environmental Quality Act
CSIP	Castroville Seawater Intrusion Project
EIR	Environmental Impact Report
GWR	Groundwater replenishment
L	Liter
MF	Microfiltration
MPWMD	Monterey Peninsula Water Management District
MRWPCA	Monterey Regional Water Pollution Control Agency
NDMA	N-Nitrosodimethylamine
NWRI	National Water Research Institute
RO	Reverse osmosis
TDS	Total dissolved solids
UV	Ultraviolet light
WPA	Water Purchase Agreement

1. PURPOSE AND HISTORY OF THE PANEL

In 2013, the National Water Research Institute (NWRI)¹ of Fountain Valley, California, a 501c3 nonprofit, appointed local and national water industry experts to an Independent Advisory Panel (Panel) to provide expert peer review of the proposed Pure Water Monterey Peninsula Groundwater Replenishment (GWR) Project being considered by the Monterey Regional Water Pollution Control Agency (MRWPCA)² and its project partner, the Monterey Peninsula Water Management District (MPWMD).³ Henceforth, MRWPCA, MPWMD, and their consultants will be referred to as the "Project Team."

The GWR project is expected to create a sustainable source of water supply by using highlytreated water from a new advanced water treatment plant (AWTP) to augment local drinking water aquifers. Specifically, the project involves developing and conveying highly-treated water from the AWTP to the Seaside Basin, where the water will be injected into the aquifer using a series of shallow (i.e., vadose zone) and deep wells. Once injected into the Seaside Basin, the treated water would mix with the groundwater present in the aquifers and be stored for future use.

This additional supply would replenish the aquifers and increase the yield of the Seaside Basin for local pumpers, including the primary pumper, California American Water (Cal-Am). The GWR project will be designed to provide 3,500 acre-feet (AF) per year of high-quality replacement water to Cal-Am for delivery to its customers in the Monterey District service area, thereby enabling Cal-Am to reduce its diversions from the Carmel River system by the same amount.

The Panel is tasked with reviewing the proposed GWR project and providing findings and recommendations on project alternatives, alternative evaluation, and associated bench and pilot studies. Examples of issues that the Panel may address include public health and safety, advanced water treatment design issues, permitting and regulatory requirements, and public outreach and advocacy.

The Panel is made up of four experts in areas related to GWR projects, such as engineering, regulatory criteria, public health, hydrogeology, and other relevant fields. Panel members include:

- George Tchobanoglous, PH.D., P.E., NAE, University of California, Davis (Davis, CA)
- Jean-François Debroux, Ph.D., Kennedy/Jenks Consultants (San Francisco, CA)
- Martin B. Feeney, P.G., CHG, Consulting Hydrogeologist (Santa Barbara, CA)
- Michael P. Wehner, MPA, REHS, Orange County Water District (Fountain Valley, CA)

Background information about the NWRI Panel process can be found in Appendix A, and brief biographies of the Panel members can be found in Appendix B.

¹<u>http://www.nwri-usa.org/</u>.

² <u>http://www.mrwpca.org/</u>.

³ <u>http://www.mpwmd.dst.ca.us/</u>.

2. PANEL MEETING

A 2-day meeting of the Panel was held on May 1-2, 2014, at both the MRWPCA Regional Treatment Plant in Marina, California (May 1) and the MRWPCA administrative offices in Monterey, California (May 2). This meeting represents the second time the Panel has met to review the proposed GWR project.

2.1 Background Material

Prior to the meeting, the following background material and reports were provided to the Panel:

• Revised draft of the 29-page concept approval proposal, titled "Monterey Regional Water Pollution Control Agency Groundwater Replenishment Project: Proposal to Inject Highly-Treated Recycled Water into the Seaside Groundwater Basin" (dated April 23, 2014). The proposal was expected to be submitted to the California Department of Public Health (CDPH) by May 15, 2014.

2.2 Meeting Agenda

Staff from NWRI and the Project Team collaborated on the development of the agenda for the Panel meeting, which is included in Appendix C. The agenda was based on meeting the following specific objectives:

- Review the draft concept approval proposal to be submitted to CDPH for review.
- Develop a working understanding of the proposed GWR Project.
- Identify proposed project strengths and areas where more information is needed.
- After the meeting, prepare a brief summary of project questions and obstacles for use by the GWR team.

The majority of the meeting was devoted to presentations made by the Project Team. Time was provided for the Panel to ask questions and engage in discussion following each presentation. The presentations included:

- Water Quality, including:
 - Source Water Characterization
 - Pilot Facility Preliminary Results
 - Baseline Groundwater Basin Quality
 - Ongoing Vadose Zone Leaching Tests
- Outreach Update
- CEQA Status Report and Permits
- Water Rights Update
- Settlement Update
- Source Control Program
- Regulatory Draft Concept Proposal
- GWR Panel Checklist: A Recap Items from October 21-21, 2013 Panel Meeting

In addition to the presentations, the Panel was given a tour of the Advanced Water Purification Demonstration Facility at the MRWPCA Regional Treatment Plant in Marina, California, and participated in a field trip to view possible water sources to be used as part of the project, including: Tembladero Slough, Blanco Drain, Reclamation Ditch, Salinas Pump Station, and the Industrial Ponds.

Once the presentations and tours were concluded, the Panel met in a closed session to discuss the information presented and address questions provided by the Project Team. Before the meeting adjourned, the Panel prepared a report outline and drafted preliminary findings and recommendations, which have been expanded upon in this report.

2.3 Meeting Attendees

All Panel members attended this meeting. Other attendees included NWRI staff, MRWPCA staff, MPWMD staff, consultants, representatives from agency partners, and regulators. A complete list of Panel meeting attendees is included in Appendix D.

3. Observations and Findings

The principal observations and findings derived from the material presented and discussed during the meeting are provided below. They are organized under the following categories:

- General
- Source Water
- Regional Treatment Plant
- Advanced Treatment
- Aquifer Injection
- Project Management
- Public Outreach
- Suggested Revisions to the Draft Concept Proposal

3.1 General

- The Panel compliments the Project Team for their excellent presentations, which were well-prepared and professional. The Panel also appreciated the background documents provided by the Project Team.
- The Panel concludes that the GWR project will contribute to the water supply portfolio of the Cal-Am's Monterey Peninsula service area by supplementing existing sources and providing a greater degree of independence, thus improving the reliability and sustainability of the region's water supplies.
- The Panel commends the Project Team for the significant amount of effort and progress that has been made in reaching project goals.
- The organization of the Panel meeting and field trip was both instructive and productive not only for Panel members, but for others in attendance, including regulators.
- The progress that the Project Team has made in their responsiveness to the previous Panel report is exemplary.
- The Panel concurs with the Project Team on the importance of securing water rights and associated contracts for the various source waters.
- The Panel has reviewed the draft project proposal to "Inject Highly-Treated Recycled Water into the Seaside Groundwater Basin" and believes that it represents a comprehensive description and assessment of the proposed GWR project and that it should be submitted to CDPH for early review.

3.2 Source Water

• Some probability distributions of the advanced treatment facility influent constituents

would be important in terms of the operation of the ozone and membrane systems.

• The Panel has some concern that the quantity number projected for indoor water use in the future may be higher than should be anticipated, given current trends in conservation.

3.3 Regional Treatment Plant

• Because of excess capacity in the current trickling filter treatment process, it may be possible to operate one of the filters in a nitrifying mode. Such an operation may (1) eliminate the need for ozone (and reduce N-Nitrosodimethylamine [NDMA] formation potential), (2) further enhance the effectiveness of the ozone, and/or (3) produce an effluent that is significantly easier to filter (based on actual data from the Orange County Water District in Fountain Valley, California).

3.4 Advanced Treatment

- The Panel is concerned with the measures that have been taken to manage salinity. More specifically, is the goal of going from 750 to 799 milligrams of total dissolved solids per liter (TDS/L) in the recycled water realistic given the quantity and quality of the existing and new water sources?
- In assessing the chemistry of the stabilized product water from the reverse osmosis (RO) process, it will be important to check a number of indexes for both precipitation and corrosion in conjunction with the various pipe materials to be used.
- The remedies for stabilizing the water need to be consistent with the leaching or plugging potential of the final water on soils at the recharge area.
- Is chlorine addition (form of chlorine, e.g., chloramine or free) part of the chemical stabilization process?
- The methodology to be used to assess whether to include ozone and/or biologically active filtration (BAF) in the overall treatment process needs to be defined (e.g., water quality, treatability, cost, or a combination of factors).

3.5 Aquifer Injection

- Additional information needs to be developed on water movement in the Santa Margarita aquifer (e.g., the sensitivity to thickness of the highly conductive zone).
- To increase the travel time of the recharged water in the subsurface, consideration should be given to operating the existing aquifer storage and recovery (ASR) wells as only injection wells without recovery.

• Given that the vadose wells and injection wells will be co-located, it is recommended that the injection well be drilled first so that intervening clay layers can be characterized so that the vadose well design can be optimized.

3.6 **Project Management**

- Effective project coordination and management will be required to move forward in the very limited timeframe available for this project.
- Consideration should be given to the employment of an overall engineering project manager to coordinate the efforts of all sub-consultants.

3.7 Public Outreach

- The Panel commends the Project Team for the effort they have undertaken (e.g., educational visuals) to make the pilot facilities accessible and an educational experience.
- Given the noise level of the room in which the pilot facility is located, it would be helpful if some outdoor facilities, such as an open area tent with educational display materials and a place to sit and converse, would help occupy the visitors not touring the inside of the pilot facility.
- Because of the effectiveness of tours of the treatment facilities on public perception, it is recommended that the pilot facilities be retained and operated beyond the current study period. The pilot-scale facilities can also be used for operator training.
- The Panel is concerned that public outreach may be moving too far ahead of the actual project in terms of developing hand outs and visual materials. It appears by the public outreach materials that the project is a foregone conclusion.
- The Panel questions the usefulness and/or effectiveness of the proposed summit with the congressional delegation. The Panel would suggest that such a meeting might be appropriate once a concept approval letter has been received from CDPH.

3.8 Suggested Revisions to the Draft Concept Proposal

As noted in Section 2.1, the concept approval proposal, "Monterey Regional Water Pollution Control Agency Groundwater Replenishment Project: Proposal to Inject Highly-Treated Recycled water into the Seaside Groundwater Basin" (dated April 23, 2014), was to be submitted to CDPH by May 15, 2014. Because of the short turnaround time, the Panel provided comments and suggested revisions to the proposal during the Panel meeting. In this section, the Panel would like to formally document comments and recommendations made at the meeting. They include:

• The Panel commends the Project Team for a well-written, high-quality proposal.

- The Panel noted that the purpose of this proposal is to receive approval from CDPH to continue to move forward with evaluating the design and implementation of the proposed project. Therefore, it does not require detailed data and information, unlike (for instance) an engineer's report. In fact, the Panel cautions against sharing data in advance of efforts being undertaken through the California Environmental Quality Act (CEQA) process (including the development of the Environmental Impact Report [EIR]).
- A consistent term should be used throughout the report to refer to the end-product (for instance, "highly treated recycled water," "product water," or "purified water").
- In Section 4.3 "Public Outreach," it is important to include the activities and results of the re-branding effort that began in early 2014, such as changing the project's name to "Pure Water Monterey."
- Within Section 5 "Proposed Project Components," the Panel recommends adding a Section 5.4 on "Aquifer Recharge Facilities." In addition, a general statement that "recharge water may enter the vadose zone" could be added to the new Section 5.4.
- Section 7 "Seaside Groundwater Basin" and Section 8 "Injection Well Facilities" could be combined into one "Groundwater" section. The information on "Injection Well Facilities" could be expanded (by no more than a page) and should include work that has been conducted to-date to verify this effort. In addition, revise the groundwater injection map to reflect recent changes to well placement.
- Update Section 9.7 "Response Retention Time" with the new model run for Well Number 1.

APPENDIX A: PANEL BACKGROUND

About NWRI

For over 20 years, NWRI – a science-based 501c3 nonprofit located in Fountain Valley, California – has sponsored projects and programs to improve water quality, protect public health and the environment, and create safe, new sources of water. NWRI specializes in working with researchers across the country, such as laboratories at universities and water agencies, and are guided by a Research Advisory Board (representing national expertise in water, wastewater, and water reuse) and a six-member Board of Directors (representing water and wastewater agencies in Southern California).

Through NWRI's research program, NWRI supports multi-disciplinary research projects with partners and collaborators that pertain to treatment and monitoring, water quality assessment, knowledge management, and exploratory research. Altogether, NWRI's research program has produced over 300 publications and conference presentations.

NWRI also promotes better science and technology through extensive outreach and educational activities, which includes facilitating workshops and conferences and publishing White Papers, guidance manuals, and other informational material.

More information on NWRI can be found online at www.nwri-usa.org.

About NWRI Panels

NWRI also specializes in facilitating Independent Advisory Panels on behalf of water and wastewater utilities, as well as local, county, and state government agencies, to provide credible, objective review of scientific studies and projects in the water industry. NWRI Panels consist of academics, industry professionals, government representatives, and independent consultants who are experts in their fields.

The NWRI Panel process provides numerous benefits, including:

- Third-party review and evaluation.
- Scientific and technical advice by leading experts.
- Assistance with challenging scientific questions and regulatory requirements.
- Validation of proposed project objectives.
- Increased credibility with stakeholders and the public.
- Support of sound public-policy decisions.

NWRI has extensive experience in developing, coordinating, facilitating, and managing expert Panels. Efforts include:

- Selecting individuals with the appropriate expertise, background, credibility, and level of commitment to serve as Panel members.
- Facilitating hands-on Panel meetings held at the project's site or location.
• Providing written report(s) prepared by the Panel that focus on findings and recommendations of various technical, scientific, and public health aspects of the project or study.

Over the past 5 years, NWRI has coordinated the efforts of over 20 Panels for water and wastewater utilities, city and state agencies, and consulting firms. Many of these Panels have dealt with projects or policies involving groundwater replenishment and potable (indirect and direct) reuse. Specifically, these Panels have provided peer review of a wide range of scientific and technical areas related water quality and monitoring, constituents of emerging concern, treatment technologies and operations, public health, hydrogeology, water reuse criteria and regulatory requirements, and outreach, among others.

Examples of recent NWRI Panels include:

- Development of Water Recycling Criteria for Indirect Potable Reuse through Surface Water Augmentation and the Feasibility of Developing Criteria for Direct Potable Reuse for the California Department of Public Health (CA)
- Developing Proposed Direct Potable Reuse Operational Procedures and Guidelines for New Mexico for the New Mexico Environment Department (NM)
- Monterey Peninsula Groundwater Replenishment Project for the Monterey Regional Water Pollution Control Agency (CA)
- Groundwater Recharge Scientific Study for the LOTT Clean Water Alliance (WA)
- Groundwater Replenishment System Program Review for the Orange County Water District (CA)
- Examining the Criteria for Direct Potable Reuse for Trussell Technologies (CA) and WateReuse Research Foundation (VA)
- Evaluating Potable Reuse for the Santa Clara Valley Water District (CA)
- Indirect Potable Reuse/Reservoir Augmentation Project Review for the City of San Diego (CA)
- **BDOC as a Surrogate for Organics Removal in Groundwater Recharge** for the California Department of Public Health (CA)
- Effluent Master Plan for Tucson Water (AZ)
- **Groundwater Replenishment Project Review** for the Los Angeles Department of Water and Power (CA)

More information about the NWRI Independent Advisory Panel Program can be found on the NWRI website at <u>http://nwri-usa.org/Panels.htm</u>.

APPENDIX B: PANEL BIOGRAPHIES

GEORGE TCHOBANOGLOUS, PH.D., P.E., NAE

Professor Emeritus University of California, Davis (Davis, CA)

For over 35 years, wastewater expert George Tchobanoglous has taught courses on water and wastewater treatment and solid waste management at the University of California, Davis, where he is Professor Emeritus in the Department of Civil and Environmental Engineering. He has authored or coauthored over 500 publications, including 22 textbooks and eight engineering reference books. Tchobanoglous has been past President of the Association of Environmental Engineering and Science Professors and currently serves as a national and international consultant to both government agencies and private concerns. Among his honors, he received the Athalie Richardson Irvine Clarke Prize from NWRI in 2003, was inducted to the National Academy of Engineers in 2004, and received an Honorary Doctor of Engineering degree from the Colorado School of Mines in 2005. In 2012, he received the first Excellence in Engineering Education Award from AAEE and AEESP. In 2013, he was selected as the AAEE and AEESP Kappe Lecturer. Tchobanoglous received a B.S. in Civil Engineering from the University of the Pacific, an M.S. in Sanitary Engineering from the University of California, Berkeley, and a Ph.D. in Environmental Engineering from Stanford University.

JEAN-FRANÇOIS DEBROUX, Ph.D.

Director, Advanced Technologies Group Kennedy/Jenks Consultants (San Francisco, CA)

At Kennedy/Jenks Consultants, Jean Debroux serves as Director of the Advanced Technologies Group, which was formed to solve technologically challenging problems. Part of this effort includes performing pilot and field studies for regulated and emerging contaminants and evaluates the cost impacts of complying with Safe Drinking Water Act regulations. A water quality expert, Debroux has extensive experience and expertise working with water utilities and research organizations in water treatment and water reuse issues, and is an active member of the WateReuse Foundation, where he served on the Research Advisory Committee for 7 years. Debroux received a B.S. in Chemical Engineering from the University of South Florida, and both an M.S. in Environmental Engineering and Ph.D. in Civil Engineering from the University of Colorado, Boulder. In addition, he attended the Environmental Management Institute at Tufts University and has served as a Post-Doctoral Research Fellow and Lecturer at Stanford University and as a Research Fellow at Université de Poitiers, France.

MARTIN B. FEENEY, P.G., CHG

Consulting Hydrogeologist (Santa Barbara, California)

Martin Feeney has been a consulting hydrogeologist since 1997, providing hydrogeologic consulting services to water agencies, private industry, and engineering firms. Prior to this, he served as hydrogeologist at various consulting firms such as Balanced Hydrologics, Inc. and Fugro West, Inc., where he provided analysis of groundwater basins, developed groundwater flow and transport, and developed saline groundwater source for desalination plants, injection wells/artificial recharge programs, and underground storage tank site assessment and remediation. He has also been involved in numerous groundwater resources and water well projects throughout California, working for groups such as Monterey County, Salinas Valley, Santa Clara Valley Water District, Ventura County, and various others. Feeney received a B.S. in Earth Sciences from the University of California, Santa Cruz and an M.S. in Environmental Planning (Groundwater) from California State University.

MICHAEL P. WEHNER, REHS, MPA

Assistant General Manager Orange County Water District (Fountain Valley, California)

Mike Wehner has over 40 years of experience in water quality control and water resources management. He has been with the Orange County Water District (OCWD) since 1991, currently serving as Assistant General Manager. Among his responsibilities, he directly manages the Water Quality and Technology Group, including Laboratory, Water Quality, Hydrogeology, Research and Development, and Health and Regulatory Affairs Departments. He is also involved with numerous aspects with the Groundwater Replenishment System (the nation's largest IPR project), including providing technical guidance on treatment and quality, as well as managing monitoring programs for the purification facility and receiving groundwater. He was also manager of OCWD's 8-year Santa Ana River Water Quality and Health Study, which evaluated the impact of using effluent-dominated river waters for groundwater recharge. Prior to joining OCWD, Wehner spent 20 years with the Orange County Health Care Agency, where he managed the Water Quality Control Section of Environmental Health. He is a Registered Environmental Health Specialist in California and is an internationally recognized expert in water quality, public health, and advanced water treatment processes, serving on expert panels in the United Kingdom, Australia, and Singapore, as well as for California and U.S. agencies and foundations. He received a Masters of Public Administration from California State University Long Beach and a B.S. in Biological Sciences from the University of California, Irvine.

NATIONAL WATER RESEARCH INSTITUTE

Independent Advisory Panel Meeting for Monterey Regional Water Pollution Control Agency on Monterey Peninsula Groundwater Replenishment Project

Preliminary Draft Meeting Agenda May 1-2, 2014

Location

Monterey Regional Water Pollution Control Agency Regional Treatment Plant--THURSDAY 14811 Del Monte Blvd. Marina, CA 93933 (831) 883-1118 Administrative Offices FRIDAY 5 Harris Court, Bldg. D Monterey, CA 93940 (831) 372-3367 On-Site Contacts: Jeff Mosher (NWRI) Cell: (714) 705-3722 Mike McCullough (MRWPCA) Cell: (831) 594-2597

Meeting Objectives:

- Develop a working understanding of the Proposed Groundwater Replenishment Project.
- Identify proposed project strengths and areas where more information is needed.
- After the meeting, prepare a brief summary of project questions and obstacles for use by the GWR team.

Thursday, May 1, 2014 – MRWPCA Regional Treatment Plant – NOTE LOCATION!

9:00 am	Welcome and Introductions (RTP)	Jeff Mosher, NWRI
9:10 am	 All Things Water Quality Source Water Characterization Pilot Facility Preliminary Results Baseline Groundwater Basin Quality Vadose Zone Leaching Analysis 	Gordon Williams, Trussell, Brad Reisinger, SPI, Phyllis Stanin, Todd Groundwater, Joe Oliver, MPWMD,
11:45 - 12:30 pm	WORKING LUNCH - RTP	
12:30 pm	Tour of Advanced Water Purification Demonstration Facility - Technical Hurdles – Gordon Williams - Building Eye Candy – Mark Millan	Gordon Williams, Trussell, Brad Reisinger, SPI
1:00 – 4:00 pm	FIELD TRIP	Mike McCullough,

	Tembladero Slough, Blanco Drain, Reclamation Ditch, Salinas Pump Station, Industrial Ponds, return to RTP	MRWPCA
4:00 pm	Outreach Update	Steve Thomas, Thomas Brand, Dave Stoldt, MPWMD, Karen Harris, MRWPCA,
4:20 pm	CEQA Status Report & Permits	Valerie Young
4:45 pm	Water Rights Update	Dave Stoldt & Larry Hampson, MPWMD
5:00 pm	Settlement Update	Bob Holden, MRWPCA
5:45 pm	Adjourn	

Friday, May 2, 2014 – MRWPCA Administration Offices – NOTE LOCATION!

8:30 am	Summary of Day 1	Jeff Mosher, NWRI George T., Panel
8:45 am	Source Control Program	Garrett Haertel, MRWPCA
9:00 am	Regulatory – Draft Concept Proposal	Jim Crook & Margie Nellor
9:45 am	BREAK	
10:00 am	GWR IAP Checklist - Recap Items from October 21-21, 2013 IAP meeting	Bob Holden, MRWPCA
10:30 am	Panel Deliberations	George T., Panel
12:00 noon	Working Lunch	
1:30 pm	Debrief with MRWPCA	All
2:00 pm	Adjourn	

APPENDIX D: MEETING ATTENDEES

Panel Members:

- CHAIR: George Tchobanoglous, PH.D., P.E., NAE, University of California, Davis (Davis, CA)
- Jean-François Debroux, Ph.D., Kennedy/Jenks Consultants (San Francisco, CA)
- Martin B. Feeney, P.G., CHG, Consulting Hydrogeologist (Santa Barbara, CA)
- Michael P. Wehner, REHS, MPA, Orange County Water District (Fountain Valley, CA)

National Water Research Institute:

- Jeff Mosher, Executive Director
- Gina Vartanian, Outreach and Communications Manager

Monterey Regional Water Pollution Control Agency:

- Garrett Haertel, P.E., Compliance Engineer
- Karen Harris, Community Relations Specialist
- Robert Holden, P.E., Principal Engineer
- Keith Israel, General Manager
- Mike McCullough, Recycled Water Project Assistant

Monterey Peninsula Water Management District

- Jonathan Lear, PG, CHg, Senior Hydrogeologist
- Joe Oliver, PG, CHg, Water Resources Division Manager

Project Team Members:

- Jim Brezack, Brezack and Associates Planning, LLC (on phone)
- Diana Buhler, Denise Duffy & Associates
- Jerry Cole, Consultant
- James Crook, Ph.D., P.E., Environmental Engineering Consultant (Retired CDPH)
- Denise Duffy, Denise Duffy & Associates
- Alison M. Imamura, AICP, Denise Duffy & Associates
- Mark Millan, Data Instincts, Inc.
- Margaret H. Nellor, P.E., Nellor Environmental Associates (on phone)
- Brad Reisinger, P.E., Separation Processes, Inc
- Bahman Sheikh, Ph.D., P.E., Water Resources and Reuse Specialist
- Phyllis Stanin, P.G., Todd Engineers
- Steve Thomas, Thomas Brand Consulting
- Gordon J. Williams, Ph.D., P.E, Trussell Technologies, Inc.
- Valerie J. Young, AICP, Environmental Planning and Water Reuse Consultant

California Department of Public Health:

• Brian Bernados, PE, Division of Drinking Water & Environmental Management

Regional Water Quality Control Board, Central Coast Region

• Peter Von Langen, Ph.D., Environmental Scientist

• Harvey Packard, Section Manager/Aquatic Habitat

Monterey County Health Department

• Cheryl Sandoval, Supervising Environmental Health Specialist, Drinking Water Protection Services

APPENDIX B

2014 MRWPCA Pure Water Project Concept Proposal and Division of Drinking Water Conditional Approval Letter



Monterey Regional Water Pollution Control Agency Pure Water Monterey Groundwater Replenishment Project

Proposal to Inject Highly-Treated Recycled Water into the Seaside Groundwater Basin

DRAFT May 19, 2014

This proposal was prepared by the Pure Water Monterey Groundwater Replenishment Project (Proposed Project or GWR) team, which includes staff from the Monterey Regional Water Pollution Control Agency (MRWPCA), the Monterey Peninsula Water Management District, and their consultants.

This proposal was reviewed by members of the Proposed Project's Independent Advisory Panel convened by the National Water Research Institute.

MRWPCA thanks the California Department of Public Health for its participation and input regarding the Proposed Project. This participation and input has been invaluable to the project team for developing the Proposed Project and this proposal.

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List of Acronyms

AFY	Acre-feet per year
AOP	Advanced oxidation process
ASR	Aquifer storage and recovery
AWT	Advanced water treatment
AWTF	Advanced Water Treatment Facility
BAF	Biologically Active Filtration
CalAm	California American Water Company
CDPH	California Department of Public Health
CECs	Constituents of emerging concern
CSIP	Castroville Seawater Intrusion Project
СТ	Disinfection contact time multiplied by disinfectant residual
DBPs	Disinfection byproducts
EIR	Environmental impact report
FAT	Full advanced treatment
gpm	Gallons per minute
GWR	Pure Water Monterey Groundwater Replenishment Project
IAP	Independent Advisory Panel
IPR	Indirect potable reuse
MF	Membrane filtration
mgd	Million gallons per day
mg/L	Milligrams per liter
mJ/cm ²	Millijoules per square centimeter
MRWPCA	Monterey Regional Water Pollution Control Agency
NDMA	N-nitrosodimethylamine
ng/L	Nanograms per liter
NPDES	National Pollutant Discharge Elimination System
RO	Reverse osmosis
RTP	Regional Treatment Plant
RWQCB	Central Coast Regional Water Quality Control Board
RUWAP	Regional Urban Water Augmentation Project
SIWTF	Salinas Industrial Wastewater Treatment Facility
SWRCB	State Water Resources Control Board
SVRP	Salinas Valley Reclamation Project
TDS	Total dissolved solids
TOC	Total organic carbon
UV	Ultraviolet light

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Section 1 - Introduction

The purpose of this proposal is to obtain concept approval from the California Department of Public Health (CDPH)¹ for the Proposed Pure Water Monterey Groundwater Replenishment Project (Proposed Project).

The Proposed Project is a planned indirect potable reuse (IPR) project that will involve injecting highly-treated recycled water from a new proposed advanced water treatment facility (AWTF) into the Seaside Groundwater Basin and subsequent withdrawal of the water at downgradient domestic water supply wells by the California American Water Company (CalAm²) for delivery to its customers in the Monterey District service area. CDPH has developed draft groundwater replenishment regulations³ and is the key regulatory agency that currently evaluates and approves IPR projects. Therefore, a decision by the proponents of the Proposed Project to implement the project will depend, in part, on obtaining concept approval from CDPH.

The Project is being developed by the Monterey Regional Water Pollution Control Agency (MRWPCA) in partnership with the Monterey Peninsula Water Management District (Water Management District). Some background on these two agencies is provided below.

Monterey Regional Water Pollution Control Agency: MRWPCA was established in 1972. MRWPCA operates the regional wastewater treatment plant, including a water recycling facility (collectively known as the Regional Treatment Plant, or RTP), a nonpotable water distribution system known as the Castroville Seawater Intrusion Project, sewage collection pipelines, and 25 wastewater pump stations. The current MRWPCA service area is shown in dark blue in Figure 1. Additional information about the RTP is provided in subsection 5.2, MRWPCA Regional Treatment Plant.

Monterey Peninsula Water Management District: The Water Management District is a special district formed in 1978 to manage, augment, and protect water resources for the benefit of the community and the environment. The Water Management District manages the production and use of water from the Carmel River stored in Los Padres Reservoir, water production in the Carmel Valley aquifer, and groundwater pumped from municipal and private wells in Carmel Valley and the Seaside Groundwater Basin. The Water Management District regulates public fresh water supply systems within its boundaries, including systems owned by CalAm. Its authority includes regulating the creation of new water distribution systems and expansions, water connection permits, allocation of water to jurisdictions within its boundaries, water conservation ordinances and inspections, and water rationing programs.

¹ Effective July 1, 2014, CDPH Drinking Water Program will become the new State Water Resources Control Board's Division of Drinking Water.

 $^{^{2}}$ CalAm is an investor-owned public utility that serves approximately 38,500 customers in the Monterey Peninsula area.

³ CDPH draft groundwater replenishment regulations website: <u>Groundwater Replenishment with Recycled Water -</u> June 26, 2013 draft regulations (PDF). Sentate Bill 104 requires CDPH to adopt these as emergency regulations by June 30, 2014 without Office of Administrative Law review.



Figure 1. MRWPCA service area map

Section 2 - Need for the Proposed Project

Historical and persistent low groundwater elevations caused by pumping have led to concerns that seawater intrusion may threaten the groundwater resources in the Seaside Groundwater Basin. The Basin has experienced chronic overdraft conditions with declining water levels in both of the Basin's aquifers that are used for water supply (the deeper, confined Santa Margarita aquifer and the shallower, unconfined Paso Robles aquifer). In response to the overdraft conditions, the basin was adjudicated in 2006 and steps to mitigate declining water levels were implemented. Over the last few years, water levels have stabilized in some areas but continue to decline in areas of concentrated pumping, especially in the deeper aquifer. Record low water levels were observed in many basin wells in 2012 and water levels remain below sea level in both aquifers adjacent to the Proposed Project. Although recent evaluations have determined that seawater intrusion is not occurring at present, both aquifers are at risk for the potential of seawater intrusion in the future.

In 1995, the State Water Resources Control Board (SWRCB) issued Order No. WR 95-10, which found that CalAm was diverting more water from the Carmel River Basin than legally entitled. The SWRCB ordered CalAm to maximize use of the Seaside Groundwater Basin (to the extent feasible) instead of diverting Carmel River water. In addition, a subsequent Cease and Desist Order (SWRCB Order Number WR 2009-0060) issued in 2009 requires CalAm to secure replacement water supplies for its Monterey District service area by December 2016 and reduce its Carmel River diversions to 3,376 acre-feet per year (AFY) by the 2016-17 timeframe.

The Proposed Project would create a reliable source of water supply by recharging the Seaside Groundwater Basin with highly-treated recycled water produced from a new AWTF using a series of shallow and deep injection wells. Once injected into the Seaside Groundwater Basin, the highly-treated recycled water from the AWTF would mix with ambient groundwater and be stored for future use.

Section 3 - Proposed Project Objectives

The primary objective of the Proposed Project is to replenish the Seaside Groundwater Basin with 3,500 AFY of high-quality recycled water from the AWTF that would replace a portion of CalAm's current water supply. To accomplish this primary objective, the Proposed Project would need to meet the following objectives:

- be capable of commencing operation, or of being substantially complete, by the end of 2016 or, if after 2016, no later than necessary to meet CalAm's replacement water needs;
- be cost-effective such that the project would supply reasonably-priced water; and
- be capable of complying with applicable water quality regulations intended to protect public health and groundwater quality.

Secondary objectives of the Proposed Project include the following:

- assist in preventing seawater intrusion in the Seaside Groundwater Basin;
- assist in diversifying Monterey County's water supply portfolio; and
- provide additional water to the RTP that could be used for crop irrigation through the Salinas Valley Reclamation Project (SVRP) and Castroville Seawater Intrusion Project (CSIP) system.

Section 4 - Current Activities Supporting Proposed Project Implementation

Activities over the last two years have included:

- initiating California Environmental Quality Act review, with a planned Final Environmental Impact Report (FEIR) in December 2014;
- selection and testing of advanced water treatment processes that are capable of treating recycled water to meet the requirements specified in the CDPH draft groundwater replenishment regulations;
- identification of potential sources of water (referred to herein as "source waters") that would be added to the existing MRWPCA wastewater supply and receive treatment at the RTP and AWTF;
- sampling of the source waters over a one-year period to fully characterize the chemical quality of each source;
- preliminary design of the advanced water treatment (AWT) pilot facilities;
- conducting a pilot-scale demonstration study of the proposed AWTF treatment train scheduled to be completed in June 2014 to: (1) determine the performance of the ozone, membrane filtration, and reverse osmosis treatment processes and identify pertinent

design criteria; and (2) ensure that the highly-treated recycled water meets all applicable water quality requirements;

- modeling and other hydrogeological studies to determine the locations and depths of injection and monitoring wells, injection well capacities, residence time of recycled water underground prior to extraction, etc.;
- design and implementation of a hydrogeological field program involving characterization of the vadose zone, installation of a monitoring well, and baseline groundwater quality sampling;
- development and implementation of an outreach program to educate the public and others about the Proposed Project and assess public acceptability of the full-scale project; and
- review of the MRWPCA industrial pretreatment and source control program.

Much of this work will support the preparation of an Engineering Report for the Proposed Project that is expected to be submitted to CDPH and Central Coast Regional Water Quality Control Board (RWQCB) by December 2014.

4.1 Independent Advisory Panel

A four-member Independent Advisory Panel (IAP), administered by the National Water Research Institute, has been formed to provide an independent third-party review of the Proposed Project for MRWPCA, the Water Management District, and regulators (e.g., CDPH, CCRWQCB, SWRCB, and Monterey County Environmental Health Department). The IAP has been kept updated on the progress of the Proposed Project through two meetings, site visits, and draft technical reports. Feedback from the IAP has been instrumental in helping to determine the research and other facets needed to ensure the Proposed Project's successful design, approval, and implementation in compliance with applicable regulatory and scientific standards.

4.2 CDPH Participation

A cornerstone of MRWPCA's efforts has been keeping CDPH actively engaged throughout project development. CDPH staff, including those from local district offices and others with experience on IPR projects in other parts of the state, have attended IAP meetings and have been actively engaged in the Proposed Project since its inception via site visits, meetings, and correspondence regarding various aspects of the project.

4.3 Public Outreach

An informed public is the key to a successful IPR project. MRWPCA began reaching out to key stakeholders in 2006 when the concept for IPR via groundwater recharge was developing. At that time, a project similar to the current Proposed Project was included in the draft EIR for the Coastal Water Project that included evaluation of other potential sources of water for the Monterey area. Outreach activities for the 2006 project included information sessions and interviews with MRWPCA Board members and other community leaders, local media events, a project website, and trips to the Orange County Water District by community leaders to view its successful Groundwater Replenishment System.

The Proposed Project began to be developed in 2010 as part of CalAm's Monterey Peninsula Water Supply Project that replaced the similar Coastal Water Project that was officially initiated in 2012. The emphasis was on its ability to be fast-tracked in time to meet the SWRCB Cease and Desist Order issued in 2009 requiring CalAm to secure replacement water supplies for its Monterey District service area by December 2016.

An outreach team was assembled in 2013 that included MRWPCA, the Water Management District, the Monterey Peninsula Regional Water Authority, and several outreach consultants. In January 2014 the public outreach tasks were transferred from MRWPCA to its project partner, the Water Management District. The project was renamed "Pure Water Monterey – A Groundwater Replenishment Project" for marketing purposes. A new logo was developed and the website URL was changed to www.PureWaterMonterey.org. The new public outreach plan is primarily focused on the safety, sustainability, and reliability of the new water supply. Facebook and Twitter pages were established to support social media marketing. The outreach team also developed a speaker bureau to facilitate community group speaking engagement coordination. Consistent messaging and images are being used to support the Proposed Project on all platforms.

MRWPCA's billing insert for December 2013/January 2014 included a description of the Proposed Project Demonstration Project with a public tour invitation. Public tours of the pilot plant facilities began in February 2014. As the outreach program moves forward, it will include a mass media campaign with radio, print, and television advertisements scheduled for 2014. The speaking bureau circuit will intensify as the Proposed Project Draft EIR is made available for public review in the fall of 2014. Also, efforts are ongoing to include non-English speakers in the public participation process.

4.4 Industrial Pretreatment and Source Control Program

MRWPCA administers an approved pretreatment program under National Pollutant Discharge Elimination System (NPDES) Permit R3-2008-0008.⁴ Not including outreach efforts, MRWPCA maintains a staff of three full-time employees and one part-time employee that provide permitting, inspection, sample collection, sample analysis, data analysis, review and response, enforcement, development of program requirements, and administration (including record keeping and data management). The part-time position provides support for regulation of the Salinas Industrial Wastewater Treatment Facility and member entity contract inspection services for the NPDES stormwater permit.

Currently, there are 18 permitted industrial users that discharge into the MRWPCA municipal wastewater system, only five of which are defined as Significant Industrial Users in accordance with federal pretreatment regulations. The total industrial flow represents approximately two percent of the wastewater flow currently coming into the RTP. MRWPCA has established technically-based local limits for heavy metals and other constituents that apply to all discharges

⁴ The NPDES permit renewal process is currently underway.

and local limits for silver that specifically apply to photo processors, x-ray developers, and printers.

In 2013, a consulting firm conducted a Pretreatment Compliance Inspection on behalf of the RWQCB. The inspection report concluded that the program was in compliance with pretreatment requirements and included recommendations for minor changes to industrial user permit language regarding self-monitoring and submittal time frames for industrial user resampling that can be easily effectuated by MRWPCA.

The CDPH draft groundwater replenishment regulations contain specific requirements relating to source control. The current MRWPCA source control program would meet these requirements, recognizing that some program enhancements would be implemented to address the addition of new sources of water to the RTP⁵; the use of the AWTF product water for IPR; and review of local limits for IPR.

Section 5 - Proposed Project Components

The physical components of the Proposed Project are described in this section. A simplified flow schematic of the major components of the Proposed Project is provided in Figure 2. The major project components are described in the subsections below:

- *Source waters* diversion of new source waters to the existing municipal wastewater collection system and conveyance of those waters as municipal wastewater to the RTP to increase availability of secondary-treated wastewater treatment at the AWTF.
- *Treatment process and facilities at RTP* use of existing primary and secondary treatment facilities at the RTP, as well as a new AWTF, AWTF product water stabilization, AWTF recycled water pump station, and brine disposal facilities.
- *Groundwater recharge facilities* new deep injection and vadose zone wells to inject product water from the Proposed Project into the Seaside Groundwater Basin, backflush facilities, pipelines, electricity/power distribution facilities, and an electrical/motor control building.

5.1 Source Waters

The preliminary determination of feasibility of the Proposed Project required a number of technical investigations to develop regulatory and design requirements. One of the key feasibility/planning actions was to assess the ability of the project to utilize supplemental source waters to augment available secondary-treated wastewater flows. Based on planning-level design information and alternative screening analysis, the following sources of water were recommended to be included in the Proposed Project:

• Monterey Peninsula stormwater and urban runoff that flows into Lake El Estero. This source would yield an average raw water supply of 87 AFY, based upon estimated daily runoff into the Lake and available conveyance capacity in the municipal wastewater system. A current proposal to add stormwater influent flows from an adjacent drainage

⁵ MRWPCA would permit agricultural wash water, storm water runoff, and any other new sources as part of its source control program.

basin to Lake El Estero through infrastructure changes is estimated to increase this yield to 119 AFY;

- City of Salinas urban stormwater and dry weather runoff from the southwest portion of the city that is currently discharged into the Salinas River. This source is estimated to yield an average raw water supply of 206 AFY;
- Salinas agricultural wash water, 80 to 90 percent of which is water used for washing produce, is currently conveyed to the Salinas Industrial Wastewater Treatment Facility (SIWTF) for treatment (aeration) and disposal by evaporation and percolation. This source is estimated to yield an average raw water supply of between 3,288 AFY and 3,733 AFY (influent to the SIWTF); and
- Municipal wastewater from MRWPCA member agencies that is conveyed to and treated through the existing primary and secondary processes at the RTP that would otherwise be discharged to the Pacific Ocean. This source is estimated to yield an average of 4,600 AFY to 6,242 AF based on a conservatively low estimate of future unused treated wastewater.



Figure 2. Proposed Project Flow Schematic

This combination of source waters was found to achieve the project objectives, and meet component evaluation criteria with the least cost and environmental effects, while providing additional benefits to MRWPCA member entities. In particular, the proposed source waters would use existing infrastructure facilities with available capacity for conveyance purposes, thus minimizing capital costs and environmental impacts.⁶

These waters would be collected through the existing MRWPCA wastewater collection system, increasing the influent flows to the RTP primary and secondary processes. Once treated by the RTP, this increase in RTP secondary effluent would be used as the influent water for the AWTF.

5.2 MRWPCA Regional Treatment Plant

The RTP receives residential, commercial, and industrial wastewater and has an average dry weather design capacity of 29.6 million gallons per day (mgd) and a peak wet weather design capacity of 75.6 mgd. It currently receives and treats approximately 17 to 18 mgd of wastewater and, therefore, has capacity to treat additional flows. The RTP primarily treats municipal wastewater, but also accepts some dry weather urban runoff and other discrete wastewater flows.

Wastewater is treated to two different standards at the RTP: (1) disinfected tertiary recycled water (as defined in the CDPH *Water Recycling Criteria*⁷) for unrestricted agricultural irrigation use; and (2) secondary treatment for discharge through the MRWPCA ocean outfall. The RTP secondary treatment consists of non-nitrifying trickling filters, bioflocculation, and clarification. In winter months, secondary-treated wastewater from the RTP is discharged to Monterey Bay through the MRWPCA ocean outfall, which includes a diffuser that centers about 11,260 feet offshore at a depth of approximately 100 feet. The diffuser on the ocean outfall is designed to convey ultimate wet weather flows of up to 81.2 mgd (above the current permitted capacity of 75.6 mgd).

When there is demand for nonpotable irrigation water, tertiary-treated wastewater from the RTP is recycled for irrigation of 12,000 acres of farmland in the northern Salinas Valley. The RTP is designed to produce up to 29.6 mgd of tertiary recycled water for use by the SVRP. The SVRP includes the tertiary treatment plant and an 80 acre-foot storage pond that holds tertiary treated recycled water and Salinas River water before it is distributed to farmland through the CSIP distribution system. The use of recycled wastewater for irrigation reduces regional dependence on local groundwater, which, in turn reduces groundwater pumping-related seawater intrusion into the Salinas Valley aquifers.

The tertiary plant has the capacity to generate approximately 33,200 AFY of recycled water. Actual tertiary water that is delivered via CSIP directly for agricultural irrigation has averaged 12,936 AFY (2001 through 2013). The amount of water delivery each year is dependent on crops grown and weather.

⁶ A source water alternatives analysis identified that source water from the Reclamation Ditch, Tembladero Slough, and/or Blanco Drain may be included in the future, if additional supplemental source water supplies are required and permits or agreements have been received for their use.

⁷ CDPH *Water Recycling Criteria*. 2009. Title 22, California Code of Regulations, Division 4, Chapter 3. http://www.cdph.ca.gov/certlic/drinkingwater/Documents/Lawbook/RWregulations-01-2009.pdf

5.3 Advanced Water Treatment Facilities at the RTP

The AWTF would receive secondary effluent from the RTP as source water for treatment.⁸ The following is a list of the proposed AWTF structures and facilities:

- inlet source water diversion facilities to bring secondary effluent to the AWTF;
- advanced treatment process facilities, including
 - o prescreening,
 - o ozonation,
 - o biologically active filtration (optional),
 - o membrane filtration (MF) treatment,
 - booster pumping of the membrane filtration filtrate (potentially with intermediate storage),
 - o cartridge filtration (optional),
 - o chemical addition,
 - o reverse osmosis (RO) membrane treatment,
 - \circ advanced oxidation process (AOP) using ultraviolet light (UV) and hydrogen peroxide (H₂O₂),
 - o decarbonation (potentially), and
 - o product-water stabilization with calcium, alkalinity and pH adjustment;
- final product storage and distribution pumping; and
- brine mixing facilities.

Additional information on each AWT process is presented below. Figure 3 provides a simplified process flow diagram illustrating the proposed treatment facilities.

AWTF Design Flows and System Waste Streams

The proposed AWTF would have a design capacity to produce between 3.5 and 4.0 mgd of highly-treated recycled water. In producing high quality water, the proposed AWTF would also produce two waste streams: backwash from the membrane filtration process and brine from the RO process. The MF backwash would be diverted back to the RTP headworks or to the RTP trickling filters. The RO concentrate would be piped to a proposed new brine and effluent receiving, mixing, and monitoring facility from which it would flow to the MRWPCA's existing outfall alone, with secondary wastewater effluent, and in the future possibly with CalAm desalination facility brine.

Inlet Raw Water Diversion Structure and Pump Station

A new diversion structure would be installed on an existing secondary effluent pipeline at the RTP to divert and convey secondary effluent to the proposed AWTF. A new influent pump station consisting of a subgrade wetwell and pumps would accept and equalize the RTP secondary effluent flow. A new inlet diversion structure, an influent pump station, and an approximately 360-foot long, 24-inch diameter pipeline to bring secondary effluent to the AWTF would also be constructed.

⁸ As described in previous sections, the Proposed Project proposes to divert additional water sources and convey those waters with municipal effluent to the RTP, including City of Salinas Urban Runoff to Salinas River, Lake El Estero Storage Management Water, Agricultural Wash Water Flows, and excess/unused RTP secondary effluent.



Figure 3. Flow Schematic of Proposed Treatment Process

AWTF Pretreatment

Before the MF process, the secondary effluent would be pretreated using pre-screening and up to three separate subsystems:

Chloramination. Chloramines would be used to reduce biofouling of the membrane systems. The chloramination system would include sodium hypochlorite storage, and chemical feed pumps, or connection to existing chlorine vacuum system, and an inline injection and mixing system. Sodium hypochlorite would either be injected upstream of ozonation or downstream of the biologically active filtration (BAF) system, depending on whether or not BAF is included in the final treatment process design. Sodium hypochlorite reacts with ammonia present in the source water to form chloramine, which is an effective biocide that reduces biological fouling on the MF and RO process membranes.

Ozonation. Ozone treatment is proposed to provide a chemical/pathogen destruction barrier and reduce the membrane fouling. The ozone system would be comprised of several components: liquid oxygen storage or an onsite oxygen generator, an ozone generator, a side-stream injector, ozone contactor, and ozone destruct units. There are two potential approaches for supplying oxygen for ozone generation: (1) liquid oxygen delivered to onsite cryogenic storage tanks and evaporated through vaporizers, or (2) produce oxygen at the treatment facility using a pressureswing adsorption oxygen generation system. Ozone generators would convert oxygen gas into ozone gas. The ozone gas would be injected into a side stream of feed water flow that would then be recombined with the main supply line after ozone injection. The ozonated water would flow into one or more contactors to provide contact time for disinfection/oxidation, ozone residual decay, and off-gassing. Off-gas would be treated through a catalytic-based ozone destruct system to prevent the release of ozone to the atmosphere. Once dissolved in the process water, ozone reacts with various contaminants in the water, resulting in several treatment benefits, including (1) reduction of organic compounds that cause membrane fouling, (2) reduction of many constituents of emerging concern (CECs), and (3) inactivation of pathogenic microorganisms. If BAF is not included, sodium bisulfite may be added to the ozone effluent to eliminate any ozone residual that remains in the water after ozonation.

Biologically Active Filtration (optional). The BAF process may be used downstream of ozone treatment to reduce the concentration of residual organic matter present in the ozone effluent and to reduce the solids loading on the membrane filtration process. The BAF system would consist of gravity-feed filter basins with several feet of granular media, and an underdrain/media support system. Ancillary systems would include a backwash basin, backwash pumps, and air compressor and supply system for an air scour system, and a washwater basin to facilitate filter backwashing.

Membrane Filtration Treatment System

The MF system would remove suspended and colloidal solids, including bacteria and protozoa using a number of new discrete process units that include: hollow fiber membrane modules and valve manifolds to direct the flow of feed, filtrate, cleaning solutions, backwash supply, backwash waste, and compressed air to the corresponding module connecting piping. Proposed appurtenant facilities would include backwash supply, cleaning, and compressed air systems. Feed pumps would draw water from the feed clearwell and supply a pressurized feed to

pretreatment strainers and the membrane units. Cleaning chemicals would include acid, caustic, and sodium hypochlorite. Backwash and screening residuals would be adjusted to a neutral pH and returned to the RTP headworks, along with residuals associated with the cleaning system. The projected recovery of treated water from the membrane filter system is roughly 90 percent; this recovery accounts for waste residuals associated with both backwashing and cleaning.

Reverse Osmosis Membrane Treatment System

An RO process that employs semi-permeable membranes is proposed to remove dissolved salts and organics from the MF filtrate. The proposed RO system would consist of a single-pass twostage system, which separates the MF filtrate feed water into a purified product stream (permeate) and a concentrated brine stream (brine). The proposed RO system would include individual process trains, housing the process membranes in pressure vessels along with connecting piping and valve manifolds for feed, permeate, concentrate, cleaning and flush supplies. The ancillary equipment for the overall RO system would include a membrane cleaning system and permeate flush system. RO membrane cleaning chemicals would likely include proprietary chemicals, acid, and caustic detergent.

Feed to the RO system would be delivered directly from the upstream MF system; or alternately stored in an intermediate equalization tank. In either case, it would be necessary to increase the feedwater pressure prior to RO using new booster pumps and high pressure feed pumps. Pretreatment chemicals would likely include an antiscalant and acid and would be injected into a low pressure line. If an equalization tank is employed, cartridge filters may be required to protect the RO process membranes from any incidental debris that may enter the tank. Brine from the RO system would be discharged to a new mixing structure with final disposal through the existing MRWPCA ocean outfall. Product water would flow to the advanced oxidation system. Separate cleaning and flush system equipment would also be included.

Advanced Oxidation Process System

The proposed new AOP system would provide a final polishing step for pathogen disinfection and would provide an additional chemical destruction barrier for the RO permeate. The proposed AOP system would consist of a chemical feed to add hydrogen peroxide and chambers containing reactors housing arrays of UV lamps along with ballasts to power the ultraviolet system. UV reacts with hydrogen peroxide to form hydroxyl radicals, which, along with the UV light, oxidizes, destroys, or inactivates chemicals of concern and pathogens. The system sizing would be driven by the requirement in the CDPH June 2013 draft groundwater replenishment regulations for AOP. Support facilities for the reactors would include chemical storage, metering pumps, and ballasts.

Post-Treatment

Product water from the AOP would be sent to the proposed new post-treatment system. Due to the high removal of minerals that is achieved through RO treatment, post-treatment stabilization of the product water is needed to prevent corrosion of pipe materials in the product water conveyance system and injection facilities. Stabilization would also be used to reduce the potential for product water to mobilize minerals and other chemicals from the soils within the Seaside Groundwater Basin upon injection. RO permeate is a soft, low alkalinity water, and the final product water quality would be adjusted to specific goals for hardness, alkalinity, and pH.

This adjustment may include decarbonation by a gas stripping tower to remove carbon dioxide (CO_2) , the addition of lime (calcium oxide), and pH adjustment with sodium hydroxide and CO_2 addition. There are several potential treatment technologies that may be used to achieve post-treatment stabilization, including: (1) a calcite contactor with caustic and CO_2 addition; (2) a lime saturator (either quicklime or hydrated lime) with CO_2 addition; or (3) the addition of purchased lime slurry. Depending on the stabilization goals, partial decarbonation (removal of CO_2) may be necessary, but at a minimum, decarbonation would be needed for any slurry feed water. If CO_2 addition were utilized, the new equipment would include liquid CO_2 storage, vaporizers, vapor heater, pressure regulator, and feed system, and diffusers. Regardless of technology, a new chemical storage system for post-treatment would be required.

Brine Mixing Facility

As discussed above, the new AWTF would produce RO brine that would be disposed or discharged via the MRWPCA's ocean outfall. In addition to the RO reject water, other water that is currently discharged to the outfall includes secondary effluent from the RTP, and brine waste collected from individual water softeners and private desalination facilities and delivered by truck to the RTP. Proper disposal of these waste streams to the outfall, and eventually the ocean, requires that they be thoroughly mixed to prevent stratification in the outfall that may lead to complicated corrosion potential to the outfall pipe and to optimize the mixing with sea water in the bay.

The brine mixing facility would accomplish the required mixing, metering and sampling, using the following processes and facilities:

- Three (3) cast-in-place concrete vaults. The first vault (over the existing outfall) would divert secondary effluent to the second, mixing vault (a 60-inch nominal static mixer in a fiberglass mixing pipe with a reducer), and a third (downstream over the existing outfall) to return the blended flows to the outfall.
- Pipelines and valves, such as 54-inch outer diameter high density polyethylene and flow meters between the first and second vaults (measures secondary effluent) and between the second and third vaults (measures combined flow).
- Flow meters on each of the brine streams entering the mixing vault and a Lab and Control Building between the second flow meter and the third vault.
- A sampling port in the third vault to measure total dissolved solids, pH, dissolved oxygen temperature, and other constituents of the blended effluent as required by permit conditions.
- Two (2) sluice gates in each of the two diversion vaults (1st and 3rd).
- An air release valve on the upstream end of the static mixer.

5.4 Groundwater Recharge Facilities

The highly-treated recycled water would be conveyed approximately 10 miles from the AWTF to the Seaside Groundwater Basin via a new pipeline. Groundwater replenishment will occur in a series of four new shallow (vadose zone wells) and four deep injection wells. Recycled water would co-mingle with groundwater and be stored in the basin for subsequent recovery by CalAm through existing production wells downgradient of the injection wells. The deep injection wells would be pumped periodically for maintenance, a process referred to as backflushing. This

pumped water would be piped a short distance to a new shallow, engineered basin (backflush basin), where water would be allowed to percolate through the deep vadose zone and return to the groundwater system. Additional details regarding the recycled water conveyance facilities are provided in Section 6. Additional details on the injection well facilities are provided in Section 7.

Section 6 - Highly-Treated Recycled Water Conveyance Facilities

The Proposed Project would include construction of a pipeline to convey the highly-treated recycled water from the proposed AWTF to the Seaside Groundwater Basin for injection, along one of two potential pipeline alignments. Each pipeline alignment option would require flow control valves, isolation valves, blow down structures for maintenance, air and vacuum release valves, and other appurtenant facilities below ground within the pipeline conveyance alignment.

The proposed conveyance system is designed to convey a total of 3,500 AFY of highly-treated recycled water to the proposed new injection sites. The conveyance system design assumes an average monthly flow of 3.13 mgd for the low range of design flow and 3.59 mgd for the high range of design flow, which correlate to flows of 3.5 and 4.0 mgd, at times when the AWTF is operating. Several factors are expected to affect the actual daily flow rates through the conveyance system, including: seasonal variations; source water supply variations; down-time for maintenance of the pumping systems and AWTF mechanical equipment; and maintenance of the wells. The conveyance pipeline would be 24 inches in diameter and would comply with the CDPH pipeline separation requirements. A maximum daily flow of approximately 3.5 to 4.0 mgd was used for the design criteria for the pump stations.

Section 7 - Injection Well Facilities

The new injection well facilities would be located in the northeastern portion of the City of Seaside about 1.5 miles inland of Monterey Bay. Highly-treated recycled water would be injected into the Seaside Groundwater Basin and would be operated to increase basin yield and to complement other pumping and injection in the basin. Current conditions and operations in the Seaside Groundwater Basin are described below.

Seaside Groundwater Basin

The Seaside Groundwater Basin underlies an approximately 19-square-mile area at the northwest corner of the Salinas Valley, adjacent to Monterey Bay. Two primary aquifers provide water supply from the basin, the shallow unconfined Paso Robles Aquifer and the deeper underlying Santa Margarita Aquifer. Groundwater is currently extracted from approximately 37 wells by 20 well owners in the Seaside Groundwater Basin. CalAm owns 12 wells and pumps approximately 80 percent of the water produced in the basin. In addition, CalAm and the Water Management District operate a Seaside Groundwater Basin Aquifer Storage and Recovery (ASR) system that stores excess Carmel River water supplies during the wet season in the groundwater basin and recovers the banked water during the following dry season for consumptive use. The estimated average yield of the existing ASR facilities is 1,920 AFY, but varies yearly based on rainfall due

to the requirement to maintain adequate Carmel River instream flows. ASR wells inject into and pump from the Santa Margarita Aquifer.

The Proposed Project is designed to provide part of the replacement water needed for CalAm to comply with the SWRCB Cease and Desist Order and the Seaside Groundwater Basin Adjudication. The Proposed Project would not produce all of the needed replacement water; the primary goal of the project is to produce 3,500 AFY to be used by CalAm in order to reduce its Carmel River diversions by that same amount.

The Proposed Project would replenish both the Paso Robles and Santa Margarita aquifers upgradient of the ASR wells and other production wells. Figure 4 presents a schematic diagram illustrating the conceptual operation of the Proposed Project in the basin.

Injection Wells

The proposed injection well facilities would be located east of General Jim Moore Boulevard, south of Eucalyptus Road in the City of Seaside, and include a total of eight wells (four deep injection wells into the Santa Margarita aquifer and four vadose zone wells to supply water to the Paso Robles aquifer), monitoring wells, and backflush facilities. The proposed site plan for the groundwater recharge components is shown on Figure 5. Wells within the same target aquifer are proposed to be spaced approximately 1,000 feet apart to minimize well interference. Separate turnouts with isolation valves would be provided to each individual well site from the conveyance pipeline. Four deep injection wells and four vadose zone wells are proposed so that the water could readily be allocated among the two well types and aquifers. With water levels below sea level in both the Paso Robles aquifer (the uppermost aquifer that is unconfined) and Santa Margarita aquifer (the deeper confined aquifer), it has been determined by the Watermaster that recharge into both aquifers would be beneficial for protection against seawater intrusion and for water supply. However, most of the basin production is within the Santa Margarita aquifer where water levels are below sea level throughout the northern coastal subarea and more than 40 to 60 feet below sea level downgradient and adjacent to the injection well facilities site.

Groundwater modeling was performed to identify the optimal allocation of recharge to the two aquifers to minimize both water outflow from the basin and changes in storage in the basin. Based on the modeling performed for the Proposed Project, the Santa Margarita aquifer is targeted to initially receive 90 percent of the highly-treated recycled water from the Proposed Project and the Paso Robles aquifer is targeted to receive 10 percent of the highly-treated recycled water through injection using vadose zone wells. This project configuration would provide maximum flexibility for well operation and for managing short-term production benefits with the benefits of long-term storage.

Collectively, the four shallow and four deep injection wells represent a maximum capacity of approximately 6,000 gallons per minute (gpm). This capacity is well above the Proposed Project design flows of 3,500 AFY (with an anticipated maximum daily flow rate of 2,493 gpm with no downtime), and thus would allow for backup of pumping capacity if one or more wells are not functioning, well maintenance, and for other operational benefits. In addition, recycled water from the Proposed Project could readily be re-allocated among the two well types and aquifers as



Figure 4. Conceptual Injection Schematic



Figure 5. Proposed Site Plan for Groundwater Recharge Components

basin conditions change in the future and to ensure compliance with CDPH retention time requirements. Wells may be installed in a phased approach (from east to west) as actual well capacity and required peak flow rates are more clearly defined. If there are future changes in the daily flow rates, sufficient number and total capacities of wells would be available to accommodate peak flows.

Backflush Facilities

Based on the experience of the Water Management District in the operation of its nearby ASR wells, backflushing of each injection well would occur about weekly and would require discharge of the backflush water to a percolation pond, or backflush basin, with a capacity of about 300,000 gallons. The backflush basin would be located in the middle of the injection well facilities site. Alternate sites have also been identified as shown on Figure 5. Separate pipelines would convey the back-flushed water from each well to the percolation pond.

Monitoring Wells

Monitoring wells would be used to monitor project performance and compliance with CDPH regulations. Because the Proposed Project would recharge two separate aquifers (Paso Robles and Santa Margarita aquifers), well clusters capable of monitoring both aquifers would be installed at four locations. Existing wells could be used for upgradient monitoring. The monitoring wells would also be used to satisfy regulatory requirements for monitoring of subsurface travel time, tracer testing, and other requirements for a groundwater replenishment project. Based on the June 2013 draft CDPH regulations, a minimum of two monitoring wells (each with two clusters to monitor both aquifers) would be required between the Proposed Project and the nearest downgradient production well. For this project, two wells (with two well clusters at each location) are included between the Proposed Project and the ASR wells to the northwest. In addition, two wells (also with two well clusters at each location) are included between the Proposed Project and the City of Seaside production well to the southwest. This results in a total of eight monitoring points (four in each aquifer) at the four locations shown on Figure 5. One set of monitoring wells would be located within close proximity to the project injection wells to support tracer testing as required by CDPH regulations. The second set of monitoring wells would be located more centrally between the project wells and the nearest downgradient water supply wells.

Extraction/Distribution System

CalAm would use existing Seaside Groundwater Basin wells, in addition to existing treatment facilities and existing pipelines in its Monterey District Service area, to recover, treat and deliver potable water from the groundwater basin to its customers. The water that CalAm extracts would include some of the Proposed Project highly-treated recycled water along with other groundwater from the basin. To meet the full replacement objective of the Proposed Project (3,500 AFY), additional distribution system pipelines would be required in the CalAm system.

Section 8 - Provisions for Public Health Protection

8.1 Source Water Monitoring Program

As previously stated, the source water for the AWTF would be secondary effluent from the

MRWPCA RTP. To ensure an adequate supply of secondary effluent for the AWTF, additional raw waters supplies (i.e., the source waters described in subsection 5.1, Source Waters) would be added to the MRWPCA collection system. The source waters would be diverted into the existing MRWPCA collection system, diluted and mixed with the existing municipal wastewater supplies, and treated through the RTP primary and secondary treatment processes prior to treatment at the AWTF. The unused secondary effluent would only be sent to the AWTF during periods when the secondary-treated wastewater quantities exceed the nonpotable recycled water demand of the CSIP area or other areas. Extensive water quality monitoring and bench scale testing have been conducted on these source waters to characterize the water quality and assess the required treatment.

A rigorous characterization of the source waters was undertaken for each type of water for the following constituents:

- General water quality parameters
- CDPH Maximum Contaminant Levels (MCLs)
 - Inorganic chemicals
 - Organic chemicals
 - Disinfection by-products (DBPs)
 - Radionuclides
 - o Microbiological parameters
- CDPH Notification Levels (NLs)
- CDPH Drinking Water Archived Advisory Levels
- EPA Unregulated Contaminant Monitoring Rule (UCMR) Lists 1, 2 and 3
- EPA Clean Water Act Priority Pollutants
- Pesticides of local interest
- CECs

8.2 Source Water Treatability

Unused wastewater: Secondary effluent in excess of the nonpotable recycled water demands will be used as part of this project. This water is currently discharged to the Monterey Bay through MRWPCA's ocean outfall. The treatment process design for the AWTF will be driven by the water quality of this existing secondary effluent. The primary water quality parameters that drive the treatment requirements for the secondary effluent are (1) pathogens, (2) total organic carbon, (3) nitrogen species (ammonia, nitrate, and nitrite) (4) mineral quality (e.g., dissolved solids including chloride, calcium, phosphate, silica), and (5) select unregulated contaminants. The concentrations of these parameters are all typical of a non-nitrified trickling filter effluent prior to disinfection.

Salinas agricultural wash water: Agricultural wash water and wastewater from other agricultural processing operations throughout the City of Salinas would be diverted into the MRWPCA wastewater collection system at the MRWPCA Salinas Pump Station site. These waters are currently treated at the SIWTF. From an organic loading perspective, this source water can be characterized as a low to moderate strength wastewater, priority pollutants were not detected and organic and CEC levels and pathogen concentrations lower than that of the raw

municipal wastewater currently treated by MRWPCA at the RTP. This water contains elevated concentrations of phosphate and total dissolved solids (TDS), as compared with the existing RTP wastewater. These elevated phosphate concentrations (e.g., 9 mg-P/L compared with the existing 3 mg-P/L) will require additional controls to prevent calcium phosphate fouling on the RO membranes. Additional iron-based coagulant may be added in the collection system at the Salinas Area Pump Station or at the RTP headworks to enhance the phosphate removal through primary and secondary treatment. Further, bench-scale testing has indicated that this wash water (when mixed with the existing wastewater and treated through the RTP primary and secondary treatment) may have a measurable increase on the rate of fouling of the membrane filter; however, the degree of this impact is being evaluated through pilot testing in April and May 2014.

Monterey and Salinas stormwater and urban runoff: Urban runoff and stormwater from the cities of Monterey and Salinas would be diverted to provide this source water. Sampling of these sources is ongoing; however, initial results indicate that elevated concentrations of TDS would be the primary water quality consideration for the identification of treatment requirements for the Monterey stormwater. However, this increase in TDS is minor from a treatability perspective, and it is not expected that the use of this water would require any changes to the process train. Once this water is mixed with the existing wastewater at the RTP, the resulting increase in TDS is expected to have a negligible impact on the final product water quality.

Agricultural drainage water: An additional type of source water that may be included in the project is agricultural drainage water from the Blanco Drain, Reclamation Ditch, and/or Tembladero slough. The Tembladero slough and Reclamation ditch also include urban and nonurban runoff. Extensive source water monitoring of the Blanco Drain water has been conducted, including monitoring of pesticides; only low levels of a few pesticides were detected. Of the pesticides that were detected, most concentrations were orders of magnitude below the any applicable regulatory or advisory levels for drinking water (i.e., CDPH MCLs or Notification Levels/Archived Advisory Levels). Only dieldrin and 1,3-dichloropropene were detected at concentrations approaching applicable drinking water regulatory/advisory levels in the raw water. It is expected that both of these pesticides would be reduced to concentrations below detection limits through dilution with the wastewater alone (i.e., prior to advanced treatment). Further, the ozone, RO, and AOP processes would also be expected to provide a significant barrier for these contaminants. Other contaminants that would drive the treatment of drainage water are the elevated levels of dissolved solids and nitrate, both of which will be reduced to acceptable levels through the RO treatment. It is expected that no additional treatment would be needed for this water, beyond what is already proposed for treating the secondary effluent.

AWTF treatment process selection: A treatment train consisting of membrane treatment and AOP plus ozone pretreatment is planned for this project, and would meet all regulatory requirements. The ozone pretreatment is included to provide an additional barrier to pathogens and organic contaminants (*e.g.*, pesticides and CECs) and to reduce the fouling on the MF system. Following ozonation, the MF system is used to remove suspended and colloidal solids, as well as protozoa, bacteria, and prepare the water for RO. The RO system provides an excellent barrier to pathogens, salinity, and chemical contaminants, including CECs, dissolved

metals, salts, and nutrients. Finally, a UV/H_2O_2 AOPAOP will be used as a final polishing step to destroy any chemical contaminants that were able to pass through the RO.

8.3 Pathogenic Microorganism Control

To protect public health, IPR projects must inactivate or remove pathogenic microorganisms from the wastewater prior to distribution. CDPH requires minimum pathogenic reductions of 12, 10, and 10 logs for viruses, *Giardia*, and *Cryptosporidium*, respectively using at least three treatment barriers.

CDPH grants log reduction credits for unit processes that have been demonstrated to remove pathogens under expected operating conditions. The proposed pathogen reduction credits for the unit processes in the AWTF and underground retention time are shown in Table 1. The log reduction credits listed in the table are typical of what other advanced water treatment facilities in California operating under similar conditions have achieved. The CDPH draft groundwater replenishment regulations allow log reductions credits for virus for underground retention time of 1-log/month up to logs (e.g., 6 month retention time). The combination of the new AWTF and predicted underground retention time is expected to achieve log reduction credits of 18, 15, and 12 for viruses, *Giardia*, and *Cryptosporidium*, respectively, which exceeds the log reduction requirements in the draft CDPH groundwater replenishment regulations. The extra credits, not including additional credits that may be granted for secondary treatment, will provide redundancy to pathogen microorganism removal.

Process	Conditions	Log Reduction Credits		
		Virus	Giardia	Crypto
Ozone ¹	O ₃ CT of 1 mg/L-min @15 °C	4	3	0
MF	Daily pressure decay test	0	4	4
RO	Online TOC or conductivity monitoring	2	2	2
UV/H_2O_2	1,000 mJ/cm ²	6	6	6
Aquifer	6-month underground retention time ²	6	0	0
Requirement		12	10	10
Total Credit		18	15	12

Table 1. Proposed Pathogen Reduction Credits for AWT Processes

¹Ozone concentration/contact time (CT) may be included if additional credit for redundancy is needed.

²Actual underground retention time expected to exceed 6 months.

8.4 Control of Nitrogen Compounds

The MRWPCA secondary effluent is a non-nitrified effluent, with a total nitrogen concentration of approximately 45 mg-N/L, mostly as ammonia. The primary AWTF nitrogen removal mechanism will be rejection through the RO membranes, where removal of nitrogen species typically exceeds 95 percent, with permeate concentrations of approximately 2 mg/L.

8.5 Regulated and Unregulated Contaminant Control

Regulated Contaminants

In addition to meeting pathogenic microorganism requirements, the AWTF recycled water must comply with all drinking water standards, specifically the CDPH primary and secondary Maximum Contaminant Levels (MCLs). Most MCLs were not detected in the source waters, and have not been monitored in the final AWTF water at this stage of the project. The RO pilot product water quality monitoring is focused on demonstrating the overall reduction of contaminants present in the source water. Water from the AWT pilot plant has consistently complied with all of the CDPH drinking water standards, with most concentrations being below detection limits.

Unregulated Contaminants

Unregulated contaminants of interest were also examined during the AWT piloting program, including relevant contaminants with CDPH Notification Levels, CDPH Archived Advisory Levels, pesticides of local interest, and CECs. The only unregulated contaminant of interest detected in the RO permeate was N-nitrosodimethylamine (NDMA), where concentrations have ranged from 20 to 32 ng/L. The UV/AOP process (not included at the pilot facility) will be designed to provide at least a 1-log reduction of NDMA, reducing the NDMA concentration in the final AWTF product water to 2 to 3 ng/L. These concentrations are well below the CDPH Notification Level of 10 ng/L.

Total Organic Carbon Control

Total Organic Carbon (TOC) can be used as a surrogate for unregulated and unknown organic chemicals contaminants. The project goal will be to maintain product water TOC concentrations below 0.5 mg/L, and thus far this goal has been consistently met during the pilot testing after RO.

8.6 Reliability and Redundancy

The full-scale AWTF and recharge of the highly-treated recycled water would provide reliability and redundancy through the use of multiple treatment barriers for each type of contaminant. Not counting the RTP, the AWTF would achieve chemical contaminant removal redundancy by employing at least two treatment technologies for most contaminant types (see Table 2) and at least three technologies for pathogens (see Tables 1 and 2).

The full-scale AWTF will achieve resiliency through its ability to respond to failures (the detection of failures is discussed in the subsection 8.8, Monitoring and Response Plan). If a
treatment failure in the RTP that may disrupt the AWTF is detected, the AWTF would be able to cease production. AWTF process failures of the RO system using online monitoring or the AOP system would also lead to plant shutdown. Given that the aquifers have large storage capacities and numerous extraction wells throughout the basin, the AWTF can cease production for an extended period of time, if needed. If a failure in the AWTF is detected, the AWTF would have the ability to divert the product water back to the RTP headworks, to the Reclamation pond (if the water meets tertiary treatment standards), or to the ocean outfall. If a failure is detected after the product water is injected into the aquifer, there will still be at least 12 months to allow for an appropriate response.

Process		Chem	ical Con	stituents		Pathoger	nic Microo	organisms
	Nitrogen	TOC	DPBs	Inorganics	CECs	Bacteria	Viruses	Protozoa
Primary/ Secondary	\checkmark	\checkmark		\checkmark	√	\checkmark	\checkmark	\checkmark
Ozone			\checkmark		\checkmark	\checkmark	\checkmark	\checkmark
MF		\checkmark		\checkmark		\checkmark		\checkmark
RO	\checkmark							
UV/H_2O_2			\checkmark		\checkmark	\checkmark	\checkmark	\checkmark
Aquifer						\checkmark	\checkmark	\checkmark

Table 2. MRWPCA GWR Multiple Treatment Barriers

8.7 Response Retention Time

The CDPH proposed groundwater replenishment regulations require a project sponsor to propose a response retention time (RRT) to allow adequate response time to identify treatment failures and implement corrective actions. The minimum time allowed by the draft groundwater replenishment regulations is 2 months, but must be justified by the project sponsor. MRWPCA will develop a RRT taking into consideration the following safety features that are part of the Proposed Project: (1) continuous online monitoring of RO treatment with real-time results reviewed by the AWTF operators; (2) multiple levels of critical control points for RTP and AWTF operations, alarms, and unit process redundancy; and (3) the ability to shut down the AWTF at a moment's notice. As part of the RRT development, MWRPCA will also consider the time necessary to provide an alternative water supply should CDPH determine that the Proposed Project has impacted a drinking water well so that it can no longer be used as a drinking water supply. The RRT would be validated by a tracer study approved by CDPH.

8.8 Monitoring and Response Plan

Monitoring of the AWTF influent and product water quality and other process data will be conducted to ensure that the AWTF is functioning properly, and that the product water meets treatment objectives. The product water will be monitored in accordance with the CDPH draft groundwater replenishment regulations.

The effectiveness of treatment processes can be verified through online process monitoring (integrity monitoring) of critical control points in the treatment process. This online monitoring is underway at the Proposed Project pilot plant and will be undertaken at the full-scale AWTF. Each process has specific indicators that can be used to verify its performance:

- Ozone: dissolved ozone residual
- MF: effluent turbidity removal and daily pressure decay testing
- RO: conductivity removal and/or effluent TOC
- UV/AOP: UV intensity, power draw, and chemical level alarms

These processes would be measured online, and alarms would be used to adjust or shut down the process, divert the flow, or alert the operations staff immediately, as appropriate. Monitoring data obtained from the pilot plant or in the start-up phase of the full-scale AWTF would be used to establish a baseline of acceptable operational conditions. The instrumentation will be maintained and verified periodically to ensure that the online data are reputable. Further preventive maintenance would be performed on the equipment on a regular basis to avoid acute or creeping failures (e.g., O-ring replacement). The monitoring data would be analyzed/calibrated on a regular basis and modified as needed to ensure a resilient and reliable treatment process.

Section 9 - Regulatory Approval of Proposed Project Concept

The purpose of this proposal is to seek CDPH approval of the Proposed Project concept. While the development of the Proposed Project to date is summarized in this report, further information is necessary to document that all regulatory requirements specified in the CDPH draft groundwater replenishment regulations can be met. As the Proposed Project moves forward, and facilities are constructed, additional information will be forthcoming and will include the following:

- a full description of the Proposed Project and all components (final design);
- source control program (e.g. how our program meets CDPH requirements especially for the new sources and a review of our local limits to address CDPH draft requirements);
- water quality monitoring plan;
- contingency plan (e.g., an alternative source of potable water or a CDPH-approved treatment mechanism) to assure that product water not meeting drinking water standards is not distributed to the public (or others);
- response plan to identify and respond to a failure to meet product water quality requirements such that inadequately-treated water does not enter the drinking water distribution system (i.e., assure compliance with the RRT)
- operations plan that identifies the operations, maintenance, analytical methods, and monitoring needed to comply with the CDPH draft groundwater replenishment regulations; and
- engineering report.



State of California—Health and Human Services Agency California Department of Public Health



EDMUND G. BROWN JR. Governor

Director & State Health Officer

June 5, 2014

Robert Holden, Principal Engineer Monterey Regional Water Pollution Control Agency 5 Harris Court, Building D Monterey, CA 93940

Dear Mr. Holden:

Pure Water Monterey Groundwater Replenishment Project Concept Monterey Regional Water Pollution Control Agency- Recycled Water System No. 2790002

The California Department of Public Health (CDPH) has reviewed the DRAFT May 19, 2014 Monterey Regional Water Pollution Control Agency, Pure Water Monterey Groundwater Replenishment Project, Proposal to Inject Highly-Treated Recycled Water into the Seaside Groundwater Basin. The purpose of this letter is to respond to the Monterey Regional Water Pollution Control Agency (MRWPCA)'s request for CDPH review and approval of the project concept. CDPH has developed draft groundwater replenishment regulations. MRWPCA has committed to meet the requirements specified in the CDPH draft groundwater replenishment regulations.

The MRWPCA proposed project for groundwater injection will involve injecting highly-treated recycled water from a proposed new advanced water treatment facility (AWTF) into the Seaside Groundwater Basin. The AWTF would receive secondary effluent from the MRWPCA Regional Treatment Plant (RTP) as source water for treatment. The following is a list of the proposed AWTF processes:

- ozonation. •
- biologically active filtration (optional), .
- membrane filtration (MF) treatment, •
- reverse osmosis (RO) membrane treatment, and •
- advanced oxidation process using ultraviolet light and hydrogen peroxide (H_2O_2).

The proposed pathogen reduction credits for the unit processes and underground retention time are shown in Table 1, Proposed Pathogen Reduction Credits for AWT Processes in the Draft Proposal. These pathogen reduction credits must be substantiated in the engineering report and operations plan. Please note that RO via online TOC or conductivity monitoring can only demonstrate 1.0 to 1.5 log removal rather than 2 log removal. Still, the log reduction credits for viruses, Giardia, and Cryptosporidium should far exceed the log reduction requirements in the draft CDPH groundwater replenishment regulations. The extra log removal credits will provide an additional safeguard to ensure adequate pathogen reduction.

Division of Drinking Water and Environmental Management, 850 Marina Bay Parkway, Bldg P., 2nd Floor, Richmond, CA 94804-6403 (510) 620-3474 (510) 620-3455 Fax Internet Address: www.cdph.ca.gov Program Internet Address: http://www.cdph.ca.gov/programs/Pages/DDWEM.aspx

R. Holden / MRWPCA June 5, 2014 Page 2

To obtain CDPH approval for an actual project, MRWPCA must provide an adequate basis for CDPH to make a finding that the project meets the requirements in the Health & Safety Code (H&S Code). CDPH has authority to condition a permit (H&S Code Section 116540) "as it deems necessary to assure a reliable and adequate supply of water at all times that is pure, wholesome, potable, and does not endanger the health of consumers". Nothing in this letter is intended to waive CDPH's authority.

Based on CDPH's review of MRWPCA's draft concept proposal, CDPH has concluded that the project, as conceived, when properly designed, constructed, and operated, should meet the requirements in the draft CDPH groundwater replenishment regulations. Therefore, CDPH conditionally approves the *Pure Water Monterey Groundwater Replenishment Project, Proposal to Inject Highly-Treated Recycled Water into the Seaside Groundwater Basin* Draft Concept. At a minimum, the conditions and future submittal requirements are described below.

Future Submittals

In order for CDPH to make the finding that the project poses no significant threat to public health and recommend issuance of a permit, MRWPCA will need to provide the additional information outlined below, including, but not limited to: engineering report, the final design, contingency plan, operations plan, response plan, water quality monitoring plan, and monitoring well locations.

Engineering Report, Final Design and Contingency Plan

Once project details are finalized, the project's Engineering Report must be submitted to CDPH for review and approval. Please refer to the current draft recharge regulations for guidance on content. Final design must be reviewed and approved before start of construction. The Engineering Report must contain an AWTF contingency plan which will assure that no untreated or inadequately-treated wastewater will be delivered to the use area.

Operations Plan

An Operations Plan must be developed to optimize individual treatment unit processes. Real-time monitoring with online instruments must be implemented to track, verify, and optimize performance of critical treatment processes in order to protect public health. The current demonstration project should provide data that would assist in accomplishing this. Full-scale commissioning and startup testing should finalize the treatment optimization process and be incorporated in the final Operations Plan.

Response Plan

Prior to operation, MRWPCA must submit a response plan for review and approval that will be implemented if needed to respond to a failure to meet product water quality requirements. The response plan should describe the steps to provide either:

- 1. an alternative source of drinking water supply to all users of a drinking water well, or
- 2. an approved treatment mechanism provided to all owners of a drinking water well

Water Quality Monitoring and Operational Reliability

Prior to discharge to Seaside Groundwater Basin, MRWPCA must develop and submit for approval a comprehensive Water Quality Monitoring Plan to determine compliance with all drinking water maximum contaminant levels (MCLs) and other pertinent standards. In addition, the Monitoring Plan shall include a sampling and analytical strategy for chemicals for which CDPH has established notification levels. To ensure proper performance of unit operations, full-scale commissioning and startup testing is required. This will confirm appropriate surrogate parameters and performance

R. Holden / MRWPCA June 5, 2014 Page 3

indicator compounds that are tailored to monitor the contaminant removal efficiency of individual unit processes.

Seaside Groundwater Basin and Monitoring Well Requirements

The number and proper location of monitoring wells must be justified. Based on information provided to date, an additional set of monitoring wells may be needed to evaluate water quality along the path of flow from the GWR Well Site #3 to the ASR Wells 1 and 2. CDPH understands that MRWPCA intends to perform a tracer study to determine travel time to the nearest drinking water wells and confirm the theoretical estimates from the modeling.

Technical and Managerial Capacity, with Focus on Treatment Plant Operators

Adequate technical and managerial capacity must be demonstrated by the MRWPCA for the project. The MRWPCA must hire, train, and retain a sufficient number of qualified operators. A response/contingency plan including communication and notification procedures must be developed to address serious water quality problems arising from treatment plant failures that could compromise the use of Seaside Groundwater Basin as a source of drinking water.

CDPH staff will continue to be available to your staff for technical discussions and to answer questions on CDPH's requirements for the project.

If you have any questions, please feel free to contact Jan Sweigert at (831) 655-6934 or myself at (510) 620-3474.

Sincerely,

Stefan Cajina, P.E., Chief North Coastal Region Drinking Water Program

cc: Peter vonLangen Central Coast Regional Water Quality Control Board 895 Aerovista Place, Suite 101 San Luis Obispo, CA 93401

> Monterey County Environmental Health Bureau 1270 Natividad Road Salinas CA 93906

APPENDIX C

Pure Water Monterey Groundwater Replenishment Project: Advanced Water Treatment Facility Piloting Report

Pure Water Monterey Groundwater Replenishment Project: Advanced Water Treatment Facility Piloting



Draft Report - January 2016

Prepared for:



Prepared by:



Trussell Technologies, Inc. John Kenny, P.E. Gordon J. Williams, Ph.D., P.E. Sarah Triolo



Separation Processes, Inc. Alex Wesner, P.E. Pure Water Monterey Groundwater Replenishment Project: Advanced Water Treatment Facility Piloting

DRAFT REPORT



January 2016

Prepared By:

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and

Separation Processes, Inc. Alex Wesner, P.E.

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Acronyms

AAL	Archived Advisory Level
AOC	Assimilable Organic Carbon
AWTF	Advanced Water Treatment Facility
BAF	Biologically active filtration
BDOC	Biodegradable dissolved organic carbon
BOD	Biochemical oxygen demand
BPA	Bisphenol A
CEB	Chemically enhanced backwash
CEC	Contaminants of emerging concern
CEPT	Chemically enhanced primary treatment
CGWRRR	California Groundwater Replenishment Reuse Regulations
CIP	Clean in place
CO_2	Carbon dioxide
COD	Chemical oxygen demand
СТ	Residual concentration times contact time
DBP	Disinfection by-product
DCP	1,3 dichloropropene
DCPA	Tetrachloroterephthalate
DDW	State Water Resources Control Board Division of Drinking Water
DO	Dissolved oxygen
DO ₃	Dissolved ozone
DOC	Dissolved organic carbon
EEM	Excitation-emission matrices
EPA	Environmental Protection Agency
EPA PP	EPA Clean Water Act Priority Pollutants
GFD	Gallons per square foot per day
gpm	Gallons per minute
GWR	Groundwater Replenishment
HAA	Haloacetic acid
HRT	Hydraulic residence time
IPR	Indirect Potable Reuse
kDal	Kilodalton
LC-MS-MS	Liquid chromatography tandem mass spectrometry
LSI	Langelier saturation index
MCL	Maximum Contaminant Level
MF	Membrane filtration
MFI	Modified fouling index
mg-min/L	Milligram-minute per liter
mg-N/L	Milligrams as nitrogen per liter
mg-P/L	Milligrams as phosphorus per liter



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mg/L	Milligrams per liter
mL	Milliliter
MPN	Most probable number
MPWMD	Monterey Peninsula Water Management District
MRWPCA	Monterey Regional Water Pollution Control Agency
mV	Millivolts
NaOCl	Sodium hypochlorite
NaOH	Sodium hydroxide
NDMA	N-Nitrosodimethylamine
NDPA	N-Nitrosodi-n-Propylamine
ng/L	Nanograms per liter
NL	Notification Level
nm	Nanometer
NTU	Nenhelometric turbidity unit
03	Ozone
OCWD	Orange County Water District
ORP	Ovidation reduction notential
nCi/I	Dicocurios por litor
	Programmable logic controller
nMCI	Primary Maximum Contaminant Level
PMCL PNFC	Predicted no-effect concentration
POC	Particulate organic carbon
	Particidae of local interact
POLI	Pesticides of local interest
ppm	Part per minion
PSA	Pressure swing absorption
psi	Pounds per square inch
psi/min	Pounds per square inch per minute
PVC	Polyvinyl chloride
RO	Reverse osmosis
RTP	Regional Treatment Plant
SBS	Sodium bisulfite
SDI	Silt density index
SEC	Size-exclusion chromatography
SIWTF	Salinas Industrial Wastewater Treatment Facility
slpm	Standard liters per minute
SM	Standard Method for the Examination of Water and Wastewater
sMCL	Secondary Maximum Contaminant Level
SVRP	Salinas Valley Reclamation Plant
TDS	Total dissolved solids
THM	Trihalomethane
TI	Threshold Inhibitor
TKN	Total Kjeldahl Nitrogen
TMP	Transmembrane pressure



ТОС	Total organic carbon
TOrC	Trace organic compound
TSS	Total suspended solids
UCMR	Unregulated Contaminant Monitoring Rule
UF	Ultrafiltration
UV	Ultraviolet
UV/AOP	UV light with hydrogen peroxide advanced oxidation process
UVT	Ultraviolet light transmittance
VFD	Variable frequency drive
VSS	Volatile suspended solids
µg/L	Microgram per liter
µS/cm	Microsiemens per centimeter



Executive Summary

The Monterey Regional Water Pollution Control Agency (MRWPCA) and the Monterey Peninsula Water Management District (MPWMD) are in the process of developing the Pure Water Monterey Groundwater Replenishment (GWR) Project. The GWR project involves treating secondary effluent from the Regional Treatment Plant (RTP) with an Advanced Water Treatment Facility (AWTF), injection into a groundwater aquifer, and subsequent withdraw to augment the potable water supply of the Monterey Peninsula. Additional source waters will be brought into the RTP to provide water for the AWTF. The AWTF will include the following major treatment processes:

- Preozonation (*i.e.*, ozonation),
- Upflow biologically active filtration (BAF; optional),
- Ultrafiltration (UF), otherwise known as membrane filtration (MF),
- Reverse osmosis (RO),
- Ultraviolet light with hydrogen peroxide advanced oxidation process (UV/AOP), and
- Product water stabilization.

Preozonation, MF, and RO were pilot tested during a nine-month long pilot testing program. The BAF process was not piloted, because it is an optional process, and the design of UV/AOP and product water stabilization systems do not require pilot testing. Pilot testing was conducted from mid-October, 2013 to mid-July, 2014, with extensive pilot water quality sampling from December 2013 to June 2014. Pilot testing follows the work of bench-scale testing, when a preliminary treatment train was developed and the treatability of various source waters was assessed (Trussell Technologies, 2014c); pilot testing occurred simultaneously with an extensive source water sampling campaign (Trussell Technologies, 2014d); and pilot testing informed the Basis of Design Report for the AWTF (Trussell Technologies and SPI, 2014b).

Secondary effluent from the RTP (non-nitrified trickling filter and solids contact effluent) was pumped into the former chlorine storage building, which was used as the pilot building. At times, additional source waters were shunted to the RTP collection system, and the resulting RTP secondary effluent was influenced by these source waters. The source waters tested during piloting consisted of City of Monterey stormwater from Lake El Estero and agricultural wash water that would otherwise go to the Salinas Industrial Wastewater Treatment Facility (SIWTF). Once within the pilot building, the secondary effluent was treated with sodium hypochlorite, ozone, MF, and RO. The ozone, MF, and RO pilot were procured from pilot equipment vendors. Two MF systems were procured to test two different MF configurations: inside-out and outside-in filtration. The RO permeate flow was 18 gallons per minute (gpm), with all product and waste flows drained to the holding pond next to the building and ultimately returned to the RTP headworks.



AWTF PILOT REPORT (INTERNAL DRAFT USE ONLY)

The objectives of the pilot testing were the following:

- Determine the preozonation ozone dose,
- Select MF technology (inside-out vs. outside-in),
- Determine sustainable MF flux,
- Determine sustainable RO recovery,
- Examine the impact of agricultural wash water shunting on RO fouling,
- Assess the product water quality, and
- Assess the water quality after each individual unit process.

These objectives were met by conducting a number of long- and short-term experiments, where operational conditions were changed and water quality and performance data were monitored. Operational conditions that were tested include the following:

- Lake El Estero and agricultural wash water shunt
- Chloramine residuals between 0 and 7 milligrams per liter (mg/L)
- Pre-ozone- and post-ozone-chloramination
- Ozone doses between 0 and 25 mg/L
- Ozone dose control methods utilizing oxidation reduction potential (ORP), dissolved ozone residual, and ultraviolet light transmittance (UVT)
- MF fluxes between 25 and 40 gallons per square foot per day (GFD)
- Inside-out MF and outside-in MF
- RO recovery of 81%
- RO feed pH setpoints of 6.0 to ambient (about 7.2)
- Phosphate precipitation in the RTP through ferric chloride addition

Pilot water quality sampling included sampling of the following parameters, before and after each unit process:

- General water quality parameters (*e.g.*, alkalinity, total organic carbon (TOC))
- Inorganics (*e.g.*, phosphate, ammonia)
- Disinfection by-products ([DBPs], *e.g.*, N-Nitrosodimethylamine [NDMA])
- Pathogens and pathogen indicators (*e.g.*, total coliforms, *Cryptosporidium*)
- Synthetic organic contaminants (*e.g.*, 1,4-dioxane, pesticides)

The following conclusions and recommendation are made based on the piloting results:

Preozonation conclusions and recommendations:

- 1. **Need for Preozonation:** Preozonation improved MF run times by a factor in the range of 4 to 8 by reducing membrane fouling. The reduction in fouling allows for a higher MF design flux, which would reduce the size and cost of the MF system. To realize these benefits, preozonation is recommended.
- 2. **Ozone Control:** Two ozone dose control methods were successfully demonstrated: (1) constant ozone dose with ORP control, and (2) ozone residual ozone dose



control. A third control method, UVT control, may provide the best ozone dose control of the three methods; however, further testing would be required, as the UVT equipment tested during piloting fouled too rapidly for use in a control system. Further testing of the UVT control method is recommended at either the pilot-scale demonstration facility or the full-scale facility to determine the benefits of the UVT control method.

- 3. **Ozone Dose:** An average transferred ozone dose of 9.5 mg/L (10 mg/L applied ozone dose at a transfer efficiency of 95%) provided sufficient preozonation. To provide this level of preozonation, an AWTF average transferred design dose of 9.5 mg/L is recommended. The AWTF maximum and minimum design transferred dose should account for the maximum and minimum design water quality.
- 4. **Secondary Performance and Ozone:** High TOC and nitrite concentrations in the RTP effluent contributed to the preozonation dose. RTP trickling filter operational changes may be able to reduce the nitrite concentration in the secondary effluent, which could reduce operational costs. If the nitrite concentration were reduced, it may be possible to reduce the design ozone dose and/or operational ozone dose.
- 5. **Ozone Disinfection:** Preliminary testing showed that disinfection credit might be possible at transferred ozone doses in the range of 15 to 19 mg/L. These doses led to ozone CTs (residual concentration times contact time) in the range of 1 to 2 mg-min/L.
- 6. **NDMA Formation:** Both pre-chloramination and post-chloramination yielded similar levels of NDMA formation. NDMA formation was about an order of magnitude lower than at West Basin Municipal Water District's Edward C. Little Facility, and it is expected that the NDMA concentration in the final product will be well below the 10 ng/L Notification Level.
- 7. **Bromate Formation:** Acceptable levels of bromate formation were observed through the ozonation process (maximum 9 micrograms per liter [μ g/L], compared to the Maximum Containment Level (MCL) of 10 μ g/L). The bromate formed during ozonation was consistently removed by the downstream RO process to levels below the detection limit (*i.e.*, less than 1 μ g/L for all samples).
- 8. **Biologically Active Filtration:** A biological process (*e.g.*, upflow BAF) downstream of preozonation would improve the product water quality, and possibly improve AWTF operation by reducing the concentration of organics in ozone-BAF effluent, including TOC, NDMA, and contaminants of emerging concern (CECs, also known as chemical of emerging concern and constituents of emerging concern).
- 9. **High Ozone Doses:** High ozone doses (*e.g.,* an average of 20 mg/L, applied) increased the concentration of TOC and formaldehyde in the RO permeate for the waters tested. These high ozone doses are not recommended on a regular basis for the AWTF, unless a downstream biological process is included downstream of ozone.
- 10. **Impact on RO Validation Testing:** Preozonation interfered with measurements analogous to those required by the Division of Drinking Water (DDW) during RO membrane integrity testing in the first 20 weeks of operation. Due to this interference, the first 20 weeks of AWTF operation will likely have to be conducted without preozonation. Alternatively, it may be possible to develop an alterative RO membrane integrity test with DDW.



Membrane conclusions and recommendations (MF and RO):

- 1. **Technology Selection:** The outside-in MF technology dramatically outperformed the inside-out MF technology during piloting. An outside-in MF membrane technology is recommended for the AWTF.
- 2. **Chloramine Residual:** A chloramine residual (*e.g.,* 2 to 5 mg/L at the RO feed) was important for controlling organic fouling on the MF system. A chloramine residual of 2 to 5 mg/L at the RO feed is recommended at the AWTF.
- 3. **Design Flux:** The outside-in MF membrane filtered for more than 30 days at a flux of 30 GFD, with a constant applied ozone dose of 10 mg/L during the agricultural wash water shunt. An MF design flux of 30 GFD is recommended for the AWTF.
- 4. **MF Fouling and Secondary Performance:** The MF membranes experienced spikes in transmembrane pressure (TMP) associated with short-term episodes of degraded secondary effluent water quality (these spikes in TMP corresponded with higher coagulant needs at the Salinas Valley Reclamation Plant [SVRP]); however, they were able to recover without operational intervention.
- 5. **MF Filtrate Water Quality:** The MF provided suitable RO pretreatment, with 99.8% of the MF effluent turbidity measurements less than 0.05 Nephelometric Turbidity Units (NTU), and all silt density index (SDI) measurements less than 3.
- 6. **RO Membrane Fouling:** At a recovery of 81%, the RO membrane required only one cleaning over a test period of approximately seven months, including extended periods with elevated phosphate concentrations and a high RO feed pH setpoint (*e.g.*, 6.8). Based on this piloting work, a preliminary AWTF design RO recovery of 81% is recommended; however, further modeling is also recommended to ascertain the effect on the RO recovery of the source waters that were not tested during piloting (*e.g.*, the Blanco Drain).
- 7. **Need for Phosphate Control**: Elevated phosphate concentrations in the agricultural wash water may foul the RO membrane if the phosphate is not removed through the RTP, or if the formation of phosphate minerals is not controlled at the RO process (*e.g.*, through acid addition). Phosphate removal in the RTP can be enhanced via the addition of ferric chloride through the chemically enhanced primary treatment (CEPT) facilities, although an application more specific to the AWTF feed water or the agricultural wash water is recommended for the AWTF if this method of phosphate control is pursued (*e.g.*, adding ferric directly to the agricultural wash water).
- 8. **pH Control:** RO specific flux dropped dramatically when pH adjustment was stopped, and adjustments to pH control affected the RO specific flux (likely due to the formation of calcium phosphate minerals). pH adjustment facilities will be necessary for the AWTF (*e.g.*, sulfuric acid).
- 9. **RO Cleaning:** An acid clean, without the use of detergents, was sufficient to restore RO permeability after scaling developed. Other cleans may be needed during full-scale operation if RO performance is reduced by foulants not observed during piloting (*e.g.*, biological, silica).
- 10. **Effect of Agricultural Wash Water:** The agricultural wash water shunt did not discernibly increase the fouling of the MF or RO membranes under the conditions tested.



UV/AOP conclusions and recommendations:

- 1. **Design UVT water quality:** During pilot testing, the RO permeate UVT was measured at 95% or greater for almost all samples (one sample was measured at 94%, but this is likely due to a high residual chloramine concentration in the RO permeate). Accordingly, a design RO permeate UVT of 95% was assumed for preliminary full-scale UV/AOP design.
- 2. **1,4-dioxane removal:** 1,4-dioxane concentrations were below the detection limit in all RO permeate samples, and it was only detected in 4 of 11 secondary effluent samples (maximum concentration of 1.2 μ g/L in the secondary effluent, whereas the notification level [NL] and the detection limit are both 1 μ g/L). The UV/AOP system will be designed to achieve at least 0.5-log removal of 1,4-dioxane (*i.e.*, 68.4% removal), and thus the concentration of 1,4-dixoxane in the product water is expected to be consistently below the NL. The full-scale AWTF UV/AOP system will be challenge tested (by spiking 1,4-dioxane) during start-up to demonstrate at least 0.5-log removal of 1,4-dioxane.

Water quality conclusions and recommendations:

- 1. **Product Water Quality:** Pilot water quality sampling results indicate that the AWTF product water is expected to meet all applicable regulations in the California Water Recycling Criteria, including the groundwater replenishment regulations for subsurface application, MCLs, NLs, and Archived Advisory Levels (AALs). The RO permeate met all requirements, except for NDMA; the UV/AOP system will be designed to meet the 1,4-dioxane removal criteria and to reduce NDMA by at least 90%, which is expected to reduce the NDMA to an acceptable concentration.
- 2. **CEC Reduction:** Ozone and RO removed all but a few CECs to levels below their detection limits. Of the CECs that were not removed to below their detection limits, all were measured at concentrations well below any limits linked to health concerns and most will be well removed through the UV/AOP system.
- 3. **DBP Formation:** DBPs (*e.g.*, NDMA and bromate) were formed through ozonation and chloramination, but at levels that would be adequately addressed by the combination of RO and AOP. DBPs are not expected to be an issue for the final product water.
- 4. **Additional RO Modeling:** RO modeling that takes into account (a) the blending of all source waters in the RTP collection system, (b) removal of select constituents through the RTP, and (c) removal of selected constituents through upstream AWTF processes is recommended to assess the fouling potential of the source waters.
- 5. **Need for Ozone:** Ozone provides benefits to the water quality, including providing a barrier to many synthetic organic compounds.
- 6. **Need for RO membrane:** RO treatment is needed for removal of several constituents, and is the backbone of the AWTF treatment train.
- 7. **Need for UV/AOP**: AOP is needed to address NDMA and provide an additional barrier against CECs (such as 1,4-dioxane) and pathogens.



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 - 8. **Source Water Variability:** Based on the source water monitoring program, it is expected that the proposed treatment train will be sufficient to meet all product water quality requirements for all of the proposed source waters.

Other design considerations:

- 1. **Biologically Active Filtration**: While BAF design criteria may be estimated, pilot testing is recommended prior to full-scale implementation to determine site-specific design criteria. Additionally, pilot testing would also be recommended to determine the effect of a BAF system on the performance of the downstream MF system, if the BAF were to be included in the AWTF.
- 2. **UV/AOP impact on organics:** Some UV/AOP systems downstream of RO in water reuse applications increase the concentration of specific organic constituents (*e.g.,* formaldehyde). UV/AOP pilot-scale testing should be considered to quantify the impact of UV/AOP on organics for this water.
- 3. **UV/AOP pathogen and chemical removal:** Chemical (*e.g.,* 1,4-dioxane, NDMA) and pathogen removal varies between water reuse projects. The full-scale AWTF design can account for this variation by selecting conservative design criteria. Alternatively, additional testing (*e.g.,* collimated bench-scale testing) offers a potential for a more aggressive full-scale design (*i.e.,* a less conservative design).
- 4. Additional Source Waters in the RTP collection system: The addition of new source waters to the RTP collection system may impact the RTP and the AWTF design in ways that were not discussed in the Source Water and Pilot Water Quality Report (*e.g.*, nitrite formation, RO recovery)(Trussell Technologies, 2014d). RTP and AWTF modeling and demonstration-scale testing is recommended to reduce uncertainty during AWTF design and start-up.
- 5. Additional Source Waters directly to the AWTF: If any of the new source waters were brought directly to the AWTF, then additional testing would be required to determine if there were additional pre-treatment needs.
- 6. **Long-term MF testing:** Several flux conditions were tested during the piloting; if additional piloting were conducted, it would be beneficial to conduct long-term testing of the 30 GFD design flux to better characterize seasonal water quality impacts.



1 Background

1.1 Project background

The Monterey Regional Water Pollution Control Agency (MRWPCA) and the Peninsula Water Management District (MPWMD) are implementing a Groundwater Replenishment (GWR) Project to augment the Monterey Bay peninsula water supply through the design and construction of an Advanced Water Treatment Facility (AWTF). This AWTF will treat secondary effluent from the RTP, and will include the following processes:

- Ozonation,
- Upflow Biologically Active Filtration (BAF; optional),
- Membrane filtration (MF),
- Reserve osmosis (RO),
- Ultraviolet advanced oxidation process (UV/AOP), and
- Product water stabilization.

The RTP wastewater supply will be augmented to provide flow for the AWTF. To achieve this augmentation, additional water supplies will be brought into the collection system. These additional water sources may include agricultural wash water, urban runoff, and potentially irrigation runoff water. A schematic of the AWTF processes, the existing RTP processes, and the additional source waters is shown in Figure 1.1.



Figure 1.1 – Schematic of AWTF treatment processes



Pilot testing was conducted to develop design criteria for select unit processes (ozone, MF, and RO) and to collect water quality samples. The pilot testing began in October 2013 and was completed in July 2014. Both the design criteria results and the water quality results are discussed in this report. Bench-scale testing and source water quality sampling was also conducted to select the AWTF processes. A summary of the bench-scale testing and source water qualities is provided below.

1.2 Source water descriptions

Each of the additional water sources to the GWR Project has unique water quality signatures. These signatures are discussed in this section, as well as the identification of treatment requirements at the RTP, AWTF and any pre-treatment for these waters.

Unused wastewater

Secondary effluent in excess of the non-potable recycled water demands will be used as part of this project. This water is currently discharged to the Monterey Bay through the MRWPCA ocean outfall. The treatment process design for the AWTF was driven by the water quality of this existing secondary effluent. The primary water quality parameters that drive the treatment requirements for the secondary effluent are: (1) pathogens, (2) total organic carbon (TOC), (3) nitrogen species (ammonia, nitrate, and nitrite) (4) mineral quality (*e.g.*, dissolved solids including chloride, calcium, phosphate, silica), and (5) select unregulated contaminants. The concentrations of these parameters are all typical of a non-nitrified trickling filter effluent prior to disinfection.

Agricultural wash water

Agricultural wash water and wastewater from other agricultural processing operations throughout the City of Salinas will be diverted into the MRWPCA wastewater collection system at the MRWPCA Salinas Pump Station site. These waters are currently treated at the Salinas Industrial Wastewater Treatment Facility (SIWTF). From an organic loading perspective, this source water can be characterized as a low to moderate strength wastewater, with organic levels and pathogen concentrations lower than that of the raw municipal wastewater currently treated by MRWPCA at the RTP. This water contains elevated concentrations of phosphate and total dissolved solids (TDS), as compared with the existing RTP wastewater. These elevated phosphate concentrations (e.g., 9 milligrams as phosphorus per liter [mg-P/L] compared with the existing 3 mg-P/L) will require additional controls to prevent calcium phosphate fouling on the RO membranes. Additional iron-based coagulant may be added in the collection system at the Salinas Area Pump Station or at the RTP headworks to enhance the phosphate removal through primary and secondary treatment. Further, bench-scale testing has indicated that this wash water (when mixed with the existing wastewater and treated through the RTP primary and secondary treatment) may have a measurable increase on the rate of fouling of the membrane filter; however, the degree of this impact was evaluated through pilot testing.



Monterey and Salinas stormwater and urban runoff

Urban runoff and stormwater from the cities of Monterey and Salinas will be diverted to provide this source water. Sampling of these sources indicates that elevated concentrations of TDS are the primary water quality consideration for the Monterey stormwater. However, the increase in TDS is minor from a treatability perspective, and it is not expected that the use of this water would require any changes to the process train. Once this water is mixed with the existing wastewater at the RTP, the resulting increase in TDS is expected to have a negligible impact on the final product water quality.

Agricultural drainage water

An additional type of source water that may be included in the project is agricultural drainage water from the Blanco Drain, Reclamation Ditch, and/or Tembladero slough (presently, the Blanco Drain and the Reclamation Ditch are included in the project, whereas the Tembladero Slough may be pursued at a later date). The Tembladero slough and Reclamation Ditch also include urban and non-urban runoff. Extensive source water monitoring of the Blanco Drain water has been conducted, including monitoring of pesticides; only low levels of a few pesticides were detected. Of the pesticides that were detected, most concentrations were orders of magnitude below applicable regulatory or advisory levels for drinking water (i.e., State Water Resources Control Board Division of Drinking Water (DDW)¹ Maximum Contaminant Levels (MCLs) or Notification Levels (NLs)/Archived Advisory Levels (AALs)). Only two were at concentrations near applicable drinking water regulatory/advisory levels in the raw water: dieldrin and 1,3 dichloropropene (DCP). It is expected that both of these pesticides would be reduced to concentrations below detection through dilution with the wastewater alone. Further, the ozone, RO, and AOP processes would also be expected to provide a significant barrier for these contaminants. Other contaminants that would drive the treatment of drainage water are the elevated levels of dissolved solids and nitrate, both of which will be reduced to acceptable levels through the RO treatment. It is expected that no additional treatment would be needed for this water, beyond what is already proposed for treating the secondary effluent.

1.3 Bench-scale testing

Bench-scale pretreatment testing was conducted on the alternative GWR Project source waters to determine an appropriate pretreatment train and the treatability of the source waters. Testing was conducted on the RTP secondary effluent without blending, blended with the Blanco Drain, and blended with the agricultural wash water, and included pretreatment trains comprised of combinations of preozonation, coagulation and/or sedimentation. For these conditions the following parameters were measured:

- General water quality parameters
- Trace organic compounds (TOrCs)
- Excitation-emission matrices (EEMs)

¹ On July 1, 2014, California's Drinking Water Program was moved from the California Department of Public Health (CDPH) to the State Water Resources Control Board (SWRCB), and as a result of the change they are now titled the Division of Drinking Water.



- Size-exclusion chromatography (SEC)
- Ultrafiltration (UF) fractionation
- Modified fouling index (MFI)
- Bacteriophage inactivation (bacteriophage MS2)
- Disinfection by-product formation (NDMA and bromate)

The pretreatment alternatives were evaluated by their impact on membrane fouling potential (EEM, SEC, UF fractionation, MFI), TOrC removal, virus inactivation, and disinfection by-product (DBP) formation.

The results from this testing were used to develop the AWTF process described below, which included preozonation as a method for reducing membrane fouling. This testing also indicated that the unused RTP secondary effluent would be the primary driver for the treatment process, with a secondary consideration coming from the high phosphate concentrations in the agricultural wash water.

1.4 AWTF process

DDW regulates GWR projects. The MRWPCA GWR Project falls under Subsurface Application DDW regulations for Indirect Potable Reuse (IPR). These regulations require advanced water treatment facilities to include RO and AOP, in addition to setting pathogen inactivation and chemical removal requirements. Membrane filtration is included to pretreat the RO feed water, and to remove pathogenic protozoa (*e.g., Cryptosporidium* and *Giardia*). Ozone is included to pretreat the MF feed water (*i.e.,* preozonation), and provide pathogen inactivation and destruction of Contaminants of Emerging Concern (CECs). The AOP process will be UV/AOP, which provides pathogen inactivation and CEC removal. Finally, product water stabilization treatment is necessary to increase the calcium concentration, alkalinity, and pH of the product water prior to conveyance, injection and distribution.

Product water stabilization and UV/AOP systems can be designed without pilot data and, thus, they were not included in the pilot program; however preozonation, MF, and RO system design criteria require piloting.

Low-pressure membrane (*e.g.*, MF systems) design fluxes must be empirically determined through pilot testing. These design fluxes are impacted by preozonation, and thus preozonation must be included in pilot testing. Lastly, some of the RO fouling mechanisms are not well understood, and piloting of the RO system is useful for demonstrating sustainable recoveries. Given these design constraints, pilot testing was conducted at the RTP on the ozone, MF, and RO processes.

1.5 Pilot objectives

The objectives of the pilot testing were the following:

- Determine the preozonation ozone dose,
- Select MF technology (inside-out vs. outside-in),



- Determine sustainable MF flux,
- Determine sustainable RO recovery,
- Examine the impact of agricultural wash water shunting on RO fouling,
- Assess the product water quality, and
- Assess the water quality after each individual unit process.



2 Pilot Facilities and Testing

The pilot facilities, processes, procedures, and schedules are discussed in the following sections.

2.1 Description of pilot facilities

The following treatment processes were included in the pilot testing to meet the pilot objectives:

- Screening
- Chloramination
- Preozonation
- Ultrafiltration
- Reverse osmosis

Screening was included to stop clogging of the ozone pump. Chloramination is required to minimize fouling of MF and RO systems. Each system is described in more detail in the following sections.

All pilot facilities were located in the building at the RTP that used to house the chlorine cylinders (a simplified process and instrumentation diagram (P&ID) is shown in Figure 2.1, layout shown in Figure 2.2, and a photo shown in Figure 2.3). The ozone equipment was procured from the ozone equipment supplier APTWater (now called Ultura), which included an ozone generation and contacting skid (HiPOx), an oxygen generation skid, and a chiller skid. Harn R/O Systems provided the membrane equipment on skids. These skids included an inside-out MF skid (Pentair module, an outside-in MF skid (Toray module), an RO skid (2:1 array, single pass; CSM membranes), an RO cleaning skid, and MF feed and filtrate tanks. Ancillary equipment was procured separately. Upflow BAF equipment (not used) was available onsite from the Filter Loading Evaluation for Water Reuse study. These facilities, and the source water, are discussed in more detail below.





Figure 2.1 - Simple Pilot P&ID





Figure 2.2 - MRWPCA GWR pilot layout





Figure 2.3 – Photo of pilot facilities. Outside-in MF front left; BAF equipment back left (not used); inside-out MF center; ozone back left; and RO right.

2.1.1 Source water

The pilot equipment received clarified secondary effluent from the RTP (non-nitrifying tricking filters, a solids contactor - also known as bioflocculation - and secondary clarifiers). A submerged pump, encased in a coarse screen² and located in the combined secondary clarifier effluent channel (GWR supply pump), pumped the secondary effluent through the pilot screens and into the ozone feed tank. The GWR supply pump pressurized the line leading to the ozone feed tank, where an automatic valve periodically opened and closed (about every 30 seconds) to keep the water level in the feed tank within a specified range. The GWR supply line flowed at about 60 gallons per minute (gpm) when the valve was open. After the secondary effluent entered the pilot building, it was pretreated with screening and sodium hypochlorite (discussed below).

Additional source waters were brought into the RTP collection system (also known as shunting) on two occasions during piloting (the timeline of these shunts are discussed later in the report). The first shunt consisted of Lake El Estero stormwater and it lasted for 56 hours. The second shunt was comprised of agricultural wash water and it was continued through the end of the pilot program.

2.1.2 Screening

Screening was included in the pilot process to remove snails from pilot influent. Early in the pilot program, occasional slugs of snails would enter the ozone pump and clog the closed impeller, reducing pilot flow. A Hayward wye-strainer with 1/16" perforated polyvinyl chloride (PVC) screens was used. This screen removes objects via physical straining (also known as size exclusion).

² Pump encasement cleaned on May 6 to restore flow (from 24-35 gpm starting April 28 to 60 gpm)



2.1.3 Chloramination

Chloramination was included in the pilot process to reduce MF and RO fouling and to inhibit snail growth in the ozone feed tank. Chloramination effectively inhibits biological growth at low concentration, which can extend MF run times and decrease the frequency of RO cleanings. Sodium hypochlorite (12.5% neat) was dosed via a Pulsafeeder diaphragm pump upstream of the ozone system to achieve a chloramine residual of 2 to 5 mg/L at the RO feed³. Non-nitrified secondary effluents contain high concentrations of ammonia (approximately 30 mg/L as N at the RTP), and hypochlorous acid and hypochlorite ions from the sodium hypochlorite solution react with the ammonia to form chloramines.

The sodium hypochlorite solution was kept at one part neat sodium hypochlorite to one part tap water (1:1) to increase the pump frequency, which minimizes large pockets of sodium hypochlorite solution and thus breakpointing, while also maintaining sufficient storage. Immediately downstream of injection, in-line static mixers were used to rapidly mix the sodium hypochlorite solution with the secondary effluent to minimize the breakpoint reaction.

2.1.4 Preozonation

Ozone pretreatment provides a number of benefits to a potable reuse treatment system, which warranted its inclusion in the AWTF and pilot treatment processes. These benefits are as follows: (1) low-pressure membrane pretreatment, (2) CEC destruction, and (3) the potential for pathogen disinfection credit. These benefits are discussed in more detail below. Following this discussion, a description of the ozone equipment follows.

Low-pressure membrane pretreatment

Ozonation prior to low-pressure membrane filtration (*i.e.*, preozonation) can increase lowpressure membrane (*e.g.*, ultrafiltration [UF] membrane) run times and/or the flux for some waters. Non-nitrified secondary effluent (*e.g.*, RTP effluent) is only moderately oxidized and contains high concentrations of large organic molecules (*i.e.*, > 10 kilodaltons [kDa]), which rapidly foul MF membranes. Ozonation of these large organic molecules reduces their size (*e.g.*, < 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/or 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 larger flux reduces the number of membrane modules required.

CEC destruction

Preozonation can reduce the concentration of CECs that are discharged to the environment through the RO concentrate. CECs, and other high molecular weight organics,

³ Field measurements made with Hach DR 890 using 25-mL total chlorine DPD packets



are typically well rejected by RO systems and thus concentrated in the RO concentrate. Ozone (O_3) can minimize the concentrating of CECs in the RO concentrate by reducing the concentration of some CECs in the RO feed. Ozone transforms CECs in the same way that it transforms MF-membrane-fouling organic molecules. CEC removal can be related to the ozone-to-TOC ratio (O_3 :TOC), where larger ratios typically correlate more CEC removal (see Table 2.1 for a qualitative description of this relationship).

O 3:TOC	Qualitative description of typical CEC removal		
0.5	Easily removed CECs are destroyed		
1	Many CECs are destroyed		
1.5	All but recalcitrant CECs are destroyed		

Pathogen disinfection credit

Preozonation can provide disinfection credit for viruses and bacteria (*e.g.*, 4 and 3 logs reduction credit, respectively, for an ozone CT of 1 milligram-minute per liter [mg-min/L]). In the same way that ozone transforms CECs and MF-fouling organic matter, ozone can destroy pathogenic viruses, bacteria, and protozoa. To claim disinfection credit, DDW requires an ozone residual be maintained at all times, such that a sufficient CT is demonstrated. If the water quality is highly variable, then the ozone system must be designed for the worst-case water quality in order to ensure disinfection at all times.

The ozone system was included in the process for both MF pretreatment and CEC removal. MRWPCA currently does not need disinfection credit from ozone (the DDW regulations require that the recycled water used as recharge water for a groundwater replenishment reuse project receives treatment that achieves at least 12-log enteric virus reduction, 10-log *Giardia* cyst reduction, and 10-log *Cryptosporidium* oocyst reduction, which are achieved through the MF, RO, and UV/AOP processes), so only preliminary testing was conducted with respect to disinfection design considerations.

Ozone generation and contacting skid

Ozone generation, injection, and contacting occurred at the ozone generation and contacting skid. Ozone was generated from high purity oxygen inside the ozone generator. High purity oxygen was received from the oxygen generation skid at approximately 15 standard liters per minute (slpm). After generation, the ozone/oxygen gas stream was injected into the screened secondary effluent. The ozone concentration in this gas stream was typically 8 to 12% ozone by weight, as measured by a Teledyne Instruments: Advanced Pollution Instrumentation gas-phase ozone analyzer. Injection was achieved with an injection quill, driven by a differential in the gas pressure compared to the liquid pressure. Mixing was achieved downstream of injection with four two-foot 1.5-inch diameter in-line static mixers (3 to 4 seconds; flow 25 to 45 gpm).

After injection and mixing, contact time was provided in the 6-inch serpentine pipeline contactor shown in Figure 2.4 (2 to 3 minute hydraulic residence time [HRT]). At the end of contacting, an air vent valve separated gas from the fluid stream. The gas stream passed



through a thermally catalyzed ozone destruct to remove ozone in the off-gas. After the offgas was removed, the ozonated secondary effluent passed through a number of sensors before quenching and final discharge to the MF feed tanks. An oxidation-reduction potential (ORP) sensor⁴, dissolved ozone (DO₃) sensor⁵, and an ultraviolet light transmittance (UVT, at 254 nm) sensor⁶ were located at the end of the contactor, downstream of the air-vent valve. These sensors were used to control the ozone dose (described in subsequent sections).

A sodium bisulfite (SBS) solution was injected downstream of the instruments, as needed, to quench residual ozone (*i.e.*, to eliminate the ozone residual through reduction reactions). The downstream membranes are sensitive to ozone, and the ozone system was occasionally operated to produce an ozone residual at the contactor effluent. When operated this way, the ozone residual was quenched with SBS. A dilution of approximately one part SBS (neat strength of 25%) to thirty-two parts non-chlorinated tap water was made (1:33). This dilution ensured a rapid pump speed, which would not allow pockets of dissolved ozone to carry downstream without quenching. After quenching was accomplished on an as needed basis, the ozonated effluent flowed to the MF feed tanks.

⁶ AccUView online UV Transmission Analyzer, HF Scientific.



⁴ George Fischer Signet +GF+, 277X series

⁵ Emerson Process Management, Rosemount Analytical, 499A OZ



Figure 2.4 - Ozone generation skid (center), chiller skid (right), and oxygen generation skid (back left), during installation

Oxygen generation and chiller skids

Oxygen was generated on-site at the oxygen generation skid (see Figure 2.5). Generation equipment consisted of a screw press air compressor, an air drier, a coalescing filter, a pressure swing absorption (PSA) oxygen purifier, an oil-water separator, and receivers. Pressure swing absorption systems take advantage of pressure dependent nitrogen adsorption capabilities of zeolite media by operating in cycles. In the high-pressure cycle, nitrogen is removed from the chilled airflow by adsorption to the media. When the media is saturated with nitrogen, the flow shifts to a parallel PSA cell, while the saturated cell is depressurized. At the low pressures that come with depressurization, nitrogen desorbs from the media and is released to the atmosphere. The cells are rotated to achieve a constant production of high purity oxygen (approximately 94% oxygen by weight⁷).

Ozone generation produces excess heat, which must be cooled. Cooling was accomplished through a closed-loop chiller system, with a water-glycol mixture as the working fluid.

⁷ Ultura lab testing prior to deployment of the PSA system





Figure 2.5 - Oxygen generation skid, during installation

2.1.5 Membrane filtration

UF is a class of low-pressure membrane filtration (MF) systems that utilizes a pressure differential to drive liquids across a semipermeable membrane. MF is dead end filtration and is generally considered to consist of pores sized between 0.1 and 0.01 microns. The filtration mechanism is size exclusion.

For the MRWPCA GWR Pilot, the MF serves as pretreatment to the RO by removing solid particles larger than 0.01 to 0.04 micron. These include viruses, bacteria, and suspended solids. Two different hollow fiber MF systems were evaluated during the MRWPCA GWR Pilot. The first was a Pentair X-flow which has an inside to outside flow configuration, meaning the feed water is introduced to the *Lumen* or inside of the fiber and the product water or *Filtrate* flows across to the outside of the fiber. The other system tested was a Toray HFU-2020N that has an outside to inside flow configuration in which the feed water enters the fiber from the outside and the product water flows from the lumen side.

Pentair X-Flow System

The Pentair X-Flow unit was provided by Harn RO systems and is shown is Figure 2.6 below. The unit was equipped with 1 Pentair *X-Flow* UF module, feed and back wash pumps both with variable frequency drives (VFDs), 700-micron Y-Strainer, and an on-



board programmable logic controller (PLC) that captured and recorded data every 2 minutes from on-board instruments.



Figure 2.6 - Pentair X-Flow Pilot Unit

The Pentair MF unit was started up on November 11, 2014 and testing officially concluded February 11, 2014. Several flux rates, ranging from 6 to 20 GFD, were attempted to identify the optimum operating point in terms of maximizing production and minimizing the cleaning frequency. At start-up, the Pentair unit was configured to automatically back wash every 25 minutes and to undergo daily Chemically Enhanced Backwash (CEB) cycles with a 200 mg/L sodium hypochlorite (NaOCI) solution followed by a Sulfuric Acid solution targeting pH 2 to 3. Throughout the pilot, a chloramine residual was maintained through the pilot system with the target of 2 to 5 mg/L at the RO feed.

Toray System

The Toray MF Pilot unit was provided by Harn RO systems and is shown in Figure 2.7 below. The unit was equipped with 2 Toray *HFU-2020N* UF modules, feed and back wash pumps both with VFDs, 100-micron Arkal self-backwashing pre-strainer, and an on-board PLC that captured and recorded data every 2 minutes from on-board instruments.





Figure 2.7 - Toray Pilot Unit

The Toray MF unit operated for just under 8 months, from November 18, 2013 through July 7, 2014. Several flux rates, ranging from 25 to 40 GFD, were attempted to identify the optimum operating point in terms of maximizing production and minimizing the cleaning frequency. While in operation, the Toray unit underwent daily CEB cycles with a 300-mg/L NaOCl solution. Throughout the pilot, a chloramine residual was maintained through the pilot system with the target of 2 to 5 mg/L at the RO feed.

2.1.6 Reverse Osmosis

RO is a class of medium- to high-pressure membrane filtration that utilizes a pressure differential to drive liquids across a semipermeable membrane. RO utilizes a pressure differential to overcome the osmotic pressure of the liquid. The precise mechanism of salt removal is not completely understood; however, there are primarily four theories. These include the *Sieve, The Wetted Surface,* the *Preferential Sorption-capillary,* and the *Solution-Diffusion Model* Mechanisms. It is the *Solution-Diffusion Model* that is most accepted.

The solution-diffusion model of transport assumes a non-porous, homogeneous membrane surface layer. Each component in a pressurized solution dissolves in the membrane and diffuses through the membrane. The flow of water and salt through the membrane is uncoupled (*i.e.*, they are independent of each other), and the water transports at a more rapid rate than the salt.

For the MRWPCA GWR Pilot, the RO serves to remove dissolved ions, bacteria, viruses, and CECs. The typical range of molecular weight cut off is less than 100 Daltons for RO membranes.

The Toray RO Pilot unit was provided by Harn RO systems and is shown below. The RO pilot unit was a two-stage configuration with 2 vessels in the first stage and one in the



second. Each vessel contained seven *CSM RE4040-FE* 4-inch RO elements. The pilot unit was equipped with a booster pump, 10-micron cartridge filter, high pressure feed pump, and an interstate booster pump. Both the high-pressure feed and interstate booster pumps were controlled by VFDs. Recovery was manually controlled. Data was recorded automatically every 10 minutes via the on-board PLC.



Figure 2.8 - RO Pilot Unit

The chemical feed system consisted of Threshold Inhibitor (TI) and acid addition. The dose rate for both chemicals was manually controlled. The TI used was Avista Technologies *Vitec 4000* and was dosed at 5 mg/L through the entire pilot. 92% Sulfuric Acid was used for pH control.

2.2 Piloting procedures

Schedules and procedures necessary to meet the pilot objects are discussed in this section.

2.2.1 Test plan

A pilot test schedule was developed to meet the pilot objectives (see Table 2.2). The major components of this test plan were as follows:

- Inside-out versus outside-in MF filtration testing
- MF flux and preozonation dose testing
- RO recovery testing
- Shunt testing (Lake El Estero and agricultural wash water)
- Water quality sampling (process, product, and DBPs)

The details of the above experiments, and their results, are discussed in detail later in the report.


Description		Month								
		11	12	1	2	3	4	5	6	7-14
Mobilization and start-up										
MF technology (inside-out vs. outside-in) selection										
Sustainable MF flux testing										
Preozonation ozone dose testing										
Sustainable RO recovery testing										
Lake El Estero Shunt testing										
Agricultural wash water shunt testing										
Individual treatment process water quality sampling										
Product water quality sampling										
Disinfection by-product water quality sampling										
Demobilization										

Table 2.2 - Pilot test schedule

2.2.2 Bench-scale stabilization

Bench-scale stabilization of the RO permeate was conducted to prepare a sample for leach testing. TODD engineers extracted soil samples from the Seaside aquifer (where GWR injection will occur) during preliminary drilling. A sample of stabilized RO permeate was used to measure the leaching potential of the soil. Product water stabilization reduces aquifer leaching and mineral mobilization (*e.g.*, arsenic), among other things. At the time of this experiment, product water stabilization goals for the MRWPCA RO permeate had not yet been developed, and thus the product water stabilization goals of Orange County Water District (OCWD) were used (shown in Table 2.3).

Table 2.3 - GWR Bench-Scale	e Post-treatment Sta	bilizatio	n Goals
	** •.	m	

Parameter	Unit	Target Value
Langelier Saturation Index (LSI)		-0.1
Calcium	mg/L as CaCO ₃	32
Alkalinity	mg/L as CaCO ₃	40
рН		8.5

These goals were targeted with the following steps:

- 1. Strip carbon dioxide (CO₂) from the RO permeate with air stripping
- 2. Add calcium with calcium chloride dehydrate
- 3. Increase alkalinity with sodium hydroxide (NaOH)
- 4. Adjust the pH, as needed, with CO₂ injection

The above procedure was followed using pilot RO permeate and shipped to TODD engineers for leaching analysis.



2.2.3 Toxicity testing

The toxicity of the RO concentrate was analyzed and compared against the requirements of the California Ocean Plan. The sample was collected on April 19 and shipped to Pacific EcoRisk for analysis. Pacific EcoRisk tested the water for acute and chronic toxicity. The test species for acute toxicity was Inland silverside (*Menidia beryllina*), and Giant Kelp (*Macrocystis pyrifera*) was used as the chronic toxicity test species. These test species are the same species used by the RTP for their regular compliance with the Ocean Plan. The results of this testing are reported in the Pacific EcoRisk toxicity report and attached Trussell Tech cover letter and the Source Water and Product Water Quality (Trussell Technologies, 2014d).

2.3 Water quality sampling scope

Two water quality sampling campaigns were conducted during the pilot test period: a source water sampling campaign and the pilot sampling campaign. The pilot sampling campaign was conducted to characterize the performance of specific processes and to evaluate the water quality of the RO permeate (*i.e.*, the AWTF process product water without UV/AOP and product water stabilization). The source water sampling campaign was conducted to evaluate the treatability of various sources in consideration for AWTF flow augmentation. The results from both of these sampling campaigns are useful when reporting the pilot results; however, this report focuses on the pilot water sampling results. A description of the source water campaign, including results, motivation, and methods, is described elsewhere (Trussell Technologies, 2014d). Select results from the source water sampling are reported in this Pilot Report when required for clarity or completeness. An overview of the source water campaign is presented below.

2.3.1 Source water quality sampling

A one-year monitoring program was started in July 2013 for five of the potential source waters. 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.

A full characterization of these source waters, as defined by DDW's Policy Memo 97-005, was performed on these waters (RTP effluent, agricultural wash waster, and Blanco Drain on a quarterly basis; Lake El Estero and Tembladero slough one time each), with an expanded monitoring list for pesticides given the high levels of agricultural activity in the area. An all-inclusive approach was taken to the source characterization, where the full list of parameters was monitored in all sources. The types of constituents included in the GWR source water monitoring campaign are the following:

- General water quality parameters
- DDW MCLs
 - Inorganic chemicals
 - Organic chemicals



- o DBPs
- Radionuclides
- Microbiological parameters
- DDW NLs
- DDW Drinking Water AALs
- Environmental Protection Agency (EPA) Unregulated Contaminant Monitoring Rule (UCMR) Lists 1, 2 and 3
- EPA Clean Water Act Priority Pollutants (EPA PP)
- Pesticides of Local Interest (PoLI)
- CECs

See the Source Water and Product Water report for detail and results (Trussell Technologies, 2014d).

2.3.2 Pilot water quality sampling

Water quality sampling was conducted on a weekly basis during piloting. Source water sampling for the GWR project (including RTP effluent) was conducted on a monthly basis. The scope and full results of the source water sampling is discussed in the Source Water and Product Water Report (Trussell Technologies, 2014d), whereas the scope of the pilot water quality sampling is discussed in this report. Select results from the source water sampling campaign are also reported in this report when necessary. The sample locations at the pilot for the pilot water quality sampling campaign were the following:

- Pilot influent (secondary effluent)
- Ozone effluent (after quenching, when quenching was needed)
- MF effluent
- RO permeate
- R0 concentrate
- MF backwash

These sample locations are highlighted in the process flow diagram shown in Figure 2.9.





Figure 2.9 – Weekly water quality sampling locations

At locations listed above, samples were collected for the following water quality parameters:

- General water quality parameters (*e.g.,* alkalinity, TOC)
- Inorganics (*e.g.*, phosphate, ammonia)
- DBPS (e.g., NDMA)
- Pathogens and pathogen indicators (e.g., total coliforms, Cryptosporidium)
- Synthetic organic contaminants (*e.g.*, 1,4-dioxane, pesticides)

A detailed list of the water quality analysis performed for each sample location is shown in Table 2.5. Monterey Bay Analytical Services and Eurofins Eaton Analytical primarily performed the analysis, with sub-contactor labs as needed. A schedule of the sample events is shown in Table 2.4. Samples collected monthly were analyzed for the widest variety of parameters, while samples collected weekly were only analyzed for routine



parameters. One sampling of the RO permeate was conducted for all MCLs, NLs, and AALs on April 8, 2014⁸.

Sample Date	Sample type
12/10/2013	Monthly
12/17/2013	Semi-monthly
12/23/2013	Weekly
12/30/2013	Weekly
1/7/2014	Weekly
1/14/2014	Monthly
1/21/2014	Weekly
1/28/2014	Semi-monthly
2/4/2014	Weekly
2/11/2014	Monthly
2/18/2014	Weekly
2/26/2014	Semi-monthly
3/4/2014	Weekly
3/11/2014	Monthly
3/18/2014	Weekly
3/25/2014	No sampling

Table 2.4 - Regular Water	Quality	Sampling	Events
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Sample Date

Sumpre 2		Sumple type
4/2/201	.4	Semi-monthly
4/8/201	.4	Monthly
4/15/20	14	Weekly
4/22/20	14	Semi-monthly
4/30/20	14	Weekly
5/6/201	4	Weekly
5/13/20	14	Monthly
5/21/20	14	Weekly
5/27/20	14	Semi-monthly
6/3/201	4	Weekly
6/10/20	14	Weekly ^a
6/17/20	14	Weekly ^a
6/24/20	14	Monthly ^a

Sample type

^a Reduced sampling; see appendix

⁸ Uranium (MCL), vanadium (NL), chlorate (NL), and N-Methyl dithiocarbamate (Metam sodium) (AAL) were omitted by the lab.



Table 2.5 – Constituents analyzed during regular water quality sampling events^a

Parameter	RTP Raw	Pilot Inf	Ozone Eff.	MF Filtrate	RO Permeate	MF Backwash	RO Conc.
General Water Quality Parameters	_						
Alkalinity		2/M		2/M	2/M		2/M
Conductivity		2/M		2/M	2/M		2/M
Hardness - Total		2/M		2/M	2/M		2/M
рН		2/M		2/M	2/M		2/M
Temperature		2/M			2/M		
Total Dissolved Solids (TDS)		2/M		2/M	2/M		2/M
Total Suspended Solids (TSS)		2/M	2/M	2/M		2/M	
Turbidity		W	W	W	W	W	W
Dissolved Oxygen (DO)		W	W				
Oxidation/Reduction Potential (ORP)			2/M	2/M	2/M		
Biochemical Oxygen Demand (BOD)		2/M	2/M	2/M	2/M	2/M	2/M
Chemical Oxygen Demand (COD)		2/M	2/M	2/M	2/M	2/M	2/M
Biodegradable dissolved organic carbon (BDOC)		M	M		М		М
Dissolved organic carbon (DOC)		M	M				0.04
Total Organic Carbon (TOC)		W	W	W	W		2/M
UV-254 Absorbance		vv	vv	VV	vv		2/M
Ammonia		147	2/M	2/M	147		м
Nitrato		W	2/M	2/M	W W		M
Nitrite		W	W	2/M	W		M
Total Kieldahl Nitrogen (TKN)		w	2/M	2/M	w		M
Aluminum			2/11	2/M	2/M		M
Arsenic		2/M		2/M	2/M		M
Barium		_,		2/M	2/M		М
Boron				2/M	2/M		М
Bromide		2/M	2/M	2/M	2/M		М
Calcium		,	,	2/M	2/M		М
Chloride				2/M	2/M		М
Cyanide		2/M		2/M	2/M		М
Fluoride				2/M	2/M		М
Iron		2/M		2/M	2/M		М
Magnesium				2/M	2/M		М
Manganese		2/M		2/M	2/M		М
Mercury				2/M	2/M		М
Molybdenum				2/M	2/M		М
Nickel				2/M	2/M		М
Phosphate (orthophosphate)		2/M		2/M	2/M		М
Potassium				2/M	2/M		M
Selenium				2/M	2/M		M
Silica				2/M	2/M		M
Strentium				2/M	2/M		M
Sulfata				2/M	2/M		M
Sulfida				2/M	2/M		M
DBPs				2/14	2/11/1		1*1
Total THMs and HAAs		2/M			2/M		м
Bromate		2/M	2/M		2/M		M
Nitrosamines		2/M	2/M	2/M	2/M		М
Microbiological Parameters		_,	_,	_,	_,		
Total coliform and <i>E. Coli</i>		W	W	W	W		
Cryptosporidium and Giardia	М	М	М	М			
Synthetic Organic Contaminants							
CECs (See Table 8)		М	М		М		М
1,4-Dioxane		М	М		М		М
Select pesticides (EPA 505 and 525.2)		М	М		М		М

^a Weekly (W), twice per month (2/M), and monthly (M)



2.4 Timeline of piloting activities

Pilot equipment was onsite at the RTP from October 2013 to July 2014. During this time various changes were made to the piloting program. One change was the shunting of additional source water to the RTP headworks. Two shunts were conducted during piloting. Lake El Estero stormwater was shunted for 56 hours in February, and the agricultural wash water was shunted from April through the end of piloting. A summary of these shunt periods is shown in Figure 2.10.



Figure 2.10 – Schedule of shunt testing during piloting

In addition to shunt water testing, another impact on the pilot feed water was the addition of ferric chloride to the RTP primary effluent. As phosphate concentrations in the RTP secondary effluent increased due to the agricultural wash water shunt, the RTP chemically enhanced primary treatment (CEPT) facilities were to add ferric to the primary effluent on an experimental basis. Over time, these doses were reduced to determine the impact of elevated concentration of phosphate on RO scaling. The ferric dose schedule, and other notable piloting events, are summarized in Figure 2.11.



¹ Supply changed from Class C sump basin to a submerged pump in combined secondary clarifier effluent channel due to concerns over the representativeness of the Class C sump station water

Figure 2.11 - Timeline of select piloting events



3 Operational results and discussion

Operational results are reported and discussed in this section. The section is divided into the major unit processes: ozone, MF, and RO. Results from the water quality sampling are reported and discussed in the following section.

3.1 Ozone

The ozone testing was conducted simultaneously with the MF flux and RO recovery testing. Ozone tests include determining an adequate ozone dose control method, testing the effect of moderate and high ozone doses on membrane fouling, and preliminary ozone CT testing. These tests and results are discussed in this section.

3.1.1 Dose control testing

The concentration of organics that cause membrane fouling and the ozone demand vary temporally in the secondary effluent. Ideally, the ozone dose is adjusted based on fluctuations in this concentration and demand. Alternatively, if the variability is low enough, a constant ozone dose may prove suitable, as the degree of under- and over-dosing may be minimal.

Three ozone dose control systems were explored during pilot testing: UVT at 254 nanometers (nm) control, ORP control, and dissolved ozone residual control. Of the three options, UVT control most accurately adjusts the ozone dose for some waters; however, UVT control at this pilot was unsuccessful due to instrumentation limitations with this feed water. Instead of UVT control, the pilot was successfully operated with both ORP and dissolved ozone residual control. These three control methods are discussed below.

UVT control

UVT is the most directly representative online metric available for the concentration of large organic molecules that foul low-pressure membranes (UF membranes), and thus controlling the ozone dose with UVT is ideal. In this control method, the ozone dose is adjusted to maintain a UVT effluent setpoint or a delta UVT setpoint (*i.e.*, the difference between the influent UVT and the effluent UVT). The UVT setpoint is empirically determined by observing the relationship between membrane fouling and various UVT setpoints.

At the pilot, the ozone effluent and delta UVT was measured during both moderate ozone dose testing (constantly applied ozone dose of 10 mg/L) and high ozone dose testing (variable ozone dose tied to ozone demand, with an average applied ozone dose of 20 mg/L) with weekly grab samples⁹. Both the moderate ozone and the high ozone doses successfully minimized membrane fouling, and thus these ozone effluent and delta UVT measurements represent preliminary UVT setpoints. The high ozone doses did not discernably decrease membrane fouling compared to the moderate ozone doses, thus the high ozone doses were likely achieving an upper limit on the oxidation of membrane

⁹ Thermo Scientific AQUAMATE



foulants. The average delta UVT during this maximum ozone testing, which likely represents a maximum delta UVT for this water, was 10% (9 to 11% for 10 samples; 1 sample at 15%). The average delta UVT for the moderate ozone doses was similar, albeit lower, at 8%, and contained higher variability (4 to 11% for 10 samples; 1 sample at 15%). The variability in the delta UVT during moderate ozone testing is likely due to regular underdosing. Regular overdosing must have also occurred (assuming variability in the ozone demand and concentration of membrane fouling organics), but the delta UVT ceiling (approximately 10 to 11%) curtailed data on the magnitude of this occurrence.¹⁰ To minimize membrane fouling, the recommended delta UVT is 10%. This delta UVT was not consistently achieved with a constantly applied moderate ozone doses (*e.g.*, 10 mg/L), indicating that, on average, this dose is slightly lower than optimal. The high ozone doses (*e.g.*, 20 mg/L) achieved this delta UVT limit all the time, indicating that this dose is optimal or that it exceeds the optimal dose (possibly significantly exceeding the optimal dose).

Effluent UVT can also be used as a setpoint, however the ozonated effluent UVT exhibited more variability than the delta UVT. The variability seems to be due to varying concentrations of compounds in the secondary effluent that absorb UV at 254 nm, but which are not oxidized by ozone (and which may not foul membranes). The effluent and delta UVT for various ozone doses are summarized in Table 3.1.

Applied ozone dose	Average delta UVT at 254 nm (%, range)	Average effluent UVT at 254 nm (%, range)
Moderate (10 - 12 mg/L)	11 (9 – 15)	65 (59 – 70)
High (15 - 22 mg/L)	9 (4 – 15)	64 (62 - 68)

Table 3.1 - Ozonated delta and effluent UVT^a

^a Based on 13 and 11 high and moderate dose samples, respectively; control (*i.e.*, no ozone addition) showed a difference of -0.3 to 1% increase in UVT).

The UVT measurements reported above indicate that UVT control is suitable for this water if UVT can be measured continuously in the ozone effluent. Suitable online UVT analyzers may be available, but the sensor tested during piloting was unable to measure UVT continuously. The analyzer UVT decreased rapidly between cleans (*e.g.*, 10% over 12 to 24 hours), due to the deposition of a foulant on the flow-through cell surface. The foulant had a yellow-orange color and could be removed with either an acid solution or physical wiping. The analyzer had an ultrasonic cleaning feature, but this did not inhibit fouling. It is recommended that future piloting efforts test alterative UVT analyzers with built-in wipers that may remove the foulant (*e.g.*, Hach Company offers a UVT analyzer with a built-in wiper blade). Although the foulant was not analyzed, it appeared to be iron and manganese precipitate, which may have formed through the oxidization of reduced iron and manganese [Fe(II) and Mn(II)] in the pilot feed water.

¹⁰ Some variability is also due to variances in the chloramine residual concentration, which varied between 2 and 7 mg/L as Cl₂ at the ozone effluent during piloting.



Another consideration with UVT control is that the UVT sample point must be located downstream of the dissolved ozone residual dissipation or after the dissolved ozone residual has been quenched. Dissolved ozone absorbs UV at 254 nm, and may interfere with organic measurement.

Constant ozone dose with ORP control

Two other ozone dose control methods were tested due to challenges with UVT control. One successful control method was to set a constant ozone dose low enough such that the ozone residual decayed after a given contact time or sample location. The presence or absence of an ozone residual at the given contact time or sample location was measured with an ORP sensor. ORP sensors register the presence or absence of oxidants, such as ozone, and they are sensitive enough to distinguish been chloramines and dissolved ozone, even at very low ozone concentrations (0.1 mg/L dissolved ozone compared to 5 mg/L as Cl₂ chloramines). If a dissolved ozone concentration is detected at the ORP sensor, then the ozone dose is turned down until the ozone concentration is no longer detected. If the ORP sensor is located at the end of the ozone contactor, then this method of control limits the concentrations of dissolved ozone leaving the ozone system to rarely detectable concentrations.

The primary limitation to this control scheme is its inability to adjust the ozone dose when the loading of membrane-fouling organics fluctuates. Thus, the ozone dose is higher or lower than needed most of the time. This control scheme was successfully operated at the pilot scale to achieve the design MF flux of 30 GFD (with a constant applied ozone dose of 10 mg/L). The ORP electrode required cleaning (*e.g.*, rinsing with a dilute acid solution) on a weekly to twice a week basis to avoid biofilm and inorganic precipitate build-up. Example ORP measurements for this water are summarized in Table 3.2. The pilot was typically operated with an ORP upper limit setpoint of 480 millivolts (mV).

Ozone residual (mg/L)	Chloramine residual (mg/L as Cl ₂)	ORP (mV)
No ozone dosed	~5	110
0 (ozone dissipated)	No chlorine dosed	215
0 (ozone dissipated)	~5	375 – 450
0.1	~5	500
0.2 – 0.5	~5	700 - 900

 Table 3.2 – Example ORP values for various ozone residuals

A variation of this method was also tested where the constant ozone dose was paired with a dissolved ozone sensor and a quenching system instead of an ORP sensor. In this set-up, the dissolved ozone sensor detects the residual ozone concentration, and an appropriate chemical quenching dose is applied to quench the residual. Quenching the ozone residual (instead of avoiding it, as is practiced in the ORP sensor configuration) allows for a higher operating ozone dose compared to the ORP sensor configuration. The downside is that



dissolved ozone sensors are less robust compared to ORP sensors. ORP electrodes require less frequent cleaning and they are less sensitive to damage.

Dissolved ozone residual control

The final ozone control system that was tested was the dissolved ozone setpoint method. In this method, the ozone dose is varied to reach an ozone setpoint at some location downstream. A dissolved ozone sensor measures the dissolved ozone, and this sensor must be located at some point where dissolved ozone is present at appropriate ozone doses. The dissolved ozone setpoint at a given sample location must be empirically determined by correlating the ozone setpoint with membrane run time. Ozone demand (ozone dose minus ozone residual) is not a direct measurement of the concentration of organics that foul membranes, but it is a function of those organics, as they contribute to ozone demand (among other compounds, such as nitrite). As the concentration of organics increase, the ozone demand increases, and the ozone dose increases correspondingly. Similarly, if the ozone demand increases for another reason (e.g., due to increase in the nitrite concentration), the ozone demand will increase, and the ozone dose will increase. Although the concentration of organics is not increasing in this later case, more ozone is needed, because more will be consumed through reactions with the increased concentration of nitrite. Thus, a dissolved ozone residual control system varies the ozone dose as the ozone demand and the concentration of membrane-fouling organics fluctuates, similarly to UVT control.

This control system was employed during the high ozone dose testing. For these tests, the dissolved ozone sensor was located at the effluent of the ozone contactor (3-minute HRT), and the setpoint was maintained at 0.1 mg/L. This setpoint and location required an average applied ozone dose of 20 mg/L, with a range of 14 to 25 mg/L. The ozone demand varied diurnally, typically with two peaks per day: one at noon, and another at midnight (see Figure 3.1 for the applied ozone dose during an example week of testing). This ozone control method successfully reduced membrane fouling during pilot testing, and adjusted the ozone dose according to changes in ozone demand.





Figure 3.1 – Example of variability in applied ozone dose required to meet the 0.1 mg/L setpoint (ozone turned off in the afternoon of 7/2 for an experiment)

Dissolved ozone decays exponentially. To minimize this decay, sample tubing or piping that feeds a dissolved ozone sensor must have a minimal residence time. Once ozone reaches the sensor, it crosses a hydrophobic membrane and is reduced at the gold cathode. The gold cathode did not tarnish during piloting, but the membrane required frequent attention (daily examination), and at least weekly replacement. The membrane is very sensitive, and is easily torn by abrasion (*e.g.*, dabbing with a Kimwipe[®]). Air entrapment behind the membrane occurred occasionally, which diminished response time, and foulant accumulated on the surface. This foulant resembled the UVT flow-through cell foulant in appearance, and it was also susceptible dilute acid solutions. Over time, irreversible foulants accumulated on the same appearance as the foulants that were easily removed with dilute acid solutions, but they were amenable to acid treatment.

3.1.2 Ozone dose testing

Various ozone doses were tested to determine a design ozone dose for preozonation. This dose is a function of the water quality, including nitrite, TOC, and other constituents that contribute to ozone demand. During testing, the effect of ozone on foam formation was observed, as excessive foam formation may impact design. These tests and observations are discussed in this section.

Applied ozone dose

Ozone dose testing included extended testing at moderate and high ozone doses, as well as testing without ozone addition. These tests were performed to determine an appropriate



preozonation design dose and to determine the impact of preozonation versus no ozone. Moderate ozone dose testing consisted of a constant applied ozone dose of 10 mg/L, whereas high ozone dose testing utilized the ozone residual control with a setpoint of 0.1 mg/L after a 3-minute HRT. This high ozone dose setpoint resulted in an average applied ozone dose of approximately 20 mg/L (ranging from 14 to 25 mg/L). Membrane flux was tested without ozone by turning off both the ozone and oxygen addition, but allowing the secondary effluent to travel through the ozone contactor (where it was dosed with sodium hypochlorite upstream of the contactor). A summary of the tests conducted is presented later in this section.

The impact of preozonation compared to the absence of ozonation was measured by comparing MF run times with and without ozone, while keeping the MF flux constant. This comparison shows that preozonation doses between 10 and 14 mg/L increase the MF run time by a factor of 4 to 8 (see Table 3.3). The factor of four increase represents a lower bound, as the chlorine pump used during daily MF CEBs was inadvertently turned off half way through the run (run #2). The factor of seven increase represents an upper bound, as the ozone doses were relatively high during this run (14 mg/L in run #1 compared to 10 mg/L in run #2). The longer run time observed during MF run #1, compared to run #2, may be due to the higher ozone dose (14 versus 10 mg/L, with the high dose possibly achieving a maximum UVT increase more consistently than the lower dose), the cessation of chlorinated CEBs half way through run #2, or to other seasonal variations in water quality.

MF Run Number	MF flux (GFD)	Run time (days)ª	Applied ozone dose (mg/L; range)
1	25	36	14 (12 - 17)
2	25	17	10 (9 - 11)
3	25	5	0

Table 3.3 - Effect of preozonation on MF run time

^a The no-ozone test began with eight days run time with ozone. These eight days were subtracted from the run times of each trial shown in this table.

The effect on transmembrane pressure (TMP) increase of preozonation versus nonozonation is shown in Figure 3.2. Preozonation seems to oxidize organic material that is not easily removed during daily CEBs. During the tests without ozone, the pressure required to maintain the flux setpoint was not significantly reduced with the CEB (*i.e.*, the TMP recovery due to the CEB was minimal).





Figure 3.2 - Effect of ozonation on CEB TMP recovery (psi is pounds per square inch)

Moderate and high ozone testing was conducted to determine a recommended design ozone dose. Various combinations of ozone dose and MF flux were tested, with the goal of achieving the highest flux with a run time of approximately thirty days (summary of runs shown in Table 3.4). This goal was achieved with a moderate ozone dose (10 mg/L) and an MF flux of 30 GFD (run time 32 days at 30 GFD, with 3.5 days at a combination of 25 and 28 GFD). Subsequent testing explored higher MF fluxes, combined with higher ozone doses. This testing included a run at an MF flux of 35 GFD and a high ozone dose (20 mg/L average, 17 to 23 mg/L range) that achieved a run time of only 15 days (with an additional six days proceeding at 30 GFD) and a run at 32 GFD at high ozone doses (20 mg/L average, 17 to 22 mg/L range¹¹) that lasted 22 days. During these experiments, run times greater than thirty days could not be achieved with fluxes of 32 GFD or greater. Given that the high ozone doses to minimize MF fouling is not recommended.

¹¹ Including about four hours of no ozone, to conduct a brief experiment



MF Run Number	Date	MF flux (GFD)	Applied ozone dose (mg/L; range)	Run time (days)
1	11/15/13 – 01/12/14	25	14 (12 - 17)	44
2 ^b	01/14 - 02/10	25	10 (9 - 11)	25
3c	02/10 - 02/25	25	10 (9 – 10), 0ª	8, 5
4 ^d	02/25 - 03/13	25	10 (10 - 11)	15
5	03/17 - 03/28	40	18 (17 - 18)	7
6	03/28 - 04/01	40	16 (15 - 17)	2
7	04/01 - 04/02	40	13 (13 – 13)	1
8	04/07 - 05/20	25, 28, 30ª	10 (10 – 10)	1, 2, 32
9	05/20 - 06/12	30, 35	21 (17 - 23)	6, 15
10	06/12/14 - 07/07/14	32	19 (17 - 22)	22

 Table 3.4 - Summary of MF run conditions and results

^a Run time corresponds to each condition shown, *e.g.*, during run 3, the system was run 8 days with a dose of 10 mg/L, and 5 days for a dose of 0 mg/L.

^b No chlorine in CEB half way through the run

^c No chlorine in CEB while ozone was applied

^d Run terminated before terminal TMP reached

Water quality

Water quality greatly impacts the required ozone dose for membrane fouling minimization (transfer efficiency, mixing, and contact time also impact the required applied ozone dose). Specifically, higher ozone doses are needed for waters that contain higher concentrations of membrane fouling organics (*e.g.*, non-nitrified secondary effluents like MRWPCA), and for effluents with higher ozone demands. Ozone demand is a measurement of the reduction in dissolved ozone after time, after its application (analogous to chlorine demand and BOD), and represents concentrations of constituents that react with ozone. Some of these constituents are membrane-fouling organics, while others are not foulants. An example of a constituent that reacts rapidly with ozone, but that is not a membrane foulant is nitrite. Nitrite will react with ozone, making less ozone available for membrane-fouling organic oxidation. Another parameter that relates to ozone demand is TOC. TOC is a bulk measurement of all of the organic carbon in the water, including membrane-fouling organics, as well as non-fouling organics that react with ozone. The MRWPCA secondary effluent has high concentrations of both nitrite and TOC, which contribute to the high ozone dose required for membrane pretreatment.

Nitrite in the secondary effluent (pilot influent) was measured at the pilot through four different sampling campaigns, which are described below (see Figure 3.3 for data):



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- 1. Grab samples collected and measured on site during piloting ("field grab")¹²
- 2. Grab samples collected during the pilot water quality sampling campaign ("pilot grab")¹³
- 3. 24-hour composite samples collected during source water quality sampling campaign ("source water 24-hr composite")¹⁴
- 4. 24-hour composite samples regularly collected by the RTP¹⁵. These data are displayed in the plot in two sets: (a) data collected while the pilot was in operation ("pilot"), and (b) all composites from 2008 to 2014 ("historical").

These data show unusually high concentrations of nitrite in the secondary effluent, which are indicative of partial nitrification in the secondary process. Ammonia measurements throughout the RTP treatment train indicate that this partial nitrification is typically occurring in the trickling filters (Trussell Technologies, 2014a). When ozone is applied to this water, the nitrite will consume 3.4 mg/L of ozone per mg/L of nitrite as N. For example, the average, weekly RTP effluent 24-hour composite nitrite concentration measured during piloting was about 0.73 mg/L as N, which would consume about 2.5 mg/L of ozone, while the largest weekly RTP effluent 24-hour composite nitrite concentration of 2.9 mg/L as N would consume 9.9 mg/L of ozone. The ozone that is consumed by nitrite is then unavailable for membrane-fouling organic oxidization. Therefore, the ozone dose needs to account for the nitrite concentration, ideally by maintaining a UVT setpoint or an ozone residual.

The design and operating ozone dose for the AWTF ozone system could be reduced if less nitrite was produced in the RTP. Nitrite production can occur in biological systems that partially nitrify. As mentioned previously, partial nitrification presently occurs in the RTP trickling filters. It may be possible to change the operation of the trickling filters to avoid this partial nitrification (*e.g.*, adjusting the recycle rate), and the production of nitrite. The average, weekly RTP effluent 24-hour composite nitrite concentration observed during piloting was 0.73 mg/L as N. If this concentration were 0.1 mg/L as N, instead of 0.73 mg/L as N, then the associated decrease in ozone demand would be 2.2 mg/L. This might allow for a decrease in the average transferred ozone dose from 9.5 mg/L to 7.3 mg/L, assuming that the nitrite would have reacted with ozone prior to the ozone reacting with the membrane fouling organics. Similarly, reducing the maximum expected nitrite concentration may be able to reduce the ozone design dose, and thus the size of the ozone system, by up to 30% (the cost of the ozone system does not scale linearly). The cost savings is potentially significant (*e.g.*, up to 1 million dollars of total project costs), and thus reducing nitrite formation in the secondary system is recommended.

¹⁵ 11/7/08 to 7/7/14, weekly, at a minimum, from May 2010 onward, as needed before; 245 samples.



¹² Hach DR 890, NitriVer[®] 3 powder pillows, diluted 10:1 using Class A glassware with lab DI water, 11/7/13 to 7/2/14; 33 samples.

¹³ Analyzed by Monterey Bay Analytical Services, SM 4500-NH₃ B&C or F/G, 12/10/13 to 6/24/14; 26 samples.

¹⁴ Analyzed by Monterey Bay Analytical Services, SM 4500-NH₃ B&C or F/G, 9/9/13 to 6/10/14; 11 samples.



Figure 3.3 – Probability plot of nitrite measured during piloting and earlier

TOC was also measured through pilot and source water sampling campaigns, and estimated from RTP dissolved organic carbon (DOC) and total suspended solids (TSS) data (see Figure 3.4)¹⁶. Particulate organic carbon (POC) in the RTP samples was estimated from DOC and TSS data by assuming that 75% of the TSS were volatile suspended solids (VSS) and that 53% of the VSS were carbon¹⁷. The difference in TOC values between the RTP samples and pilot and source water samples is partially due to the method of estimation (16 to 32%, based on validating the method with pilot and source water data, respectively).

¹⁷ Assuming a generic cell chemical formula of $C_5H_7O_2N$



¹⁶ 23 pilot grab samples, 12 source water composite samples, 828 RTP samples from January 2, 2011 to May 15, 2014

The rest of the difference is possibly due to differences in the TOC measurement method (Standard Method [SM] 5310B and SM5310C for the RTP and the source water composite samples, respectively), where SM5310B generally includes compounds that are chemically refractory and not measured by SM5310C and more efficiently oxidizes high concentrations of suspended organic carbon. Error may have also been introduced in the dilution step required for the SM5310C sample. Differences in TSS measurements may have been due to sedimentation in the sample carboys prior to pouring samples for TSS analysis. The difference between pilot grab samples and RTP composite samples may be due to diurnal variations in water quality. Given the difference between the two datasets, the higher, more conservative, TOC values are recommended for design purposes. Regardless of dataset, these TOC values are fairly typical for a non-nitrified trickling filter secondary effluent, and are high compared to nitrified secondary effluents. The high TOC concentrations increase the ozone demand of the water, and thus the doses necessary for membrane pretreatment.



Figure 3.4 – Probability plot of TOC measured during piloting, and estimated TOC from RTP effluent sampling



Instantaneous ozone demand was measured during brief experiments with grab samples and continuously with online instrumentation (see Table 3.5). An ORP and dissolved ozone residual sensor were used to measure the ozone residual at the end of the ozone contactor (contact time of 3 minutes at a flow of 28 gpm). ORP readings were used to detect the presence or absence of ozone (indicating a concentration of zero, in the absence of ozone). Thirty-second ozone demand was calculated from 30-second ozone residual grab samples¹⁸. When a residual was detected, these 30-second residual concentrations were used to estimate the instantaneous ozone demand. These ozone demand values are typical for non-nitrified secondary effluents, high compared to typical ozone applications, and result in the preozonation doses that are higher than typical ozone applications.

Transferred ozone dose (mg/L)	Number of measurements	Estimated instantaneous ozone demand (mg/L) ^a	30-second ozone demand (mg/L) ^b	~3-minute ozone demand (mg/L)
9	1		10	10
15 - 19	5	12 - 16	13 - 17	15 - 19
12 – 22	20,437			12 - 22
8 - 14	ca. 70,000			8 - 14

Table 3.5 - Estimated and measured ozone demand

^a Assuming first-order decay following instantaneous reactions (Rakness, 2008), which requires measurement of an ozone residual downstream of instantaneous reactions (*e.g.*, 30 seconds).

^b Based on ozone residual measurements at 30 seconds

As mentioned previously, the applied ozone dose was varied to meet an ozone setpoint during the high ozone dose testing. A week of data from this phase of testing is shown again in Figure 3.5 with the addition of ozone influent online turbidity. The applied ozone dose correlates to the 3-minute ozone demand, when multiplied by transfer efficiency (88% during this period of testing). Within a week, the ozone demand varies by about 4 mg/L at these doses, with diurnal variations between 2 and 3 mg/L. These data also show that turbidity correlates somewhat with ozone demand, with turbidity spikes observed during most ozone demand spikes (although of differing magnitudes).

¹⁸ Hach AccuVac Ampules, low (0 to 0.25 mg/L) or high (0 to 1.50 mg/L), as needed; indigo method with DR 890.





Figure 3.5 – Applied ozone dose to meet effluent setpoint of 0.1 mg/L and ozone influent turbidity

Turbidity was measured upstream of the ozone system with an online analyzer¹⁹. The average turbidity observed during piloting was 2.4 NTU (range of 0.9 to 6.2 NTU, at the 1st and 99th percentile, respectively). A probability plot of this data is shown in Figure 3.6, and a trend is shown in Figure 3.7. The high turbidity values observed in the probability plot may be due to slugs of high turbidity water that sheared from the sample tubing walls and passed through the analyzer, or from periodic cleanings. The overwhelming majority of the readings are between 0.9 and 6.2 NTU. The trend shows seasonal variation in the mean turbidity, and seasonal variation in the diurnal variation (*i.e.*, changes in the thickness of the band).

¹⁹ Hach 1720E Low Range Turbidimeter













Foam

Foam creation was minimal through the ozone process during piloting. Qualitative observations could not distinguish between the volume of foam created with the application of ozone and the volume created without the application of ozone or high-purity oxygen. Thus, it appeared that foam was created from constituents in the secondary effluent, perhaps as the flow may have been aerated during the 5-foot drop, which was exposed to the atmosphere. Throughout the majority of pilot testing, the ozonated effluent flowed to MF feed tanks, which contained overflow pipes (2 to 3 inches) at different elevations. The lower elevation overflow pipe continuously drained ozonated effluent, and thus minimal foam accumulated in the MF feed tank with the lower elevation overflow pipe. The MF feed tank with the higher elevation overflow pipe accumulated 2 to 6 inches of foam. When this latter feed tank was modified to ensure that foam wasting did not even occur on an infrequent basis (*e.g.,* during daily CEBs), the foam depth did not change. Presumably, the foam breakdown rate limited the foam depth.

3.1.3 Transfer efficiency

Ozone transfer efficiency is the fraction of applied gaseous ozone that dissolves into the liquid phase (*e.g.,* 100% transfer efficiency equates to all of the applied ozone dissolving into the liquid). In practice, this is estimated with measurement of the ozone concentration in the off-gas and the applied gas, assuming no gas-phase ozone decay. Increasing ozone transfer efficiency decreases the ozone that is wasted (*i.e.,* sent to the ozone destruct). Transfer efficiency is used to calculate the transferred ozone dose from the applied ozone dose (the transferred ozone dose is the product of the applied ozone dose and the transfer efficiency). Given that transfer efficiencies will vary between ozone installations, or between pilot-scale and full-scale, the transferred ozone dose is useful for comparing systems, or translating pilot results to full-scale design. Transfer efficiency was measured at the pilot on a weekly basis. The results from these measurements are shown in Table 3.6 for both the moderate ozone dose testing, and the high ozone dose testing.

During piloting, transfer efficiency primarily correlated with ozone system flow. Mixing at the pilot was achieved through static mixers, which are a function of flow, and transfer efficiency is dependent on mixing. Thus low system flows resulted in lower transfer efficiencies. Due to pump capacity limitations, the ozone flow was increased or decreased at the pilot to achieve moderate and high doses, respectively. Thus, the transfer efficiency also correlates fairly well to ozone dose. Minor flow or head loss adjustments during the moderate dose testing lead to a wider range in transfer efficiencies (*i.e.*, 92 to 98%, with one measurement at 87% associated with low flow conditions as the GWR supply pump capacity dropped off due to clogging).



Ozone test phase (applied dose)	Average transfer efficiency (%, range)		
Moderate (10 mg/L)	95 (87 – 98)		
High (20 mg/L, average)	88 (86 – 90)		
Other (12 – 16 mg/L)	92 (91 – 93)		

Table 3.6 - Pilot ozone transfer efficiency

3.1.4 Disinfection CT preliminary testing

A potential use of preozonation is to achieve disinfection credit. This disinfection credit requires the maintenance of an ozone CT (*e.g.*, 1 mg-min/L) through the measurement of the ozone residual in the ozone contactor. The ozone residual must be measured in at least one location; however, measuring the ozone residual in multiple locations increases the resolution of the ozone decay curve, which may increase the reportable ozone CT. Methods for calculating the ozone CT include the following: (1) assuming that the ozone residual is constant between measurements, or (2) constructing an ozone decay curve, assuming first-order decay kinetics (Rakness, 2008). The latter method more accurately represents ozone decay, and yields higher CT values.

Preliminary measurements of the ozone CT were taken at the pilot for both the moderate ozone dose (10 mg/L, applied) and the high ozone dose (20 mg/L, average applied). At the high dose, CTs of 1 to 2 mg-min/L could be achieved with transferred ozone doses of approximately 15 to 19 mg/L (five sampling events; Table 3.7 for summary)²⁰. At the moderate dose, no ozone residual was detected at the first sample point (one sampling event, triplicates). These preliminary data show that the high ozone doses (*e.g.,* transferred ozone dose of 18 mg/L) can achieve disinfection CTs (CT greater or equal to 1 mg-min/L). Further testing would be required to determine the transferred ozone dose necessary to sustain a disinfection CT on a continuous basis. A full-scale ozone disinfection design must be conservative enough to account for a wide range of water qualities that affect ozone demand.

Applied ozone dose(s) (mg/L) ^a	Ozone CT (mg-min/L) ^b
21	1.9
20	1.4
18	0.8
17	1.2
19	1.4

Fable 3.7 – Ozone CT measurements	for	various	applied	ozone	doses
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^a Transfer efficiency approximately 88%

^b Calculated based on Rakness, 2008

²⁰ The ozone residual was measured at four locations in the ozone contactor (approximate sample times of 0.5, 1.0, 1.5, and 2.5 minutes, assuming a 80% baffling efficiency).



3.1.5 Sodium Hypochlorite Dose Location experiment

The effect of the sodium hypochlorite dose location on NDMA formation was tested on 6/27/14. NDMA may form from chloramination and/or ozonation of secondary effluent. At the AWTF, both oxidants will be added to the secondary effluent for membrane pretreatment. The order that these oxidants are introduced into the secondary effluent may impact the total NDMA formation across both of these processes. For example, ozone NDMA precursors may not be the same as chloramine precursors, and one oxidant may oxidize the precursors of the other.

Two test conditions were examined (in triplicates) at the pilot to understand the effect of the sodium hypochlorite dose locations on NDMA formation: chlorine upstream of ozone (pre-chloramination) and chlorine downstream of ozone (post-chloramination). Two controls were also tested: only chlorine and only ozone. The results of these tests are shown in Table 3.8. The results show that pre-chloramination and post-chloramination produced essentially the same concentration of NDMA, at concentrations that are in agreement with other measurements of NDMA at the pilot. Both pre- and post-chloramination produced slightly less NDMA than the added effects of NDMA formation from the addition of only one of the oxidants (formation of 41 nanograms per liter [ng/L], range of 37 to 47 ng/L). Based on these results, either pre- or post-chloramination is expected to yield acceptable NDMA formation levels at the AWTF.

Parameter	Average NDMA (ng/L)ª (Range)			
Test condition	Influent	Effluent	Formation	
Pre-chloramination ^c	11	49	38	
		(45 - 52)	(34 - 41)	
Post-chloramination ^c	7.6	46	38	
		(44 - 48)	(36 - 40)	
Only chloromination	6.7	17	11	
Unly chloramination		(15 - 22)	(8 - 15)	
Only or operation	9.3	40	31	
Uniy ozonation		(36 - 44)	(27 - 35)	

Table 3.8 - NDMA	pre- and	post-chloramination	formation
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^a Two hours contact time

^b Ozone dose of 10 mg/L applied (approximately 90% transfer efficiency)

^c Chlorine residual of 6.2 - 6.3 mg/L as Cl₂

^d Samples collected at about 1 hour intervals between test conditions

3.1.6 TOC transformation experiment

The transformation of TOC through ozonation was measured at the pilot during an experiment conducted on July 2nd, 2014. Ozone typically increases assimilable organic carbon (AOC) in secondary effluents by transforming organic molecules that microorganisms cannot use as energy into smaller organic molecules that are more readily available to microorganisms. AOC is a measurement of the concentration of organic



material in a sample that can be assimilated by microorganisms (AOC is truly only a measurement of the assimilability of the organic carbon to the species of microorganisms used in the AOC test). Ozone cannot increase the TOC of water (*i.e.*, it does not add carbon to the water), and it typically does not lower TOC (*i.e.*, it typically does not mineralize carbon). However, by transforming the chemical properties or size of the organic molecules, ozonation may impact the removal of TOC through downstream processes (*e.g.*, RO).

The pilot TOC transformation experiment was conducted at an applied ozone dose of 21 mg/L (transfer efficiency approximately 88%). Under this condition, TOC, ultraviolet light absorbance (UVA), AOC, and aldehyde samples were collected at the MF effluent and RO permeate. A control condition was also tested, where ozone (and oxygen) were not applied to the chloraminated secondary effluent. The results from the analysis of these samples are summarized in Table 3.9.

Sample Location ^a	ation ^a MF Effluent		RO Peri	Unit	
Condition	No Ozone	With Ozone	No Ozone	With Ozone	UIIIt
Bulk parameters:					
Total Organic Carbon ^b	7.5	8.6	ND (< 0.2) ^c	0.39	mg/L
Dissolved UV Abs. at 254 nm	0.189	0.107	ND (< 0.009)	0.011	cm ⁻¹
Assimilable Organic Carbon	1400	2900	<10	50	µg/L
Aldehydes:					
Formaldehyde	20	130	9.2	71	µg/L
Acetaldehyde	9.4	55	2.7	17	µg/L
Benzaldehyde	2.6	3.9	1.2	1.3	µg/L
Crotonaldehyde	1.1	ND (< 1)	ND (< 1)	ND (< 1)	µg/L
Glyoxal	12	130	ND (< 10)	ND (< 10)	µg/L
Methyl glyoxal	ND (< 10)	27	ND (< 10)	ND (< 10)	µg/L
Butanal	ND (< 1)	5.7	ND (< 1)	ND (< 1)	µg/L
Decanal	ND (< 1)	ND (< 1)	ND (< 1)	ND (< 1)	µg/L
Heptanal	ND (< 1)	10	ND (< 1)	ND (< 1)	µg/L
Hexanal	ND (< 1)	13	1	1.2	µg/L
Nonanal	2.2	7.6	ND (< 1)	ND (< 1)	µg/L
Octanal	ND (< 1)	ND (< 1)	ND (< 1)	ND (< 1)	µg/L
Pentanal	ND (< 1)	ND (< 1)	ND (< 1)	ND (< 1)	µg/L
Propanal	3.1	15	ND (< 1)	5.1	µg/L

 Table 3.9 - TOC transformation through the ozonation process

^a ND (not detected, or below the detection limit; detection limit shown in parenthesis)

^b Measured in triplicates in the RO permeate; average shown

^c Measured as 0.21 mg/L by Trussell Technologies lab (0.20 - 0.23), hold time 35 days



The ozone dose tested during this experiment represents a high ozone dose. This high ozone dose was not used as the basis of design for the preliminary AWTF design (rather the 10 mg/L dose was used). Thus, these data should exaggerate what is expected at the AWTF, with the lower ozone doses (lower ozone doses will transform the organics to a lesser degree). With this high ozone dose, the RO permeate TOC concentration approximately doubled compared to without ozone (it increased by 70%, assuming the non-ozone test condition RO permeate TOC was at the detection limit and that RO TOC rejection is independent of influent TOC concentration).

The increase in RO permeate TOC is only partially explained by the increase in RO permeate AOC (21 to 26%, assuming the no-ozone test condition RO permeate TOC was at the detection limit), which means that the rest of the RO permeate TOC increase is due to organic molecules that were transformed such that they can pass through RO (*e.g.*, smaller), but not to the degree that they were assimilated during the AOC test (*i.e.*, 74 to 79% of the increase in TOC is recalcitrant). An increase in RO permeate AOC may foster biological growth in the downstream conveyance system, if sufficient chloramine concentrations are not present for inhibition. Given that the increase in AOC is small, a chloramine residual will be present in the conveyance system, and these data come from an experiment with ozone doses higher than the design AWTF dose, the AWTF is expected to meet all product water quality goals. The effect of the AWTF design ozone dose (*i.e.*, 10 mg/L applied pilot dose) on RO permeate TOC concentrations is further discussed in the product water quality section of this report.

Notable results from the aldehyde analysis are the formation of formaldehyde and acetaldehyde. As is discussed in the Source Water and Product Water Quality Report, the formaldehyde NL is 100 micrograms per liter (µg/L). Acetaldehyde does not have an NL, or any other regulatory level, but a Predicted No-effect Concentration (PNEC) has been developed, which is 23 μ g/L (Anderson, 2010). The concentrations measured in the RO permeate during this experiment were somewhat close to these levels, but below them. This experiment was conducted at a high ozone dose (21 mg/L) and at a fairly high O₃:TOC ratio (approximately 1.4 with approximate nitrite effects taken into account). The AWTF will be designed for lower ozone doses (10 mg/L) and lower O_3 :TOC ratios (*e.g.*, 0.5), which will result in lower formaldehyde and acetaldehyde production (26 and 5.1 μ g/L of formaldehyde and acetaldehyde, respectively, measured during one sample event of the RO permeate with a secondary effluent TOC of 14 mg/L and transferred ozone dose of approximately 9.1 mg/L). Formaldehyde may increase slightly through the UV/AOP process; however, this increase is expected to be minor, such that AWTF product water formaldehyde concentration is not expected to exceed the NL. If further pilot testing is conducted, testing the effect of the UV/AOP process on the concentration of RO permeate organics should be considered to verify that the effect of UV/AOP on organic formation is minor.



3.2 Ultrafiltration

3.2.1 Pentair module testing (inside-out)

Several operational parameters were monitored and used to evaluate the Pentair MF system performance. These include *TMP*, *Flux*, and *Permeability*. *TMP* is the pressure differential between the feed and filtrate side of the membrane and is measured in pounds per square inch (psi). *Flux* is the volumetric flow rate across the membrane measured in gallons per square feet per day, GFD. *Permeability* is the flux divided by the TMP and is a measure of the ability of the membrane barrier to allow passage or diffusion of a substance. Data *Normalization* is a mathematical technique that allows the user to compare operation at a specific set of conditions to a reference set of conditions. This allows the user to determine whether changes in membrane performance are caused by fouling, damage to the membrane, or are just due to different operating conditions such as temperature.

Flux and transmembrane pressure testing

From start-up the Pentair X-Flow module had difficulties in this application. The membrane TMP along with the operating flux are plotted in Figure 3.8. Initially, the flux rate was set to 25 GFD; however, at this flux the membrane would rapidly approach the critical TMP within 2 to 3 days. The reason for the rapid TMP increase was originally thought to be caused by the relatively large 700-micron mesh size of the pre-strainer.

From December 16th, 2013 through January 18th, 2014 the flux rate was dramatically reduced to between 12 and 17 GFD. This was done primarily to keep the unit operational while the pre-strainer could be replaced with one similar to the Toray unit. On January 18th, a 100-micron pre-strainer was installed on the Pentair unit. On January 20th, the flux rate was increased from 17 to 20 GFD. Within a matter of hours, the TMP reached the critical value.





Figure 3.8 - Pentair TMP and Flux

A field technician from Harn RO systems performed a routine clean in place (CIP) on the Pentair unit on Jan 29th. The unit was returned to service at 17 GFD on January 30th, 2014. Following the CIP, the TMP was stable. One week after the CIP on Feb 6th, the flux rate was increased to 20 GFD. The TMP reached the critical value within three days. Because the Pentair unit was unable to maintain flux above 17 GFD, it was decided the inside out configuration was not suitable for this application.

3.2.2 Toray module Testing (outside-in)

Feed Water Quality

During piloting, the feed water quality remained relatively stable. Temperature, turbidity, and pH are plotted in Figure 3.9. The turbidity trend shows spikes in excess of 10 NTU. Fouling of the analyzer cuvette caused these spikes. The actual feed turbidity was never observed to be above 10 NTU.





Figure 3.9 - Toray Feed Parameters

Flux and transmembrane pressure testing

Between the initial startup and shutdown, nine CIP cycles were performed on the Toray MF unit. The following section summarizes operating conditions and durations of each trial. For each trial, the total continuous run time is presented. The continuous run time neglected time off line resulting from periodic shutdowns of upstream equipment, such as repairs within the MRWPCA RTP and ozone system repairs.

TMP, flux, and permeability were operational parameters that were monitored and used to evaluate the Toray MF system performance (see Figure 3.10 for TMP and flux data).





Figure 3.10 - Toray Transmembrane Pressure (Flux axis shown with truncated scale for ease of viewing the data)

Trial 1: 11/15/2013 - 01/12/2014

The first CIP was performed after 44 days (6.3 weeks) of continuous operation at a flux of 25 GFD and was done as a matter of routine maintenance. The TMP data shows a small spike that occurred on January 3rd, 2014. After an investigation of operations, it was determined that the chlorine feed used for chloramination went dry over a long holiday weekend. This is noted to exemplify the importance of controlling organic foulants. Once the chlorine system was returned to service, the MF system self-corrected.

Trial 2: 1/14/2014 - 2/10/2014

The second run yielded a shorter run time: 25 days (3.6 weeks) of continuous operation at 25 GFD. However, this run was likely abbreviated due to an inadvertent chemical feed pump shut down. The chemical pump that supplies NaOCl during the daily CEB was unintentionally disabled on Jan 29th. This was not discovered and corrected until Feb 18th. In addition to the lack of cleaning chemicals, the 2nd CIP was performed a few days early to ensure the system was fully operation for the monthly water quality sample scheduled for the second week of February (*i.e.*, the run could have lasted longer if the unit was allowed to reach the TMP shutdown setpoint of 21 psi).



Trial 3: 2/10/2014 – 2/25/2014

A planned ozone shut down was scheduled during this run. Once stable, MF operation was established at 25 GFD following the 2nd CIP, and the ozone system was taken off line to evaluate the corresponding effect to the membrane systems. Coincidentally, the same day the ozone was turned off, it was discovered that the chlorine pump was off and the regularly scheduled CEBs were resumed with the commencement of the no-ozone test. On February 18th the ozone system was turned off. The resulting TMP increase was very rapid, going from an average of 3 psi to the critical value within seven days. During trial 3, the Toray unit operated continuously for a total of 12.7 days (1.8 weeks) before reaching the critical TMP.

Trial 4: 2/25/2014 - 3/13/2014

Following the ozone shut down trial, the Toray unit was cleaned and returned to service at 25 GFD with the ozone system returned to service. After 15 days (2.1 weeks) of continuous operation, the unit was cleaned to prepare for the next trial, operating at an increased flux rate of 40 GFD. This CIP was performed as matter of preparation for the next phase of testing (*i.e.*, the CIP was not performed due to the module reaching the TMP shutdown setpoint).

Trial 5: 3/17/2014 – 3/28/2014

During the fifth trial, the MF flux rate was increased from 25 GFD to 40 GFD, and the ozone dose was increased from 10 mg/L to 18 mg/L. The TMP increase during the first 6 days was steady and moderate, from an average of 4.5 psi to 5.57. Then on the seventh day operating at 40 GFD, the TMP went from 5.75 to 29 psi in a matter of hours. The unit was returned to service by forcing several back-to-back backwash cycles followed by a CEB. These backwashes were undertaken to determine if the fouling event was due to a one-time surge in poor water quality. The unit was returned to service; however, it shut down on high TMP within two days. This trial yielded a substantial shorter run time of 8.2 days (1.2 weeks) of continuous operation.

Trial 6: 3/28/2014 - 4/1/2014

Initially it was not clear if the rapid fouling of the previous trial had resulted from the increased flux rate, inorganic fouling resulting from the increased Ozone dose, or simply an ineffective clean prior to the trial. The Toray unit was cleaned and returned to service under the same conditions, except that the ozone dose was decreased from 18 to 16 mg/L to reduce the likelihood of inorganic precipitation. This time the unit fouled in two days. The total continuous run time for this trial was 1.6 days.

Trial 7: 4/1/2014 – 4/2/2014

Following the 6th trial, the Toray unit was cleaned once again, and the ozone dose was lowered to 13 mg/L to further reduce the likelihood of inorganic precipitation. However within two days the critical TMP was reached. During Trial 7, the Toray unit operated continuously for 1.2 days at 40 GFD.



Trial 8: 4/7/2014 – 5/20/2014

Once it was established that 40 GFD was too aggressive, the flux rate was reduced. Following the 7th CIP, the unit was operated at 25 GFD for a day to verify the membrane module had not sustained irreversible fouling. The flux rate was then increased to 28 GFD for two more days. On the third day, April 11, the flux rate was increased to 30 GFD. The Ozone dose was 10 mg/L. During this trial, the Toray unit operated continuously for an additional 31.9 days (4.6 weeks) at 30 GFD. The total continuous run time for this trial was 35.4 days (5.1 weeks). On April 15th, the TMP rapidly jumped from 3 to 6 psi. Based on previous trials, it appeared the TMP was about to run away to the critical value. However, by the next day the TMP began to drop. Each consecutive day the TMP continued to drop until April 19th, when the TMP fell in line with a normal rate of increase. For the remainder of the trial, the rate of TMP increase was normal. This spike is explained in the following section.

Trial 9: 5/20/2014 - 6/12/2014

The 9th trial began by continuing to operate the Toray unit at 30 GFD for a week and changing the ozone dose to an average of 20 mg/L. During this time, the TMP showed no appreciable increase, less than 1 psi. In an effort to identify the upper limit to the sustainable operating flux, on May 28th the flux rate was increased to 35 GFD. On June 3rd, the TMP again took another unexpected jump. Once again, on the 4th the TMP dropped back in line with the normal rate of increase. The Toray unit operated continuously for 20.9 days (2.9 weeks), 15 days at 35 GFD.

Trial 10: 6/12/2014 - 7/7/2014

During the entire 10th trial, the Toray unit was operated at 32 GFD, while the ozone dose was maintained at an average of 20 mg/L. The Toray unit operated continuously for 22.2 days (3.2 weeks).

In addition to the TMP and Flux data, Figure 3.10 (introduced above) also shows Toray membrane testing milestones such as the CIPs, the chemical pump inactivation, and the ozone deactivation trial (indicated by vertical lines on the plot). An evaluation of the operating data over the course of the pilot operation period indicates the optimum operating flux rate is 30 GFD.

All the CIPs, except CIP number five, were performed in two steps, first with a 3,000 parts per million (ppm) NaOCl solution followed by a 3% Citric Acid solution. Each solution was recirculated for one hour, and then left to soak for three more hours. During the soak, the module was aerated for 30 seconds every 30 minutes. CIP number five had the acid portion performed first, followed by the NaOCl portion. With the exception of the chemical order, the chemical concentrations and sequences were identical to the other CIPs.

Over the course of the pilot, two unexpected TMP spikes were observed: one on April 15th 2014 and the other on June 4th 2014. Further investigation of the RTP revealed a decline in secondary effluent quality, which led to filtration difficulties at the Salinas Valley Reclamation Plant (SVRP; *i.e.*, SVRP required a significant increase in the coagulant dose to



meet their effluent turbidity requirements)²¹. A plot of the TMP, along with the coagulant dose, is shown in Figure 3.11. The two TMP spikes are highlighted in red. A decline in MF performance is likely during times when the RTP secondary effluent water quality is low. However, the pilot unit recovered from these events without additional cleanings or operational effort.



Figure 3.12 below contains the plot of the normalized membrane permeability.

²¹ Coagulant is a polymer blend (JC-1676), and is added to the secondary effluent whenever the SVRP coagulant addition (also JC-1676) exceeds 10 mg/L (operator initiated). This coagulant may have also impacted filterability at the pilot (by increasing or decreasing the MF TMP).







A plot of the filtrate turbidity data is shown in Figure 3.13. 99.8% of the 134,600 data points collected were less than 0.05 NTU. Furthermore, all of the silt density index (SDI) results were less than 3.0. The PLC could not record daily membrane integrity test results; however, they never exceeded 0.1 pounds per square inch per minute (psi/min; *i.e.*, the alarm set point). In general, values below 0.5 psi/min indicate an integral membrane. Above 0.5 psi/min, membrane pinning may be required.









3.3 Reverse osmosis

3.3.1 Performance testing

The feed parameters are plotted in Figure 3.14. The feed conductivity experienced two significant spikes, one in December of 2013 and the second in late February 2014. The cause of the first spike is unknown; however, the second spike resulted from the temporary introduction of Lake El Estero water between February 20th and March 1st for testing purposes. During the period of time between May 12 and June 3, 2014, the conductivity analyzer probe had malfunctioned; hence, there were no data collected through the PLC. During this time, the feed conductivity was measured manually and an average value of 1690 microsiemens per centimeter (μ S/cm) was used for data normalization.

The feed temperature dropped suddenly from 22 °C to 20 °C in December 2013, then began to climb steadily to 24 °C by the conclusion of the pilot in June 2014. Overall, the water temperature was stable and did not cause any operational challenges. At the onset of the pilot, the target pH was 6.8 with calcium phosphate being the primary constituent of concern. In late February, the feed pH began to increase unexpectedly.



Originally, the cause of the pH rise was unknown. In an effort to maintain the target 6.8 value, the acid dose was slowly increased. On April 21, 2014, it was discovered that the pH probe had been drifting high. The acid dose was adjusted and the actual pH was monitored manually with field measurements. The online data showed the pH between April 21 and June 13, 2014 to be around 8.0. The actual value was 6.8 through May 21, at which time the target pH was lowered to 6.0, shown with the red dashed line. The pH target was lowered on May 21st to target calcium phosphate because the RTP began receiving agricultural wash water, which contains elevated phosphorus levels.



Figure 3.14 - RO Feed Parameters

The RO system performance was very stable from startup on November 25th, 2014, though shut down on July 7, 2014, after just over 7 months of operation. During the course of the pilot, the RO unit required only one CIP, which occurred on April 28th, 2014. Throughout the pilot testing, a chloramine residual was maintained through the pilot system with the target of 2 to 5 mg/L at the RO feed.

Several operational parameters were monitored and used to evaluate the RO system performance. These include: *Specific Flux, Normalized Differential Pressure, Feed Pressure, Normalized Rejection,* and *Normalized Permeate Conductivity.* The Specific Flux is the ratio of the Flux to the Net Driving Pressure, where the net driving pressure is the available feed pressure less the sum of the osmotic, train differential, and permeate back pressures. The differential pressure is a measure of the pressure drop from the feed to the concentrate and can be measured either across the entire train or across the individual train stages. Rejection is a measure of the total dissolved ions removed from the feed water.


The overall train normalized specific flux along with the ratio of individual specific flux for both stages are shown in Figure 3.15. The normalized specific flux is the specific flux normalized for temperature. The specific flux ratio is an indicator of any differential fouling or scaling between the two stages.

In mid-January, the specific flux began to decrease slightly, and continued to decrease while the ozone system was off line. However, immediately following the restart of the ozone, the RO specific flux began to recover slightly. While the lack of ozone likely played a role in the specific flux decrease, the exact cause is unknown. The specific flux decrease also coincides with the feed conductivity increase that occurred when the pilot received Lake El Estero water, which also likely had an effect on the RO performance.

On March 14, 2014, the overall specific flux dropped sharply. An evaluation of the second stage differential pressure (*i.e.*, the pressure drop between the feed and concentrate) also shows a sharp decrease during this time. Additionally, the permeate flow from the tail vessel also began to drop off during this time. All of these operational factors indicate scale formation in the tail end of the RO unit. The RO unit was taken off line on April 28 for the only CIP. The unit was cleaned with a 3.0% Citric Acid solution. The solution was heated to 100 °F. The solution was recirculated through the second stage for 30 minutes, and allowed to soak for 60 minutes. While the second stage was soaking, the CIP solution was recirculated through the first stage and allowed to soak for 60 minutes. The entire procedure was performed twice for a total of three hours of acid contact time per stage.

Following the clean, the specific flux data appeared to recover beyond that of the startup value. The days following the CIP continued to show increasing specific flux. An evaluation of the on-board instruments revealed the flow rates being recorded by the PLC were different than those reported on the respective flow meter displays. After trouble shooting the symptoms, it was determined that an analog input card in the PCL had failed. This card was replaced on May 15, 2014. Following the analog card replacement, the specific flux trend returned to the expected post-CIP value.

On May 28th, the sulfuric acid supply ran dry for approximately 20 hours (this is evident by the sudden drop in specific flux and the spike in the specific flux ratio). Immediately after it was discovered, the supply was refilled and the feed pH was dropped to 5.0 for approximately one hour. During this hour, the flow from the tail vessel was monitored and it slowly showed signs of recovery. It was decided to return the RO unit to service, monitor performance, and clean if necessary. Following this incident, the RO unit performance returned and maintained stable operation for the duration of the pilot.





Figure 3.15 - RO Specific Flux and Specific Flux Ratio

The overall train normalized differential pressure plot is shown in Figure 3.16. The differential pressure remained very stable over the duration of the pilot. There was a slight decrease prior to the CIP, caused by a drop in the second stage differential pressure. In mid-June, 2014, there was a slight jump from about 27 to 29 psi.





Figure 3.16 - Normalized Differential Pressure

The individual stage normalized differential pressures are shown in Figure 3.17. The second stage decrease prior to the clean is very evident here, while Stage 1 remained very stable.





Figure 3.17 - Stage Normalized Differential Pressures

The actual feed pressures for both stages are shown in Figure 3.18. The red dashed lines were added to highlight post clean performance. The jump in the second stage feed pressure prior to the clean is another indicator of tail end element scaling. Following the clean and the analog card replacement, both stage feed pressures returned to normal levels relative to start-up values.







The normalized salt rejection trend is shown in Figure 3.19. Overall, the data are very stable, exceeding 98.5%. The small spike shown prior to the analog card replacement is erroneous.





Figure 3.19 - Normalized Rejection

The normalized permeate conductivity trend is shown in Figure 3.20. While this data shows some fluctuation, the overall trend is very stable.





Figure 3.20 - Normalized Permeate Conductivity

3.3.2 Inorganic foulants

Phosphate minerals

Phosphate (mostly in the form of dihydrogen and hydrogen phosphate; also known as orthophosphate) is an ion of particular interest with respect to RO scaling, given the high concentrations of phosphate in the agricultural wash water. Hydrogen phosphate forms a sparingly soluble mineral with calcium when these constituents are at high enough concentrations. Phosphate is a salt of phosphoric acid, and the concentration of hydrogen phosphate is dependent upon pH (acid dissociation constants pK_2 and pK_3 , 7.2 and 12.3, respectively). Given this dependence on pH, acid is one method of calcium phosphate control. The concentrations of these ions increase when they are retained on the RO concentrate side of the RO membrane. With an RO recovery of 81%, these ions are concentrated by a factor of 5.3 (assuming 100% rejection across the OR membrane). With the high feed concentrations associated with the agricultural wash water shunt (a high of 9 mg/L as P with the shunt compared to 4 mg/L as P without the shunt), the concentrating effect of the RO may cause scaling and fouling of the membrane, if adequate control measures are not employed (*e.g.*, pH adjustment). Phosphate concentrations measured in the secondary effluent of the RTP during piloting are shown in Figure 3.21. The samples were composited over a period of 24-hours (flow weighted), and passed through a 0.2micron-pore-diameter filter prior to analysis.²²

²² RTP Lab with ion chromatography; 0.2 micron filtration required due to capillary tubing size restrictions





Figure 3.21 – Phosphate concentration in the secondary effluent during piloting (includes effect of CEPT control)

Although the elevated concentrations of phosphate in the secondary effluent during April and May were a concern, pH control seemed to stave off phosphate-related fouling. The RO feed pH was manually controlled at approximately 6.8 until May 21st, when the manual RO feed pH setpoint was set to 6.0 (manual control was necessary while a faulty pH sensor on the RO skid was replaced, and the feed pH was verified approximately weekly during this time period). While there may have been diurnal variations in the MF effluent pH (which would correspond to variations in the RO feed pH, given the manual control), the RO system did not discernably foul with these setpoints, under the high phosphate loads. On the other hand, the RO fouled rapidly when pH control was ceased (the RO recovered from this event after pH control was reinstated), and small perturbations to the RO feed pH appeared to impact the RO specific flux (an indicator that is typically used to monitor RO fouling). The one fouling event that required RO cleaning occurred prior to the higher phosphate concentrations associated with the agricultural wash water shunt (March 15, whereas the agricultural wash water shunt began on April 1). Another factor that may have contributed to the RO performance with these high phosphate loads is that the MF system may have filtered out sub-colloidal phosphate precipitates. The nominal pore size of the MF system was 0.01 microns, and any sub-colloids larger than this size would be well removed through the MF system. Although filtration through the MF system is possible, pH control likely played a key role in controlling phosphate-related mineral scaling, and thus pH control is recommended for the AWTF.



Phosphate removal at the RTP may occur through biological uptake and wasting, or through precipitation and sludge removal. Phosphorus typically makes up 1.5 to 2% of the dry weight of microbial cells. As cells increase in number through the secondary process. they remove dissolved phosphate from the wastewater. When these cells are settled out in the secondary clarifiers, the phosphorus is removed from the treated wastewater. Another method of phosphorus removal is chemical precipitation with metal salts (e.a., ferric). With appropriate doses, ferric chloride can form sparingly soluble minerals with phosphate that settle out from the wastewater. A stoichiometric relationship between ferric dose and phosphate precipitation typically exists for high residual (effluent) phosphate concentrations (*i.e.*, when effluent dissolved phosphate concentrations are not low). As lower effluent phosphate concentrations are targeted, metal hydroxides form and the removal mechanism transitions from precipitation to adsorption to these metal hydroxides. This transition significantly increases the required ferric dose (Sedlak, 1991). A potential negative effect of a ferric chloride based phosphate control is the possibility of dissolved iron carryover into the RO feed. Iron is one of the many ions that contribute to RO scaling, and this carryover could possibly impact RO performance.

During the time period of elevated phosphate concentration in the RO feed (April through July), ferric chloride was experimentally used to control phosphate concentrations in the secondary effluent (see timing and magnitude of doses in Figure 3.22).²³ The starting ferric chloride dose of 18 mg/L had a statistically significant impact average on the phosphate concentration compared to the residual phosphate concentrations of the lower dose and no dose, after adjusting for variations in the RTP influent concentration (95% confidence). This high dose seems to have achieved residual phosphate concentrations that were similar to the secondary effluent concentrations prior to the agricultural wash water shunt. The lower dose of 9 mg/L did not yield a residual phosphate concentration that was statistically significant from the high dose or no ferric addition secondary effluent concentration.

²³ Ferric chloride (41% strength ferric chloride) dosed through the RTP chemically enhanced primary treatment (CEPT) facilities





Figure 3.22 – Phosphate measurements during agricultural wash water shunt and ferric chloride doses

An approximate qualitative representation of the change in phosphorus concentration is shown in Figure 3.23. These data come from 24-hour composite samples at five locations in the RTP: RTP influent, primary influent (after recycle streams are included), primary effluent, trickling filter effluent, and secondary effluent. Although the difference in phosphate concentrations across neighboring sample locations was directly used to calculate the increase or decrease in phosphate as if all samples were collected over the same time period and with the same weighting scheme, the collection times and collection weighting schemes actually varied between sample locations.²⁴ Further, these data indicate an overall increase in phosphate concentrations through the RTP (*i.e.*, an increase in RTP influent compared to the secondary effluent; although not statistically significant at the 95% confidence interval). This increase may be due to suspended phosphate dissolving into the dissolved form (to pass through a 0.2-micron filter) through the RTP. With these caveats in mind, it may be possible to make broad observations from the data. First, these data seem to indicate a recirculation of phosphate through the recycling flow, presumably from the screw press pressate (three grab samples indicate 63 to 111 mg/L as P in late May). They also seem to show removal through biological clarification. Finally, the data appear to indicate that phosphate removal through primary sedimentation may have

²⁴ RTP influent and secondary effluent were flow-weighted and collected from midnight to midnight; primary effluent and trickling filter were time-weighted, from approximately 7 am to 7 am; primary influent was time weighted up until 4/30/14, and flow-weighted after said date, from approximately 7 am to 7 am, regardless.



been negligible, although this observation may be skewed by absence of total phosphate data (including dissolved and suspended).



Figure 3.23 - Change in orthophosphate concentration through RTP (the mean of these changes across treatment processes are not statistically significant at the 95% confidence interval; all samples are 24-hour composites, but collection time periods and weighting schemes vary between sample locations)

Full-scale design, and later operation, of the AWTF should consider the costs and benefits of chemical precipitation (*e.g.*, ferric chloride), pH control (*e.g.*, sulfuric acid control at the RO feed), or other methods (*e.g.*, biological phosphorus removal) for controlling phosphate in the RO feed.

Other mineral foulants

In addition to calcium phosphate minerals, there are a number of other sparingly soluble minerals that may contribute to RO scaling (*e.g.*, aluminum silicates). The ions that constitute these sparingly soluble minerals were measured during piloting (see results of these measurements in Table 3.10; the probability plots of three ions with particularly high concentrations in this feed water are shown in Figure 3.24 and Figure 3.25). In some cases (*e.g.*, calcium phosphate minerals), the solubility of these minerals can be increased (*i.e.*, decrease the rate of mineral formation, or eliminate mineral formation) by decreasing the RO feed pH (*e.g.*, through acid addition). Lowering the pH, however, may have the opposite effect on some other minerals, where their solubility may decrease (*i.e.*, the rate of mineral formation may increase). Some RO scaling minerals are also amendable to anti-



scalants (also known as anti-foulants or threshold inhibitors); however, anti-scalants are not available at this time for all minerals that may foul RO membranes in water reuse applications.

Constituent (mg/L)	Median	Range ^a
Alkalinity	306	250-342
Aluminum	0.078	0.021-0.75
Calcium	58	51-65
Chloride	230	203-266
Fluoride	0.6	0.5-0.8
Phosphate	3.1	0.3-14
Magnesium	22	10-26
Manganese	0.052	0.043-0.078
Nitrate	19.9	<1-47
Silica	39	38-40
Sodium	152	149-173
Potassium	20	19-21
Iron	0.378	0.157-0.931
Barium	0.011	0.003-0.029
Sulfate	90	84-94
Strontium	0.378	0.360-0.396
TDS	808	757-897

Table 3.10 - Inorganic parameters of concern with respect to RO fouling, measuredin the RO feed water

^a 13 samples, except for nitrate (12 samples), with approximately 6 samples during the agricultural wash water shunt





Figure 3.24 - Probability plot of calcium and silica concentrations in RO feed water



Figure 3.25 – Probability plot of phosphate concentrations in the RTP effluent after April 1, 2014, the date on which the agricultural wash water was routed into the RTP, and only when ferric chloride was not added at the RTP (*i.e.*, excluding dates 4/16 through 6/2)



Inorganic parameters of concern (*i.e.*, the ions that may form sparingly soluble minerals in RO membranes) were also measured during the source water sampling campaign (Trussell Technologies, 2014d). The results from this sampling effort are summarized in Table 3.11. Some of these ions are present in the source waters at concentrations that are of concern with respect to RO fouling (e.g., iron, aluminum). However, these source waters will be blended and treated prior to entering the RO. They will blend together with municipal and industrial wastewater in the RTP collection system; they will undergo primary and secondary treatment through the RTP (where sedimentation of solid-bound ions, and biological update may occur); and they will receive chloramination, preozonation and MF treatment (where oxidative precipitation and removal may occur). Direct water quality samples are not available to characterize these effects, as select source water shunting occurred during the pilot program. If the final RO feed water quality can be estimated (after the effects of blending, RTP removal, and upstream AWTF removal), then RO modeling can be conducted to determine the impact of these constituents on RO fouling and RO recovery. An estimate of final RO feed water quality, and the associated RO modeling, is outside the scope of this pilot report; however, both of those tasks are recommended to ascertain the impact of the source water quality on the RO design and operation. The concentrations of some salts in the source waters may limit the RO recovery if they are not well removed by upstream processes, or sufficiently reduced through blending.



Table 3.11 – Observed median concentrations and ranges of inorganic parameters of concern for RO scaling. All concentrations in mg/L.

Parameter	RTP Effluent	Ag Wash Water	Blanco Drain	El Estero	Tembladero Slough
Alkalinity	316 (277-344)	168 (157-260)	356 (327-373)	185 (157-212)	363
Aluminum	0.048 (0.021-0.256)	0.237 (0.14-0.598)	0.77 (0.26-2.04)	0.296 (0.189-0.402)	1.54
Calcium	58 (54-62)	81 (76-100)	154 (128-169)	100 (77-122)	166
Chloride	217 (183-235)	237 (154-292)	274 (241-307)	423 (332-514)	394
Fluoride	0.56 (0.4-0.8)	0.3 (<i><0.1-</i> 31.9)	0.7 (0.66-0.9)	0.3	0.7
Phosphate (as P)	3.0 (2.2-13)	27.5 (10.5-47.2)	<0.1 (<0.1-0.2)	<0.1	<0.1
Magnesium	22 (20-24)	34 (28-39)	146 (140-177)	42 (32-52)	159
Manganese	0.045 (0.034-0.051)	0.049 (0.039-0.051)	0.243 (0.06-0.449)	0.281 (0.219-0.342)	0.108
Nitrate	21.5 (<1-42)	22.5 (<1.1-28)	292 (70.3-352)	<1	255
Silica	40 (39-44)	44 (41-48)	30.5 (26-63)	<0.5	30
Sodium	161 (144-173)	177 (133-200)	241 (196-266)	235 (174-296)	333
Potassium	21 (19-22)	36 (32-42)	2.3 (1-2.7)	7.8 (6.2-9.3)	4.9
Iron	0.339 (0.175-0.537)	0.434 (0.3-0.875)	1.563 (0.639-3.891)	0.355 (0.202-0.508)	2.962
Barium	0.0115 (0.011-0.026)	0.096 (0.082-0.109)	0.068 (0.054-0.079)	0.086 (0.065-0.107)	0.119
Sulfate	88 (83-151)	170 (153-172)	523 (498-530)	157 (127-186)	412
Strontium	0.37 (0.29-0.74)	0.58 (0.51-1.30)	1.25 (0.99-2.20)	0.5	1.8
TDS	793 (771-803)	1282 (797-1591)	2003 (1822-2066)	1226 (946-1506)	1968

3.4 UV Hydrogen Peroxide Advanced Oxidation Process

Although this process was not piloted, results from the pilot water sampling campaign and the source water quality sampling campaign (see Trussell Technologies, 2014d for detailed report on the source water quality) inform the UV/AOP design. Design considerations are discussed in this section, after a brief introduction to the UV/AOP process in the AWTF.



At the AWTF, the UV/AOP will provide a final polishing step for pathogen disinfection and an additional chemical destruction barrier for the RO permeate. Hydrogen peroxide will be added to a reactor, which houses arrays of ultraviolet lamps. Ultraviolet light from these lamps react with hydrogen peroxide to form hydroxyl radicals, which, along with the ultraviolet light, oxidizes, destroys, or inactivates chemicals of concern and pathogens. The system sizing will be driven by the requirement in DDW's Groundwater Replenishment Regulations criteria for advanced oxidation (*i.e.*, NDMA and 1,4-dioxane removal requirements).

Although the RO is capable of removing the majority of organic and inorganic compounds, some particularly recalcitrant, low molecular weight compounds (especially neutrally charged compounds) are found in RO permeate (*e.g.*, NDMA and 1,4-dioxane). AOP systems are designed in this context to achieve required levels of NDMA and 1,4-dioxane removal, as removal of these compounds is indicatives removal of a wide variety of CECs. NDMA removal requirements are designed to achieve an effluent concentration less than the NL of 10 ng/L. The 1,4-dioxane removal requirements are stipulated by DDW in the Groundwater Replenishment regulations (0.5-log removal).

Secondary effluent NDMA concentrations are typically below the NL; however, NDMA is formed through ozonation and chloramination processes (see Figure 3.26). The ozone oxidant is short-lived, and thus NDMA formation from ozone is rapid. Chloramines are persistent, and NDMA formation may continue with residual chloramine if NDMA precursors are present (thus the NDMA concentration increases through the MF process). The RO process achieves measurable NDMA removal, but this removal is not sufficient to reach the NL. Given that NDMA can increase through the application of oxidants, the concentration of NDMA precursors in the source water is important in evaluating the RO feed NDMA concentration. The concentration of NDMA precursors of the RTP effluent combined with the agricultural wash water was empirically tested during piloting, by measuring NDMA after applying sodium hypochlorite and ozone (see Figure 3.26 and Figure 3.27), where the impact of the agricultural wash water shunt on the RO permeate concentration appears to be minimal. NDMA formation in the Blanco Drain water was minimal during bench scale testing after the application of ozone (Trussell Technologies, 2014b). Given that NDMA formation from other source waters is expected to be minimal, the maximum NDMA concentration observed during piloting was used as the basis of UV/AOP design (32 ng/L). Based on this maximum measurement, the UV/AOP system will be designed to achieve a 1.5-log reduction in NDMA, which will produce an effluent concentration of 1 ng/L, an order of magnitude below the NL.





Figure 3.26 - Probability plot of NDMA concentrations through the pilot





1,4-dioxane has been detected in the RTP effluent at levels very close to the California NL of 0.001 mg/L, and it has not been detected in the other source waters (Table 3.12). As mentioned previously, the AOP will be designed to achieve 0.5-log removal of 1,4-dioxane, which will be demonstrated during start-up of the full-scale AWTF. This level of removal will bring the effluent concentration below the NL. Blending of the additional source waters is expected to reduce the UV/AOP 1,4-dioxane concentration even further, such that there is no measureable level in the UV/AOP feed.



	RTP Effluent	Ag Wash	Blanco Drain	El Estero	Tembladero Slough
1,4-dioxane (mg/L)	<0.001 (<0.001- 0.0012)	<0.001	<0.001	<0.001	<0.001

Table 3.12 - 1,4-dioxane concentrations measured in potential source waters

UVT is another key parameter for the design of the AOP system. AOP systems rely on the formation of hydroxyl radicals, which are strong oxidants that react rapidly with organics. In a UV hydrogen peroxide AOP system, the formation of hydroxyl radicals is dependent on how much UV light reaches and reacts with the hydrogen peroxide. UVT is a measurement of how much UV light will be transmitted in a water matrix (*i.e.,* it is an indicator of how much UV light will reach hydrogen peroxide); thus UVT relates to hydroxyl radical production. A UVT of 95% or greater was initially specified for the AOP. UVT values greater than this design value were observed during the initial testing; however, the UVT dropped shortly after the start of the agricultural wash water shunt test at the start of April 2014 (Figure 3.28).





Several process changes were occurring at the pilot facility from April through June 2014 (when the UVT dropped), including: the addition of ferric chloride as part of the CEPT, an increase in the chloramine residual used to prevent bio-fouling across the membrane processes, and an increase in the ozone dose associated with experimentation with higher MF flux rates. For the lowest UVT value observed in RO permeate (April 2014; 94%), the chloramine residual was approximately 7 mg/L, exceeding the target range of 2 to 5 mg/L. Chloramines reduce UVT (through the absorbance of UV light), and thus it is believed that this low UVT value is not realistic of future operating conditions (the AWTF will have better control over the chloramine residual, compared to the pilot facilities; see probability plot in Figure 3.29). Correspondingly, the UV/AOP system design was not based on a UVT of 94%; instead, the AOP process design UVT remains at 95%.







Figure 3.29 - Probability plot of UVT of the RO permeate



4 Product Water Quality

The results of the pilot testing, pilot water quality monitoring, and the source water monitoring (Trussell Technologies, 2014d) can be used to estimate the expected product water quality from the AWTF. The product water must be in compliance with all relevant regulations, and must also meet safe levels for other unregulated constituents such as pesticides and CECs. Where possible, worst-case product water qualities have been predicted based on piloting and source water monitoring; demonstrating that the AWTF can treat the worst-case water quality to levels below specified limits ensures consistent compliance and protection of public health.

4.1 Regulated Constituents

4.1.1 Total Nitrogen

The effluent limitation for total nitrogen is 10 mg N/L (DDW Groundwater Replenishment regulations), and the pilot plant consistently met this limit (Figure 4.1). 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 RTP effluent.



Figure 4.1 – Removal of total nitrogen through the pilot

The Blanco Drain has significantly elevated levels of nitrate – the median concentration observed during sampling was 68 mg/L as N, compared to the 5.4 mg/L as N seen in the RTP effluent during source water sampling. These high nitrate concentrations contribute to the high total nitrogen concentration observed in the Blanco Drain (70 mg/L as N), compared to the RTP effluent (44 mg/L as N, where the RTP effluent total nitrogen is mostly comprised of its high ammonia levels). The impact of the Blanco Drain on the RTP



effluent total nitrogen concentration can be reasonably predicted because nitrogen removal is not expected in the RTP. Using the projected monthly flows, total nitrogen concentrations throughout the year were predicted. The results of the analysis are summarized in Table 4.1, including the highest monthly total nitrogen based on the median observed values and the maximum observed values. Despite the high nitrate levels in the Blanco Drain, the maximum predicted total nitrogen under median conditions is only about 5% higher than what has already been observed values, is only 8.5% higher than the observed maximum in the RTP effluent (without Blanco Drain blending).

Table 4.1 – Observed and predicted total nitrogen concentrations calculated using both median and maximum values. Observed concentrations are from RTP effluent; blended concentrations include RTP effluent, wash water, Blanco Drain, El Estero, and Tembladero Slough.

Parameter	RTP Effluent (mg N/L)	Blended Source Waters (mg N/L)
Median	44.4	46.5
Maximum	50.5	54.8

The average total nitrogen removal through the pilot was 94.3%. Assuming this removal, a blended source water total nitrogen concentration of 46.5 mg N/L would be reduced to 2.7 mg N/L and total nitrogen of 54.8 mg N/L would be reduced to 3.1 mg N/L. Both of these concentrations are still well below the limit of 10 mg N/L. Therefore, despite high nitrate levels (and corresponding high total nitrogen levels) in the Blanco Drain, the AWTF should have no problem meeting the 10 mg/L total nitrogen effluent limit.

4.1.2 Total Organic Carbon

TOC can be used as a surrogate for unregulated and unknown organic chemical contaminants. The project goal is to maintain RO permeate TOC concentrations below 0.5 mg/L (per the DDW Groundwater Replenishment regulations)²⁵. Although the TOC in the wash water was measured at high concentrations compared the RTP effluent (Trussell Tech, 2014d), the wash water was measured prior to it receiving biological treatment. Primary and secondary treatment at the RTP is expected to significantly decrease the wash water TOC concentration. In fact, a significant decrease in the RTP effluent TOC was observed during the time period of the agricultural wash water shunt, compared with values observed before the shunt: 14.8 ± 0.7 mg/L and 13.0 ± 0.7 mg/L (mean $\pm 95\%$ confidence interval), for before and after the shunt testing, respectively (see Figure 4.2). It is expected that the addition of low-TOC waters (*e.g.*, Blanco Drain, Tembladero Slough, Lake El Estero) would only further decrease the TOC.

²⁵ For groundwater recharge by subsurface application, DDW requires that the applied recycled water TOC (24-hour composite sample, minimum once a week) not exceed 0.5 mg/L based on a 20-week running average of all TOC results and an average of the last four TOC results. Grab samples may be used in lieu of a 24-hour composite sample if it is demonstrated that a grab sample is representative of the water quality throughout a 24-hour period.







The TOC concentrations in the RO permeate are impacted by the ozone dose. Sampling of the RO permeate at a time when ozone was not running indicates that ozone can significantly increase the TOC concentration in the RO permeate (RO permeate TOC concentrations of 0.39 mg/L and < 0.20 mg/L with and without ozone, respectively [ozone applied dose 21 mg/L]). In May 2014, the ozone dose in the pilot was increased to test the impact on the run-time of the MF unit; as illustrated in Figure 4.3, this increase caused the TOC in the RO permeate to increase, going above 0.5 mg/L three times. The design ozone dose chosen for the full-scale AWTF is the lower dose; this, coupled with the expected reduction in TOC from blending with other low-TOC source waters, indicates that an average RO permeate level of 0.5 mg/L TOC or less is consistently achievable.





Figure 4.3 – TOC concentrations in the pilot RO permeate. Increase in ozone dose started on 5/20/14 and continued through the end of piloting

In addition to the ongoing product water TOC limit of 0.5 mg/L, DDW also maintains a stricter, temporary RO permeate TOC limit of 0.25 mg/L (95% of samples) for the first 20 weeks. While the ongoing limit is meant to continuously guarantee the quality of the product water, the temporary limit is one of two methods that DDW employs to ensure high quality RO membranes are procured for GWR projects (the other tool is sodium chloride rejection requirements). DDW has observed a relationship between the RO permeate TOC concentration during the first 20 weeks of RO operation and the quality of the RO membrane; however, this relationship was observed prior to the advent of preozonation. As discussed earlier, preozonation can increase the RO permeate TOC concentration from less than 0.25 mg/L (e.g., 0.2 mg/L) to greater than 0.25 mg/L (e.g., 0.4 mg/L), even in high quality RO membranes (i.e., membranes that can meet the 0.25 mg/L TOC limit for 20 weeks without preozonation and that can meet the sodium chloride rejection requirements). Given this interference, RO membrane quality verification (the first 20 weeks of AWTF operation) will likely have to be conducted without preozonation. Alternatively, it may be possible to develop an alternative approach to RO membrane quality verification with DDW.

4.1.3 Pathogens

Pathogen removal to levels below detection (*i.e.*, below current detection limits) was observed through the pilot. The addition of other source waters is not expected to impact pathogen removal, since the other source waters have lower concentrations of pathogens, compared to the RTP. Additionally, the UV/AOP, which has not been piloted, will be designed for 6-logs of removal credit (*i.e.*, 99.9999% removal credit) for viruses, *Giardia* and *Cryptosporidium*. A summary of pathogen and pathogen indicator concentrations is shown in Table 4.2. A summary of expected log removal credits is shown in Table 4.3.



Measurement of *Giardia* and *Cryptosporidium* can present a particular challenge in the matrices samples at the RTP and the pilot plant. At this point in time, no standard method has been developed for the measurement of these species in wastewater and recycled water, which contain constituents that interfere with common methods of measurement. The best widely accepted method available at this time is EPA method 1623a, which was used for analysis of the treated wastewater. One of the separation steps in 1623a is a filtration step, and this step is infeasible for the high solids concentration of raw wastewaters (*e.g.*, RTP Influent). Draft EPA method 1693 omits this filtration step, and this method was employed for the raw wastewater samples. Despite these limitations, some general conclusions can be drawn from the data, such as those mentioned above.

Constituent/	RTP	Pilot Influent	Ozone Effluent	MF	RO
sample location	Influent ^d	(secondary effluent)		Effluent	Permeate
Cryptosporidium	< 2	< 0.35	2.65^{a}	<0.09	
(oocysts/L)	1 - 8	(<i><0.09</i> -0.9)	(0.3-23.3)		
Recovery ^c	23%	30%	92%	26%	
Giardia	8847	< 0.15	<0.2ª	<0.09	
(cysts/L)	1634 - 13626	(<0.09-1.1)	(<0.09-4.4)		
Recovery ^c	e	<0.092%	76%	50%	
Total coliform ^b		2.8×10^{5}	6.3x10 ²	<1	<1
(MPN/100 mL)		(2.4x10 ³ – 1.6x10 ⁶)	(5.5x10 ¹ - 3.1x10 ³)		
E. coli ^b		$6.0 ext{x} 10^4$	2.7x10 ¹	<1	<1
(MPN/100 mL)		$(4.9x10^2 - 3.3x10^5)$	(<1 - 5.5x10 ²)		

 Table 4.2 - Summary of pathogen removal observed through the pilot

^a There were consistently higher *Cryptosporidium* concentrations in the ozone effluent than the pilot influent (secondary effluent). This effect appears to be an artifact of the analysis; whereas the ozonation of the water likely increased the method recovery for *Cryptosporidium* and *Giardia*. ^b Values are geometric means; MPN (most probable number)

^c Recovery measured on one of the six samples

^d Draft EPA method 1693, which omits the filtration step of EPA method 1623a (1623a used on other samples)

^e ColorSeed not used, thus native *Giardia* interfered with matrix spike (recovery was 658%)



	Log reduction credits			
Process	Enteric virus	Giardia cysts	Cryptosporidium oocysts	
RTP (primary and secondary treatment) ^a	0	0	0	
Ozone ^a	0	0	0	
MF ^b	0	4	4	
RO	1.5	1.5	1.5	
AOP (UV/H ₂ O ₂)	6	6	6	
Final disinfection (free chlorine) ^a	0	0	0	
Aquifer residence time ^c	5.4	0	0	
Regulatory requirement	12	10	10	
Total pathogen removal credit	12.9	11.5	11.5	

Table 4.3 - Anticipated pathogen log removal credit

^a Not pursuing pathogen credit at this time

 $^{\rm b}\,\rm Not$ pursuing virus removal credit at this time

^c Based on modeling; actual residence time expected to exceed 6 months (actual residence time to be determined through tracer testing)

4.1.4 Maximum Contaminant Levels

One product water quality goal is to meet all of the DDW MCLs for drinking water. Results from the pilot testing indicate that the RO should produce a permeate that is in compliance with these MCLs; a summary of all compounds with an MCL that were detected at least once in the RO permeate is presented in Table 4.4. In this table sMCL and pMCL represent Secondary and Primary Maximum Contaminant Levels.

There are several constituents that have been measured above or close to their MCL in the source waters that were not included in the piloting testing for extended periods (*i.e.,* Blanco Drain, Lake El Estero, Tembladero Slough). However, because the best available treatment technologies are being used, and because high levels of removal in the pilot testing have been achieved, none of these constituents are expected to impact the ability of the AWTF to meet all MCLs.



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

Table 4.4 - Constituents with MCLs detected in RO permeate

^a 13 samples analyzed except for chromium and radium-226 (1 sample), total trihalomethanes (12 samples), turbidity (25 samples), and nitrate and nitrite (26 samples).
^b Odor threshold was measured at 5 units (above the sMCL of 3) on one sample without dechlorination. The high odor threshold is almost surely due to the residual chloramines, and not due to other odorous compounds present in the water.

Bromate is a regulated ozone DBP that was closely monitored during the pilot testing (MCL 10 μ g/L). Bromate formation during ozonation is shown in Figure 4.4, where the highest concentration observed (9 μ g/L) was still below the 10 μ g/L MCL. RO is one of the best available technologies for bromate reduction, and for all samples collected during the



piloting, the RO reduced the product water bromate concentration to below detection (*i.e.*, less than $1 \mu g/L$).



Figure 4.4 – Bromate formation through ozonation and removal through RO treatment

4.2 Unregulated Constituents

4.2.1 Notification Levels and Archived Notification Levels

The only constituent measured in the RO permeate above its DDW NL or DDW AAL was NDMA (see Table 4.5). However, the UV/AOP process is specifically design 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 to insure that the product water 1,4-dioxane concentration will be significantly below the NL (1,4-dioxane log removal will be demonstrated during start-up of the full-scale AWTF).



Constituent	Unit	Limit	Median (Range)	Number of samples analyzed
Boron	mg/L	1 (NL)	0.18 (0.16 – 0.23)	13
Formaldehyde ^a	mg/L	0.1 (NL)	0.049 (0.026 – 0.071)	2
NDMA	ng/L	10 (NL)	27 (20 – 32)	14
N-Nitrosodi-n- Propylamine (NDPA)	ng/L	10 (NL)	<2 (<2 - 2.9)	14
Chloropicrin	μg/L	50 (AAL)	3.5	1
2,3,5,6- Tetrachloroterephthalate (DCPA)	mg/L	3.5 (AAL)	0.0001	1

^a The high formaldehyde concentration was measured with a transferred ozone dose of approximately 18 mg/L, which is higher than the AWTF design transferred ozone dose

4.2.2 CEC Panel

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. 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 AWTF will include UV/AOP, which would be used as 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 GWR pilot system are shown in Figure 4.5.

In three of the seven monthly sampling events, there were a few CECs detected in RO permeate (not including previously discussed NDMA). These compounds included 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 from these compounds was excluded from the analysis. For quinoline (a chemical found in cigarettes) 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, *i.e.*, 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). In other words, it is expected that all of these compounds will be below current detection limits in the UV/AOP effluent.





Figure 4.5 – CEC removal demonstrated during GWR pilot testing, through ozonation and reverse osmosis. Unfilled sections indicate results were below detection limit. All values shown are maximum detected values.



4.2.3 Dissolved solids

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 4.6. 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.

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

Table	4.6 -	Removal	of select	dissolved	s biloz f
Iabic	T .U	numuvai	UI SCICCI	uissoivee	JUIIUS

^a Removals calculated from 13 samples events with the exception of nitrate (12 sampling events)

b Sulfate was measured prior to sulfuric acid addition – removals including sulfate from sulfuric acid would be approximately >99.2 to >99.6%

4.2.4 Suspended solids

Aggregate solid parameters (*i.e.*, TSS and turbidity) and an organic parameter that includes solids bound organics (*i.e.*, TOC) were measured to determine removal through the MF system. Solids removal (*e.g.*, TSS and turbidity removal) in groundwater recharge projects is important for RO pretreatment and to avoid plugging of the aquifer. The median TSS and turbidity measured upstream and downstream of the MF system during piloting are shown in Figure 4.6. These data show that the MF system is a robust system for particle removal, and that it can provide an RO feed water low in turbidity. This solids removal correlated with a statistically significant reduction in the median TOC concentration across the MF process from 14 to 11 mg/L (95% confidence).





Figure 4.6 - Removal of solids through the MF process (median value shown; median MF effluent turbidity is less than the detection limit [0.05 NTU])



5 Conclusions and Recommendations

5.1 Design Conclusions

The following conclusions and recommendation are made based on the piloting results:

5.1.1 Preozonation conclusions and recommendations:

- 1. **Need for Preozonation:** Preozonation improved MF run times by a factor in the range of 4 to 8 by reducing membrane fouling. The reduction in fouling allows for a higher MF design flux, which would reduce the size and cost of the MF system. To realize these benefits, preozonation is recommended.
- 2. Ozone Control: Two ozone dose control methods were successfully demonstrated: (1) constant ozone dose with ORP control, and (2) ozone residual ozone dose control. A third control method, UVT control, may provide the best ozone dose control of the three methods; however, further testing would be required, as the UVT equipment tested during piloting fouled too rapidly for use in a control system. Further testing of the UVT control method is recommended at either the pilot-scale demonstration facility or the full-scale facility to determine the benefits of the UVT control method.
- 3. **Ozone Dose:** An average transferred ozone dose of 9.5 mg/L (10 mg/L applied ozone dose at a transfer efficiency of 95%) provided sufficient preozonation. To provide this level of preozonation, an AWTF average transferred design dose of 9.5 mg/L is recommended. The AWTF maximum and minimum design transferred dose should account for the maximum and minimum design water quality.
- 4. **Secondary Performance and Ozone:** High TOC and nitrite concentrations in the RTP effluent contributed to the preozonation dose. RTP trickling filter operational changes may be able to reduce the nitrite concentration in the secondary effluent, which could reduce operational costs. If the nitrite concentration were reduced, it may be possible to reduce the design ozone dose and/or operational ozone dose.
- 5. **Ozone Disinfection:** Preliminary testing showed that disinfection credit might be possible at transferred ozone doses in the range of 15 to 19 mg/L. These doses led to ozone CTs (residual concentration times contact time) in the range of 1 to 2 mg-min/L.
- 6. **NDMA Formation:** Both pre-chloramination and post-chloramination yielded similar levels of NDMA formation. NDMA formation was about an order of magnitude lower than at West Basin Municipal Water District's Edward C. Little Facility, and it is expected that the NDMA concentration in the final product will be well below the 10 ng/L Notification Level.
- 7. **Bromate Formation:** Acceptable levels of bromate formation were observed through the ozonation process (maximum 9 micrograms per liter [μ g/L], compared to the Maximum Containment Level (MCL) of 10 μ g/L). The bromate formed during ozonation was consistently removed by the downstream RO process to levels below the detection limit (*i.e.*, less than 1 μ g/L for all samples).
- 8. **Biologically Active Filtration:** A biological process (*e.g.,* upflow BAF) downstream of preozonation would improve the product water quality, and possibly improve



AWTF operation by reducing the concentration of organics in ozone-BAF effluent, including TOC, NDMA, and contaminants of emerging concern (CECs, also known as chemical of emerging concern and constituents of emerging concern).

- 9. **High Ozone Doses:** High ozone doses (*e.g.,* an average of 20 mg/L, applied) increased the concentration of TOC and formaldehyde in the RO permeate for the waters tested. These high ozone doses are not recommended on a regular basis for the AWTF, unless a downstream biological process is included downstream of ozone.
- 10. **Impact on RO Validation Testing:** Preozonation interfered with measurements analogous to those required by the Division of Drinking Water (DDW) during RO membrane integrity testing in the first 20 weeks of operation. Due to this interference, the first 20 weeks of AWTF operation will likely have to be conducted without preozonation. Alternatively, it may be possible to develop an alterative RO membrane integrity test with DDW.

5.1.2 Membrane conclusions and recommendations (MF and RO):

- 1. **Technology Selection:** The outside-in MF technology dramatically outperformed the inside-out MF technology during piloting. An outside-in MF membrane technology is recommended for the AWTF.
- 2. **Chloramine Residual:** A chloramine residual (*e.g.*, 2 to 5 mg/L at the RO feed) was important for controlling organic fouling on the MF system. A chloramine residual of 2 to 5 mg/L at the RO feed is recommended at the AWTF.
- 3. **Design Flux:** The outside-in MF membrane filtered for more than 30 days at a flux of 30 GFD, with a constant applied ozone dose of 10 mg/L during the agricultural wash water shunt. An MF design flux of 30 GFD is recommended for the AWTF.
- 4. **MF Fouling and Secondary Performance:** The MF membranes experienced spikes in transmembrane pressure (TMP) associated with short-term episodes of degraded secondary effluent water quality (these spikes in TMP corresponded with higher coagulant needs at the Salinas Valley Reclamation Plant [SVRP]); however, they were able to recover without operational intervention.
- 5. **MF Filtrate Water Quality:** The MF provided suitable RO pretreatment, with 99.8% of the MF effluent turbidity measurements less than 0.05 Nephelometric Turbidity Units (NTU), and all silt density index (SDI) measurements less than 3.
- 6. **RO Membrane Fouling:** At a recovery of 81%, the RO membrane required only one cleaning over a test period of approximately seven months, including extended periods with elevated phosphate concentrations and a high RO feed pH setpoint (*e.g.*, 6.8). Based on this piloting work, a preliminary AWTF design RO recovery of 81% is recommended; however, further modeling is also recommended to ascertain the effect on the RO recovery of the source waters that were not tested during piloting (*e.g.*, the Blanco Drain).
- 7. **Need for Phosphate Control**: Elevated phosphate concentrations in the agricultural wash water may foul the RO membrane if the phosphate is not removed through the RTP, or if the formation of phosphate minerals is not controlled at the RO process (*e.g.*, through acid addition). Phosphate removal in the RTP can be enhanced via the addition of ferric chloride through the chemically



enhanced primary treatment (CEPT) facilities, although an application more specific to the AWTF feed water or the agricultural wash water is recommended for the AWTF if this method of phosphate control is pursued (*e.g.*, adding ferric directly to the agricultural wash water).

- 8. **pH Control:** RO specific flux dropped dramatically when pH adjustment was stopped, and adjustments to pH control affected the RO specific flux (likely due to the formation of calcium phosphate minerals). pH adjustment facilities will be necessary for the AWTF (*e.g.*, sulfuric acid).
- 9. **RO Cleaning:** An acid clean, without the use of detergents, was sufficient to restore RO permeability after scaling developed. Other cleans may be needed during full-scale operation if RO performance is reduced by foulants not observed during piloting (*e.g.*, biological, silica).
- 10. **Effect of Agricultural Wash Water:** The agricultural wash water shunt did not discernibly increase the fouling of the MF or RO membranes under the conditions tested.

5.1.3 UV/AOP conclusions and recommendations:

- 1. **Design UVT water quality:** During pilot testing, the RO permeate UVT was measured at 95% or greater for almost all samples (one sample was measured at 94%, but this is likely due to a high residual chloramine concentration in the RO permeate). Accordingly, a design RO permeate UVT of 95% was assumed for preliminary full-scale UV/AOP design.
- 3. **1,4-dioxane removal:** 1,4-dioxane concentrations were below the detection limit in all RO permeate samples, and it was only detected in 4 of 11 secondary effluent samples (maximum concentration of 1.2 μ g/L in the secondary effluent, whereas the notification level [NL] and the detection limit are both 1 μ g/L). The UV/AOP system will be designed to achieve at least 0.5-log removal of 1,4-dioxane (*i.e.*, 68.4% removal), and thus the concentration of 1,4-dixoxane in the product water is expected to be consistently below the NL. The full-scale AWTF UV/AOP system will be challenge tested (by spiking 1,4-dioxane) during start-up to demonstrate at least 0.5-log removal of 1,4-dioxane.

5.1.4 Water quality conclusions and recommendations:

- 1. **Product Water Quality:** Pilot water quality sampling results indicate that the AWTF product water is expected to meet all applicable regulations in the California Water Recycling Criteria, including the groundwater replenishment regulations for subsurface application, MCLs, NLs, and Archived Advisory Levels (AALs). The RO permeate met all requirements, except for NDMA; the UV/AOP system will be designed to meet the 1,4-dioxane removal criteria and to reduce NDMA by at least 90%, which is expected to reduce the NDMA to an acceptable concentration.
- 2. **CEC Reduction:** Ozone and RO removed all but a few CECs to levels below their detection limits. Of the CECs that were not removed to below their detection limits, all were measured at concentrations well below any limits linked to health concerns and most will be well removed through the UV/AOP system.



- 3. **DBP Formation:** DBPs (*e.g.*, NDMA and bromate) were formed through ozonation and chloramination, but at levels that would be adequately addressed by the combination of RO and AOP. DBPs are not expected to be an issue for the final product water.
- 4. **Additional RO Modeling:** RO modeling that takes into account (a) the blending of all source waters in the RTP collection system, (b) removal of select constituents through the RTP, and (c) removal of selected constituents through upstream AWTF processes is recommended to assess the fouling potential of the source waters.
- 5. **Need for Ozone:** Ozone provides benefits to the water quality, including providing a barrier to many synthetic organic compounds.
- 6. **Need for RO membrane:** RO treatment is needed for removal of several constituents, and is the backbone of the AWTF treatment train.
- 7. **Need for UV/AOP**: AOP is needed to address NDMA and provide an additional barrier against CECs (such as 1,4-dioxane) and pathogens.
- 8. **Source Water Variability:** Based on the source water monitoring program, it is expected that the proposed treatment train will be sufficient to meet all product water quality requirements for all of the proposed source waters.

5.1.5 Other design considerations:

- 7. **Biologically Active Filtration**: While BAF design criteria may be estimated, pilot testing is recommended prior to full-scale implementation to determine site-specific design criteria. Additionally, pilot testing would also be recommended to determine the effect of a BAF system on the performance of the downstream MF system, if the BAF were to be included in the AWTF.
- 8. **UV/AOP impact on organics:** Some UV/AOP systems downstream of RO in water reuse applications increase the concentration of specific organic constituents (*e.g.*, formaldehyde). UV/AOP pilot-scale testing should be considered to quantify the impact of UV/AOP on organics for this water.
- 9. **UV/AOP pathogen and chemical removal:** Chemical (*e.g.*, 1,4-dioxane, NDMA) and pathogen removal varies between water reuse projects. The full-scale AWTF design can account for this variation by selecting conservative design criteria. Alternatively, additional testing (*e.g.*, collimated bench-scale testing) offers a potential for a more aggressive full-scale design (*i.e.*, a less conservative design).
- 10. Additional Source Waters in the RTP collection system: The addition of new source waters to the RTP collection system may impact the RTP and the AWTF design in ways that were not discussed in the Source Water and Pilot Water Quality Report (*e.g.*, nitrite formation, RO recovery)(Trussell Technologies, 2014d). RTP and AWTF modeling and demonstration-scale testing is recommended to reduce uncertainty during AWTF design and start-up.
- 11. Additional Source Waters directly to the AWTF: If any of the new source waters were brought directly to the AWTF, then additional testing would be required to determine if there were additional pre-treatment needs.
- 12. **Long-term MF testing:** Several flux conditions were tested during the piloting; if additional piloting were conducted, it would be beneficial to conduct long-term




testing of the 30 GFD design flux to better characterize seasonal water quality impacts.



6 Reference

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7 Appendix

The following attachments are included in the appendix:

- June Pilot Water Quality Constituent sample frequency table
- Pilot Water Quality Sampling Campaign Summary sheets



Constituents analyzed during reduced sampling events (6/10 through 6/24): M is monthly and W is weekly

Parameter	RTP Raw	Pilot Inf	Ozone Eff.	MF Filtrate	RO Permeate	MF Backwash	RO Conc.
General Water Quality Parameters							
Alkalinity		М		М	М		
Conductivity		М		М	М		
Hardness - Total							
pH							
Temperature							
Total Dissolved Solids (TDS)				М	М		
Total Suspended Solids (TSS)							
Turbidity							
Dissolved Oxygen (DO)							
Oxidation/Reduction Potential (ORP)							
Biochemical Oxygen Demand (BOD)							
Chemical Oxygen Demand (COD)							
Biodegradable dissolved organic carbon (BDOC)							
Dissolved organic carbon (DOC)					***		
Total Organic Carbon (TOC)				W	W		
UV-254 Absorbance				W	W		
Inorganics		147			147		
Nitrata		VV 147			VV 147		
Nitrito		VV 147			VV 147		
Total Violdahl Nitragan (TVN)		VV 147			VV 147		
		vv		м	VV M		
Arconic				M	M		
Parium				M	M		
Baron				M	M		
Bromido				M	M		
Calcium				M	M		
Chloride				M	M		
Cvanide				M	M		
Fluoride				M	M		
Iron				М	М		
Magnesium				М	М		
Manganese				М	М		
Mercury				М	М		
Molybdenum				М	М		
Nickel				М	М		
Phosphate (orthophosphate)				М	М		
Potassium				М	М		
Selenium				М	Μ		
Silica				М	Μ		
Sodium				М	Μ		
Strontium				М	Μ		
Sulfate				М	М		
Sulfide				М	М		
DBPs							
Total THMs and HAAs							
Bromate							
Nitrosamines		М	М	М	М		
Microbiological Parameters					147		
rutar contorni and <i>E. coll</i>					vv		
Synthetic Organic Contaminants		м	м		м		
CECs (See Table 8)		1*1	1•1		141		
1.4-Dioxane							
Select pesticides (EPA 505 and 525.2)							





Sampling Constituent	Contaminant	Analytical		waa	Pilot Influ (Secondary E	ent ffluent)	Ozone Effl	uent	MF Efflu	ent	RO Perm	eate	RO Concen	trate
Sampling Constituent	List	Method	Units	MCL/NL	Median (Range)	Detected / Measured	Median (Range)	Detected / Measured	Median (Range)	Detected / Measured	Median (Range)	Detected / Measured	Median (Range)	Detected / Measured
General Water Quality Paramete	rs													
Alkalinity		SM 2330B	mg/L as CaCO ₂		306 (260-342)	13 / 13			298 (257-344)	13 / 13	10 (8-26)	13 / 13	875 (402-1289)	12 / 12
Ammonia		SM 4500NH3F,G	mg/L as N		32.1 (25.5-45.1)	26 / 26	29.9 (22.5-41.1)	12 / 12	29.5 (22.4-41.5)	12 / 12	1.4 (0.9-2.1)	26 / 26	125 (122-177)	6/6
Biochemical Oxygen Demand, 5-day @ 20°C (BOD)		SM 5210B	mg/L	-	91 (52-119)	12 / 12	32 (7-116)	12 / 12	11 (<2-104)	11 / 12	<2 (<2-4)	3 / 12	22 (11-226)	7/7
Bromide		EPA 300.0	mg/L		0.2 (0.1-0.3)	12 / 12	0.2 (0.1-0.2)	12 / 12	0.2 (0.1-0.2)	13 / 13	<0.1	0 / 13	0.6 (0.5-1.2)	6/6
Calcium		EPA 200.7	mg/L		58 (51-65)	9/9			58 (56-71)	13 / 13	<0.5 (<0.5-1)	1 / 13	254 (234-291)	11 / 11
Chemical Oxygen Demand (COD)		EPA 410.4/Hach 8000	mg/L		95 (36-174)	12 / 12	79 (22-134)	12 / 12	73 (1-111)	12 / 12	3.5 (<2-6)	1 / 12	259 (<10-462)	11 / 12
Chloride	sMCL	EPA 300.0	mg/L	250	230 (203-266)	3/3			234 (134-266)	13 / 13	3 (<1-6)	12 / 13	1007 (962-1030)	6/6
Color	sMCL	SM 2120B	units	15							<3	0 / 1		
Conductivity (Specific Conductance)	sMCL	SM 2510B	µS/cm	900	1608 (1490-1717)	13 / 13			1630 (1543-1763)	13 / 13	38 (32-46)	13 / 13	6250 (5580-7200)	12 / 12
Copper	sMCL, EPA PP	EPA 200.8	mg/L	1.3/1.0					· · · · ·		<0.004	0 / 1		
Dissolved organic carbon (DOC)		SM 5310C	mg/L		13 (11-14)	6/6	14 (13-16)	6/6					<3	0 / 1
Biodegradable Disssolved Organic Carbon		Allgeier, 1996	mg/L		<3	0/6	<6 (<6- 6.4)	1/6			0.46 (<0.3-1)	5/6	<15	0/6
Dissolved oxygen (DO)		Field/SM4500-O	mg/L		4.89 (3.82-6.2)	20 / 20	>20 (15.7-38)	17 / 23						
Foaming Agents (MBAS)	sMCL	SM 5540C	mg/L	0.5							<0.05	0 / 1		
Iron	sMCL	EPA 200.7	mg/L	0.3	0.378 (0.157-0.931)	12 / 12			0.055 (0.042-0.082)	13 / 13	<0.01	0 / 13	0.25 (0.183-0.3)	6/6
Magnesium		EPA 200.7	mg/L		22 (10-26)	11 / 11			22 (20-28)	13 / 13	<0.5	0 / 13	100 (89-125)	11 / 11
Manganese	sMCL, NL	EPA 200.8	mg/L	0.5/0.5	0.052 (0.043-0.078)	12 / 12			0.04 (0.032-0.052)	13 / 13	<0.01 (<0.01 -0.01)	1 / 13	0.163 (0.15-0.206)	6/6
Nitrate	pMCL	EPA 300.0	mg/L as NO₃	45	19.9 (<1-47.0)	25 / 26	25.9 (5.8-55)	12 / 12	26.7 (5.3-57.0)	12 / 12	<1 (<1 -3.1)	17 / 26	118 (39-238)	6/6
Nitrite	pMCL	EPA 300.0	mg-N/L	1	1.3 (0.6-2.8)	26 / 26	<0.1 (<0.1 -0.3)	9 / 25	<0.1 (<0.1 -0.2)	3 / 12	<0.1 (<0.1 -0.4)	20 / 26	<0.1	0/6
Nitrate+Nitrite		EPA 300.0	mg-N/L		5.6 (0.8-12.1)	26 / 26	7 (1.5-12.4)	11 / 11	7.4 (1.4-13.7)	12 / 12	0.6 (0.1-1.6)	23 / 23	46.5 (8.9-60.7)	5/5
Odor-Threshold	sMCL	SM 2150B	units	3							5	1/1		
Oxidation Reduction Potential (ORP)		Field	mV		270	1/1	343 (162-394)	13 / 13	321 (256-448)	13 / 13	586 (402-645)	12 / 12		
pH (field)		Field	pН		7.24 (7.16-7.38)	7/7	7	1/1	7.31 (7.28-7.43)	9/9	5.22 (5.04-6.05)	9/9	6.92 (6.6-7.58)	8/8
pH (laboratory)		SM 2330B/SM4500H+ B	pН		7.51 (7.42-7.8)	3/3	6.88	1/1	7.5 (6.9-7.7)	12 / 12	5.6 (5.3-6.87)	11 / 11	7.2 (6.8-7.6)	9/9
Phosphate		EPA 300.0	mg/L as P		3.05 (0.3-14.0)	12 / 12			3.1 (1.63-14.00)	13 / 13	<0.1 (<0.1 -0.1)	1 / 13	13.2 (11.4-22.2)	6/6
Potassium		EPA 200.7	mg/L		20 (19-21)	3/3			22 (19-24)	13 / 13	0.6 (<0.5 -3.2)	12 / 13	98 (82-112)	6/6
Silica		EPA 200.7	mg/L		39 (38-40)	3/3			41 (38-45)	13 / 13	<0.5 (<0.5 -1)	4 / 13	175 (167-191)	6/6
Silver	sMCL, EPA PP	EPA 200.8	mg/L	0.1	• •						<0.01	0/1		
Sodium		EPA 200.7	mg/L		152 (149-173)	3/3			178 (129-199)	13 / 13	5 (4-6)	13 / 13	744 (532-880)	6/6
Sulfate	sMCL	EPA 300.0	mg/L	250	90 (84-94)	3/3			92 (88-103)	13 / 13	<1 (<1 -1)	1 / 13	918 (619-1098)	6/6

	Contaminant	Analytical		waa	Pilot Influ (Secondary E	ent ffluent)	Ozone Effle	uent	MF Efflu	ent	RO Perme	eate	RO Concen	trate
Sampling Constituent	List	Method	Units	MCL/NL	Median (Range)	Detected / Measured	Median (Range)	Detected / Measured	Median (Range)	Detected / Measured	Median (Range)	Detected / Measured	Median (Range)	Detected / Measured
Sulfide		SM4500SD	mg/L						<0.05 (<0.05- 0.063)	1 / 13	<0.05	0 / 13	<0.05	0/6
Temperature		Field/SM 2550B	°C		21.6 (9.9-23.5)	15 / 15	19.9 (18.6-21.4)	3/3	20.6 (19.4-22.5)	3/3	22.2 (19.9-24.2)	15 / 15	21.6 (20.6-22.5)	2/2
Total Dissolved Solids (TDS)	sMCL	EPA 160.1/SM 2540C	mg/L	500	808 (757-897)	12 / 12	(1010 2 11 1)		828 (794-931)	13 / 13	<10 (<10-26)	4 / 13	3797 (3230-4766)	12 / 12
Total Hardness		SM 2340B	mg/L as		235	12 / 12			239 (232-293)	12 / 12	<10 (<10 -2)	1/4	1070	12 / 12
Total Kjeldahl Nitrogen (TKN)		EPA 351.2/SM 4500B C	mg/L		33.4	26 / 26	32 (25 5-42 8)	12 / 12	30.9 (20 1-42 1)	12 / 12	1.7	26 / 26	133 (121-177)	6/6
Total Nitrogen		calculation	mg/L		40.9	26 / 26	40.8	11 / 11	37.9	12 / 12	2.1	25 / 25	171.7	6/6
Total Organic Carbon (TOC)		SM 5310C	mg/L		14 (12-18)	25 / 25	14 (12-16)	25 / 25	11 (10-13)	28 / 28	0.34	33 / 33	52 (46-55)	11 / 11
Total Phosphorus as P		SM 4500-PE/EPA 365 1	mg/L		(12 10)		(12.10)		(10 10)		<0.02	0 / 1	(10 00)	
Dissolved Phosphorus		SM 4500-PE/EPA 365 1	mg/L								<0.02	0 / 1		
Total Suspended Solids (TSS)		SM 2540D	mg/L		5.5 (<2-9)	11 / 12	4 (2-10)	12 / 12	<2	0 / 12	<2	0 / 1		
Turbidity	sMCL	EPA 180.1	NTU	5	2.9 (1.6-5.7)	25 / 25	2.8 (1.2-4.7)	25 / 25	<0.05 (<0.05- 0.1)	20 / 25	<0.05 (<0.05- 0.1)	2 / 25	0.2 (0.1-6.2)	25 / 25
UV-254 Absorbance		SM 5910	cm ⁻¹		0.204	25 / 25	0.14	25 / 25	0.131	26 / 26	0.012	26 / 26	0.541	12 / 12
UV Transmittance		calculation	%		63% (59%-67%)	25 / 25	72% (64%-78%)	25 / 25	74% (67%-79%)	26 / 26	97% (94%-99%)	26 / 26	29% (19%-59%)	12 / 12
Zinc	sMCL, EPA PP	EPA 200.8	mg/L	5							<0.01	0 / 1		
Microbiological Quality														
Cryptosporidium		EPA 1623	oocysts/L	TT	0.35 (<0.09-0.9)	4 / 6	2.7 (0.3-23.3)	6/6	<0.09	0/6				
Giardia		EPA 1623	cysts/L	-	0.15 (<0.09-1.1)	3/6	0.2 (<0.09-4.4)	4 / 6	<0.09	0/6				
Total coliform ¹	pMCL	SM 9223B	MPN/100 mL	TT	2.8x10 ⁵ (2.4x10 ³ -1.6x10 ⁶)	21 / 22	6.3x10 ² (5.5x10 ¹ -3.1x10 ³)	22 / 25	<1	0 / 25	<1	0 / 26		
E. coli ¹	pMCL	SM 9223B	MPN/100 mL	TT	6.0x10 ⁴ (4.9x10 ² -3.3x10⁵)	22 / 22	2.7x10 ¹ (<1-5.5x10 ²)	20 / 25	<1	0 / 25	<1	0 / 26		
DDW Drinking Water Maximum (Contaminant Le	vels (MCLs) - pri	mary MCL	s (pMCLs)	and secondary M	CLs (sMCI	_s)							
MCLs - Inorganics														
Aluminum	pMCL, sMCL,	EPA 200.8	mg/L	1/0.2	0.078	3/3			<0.01 (<0.01-0.105)	6 / 13	<0.01 (<0.01 -0.045)	2 / 13	0.047	6/6
Antimony	pMCL, EPA PP	EPA 200.8	mg/L	0.006	(0.02 1 0.1 0)				(0.0 / 0.100)		< 0.001	0 / 1	(0.011 0.000)	
Arsenic	pMCL, EPA PP	EPA 200.8	mg/L	0.01	0.003 (0.002-0.045)	12 / 12			0.003 (0.002-0.003)	13 / 13	<0.001 (<0.001- 0.002)	7 / 13	0.009 (0.008-0.012)	6/6
Asbestos	pMCL, EPA PP	EPA 100.2	MFL	7							<0.2	0/1		
Barium	pMCL	EPA 200.8	mg/L	1	0.011 (0.003-0.029)	3/3			<0.01 (<0.01- 0.04)	1 / 13	<0.01	0 / 13	0.033 (0.017-0.039)	6/6
Beryllium	pMCL, EPA PP	EPA 200.8	mg/L	0.004							<0.001	0 / 1		
Cadmium	pMCL, EPA PP	EPA 200.8	mg/L	0.005							<0.0005	0 / 1		
Chromium	pMCL, EPA PP, UCMR 3	EPA 200.8	mg/L	0.05							0.005	1/1		
Cyanide	pMCL, EPA PP	SM 4500CN-F	mg/L	0.15	0.022 (<0.005-0.054)	10 / 12			0.014 (<0.005-0.095)	11 / 13	<0.005 (<0.005 -0.007)	2 / 13	0.056 (0.006-0.143)	6/6
Fluoride	pMCL	SM 4500F-C/EPA 300.0	mg/L	2	0.6 (0.5-0.8)	3/3			0.8 (0.6-1.1)	13 / 13	<0.1 (<0.1 -0.2)	1 / 13	3.5 (3.1-3.8)	6/6
Mercury	pMCL, EPA PP	EPA 245.1	mg/L	0.002	<0.0002	0 / 1			<0.0002	0 / 13	<0.0002	0 / 13	0.00034	5/6

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	Contaminant	Analytical	11-24-	DDW	Pilot Influ (Secondary E	ient :ffluent)	Ozone Effi	uent	MF Efflu	ient	RO Perm	eate	RO Concer	itrate
Sampling Constituent	List	Method	Units	MCL/NL	Median (Range)	Detected / Measured	Median (Range)	Detected / Measured	Median (Range)	Detected / Measured	Median (Range)	Detected / Measured	Median (Range)	Detected / Measured
Nickel	pMCL, EPA PP	EPA 200.8	mg/L	0.1	<0.01	0/3			<0.01	0 / 13	<0.01	0 / 13	0.0205 (0.016-0.023)	6/6
Perchlorate	pMCL, UCMR 1	EPA 314	mg/L	0.006							<0.002	0/1		
Selenium	pMCL, EPA PP	EPA 200.8	mg/L	0.1	0.003	3/3			0.004	13 / 13	<0.002 (<0.002 -0.01)	7 / 13	0.013 (0.01-0.017)	6/6
Thallium	pMCL, EPA PP	EPA 200.8	mg/L	0.002	()				()		<0.001	0/1	(0.01 0.011)	
MCLs - Volatile Organic Chemic	als (VOCs)			•			•				•	·		
1,1-Dichloroethane	pMCL, EPA PP, UCMR 3	EPA 524.2	mg/L	0.005							<0.0005	0/1		
1,1-Dichloroethylene	pMCL, EPA PP	EPA 524.2	mg/L	0.006							<0.0005	0/1		
1,1,1-Trichloroethane	pMCL, EPA PP	EPA 524.2	mg/L	0.2							<0.0005	0/1		
1,1,2-Trichloro-1,2,2-Trifluoroethane (Freon 113)	pMCL	EPA 524.2	mg/L	1.2							<0.0005	0 / 1		
1,1,2-Trichloroethane	pMCL, EPA PP	EPA 524.2	mg/L	0.005							<0.0005	0/1		
1,1,2,2-Tetrachloroethane	pMCL, EPA PP	EPA 524.2	mg/L	0.001							<0.0005	0/1		
1,2-Dichlorobenzene	pMCL, EPA PP	EPA 524.2	mg/L	0.6							<0.0005	0/1		
1,2-Dichloroethane	pMCL, EPA PP	EPA 524.2	mg/L	0.005							<0.0005	0/1		
1,2-Dichloropropane	pMCL, EPA PP	EPA 524.2	mg/L	0.005							<0.0005	0/1		
1,2,4-Trichlorobenzene	pMCL, EPA PP	EPA 524.2	mg/L	0.005							<0.0005	0/1		
1,3-Dichloropropene	pMCL, PoLI, EPA PP	EPA 524.2	mg/L	0.0005							<0.0005	0 / 1		
1,4-Dichlorobenzene	pMCL, EPA PP	EPA 524.2	mg/L	0.005							<0.0005	0/1		
Benzene	pMCL, EPA PP	EPA 524.2	mg/L	0.001							<0.0005	0/1		
Carbon Tetrachloride	pMCL, EPA PP	EPA 524.2	mg/L	0.0005							<0.0005	0/1		
cis-1,2-Dichloroethylene	pMCL	EPA 524.2	mg/L	0.006							<0.0005	0/1		
Dichloromethane	pMCL, EPA PP	EPA 524.2	mg/L	0.005							<0.0005	0/1		
Ethylbenzene	pMCL, EPA PP	EPA 524.2	mg/L	0.3							<0.0005	0/1		
Methyl-tert-butyl ether (MTBE)	pMCL, sMCL, UCMR 1	EPA 524.2	mg/L	0.013/0.005							<0.0005	0 / 1		
Monochlorobenzene	pMCL	EPA 524.2	mg/L	0.07							<0.0005	0/1		
Styrene	pMCL	EPA 524.2	mg/L	0.1							<0.0005	0/1		
Tetrachloroethylene	pMCL, EPA PP	EPA 524.2	mg/L	0.005							<0.0005	0/1		
Toluene	pMCL, EPA PP	EPA 524.2	mg/L	0.15							<0.0005	0/1		
trans-1,2-Dichloroethylene	pMCL	EPA 524.2	mg/L	0.01							<0.0005	0/1		
Trichloroethylene	pMCL, EPA PP	EPA 524.2	mg/L	0.005							<0.0005	0/1		
Trichlorofluoromethane	pMCL	EPA 524.2	mg/L	0.15							<0.0005	0 / 1		
Vinyl Chloride	pMCL, EPA PP	EPA 524.2	mg/L	0.0005							<0.0003	0/1		
Xylenes	pMCL	EPA 524.2	mg/L	1.75							<0.0005	0/1		
MCLs - Non-Volatile Synthetic C	Organic Chemica	ls (SOCs)	<u>.</u>											
2,4-D	pMCL	EPA 515.4	mg/L	0.07							<0.0001	0 / 1		
Alachlor	pMCL, UCMR 2	EPA 505	mg/L	0.002	<0.0001	0/6	<0.0001	0/6			<0.0001	0/6	<0.0001	0/6
Atrazine	pMCL	EPA 525.2	mg/L	0.001	<0.00005	0/6	<0.00005	0 / 6			<0.00005	0/6	<0.00005	0 / 6
Bentazon	pMCL	EPA 515.4	mg/L	0.018							<0.0005	0/1		
Benzo(a)pyrene	pMCL, EPA PP	EPA 525.2	mg/L	0.0002	<0.005	0/6	<0.00002	0 / 6			<0.00002	0/6	<0.00002	0/6
Carbofuran	pMCL	EPA 531.2	mg/L	0.018							<0.0005	0/1		
Chlordane	pMCL, EPA PP	EPA 505	mg/L	0.0001	<0.0001	0/6	<0.0001	0/6			<0.0001	0/6	<0.0001	0/6
Dalapon	pMCL	EPA 515.4	mg/L	0.2							<0.001	0/1		
Di(2-ethylhexyl)adipate	pMCL	EPA 525.2	mg/L	0.4	<0.0006	0/6	<0.0006	0 / 6			<0.0006	0/6	<0.0006	0/6
Di(2-ethylhexyl)phthalate	pMCL, EPA PP	EPA 525.2	mg/L	0.004	0.0012 (<0.0006-0.078)	5/6	0.00082 (<0.0006-0.0014)	5/6			<0.0006	0 / 6	<0.0006	0/6
Di(2-ethylhexyl)phthalate	pMCL, EPA PP	EPA 8720C	mg/L	0.004							<0.004	0/1		

	Contaminant	Analytical	11-24-	DDW	Pilot Influ (Secondary E	ient :ffluent)	Ozone Effi	uent	MF Efflu	ent	RO Perme	eate	RO Concen	trate
Sampling Constituent	List	Method	Units	MCL/NL	Median (Range)	Detected / Measured	Median (Range)	Detected / Measured	Median (Range)	Detected / Measured	Median (Range)	Detected / Measured	Median (Range)	Detected / Measured
Dibromochloropropane	pMCL	EPA 551.1	mg/L	0.0002							<0.00001	0/1		
Dinoseb	pMCL	EPA 515.4	mg/L	0.007							<0.0002	0/1		
Diquat	pMCL, PoLI	EPA 549.2	mg/L	0.02							<0.0004	0/1		
Endothall	pMCL	EPA 548.1	mg/L	0.1							<0.005	0/1		
Endrin	pMCL	EPA 505	mg/L	0.002	<0.00001	0/6	<0.00001	0/6			<0.00001	0/6	<0.00001	0/6
Ethylene Dibromide	pMCL	EPA 551.1	mg/L	0.00005							<0.00001	0/1		
Glyphosate	pMCL, PoLI	EPA 547	mg/L	0.7							<0.006	0/1		
Heptachlor	pMCL, EPA PP	EPA 505	mg/L	0.00001	<0.00001	0/6	<0.00001	0/6			<0.00001	0/6	<0.00001	0/6
Heptachlor Epoxide	pMCL, EPA PP	EPA 505	mg/L	0.00001	<0.00001	0/6	<0.00001	0/6			<0.00001	0/6	<0.00001	0/6
Hexachlorobenzene	pMCL	EPA 525.2	mg/L	0.001	<0.00005	0/6	<0.00005	0/6			<0.00005	0/6	<0.00005	0/6
Hexachlorocyclopentadiene	pMCL	EPA 525.2	mg/L	0.05	<0.00005	0/6	<0.00005	0/6			<0.00005	0/6	<0.00005	0/6
Lindane	pMCL, PoLI	EPA 505	mg/L	0.0002	<0.00001	0/6	<0.00001	0/6			<0.00001	0/6	<0.00001	0/6
Methoxychlor	pMCL	EPA 505	mg/L	0.03	<0.00005	0/6	<0.00005	0/6			<0.00005	0/6	<0.00005	0/6
Molinate	pMCL, UCMR 1	EPA 525.2	mg/L	0.02	<0.0001	0/6	<0.0001	0/6			<0.0001	0/6	<0.0001	0/6
Oxamyl	pMCL, PoLI	EPA 531.2	mg/L	0.05							<0.001	0/1		
Pentachlorophenol	pMCL. EPA PP	EPA 525.2	ma/L	0.001	<0.00004	0/6	<0.001	0/6			<0.001	0/6	<0.001	0/6
Picloram	pMCL	EPA 515.4	ma/L	0.001							< 0.0001	0/1		
Polychlorinated Biphenyls	pMCL	EPA 505	ma/L	0.0005	<0.0001	0/6	<0.0001	0/6			<0.0001	0/6	<0.0001	0/6
Simazine	pMCL. PoLI	EPA 525.2	ma/L	0.004	<0.00005	0/6	<0.00005	0/6			<0.00005	0/6	<0.00005	0/6
Thiobencarb	pMCL, sMCL,	EPA 525.2	mg/L	0.07/0.001	<0.0002	0/6	<0.0002	0/6			<0.0002	0/6	<0.0002	0/6
Toxaphene	pMCL. EPA PP	EPA 505	ma/L	0.003	<0.0005	0/6	<0.0005	0/6			<0.0005	0/6	<0.0005	0/6
2.3.7.8-TCDD (Dioxin)	pMCL, EPA PP	EPA 1613	ma/L	3.00E-08							<1.96E-9	0/1		
2.4.5-TP (Silvex)	pMCL	EPA 515.4	ma/L	0.05							<0.0002	0/1		
MCLs - Radionuclides														
Gross Alpha Particle (excluding radon and uranium)	pMCL	EPA 900.0	pCi/L	15							3	1/1		
Beta/photon emitters (K40 adjusted)	pMCL	EPA 900.0	pCi/L	50							< 2.51	0/1		
Radium-226	pMCL	EPA 903.1	pCi/L	5 (Combined)							0.298±0.327	1/1		
Radium-228	pMCL	EPA 904.0	pCi/L	(,							<0.78±0.395	0/1		
Strontium-90	pMCL	EPA 905.0	pCi/L	8							<0.589±0.268	0/1		
Tritium	pMCL	EPA 906.0	pCi/L	20,000							<216±125	0/1		
MCLs - Disinfection By-Product	s (DPBs)				-		•							
Total trihalomethanes (TTHM)	pMCL	EPA 551.1	mg/L	0.08	0.00053 (<0.0005-0.002)	7 / 12					0.0019 (0.00068-0.005)	12 / 12	0.012 (0.0037-0.039)	6/6
Total Haloacetic acids (HAAs)	pMCL	SM6251B	mg/L	0.06	0.0042 (<0.002-0.0089)	10 / 12					<0.002	0 / 12	0.094 (0.063-0.11)	6/6
Trichloroacetic acid	-	SM6251B	mg/L		0.0037 (0.0013-0.0069)	12 / 12					<0.001	0 / 12	0.025 (0.012-0.036)	6/6
Dichloroacetic acid	-	SM6251B	mg/L		<0.001 (<0.001- 0.002)	3 / 12					<0.001	0 / 12	0.044 (0.026-0.058)	6/6
Bromate	pMCL	EPA 317	mg/L	0.01	<0.001	0 / 12	0.0034 (<0.001-0.009)	9 / 12			<0.001	0 / 12	0.0053 (<0.001-0.011)	4/6
Chlorite	pMCL	EPA 300.1	mg/L	1							<0.01	0/1		
DDW Drinking Water Notificatio	n Levels (NLs)													
Boron	NL	EPA 200.7	mg/L	1	0.29 (0.29-0.3)	3/3			0.29 (0.27-0.38)	13 / 13	0.18 (0.16-0.23)	13 / 13	0.63 (0.58-0.87)	6/6
n-Butylbenzene	NL	EPA 524.2	mg/L	0.26							<0.0005	0/1		
sec-Butylbenzene	NL, EPA CCL	EPA 524.2	mg/L	0.26							<0.0005	0/1		
tert-Butylbenzene	NL	EPA 524.2	mg/L	0.26							<0.0005	0/1		

	Contaminant	Analytical	11-24-	DDW	Pilot Influ (Secondary E	ient (ffluent)	Ozone Effl	uent	MF Efflu	ient	RO Perme	eate	RO Concen	trate
Sampling Constituent	List	Method	Units	MCL/NL	Median (Range)	Detected / Measured	Median (Range)	Detected / Measured	Median (Range)	Detected / Measured	Median (Range)	Detected / Measured	Median (Range)	Detected / Measured
Carbon disulfide	NL	EPA 524.2	mg/L	0.16							<0.0005	0/1		
2-Chlorotoluene	NL	EPA 524.2	mg/L	0.14							<0.0005	0/1		
4-Chlorotoluene	NL	EPA 524.2	mg/L	0.14							<0.0005	0/1		
Diazinon	NL, UCMR 1, PoLI	EPA 525.2	mg/L	0.0012	<0.0001	0/6	<0.0001	0/6			<0.0001	0/6	<0.0001	0/6
Dichlorodifluoromethane (Freon 12)	NL	EPA 524.2	mg/L	1	<0.0005	0/1								
1,4-Dioxane	NL, UCMR 3	EPA 522	mg/L	0.001	<0.001	0/1	<0.001	0/6			<0.001	0/6	0.0032 (0.0029-0.0042)	6/6
Ethylene glycol	NL	EPA 8270C	mg/L	14							<0.04	0/1		
Formaldehyde	NL, EPA CCL	EPA 556	mg/L	0.1							0.026	1/1		
HMX (or Octogen)	NL	LC-MS-MS	mg/L	0.35							<0.0001	0/1		
Isopropylbenzene	NL	EPA 524.2	mg/L	0.77							<0.0005	0/1		
Methyl isobutyl ketone (MIBK)	NL	EPA 524.2	mg/L	0.12							<0.005	0/1		
Naphthalene	NL	EPA 524.2	mg/L	0.017							<0.0005	0/1		
N-Nitrosodiethyamine (NDEA)	NL, UCMR 2	EPA 521	ng/L	10	2.3 (<2-4.4)	8 / 10	<2 (<2- 2.7)	4 / 14	<2 (<2- 3)	5 / 14	<2	0 / 14	5.4 (<2-7.1)	4/6
N-Nitrosodimethylamine (NDMA)	NL, EPA PP, UCMR 2	EPA 521	ng/L	10	8.1 (4.1-17)	11 / 11	41 (27-60)	14 / 14	49 (34-77)	14 / 14	27 (20-32)	14 / 14	120 (84-150)	6/6
N-Nitrosodi-n-propylamine (NDPA)	NL, EPA PP, UCMR 2	EPA 521	ng/L	10	<2 (<2 -76)	3 / 10	<2 (<2 -66)	4 / 14	<2 (<2 -78)	6 / 14	<2 (<2 -2.9)	1 / 14	<2 (<2 -19)	2/6
Propachlor	NL	EPA 525.2	mg/L	0.09	<0.00005	0/6	<0.00005	0/6			<0.00005	0/6	<0.00005	0/6
n-Propylbenzene	NL	EPA 524.2	mg/L	0.26							<0.0005	0/1		
RDX (Hexahydro-1,3,5-trinitro-1,3,5-tr	NL, UCMR 1&2	LC-MS-MS	mg/L	0.0003							<0.0001	0/1		
Tertiary butyl alcohol (TBA)	NL	EPA 524.2m	mg/L	0.012							<0.002	0/1		
1,2,3-Trichloropropane (1,2,3-TCP)	NL	EPA 524.2m	mg/L	5.00E-06							<0.0005	0/1		
1,2,4-Trimethylbenzene	NL, EPA PP	EPA 524.2	mg/L	0.33							<0.0005	0/1		
1,3,5-Trimethylbenzene	NL	EPA 524.2	mg/L	0.33							<0.0005	0/1		
2,4,6-Trinitrotoluene (TNT)	NL, UCMR 2	LC-MS-MS	mg/L	0.001							<0.0001	0/1		
DDW Drinking Water Archived A	dvisory Levels	(aNLs)												
Aldicarb	aNL	EPA 531.2	mg/L	0.007							<0.0005	0 / 1		
Aldrin	aNL	EPA 505	mg/L	0.000002	<0.00001	0/6	<0.00001	0/6			<0.00001	0/6	<0.00001	0/6
Baygon	aNL	EPA 531.2	mg/L	0.03							<0.0005	0 / 1		
alpha-BHC	aNL	EPA 8081A	mg/L	0.01*/ 0.000015							<0.00005	0 / 1		
beta-BHC	aNL	EPA 8081A	mg/L	0.05*/ 0.000025							<0.00005	0 / 1		
Captan	NL, EPA CCL, Pol	EPA 8081/8082	mg/L	0.015							<0.00005	0/1		
Carbaryl	aNL, PoLI	EPA 531.2	mg/L	0.7							<0.0005	0/1		
Chloropicrin	aNL, PoLI	EPA 551.1	mg/L	0.05							0.0035	1/1		
Chloropropham (CIPC)	aNL	EPA 8321	mg/L	1.2							<0.002	0/1		
1,3-Dichlorobenzene	aNL	EPA 8270C	mg/L	0.6							<0.005	0/1		
Dieldrin	aNL, EPA PP	EPA 525.2	mg/L	0.000002	<0.0002	0/6	<0.00001	0/6			<0.0002	0/6	<0.0002	0/6
Dieldrin	EPA PP, aNL	EPA 505	mg/L	0.000002	<0.00001	0/6	<0.0001	0/6			<0.00001	0/6	<0.00001	0/6
Dimethoate	aNL, UCMR 2, PoLI	EPA 525.2	mg/L	0.001	<0.0001	0/6	<0.0001	0/6			<0.0001	0/6	<0.0001	0/6
2,4-Dimethylphenol	aNL, EPA PP	EPA 8270C	mg/L	0.1							<0.005	0/1		
Diphenamide	aNL	EPA 8141	mg/L	0.2							<0.0001	0/1		
Ethion	aNL	EPA 8141	mg/L	0.004							<0.0001	0/1		
Malathion	aNL, PoLI	EPA 525.2	mg/L	0.16	<0.0001	0/6	<0.0001	0/6			<0.0001	0/6	<0.0001	0/6
Methylisothiocyanate	aNL	EPA 131	mg/L	0.19							<0.001	0/1		
Methyl parathion	aNL	EPA 8141	mg/L	0.002							<0.0001	0/1		

	Contaminant	Analytical		DDW	Pilot Influ (Secondary E	ent ffluent)	Ozone Effl	uent	MF Efflu	ent	RO Perm	eate	RO Concen	trate
Sampling Constituent	List	Method	Units	MCL/NL	Median (Range)	Detected / Measured	Median (Range)	Detected / Measured	Median (Range)	Detected / Measured	Median (Range)	Detected / Measured	Median (Range)	Detected / Measured
Parathion	aNL	EPA 525.2	mg/L	0.04	<0.0001	0/6	<0.0001	0/6			<0.0001	0/6	<0.0001	0/6
Pentachloronitrobenzene	aNL	EPA 8270C	mg/L	0.02							<0.01	0 / 1		
Phenol	aNL, EPA PP	EPA 8270C	mg/L	4.2							<0.005	0/1		
2,3,5,6-Tetrachloroterephthalate (DCF	aNL	EPA 515.4	mg/L	3.5							0.0001	1/1		
Trithion	aNL	EPA 8081/8082	mg/L	0.007							< 0.00005	0 / 1		
EPA Unregulated Contaminant N	Ionitoring Rule	(UCMR) Lists 1 t	hrough 3											
Acetochlor	UCMR 1&2	EPA 525.2	µg/L		<0.1	0/6	<0.1	0/6			<0.1	0/6	<0.1	0/6
EPTC	UCMR 1, PoLI	EPA 525.2	µg/L		<0.1	0/6	<0.1	0 / 6			<0.1	0/6	<0.1	0/6
Metolachlor	UCMR 2	EPA 525.2	µg/L		<0.05	0/6	<0.05	0/6			<0.05	0/6	<0.05	0/6
Molybdenum	UCMR 3	EPA 200.8	µg/L		58 (5-110)	2 / 2			6 (4-13)	13 / 13	<1	0 / 13	23 (20-59)	6/6
N-nitroso-di-n-butylamine (NDBA)	UCMR 2	EPA 521	ng/L		2.7 (<2-6.7)	5 / 10	<4 (<4- 9.4)	4 / 14	<4 (<4- 4.2)	4 / 14	<4 (<4- 3.1)	1 / 14	<4 (<4 -4.7)	2 / 6
N-nitroso-methylethylamine (NMEA)	UCMR 2	EPA 521	ng/L		<2	0 / 10	<2	0 / 14	<2	0 / 14	<2	0 / 14	<2 (<2 -3)	1/6
N-Nitrosopyrrolidine (NPYR)	UCMR 2	EPA 521	ng/L		<2 (<2 -2.7)	4 / 10	<2 (<2 -3.3)	7 / 14	2.4 (<2-3.6)	10 / 14	<2	0 / 14	2.7 (<2-6.3)	4 / 6
Strontium	UCMR 3	EPA 200.8	µg/L		378 (360-396)	2/2			356 (318-426)	13 / 13	<5 (<5 -3)	4 / 13	1557 (1452-1710)	6/6
Terbacil	UCMR 1	EPA 525.2	µg/L		<0.1	0/6	<0.1	0 / 6			<0.1	0/6	<0.1	0/6
EPA Clean Water Act Priority Po	llutants (PPs)													
2,4-dinitrotoluene	EPA PP, UCMR 1	EPA 525.2	µg/L		<0.1	0/6	<0.1	0/6			<0.1	0/6	<0.1	0 / 6
2,6-dinitrotoluene	EPA PP, UCMR 1	EPA 525.2	µg/L		<0.1	0/6	<0.1	0/6			<0.1	0/6	<0.1	0/6
4,4-DDD	EPA PP	EPA 525.2	µg/L		<0.1	0/6	<0.1	0 / 6			<0.1	0/6	<0.1	0/6
4,4-DDE	EPA PP, UCMR 1	EPA 525.2	µg/L		<0.1 (<0.1 -0.021)	1/6	<0.1	0/6			<0.1	0/6	<0.1	0/6
4,4-DDT	EPA PP	EPA 525.2	µg/L		<0.1	0/6	<0.1	0 / 6			<0.1	0/6	<0.1	0/6
Acenaphthene	EPA PP	EPA 525.2	µg/L		<0.1	0/6	<0.1	0/6			<0.1	0/6	<0.1	0/6
Acenaphthylene	EPA PP	EPA 525.2	µg/L		<0.1	0/6	<0.1	0/6			<0.1	0/6	<0.1	0/6
Aldrin	EPA PP	EPA 525.2	µg/L		<0.01	0/6	<0.05	0 / 6			<0.05	0/6	<0.05	0/6
Alpha-BHC	EPA PP	EPA 525.2	µg/L		<0.1	0/6	<0.1	0/6			<0.1	0/6	<0.1	0/6
Alpha-endosulfan	EPA PP	EPA 525.2	µg/L		<0.1	0/6	<0.1	0/6			<0.1	0/6	<0.1	0/6
Anthracene	EPA PP	EPA 525.2	µg/L		<0.02	0/6	<0.02	0 / 6			<0.02	0/6	<0.02	0/6
benzo(a) anthracene	EPA PP	EPA 525.2	µg/L		<0.05	0/6	<0.05	0/6			<0.05	0/6	<0.05	0/6
Benzo(b) fluoranthene	EPA PP	EPA 525.2	µg/L		<0.02	0/6	<0.02	0/6			<0.02	0/6	<0.02	0/6
Benzo(ghi) perylene	EPA PP	EPA 525.2	µg/L		<0.05	0/6	<0.05	0/6			<0.05	0/6	<0.05	0/6
Benzo(k) fluoranthene	EPA PP	EPA 525.2	µg/L		<0.02	0/6	<0.02	0 / 6			<0.02	0/6	<0.02	0/6
Beta-BHC	EPA PP	EPA 525.2	µg/L		<0.1 (<0.1 -0.15)	1/6	<0.1	0/6			<0.1	0/6	<0.1	0/6
Beta-endosulfan	EPA PP	EPA 525.2	µg/L		<0.1	0/6	<0.1	0 / 6			<0.1	0/6	<0.1	0/6
Bromoform	EPA PP	EPA 551.1	µg/L		<0.5	0 / 12					<0.5	0 / 11	<0.5	0/6
Butyl benzyl phthalate	EPA PP	EPA 525.2	µg/L		<0.5	0/6	<0.5	0/6			<0.5	0/6	<0.5	0/6
Chlorodibromomethane	EPA PP	EPA 551.1	µg/L		<0.5	0 / 12					<0.5	0 / 11	<0.5 (<0.5 -0.56)	1/5
Chloroform	EPA PP	EPA 551.1	µg/L		0.53 (<0.5-2)	7 / 12					1.6 (0.68-4.2)	11 / 11	11 (3.7-38)	6/6
Chrysene	EPA PP	EPA 525.2	µg/L		<0.02	0/6	<0.02	0/6			<0.02	0/6	<0.02	0/6
Delta-BHC	EPA PP	EPA 525.2	µg/L		<0.1	0/6	<0.1	0/6			<0.1	0/6	<0.1	0/6
Di-N-Butyl Phthalate	EPA PP	EPA 525.2	µg/L		<10	0/6	<1	0/6			<1	0/6	<1	0/6
Di-n-octyl phthalate	EPA PP	EPA 525.2	µq/L		<10	0/6	<0.1	0/6			<0.1	0/6	<0.1	0/6

Someline Constituent	Contaminant	Analytical	Unite	DDW	Pilot Influ (Secondary E	ent ffluent)	Ozone Effi	uent	MF Efflu	ent	RO Perm	eate	RO Concen	trate
Sampling Constituent	List	Method	Units	MCL/NL	Median (Range)	Detected / Measured	Median (Range)	Detected / Measured	Median (Range)	Detected / Measured	Median (Range)	Detected / Measured	Median (Range)	Detected / Measured
Dibenz(a,h) anthracene	EPA PP	EPA 525.2	µg/L		<0.05	0/6	<0.05	0/6			<0.05	0/6	<0.05	0/6
Dichlorobromomethane	EPA PP	EPA 551.1	µg/L		<0.5	0 / 12					<0.5	0 / 11	<0.5 (<0.5 -0.96)	2/5
Diethyl Phthalate	EPA PP	EPA 525.2	µg/L		<0.5	0/6	<0.5	0/6			<0.5	0/6	<0.5	0/6
Dimethyl phthalate	EPA PP	EPA 525.2	µg/L		<0.5	0/6	<0.5	0/6			<0.5	0/6	<0.5	0/6
Endosulfan sulfate	EPA PP	EPA 525.2	µg/L		<0.1	0/6	<0.1	0/6			<0.1	0/6	<0.1	0/6
Endrin	EPA PP	EPA 525.2	µg/L		<0.1	0/6	<0.2	0/6			<0.2	0/6	<0.2	0/6
Endrin aldehyde	EPA PP	EPA 525.2	µg/L		<0.1	0/6	<0.1	0/6			<0.1	0/6	<0.1	0/6
Fluoranthene	EPA PP	EPA 525.2	µg/L		<0.1	0/6	<0.1	0/6			<0.1	0/6	<0.1	0/6
Fluorene	EPA PP	EPA 525.2	µg/L		<0.05	0/6	<0.05	0/6			<0.05	0/6	<0.05	0/6
Hexachlorocyclopentadiene	EPA PP	EPA 525.2	µg/L		<0.05	0/6	<0.05	0/6			<0.05	0/6	<0.05	0/6
Indeno (1,2,3-cd) pyrene	EPA PP	EPA 525.2	µg/L		<0.05	0/6	<0.05	0/6			<0.05	0/6	<0.05	0/6
Isophorone	EPAPP	EPA 525.2	µg/L		<0.5	0/6	<0.5	0/6			<0.5	0/6	<0.5	0/6
Naphthalene	EPA PP	EPA 525.2	µg/L		<0.3	0/6	<0.3	0/6			<0.3	0/6	(<0.3-0.022)	2/6
PCB-1016 (Arochlor 1016)	EPA PP	EPA 505	µg/L		<0.08	0/6	<0.08	0/6			<0.08	0/6	<0.08	0/6
PCB-1221 (Arochlor 1221)	EPA PP	EPA 505	µg/L		<0.1	0/6	<0.1	0/6			<0.1	0/6	<0.1	0/6
PCB-1232 (Arochlor 1232)	EPA PP	EPA 505	µg/L		<0.1	0/6	<0.1	0/6			<0.1	0/6	<0.1	0/6
PCB-1242 (Arochlor 1242)	EPA PP	EPA 505	µg/L		<0.1	0/6	<0.1	0/6			<0.1	0/6	<0.1	0/6
PCB-1248 (Arochior 1248)		EPA 505	µg/L		<0.1	0/6	<0.1	0/6			<0.1	0/6	<0.1	0/6
PCB-1254 (Arochior 1254)		EPA 505	µg/L		<0.1	0/6	<0.1	0/6			<0.1	0/6	<0.1	0/6
PCB-1200 (Alocillot 1200)		EPA 505 2	μg/L		<0.1	0/6	<0.1	0/6			<0.1	0/6	<0.1	0/6
Pyrene	EPA PP	EPA 525.2	μg/L μg/l		<0.04	0/6	<0.04	0/6			<0.04	0/6	<0.04	0/6
Pesticides of Local Interest (Pol			P3-2											
Chlorothalonil (Draconil, Bravo)	PoLI	EPA 525.2	µg/L		<0.1	0/6	<0.1	0/6			<0.1	0/6	<0.1	0/6
Chlorpyrifos	PoLI	EPA 525.2	µg/L		<0.05	0/6	<0.05	0/6			<0.05	0/6	<0.05	0/6
Contaminants of Emerging Con	cern (CECs)													
1,7-Dimethylxanthine	CECs	LC-MS-MS	ng/L		24 (<10 -900)	4/7	<10 (<10 -170)	3/7			<10	0 / 6	<10 (<10 -240)	2 / 6
2,4-D	CECs	LC-MS-MS	ng/L		<5 (<5 -6.7)	1/7	<5 (<5- 20)	1/7			<5	0 / 7	<5 (<5- 98)	2/6
4-nonylphenol - semi quantitative	CECs	LC-MS-MS	ng/L		<100	0 / 7	<100	0/7			<100	0/7	<100	0/6
4-tert-octylphenol	CECs	LC-MS-MS	ng/L		280 (<50-790)	5/7	120 (<50-290)	5/7			<50	0 / 7	335 (<50-810)	5/6
Acesulfame-K	CECs	LC-MS-MS	ng/L		33000 (14000-85000)	7/7	21000 (2700-25000)	7/7			<20	0 / 7	77500 (14000-130000)	6/6
Acetaminophen	CECs	LC-MS-MS	ng/L		94 (<5-390)	5/7	6.9 (<5-890)	4/7			<5	0 / 7	58 (<5 -420)	3 / 6
Albuterol	CECs	LC-MS-MS	ng/L		18 (<5-72)	5/7	<5 (<5- 83)	2/7			<5 (<5- 31)	1/7	5.7 (<5-16)	3/6
Amoxicillin (semi-quantitative)	CECs	LC-MS-MS	ng/L		2300 (1200-3700)	7/7	<20 (<20- 320)	3/7			<20	0 / 7	33 (<20-820)	4 / 6
Andorostenedione	CECs, UCMR 3	LC-MS-MS	ng/L		<5 (<5- 26)	1/7	<5	0 / 7			<5	0 / 7	<5 (<5- 11)	2/6
Atenolol	CECs	LC-MS-MS	ng/L		460 (310-620)	7/7	110 (21-220)	7/7			<5	0 / 7	265 (120-460)	6/6
Atrazine	CECs	LC-MS-MS	ng/L		<5	0/7	<5	0/7			<5	0/7	<5	0/6
Azithromycin	CECs	LC-MS-MS	ng/L		<20 (<20- 3600)	1/7	<20 (<20 -180)	1/7			<20	0/7	<20 (<20 -670)	1/6
Bendroflumethiazide	CECs	LC-MS-MS	ng/L		<5	0/7	<5	0/7			<5	0/7	<5	0/6
Bezafibrate	CECs	LC-MS-MS	ng/L		69 (54-120)	7/7	12 (<5-46)	5/7			<5	0 / 7	116 (27-250)	6/6

	Contaminant	Analytical		DDW	Pilot Influ (Secondary E	ent ffluent)	Ozone Effl	uent	MF Efflu	ent	RO Perme	eate	RO Concen	trate
Sampling Constituent	List	Method	Units	MCL/NL	Median (Range)	Detected / Measured	Median (Range)	Detected / Measured	Median (Range)	Detected / Measured	Median (Range)	Detected / Measured	Median (Range)	Detected / Measured
BPA	CECs	LC-MS-MS	ng/L		<10 (<10 -66)	2/7	<10	0 / 7			<10	0/7	16 (<10-38)	3/6
Bromacil	CECs	LC-MS-MS	ng/L		<5	0/7	<200	0/7			<200	0 / 7	<200	0/6
Butalbital	CECs	LC-MS-MS	ng/L		<5 (<5- 91)	2/7	<5	0 / 7			<5	0 / 7	<5	0/6
Butylparben	CECs	LC-MS-MS	ng/L		<5	0 / 7	<5	0/7			<5	0 / 7	<5 (<5 -8.3)	1/6
Caffeine	CECs	LC-MS-MS	ng/L		580 (110-1200)	7/7	190 (<5-430)	6 / 7			<5 (<5 -12)	1 / 6	895 (55-1700)	6/6
Carbadox	CECs	LC-MS-MS	ng/L		<5	0/7	<5	0 / 7			<5 (<5- 11)	1/7	<5	0/6
Carbamazepine	CECs	LC-MS-MS	ng/L		130 (120-200)	7/7	<5	0 / 7			<5	0 / 7	<5 (<5- 5.3)	1 / 6
Carisoprodol	CECs	LC-MS-MS	ng/L		82 (<5-580)	5/7	71 (<5-470)	6 / 7			<5	0 / 7	260 (<5-2500)	5/6
Chloramphenicol	CECs	LC-MS-MS	ng/L		<10	0/7	<10	0/7			<10	0 / 7	<10	0/6
Chloridazon	CECs	LC-MS-MS	ng/L		<5	0/7	<5	0/7			<5	0 / 7	<5	0/6
Chlorotoluron	CECs	LC-MS-MS	ng/L		<5	0/7	<5	0/7			<5	0 / 7	<5	0/6
Cimetidine	CECs	LC-MS-MS	ng/L		190 (<5 -3600)	5/7	<5	0 / 7			<5	0 / 7	<5	0/6
Clofibric Acid	CECs	LC-MS-MS	ng/L		<5	0/7	<5	0/7			<5	0 / 7	<5	0/6
Cotinine	CECs	LC-MS-MS	ng/L		100 (25-200)	7/7	69 (21-130)	7/7			<10	0 / 7	180 (44-550)	6/6
Cyanazine	CECs	LC-MS-MS	ng/L		<5	0/7	<5	0 / 7			<5	0 / 7	<5	0/6
DACT	CECs	LC-MS-MS	ng/L		<5 (<5 -6.9)	1/7	<5 (<5 -40)	2/7			<5	0 / 7	<5 (<5- 10)	1/6
DEA	CECs	LC-MS-MS	ng/L		<5	0 / 7	<5	0 / 7			<5	0 / 7	<5 (<5- 9.5)	2 / 6
DEET	CECs	LC-MS-MS	ng/L		300 (93-380)	7/7	95 (<10-220)	6 / 7			<10	0 / 7	390 (<10-1000)	5/6
Dehydronifedipine	CECs	LC-MS-MS	ng/L		67 (5.7-120)	7/7	100 (5.2-220)	7/7			<5	0 / 7	370 (99-610)	6/6
DIA	CECs	LC-MS-MS	ng/L		<5 (<5- 12)	1/7	<5	0 / 7			<5	0 / 7	<5	0/6
Diazepam	CECs	LC-MS-MS	ng/L		<5	0 / 7	<5	0 / 7			<5	0 / 7	7.1 (<5-11)	4/6
Diclofenac	CECs	LC-MS-MS	ng/L		58 (<5-170)	5/7	<5	0 / 7			<5	0 / 7	<5	0/6
Dilantin	CECs	LC-MS-MS	ng/L		120 (82-180)	7/7	58 (29-94)	7/7			<20	0 / 7	240 (170-270)	6/6
Diuron	CECs	LC-MS-MS	ng/L		31 (<5-96)	5/7	<5 (<5 -47)	3 / 7			<5	0 / 7	37 (<5-280)	3/6
Erythromycin	CECs, EPA CCL	LC-MS-MS	ng/L		<10 (<10 -120)	2/7	<10	0 / 7			<10 (<10 -13)	1/7	15 (<10 -43)	4/6
Estradiol	CECs, UCMR 3	LC-MS-MS	ng/L		<5	0/7	<5	0/7			<5	0 / 7	<5	0/6
Estrone	CECs, UCMR 3	LC-MS-MS	ng/L		29 (12-320)	7/7	<5 (<5 -6.2)	1/7			<5	0 / 7	<5 (<5 -7.8)	2 / 6
Ethinyl Estradiol - 17 alpha	CECs, UCMR 3	LC-MS-MS	ng/L		<5 (<5 -2500)	1/7	<5 (<5 -520)	1/7			<5	0 / 7	<5 (<5 -3400)	1 / 6
Ethylparaben	CECs	LC-MS-MS	ng/L		<20	0/7	<20	0 / 7			<20	0 / 7	<20	0/6
Flumeqine	CECs	LC-MS-MS	ng/L		<10	0/7	<10	0/7			<10	0/7	<10	0/6
Fluoxetine	CECs	LC-MS-MS	ng/L		18 (<10-27)	6/7	<10 (<10 -11)	1/7			<10 (<10 -19)	1/7	<10	0/6
Gemfibrozil	CECs	LC-MS-MS	ng/L		1200 (1000-1500)	7/7	<5 (<5 -41)	1/7			<5	0 / 7	9 (<5-460)	3/6
lbuprofen	CECs	LC-MS-MS	ng/L		46 (<10 -220)	4/7	35 (<10-120)	5/7			<10	0 / 7	195 (<10-510)	4 / 6
lohexal	CECs	LC-MS-MS	ng/L		9800 (7800-40000)	7/7	7600 (5400-11000)	7/7			<10 (<10 -16)	1/7	29000 (3000-40000)	6/6

Sampling Constituent	Contaminant	Analytical		DDW	Pilot Influ (Secondary E	ent ffluent)	Ozone Effi	uent	MF Efflu	ent	RO Perm	eate	RO Concen	trate
Sampling Constituent	List	Method	Units	MCL/NL	Median (Range)	Detected / Measured	Median (Range)	Detected / Measured	Median (Range)	Detected / Measured	Median (Range)	Detected / Measured	Median (Range)	Detected / Measured
Iopromide	CECs	LC-MS-MS	ng/L		1600 (960-3500)	7/7	1100 (570-2800)	7/7			<5	0/7	4250 (2200-9400)	6/6
Isobutylparaben	CECs	LC-MS-MS	ng/L		<5	0 / 7	<5	0 / 7			<5	0 / 7	<5 (<5 -13)	1/6
Isoproturon	CECs	LC-MS-MS	ng/L		<100	0 / 7	<100	0/7			<100	0 / 7	<100	0 / 6
Ketoprofen	CECs	LC-MS-MS	ng/L		73 (39-170)	7/7	31 (<5-55)	6 / 7			<5	0/7	130 (89-160)	6/6
Ketorolac	CECs	LC-MS-MS	ng/L		10 (<5-19)	4/7	<5	0/7			<5	0 / 7	<5 (<5-7)	1/6
Lidocaine	CECs	LC-MS-MS	ng/L		250 (100-580)	7/7	16 (<5-110)	5/7			<5	0 / 7	78 (<5-340)	4 / 5
Lincomycin	CECs	LC-MS-MS	ng/L		46 (<10-74)	5/7	<10 (<10 -110)	2/7			<10	0 / 7	<10	0/6
Linuron	CECs, PoLI	LC-MS-MS	ng/L		<5	0 / 7	<5	0/7			<5	0 / 7	<5 (<5- 12)	1/6
Lopressor	CECs	LC-MS-MS	ng/L		580 (350-1200)	7/7	<20 (<20- 260)	3/7			<20	0 / 7	95 (<20-370)	4 / 6
Meclofenamic Acid	CECs	LC-MS-MS	ng/L		<5 (<5- 280)	1/6	<5	0 / 7			<5	0/7	<5	0/6
Meprobamate	CECs	LC-MS-MS	ng/L		220 (130-350)	7/7	180 (87-280)	7/7			<5	0/7	335 (260-680)	6/6
Metazachlor	CECs	LC-MS-MS	ng/L		<5	0/7	<5	0/7			<5	0 / 7	<5	0/6
Methylparaben	CECs	LC-MS-MS	ng/L		<20 (<20 -28)	1/7	<20 (<20 -20)	1/7			<20	0 / 7	<20	0/6
Metolachlor	CECs	LC-MS-MS	ng/L		<5	0/6	<5	0/7			<5	0/7	<5	0/6
Naproxen	CECs	LC-MS-MS	ng/L		28 (<10-240)	4/7	<10	0 / 7			<10	0 / 7	<10	0/6
Nifedipine	CECs	LC-MS-MS	ng/L		<20 (<20- 150)	2/7	<20	0 / 7			<20	0 / 7	<20 (<20 -66)	1/6
Norethisterone	CECs	LC-MS-MS	ng/L		<5 (<5- 25)	2/7	<5	0 / 7			<5	0 / 7	<5	0/6
Oxolinic Acid	CECs	LC-MS-MS	ng/L		<10	0/7	<10	0/7			<10	0 / 7	<10	0 / 6
Pentoxifylline	CECs	LC-MS-MS	ng/L		11 (<5-80)	5/7	<5 (<5-11)	2/7			<5	0 / 7	<5 (<5- 51)	3 / 6
Phenazone	CECs	LC-MS-MS	ng/L		<5 (<5- 16)	1/7	<5	0 / 7			<5	0 / 7	<5	0/6
Primidone	CECs	LC-MS-MS	ng/L		49 (31-66)	7/7	24 (11-42)	7/7			<5	0 / 7	100 (<5-180)	5/6
Progesterone	CECs	LC-MS-MS	ng/L		<5 (<5- 330)	2/7	<5 (<5 -6.6)	1/7			<5	0 / 7	7 (<5-11)	3 / 6
Propazine	CECs	LC-MS-MS	ng/L		<5	0/7	<5	0/7			<5	0 / 7	<5	0/6
Propylparaben	CECs	LC-MS-MS	ng/L		<5	0/7	<5	0/7			<5	0 / 7	<5	0 / 6
Quinoline	CECs, EPA CCL	LC-MS-MS	ng/L		<5 (<5- 130)	1/7	<5 (<5- 41)	1/7			<5 (<5- 94)	1/7	<5	0/6
Simazine	CECs	LC-MS-MS	ng/L		<5	0/7	<5	0/7			<5	0 / 7	<5	0 / 6
Sucralose	CECs	LC-MS-MS	ng/L		37000 (26000-44000)	7/7	33000 (20000-40000)	7/7			<100	0 / 7	150000 (<100-180000)	5/6
Sulfachloropyridazine	CECs	LC-MS-MS	ng/L		<5	0 / 7	<5	0/7			<5	0/7	<5	0/6
Sulfadiazine	CECs	LC-MS-MS	ng/L		<5	0 / 7	<5	0/7			<5	0 / 7	<5	0/6
Sulfadimethoxine	CECs	LC-MS-MS	ng/L		<5	0/7	<5	0/7			<5	0/7	<5	0/6
Sulfamerazine	CECs	LC-MS-MS	ng/L		<5 (<5- 29)	1/7	<5	0 / 7			<5	0/7	<5	0/6
Sulfamethazine	CECs	LC-MS-MS	ng/L		<5	0/7	<5	0/7			<5	0/7	<5	0/6
Sulfamethizole	CECs	LC-MS-MS	ng/L		<5	0/7	<5	0/7			<5	0/7	<5	0/6
Sulfamethoxazole	CECs	LC-MS-MS	ng/L		800 (350-990)	7/7	32 (<5-140)	6 / 7			<5	0/7	104 (<5-490)	4/6
Sulfathiazole	CECs	LC-MS-MS	ng/L		<5	0/7	<5 (<5 -5)	1/7			<5	0/7	<5	0/6

	Contaminant	Analytical	1114-	DDW	Pilot Influ (Secondary E	ient Effluent)	Ozone Eff	uent	MF Efflu	ent	RO Perm	eate	RO Concer	ntrate
Sampling Constituent	List	Method	Units	MCL/NL	Median (Range)	Detected / Measured	Median (Range)	Detected / Measured	Median (Range)	Detected / Measured	Median (Range)	Detected / Measured	Median (Range)	Detected / Measured
ТСЕР	CECs	LC-MS-MS	ng/L		290 (100-440)	7/7	320 (120-500)	7/7			<10	0 / 7	1200 (580-2000)	6/6
ТСРР	CECs	LC-MS-MS	ng/L		470 (280-860)	7/7	340 (240-850)	7/7			<100	0 / 7	1550 (1200-2200)	6/6
TDCPP	CECs	LC-MS-MS	ng/L		460 (180-800)	7/7	300 (220-800)	7/7			<100	0 / 7	1450 (720-1700)	6 / 6
Testosterone	CECs, UCMR 3	LC-MS-MS	ng/L		<5 (<5 -18)	1/7	<5	0 / 7			<5	0 / 7	<5	0 / 6
Theobromine	CECs	LC-MS-MS	ng/L		<10 (<10 -310)	2/7	<10 (<10 -580)	2/7			<10	0 / 7	<10 (<10- 920)	2 / 6
Theophylline	CECs	LC-MS-MS	ng/L		430 (<20-1300)	5/7	<20 (<20 -1600)	3 / 7			<20	0 / 7	135 (<20-1000)	3 / 6
Triclosan	CECs	LC-MS-MS	ng/L		140 (11-1600)	7/7	<10 (<10 -30)	3 / 7			<10	0 / 7	11 (<10-92)	3 / 6
Trimethoprim	CECs	LC-MS-MS	ng/L		400 (200-730)	7/7	<5	0 / 7			<5	0 / 7	<5 (<5 -21)	1/6
Warfarin	CECs	LC-MS-MS	ng/L		<5 (<5 -14)	2/7	<5	0/7			<5	0 / 7	<5	0 / 6

¹ Values for total coliform and *E. coli* are in the format geometric mean (range)

SM is Standard Methods for the Examination of Water and Wastewater; LC-MS-MS is Liquid Chromatography, tandem Mass Spectrometry; mg is milligram; L is Liter; µg is microgram; ng is nanograms; EPA is Environmental Protection Agency NTU is Nephelometric Turbidity Units; cm is centimeter; MPN is Most Probable Number; mL is milliliter; MFL is Million Fibers per Liter; pC is picocuries; TT is Treatment Technique; UV is ultraviolet

APPENDIX D

Pure Water Monterey Groundwater Replenishment Project: Recharge Impacts Assessment Report



TECHNICAL MEMORANDUM

PROJECT #: 9155.0202

- **TO:** Edwin Lin, Todd Groundwater
- FROM: Pascual Benito and Derrik Williams
- PROJECT: Pure Water Monterey
- **SUBJECT:** Pure Water Monterey Project Wellfield Design Modeling Results With Updated Local Santa Margarita Aquifer Properties and 70/30 Deep/Shallow Recharge Split

EXECUTIVE SUMMARY

Monterey One Water (M1W) is developing the Pure Water Monterey (PWM) groundwater replenishment project (Project), a Groundwater Replenishment Reuse Project (GRRP). This project will recharge the two primary drinking water aquifers of the Seaside groundwater basin with an average of 3,500 AFY of high quality purified recycled water and provide lesser quality recycled water to the Salinas Valley.

The calibrated groundwater model of the Seaside Groundwater Basin (HydroMetrics WRI, 2009) was used to estimate the aquifer response from the Project. A predictive model incorporating reasonable future hydrologic conditions was developed for this impact analysis. The groundwater model was calibrated through 2008; therefore, the predictive model begins in 2009. The predictive model simulates a 33-year period: from 2009 through 2041. Injection of PWM purified recycled water is simulated to begin in October 2016 in the model to allow for comparison with the results from previous simulations of Project scenarios. The model aquifer parameters for the Santa Margarita Aquifer, including horizontal hydraulic conductivity, specific storage, and aquifer thickness, were updated locally in the area around the injection and capture wells based on aquifer test results from ASR-1, -2, -3, and -4, DIW-1 and -2, and the Paralta well.

Simulated future Carmel River flows were based on historical flow records. The amount of Carmel River water available for winter injection into the Seaside Basin was estimated by Monterey Peninsula Water Management District (MPWMD) staff. They compared historical daily streamflows with minimum streamflow requirements for each day, and then identified how much water could be extracted from the Carmel River for injection each month.



Future water demand for Cal-Am was estimated from historical demands for the period 2001-2010. Roughly two-thirds of the total Cal-Am demand was predicted to be met by extraction of native groundwater, injected Carmel River water, and injected PWM water. The monthly pumping rate within each year was distributed in proportion to the total monthly demand, with modifications made to compensate for capacity reductions caused by ASR injection.

Particle tracking was used to estimate the travel time of injected Project water from the point of recharge to the closest point of extraction under variable hydrologic and operating conditions. Particle tracking showed that the shortest travel time for any recharged PWM water is 328 days (10.8 months) in the Santa Margarita Aquifer and 1,394 days (3 years and 9.8 months) in the Paso Robles Aquifer. The majority of the particle travel times to production wells take longer than one year and travel times of less than a year occur in only 13 months out of the 300 months during which the PWM project is simulated being in operation, which is 4% of the time.

PROJECT DESCRIPTION

Monterey One Water (M1W) is developing the Pure Water Monterey (PWM) groundwater replenishment project (Project), a Groundwater Replenishment Reuse Project (GRRP). This project will recharge the two primary aquifers in the Seaside groundwater basin with an average of 3,500 AFY of high quality purified recycled water and deliver lesser quality recycled water to the Castroville Seawater Intrusion Project (CSIP). California American Water Company (Cal-Am) will recover 3,500 AFY of the recharged water through existing production wells in the basin, based on demand and well capacity/availability. The project will also include a groundwater banking program that will build a drought reserve account of up to 1,000 AF of water in the Seaside Basin during normal and wet years. The extra recharge during normal and wet years will be offset by an increase in CSIP deliveries and a corresponding decrease in Seaside groundwater basin injection during dry years, during which Cal-Am pumps from the drought reserve account. The locations of the project's facilities, along with other operating production wells, are shown on Figure 1.

The PWM Project includes a total of four injection wells. Two deep injection wells (DIWs), DIW-1 and DIW-2, will inject approximately 70 percent of the purified recycled water directly into the Santa Margarita Aquifer. Two vadose zone wells (VZWs), VZW-1¹ and VZW-2, will inject approximately 30 percent of purified recycled water in the unsaturated Aromas Sand Formation for percolation into the underlying Paso Robles Aquifer. Well DIW-1 was installed and tested in 2017 during the first phase of construction (Phase 1). Wells DIW-2 and VZW-2

¹ Well VZW-1 in Figure 1 and Figure 11 is actually VZW-1A. The original VZW-1 well 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. The name VZW-1 is used to refer to this location throughout the document.



were installed and tested in 2018/2019 during the second phase of construction (Phase 2). Well VZW-1 will be installed under Phase 2 construction in April 2019.

Montgomery & Associates, Inc. (M&A) has completed groundwater flow and particle tracking simulations of the Project. This simulation was undertaken to predict the fate and travel time of injected Project recycled water. This modeling was completed in support of well phasing and wellfield design for the Phase 1 and 2 construction of the PWM injection well facilities.



Figure 1. Production and PWM Injection Well Locations



MODEL BACKGROUND AND ASSUMPTIONS

The calibrated groundwater model of the Seaside Groundwater Basin (HydroMetrics WRI, 2009)² was used to estimate the underground retention time of injected purified recycled water from Project injection wells to nearby production wells in the Santa Margarita Aquifer and Paso Robles Aquifer. The Seaside Basin Watermaster model used for this analysis is the same groundwater model used in support of the Project EIR. The model background and assumptions are repeated here for completeness.

The Seaside model is a regional groundwater flow model that was developed in 2009 for the Seaside Basin Watermaster. It covers an area larger than the adjudicated Seaside Groundwater Basin, extending east and north of the basin boundary into the Salinas Valley. The model was developed for the purpose of guiding basin management decision such as:

- evaluating impacts from supplemental water projects
- determining storage efficiency of artificially recharged water
- re-estimating safe yield, and
- determining how much supplemental water is needed to reach protective groundwater elevations which would protect the basin from seawater intrusion

The three-dimensional numerical groundwater flow model was built using the U.S. Geological Survey's MODFLOW-2005 model code (Harbaugh, 2005). The model simulates five geologic layers: Aromas Red Sands, upper Paso Robles Aquifer, middle Paso Robles Aquifer, lower Paso Robles Aquifer, and Santa Margarita Sandstone/Purisima Formation. The model has been calibrated through history matching of water level data from January 1987 through December 2008. The model incorporates the time-dependent recharge calculated as part of the conceptual model and all of the pumping data. The model simulates the interaction of groundwater in the study area with the Pacific Ocean, as well as the interaction with the adjacent Salinas Groundwater Basin.

The model has been used extensively by the Seaside Basin Watermaster Technical Advisory Committee (TAC) to simulate groundwater response to potential future basin management activities and provide information on how to achieve protective groundwater elevations at the coast.

Minor modifications were made to the calibrated hydrogeologic parameters to incorporate data from aquifer tests conducted in the two Project DIWs (DIW-1 and DIW-2), four MPMWD ASR wells, and an additional local drinking water well (Paralta). A predictive model incorporating variable future hydrologic conditions was developed for this impact analysis. The groundwater

² The original groundwater model report is available at the following URL: <u>http://www.seasidebasinwatermaster.org/Other/Seaside modeling report FINAL.pdf</u>



model was calibrated through 2008; therefore, the predictive model begins in 2009. The predictive model simulates a 33-year period: from 2009 through 2041. Injection from the Pure Water Monterey project was assumed to start in October 2016 and was operating throughout the remaining 25 years of the simulation. Although Project injection is scheduled to begin in June 2019, the project was still simulated with the previous start date (October 2016) to allow for comparison with the results from previous simulations of Project scenarios.

Updated Parameters Based on Aquifer Tests

The hydrogeological properties for the Santa Margarita Aquifer in the model were updated locally in the vicinity of the project to incorporate site specific data from aquifer pump tests conducted in project wells DIW-1 (Todd 2018) and DIW-2 (Todd, 2019), and in five nearby wells consisting of ASR-1 (Padre, 2002), ASR-2 (Pueblo, 2008), ASR-3 (Pueblo, 2012), ASR-4 (Pueblo, 2015), and the Paralta well (Fugro, 1997). The estimated aquifer properties for the seven wells are listed in Table 1, and their locations shown in Figure 2. The aquifer thickness (b), estimated transmissivity (T), and storativity (S) values, were used to calculate and assign horizontal hydraulic conductivity (K = T/b) and specific storage (Ss = S/b) values to the cluster of model grid cells around each of the wells. The aquifer thickness was also used to adjust the model layer thickness at each location. Santa Margarita Aquifer parameters and layer thickness for all the model grid cells in a region within a 3,100-foot radius³ (region shown in orange in Figure 2) of each of the wells were then re-interpolated based on the new data. The original model parameters outside the 3,100 foot interpolation buffer region remain unchanged. The interpolation region was clipped along the Ord Terrace Fault line as to not modify grid cell parameter values on the other side of the fault. This local change in aquifer parameters ensures smooth spatial variation between calibrated parameters and updated local parameters; calibrated parameters are unchanged outside of this area. The model was not recalibrated with updated parameters.

An effective porosity value of 24% was assigned to the Santa Margarita Aquifer based on actual porosity measurements of aquifer material collected during the installation of well ASR-2 (Pueblo, 2008). All other aquifer layers were assigned an effective porosity value of 20%.

³ The radial distance of 3,100 feet was chosen based on the geometric mean of the estimated radius of influence from the short term aquifer tests at wells DIW-1 and DIW-2.



Well	Aquifer Thickness b (ft)	Transmissivity T (ft²/day)	Horizontal Hydraulic Conductivity K = T/b (ft/day)	Storativity S (ft/ft)	Specific Storage Ss = S/b (1/ft)	Data Source
DIW-1	280	21,878	78	9.29E-04	3.32E-06	(Todd, 2018)
DIW-2	170	14,188	83	2.57E-03	1.51E-05	(Todd, 2019)
ASR-1	220	13,946	63	-	1.66E-06*	(Padre, 2002)
ASR-2	230	18,803	82	3.83E-04	1.66E-06	(Pueblo, 2008)
ASR-3	240	15,861	66	2.00E-04	8.33E-07	(Pueblo, 2012)
ASR-4	240	13,139	55	-	8.33E-07**	(Pueblo, 2015)
Paralta	180	11,376	63	1.80E-03	1.00E-05	(Fugro, 1997)

Table 1. Local Santa Margarita Aquifer Hydrogeologic Properties from Pumping Tests

*assumed same value as ASR-2

**assumed same value as ASR-3



Figure 2. Model Santa Margarita Aquifer Parameter Update Region



Predicted Hydrology Assumptions

The hydrology (rainfall and recharge) used to calibrate the groundwater model was applied to the predictive model. To extend the hydrology through the predictive period, the 1987 through 2008 hydrology data were used to simulate model years 2009 through 2030, and the 1987 through 1997 hydrology data were then repeated for 2031 through 2041 (Figure 3). This is the approach that has been adopted for all predictive models of the Seaside Basin since 2009. By using this hydrology, even during the period January 2009 to present when actual hydrology is known, the model runs can be used to compare relative groundwater levels but not to assess absolute Basin conditions.



Figure 3. Repetition of Hydrology for Predictive Model

Predicted Carmel River Flow and Injection Assumptions

Monterey Peninsula Water Management District (MPWMD) estimated the amount of Carmel River water available for ASR injection for the predictive simulation based on historical streamflow records. Because the future simulated hydrology is based on the historical hydrology between 1987 and 2008, the future streamflows are expected to be the same as the historical streamflows. MPWMD staff compared historical daily streamflows between water year 1987 and water year 2008 with minimum streamflow requirements for each day. This allowed MPWMD to identify how many days in each month ASR water could be extracted from the Carmel River. Using a daily diversion rate of 20 acre-feet per day, MPWMD calculated how many acre-feet of water from the Carmel River could be injected into the ASR system each month.

Figure 4 shows the estimated available monthly ASR injection volumes for the predictive simulation. The Carmel River water available for injection was divided between the ASR 1&2 Well Site and the ASR 3&4 Well Site according to the historic division of injection.



Figure 4. Estimated Monthly Carmel River ASR Injection Volumes



Pure Water Monterey Project Recharge Assumptions

The simulated Project recharges varying volumes of water each year, with an average of 3,500 acre-feet recharged per year. Of this, 70% of the water is delivered to the Santa Margarita Aquifer through two DIWs(DIW-1 & DIW-2, located at EIR Site-2 and Site-3, respectively), and 30% is delivered to the Paso Robles Aquifer through two VZWs (VZW-1 & VZW-2, located at EIR Site-2 and Site-3, respectively). The amount of water recharged each year depends upon whether the predicted hydrology is in a drought or non-drought year, and upon the rules for banking and delivering water to CSIP.

Figure 5 shows the volume of water recharged by the Project for each water year. While the annual recharge of PWM water varies from year to year, the recovery of water through Cal-Am's pumping wells is maintained at a constant 3,500 acre-feet every year. A monthly recharge schedule that includes an accounting and description of the CSIP banking and delivery program is shown on the 11" x 17" sized Table 8 at the end of this technical memorandum. Table 2 shows the percent of recharge allocated between the DIWs and VZWs and.

	Recharge Well					
	DIW-1	DIW-2	VZW-1	VZW-2		
% of Total Recharge	70%		30%			
% of Deep Recharge	45%	55%	0%	0%		
% of Vadose Zone Recharge	0%	0%	60%	40%		
% of Total Recharge	31.5%	38.5%	18.0%	12.0%		

Table 2. Allocation of Recharge to DIWs and VZWs, Percent



Figure 5. Annual PWM Recharge



Predicted Pumping Assumptions

Montgomery & Associates made a number of assumptions about future pumping rates by various entities in the Seaside Basin. These assumptions were consistent with assumptions developed for previous modeling exercises in the basin. Pumping assumptions were developed for standard producers, alternative producers, golf courses, and Cal-Am.

Water Year 2009 through Water Year 2012 Pumping

Actual pumping and injection data for all wells from January 2009 through December 2012 are included in the predictive simulation.

Municipal Pumping from Water Year 2013 Onwards

Predicted pumping by the City of Seaside and the City of Sand City follows the triennial reductions prescribed in the Amended Decision (California American Water v. City of Seaside et al., 2007). These pumping reductions are designed to reduce basin-wide pumping to the approximate safe yield of 3,000 acre-feet per year by 2021.

Cal-Am Pumping from Water year 2013 Onwards

A number of assumptions were necessary to estimate Cal-Am's monthly pumping rates and pumping distribution. Assumptions about Cal-Am's future pumping constraints and future demands are discussed below.

Cal-Am Pumping Constraints

Predicted Cal-Am pumping comes from the five existing Cal–Am wells, and two ASR sites. The five existing Cal-Am wells are:

- Luzern #2
- Ord Grove #2
- Paralta
- Playa #3
- Plumas #4

Data supplied by Cal-Am show that the pumping capacity of their five existing wells is 3,653 gallons per minute, or 16 acre-feet per day. Based on conversations with the MPWMD, it is assumed that each ASR well site can produce 1,750 gallons per minute. The total pumping capacity of all seven wells is therefore 7,153 gallons per minute, or 31.6 acre-feet per day.



The MPWMD injection and extraction schedule identifies months when ASR wells are not available to pump groundwater, either because they are being used for injection or they are resting. For months when the ASR wells were not available, Cal-Am's pumping capacity was set to 16.1 acre-feet per day. For months when the ASR wells were available, Cal-Am's pumping capacity was set to 31.6 acre-feet per day. Information from MPWMD helped determine when ASR wells are unavailable for pumping. MPWMD developed the future injection and extraction schedule of the ASR wells based upon their historical monthly operation from October 1986 to 2008. This historical timeframe aligns with the observed climate and hydrologic pattern that are used to specify the future climate and hydrologic pattern in the groundwater model.

Cal-Am Water Demand

The monthly distribution of Cal-Am's total water demand was used to estimate a likely monthly distribution of future pumping. The water supplied to Cal-Am customers is derived from a variety of sources, including native Seaside Basin groundwater, ASR recovery water, CAWD recycled water facility, Sand City desalination, Pacific Grove package recycled water plant, various legal water rights to Carmel River, and additional temporary water rights from the Carmel River that will cease to exist in 2022 as required by the CDO amendment issued in 2016. Groundwater pumping may become a more significant source of Cal-Am's supply in the future. Cal-Am's historical demand numbers were provided by MPWMD in 2013, and are based on average water deliveries for the years 2001-2010.

Table 3 shows the calculations used to estimate Cal-Am's future monthly pumping demand. The assumed average monthly demand, shown in acre-feet in the second column, is the measured demand provided by MPWMD. It is worth noting that the maximum monthly demand of 1,490 acre-feet (48 acre-feet per day) for the Cal-Am Monterey District system exceeds the assumed combined well capacity of about 31.6 acre-feet per day. Demand beyond the combined well capacity was assumed to be met by other, non-groundwater sources.

The third column shows the percentage of Cal-Am's demand by month. We assumed that the maximum demand month of July represents a time when Cal-Am is pumping at its full capacity of 31.6 acre-feet per day. The demand for each other month, shown in column 4, was scaled as a percentage of this full capacity. For example, we calculated that Cal-Am only pumps 64% of its capacity in March, because the March demand is only 64% of the July demand. Column 5 shows the amount of water Cal-Am would likely pump in any month. Column 5 values are calculated by multiplying the percentages in column 4 by the full pumping capacity of 31.6 acre-feet per day.



Month	Cal-Am Assumed Average Monthly Demand (AF)	Percent of Annual Production	Percent of July Production	Estimated Future Monthly Pumping (AF)
October	1,242	8.96%	0.83	816
November	1,005	7.25%	0.67	660
December	900	6.49%	0.60	591
January	871	6.28%	0.58	572
February	814	5.87%	0.55	534
March	947	6.83%	0.64	622
April	1,049	7.57%	0.70	689
May	1,307	9.43%	0.88	858
June	1,400	10.10%	0.94	919
July	1,490	10.75%	1.00	978
August	1,469	10.60%	0.99	965
September	1,363	9.84%	0.92	895

Table 3. Cal-Am Estimated Seasonal Demand⁴

Based on these assumptions and calculations, Cal-Am's total future annual pumping demand is 9,099 acre-feet per year.

Annual water available for Cal-Am pumping

Cal-Am's future pumping from the Seaside basin will be drawn from three pools of water:

- Native groundwater
- Groundwater replenishment (PWM) project water (also shown as GWR "Groundwater Replenishment" on some figures)
- Aquifer storage and recovery (ASR) project water

The availability of these resources is graphed on Figure 6. This graph consists of the three components listed above.

- The native water (red) is subject to triennial reductions through 2021. After 2021, the amount of pumping native water is held constant. This pool of water also includes pumping for Security National Guaranty, Inc. (SNG, a groundwater pumper) development which is assumed to increase from 2013 through 2017.
- PWM water (green, "GWR") is assumed to become available in the 2017 model year, and supply 3,500 acre-feet every year.

⁴ Demand values were provided by MPWMD in 2013 and are based on average water deliveries for the years 2001-2010



• ASR water (blue) availability is subject to weather conditions. The maximum amount that can be pumped annually is 1,500 acre-feet. Less is pumped during dry years.

The purple line on Figure 6 shows Cal-Am's assumed estimated total future annual pumping demand of 9,099 acre-feet per year. The water available for pumping from the three pools of water is projected to be less than the pumping demand for all years. The dashed orange line is the annual demand that Cal-Am could reasonably pump, given the reductions in capacity that take place when the ASR wells are unavailable for extraction. Because Cal-Am's reasonable pumping capacity (orange dashed line) is always greater than the sum of the three water pools, Cal-Am always has the capacity to pump its full water allotment.



Figure 6. Annual Cal-Am Water Allocation by Water Right Source



Pumping Allocation by Well

When no ASR water is being extracted, Cal-Am's monthly pumping from the Seaside Basin is allocated among their available wells with the following order of preference:

- Ord Grove #2
- Paralta
- ASR wells
- Luzern
- Playa #3
- Plumas #4

The total demand during any month was first allocated to the Ord Grove Well up to its capacity. Demand was then allocated to the Paralta Well up to its capacity, and so on. The ASR wells are considered unavailable for extraction if they are injecting water, or have injected water at any time during the previous 3 months. The projected injection schedule was used to flag months during which the ASR wells would be unavailable. During months when ASR wells are not available for pumping, the order of preference continues directly from the Paralta Well to the Luzern well. This generally occurs during early summer, when total pumping is high and the ASR has recently injected excess spring Carmel River flows.

Figure 7 shows the monthly pumping by well. When ASR water is being extracted, the ASR wells are preferentially used to extract ASR water. If the ASR wells' capacity is inadequate to extract all ASR water, the remaining ASR water is allocated to the remaining wells as described above. If the ASR wells' capacity is greater than the ASR water allocated during a month, then the ASR wells remain available to extract native and PWM water up to their remaining capacity.





Golf Course Pumping From Water Year 2013 Onwards

The simulation assumes that golf course pumping is based on the hydrologic year. For example, pumping in January 2015 was assumed to be the amount pumped in January 1993, because the simulated 2015 hydrology is based on 1993 hydrology. This ensures that the demand corresponds to the hydrology. If the amount pumped by a golf course pre-adjudication exceeded the golf course's adjudicated right, pumping was capped at the golf course's adjudicated amount.

Additional golf course pumping adjustments accounted for in the simulation were:

- The Bayonet and Blackhorse golf courses pumped no water until September 2016. This is based on an in-lieu replenishment program the City of Seaside implemented for its golf course pumping. Under this program, Marina Coast Water District provided water in-lieu of the City pumping from the Seaside Basin. The City is assumed to start pumping its golf course wells again starting September 2016.
- In 2007, irrigation upgrades at the Bayonet and Black Horse golf courses reduced irrigation demand by approximately 10% from historical amounts.
- The City of Seaside was assumed to begin pumping an average of 360 AFY from its wells for golf course supply starting in September 2016. These projected quantities were used rather than basing demand on the hydrology year.

Predicted Alternative Producer and Private Pumping

Predicted alternative producer pumping was set at measured Water Year (WY) 2011 volumes from WY 2013 onwards. All other pumpers not covered by the Decision, including Cal Water Service and private wells, also pumped at WY 2011 volumes from WY 2013 onwards.

The simulation accounted for the following pumping exceptions:

- Water for SNG, which is an Alternative Producer, is supplied from Cal-Am wells under an agreement with Cal-Am. When the SNG site is developed they will be supplied with water by Cal-Am, who will use SNG's water right of 149.7 acre-feet/year. Currently there is no production from the SNG well. Based on input from the property owner, Ed Ghandour, project construction was simulated as starting in 2013, and used 25 AFY of water. Water usage thereafter was estimated to be:
 - o 2014 30 AFY
 - o 2015 50 AFY
 - \circ 2016 onwards 70 AFY



NO-PROJECT SCENARIO

The No-Project scenario developed for the EIR analysis was also used as a No-Project scenario in the current analysis. The No-Project scenario included all of the assumptions on future hydrology, future ASR injection, future municipal pumping, and future alternative producer pumping discussed above, and also used the updated local Santa Margarita Aquifer hydrogeologic properties. No Project injection was included in the No-Project scenario.

Cal-Am pumping in the No-Project scenario was estimated using the same assumptions detailed above. The only difference is that no Project water was available for extraction. The total annual amount of water pumped by Cal-Am is shown on Figure 8. The monthly pumping by well for the No-Project scenario is shown in Figure 9.



Figure 8. Annual Cal-Am Water Allocation by Water Right Source for No-Project Scenario


Figure 9. Monthly Pumping Totals by Well for No-Project Scenario



PARTICLE TRACKING APPROACH

Particle tracking was conducted to estimate the fate and transport of injected Project purified recycled water. Particles were first introduced around all four PWM Project injection wells on the simulated period corresponding to October 1, 2016. A new set of particles was released into the model at the beginning of every month until the end of the simulation in 2042. Each month, 40 particles were released from each injection well. Every particle was tracked through the model until it terminated at an extraction well, or until the end of the simulation period in 2042. By introducing the particles continuously, we ensured that there were particles introduced and tracked during times when the travel times would be the fastest.

Particles were placed along the edges of each of the model grid cells that contained the injection and vadose wells, and whose dimensions are shown in Table 4. This strategy is necessary to ensure that the particles are carried outward in all directions in the same manner that water would travel radially from a well. Placing many particles at the exact location of the well results in only a single path taken by all particles. While the approach of placing particles around the edge of the model cell gives a more accurate picture of the dispersal pattern of the water from the injection wells, it also places some particles initially closer to the extraction wells than other particles, potentially resulting in faster simulated travel times.

	Recharge	Model Grid Cell Dimensions								
	Well	Side Length 1 (ft)	Side Length 2 (ft)	Area (ft ²)						
-	DIW-1	100.0	375.0	37,500.0						
-	DIW-2	150.0	281.5	42,225.0						
_	VZW-1	100.0	250.0	25,000.0						
_	VZW-2	225.0	281.5	63,337.5						

Table 4. Dimensions of Model Grid Cells Containing Project Recharge We	ells

Particles are captured by wells not when they reach the exact location of the extraction wells, but when they reach the edge of the model grid cell that contains an extraction well. This also leads to faster simulated travel times. The results shown below should therefore be considered conservative estimates as they do not include the additional travel time that would occur from the edge of the grid cell to the actual location of the well. For the vadose zone wells, the particles are simulated as being released at the top of water table, and thus the travel times are also conservative as they do not include the time the water takes to percolate through the vadose zone. A brief analysis estimating the



magnitude of the additional intra-cell and vertical vadose zone travel times is presented at the end of the results section.

MODEL RESULTS

Particle Tracking Results

Figure 10 and Figure 11 show the path each particle released on a specific date takes from its initial injection location to either an extraction well or its final location when the simulation ends. The position of each particle is color-coded according to the travel time to reach that position. Figure 10 shows the paths originating from DIW-1 and DIW-2 in the Santa Margarita Aquifer, and Figure 11 shows the paths originating from VZW-1 and VZW-2. The particle tracks shown on each figure display the fate of all particles that were released in the model period corresponding to February 1, 2030. This date was selected because it is the release period resulting in the fastest observed travel time (328 days, or 10.8 months, between DIW-2 and ASR-1&2). The travel time color-coding illustrates that although the fastest particle travel path from the deep injection reaches may reach ASR 1&2 in under 12 months, the rest of particles don't arrive until after more than 12 months.

The particle path figures show that the northwestern-directed groundwater flow field dominates the migration of particles from the vadose zone wells while the local dynamics of the many deep injection and extraction wells dominate the migration pathways of the particles from the deep injection wells. As noted above, there are several particle paths that fluctuate towards and away from the ASR 1&2 well locations before the particles are captured. These fluctuations are the result of the injection and extraction pattern at the ASR wells. For the vadose zone injection Figure 11 shows some particle path lines which appear to bifurcate and/or take very sharp turns. These occur at the locations where particles have moved downward from a shallow to deeper model layer and experience changes in the magnitude and direction of flow gradients due to different conditions (e.g. different extraction well screen depths and/or different hydraulic properties).

The production wells that capture particles released from any of the four Project recharge wells are ASR 1&2, Luzern, Ord Grove #2, and Paralta. No particles are captured by ASR 3&4 or City of Seaside #3 for this simulation. Table 5 lists the fastest travel times between each recharge well and the group of six nearest extraction wells. No value is shown if no particle travelled between the two wells.





Figure 10. Particle Paths and Travel Times from Deep Injection Wells for Single Particle Release Time



Figure 11. Particle Paths and Travel Times from Vadose Zone Wells for Single Particle Release Time



	Recharge Well of Origin							
Extraction Well	DIW-1	DIW-2	VZW-1	VZW-2				
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					

 Table 5. Fastest Travel Times between Recharge and Extraction Wells during the 25-Years of Simulated

 Project Recharge, in days

Note: - = no particle traveling between wells

Figure 12 shows the fastest travel times between the PWM Project injection wells and the nearest extraction wells vary depending upon time of release. The horizontal axis represents the time at which groups of particles were released from the injection wells and the vertical axis represents time in days it took for the fastest particle to reach an extraction well. Each dot represents the time travelled by the fastest particle. The green and red dots show travel times from the locations of the deep injection wells DIW-1 and DIW-2, respectively. The magenta dots show travel times from the locations of the vadose zone well VZW-1, and travel times from VZW-2 are shown in orange.

The fastest particles are those released from well DIW-2 and captured at the ASR 1&2 Well Site. The fastest time any particle takes to travel from an injection well to a nearby extraction well is 328 days (10.8 months). Travel times from deep injection well DIW-1 are the next fastest; taking approximately 344 days (11.4 months) for the fastest particles to reach the ASR 1&2 Well Site. The fastest particles released from the Vadose Zone wells are from VZW-2 which take 1,394 days (44.3 months, or 3.7 years) to reach the Luzern well, followed closely by VZW-1 to Paralta with travel time of 1,399 days (46 months, or 3.8 years). Note that the travel time from VZW-2 to the Ord Grove #2 well is much slower (21.1 years) than the travel time to the further away 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.

The majority of the particle travel times to production wells take longer than one year and travel times of less than a year occur in only 13 months out of the 300 months during which the PWM project is simulated being in operation, which is 4% of the time.



For most of the wells, there is a notable variation throughout the simulation in the minimum travel time taken by the released particles. Travel times from both deep injection wells are strongly influenced by the injection-extraction cycles of the ASR wells. Travel times from well DIW-2 experience more influence from the ASR wells than travel times from well DIW-1 because it is closer to the ASR well sites. These ASR wells both inject and extract water throughout the simulation period, thereby impacting groundwater gradients. These ASR wells sometimes draw particles in and sometimes repel them, creating greatly different trajectories depending on when a particle approaches the ASR wells. For example, particles that are released from well DIW-2 in the late winter and early spring and captured by wells ASR 1&2 in the late fall experience the fastest travel times. These particles approach the ASR 1&2 wells during fall pumping season and are captured before any injection begins in the winter. Particles that approach the ASR wells during the simulated drought of 2030-2034 experience less seasonal variation in travel times. During this period, particles encounter no injection of Carmel River water that would repel them from their path, and less pumping to draw them toward a well.



Figure 12. Fastest Travel Times to a Pumping Well versus Release Dat



The two vadose zone wells also display variations in minimum travel times throughout the simulation period. These particles are initially released at shallow depths, above the influence of the large-capacity injection and extraction wells. The dynamics of the shallow layers in the model are mostly influenced by fluctuations in natural recharge and by the vadose zone injection itself. Variations in these factors can lead to saturation, desaturation of shallow model cells, and rapid changes in vertical and horizontal gradients in these cells. Particles also move from shallower to deeper model layers where they experience different gradients and groundwater velocities depending on the extraction wells active in those layers. This type of behavior explains the large fluctuations in minimum travel times that are seen in vadose zone well VZW-2. The behavior is most notable following the first simulated drought in WY2024 during which project recharge to the shallow aquifer drops by 300 acre-feet and water levels in the specific grid cells to which recharge is applied drop suddenly and then rise again suddenly the following year.

Table 6 shows the percent of particles injected at each of the injection locations that were captured by each extraction well. This table only shows the fate of the captured particles – not the fate of all particles. As a result, the columns add to 100% for each scenario, even though most of the particles released from the vadose zone wells were not captured by the end of the simulation. The Paralta, Ord Grove 2, and Luzern wells capture the greatest share of the captured particles even though it takes considerably longer for particles to travel to these wells, as shown on Figure 12.

		Recharge Well of Origin							
Extraction Well	DIW-1	DIW-2	VZW-1	VZW-2					
ASR 1&2	24%	33%	0	0					
ASR 3&4	0	0	0	0					
City Seaside #3	0	0	0	0					
Luzern	0	0	0	95%					
Ord Grove 2	0	61%	1%	5%					
Paralta	76%	6%	99%	0					

Table 6. Percent of Particles Travel between Injection and Extraction Wells

Note: -- = no particle traveling between wells



We emphasize that the travel times shown in Table 5 are the shortest travel times observed in the simulation and do not represent a typical travel time for the corresponding injection-extraction well pair. Histograms of the distribution of travel times from DIW-1 and DIW-2 to ASR 1&2 are presented on Figure 13 and show that most of the particles released at these wells take well over a year to reach the ASR 1&2 wells. Statistics for these travel times are presented in Table 7; the median travel times (50th percentile) for both DIW-1 and DIW-2 are greater than 600 days and 75% of the particles (25th percentile) from both wells take over 500 days to reach ASR 1&2.



Figure 13. Histograms of travel times between DIW-1 and DIW-2 and ASR 1&2



Well of	Percentile of travel times to ASR 1&2 (days)							
ongin	25 th	50 th	75 th					
DIW-1	505	612	786					
DIW-2	591	831	1,145					

Table 7	7 5	Statistics	for	Travel	Times	from	DIW-2	and	DIW-1	l to	ASR	182
				110101	111100	II OIII		ana			71011	102

As described earlier, the estimated travel times are conservative in that the particles are released and captured at the edges of the model grid cells that contain the injection and extraction wells, rather than at the wells themselves. The intra-grid cell travel time that the particles would occur as particles moved the injection well to the edge of grid cell, and then from the edge of the extraction well grid cell to the well itself, are excluded. The magnitude of the intra-cell travel time depends on the injection/extraction rate at each well, and the distance from the edge of the cell to the actual location of the well within the grid cell. In order to provide an estimate for the magnitude of this additional intra-cell travel time, an analytic expression for the travel time to/from a pumping/injecting well operating at a constant flow rate (USEPA, 1987) was used. For travel times between DIW-1 and DIW-2 and the ASR-1&2 locations, this intra-grid cell travel time is estimated to add somewhere between 11 to 23 days of additional travel time. Similarly, for the vadose zone wells, the simulated recharge is modeled as being applied directly to the top of water table in the upper aquifer, and does not explicitly account for the vertical travel time that would occur through the vadose zone as the water percolates down to the water table. The general magnitude of this vertical travel time was conservatively estimated by using Darcy's Law to calculate the vertical travel time over the distance from 100 feet below ground surface down through each of the upper aquifer layers down to the top of the water table, utilizing the calibrated saturated vertical hydraulic conductivities for each layer and an assumption of a unit hydraulic gradient, and a porosity of 20%. For VZW-1 this vertical vadose travel time was estimated to be on the order of 245 days, and for VZW-2 on the order of 313 days.

It should be noted that the advective groundwater velocity which determines the travel time of particles from the recharge wells, is slower than the velocity of pressure propagation that occurs with the increase in pressure head (or hydraulic heads) that spreads out from the recharge wells. Thus for a confined aquifer such as the Santa Margarita Aquifer, the hydraulic head increases associated with the project propagate outward into the aquifer faster than the actual injected water moves.



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	Simulated		Drought			Annual			on concaa.		otorago an		In	iection De	liverv Sche	edule (AFN	/1)				
	Historical	Salinas	Year			Recycled	Drought	Cumulative									,				
	Climate	Station	Criteria	Injection	Injection	Water to	Reserve	Drought													
Water	Water	Precip	(<75% of	Delivery	Volume	CSIP	Change	Reserve													
Year	Year	(% of Ave.)	Average)	Schedule	(AF)	(AF)	(AF)	(AF)	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	June	July	Aug	Sep	Total
2017	1995	131%		A	3,700	-	200	200	331	321	331	331	299	331	288	297	288	297	297	288	3,700
2018	1996	95%		A	3,700	-	200	400	331	321	331	331	299	331	288	297	288	297	297	288	3,700
2019	1997	123%		A	3,700	-	200	600	331	321	331	331	299	331	288	297	288	297	297	288	3,700
2020	1998	240%		A	3,700	-	200	800	331	321	331	331	299	331	288	297	288	297	297	288	3,700
2021	1999	98%		A	3,700	-	200	1,000	331	321	331	331	299	331	288	297	288	297	297	288	3,700
2022	2000	114%		В	3,500	-	-	1,000	297	288	297	297	268	297	288	297	288	297	297	288	3,500
2023	2001	93%		В	3,500	-	-	1,000	297	288	297	297	268	297	288	297	288	297	297	288	3,500
2024	2002	74%	Drought	G	2,500	1,000	(1,000)	-	297	288	297	297	268	297	124	128	124	128	128	124	2,500
2025	2003	94%		A	3,700	-	200	200	331	321	331	331	299	331	288	297	288	297	297	288	3,700
2026	2004	82%		A	3,700	-	200	400	331	321	331	331	299	331	288	297	288	297	297	288	3,700
2027	2005	148%		A	3,700	-	200	600	331	321	331	331	299	331	288	297	288	297	297	288	3,700
2028	2006	118%		A	3,700	-	200	800	331	321	331	331	299	331	288	297	288	297	297	288	3,700
2029	2007	73%	Drought	D	2,700	1,000	(800)	-	331	321	331	331	299	331	124	128	124	128	128	124	2,700
2030	2008	79%		A	3,700	-	200	200	331	321	331	331	299	331	288	297	288	297	297	288	3,700
2031	1987	60%	Drought	E	3,300	400	(200)	-	331	321	331	331	299	331	222	229	222	229	229	222	3,300
2032	1988	40%	Drought	F	3,500	200	-	-	331	321	331	331	299	331	255	263	255	263	263	255	3,500
2033	1989	63%	Drought	F	3,500	200	-	-	331	321	331	331	299	331	255	263	255	263	263	255	3,500
2034	1990	57%	Drought	F	3,500	200	-	-	331	321	331	331	299	331	255	263	255	263	263	255	3,500
2035	1991	88%		A	3,700	-	200	200	331	321	331	331	299	331	288	297	288	297	297	288	3,700
2036	1992	90%		A	3,700	-	200	400	331	321	331	331	299	331	288	297	288	297	297	288	3,700
2037	1993	140%		A	3,700	-	200	600	331	321	331	331	299	331	288	297	288	297	297	288	3,700
2038	1994	83%		A	3,700	-	200	800	331	321	331	331	299	331	288	297	288	297	297	288	3,700
2039	1995	131%		A	3,700	-	200	1,000	331	321	331	331	299	331	288	297	288	297	297	288	3,700
2040	1996	95%		В	3,500	-	-	1,000	297	288	297	297	268	297	288	297	288	297	297	288	3,500
2041	1997	123%		В	3,500	-	-	1,000	297	288	297	297	268	297	288	297	288	297	297	288	3,500

Table 8 Planned Project Water	Injection Schedule and CSIE	Storage and Delivery Operation

Injection Delivery Schedule (AF/month)				Nov	Dec	Jan	Feb	Mar	Apr	May	June	July	Aug	Sep	Total
before drought reserve complete	wet/normal year	А	331	321	331	331	299	331	288	297	288	297	297	288	3,700
after drought reserve complete	wet/normal year	В	297	288	297	297	268	297	288	297	288	297	297	288	3,500
before drought reserve complete	drought year (min. AWTF delivery)	С	331	321	331	331	299	331	107	111	107	111	111	107	2,601
before drought reserve complete	drought year (1,000 AF to CSIP)	D	331	321	331	331	299	331	124	128	124	128	128	124	2,700
before drought reserve complete	drought year (400 AF to CSIP)	E	331	321	331	331	299	331	222	229	222	229	229	222	3,300
before drought reserve complete	drought year (200 AF to CSIP)	F	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)	G	297	288	297	297	268	297	124	128	124	128	128	124	2,500



Recharge Impacts Assessment Report

March 2015

Pure Water Monterey Groundwater Replenishment Project







RECHARGE IMPACTS ASSESSMENT REPORT

PURE WATER MONTEREY GROUNDWATER REPLENISHMENT (GWR) PROJECT

March 2015

TODD GROUNDWATER

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Appendices

APPENDIX A: Todd Groundwater, Technical Memorandum, To: Bob Holden, PE, From: Phyllis Stanin, Selection of Recharge Location for GWR Project, Seaside Groundwater Basin, May 29, 2014.

APPENDIX B: HydroMetrics Water Resources Inc. (HydroMetrics), Memorandum to Mr. Bob Holden, Subject: Groundwater Replenishment Project Development Modeling, October 2, 2013. <u>Removed from this document. Replaced by Montgomery & Associates Technical</u> Memorandum, March 25, 2019.

APPENDIX C: HydroMetrics WRI (HydroMetrics), Technical Memorandum, To: Bob Holden/ MRWPCA, From: Stephen Hundt and Derrik Williams, GWR Project EIR: Project Modeling Results, January 12, 2015. <u>Removed from this document. Replaced by Montgomery &</u> Associates Technical Memorandum, March 25, 2019.

APPENDIX D: Groundwater Quality Analytical Program, Groundwater Analytical Results, MRWPCA Field Program, Tables D-1 and D-1A through D-1P.

1. INTRODUCTION

Monterey Regional Water Pollution Control Agency (MRWPCA), in partnership with Monterey Peninsula Water Management District (MPWMD), is developing the Proposed Pure Water Monterey Groundwater Replenishment (GWR) Project (Proposed Project) to provide a high-quality recycled water supply for the northern Monterey County area. The Proposed Project consists of two components: advanced treated water for injection in the Seaside Groundwater Basin to replace urban supplies (the GWR Facilities) and additional recycled water for irrigation supplies to be provided through the existing Castroville Seawater Intrusion Project (CSIP). Specifically, MRWPCA plans to construct and operate an advanced water treatment facility (AWTF) to produce up to 3,700 acre feet per year (AFY) of highly-purified recycled water for conveyance to and recharge in the Seaside Groundwater Basin. In addition, MRWPCA would deliver approximately 4,750 to 5,290 AFY of supplemental water to the CSIP area.

In accordance with the California Environmental Quality Act (CEQA), MRWPCA as the lead agency is preparing an Environmental Impact Report (EIR) for the Proposed Project. This report is being prepared to assess potential impacts of the Proposed Project on groundwater resources. Although the Seaside Basin recharge and CSIP delivery components of the Proposed Project are closely related, this impacts assessment report focuses on groundwater impacts from injection and recovery of the Proposed Project water (product water) in the Seaside Basin. Potential impacts from the irrigation water component are addressed separately in the EIR.

This recharge impacts assessment report provides details on proposed recharge facilities including injection wells (Injection Well Facilities) and general information on how the Proposed Project would be constructed and operated. In addition, an analysis of potential impacts from the Proposed Project on groundwater resources (including water levels and quality) is presented to support the EIR.

1.1. GWR FACILITIES

The Proposed Project would provide up to 3,700 AFY of product water for recharge in the Seaside Groundwater Basin (or Seaside Basin). The feed water for treatment at the new AWTF would be secondary-treated municipal wastewater from MRWPCA's Regional Treatment Plant (RTP). Prior to treatment at the RTP, the raw municipal wastewater would be augmented by urban stormwater/runoff, agricultural wash water, and runoff collected in local drainage ditches including the Reclamation Ditch, the Blanco Drain, and Tembladero Slough. The AWTF would include pre-treatment (using pre-screening, ozone, and potentially biologically activated filtration); membrane filtration; reverse osmosis (RO); advanced oxidation (AOP) using ultraviolet light (UV) and hydrogen peroxide; and product water stabilization with calcium and alkalinity.

The AWTF recycled water would be conveyed by pipeline from the AWTF to newlyconstructed shallow and deep recharge (injection) wells in the north-central portion of the Seaside Basin (Figure 1). Recharged water would be stored in the groundwater basin for subsequent extraction by California American Water Company (CalAm) using existing production wells. The Proposed Project would increase the basin yield and allow CalAm to reduce Carmel River diversions in compliance with a state order to secure replacement water supplies (MRWPCA, May 2013).

Recycled water would be recharged into the Seaside Basin's two primary aquifers used for water supply - the Paso Robles Aquifer and the underlying Santa Margarita Aquifer. Recharge would be accomplished through relatively shallow vadose zone wells (Paso Robles Aquifer) and deep injection wells (Santa Margarita Aquifer). Locations of the Proposed Project Injection Well Facilities site and proposed vadose zone and deep injection wells are shown on Figure 2.

This report focuses on the Proposed Project recharge, storage, and recovery operations and analyzes potential impacts from the Proposed Project on groundwater resources. The groundwater impacts assessment will provide technical support for the EIR.

1.2. REPORT GOAL AND OBJECTIVES

The goal of this report is to assist with development and implementation of the Proposed Project by developing and analyzing the recharge components of the project. Specifically, the recharge components include recharge wells (also referred to as injection wells), operational facilities, and the fate and transport of the recycled water in the groundwater basin. To achieve this goal, the following objectives have been identified for this report:

- provide the technical basis for Proposed Project recharge components including wells and operational facilities
- support the EIR with a groundwater impacts analysis
- outline potential steps for construction and operation of the recharge components of the Proposed Project
- provide a preliminary schedule for construction of recharge components
- incorporate existing studies for project development and implementation.

1.3. INCORPORATION OF RECENT STUDIES

Numerous studies have been conducted involving various aspects of the Proposed Project. Collectively, these studies provide the technical basis for project development and operations and support ongoing analyses including preparation of an EIR. Studies summarized below are the most relevant for the groundwater and recharge components of the Proposed Project and do not represent a comprehensive list. The following descriptions of the studies provide an understanding of how the work done by others is incorporated into this report.

1.3.1. MRWPCA Field Program

In December 2013 and January 2014, Todd Groundwater developed and implemented a field program (referred to herein as the MRWPCA field program or field program) in the vicinity of the Proposed Project Injection Well Facilities site. The field program involved data collection and testing through the 400 feet of vadose zone and installation and sampling of a new monitoring well drilled to a depth of 535 feet. The entire borehole was continuously cored and selected core samples were analyzed for hydraulic properties, mineralogy, and leaching potential. The new well, MRWPCA MW-1, is screened in the upper Paso Robles Aquifer and is capable of monitoring the water table beneath the site. MRWPCA MW-1 and five existing nearby production and monitoring wells were sampled to supplement existing groundwater quality data in the area. MRWPCA MW-1 and the five additional wells (FO-7 Shallow, FO-7 Deep, PRTIW, ASR MW-1, and Seaside 4) are shown on Figure 2.

The field program also included an analysis of potential geochemical changes in groundwater as a result of the Proposed Project. In conformance with the State Recycled Water Policy (California SWRCB, 2013), a Regional Water Quality Control Board may impose restrictions on a proposed groundwater replenishment project if the project changes the geochemistry of an aquifer thereby causing the dissolution of constituents from the geologic formation into groundwater. To assess if the Proposed Project has the potential to cause dissolution, laboratory leaching analyses were conducted on core samples to ensure the protection of groundwater beneath the Proposed Project's vadose zone wells. Results of the leaching analyses were further analyzed using geochemical modeling.

Results of the program have been documented and analyzed in a separate report prepared by Todd Groundwater (Todd Groundwater, 2015). The groundwater quality data collected during the MRWPCA field program, along with the results of the core leaching analyses and associated geochemical modeling, are incorporated herein (see sections 7.3 and 7.4) to assist with the assessment of potential impacts from the Proposed Project on groundwater quality.

1.3.2. Proposed Project Product Water Quality

MRWPCA constructed a GWR pilot treatment plant on the RTP site to evaluate treatment options for the AWTF and collected data to characterize the water quality of the product water and reverse osmosis concentrate by-product. The GWR pilot plant product water was analyzed for various constituents as the treatment process was adjusted and optimized. Analyses demonstrated that the product water would meet drinking water standards. However, the GWR pilot plant did not include a process to provide chemical stabilization, which would be included in the proposed AWTF to protect against corrosion in conveyance pipelines and recharge wells. The planned stabilization would also limit the potential for product water injected into the Proposed Project vadose zone wells to leach constituents from the geologic formation and impact groundwater quality as mentioned above. Bench scale chemical stabilization was conducted on the GWR pilot plant product water to simulate final water quality and to allow for evaluation of the leaching potential of the recycled water as part of the laboratory leaching analyses. Additional details and water quality data of the bench scale water sample are provided in Section 7.3.4. Results of the leaching analyses and geochemical modeling are summarized in Section 7.3.5 of this report. Details of the analysis and an expanded discussion of the results are presented in the draft report on the field program (Todd Groundwater, 2015).

1.3.3. Groundwater Modeling with the Seaside Basin Watermaster Model

To provide a quantitative assessment of the Proposed Project impacts on water levels and other production wells, and to assess changing conditions relating to the potential for seawater intrusion, a basin-wide numerical model has been used. Specifically, the Seaside Basin Watermaster has constructed and calibrated a multi-layer transient groundwater flow model using MODFLOW 2005. HydroMetrics WRI (HydroMetrics), consultant to the Seaside Basin Watermaster, has been retained by MRWPCA to apply the Watermaster model to simulate potential impacts of the Proposed Project on groundwater resources. Results of the modeling are presented in a technical memorandum (TM), included as Appendix C of this report and summarized herein.

2. RECYCLED WATER DELIVERY FOR RECHARGE

MRWPCA has evaluated the amounts and availability of the Proposed Project source waters and has developed estimates of monthly deliveries of recycled water to the Seasisde Basin. On average, about 3,500 AFY would be delivered to the Seaside Basin, but monthly amounts would vary based on hydrologic conditions.

Specifically, the Proposed Project would incorporate the concept of a drought reserve account. During wet and normal years, the Project would convey an extra 200 acre feet (AF) of advanced treated water to the Seaside Basin for recharge and storage, up to a cumulative total of 1,000 acre feet. During dry conditions, the Project could reduce its deliveries to the Seaside Basin by as much water as had accumulated in the drought reserve. The Project water that is not delivered to the Seaside Basin would instead be used to augment irrigation supplies delivered through the CSIP. CalAm would continue to extract 3,500 AFY for municipal supplies by using the water stored in the drought reserve. These operational guidelines have been translated into potential monthly delivery amounts to the Seaside Basin as discussed in more detail below.

2.1. DELIVERY SCHEDULES AND OPERATION OF THE DROUGHT RESERVE ACCOUNT

MRWPCA has evaluated the availability and amounts of source waters, capacity of the AWTF, minimum delivery targets, and operational guidelines discussed above in order to develop potential delivery schedules for recharge to the Seaside Basin. Based on this analysis, there are eight potential delivery schedules that could occur, based on two water management decision points made in each year of GWR operation. These eight delivery schedules are presented in Table 1. The two management decisions that determine appropriate deliveries to the Seaside Basin are described below.

The first management decision would be made by October 1, the beginning of the water year,¹ and would dictate which of two delivery schedules is followed during October through March of that water year. The decision would be based on whether or not the drought reserve account is full (1,000 AF). If the account is full, the project would deliver monthly amounts from October through March based on average annual deliveries (highlighted in purple on Table 1; for example, see October through March deliveries for Schedule 2 and Schedule 8). If the account balance is less than 1,000 AF on October 1, then an additional 200 AF would be delivered from October through March (highlighted on Table 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 would produce a total of 3,700 AFY (Schedule 1) or a total of 3,500 AFY (Schedule 2) (Table 1).

¹ A Water Year 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.

Product Water Delivery Schedules for			Acre-Feet per Month (AF/month)										Total	Add to	Available		
Seaside Basin Injection			Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	June	July	Aug	Sep	AFY	Reserve	in Reserve
1	Drought Reserve <1,000 AF	Wet/Normal Year	331	321	331	331	299	331	288	297	288	297	297	288	3,700	200	-
2	Drought Reserve 1,000 AF	Wet/Normal Year	297	288	297	297	268	297	288	297	288	297	297	288	3,500	-	-
3	Drought Reserve <1,000 AF	Drought Year	331	321	331	331	299	331	255	263	255	263	263	255	3,500	200	200
4	Drought Reserve <1,000 AF	Drought Year	331	321	331	331	299	331	222	229	222	229	229	222	3,300	200	400
5	Drought Reserve <1,000 AF	Drought Year	331	321	331	331	299	331	189	196	189	196	196	189	3,100	200	600
6	Drought Reserve <1,000 AF	Drought Year	331	321	331	331	299	331	156	162	156	162	162	156	2,900	200	800
7	Drought Reserve <1,000 AF	Drought Year	331	321	331	331	299	331	124	128	124	128	128	124	2,700	200	1,000
8	Drought Reserve 1,000 AF	Drought Year	297	288	297	297	268	297	124	128	124	128	128	124	2,500	-	1,000
Maximum Monthly Injection Rates			Injection Rates in Gallons per Minute (gpm)										Maximu	m			
			Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	June	July	Aug	Sep		(gpm)	
Santa Margarita Aquifer (90%)			2,175	2,179	2,175	2,175	2,175	2,175	1,955	1,951	1,955	1,951	1,951	1,955		2,179	
	Paso Robles Aquifer (10%)			242	242	242	242	242	217	217	217	217	217	217		242	
	Total			2,422	2,417	2,417	2,417	2,417	2,173	2,168	2,173	2,168	2,168	2,173		2,422	

Table 1.Product Water Available for Injection

The second management decision would be made in early Spring as to which schedule will be followed for deliveries in April through September. This decision would 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 would be made by the Monterey County Water Resources Agency (MCWRA). If it is a wet/normal year, the delivery would follow the April through September delivery schedule shown for both Schedule 1 and Schedule 2. However, if MCWRA requests water from the drought reserve account during a drought year, the delivery schedule for April through September would follow one of the drought delivery schedules shown in green on Table 1. The selection of the drought schedule would be based on the then-current balance in the drought reserve account (as of April 1 – see last column on Table 1).

2.2. MAXIMUM DELIVERY FOR RECHARGE

The maximum monthly amount of advanced-treated recycled water available from any of the eight potential delivery schedules on Table 1 has been converted to a maximum monthly injection rate in gallons per minute (gpm) for each aquifer. These rates are summarized in the lower portion of Table 1. The maximum injection rates are estimated for planning purposes to design recharge facilities that will accommodate peak flows and to inform the number and spacing of injection wells. As shown in Table 1, the total maximum injection rate for any of the schedules is 2,422 gpm (lower right on Table 1). Assuming 90 percent of the water is injected into the deeper Santa Margarita Aquifer, deep injection wells need to accommodate an estimated peak flow of about 2,179 gpm (see Section 3.3.5.1 for an explanation on allocating recharge between the two aquifers). Assuming 10 percent of the water is injected into the Paso Robles Aquifer, shallow injection (or vadose zone) wells would need to be capable of injection rates up to about 242 gpm.

For the purposes of project planning and EIR analysis, recharge facilities are sized for these maximum rates incorporating conservative injection rates and allowing for down-time associated with well operation and maintenance. As actual operation is refined, monthly injection amounts can be balanced with operation at the AWTF, as needed. However, this approach provides future project flexibility and allows for evaluation of reasonable "worst-case" potential environmental impacts on groundwater resources associated with the recharge component of the Proposed Project.

3. PROJECT LOCATION AND HYDROGEOLOGIC SETTING

3.1. GROUNDWATER BASIN AND STUDY AREA

The Proposed Project Injection Well Facilities site is located within a portion of the Seaside Subbasin of the Salinas Valley Groundwater Basin as defined by the California Department of Water Resources (CDWR) in the Bulletin 118 description of California's groundwater basins (CDWR, 2004). The boundaries of the Seaside Subbasin and delineation of four subareas within the subbasin have been redefined by Yates et al. (2005) based on a reinterpretation of geologic faulting and groundwater flow divides. The northern basin boundary is based on a groundwater divide that is subject to movement with changing conditions in groundwater levels (Yates, et al., 2005; HydroMetrics, 2010).

The redefined subbasin covers about 20 square miles and is referred to as the Seaside Groundwater Basin, or simply Seaside Basin, in this report. The boundaries of the Seaside Groundwater Basin and four subareas are shown on Figure 1. Basin wells (including production and monitoring wells) are also shown on the figure to highlight areas of groundwater development. Figure 2 includes production and monitoring wells in the vicinity of the Proposed Project Injection Well Facilities.

The Proposed Project Injection Well Facilities would be located within the northeasternmost subarea of the Seaside Groundwater Basin, referred to as the Northern Inland Subarea (Figure 1). The site is close to the Northern Coastal Subarea where most of the basin's groundwater pumping occurs (as indicated by the relatively large number of wells on Figure 1). Groundwater production also occurs in the Southern Coastal Subarea and the Laguna Seca Subarea.

Historically, only minimal pumping has occurred within the Northern Inland Subarea. Of the three wells in the subarea shown on Figure 1, only one well - the City of Seaside Reservoir Well (identified on Figure 2) - has provided water supply. The other two wells in the Northern Inland Subarea are monitoring wells. The subarea has remained largely undeveloped as a result of its long-term use as a large firing range by the U.S. Army on the former Fort Ord military base, which closed in 1994.

The southern subareas are considered less hydraulically connected to the Proposed Project Injection Well Facilities area and are not included in the Study Area for the impact analysis. Accordingly, for the purposes of the impact analysis, the Study Area is defined as the Northern Inland and Northern Coastal subareas of the Seaside Groundwater Basin.

3.1.1. Seaside Basin Adjudication

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 sources of water from outside the basin for injection into the basin or for replacing pumping (i.e., in lieu replenishment). Further, the Watermaster has responsibilities with respect to securing replenishment water from outside the basin to offset the over-production in the basin.

3.1.2. Groundwater Use

Groundwater pumping in the Seaside Groundwater Basin provides water supply for municipal, irrigation (primarily golf courses), and industrial uses. Historically, about 70 to 80 percent 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 79 percent of the groundwater pumped in water year (WY) 2013² (Watermaster, 2013).

Available annual pumping in the Coastal subareas and total basin production over the last 20 years are shown on Figure 3. Over this time period, production in the Coastal subareas has averaged about 4,000 AFY and total basin production has averaged about 5,000 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 State Water Resources Control Board (SWRCB) placed constraints on out-of-basin supplies (Figure 3).

Since 2008, groundwater pumping has declined. Pumping in coastal subareas averaged about 4,505 AFY from 1996 through 2008, but has decreased to about 3,288 AFY from 2009 through 2013 (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 production data in Figure 3 do not include injection and recovery from the nearby Monterey Peninsula Aquifer Storage and Recovery Project (ASR Project) where about 1,100 AFY has been injected and/or recovered from 2010 through 2012. Details of that project are summarized in the following subsection.

3.1.3. ASR Project

The ASR Project is operating in the Seaside Basin downgradient and within about 1,000 feet from the Proposed Project Injection Well Facilities site. CalAm and MPWMD are in partnership in implementing the ASR Project, which involves the injection of treated Carmel River Basin groundwater into a series of ASR wells for seasonal storage in the basin and subsequent recovery for drinking water supply.

² Water Year (WY) 2013 begins October 1, 2012 and ends September 30, 2013.

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). The ASR wells are also planned for injection of product water from a proposed ocean desalination plant to be developed by CalAm.

As of 2014, four ASR wells have been installed along General Jim Moore Boulevard in the City of Seaside, California (Figure 2). ASR-1 and ASR-2 are located about 1,000 feet northwest of the Proposed Project Injection Well Facilities site. ASR-3 and ASR-4 are located about 1,600 feet to the northwest of the Proposed Project wells (Figure 2).

The amount of Carmel River water injected varies from year to year depending on 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). Table 2 summarizes river water that has been injected and recovered as part of the ASR Project for the last five complete water years.

Water Year	ASR Injection (AFY)	ASR Recovery (AFY)
2010	1,110	0
2011	1,117	1,110
2012	131	1,117
2013	294	644
2014	0	0
Total	2,652	2,871

Table 2. Injection and Recovery Volumes, ASR Project

Although data in Table 2 indicate that the ASR Project has recovered more water than injected over the last four years, the table does not include the full historical record of all of the injected water as the first ASR test well was drilled in 1998. A regulatory order requires that the injected Carmel River water be extracted to meet demands, and the project is not operated for the long-term replenishment of basin aquifers (i.e., recharge that is kept in the basin without extraction) (Watermaster, 2012).

3.1.4. Watermaster Numerical 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 model provides a basin-wide tool for evaluating protective water levels and various groundwater management strategies.

The Watermaster model covers approximately 76 square miles of the Salinas Valley Groundwater Basin including the Seaside Groundwater 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 units³ as follows:

- Layer 1 Older Dune deposits and Aromas Red Sand
- 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
- Layer 5 Santa Margarita Aquifer (including the Purisima Formation where present).

Additional details on the basin hydrostratigraphy and aquifers are discussed in Section 4 of this report.

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 occur 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).

The model provides a valuable quantitative tool for the evaluation of the Proposed Project and potential impacts to basin water levels and wells. HydroMetrics has been contracted by MRWPCA to apply the model to simulate aquifer response to various conditions including No-Project conditions and conditions associated with the Proposed Project. Modeling results are provided in the appendices and summarized in the impacts section of this report (Section 7).

3.2. PROPOSED PROJECT INJECTION WELL FACILITIES SITE

The Proposed Project Injection Well Facilities would be located along a strip of land on the eastern boundary of the City of Seaside, California and about 1.5 miles inland from Monterey Bay (Figure 1). Facilities would be constructed within an approximate 150-feet wide corridor of land about 3,000 feet long (Figure 2). The corridor would begin approximately 1,200 feet south of Eucalyptus Road, and would extend south-southwest for approximately 3,000 feet toward General Jim Moore Boulevard. The southwestern end of the Injection Well Facilities site would be approximately 200 feet east of General Jim Moore Boulevard.

The Proposed Project Injection Well Facilities would be situated along existing unimproved roads of former Fort Ord lands and along the edge of two parcels that are proposed for

³ 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).

conveyance from the Fort Ord Reuse Authority to the City of Seaside. This property boundary has been identified by the City of Seaside as functioning as a utility right-of-way corridor where the Proposed Project wells could be located for minimum interference with future land use plans. The site was selected using the following criteria:

- upgradient of existing CalAm production wells for efficient recovery of recharged project water that has comingled with native groundwater and ASR-injected Carmel River water
- 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 depressions⁴ to provide replenishment water to areas of declining water levels.

Over the last few years, several alternate proposed project Injection Well Facilities locations within the Seaside Basin were considered for project development. Two locations, previously referred to as the Coastal location and the Inland location, were considered favorable and were evaluated in 2009 during early project development. Since that time, further analyses have been conducted and the Coastal location has been eliminated from consideration due to hydrogeologic conditions, engineering factors, and costs. A discussion of the selection of the current Proposed Project Injection Well Facilities location as the preferred location over the Coastal location is documented in a TM provided in Appendix A (Todd Groundwater, May 2014). The current Proposed Project site Injection Well Facilities has been modified slightly from the previously considered inland location to optimize project performance.

3.2.1. Physical Setting

The Proposed Project Injection Well Facilities are located on an upper coastal plain of low hills and mature dunes that slopes northward toward the Salinas Valley and westward toward Monterey Bay (approximately 1.5 miles to the west) (Figure 1). The Proposed Project Injection Well Facilities area is characterized by rolling hills and closed depressions. The area is currently undeveloped and surrounded by natural vegetation that is cross-cut by unimproved roads and trails associated with former military activities (Figure 2). An access road to a small water reservoir is across Eucalyptus Road from the northern-portion of the Proposed Project Injection Well Facilities area. This reservoir and adjacent groundwater well have been used historically for irrigation at a golf course west of General Jim Moore Boulevard (Figure 2).

3.2.2. Topography

The ground surface elevation rises across the groundwater basin from sea level at the coast to more than 800 feet above mean sea level (msl) in the southeastern portions of the basin.

⁴ As groundwater is pumped, water levels are lowered in the aquifer creating a zone of water levels lower than ambient levels, and referred to as a cone of depression around the pumping well(s).

For the area shown on Figure 2, ground surface elevations rise to about 550 feet msl in the east central portion of the map. Along Eucalyptus Road, ground surface elevations vary from about 470 feet msl at the monitoring well identified as FO-7 to about 430 feet msl at the recently drilled monitoring well identified as MRWPCA MW-1, down to about 340 feet msl at General Jim Moore Boulevard and at ASR-1 (Figure 2). Ground surface elevations along the Proposed Project area vary from about 455 feet msl at proposed DIW-1, 396 feet msl at DIW-2, sloping downward to about 300 feet msl at DIW-4.

3.2.3. Climate and Hydrology

The Proposed Project Injection Well 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 Groundwater 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 percent of the total recharge estimated for this undeveloped subarea (HydroMetrics, 2009). (Additional sources of recharge allow for the natural safe yield from adjacent coastal subareas to be higher as noted in Section 3.1.2).

3.2.4. Land Use

The Proposed Project Injection Well Facilities would 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 proposed site is on the northwestern edge of a large upland area referred to as the Inland Ranges (HLA, 1994). 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 and the area of the Proposed Project wells are shown on Figure 4.

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 Proposed Project Injection Well Facilities location (approximately 200 feet south and east), with Range 48 (HA-48) farther east (Figure 4).

Considerable expended and unexploded ordnance (UXO) 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, heat generating, armor piercing, white phosphorous, smoke tracer, illumination, incendiary, and photo flash devices. As a result of the spontaneous ignition of a white phosphorous grenade in August 2009, a Munitions and Explosives of Concern (MEC) sweep was conducted at Range 48. This surface sweep removed MEC or MEC-like items using physical and demolition methods.
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 Proposed Project Injection Well Facilities site.

Most of these lands are now controlled by the Fort Ord Reuse Authority (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) that were associated with military munitions (e.g., unexploded ordnance (UXO) or munitions and explosives of concern (MEC)). 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 (DTSC) and the U.S. Environmental Protection Agency (USEPA) to conduct munitions remediation activities, scheduled for completion by 2015.

Most of the ESCA parcels, including the area of the Proposed Project wells, will ultimately be transferred to the City of Seaside. The ESCA parcels that contain the Proposed Project Injection Well Facilities were less impacted by former Fort Ord activities than other parcels associated with Site 39 and have already been cleared of MEC and approved for future development. The Proposed Project wells are purposefully located along the southern-southeastern edge of the parcels and are not expected to interfere with future redevelopment by the City of Seaside (Figure 4). By spacing the wells along the parcel boundary, it is anticipated that any visual or noise concerns would also be minimized in comparison to a configuration where multiple deep injection wells were operating closer together.

3.3. Hydrostratigraphy and Target Aquifers

The Seaside Groundwater Basin consists of semi-consolidated to consolidated sedimentary units overlying relatively low permeability rocks of the Miocene Monterey Formation and older crystalline rocks. The sedimentary units consist of deep 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 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, referred to as compartmentalization, within the basin. Both faults are generally south of the Proposed Project Injection Well 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 Proposed Project wells (DIW-4 and VZW-4) and could potentially result in some hydraulic separation between the project wells and the closest municipal well to

the southwest, Seaside No. 4 (Figure 2). This uncertainty would not affect the Proposed Project operations. As a conservative assumption, the hydrogeologic investigation assumes that the wells are hydraulically connected.

Two main sedimentary units provide the source of groundwater supply for existing pumping operations in the Seaside Basin: the continental Quaternary-age (Pleistocene) Paso Robles Formation and the 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 (CDWR, 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.

Aquifer parameters and groundwater conditions associated with each of the two target aquifers in the Proposed Project Injection Well Facilities area are discussed in more detail below. Also included is a discussion of vadose zone properties of the older dune sands and Aromas Sand beneath the proposed site to assist in design of recharge wells (vadose zone wells) for the Proposed Project. A geologic cross section, shown on Figure 5, illustrates the subsurface conditions beneath the area. The location of the cross section and corresponding wells are shown on Figure 2. Subsurface conditions and aquifer parameters in the Proposed Project Injection Well Facilities area are also summarized on Table 3 and discussed in the following sections.

	Aromas Sand / Older Dune Deposits	Paso Robles Aquifer	Santa Margarita Aquifer	Data Sources
	Fine brown sand, silty sand,	Heterogeneous package of	Fine- to medium-grained well sorted	
	some medium to coarse sand,	interbeds of sand, silt, and clay	sand to silty sand; sandy silt in	
Lithology	minor silt and clay.	mixtures. Average bed thickness of	lower portions of formation; minor	1, 2, 3
Interval Thickness	400 feet	250 feet	280 feet	1, 2
Percent Sand	92%	52%	74%	2
		050 5 1	000 ()	Figure 5; Ground
Depth	Surface sediments	356 feet	609 feet	surface elev.
Groundwater Conditions	unsaturated	unconfined	semi-confined	4, 5
Aquifer Parameters			11 377 to 13 947 feet ² /day	
Transmissivity (T)	Not applicable;	$650 \text{ foot}^2/\text{dow to 1} 504 \text{ foot}^2/\text{dow}$	24.002 foot ² /dov	1 5 6 7 8 0
Horiz Hydraulic		659 leet /day to 1,524 leet /day	24,003 leet /day	1, 5, 6, 7, 8, 9
Conductivity (K _h)	350 feet/day	20 feet/day	63 feet/day	2, 6
Vertical Hydraulic				
Conductivity (K _v)	70 feet/day	0.66 feet/day to 16 feet/day	0.63 feet/day	1, 3, 7
	0.24 to 0.40 (sand);		0.0018	
Storativity (S)	0.04 to 0.09 (silt; silty sand)	0.12	0.00258	1, 4, 5
Average Coastal Subarea	Not applicable; unsaturated	Est. 500 AFY	Est. 2,500 AFY	
Production	locally	(15% of total coastal production)	(85% of total coastal production)	9, 10
Area Water Levels Below	Not applicable; unsaturated			
Sea Level	locally	900 acres	>2,000 acres	9

Table 3. Estimated Subsurface Conditions in Proposed Project Area

Data Sources: 1.Todd Groundwater, 2014; 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.

3.3.1. Older Dune Sands/Aromas Sand

The shallowest geologic deposits at the Proposed Project Injection Well Facilities site are composed of recent and older eolian sands and older continental deposits of Pleistocene age referred to herein as the 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).

The entire sequence was recently cored in a boring for a recently-installed monitoring well by Todd Groundwater in the Proposed Project Injection Well Facilities area (see MRWPCA MW-1 on Figure 2). 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 to support the Proposed Project development. Complete laboratory results are documented and analyzed in a separate report (Todd Groundwater, February 2015).

Geologic core descriptions from MRWPCA MW-1 indicate that the Aromas Sand is approximately 400 feet thick in the Proposed Project Injection Well Facilities area and is composed primarily of fine-grain sand (about 92 percent sand) with minor amounts of silt and clay. The upper 300 feet is the most homogeneous with generally higher permeability values. As previously shown on Table 3, the unit is associated with high horizontal hydraulic conductivity (350 feet per day) and vertical hydraulic conductivity (70 feet per day) as estimated from laboratory core data.

The geologic unit is illustrated on the cross section on Figure 5 and ranges from about 225 feet at ASR-1 up to about 400 feet thick at MRWPCA MW-1 and monitoring well FO-7. Also shown on the cross section are geophysical logs for the three existing wells that 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) ⁵, generally indicative of higher permeability sediments. The Aromas Sand is unsaturated in the Proposed Project Injection Well Facilities area as indicated by the deeper water levels shown on the cross section (water table and potentiometric surface, Figure 5).

Also projected onto the cross section are schematic diagrams of Proposed Project wells (Figure 5). In particular, vadose zone wells (labeled VZW-1 and shown on Figure 2) would be used for recharge into the shallow aquifer. The advanced treated water recharged through vadose zone wells would be released into the Aromas Sand for percolation to the water table. Selection of vadose zone wells as a recharge method is discussed in subsequent sections of this report. Details of the Proposed Project wells, including preliminary designs, are provided in Section 4.

⁵ 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.

3.3.2. Paso Robles Aquifer

Beneath the Aromas Sand is the Paso Robles Formation (Figure 5). The formation is heterogeneous and contains interbeds of sand, silt, and clay mixtures (Yates et al., 2005). Silt and clay layers are described 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 saturated in the Proposed Project Injection Well Facilities area (and coastal areas) and forms the shallow aquifer in the basin (referred to as the Paso Robles Aquifer herein). Permeable units in the Paso Robles aquifer are screened in several production wells downgradient of the Proposed Project Injection Well Facilities area.

The heterogeneous nature of the aquifer can be seen on the electric logs from FO-7, ASR-1, and MRWPCA MW-1 in the Proposed Project Injection Well Facilities area (Figure 5). 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 permeability. These sands are screened in MRWPCA 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 indicator of 25 ohmmeters on the electric log of a nearby Paso Robles test well, the overall Paso Robles aquifer is estimated to contain about 52 percent sand (Table 3).

3.3.2.1. Paso Robles Aquifer Parameters

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 Proposed Project Injection Well Facilities area, representative aquifer parameters include a T value of about 659 square feet per day (ft²/day) to 1,524 ft²/day, a K value of 20 ft/day and an S value of 0.12 (dimensionless), reflecting an effective porosity of 12 percent. These parameters for the Paso Robles Aquifer are listed in Table 3.

3.3.2.2. Groundwater Recharge in the Paso Robles Aquifer

The Paso Robles aquifer is recharged mainly from surface infiltration of precipitation (HydroMetrics, 2009). The formation crops out in the eastern portion of the basin where rainfall infiltrates directly into the aquifer units (Yates, et al., 2005). In the Proposed Project Injection Well Facilities area, recharge occurs by percolation through the surficial deposits of the Aromas Sand.

3.3.2.3. Groundwater Production in the Paso Robles Aquifer

The Paso Robles Aquifer is less productive than the deeper Santa Margarita Aquifer, but is screened in several production and monitoring wells near the Proposed Project Injection Well Facilities area. In particular, the Paso Robles is screened in production wells Paralta, Ord Grove, PRTIW, MMP, and Seaside 4, all located within about 1,000 feet west of General Jim Moore Boulevard. In addition, the Reservoir well, located east of General Jim Moore Boulevard and north of Eucalyptus Road, is also screened in the Paso Robles Aquifer. The Paralta and Ord Grove wells are also screened in the deeper 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 percent 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 less. Recent analysis indicated that only about 20 percent of the basin pumping was from the Paso Robles Aquifer (HydroMetrics, October 2013 – see Appendix B).

It is expected that this declining trend in Paso Robles Aquifer production will continue into the future as the main producer in the Coastal Subareas, CalAm, transitions from their 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. Accordingly, the planned 10% allocation of GWR recharge to the Paso Robles Aquifer is reasonable as a future approximation, as further described in subsequent sections of this report (i.e., Section 3.3.5).

3.3.3. 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 Proposed Project Injection Well Facilities area.

The Santa Margarita Aquifer is shown on the cross section on Figure 5. 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 Proposed Project Injection Well Facilities area and contains about 74 percent sand (with the remainder containing sandy silt and minor clay). The aquifer is about 600 feet deep in the Proposed Project Injection Well Facilities area as indicated on Figure 5.

3.3.3.1. Santa Margarita Aquifer Parameters

A review of Santa Margarita Aquifer parameters in the Proposed Project Injection Well Facilities and coastal areas indicated an average T value of 11,377 ft²/day (Fugro, 1997; Padre, 2002). More recent aquifer tests in ASR-1 indicated a similar, but slightly higher, T value of 13,947 ft²/day (Padre, 2002). The Watermaster model has a T value of about 24,000 ft²/day in the Proposed Project Injection Well Facilities area.

Storativity (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 3.

3.3.3.2. Santa Margarita Aquifer Recharge

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.

3.3.3.3. Santa Margarita Aquifer Production

Coastal pumping in the Santa Margarita Aquifer was estimated to average about 2,500 AFY from 1999-2003, or about 60 percent of the coastal subarea production. Recent changes in wells and production intervals indicate that this percentage has increased. Basin-wide, the total production from the Santa Margarita is estimated to be about 80 percent (HydroMetrics, 2013, see Appendix B).

3.3.4. Groundwater Occurrence and Flow

As discussed above, groundwater occurs under unconfined and confined conditions in the Seaside Basin. Prior to groundwater development, groundwater flow patterns 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. As pumping has lowered water levels in the northern subareas, changes in water levels and flow patterns across the boundary to the south have become more pronounced, with water levels in the southern subarea remaining higher and less influenced by pumping gradients.

In the Proposed Project Injection Well Facilities area, the unconfined water table occurs in the Paso Robles Aquifer leaving the overlying Aromas Sand unsaturated (Figure 5). To be specific, the water table occurs at a depth of about 400 feet below ground surface (bgs). Groundwater within 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. Beneath the Proposed Project Injection Well Facilities area, the potentiometric surface⁶ in the Santa Margarita Aquifer is generally about 5 to 10 feet lower than the water table (Figure 5).

Water levels have been monitored in the Seaside Basin for at least 25 years. These data document the decline of water levels in the mid-1990s and a recent partial recovery of water levels in some areas. In general, changes in water levels have occurred in response to changes in groundwater production and ASR operation.

Figure 6 shows a long-term hydrograph of a well in the Northern Coastal Subarea, the PCA East well, to illustrate water level trends and fluctuations since 1989 in coastal areas of the basin. The curve highlighted in orange on Figure 6 represents water levels in the Paso Robles Aquifer and the lower curve represents water levels in the Santa Margarita Aquifer. Figure 7 shows hydrographs in two monitoring wells close to the Proposed Project Injection Well 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 East Well on Figure 6. Similar to the PCA East 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. Locations of the wells with hydrographs on Figures 6 and 7 are shown on Figure 8.

Hydrographs and water level contour maps are discussed in the following sections.

3.3.4.1. Water Levels in the Paso Robles Aquifer

As shown on Figure 6, water levels in the Paso Robles Aquifer (PCA East – 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. However, water levels remain below msl farther inland where a pumping depression persists (Figure 8).

An additional hydrograph for the Paso Robles Aquifer is shown on the top graph on Figure 7. Water levels in FO-7 (shallow curve shown in orange) illustrate water table conditions about 3,000 feet north of the Proposed Project Injection Well 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 7). This decline is consistent with

⁶ The level to which water rises in a well.

downgradient pumping in both aquifers that has created a localized pumping depression in the Northern Coastal Subarea.

Figure 8 shows the pumping depression by the closed contour of 0 feet msl (sea level) on the water level contour map (contours from HydroMetrics, 2013). This map, representing water levels measured in July and August 2013, 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 Proposed Project Injection Well Facilities area flows west toward the center of the depression where water levels are lower than - 40 feet below msl.

The map also shows that the water levels in the adjacent Southern Coastal Subarea are not significantly influenced by the pumping depression. Contours in that subarea indicate westerly groundwater flow toward the coast and provide some evidence of compartmentalization of the groundwater system across the subarea boundary.

3.3.4.2. Water Levels 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 6, the potentiometric surface of the semi-confined Santa Margarita Aquifer indicates a long-term decline in the PCA East (Deep) well since the mid-1990s with only seasonal recovery. 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. In general, the rate of decline has been less since about 2006 as a result of the adjudication of the groundwater basin and subsequent changes in pumping rates. Nonetheless, water levels have been below sea level in the coastal PCA East (Deep) well since 1995, increasing the risk of seawater intrusion.

Figure 7 shows similar trends and fluctuations on two hydrographs from Santa Margarita wells closer to the Proposed Project Injection Well Facilities area (FO-7 is about 3,000 feet north and Paralta Test Well is about 1,300 feet to the northwest, see Figure 8 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 would raise 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 (Figure 7).

Figure 9 shows the widespread area of water level declines on a recent water level contour map for the Santa Margarita Aquifer (contours from HydroMetrics, 2013). The map shows that water levels are below msl over almost all of the Northern Coastal Subarea and a large 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 (Figures 6 and 7). Water levels beneath the Proposed Project Injection Well Facilities area range from about -10 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 subbasin. 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.

3.3.5. Proposed Project Target Aquifers

Hydrogeologic and groundwater data indicate that both aquifers in the Seaside Basin could be recharged to increase basin yield. As shown by the water level contour maps in Figures 8 and 9, water levels in both aquifers have fallen below sea level, placing them both at risk for seawater intrusion.

To increase the basin yield and well production as envisioned in the Proposed Project, replenishment would occur to prevent adverse impacts on basin water levels. If an aquifer is pumped but not directly recharged, water levels may exhibit a short-term decline in one aquifer and a rise in the other. Although most of the groundwater production (and corresponding water level declines) has occurred within the Santa Margarita Aquifer, numerous production wells are also screened in the Paso Robles Aquifer.

These and other considerations for incorporating each aquifer into the Proposed Project are summarized in Table 4. Relative benefits and limitations are listed for comparison between the two aquifers. Issues are focused on the ability to recharge the Proposed Project's recycled water in a cost effective manner in order to allow basin yield to be increased. Based on the information discussed above and summarized in Table 4, the Proposed Project would include recharge into both of the basin aquifers.

	Paso Robl	es Aquifer	Santa Margarita Aquifer		
Issue	Relative Benefit	Relative Limitation	Relative Benefit	Relative Limitation	
Aquifer Characteristics	Relatively shallow and thick aquifer.	More heterogeneous, interebedded with low permeability units, lower sand content, and lower hydraulic conductivity (K) values.	More permeable and homogeneous with a larger percentage of sand and higher K values.	Deep aquifer, occurring at depths greater than 600 feet locally.	
Groundwater Occurrence and Recharge Methods	Unconfined groundwater allows for surface recharge. Deep water table creates large storage volume. Some downward leakage recharges underlying Santa Margarita Aquifer.	Interbeds limit downward migration of recharge in some areas. Lower K values limit injection capacity. Local test wells only capable of injecting about 350 gpm.	Semi-confined groundwater will respond more quickly to the same amount of recharge than in the shallower unconfined aquifer. High K values allow for high injection capacity. Local ASR wells inject >1,000 gpm.	Semi-confined groundwater has less storage. Direct recharge will require relatively expensive deep injection wells.	
Water Levels and Recovery of Product Water	Water levels below sea level over large area. Several downgradient production wells screened in both aquifers.	Water level declines occur over a smaller area than Santa Margarita declines. Fewer wells are screened in the Paso Robles Aquifer.	Water levels declines are more severe, cover a larger area, and are below sea level throughout the Northern Coastal Subarea.	May require more coordination with nearby ASR operations.	

Table 4. Aquifer Considerations for the Proposed Project Injection Well Facilities Site

3.3.5.1. Groundwater Modeling for Aquifer Allocation

The amount of recycled water from the Proposed Project allocated to the Paso Robles Aquifer and the Santa Margarita Aquifer can be varied to meet a variety of Proposed Project objectives including increasing basin yield, raising water levels, and providing adequate underground retention time of recycled water to meet regulatory requirements (see Section 4.1.4). The primary objective of the Proposed Project is to replenish the groundwater basin in a manner that allows for increased production in existing basin wells.

To support project planning, HydroMetrics applied the Watermaster groundwater model to determine the optimal allocation of recycled water injection between the two aquifers. Criteria for determining the optimal allocation included the following:

- capability of existing drinking water wells to capture the recharged recycled water
- minimizing loss of injected recycled water to ocean outflow
- balancing inflows and outflows with no groundwater storage changes.

A TM prepared by HydroMetrics documents the modeling assumptions and results. That TM is provided in Appendix B of this report (HydroMetrics, October 2013). Three scenarios were simulated as summarized in Table 5 below.

Model Scenario	Paso Robles Recharge	Santa Margarita Recharge
1	100%	0%
2	0%	100%
3	20%	80%

Table 5. Aquifer Allocation of Recharge Water in Model Scenarios

Based on the results of the modeling and application of evaluation criteria, an aquifer allocation between 80 percent and 100 percent of recharge to the Santa Margarita Aquifer (accompanied by 20 percent to 0 percent of recharge to the Paso Robles Aquifer) was judged optimal to allow increased production with minimal impacts to basin storage. Based on these results, the following recycled water injection allocations were proposed: 90 percent for the Santa Margarita Aquifer and 10 percent for the Paso Robles Aquifer. This allocation also approximates the production allocation from each aquifer screened in existing production wells.

3.3.6. Methods Considered for Groundwater Recharge

In order to select the most cost effective groundwater recharge method for the Proposed Project, Todd Groundwater examined various recharge methods for both aquifers. A summary of this examination is provided in the subsequent sections.

3.3.6.1. Paso Robles Aquifer Recharge Method

Several recharge methods were considered for recharge into the Paso Robles Aquifer: surface recharge basins, vadose zone wells, and deep injection wells.

3.3.6.1.1. Surface Recharge Methods

Surface recharge basins were considered for the Proposed Project, given their long performance record in California and relative ease of construction and maintenance. However, surface recharge basins capable of recharging the total amount of water for the Proposed Project would require a large surface area of relatively flat land (estimated at about 10 acres) in a hydrogeologically-favorable location. MRWPCA determined that purchase of such a large parcel in the project area would be very expensive, even if land could be located. Even though recharge into the Paso Robles Aquifer was eventually allocated to be only a small percentage of project water, a surface basin would have a larger visual impact than using subsurface methods such as injection wells. In addition, subsurface methods can be spaced for minimal overall land disturbance. Also, the travel time for recharge water to reach the aquifer would be maximized in surface basins. For these and other reasons, surface recharge methods were eliminated from further consideration.

3.3.6.1.2. Deep Injection Wells

Deep injection wells for the Paso Robles Aquifer recharge were considered but eliminated after a hydrogeologic review of a test injection well that had been installed near the Proposed Project Injection Well Facilities. Specifically, MPWMD drilled a Paso Robles test injection well, PRTIW, for potential storage and recovery of surface water in the Paso Robles Aquifer. PRTIW is located west of General Jim Moore Boulevard across from the ASR-1 wellfield (Figure 2).

Injection testing in PRTIW indicated relatively low injection rates of approximately 350 gpm (compared to the nearby ASR Project and Proposed Project wells in the Santa Margarita Aquifer, which are expected inject approximately 1,000 gpm), due to the lower hydraulic conductivity of the aquifer. The rate was deemed inadequate for an economical injection well by MPWMD, and the well is now being used for monitoring and for extracting water for irrigation supplies. Even though injection of 350 gpm might be considered an acceptable rate for the Proposed Project, it is unlikely that such a rate could be sustained on a long-term basis. Because of the heterogeneity and overall lower permeability in the Paso Robles Aquifer, injection capacity is likely to decrease more rapidly than in the more permeable Santa Margarita Aquifer. Lower permeability aquifers can be more susceptible to physical and biological processes that clog pores and restrict groundwater flow.

3.3.6.1.3. Vadose Zone Wells

A vadose zone well is an injection well installed in the unsaturated zone above the water table. These wells typically consist of a large-diameter borehole with a casing/screen assembly installed with a filter pack. The well is used as a conduit for transmitting water into the subsurface, allowing infiltration into the vadose zone through the well screen and percolation to the underlying water table. Creating this pathway is advantageous for replenishment projects where surficial soils or the shallow subsurface contain clay layers or other low permeability impediments to deep percolation. Vadose zone wells allow

replenishment water to bypass shallow layers, reaching the water table faster and along more direct pathways. In addition, replenishment water quality can potentially benefit from soil-aquifer treatment (SAT) in the lower vadose zone prior to arrival at the water table.

Historically, vadose zone wells have been used in the U.S. with varying success, primarily functioning as disposal wells, or "dry wells" and often used for lower quality wastewater or stormwater. The primary disadvantage to using vadose zone wells is the difficulty of repairing wellbore/aquifer damage from physical or biological clogging once it occurs in the well. Typical well development and rehabilitation techniques cannot be conducted on wells screened in the vadose zone. However, the high quality recycled water anticipated for injection for the Proposed Project would be less likely to create potential clogging. Further, design specifications can be incorporated to mitigate clogging and other factors that decrease well performance such as air entrainment.

Over the last 15 years, vadose zone wells have been used successfully in similar areas for recharging recycled water. In particular, the City of Scottsdale, Arizona operates approximately 35 active vadose zone wells (with 27 additional backup wells) for groundwater recharge of recycled water at their Water Campus. Recharge capacity on a per well basis averages about 200 gpm to 400 gpm with some wells capable of injection rates higher than 1,000 gpm. Wells are spaced about 100 feet apart. MRWPCA visited the City to review details of the project. City technical staff provided information and data from these wells in support of the Proposed Project (City of Scottsdale, personal communication, July 16, 2007; July 27, 2007).

Some of the advantages and disadvantages of using vadose zone wells are listed below. Advantages of incorporating vadose zone wells into the Proposed Project include:

- greater certainty of migration pathways into the subsurface compared to surface basins
- ability to by-pass shallow low permeability layers, if any
- less land requirement than surface recharge basins
- no evaporation losses
- less expensive to construct compared to injection wells.

Some disadvantages of using vadose zone wells include:

- limited methods to develop or rehabilitate wells to address lost capacity due to clogging
- limited recharge rates
- air entrainment can reduce recharge capacity if wells are not operated properly.

Because of prior data gaps associated with the physical characteristics and recharge capability of the deep vadose zone at the Proposed Project Injection Well Facilities site, the MRWPCA field program focused on core samples and laboratory analyses throughout the vadose zone to about 130 feet below the water table. Results of the field program and

laboratory analyses were used to confirm design features of the vadose zone wells for the Proposed Project (Section 4.2). Complete results of the vadose zone characterization are documented in a separate report on the field program (Todd Groundwater, February 2015).

3.3.6.2. Santa Margarita Aquifer Recharge Method

Due to the semi-confined groundwater conditions in the Santa Margarita Aquifer, deep injection wells are the only viable method for groundwater replenishment. Although some vertical natural recharge occurs from the Paso Robles Aquifer into the Santa Margarita Aquifer, the amount and timing are uncertain. As noted above (Section 3.3.3.3), most of the extraction in the Northern Coastal Subarea is from the Santa Margarita Aquifer. Direct injection into the aquifer would allow for immediate benefits to water levels in that aquifer and allow downgradient wells to recover the recycled water in a more direct manner.

Successful use of deep injection wells in the Santa Margarita Aquifer has already been demonstrated at the nearby MPWMD ASR Project. Located only about 1,000 feet to 1,600 feet from the Proposed Project Injection Well Facilities site, these wells provide site-specific information on aquifer properties, injection capacity, well design, and costs. According to MPWMD, ASR wells are capable of sustaining injection rates of 1,000 gpm to 1,500 gpm. Testing data in ASR-1 indicated a T value of 104,325 gallons per day per foot (gpd/ft) and a specific capacity of 55 gallons per minute per foot of drawdown (gpm/ft) dd (Padre, 2002). Collectively these data, along with ongoing operational data, indicate that only three to four deep injection wells (allowing for down time associated with well maintenance) would be needed for the Proposed Project to recharge recycled water, a number that is feasible for the Proposed Project.

In addition to these site-specific data, there are four operating groundwater replenishment injection projects in California that have demonstrated the viability of long-term deep injection of recycled water. One example is the project implemented by the Orange County Water District (OCWD). For more than 36 years, OCWD has injected recycled water (and diluent water until 2008) into the Talbert Barrier, a line of more than 40 injection wells creating a hydraulic barrier to seawater along the Orange County coast. A second example is the West Coast Basin Barrier Project in nearby Los Angeles County, where recycled water (and potable water) has been injected into aquifers associated with the West Coast Basin Barrier Project since 1995. The barrier consists of an 8-mile line of about 150 injection wells from the Los Angeles airport to the Palos Verdes peninsula. Both projects have replenished various aquifers, increased the sustainable yield of the basins, and impeded the further intrusion of seawater.

4. PROPOSED PROJECT WELLS

The conceptual layout and preliminary design for the Proposed Project wells are based on the amount of recycled water available for replenishment (see Section 2) and the local hydrogeology (see Section 3). General specifications suggested for the two types of injection wells (vadose zone well and deep injection well) are summarized in Table 6.

Table 6.Proposed Project Well Specifications

Potential Project Specification ¹	Paso Robles Aquifer	Santa Margarita Aquifer
Depth to Aquifer Top	371 feet	623 feet
Depth to Aquifer Bottom	623 feet	903 feet
Depth to Water	382 feet	404 feet
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 13,947 ft ² /day
Hydraulic Conductivity	20 ft/day	63 ft/day
Number of Wells	4	4
Injection Capacity per well	500 gpm	1,000 gpm
Total Injection Capacity	2,000 gpm	4,000 gpm
Extraction Capacity per well (for well maintenance)	NA	2,000 gpm

¹ Assumes project well configuration as shown on Figure 2 with an average ground surface elevation of 379 feet, mean sea level (msl). Depths are average depths for all wells.

ft²/day – square foot per day; gpm = gallons per minute; NA – not applicable

The injection wells would be constructed on a parcel of land (APN-031-211-001-000) that is currently owned by FORA and scheduled for re-conveyance to the City of Seaside (City). This conceptual project configuration has been presented to the City in informational meetings but has not yet been formally approved by FORA or the City. The City, through its Municipal Code Ordinance, has placed prohibitions and restrictions on construction of wells on certain FORA parcels. However, the Proposed Project Injection Well Facilities would be located on a parcel that is not on the City's prohibited/restricted construction list. The only Municipal Code restriction for this parcel involves soils management during construction activities, which would be readily incorporated into the Proposed Project well Technical Specifications and drilling program requirements.

The Proposed Project injection well locations are shown on Figure 10 along with other project components including back-flush basins and monitoring wells. Estimated ground

surface elevation, depth to water and the aquifers encountered in each proposed well are presented in Table 7.

	ccr ¹	Groundwater	Depth to	Paso I	Robles ³	Santa N	largarita	Well
GWR PROJECT WELLS	GSE	Elevation ²	Water	Depth to Top	Depth to Base	Depth to Top	Depth to Base	Depth
	ft, msl	ft, msl	ft, bgs	ft, bgs	ft, bgs	ft, bgs	ft, bgs	ft, bgs
Santa Margarita Deep Injection Wells (DIW)								
GWR-DIW-1	455	-22	477	425	645	700	1000	1020
GWR-DIW-2	395	-30	425	395	647	647	947	967
GWR-DIW-3	365	-30	395	365	605	605	865	885
GWR-DIW-4	299	-18	317	299	539	539	799	819
Average	378.5	-25	404	371	609	622.75	902.75	922.75
Paso Robles Vadose Zone Well	s (VZW)							
GWR-VZW-1	455	-5	460					200
GWR-VZW-2	395	-20	415					200
GWR-VZW-3	365	-30	395					200
GWR-VZW-4	299	-15	314					150
Average	379	-18	396					187.5

Table 7.Proposed Project Wells

¹Ground Surface Elevation (GSE) based on Ord_Topo_Polyline shapefile from Marina Coast Water District, 2013.

² Water levels from July/August 2013 estimated from HydroMetrics WY 2013 SW Intrusion Analysis Report, December 2013, Figures 28 and 29. ²Groundwater elevation and depth to water represents the water table for the VZWs and the Santa Margarita potentiometric surface for DIWs. ³Aquifer geometry estimated from cross section analysis.

bgs = below ground surface

msl = mean sea level (negative indicates below sea level)

4.1. DEEP INJECTION WELLS

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

- sufficient capacity to accommodate delivered recycled water from the AWTF
- sufficient number of wells to plan for well maintenance and repairs offline
- adequate well spacing to minimize hydraulic mounding interference with other project wells or nearby ASR Project wells
- location sufficiently close to existing production wells to allow the efficient recovery of recycled water
- location with sufficient distance from downgradient production wells to comply with regulatory requirements regarding response and retention times (see Section 4.1.4).

These proposed design considerations are summarized in the following sections.

4.1.1. Deep Injection Well Capacity

Although MPWMD has installed four successful deep injection (and recovery) wells at the nearby ASR Project, the manner in which the Proposed Project deep injection wells would be operated may result in a slightly different well capacity than the ASR wells. Compared to the ASR Project wells, the Proposed Project wells would receive recycled water on a more continuous basis, would inject water at a more consistent rate over time, and would not be used for recovery of injected water (which would be accomplished through existing

downgradient production wells). Injection wells would only be pumped (backwashed) periodically for well maintenance.

In consideration of these factors, a design injection rate slightly lower than the ASR Project wells has been selected for the Proposed Project. Injection capacity at the nearby ASR wellfield is estimated at approximately 1,500 gpm/well. Therefore, a slightly more conservative injection rate of 1,000 gpm/well is estimated for the Proposed Project. This rate would minimize local mounding and long-term stress on the wells.

4.1.2. Number of Deep Injection Wells

Table 1 (in Section 2) presents potential recycled water delivery schedules to provide an average of 3,500 AFY and a maximum of 3,700 AFY of recycled water for Seaside Basin recharge. A key criterion is that the deep injection wells must be capable of accepting the maximum daily injection rate for recycled water from the AWTF for the Santa Margarita Aquifer. As shown in Table 1, the maximum rate for Santa Margarita injection is estimated at 2,179 gpm. With an injection capacity of 1,000 gpm/well, a minimum of three deep injection wells with total design capacity of 3,000 gpm would be required.

Although three wells appear to have sufficient capacity to handle the proposed recycled delivery schedules, extra injection capacity would be desirable to account for well maintenance/down time and potential decreases in well capacity over time. For planning purposes, an injection well is assumed to be operational about 80 percent of the time. Although decreasing injection capacity with time would be managed through well maintenance (back-flushing), the exact maintenance schedule is difficult to predict. Because a well might be down for maintenance (or other reasons) at a time when the maximum injection rate would be required, it is reasonable to incorporate a fourth deep injection well into the Proposed Project.

Accordingly, a total of four deep injection wells are proposed for the project, designated as DIW-1 through DIW-4 on Figure 10. The four proposed wells would provide a total operational capacity of 4,000 gpm, allowing capacity to be reduced to 3,000 gpm when any one well goes offline.

4.1.3. Location and Spacing of Deep Injection Wells

As shown on Figure 10, the deep injection wells have been sited with approximately 1,000 feet between Proposed Project wells. A minimum 1,000-foot spacing is also maintained between each Proposed Project well and the closest downgradient well. There are technical and regulatory considerations for the location and spacing of these wells. Because the injection wells would be operated continuously (except during routine maintenance), water levels are expected to rise or "mound" around the injection wells and expand over time until steady state conditions are reached. As these groundwater mounds overlap in the subsurface, groundwater 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, spacing

between the injection wells and downgradient production wells is considered to balance the timely recovery of recharged water with longer retention times required by state regulations (see section 4.1.3.2). These considerations are discussed in more detail below.

4.1.3.1. Hydraulic Interference

For the four deep injection wells that target the same confined aquifer, the proposed well spacing considers the potential for hydraulic interference due to groundwater mounding. Preliminary modeling conducted in 2005 for the CalAm ASR Project indicated that well spacing of about 1,000 feet between wells screened in the Santa Margarita Aquifer would result in only minor interference (ASR Systems, April 2005). Because the hydraulic properties assumed for that modeling are similar to those anticipated beneath the project Injection Well Facilities site, the 1,000-foot spacing is incorporated for the Proposed Project. By moving wells back to the edge of the parcel, the Proposed Project wells would also retain 1,000 feet spacing from the ASR wellfields to minimize interference with ASR operation.

4.1.3.2. Response Retention Time

The SWRCB Division of Drinking Water (formerly the California Department of Public Health) has adopted Groundwater Replenishment Regulations (SWRCB Regulations) for the recharge of recycled water (SWRCB, June 2014). The SWRCB Regulations contain requirements for underground retention time of recycled water that could also potentially affect well spacing. For example, recycled water must be retained underground for a sufficient period of time (as proposed by a project sponsor as part of the California Water Code project permitting⁷) to identify and respond to any treatment failure so that inadequately treated recycled water does not enter a potable water system (referred to as the response retention time). The response retention time has to be at least two months. The 1,000-feet distance between Proposed Project wells and the closest downgradient production wells is expected to result in a travel time of approximately one year. Therefore, the proposed configuration of the Proposed Project wells would readily meet the minimum required response retention time.

4.1.3.1. Underground Retention Time

Additional requirements in the SWRCB Regulations were also considered for well locations and spacing. According to the SWRCB Regulations, a groundwater replenishment project must achieve a 12-log enteric virus reduction using at least three treatment barriers, one of which can be underground retention time with a 1-log reduction per month up to 6 months (6-logs). Notwithstanding the effectiveness of the RTP and AWTF in controlling pathogens, the Proposed Project includes a conservative goal of achieving up to a 6-log virus reduction credit by keeping the recycled water underground for six months prior to arrival at the closest downgradient production wells (ASR-1, ASR-2, and City of Seaside 4 – see Figure 10).

This underground retention time will be demonstrated through a field tracer test after project implementation in compliance with the SWRCB Regulations. For planning purposes, the Watermaster groundwater model has been used to predict or estimate underground retention times for Proposed Project wells. When a model is used to demonstrate the travel

⁷ This process includes submittal of an Engineering Report for approval by the SWRCB Division of Drinking Water and review by the CRWQCB.

time, the required retention time is doubled to account for uncertainty in the method of analysis as required by the SWRCB Regulations. Therefore, the model needs to demonstrate a travel time of one year to allow for a six-month credit. Preliminary modeling indicates that seven of the eight Proposed Project wells would meet the one year requirement needed to assume a 6-log virus reduction credit prior to a tracer test. However, modeling indicates that recycled water injected into one injection well, DIW-3, could reach ASR-1 in less than one year (shortest time of 327 days) under certain pumping conditions during five years of the 25-year simulation period. The fastest travel time of 327 days is 38 days short of the modelbased one-year travel time project planning goal.

While the necessary underground retention time of six months remains applicable to the Proposed Project, a tracer test, rather than modeling alone, will be needed to demonstrate the project can meet the underground retention time to claim a 6-log reduction credit. Until that test can occur, it is assumed for planning purposes that the estimated minimum 10.5 to 11 months travel time from DIW-3 to the nearest extraction well will limit the reduction credit to a 5-log credit for the Proposed Project. For the conservative purposes of the EIR analysis, it is anticipated that a 5-log reduction credit can be achieved based on modeling results and future revisions would be based on an actual tracer test that is initiated after project startup. Model results are discussed in detail in Section 7. Documentation of the particle tracking associated with the modeling of the Proposed Project is provided in the TM by HydroMetrics (January 2015), included in this report as Appendix C.

4.1.4. Preliminary Deep Injection Well Design

Incorporating some of the successful design features already tested in MPWMD ASR wells, a preliminary well design for a Proposed Project deep injection well has been developed. The exact well depth and screen placement may be determined based on field results during project construction. Current design criteria are summarized in Table 8. A preliminary deep injection well construction diagram is shown on Figure 11.

Component/Parameter	Criteria
Number of Santa Margarita injection wells	4
Average depth to water	400 feet
Injection rate per well	1,000 gpm
Discharge rate per well	2,000 gpm
Average well depth	909 feet
Casing size and materials	18-inch outer diameter (OD) stainless steel
Screen assembly	230 feet stainless steel wirewrap
Pump for back-flush	400 horse power (Hp)

Table 8. Summary of Design Criteria For Proposed Project Injection Wells

4.2. 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 from the AWTF are also important considerations. Recent data from the MRWPCA field program was used to analyze a preliminary vadose zone well design and operational parameters for the Proposed Project. Complete results of the field program are presented in a separate report (Todd Groundwater, February 2015). For planning purposes, the vadose zone well layout is shown on Figure 10 and discussed in more detail below.

4.2.1. Well Capacity

MRWPCA collected site-specific data during the 2013-2014 field program to better assess potential injection capacity and optimize well design for recharging the Paso Robles Aquifer. Based on core samples and geologic logging in MRWPCA MW-1, the vadose zone appears more homogeneous and permeable than the saturated zone of the Paso Robles Aquifer. Hydraulic conductivity data from core samples indicate the potential for high injection rates. An analysis of vadose zone well capacity presented in the field program report (Todd Groundwater, February 2015) indicated that one vadose zone well could likely recharge the entire allocation of 242 gpm. The analysis suggests that with about 100 feet of screen, an injection rate of approximately 500 gpm could be achieved. This analysis is supported by the large storage capacity in the vadose zone beneath the Proposed Project Injection Well Facilities site.

Thin, low-permeability silt and clay zones were more prevalent in the lower portions of the vadose zone that could potentially decrease injection rates or result in long travel times to the water table. A comparison of these zones with geologic descriptions in the closest production wells (Reservoir Well and PRTIW) indicate that these layers are not likely continuous over the Proposed Project Injection Well Facilities area.

4.2.2. Number of Wells

With an estimated injection capacity of 500 gpm, only one vadose zone well would be needed to accommodate the anticipated delivery of product water. As shown in Table 1 (Section 2), the maximum injection rate estimated for the Paso Robles Aquifer is 242 gpm.

However, more than one well is recommended for several reasons. First, the long-term injection capacity of vadose zone wells is uncertain and may also represent very long travel times. Vadose zone wells are subject to clogging and cannot be redeveloped using conventional techniques. Vadose zone wells are much less expensive than deep injection wells and can be incorporated into the Proposed Project at a much lower cost. In addition, the extra capacity would provide the Proposed Project with operational flexibility. If unanticipated well problems arise, additional vadose zone capacity would allow injection to continue while wells are being repaired or replaced. If monitoring indicates that certain target recharge areas are being under-supplied to the Paso Robles Aquifer, additional

vadose zone wells would allow recharge to be targeted in specific areas. Accordingly, four vadose zone wells are being incorporated into the Proposed Project design.

4.2.3. Spacing and Location of Wells

The locations of the vadose zone wells along the 3,000 feet corridor are less sensitive to the criteria for placing the deep injection wells with respect to the distance to the nearest downgradient production well. In particular, vadose zone wells are less sensitive to the requirement for underground retention time described previously (Section 4.1.3.1). Average linear groundwater velocities are lower in the Paso Robles Aquifer due to lower permeability, which adds to the travel time to production wells. In addition, travel time is lengthened by the additional time needed for water to percolate from vadose zone well screens to the water table.

In addition, the spacing between wells is considered less critical for hydraulic interference than deep injection well spacing, given the large storage volume in the vadose zone and the relatively small amounts of injection planned for the vadose zone wells. Well spacing at the Scottsdale Water Campus was only a few hundred feet for wells of similar depth and injection rates as the Proposed Project. Further, there is no spacing requirement between deep injection wells and vadose zone wells because they are recharging separate aquifers.

For planning purposes, it is proposed that one vadose zone well would be placed next to each of the four deep injection wells, resulting in a well spacing of 1,000 feet between vadose zone wells (Figure 10). This configuration provides some construction and operational conveniences in that deep and shallow wells are in close proximity for monitoring and maintenance.

4.2.4. Preliminary Well Design

Based on the above analysis of the Proposed Project, a preliminary vadose zone well design has been developed. The preliminary well design incorporates some of the appropriate design features from the City of Scottsdale's successful vadose zone wells including well and casing diameter and materials. Most of the City of Scottsdale's recent wells consist of a 30inch to 48-inch diameter borehole containing a 12-inch to 18-inch PVC casing/screen assembly with approximately 100 feet of slotted screen. Wells were typically drilled to a depth of 150 to 180 feet and installed with a filter pack from the bottom of the well up to a surface seal. The vadose zone beneath Scottsdale consists of permeable alluvial sediments with the water table at a depth of approximately 400 feet, conditions similar to the Proposed Project Injection Well Facilities site (City of Scottsdale, personal communication, July 27, 2007).

One of the early operational problems experienced by the City of Scottsdale was lost capacity due to air entrainment, a situation remedied by maintaining a full water column in the recharge pipe and preventing cascading water in the well (Marsh, et al., 1997). Casing failures also have occurred in some wells and appear to correlate to the placement and

operational pressure of the injection line at the well screen (City of Scottsdale, personal communication, July 16, 2007).

Over time, the City of Scottsdale has modified their well design to install one or more smalldiameter recharge lines to the bottom of the well (e.g., a 4-inch PVC casing referred to as an eductor line). The well design also incorporates transducer tubes, ventilation lines, and lines to access the gravel pack (City of Scottsdale, personal communication, July 27, 2007). These three additional components allow for more accurate monitoring, less chance of air entrainment, and ability to add to the gravel pack, respectively.

Based on the information reviewed from the Scottsdale vadose zone wells and site-specific conditions investigated during the recent MRWPCA field program, design criteria have been developed for the Proposed Project wells as summarized in Table 9. A preliminary vadose zone well construction diagram is provided on Figure 12.

Component/Parameter	Criteria
Number of wells	4
Depth to water table	380 feet
Borehole diameter	48 inches to 150 feet; 30 inches to 200 feet
Casing/Screen diameter	18-inch OD PVC with 100 feet slotted casing (100 slot)
Injection	4-inch OD PVC eductor line
Injection capacity	500 gpm
Annular material	Artificial filter pack or gravel
Monitoring equipment	Transducer

Table 9.Summary of Design Criteria for Proposed Vadose Zone Wells

4.3. Well Maintenance and Back-flushing Operations

Deep injection wells would need to be pumped periodically to maintain injection capacity, a process known as back-flushing. Injection rates typically decrease with time as a result of numerous conditions that can clog the well such as air entrainment, filtration of suspended or organic material, bacterial growth, precipitates due to geochemical reactions, swelling of clay colloids, dispersal of clay particles due to ion exchange, and/or mechanical compaction of aquifer materials (Fetter, 1988). Clogging rates are often directly related to the presence of solids in the recharge water and indirectly related to the permeability of the aquifer (i.e., higher clogging rates are typically correlated to lower permeability aquifers). Pumping reverses the flow in the well, alters the geochemical environment, and dislodges some of the clogging particles.

4.3.1. Back-flushing Rates and Schedule

Back-flushing is typically conducted at pumping rates higher than injection rates. In a plugging survey published by Pyne (2005), injection rates averaged about 75 percent of extraction rates, but that percent varied widely from project to project. At the nearby ASR Project, MPWMD back-flushes the wells at about twice the injection rate. For planning purposes, it is assumed that the Proposed Project would also back-flush the deep injection wells at twice the injection rate of 1,000 gpm, and back-flushing would be conducted at 2,000 gpm.

The optimal back-flushing schedule and required pumping volumes would be determined once the injection wells are operational. At one Arizona project, injection well operators found that frequent pumping for short periods on a daily basis was the most effective schedule for re-establishing declining capacity (Bouwer, 2002). Other operators have found monthly pumping to be adequate.

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 Proposed Project recycled water will contain relatively low suspended or total dissolved solids (TDS), clogging rates of the deep injection wells may be lower than observed at nearby ASR wells. However, because the Proposed 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 is being assumed for planning purposes. Regardless of the pumping frequency, a facility for retention and recharge of the discharged water would be constructed.

For planning purposes, a back-flush schedule similar to the one established at the nearby ASR wellfields would be incorporated into the Proposed Project. The ASR operations suggest that the proposed deep injection wells would be pumped for approximately four hours each on a weekly basis at a pumping rate of 2,000 gpm (twice the estimated injection rate). The actual amount of backflushing would be based on operational needs established in the field, but this schedule represents a reasonable maximum for evaluation of potential impacts. This schedule would produce approximately 480,000 gallons per well per week for discharge into a back-flush basin.

4.3.2. Back-flush Basin Location

In order to facilitate the back-flushing operation, a small surface basin would be constructed near the Proposed Project wells. Water would be piped to the basin, 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 would be conserved. This approach for infiltration of back-flushed water was conceptually approved by the SWRCB Division of Drinking Water (Division of Drinking Water, 2014). A preliminary design of the basin and other back-flushing appurtenances has been conducted for MRWPCA by E2 Consulting Engineers.

Several sites have been considered for the proposed back-flush basin location. Although only one site would be needed to support the Proposed Project, three potential sites are shown on Figure 10. The northeastern-most site is the preferred location for the Proposed Project due to its proximity to DIW-1 and DIW-2, the two wells likely to be installed first during the construction phase of the project. The northeastern basin location is also situated on a relatively flat area along the comparatively steep grade of the Proposed Project area.

Two alternate basin sites have been conceptualized at the southern portion of the Proposed Project Injection Well Facilities site near General Jim Moore Boulevard. One site is of similar design to the northeastern basin alternative and is situated at the lowest ground surface elevation of the Proposed Project Injection Well Facilities area (refer to the southern area of blue shading on Figure 10). That basin would be capable of receiving and recharging back-flush water from the Proposed Project wells via a gravity-flow pipeline.

A third location for a back-flush basin is identified northwest of the second location and within 100 feet of General Jim Moore Boulevard. This larger, and potentially deeper basin, was originally identified by MPWMD as an alternative site for back-flush water from the ASR Project wells. The basin is located within a natural depression, referred to as the San Pablo depression due to its proximity to San Pablo Avenue (see Figure 10). Discussions between MPWMD and MRWPCA indicated that there may be some efficiency for sharing a back-flush basin. However, basin construction has not yet been approved and MPWMD has been considering other discharge options in addition to the San Pablo depression.

4.3.3. Back-flush Basin Design

The basin would be constructed on the Aromas Sand, which comprises the upper 300- to 400-feet of vadose zone beneath the Proposed Project Injection Well Facilities area. This geologic unit was recently evaluated in a nearby monitoring well MRWPCA MW-1 (Figure 10). Core samples throughout the vadose zone were collected and analyzed for vertical permeability values to assist with the design. 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 277 feet contain very little fine-grained sediment (silt or clay). The lowest permeability value above that depth 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 preferred Proposed Project back-flush basin location, see Figure 10).

Although the vertical permeability value of 28 feet per day may not translate into a longterm infiltration rate, the laboratory data and geologic core samples from MRWPCA MW-1 indicate that the upper 277 feet of the vadose zone is capable of rapid infiltration and storage of water discharged into a back-flush basin. Further, these rates suggest that the basins would be empty on a regular basis for drying and periodic tilling to break up any surficial clogging. For planning purposes, a conservative design infiltration rate of six feet per day is assumed. That rate is judged reasonable, given that it is only about 20 percent of the lowest permeability value recorded in the upper 277 feet of the vadose zone. Based on these data, E2 Consulting Engineers has developed a preliminary design for the back-flush basin at the Proposed Project Injection Well Facilities site. The preliminary design covers a footprint of approximately 180 feet by 50 feet and would be located between DIW-2 and DIW-3 in the general vicinity of the northeastern-most location shown on Figure 10.

4.3.4. Vadose Zone Wells and Back-flushing

Although vadose zone wells are also subject to clogging, they are constructed above the water table and cannot be readily back-flushed. The injection rate decline in those wells will not be known until the Proposed Project injection begins. However, there are many factors associated with the Proposed Project that would compensate for this potential issue. First, injection design rates are much smaller than indicated by recent permeability data for the Aromas Sand (Todd Groundwater, February 2015). Second, only about 10 percent of the total recycled water produced by the AWTF is currently planned for injection into vadose zone wells. With the assumed conservative injection rate and the smaller amounts of water available for injection, wells would not be needed full time and can dry between injection cycles. This would encourage die-off of any bacterial growth in the well. In addition, the Proposed Project recycled water would be highly treated with very low suspended or dissolved solids that could clog wells. Finally, more vadose zone wells are being incorporated into the Proposed Project than the anticipated volumes suggest are needed. If vadose zone wells are capable of 500 gpm as planned, four wells would provide a capacity of 2,000 gpm. However, a total capacity of only about 242 gpm is needed to handle the maximum amount of water allocated for the Paso Robles Aguifer (see Table 1). Collectively, these factors indicate that vadose zone wells can be incorporated successfully into the Proposed Project without back-flushing.

Even if all of the factors above are not sufficient to maintain injection capacity, there is the potential to install temporary equipment into the vadose zone wells to flush the annular space and pump out water that subsequently flows into the well. This method may be considered if injection rates in vadose zone wells cannot be sustained or managed with the number of wells proposed. The current design of the back-flushing detention basin would be capable of handling this small amount of extra water on a temporary basis if needed.

4.4. MONITORING WELLS

New monitoring wells and a monitoring well program are incorporated into the Proposed Project to demonstrate ongoing project performance and to comply with existing regulations. Objectives of the monitoring well program would be to comply with SWRCB and Central Coast Regional Water Quality Control Board (CRWQCB) regulatory requirements by:

- collecting baseline water quality samples prior to startup of the Proposed Project
- monitoring groundwater levels and water quality; the well design would allow for sample collection from each aquifer receiving recycled water
- siting one downgradient well with groundwater travel times (underground retention time) no less than two weeks and no more than six months from the Proposed

Project 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 Proposed Project Injection Well Facilities and the nearest downgradient potable water supply (in addition to the downgradient monitoring well used to demonstrate retention time).

The monitoring wells would also be used to collect data as part of the tracer study (or studies) to demonstrate an underground recycled water retention time of at least six months for a 6-log virus reduction credit and the response retention time that would be developed as part of the California Water Code project permitting process for the Proposed Project.

4.4.1. Monitoring Well Locations

The number and location of appropriate monitoring wells will be negotiated with the SWRCB Division of Drinking Water and CRWQCB for the Proposed Project. Proposed monitoring wells would satisfy the regulations described above and allow for proper monitoring of project performance. After the completion of one field tracer test, results may eliminate the need for one or more monitoring wells located close to remaining injection wells. Further, it appears from preliminary particle tracking results that several injection wells could be monitored by one set of downgradient monitoring points. Nonetheless, the locations of the monitoring wells have not yet been optimized and approved by the SWRCB Division of Drinking Water or CRWQCB. Accordingly, two monitoring well locations for each of three injection well clusters are assumed for the purposes of the impacts analysis.

Following this conservative assumption, the Proposed Project could incorporate up to six downgradient monitoring wells in each aquifer (12 monitoring points) on the north, central, and south portions of the project area, resulting in monitoring wells at six locations (GWR MW-1 through GWR MW-6 on Figure 10). At each of the six monitoring well locations, two adjacent, but separate boreholes would be drilled in close proximity (within about 20 feet) of each other at the same location – one for the Paso Robles Aquifer and one for the Santa Margarita Aquifer (referred to as a well cluster). These six well clusters would result in 12 monitoring points at six locations. For simplicity, each well cluster is referred to as one monitoring well in the text and on the figures.

This monitoring well distribution would allow two downgradient well clusters between each of three injection wells (DIW-2, DIW-3, and DIW-4) and the closest production wells (ASR-1 and ASR-2 for DIW-2 and DIW-3 and Seaside No. 4 for DIW-4). Due to the location and distance of DIW-1 from the nearest downgradient well, GWR MW-2 would also provide monitoring of DIW-1 and no additional wells in the eastern project area are envisioned (Figure 10).

Three of the downgradient monitoring well clusters (GWR MW-1, GWR MW-3, and GWR MW-5) would be located within about 100 feet of three Proposed Project injection wells (DIW-2, DIW-3, and DIW-4) to allow near-injection monitoring and to accommodate tracer testing in compliance with the SWRCB Regulations (SWRCB, 2014). According to the

regulations, the near-injection monitoring well would monitor subsurface transport times between two weeks and six months (SWRCB, 2014). This well can also serve as the monitoring well for an injectate tracer test. Three additional downgradient monitoring well clusters, GWR MW-2, GWR MW-4, and GWR MW-6, would be located about halfway between the Proposed Project and the nearest drinking water well in order to monitor groundwater conditions with more than 30 days of transport time away from the drinking water well (SWRCB, 2014).

MRWPCA MW-1 and FO-7 (shallow and deep) would provide upgradient data to support the monitoring program by serving as control wells (Figure 10). Sampling of these wells in January 2014 included an expanded analyte list to provide background water quality data.

5. WELL CONSTRUCTION ACTIVITIES

The field construction program involves construction and testing of the Proposed Project wells as described in this section. The actual timing of construction, equipping, and hook-up of the proposed wells would be coordinated with construction of the Proposed Project facilities being developed by others.

5.1. FIELD PLANNING

Prior to the initiation of the proposed well construction field program (referred to simply as field construction program in this section), numerous planning activities would be required including:

- identification of specific field activities
- sequencing and scheduling of events
- development of Technical Specifications for wells and the drilling and testing program
- selection of qualified contractors
- assistance to MRWPCA for permit applications, as needed
- confirmation of sampling protocols
- coordination with analytical laboratories
- preparation of field documents that may be required by FORA or the City such as Health and Safety Plans, Traffic Control Plans, Hazardous Materials Plan, and/or Noise Control Plans.

Logistics for the proposed field construction program would include any mitigation measures that may be required by the EIR.

5.1.1. Permits

The numerous permits required for the Proposed Project are documented in the EIR. The primary permits related to well drilling and construction are listed below.

5.1.1.1. Fort Ord Reuse Authority (FORA) Right-of-Entry

Until the ESCA parcels have been cleared by FORA (scheduled for 2015), a Right-of-Entry (ROE) permit will be required for any field work conducted in the Proposed Project Injection Well Facilities area. MRWPCA would be required to submit a workplan for proposed field activities and an ROE application with a reimbursement agreement for application review. For the recently-completed MRWPCA field program, this ROE permit process was initiated in March 2013, but not completed until September 2014 (18 months later). Although there are some efficiencies that have been learned during this initial application phase, long lead times would still be required for FORA ROEs for the proposed field construction program.

5.1.1.2. City of Seaside Conditional Use Permit and Encroachment Permit The City of Seaside has established operating procedures for any projects involving soil disturbance or groundwater wells within the former Fort Ord lands (Chapter 15.34, Seaside Municipal Code, also referred to as the Ordnance Ordinance). Permit conditions are applicable to projects that disturb greater than 10 cubic yards (yds³) of soil on certain parcels identified as having munitions or explosives of concern or a project involving a well installation or groundwater replenishment (limited to parcels having a groundwater covenant as defined by the ordinance that restricts groundwater use).

The Proposed Project Injection Well Facilities would be located on portions of two parcels (APN 031-151-048-000 and APN 031-211-001-000) that are not associated with a groundwater covenant in the Ordnance Ordinance but are associated with some construction restrictions. These include no soil disturbance without a soils management plan, notification of possible MEC, and access requirements.

The City will also require a Conditional Use Permit (CUP) to be approved by the Planning Commission. Currently, the City views the wells associated with the Proposed Project as a utility that requires a CUP application and fee.

5.1.1.3. Monterey County

Monterey County Drinking Water Protection Services, Environmental Health Bureau requires a permit for all water supply and monitoring wells. Application forms can be downloaded from the Environmental Health Bureau website for the monitoring wells. For the proposed injection wells, the Drinking Water Protection Services should be contacted directly. The applications must be signed by the property owner; for this project, an encroachment permit from a municipality (e.g., City of Seaside) can be submitted in lieu of a property owner signature. For the recent monitoring well, a signature from FORA was also required because they were the land owner at that time. Application fees are required for each well.

5.1.1.4. California Department of Water Resources (CDWR) and Monterey County Water Resources Agency (MCWRA)

All wells drilled in California, including monitoring and injection wells, require a permit from the CDWR. Such permits, including required completion of a Driller's Log, would be secured by the drilling contractors used for Proposed Project. In Monterey County, MCWRA has a cooperative agreement with the CDWR to manage the Driller's Log permits. Also, DEH provides paperwork from the Monterey County DEH well construction permit process (described above) to MCWRA.

5.1.1.5. CRWQCB and SWRCB Division of Drinking Water

Currently, groundwater replenishment projects must obtain a permit from the CRWQCB (Waste Discharge Requirements and/or Waste Discharge and Water Reclamation Requirements) in accordance with California Water Code Sections 13523 and 13523.1. This process entails submittal of a Report of Waste Discharge to the CRWQCB and an Engineering Report for review by the CRWQCB and approval by the SWRCB Division of Drinking Water. The Division of Drinking Water issues a conditional approval letter, which contains

provisions for the CRWQCB to include in the permit. Effective July 1, 2014, California Water Code Section 13528.5 provides the SWRCB (and hence the Division of Drinking Water) with the authority to issue groundwater replenishment permits. At this time is it is not known if or when the Division of Drinking Water might take over the permitting responsibility from the CRWQCB.

An additional permit for well construction may also be required by the CRWQCB. If drilling methods result in application to land of cuttings or drilling fluids/development water, a Notice of Intent may be required to comply with a state-wide General Order (No. 2003-0003-DWQ). This General Order allows the CRWQCB to grant a permit through an administrative approval process for *General Waste Discharge Requirements for Discharges to Land with a Low Threat to Water Quality*. General Order No. 203-0003-DWQ applies to well development discharge, monitoring well purge water discharge, and boring waste discharge.

5.1.1.6. U. S. Environmental Protection Agency (USEPA) Injection Well Registration The USEPA administers the Underground Injection Control (UIC) Program, which contains requirements for various classes of injection wells in the state. Injection wells associated with the Proposed Project are designated as Class V wells under the UIC program. 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 USEPA permit would not be necessary. However, the wells must be registered on the UIC injection well database maintained by USEPA.

5.1.2. Well Technical Specifications

Technical Specifications would be developed for each of the Proposed Project injection wells and monitoring wells. These detailed documents would provide a preliminary well design and describe methods and standards for each well. The specifications would also identify requirements for drilling cuttings and fluid disposal, and use of local utilities, if allowed. In addition, specifications would provide constraints associated with the ROE or other permits not obtained by the drilling contractor. The documents would require preparation and implementation of a site-specific health and safety program.

5.2. INSTALLATION AND TESTING OF DEEP INJECTION WELLS

The drilling of a deep injection well would require sufficient space for drilling rig access and for storage of temporary wastes such as drilling fluid and cuttings from the borehole. In general, a relatively small site (smaller than about 100 feet by 100 feet) can be accommodated, but may result in increased well costs if staging and equipment storage is limited or if onsite equipment cannot be located for optimal construction operations. However, such a site may not be sufficient to support additional project components such as pits or holding tanks for well discharge. Technical specifications would be based on the drilling site available.

5.2.1. Drilling

The proposed deep injection wells would be drilled with rotary drilling methods similar to those employed for the ASR wellfield. Those wells were drilled using reverse rotary drilling methods and polymer-based drilling fluids to minimize deep invasion of fluids into the formation. Similar methods would be used for the Proposed Project wells to minimize borehole impacts from drilling fluids. Cuttings from the borehole would be logged by a California Certified Hydrogeologist. Open-hole geophysical logging would also be conducted.

It is anticipated that at least one of the Proposed Project monitoring wells would be installed prior to the installation of the proposed deep injection well. This would provide site-specific information and inform details of injection well design. The well would also provide a monitoring point during injection well testing.

5.2.2. Design, Installation, and Development

The proposed deep injection well design would incorporate 18-inch to 24-inch diameter production casing and a wire-wrap stainless steel screen. Screen selection and filter pack design would be developed using both cuttings from the adjacent proposed monitoring well in addition to data collected from nearby ASR wells. Mechanical and pumping techniques would be used to develop the well after installation. Video logs would be conducted in the final wellbore to document well construction and ensure appropriate down-hole conditions for equipping.

5.2.3. Testing and Equipping

Both variable (step) and constant discharge pumping test and constant injection tests would be completed in the proposed injection wells. An 8- to 24-hour test length would be sufficient for the variable and constant rate tests. Flowmeter surveys would be conducted following pumping and injection testing to identify water movement within the wellbore. For planning purposes, it is assumed that both static and dynamic flow testing will be conducted.

The variable and constant rate discharge tests would be conducted immediately following installation and well development and would provide aquifer parameters to support final well design. Injection testing could be conducted after the constant rate discharge tests, but would require product water that may not be available at the time of well construction. As such, injection testing may be delayed unless an adequate alternative water source is available for testing purposes.

At the end of the constant rate discharge test, a water quality sample would be collected to confirm local groundwater quality. Constituents targeted for analysis would be based on compliance with the SWRCB and CRWQCB requirements. The well would be disinfected with chlorine to control any bacterial growth introduced during installation.

A 400 horsepower, variable speed pump for the proposed injection wells is assumed for planning purposes and costs. Additional requirements for wellhead equipment and surface connections are being developed with others on the Proposed Project team.

To maintain injection capacity, the wells would need to be taken offline for periodic pumping to back-flush the well screens and repair or prevent physical clogging. Details for the back-flush basin were discussed previously in this report (Section 4.3). This water would not be lost from the project, but would be allowed to percolate back into the groundwater basin.

5.3. INSTALLATION AND TESTING OF VADOSE ZONE WELLS

The drilling, installation, and testing of the proposed vadose zone wells would likely require less surface area than the proposed deep injection wells. Currently, the proposed vadose zone wells are planned to be on the same well sites as the proposed deep injection wells to minimize construction and ground disturbance to a smaller area than would otherwise be needed.

5.3.1. Drilling

The proposed vadose zone wells would be drilled using the bucket auger drilling method. The field data and results from the drilling, logging, and installation of GWR MW-1 and DIW-1 would be used to confirm the depth and placement of well screens. Grab samples in the vadose zone well boreholes would be logged by a certified California Hydrogeologist during drilling to assist in final vadose zone well design. Open-hole geophysical logging (including induction logging and other logs suitable for the unsaturated zone) would be conducted to assist in stratigraphic characterization. The final logging program would depend on the quality of the data collected in DIW-1. The usefulness of additional logging, such as a video log, would be evaluated based on results of the initial field investigation and pilot testing.

5.3.2. Design and Installation

The preliminary vadose zone well design is discussed in Section 4.2.4 and shown on Figure 12. An 18-inch diameter casing would be set in a borehole drilled to below 200 feet. The annular space would be filled with a high quality gravel pack appropriately sized to avoid plugging the formation with filter-pack fines during long-term injection. Dry chlorine would be mixed with the gravel pack during installation to control bacterial growth that may have been introduced during well installation. Air vents and a transducer tube would also be installed in the annular space of the well.

The casing would be perforated over an approximate 100-foot interval to optimize the open area for recycled water recharge. An eductor tube (typical 4-inch diameter) would be installed in the casing and used to introduce water into the wellbore in a manner that avoids turbulent flow in the open casing and potential air entrainment. The eductor tube would be installed with an orifice plate on the bottom or a variable orifice valve to introduce specified

sustained or variable flows. An air vent would also be installed in the casing to allow air to escape while being displaced by the water.

5.3.3. Pilot Testing and Monitoring

Injection testing would be conducted to establish a wetting front and estimate long-term injection rates. A one-month test is assumed to be sufficient to inform any well design modifications for the remaining wells. In general, the subsequent three vadose zone wells would be installed in the same manner as the first vadose zone well, which is considered a pilot well.

To allow for monitoring during pilot testing, a small-diameter boring would be drilled adjacent to the pilot vadose zone well to install temperature probes or other monitoring devices to track the wetting front of the project water as it percolates through the vadose zone. This monitoring would provide valuable information for the demonstration of underground retention time associated with the SWRCB Regulations (SWRCB, 2014).

Hook-up to the conveyance system may incorporate a butterfly valve that allows automatic recharge operation at each well. All wells would be equipped with a high water level alarm. Well hook-ups and onsite water supply lines would be coordinated with pipeline and surface equipment designs by others. Once installed, the vadose zone wells would require a relatively small surficial footprint and can be incorporated into the Proposed Project close to deep injection wells.

5.4. DRILLING, INSTALLATION AND DEVELOPMENT OF MONITORING WELLS

The Proposed Project monitoring wells would be drilled with the direct or reverse rotary method. Wells would either be installed as well clusters (separate casings in two smaller boreholes) or nested wells (two casings in one larger borehole) in order to monitor both the Paso Robles and Santa Margarita Aquifers at each monitoring well location. For planning purposes, well clusters are assumed.

Geologic samples from all boreholes would be logged by a California Certified Hydrogeologist. Geophysical logging would be conducted to supplement geologic data from the well cuttings.

Casing diameter would need to be sized to accommodate a sampling pump sufficiently large to lift a groundwater sample from depths greater than 400 feet (minimum 3-inch outer diameter). Wells would be drilled to similar depths as the closest proposed deep injection well and screened similar to injection wells for the Santa Margarita Aquifer. For the Paso Robles Aquifer monitoring, well casings would be screened across the upper-most permeable zones and close to the water table in order to track shallow recharge from the proposed vadose zone wells.

5.5. GROUNDWATER MONITORING PROGRAM

Following installation, all of the Proposed Project monitoring wells and deep injection wells would be sampled and analyzed to collect baseline water quality data in conformance with SWRCB Division of Drinking Water and CRWQCB requirements.

6. PROPOSED PROJECT INJECTION WELL FACILITIES: SEQUENCING AND SCHEDULE

Field planning for the Proposed Project Injection Well Facilities would begin soon after certification of the Final EIR. One of the initial steps in field planning would involve the preparation of Technical Specifications for the wells and applications for drilling permits. The FORA right-of-entry permit for the recently installed monitoring well took approximately 14 months to secure.

The field activity sequencing could consider some alternate scheduling to minimize construction time while providing some flexibility for unanticipated subsurface conditions that would impact well drilling. A list of steps describing the potential sequencing of the Proposed Project well program is provided below. Well locations are shown on Figure 10. The field program generally begins in the north (DIW-1) and ends in the south (DIW-4).

- Mobilize a bucket auger rig to the field to install surface conductor casing at the two northern monitoring well sites (GWR MW-1 and GWR MW-2). Then move the auger rig to each of the four deep injection well sites (DIW-1, DIW-2, DIW-3, and DIW-4 for conductor casing installation. Surface casings may also be installed for GWR MW-3 and MW-4 before the bucket auger rig is released. Each surface casing is assumed to be installed in one day including rig mobilization.
- 2. As soon as the bucket auger rig completes the casing at GWR MW-1, mobilize a reverse rotary drilling rig to the field to drill, log, install, and develop two well clusters (Shallow and Deep) at the first monitoring well location. Data from GWR MW-1 would be used to finalize the pre-drilling design of DIW-1. The reverse rig can then be moved to GWR MW-2 to complete the monitoring wells on the north end of the site. Monitoring wells would need to be the first wells installed to allow for collection of baseline groundwater data prior to project startup. A small pump rig can be moved onto GWR MW-2 to complete the monitoring wells while the reverse rotary rig is moved to DIW-1.
- 3. The reverse rotary rig would drill and install DIW-1. The pump rig would be brought onto DIW-1 for well development and pumping/injection testing, allowing the reverse rig to move to DIW-2. Pumping test would be conducted initially with the pump rig. The injection testing may be delayed, depending on the availability of source water; product water would not be available initially after well completion. The remaining DIW wells would be drilled in a similar manner with the pump rig following the reverse rig.
- 4. Monitoring well clusters at GWR MW-3 and MW-4 can be completed with the reverse rotary rig after completion of the deep injection wells. Alternatively, an additional reverse rotary rig could be brought in to complete the monitoring well program prior to drilling DIW-4. In that way, hydrogeologic data in the southern

Proposed Project area could be obtained that might inform well design modifications for DIW-4. In addition, baseline sampling events would need to be conducted prior to injection into DIW-4.

- 5. Mobilize a bucket auger rig to the field to drill a pilot vadose zone well, VZW-1. The vadose zone program could begin after the installation of DIW-1 or after all deep injection wells and monitoring wells are installed. It is recommended that at least the two northern monitoring wells and DIW-1 be completed prior to construction of vadose zone wells. This would allow analysis of the site-specific hydrogeologic data collected during the drilling of the three wells to ensure an optimal pre-drilling design of the vadose zone wells. The first vadose zone well should be viewed as a pilot well or test well to allow testing of the injection capacity prior to installation of the remaining wells. The injection capacity of 500 gpm/well used in project planning is highly conservative, given the thick and permeable sands in the vadose zone. In addition, the maximum amount of injection into the Paso Robles Aquifer is small (277 gpm) and may be accommodated with fewer wells. However, this testing and sequencing of wells would allow optimization and modification of vadose zone well design, as necessary.
- 6. An additional, small-diameter boring would be installed adjacent to the pilot vadose zone well and equipped with temperature probes or other vadose zone monitoring devices to allow tracking of the wetting front with the initial pilot well testing. The boring could be installed in close proximity to the vadose zone well and would not require additional construction space than has already been allocated for the EIR evaluation. A 30-day (approximate) pilot test would be conducted in VZW-1 to quantify the injection capacity of the vadose zone at that location and to inform future well design.
- 7. Construction and installation of the back-flush basin could be conducted during the initial drilling of DIW-1 to provide a temporary location for well testing water. Alternatively, other arrangements could be made for testing water, allowing the back-flush basin construction to be completed during conveyance piping and wellhead equipping. It is assumed that pipeline installation would be best conducted soon after the drilling program has been completed to allow for injection testing.

Depending on the timing of other activities, the field program could also be completed in phases. For example, GWR MW-1, MW-2, DIW-1 and DIW-2 could be completed in an initial phase to allow for tracer testing and groundwater modeling prior to installation of the remaining program wells. Phasing would be controlled by the amount and timing of product water available for injection.
The Seaside Groundwater Basin is an important resource for a reliable water supply for the Monterey Bay area. Increased replenishment of basin aquifers has many benefits including locally higher groundwater levels and increased basin yield, while mitigating the effects of over-pumping during the dry season. Potential impacts from the Proposed Project on water levels, quantity, and quality are described in this section.

7.1. GROUNDWATER LEVELS AND QUANTITY

In order to predict the transport of recycled water in the groundwater system and to evaluate potential impacts of the Proposed Project on groundwater levels and quantity, HydroMetrics has conducted groundwater modeling using the Seaside Basin groundwater flow model. The modeling of the Proposed Project builds on previous modeling runs that were used during project development to allocate project water between the two basin aquifers (HydroMetrics, October 2013). The initial project development modeling was described previously in this report (Section 3.3.5.1); the TM documenting the project development modeling results is included in this report as Appendix B. The Proposed Project modeling is included in this report as Appendix C.

The Proposed Project modeling incorporated the proposed delivery schedule and drought reserve account as described in Section 2. The appropriate delivery schedule of the eight schedules shown on Table 1 was assigned to each year of project operation in the modeling based on hydrology and the balance of the drought reserve account. The amounts used for injection for each year of the 25-year simulation are documented in an attachment at the end of the HydroMetrics TM (Appendix C).

A brief summary of the Proposed Project modeling in Appendix C and implications for project impacts on groundwater resources are discussed in the following sections.

7.1.1. Modeling Approach

The Proposed Project modeling was conducted using the predictive model setup that the Watermaster has developed previously for analyzing future conditions in the basin. The predictive model covers a 33-year period from 2009 through 2041. The Proposed Project well operations are currently anticipated to begin in 2017. For purposes of the modeling analysis, the injection was simulated as beginning in October 2016 to cover the entire Water Year (WY) 2017 and allow for a 25-year analysis of the project.

The Proposed Project modeling was also conducted using reasonable assumptions of future operation of production wells in the 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 Proposed Project product water based on existing well capacity and water demand (see Appendix C).

The Proposed Project modeling also incorporated a quantitative assessment of future operations of the ASR Project. This assessment was developed by MPWMD, which coordinates the ASR injection and extraction operations under cooperative agreements with CalAm. The assessment was based on historical hydrologic conditions on the Carmel River between 1987 and 2008 and approved rules of ASR operation. This allowed MPWMD to predict both injection and recovery schedules at each ASR well over time. By incorporating this assessment into the model setup, the Proposed Project was evaluated during a full range of ASR injection and recovery (pumping) conditions (see Appendix C).

7.1.2. Modeling Results

The Proposed Project modeling simulated the travel time between injection wells and the closest production wells under the varying hydrologic and pumping conditions throughout the 33-year simulation, incorporating all of the associated delivery schedules in Table 1. The Proposed Project modeling also evaluated changes in water levels at eight production wells over time and assessed the potential for the Proposed Project to potentially affect the risk for seawater intrusion. Full modeling results are presented in Appendix C and summarized below.

7.1.2.1. Flow Paths and Travel Time to Production Wells

The travel time analysis, a modeling process referred to as particle tracking, evaluated the transport of recycled water from injection well to production (extraction) wells. The analysis allows the visualization of groundwater flow paths and provides details for demonstrating compliance with the underground retention time requirements in the SWRCB Regulations.

For the particle tracking analysis, "particles" (acting as a simulated tracer 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 when the Proposed Project was in operation. This ensured that the fastest travel time under numerous combinations of pumping and ASR operations could be identified. Particles were simulated as being released around the edges of each model cell containing an injection well and tracked as the water flows downgradient in the groundwater system. Particles were tracked until they reached a cell containing a production well. Tracking from the edges of cells (rather than at the well within the cell) allows for a thorough examination of particle transport, but is also conservative in that it eliminates the additional distance a particle would travel between the actual well and the edge of a cell.

The fastest flow paths as indicated by the model particle tracking simulations are shown on Figure 13. The upper map on Figure 13 shows simulated flow paths from the deep injection wells and the lower map shows the paths from the vadose zone wells. Simulated flow paths from the deep injection wells are being influenced by the dynamic system created by changes in pumping and injection in both production and ASR wells. As shown, the shortest simulated flow paths are from DIW-3 to the nearby ASR wells (shown in red on the top of Figure 13). Simulated vadose zone flow paths are not impacted by the ASR wells, which are screened in the deeper Santa Margarita Aquifer. Recycled 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). Injection at VZW-1 does not arrive at any production well during the travel time simulation shown in Figure 13, but provides replenishment to the local Paso Robles Aquifer as water flows downgradient.

The fastest travel times for each of the injection wells are tabulated by HydroMetrics (Appendix C) and reproduced in Table 10. The shading for each injection well in Table 10 generally corresponds to the colors of the respective well flow paths on Figure 13.

Extraction	Well of Origin of Particles with Fastest Travel Time (Days)								
Well	DIW-1	DIW-2	DIW-3	DIW-4	VZW-1	VZW-2	VZW-3	VZW-4	
ASR 1&2	-	371	327	1,780	-	-	-	-	
ASR 3&4	724	-	-	3,074	-	-	-	-	
Luzern	-	-	-	-	-	-	3,140	-	
Ord Grove	3,718	1,952	1,052	1,497	-	-	-	4,250	
Paralta	506	521	852	2,076	-	5,114	-	-	

Table 10.Simulated Fastest Travel Times between Injection and ExtractionWells, in days

Note: - = no particle traveling between wells

As shown in Table 10, simulated travel times vary considerably from each injection point to a production well. The deep injection wells provide water to six different wells (including four ASR wells, Paralta, and Ord Grove), varying from 327 days (about 11 months) to more than 3,000 days (more than eight years). Simulated travel times are longer for the injection into the vadose zone wells, but water is still being added to basin storage, which increases hydraulic gradients and groundwater flow toward downgradient wells.

Regarding the underground retention time in the SWRCB Regulations, it appears that project water would remain in the groundwater system for at least six months, which would provide the Proposed Project with the maximum allowed 6-log virus removal credit. However, the demonstration of retention time with groundwater modeling requires a one-year travel time for approval of the six-month credit; DIW-3 does not meet the one-year requirement for all conditions (including the fastest simulated travel time for DIW-3 shown in Table 10). Although the simulated travel times from all injection wells meet the one-year requirement during 20 of the 25-year GWR simulation period, simulated travel times for injection in DIW-3 during five years of the simulation are between 327 days and 365 days. The shortest simulated travel time from DIW-3 to ASR-1/ASR-2 is 327 days, 38 days short of the 365-day simulated travel time needed for the maximum 6-log removal credit. The modeling does, however, support at least a 5-log removal credit. The six-month credit would be re-evaluated as part of the tracer testing to be conducted after the Proposed Project begins operation.

7.1.2.2. Groundwater Levels

Because the Proposed Project would provide additional water for downgradient extraction, the project would result in both higher and lower water levels in existing basin wells over time depending on the timing of extraction and the buildup of storage in the basin. An examination of eight key production wells was completed by HydroMetrics and presented for the entire 33-year simulation period (including 25 years of GWR project operation) (HydroMetrics, January 2015, in Appendix C). These hydrographs illustrate simulated changes in water levels over time at various locations within the basin with and without the Proposed Project. Hydrographs for all eight wells (with one hydrograph representing both ASR-1 and ASR-2) are presented and discussed in the HydroMetrics TM (see Appendix C). Four example hydrographs comparing the *Proposed Project* with a *No Project* scenario are presented on Figures 14 and 15, representing deep and shallow water levels, respectively.

7.1.2.2.1. Deep Water Levels

Figure 14 presents water levels representing two ASR wells closest to the Proposed Project Injection Well Facilities (ASR-1 and ASR-2) and a downgradient production well, Ord Grove 2. Well locations are shown on Figure 10 (Ord Grove 2 is labeled Ord Grove on the figure). On both Figures 14 and 15, the *No Project* scenario is represented by the blue line and the GWR *Project* scenario is represented by the green line. The Proposed Project is simulated to begin in late 2016 (WY 2017); prior to that time period, the water levels for the *No Project* and *Project* scenarios are the same (Figures 14 and 15).

In general, simulated deep water levels (Figure 14) rise in the ASR and Ord Grove wells soon after the Proposed Project is implemented in late 2016. Although simulated water levels continue to rise and fall due to seasonal fluctuation associated with water demand and pumping, water levels do not fall to the lower levels observed in 2011 – 2016. The general rise in water levels occurs under both *Project* and *No Project* conditions. This change is primarily due to the decrease in overall basin pumping as required under the adjudication. For the ASR wells, simulated water levels under the *Proposed Project* scenario are similar to or slightly higher than the *No Project* water levels.

An exception to this occurs during a drought cycle, generally represented by the time period 2031 – 2035, when simulated water levels associated with the Proposed Project are one to nine feet lower than under *No Project* conditions. During that time, the ASR wells are pumping to recover GWR Project water under *Project* conditions, but the ASR wells are not operating under *No Project* conditions. ASR wells are idle during *No Project* conditions because, during drought conditions, no water is available to be extracted from the Carmel River Alluvial Aquifer for ASR injection and no stored water is available for ASR recovery. Because the simulated pumping for the *Project* conditions causes water levels in the wells to fluctuate more than for the *No Project* conditions during a simulated drought cycle. This impact is seen as beneficial overall in that simulated water levels are not lowered significantly and only for a short duration, while simulated groundwater pumping and water supply has been increased during a drought. Under both scenarios, overall simulated water levels remain higher than current levels.

For the Ord Grove well (Figure 14), simulated water levels are relatively similar for the *Project* and *No Project* scenarios from project implementation to about 2029. At that time, *Proposed Project* simulated water levels are generally lower (up to about 10 feet lower), but typically less than about five feet lower during the bottom of each pumping cycle. Again, this is due to the increased pumping allowed by the increased recharge of the Proposed Project. Also, the simulated lower water levels during the drought cycle are higher than the low levels reached prior to the initiation of the Proposed Project. Because simulated water levels are higher than current levels while production is being increased in the basin, the Proposed Project is considered to have a beneficial impact on water supply without a significant adverse impact to groundwater levels and wells.

7.1.2.2.2. Shallow Water Levels

Figure 15 documents changes in simulated water levels under both *Project* and *No Project* scenarios, as illustrated by the Luzern and PCA-W Shallow wells (both screened in the Paso Robles Aquifer). Similar to the deeper hydrographs, simulated water levels generally rise under both *Project* and *No Project* conditions due to an overall decrease in basin pumping. After the Proposed Project is initiated, the Luzern well is pumped to recover the recharged water, although the water has not yet arrived in the vicinity of the well. This creates slightly lower simulated water levels (up to about seven feet) in early stages of the Proposed Project. This also occurs in the PCA-W Shallow well, but the difference is only a few feet because this well is not being pumped to recover Project water. With time, simulated water levels in the Luzern and PCA-W wells rise under the *Project* scenario as Project recharge water moves downgradient toward these wells. The benefit of additional recharge is demonstrated by higher simulated water levels (beginning in about 2030).

Importantly, simulated water levels do not fall below pre-project levels and do not fall below the Protective Elevation for seawater intrusion (see the Protective Elevation line on PCA-W Shallow well on Figure 15). These Protective Elevations have been determined by the Seaside Basin Watermaster to provide target water levels that are considered to protect the basin from the adverse consequences of seawater intrusion (HydroMetrics, 2009). Although other coastal wells remain below Protective Elevations with and without the Proposed Project, the changes predicted to be associated with the Proposed Project are demonstrated by the hydrograph of PCA-W Shallow, the closest coastal well. These data indicate that the Proposed Project will not exacerbate the risk for seawater intrusion compared to the *No Project* conditions.

7.1.2.3. Groundwater Quantity

The modeling simulations of the Proposed Project recover only the water recharged to the aquifers. As such, the Proposed Project would not result in a significant change in groundwater storage in the basin because the water being injected would eventually be extracted for municipal use. Further, the Proposed Project would increase basin yield and groundwater supply.

7.2. IMPACTS ASSESSMENT ON GROUNDWATER LEVELS AND QUANTITY

Based on the results of the modeling and groundwater analyses, potential impacts of the Proposed Project on groundwater levels and quantity are compared to thresholds of significance as developed from CEQA guidance.

7.2.1. Thresholds of Significance

Appendix G of the 2013 CEQA Guidelines provides the following question to be addressed as part of the Proposed Project EIR regarding groundwater resources:

Would the Proposed Project substantially deplete groundwater supplies or interfere substantially with groundwater recharge such that there would be a net deficit in aquifer volume or a lowering of the local groundwater table level (e.g., the production rate of pre-existing nearby wells would drop to a level which would not support existing land uses or planned uses for which permits have been granted)?

The criterion above was applied to the results of the groundwater modeling as summarized in the following section. Additional CEQA questions and significance criteria have been developed for addressing water quality. The analysis of groundwater quality is provided in Section 7.3 with the impacts analysis and the significance criteria provided in Section 7.4.

7.2.2. Analysis of Potential Impacts

As discussed above, simulated water levels are sometimes lower under the *Project* scenario because of increased pumping at existing extraction wells. However, simulated water levels are lowered only about 10 feet or less and would be lowered for a relatively short duration, typically for a few months. In addition, simulated water levels are generally higher than preproject levels. As such, none of the municipal or private production wells would experience a reduction in well yield or physical damage. All existing wells would be capable of pumping the current level of production or up to the permitted production rights.

In addition, analysis of the closest shallow coastal well (PCA-West Shallow) indicates that increased pumping of project water would not result in water levels falling below elevations protective of seawater intrusion. Although it would take time for the beneficial impacts of recharge to reach coastal pumping wells, the increased pumping of nearby Paso Robles production wells would only reduce water levels about two feet near the coast. The closest coastal well, PCA-W shallow remains above Protective Elevations for the duration of the model simulation period.

In addition, there would be no adverse impacts to the quantity of groundwater resources. Because the Proposed Project would only recover the amount of water injected, there would be no long-term change in groundwater storage associated with the Proposed Project.

7.3. EXISTING GROUNDWATER QUALITY AND PROPOSED PROJECT RECYCLED WATER QUALITY

In order to evaluate potential impacts on water quality from the Proposed Project, both ambient groundwater quality and quality of the Proposed Project recycled water are characterized. The characterization of ambient groundwater quality establishes a baseline for a water quality impacts assessment in support of the EIR. The characterization incorporates available data and previous investigations, and also summarizes the results of new geochemical evaluations regarding the interaction of the existing geologic sediments in the Proposed Project area with product water generated from the GWR pilot/demonstration treatment facility⁸. Those geochemical analyses are presented more fully in a separate report on the MRWPCA field program (Todd Groundwater, February 2015).

The Proposed Project Injection Well Facilities study area shown on Figure 2 was used as the focus of the groundwater quality characterization. In order to incorporate additional available water quality data, the study area was expanded about 2,000 feet to the west to include five additional production wells. Water quality data were also evaluated for: 1) the Carmel River water, which is injected into nearby ASR wells; and 2) predicted recycled water quality to be produced at the AWTF and to be injected into the Seaside Basin. The geochemical evaluation utilized data from the advanced treatment pilot testing and bench scale chemical stabilization, which did not include all of the new source waters to be treated at the RTP and subsequently treated at the proposed AWTF. However, the data are a reasonable representation for purposes of the EIR. Types of data and analyses are described in the subsequent sections of this report.

7.3.1. Data Sources

Previous investigations on groundwater quality in the Seaside Groundwater Basin were reviewed including Fugro (1998), Yates et al. (2005), and HydroMetrics (2009). Recent annual reports developed by the Watermaster contain evaluations of potential seawater intrusion (HydroMetrics, 2013). Information was also reviewed in the Final Salt and Nutrient Management Plan (SNMP), which includes summaries of ambient groundwater quality including concentrations of TDS, nitrate, and other constituents (HydroMetrics, 2014).

Recent and historical groundwater quality data for the Proposed Project Injection Well Facilities study area were provided by MPWMD and CalAm. These data were supplemented with recent data collected by Todd Groundwater in association with the MRWPCA field program. Data provided from these sources are summarized in Table 11 and described in the following sections.

⁸ A description of the water quality of the Proposed Project product water is provided in Section 7.3.4. based on a bench-scale stabilized sample from the pilot treatment facility.

Table 11. Source of Groundwater Quality Data

Water Quality Database	Data Source					
water Quality Database	MPWMD	Cal-Am	MRWPCA			
# Wells	14	8	6			
Time Period	1990-2012	2010 - 2013	2014			
Anions	х	х	х			
Metals (including major cations)	х	х	х			
Conventional Chemistry Parameters	х	х	х			
Chlorinated Pesticides and PCBs	х	х	х			
Nitrogen and Phosphorus Pesticides	х	х	х			
Organic Analytes	х	х	х			
Chlorinated Acids	х	х	х			
Carbamates		х	х			
Volatile Organic Compounds (VOCs)	х	х	х			
Semivolatile Organic Compounds		х	х			
Haloacetic Acids		х	х			
Herbicides		х	х			
Nitroaromatics and Nitramines (Explosives)			х			
Other (e.g., isotopes)			х			

PCBs – Polychlorinated Biphenyls

Organic Analytes – including 1,2-Dibromo-3-chloropropane, 1,2-Dibromoethane (EDB), diquat, endothall, glyphosate

Carbamates – organic compounds derived from carbamic acids

7.3.1.1. MPWMD Groundwater Quality Monitoring Program

MPWMD conducts a basin-wide groundwater monitoring program with support from the Seaside Basin Watermaster. Components of the program also serve as the monitoring program for the ASR Project. An electronic database in Access[©] format was provided by MPWMD for this analysis. The database included the Watermaster monitoring program data along with historical groundwater quality data dating back to 1990. Data from 14 wells were used in the water quality characterization.

7.3.1.2. CalAm Production Well Monitoring

CalAm monitors the water quality from their production wells in the basin in compliance with drinking water requirements per California Water Code, Title 22. These data were provided to Todd Groundwater in Excel[©] format for eight production wells in the water quality study area and included samples from 2010 through 2013.

7.3.1.3. Water Quality Analyses from MRWPCA Field Program

From December 2013 through February 2014, Todd Groundwater conducted a field program for MRWPCA in support of the Proposed Project. The program included a detailed vadose zone analysis, installation and sampling of a new monitoring well (MRWPCA MW-1), and groundwater sampling from five additional wells in the Proposed Project Injection Well Facilities area including two upgradient monitoring wells (FO-7 Shallow and FO-7 Deep) that had not previously been sampled for groundwater quality. The field program, including all testing and analyses, is documented in a separate report (Todd Groundwater, February 2015). Groundwater sampling results were incorporated into this report to support the water quality impacts assessment. Wells sampled during the field program are summarized in Table 12.

Well	Well Type	Screened Aquifer	Well Depth (feet, bgs)	Screen Interval (feet, bgs)
MRWPCA 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

Table 12.Wells Sampled in 2013-2014 Proposed Project Field Program

Notes: All wells sampled January/February 2014. bgs = below ground surface.

An expanded list of constituents was analyzed in these samples (compared to the list of constituents available from monitoring at other basin wells) including:

- chemicals including explosives associated with former Fort Ord activities
- constituents in the SWRCB Regulations
- constituents of emerging concern (CECs) as included in the SWRCB Recycled Water Policy
- isotopic data to support hydrogeologic analysis
- data to support geochemical modeling in order to analyze the compatibility of the Proposed Project recycled water with ambient groundwater.

Laboratory analyses of groundwater samples collected at these six wells are presented in Appendix D (as Tables D-1A through D-1P).

7.3.1.4. Water Quality Database

Data sets from the sources described above were compiled into an Access[©] database. This database was used to characterize groundwater quality and identify potential constituents of concern for the Proposed Project water quality impacts assessment.

7.3.2. Groundwater Quality Characterization

The available data representing general groundwater chemistry were checked for accuracy and then evaluated using various geochemical techniques, as summarized in this section.

7.3.2.1. 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 (see 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 total calcium carbonate (CaCO₃) concentrations were recalculated to bicarbonate (HCO₃⁻) 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.

For geochemical plotting purposes, the most recent available data were used for wells near the Proposed Project Injection Well Facilities. The six wells included in the MRWPCA 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.

7.3.2.2. Analytical Accuracy Using Charge Balance and Cation/Anion Ratios

A cation-anion balance (also known as a charge balance) was calculated for the available analytical data. This is a method by which water quality analytical accuracy is checked to ensure that the water is electrically neutral (hence the term, *charge balance*). For an ideal charge balance, the sum of the anions in milliequivalents per liter (meq/L) should equal the sum of cations in meq/L (Hounslow, 1995).

The charge balance is usually expressed by the equation:

Balance = (Σ cations – Σ anions) / (Σ cations + Σ anions) * 100

If the calculated cation-anion balance is less than 10 percent, then the data are assumed to be accurate. If the resulting balance is greater than 10 percent, then one or more of the following conditions may apply:

- the data are inaccurate
- other constituents, such as trace metallic ions or organic ions, may have been present that were not analyzed
- the water was very acidic and hydrogen ions were not present.

Another accuracy check is the ratio of the total cations/total anions, which is also calculated in meq/L. If the ratio equals 1.0, or is at least between 0.90 and 1.10, the data are considered to be accurate. Because a limited number of cations and anions were analyzed, a cation-anion balance of less than 10 percent is assumed to be accurate. Results of the charge balance and cation/anion ratio are provided in Table 13.

Well Designation	Well Designation Aquifer Screened		Target Ratio Accuracy	Charge Balance (%)	Target Balance Accuracy %
Darwin	Paso Robles	0.84	0.9-1.10	-8.81	≤ 10
Military	Paso Robles	0.91	0.9-1.10	-4.851	≤ 10
Seaside Mid. School	Paso Robles	0.96	0.9-1.10	-2.13	≤ 10
MRWPCA MW-1	Paso Robles	1.018	0.9-1.10	0.87	≤ 10
FO-7 Shallow	Paso Robles	1.32	0.9-1.10	13.61	≤ 10
PRITW Mission	Paso Robles	0.84	0.9-1.10	-8.70	≤ 10
City of Seaside Muni 4	Paso Robles	0.97	0.9-1.10	-1.44	≤ 10
ASR-2	Santa Margarita	1.17	0.9-1.10	7.93	≤ 10
ASR-3	Santa Margarita	0.78	0.9-1.10	-12.65	≤ 10
Ord Terrace Shallow	Santa Margarita	0.94	0.9-1.10	-3.15	≤ 10
Ord Terrace Deep	Santa Margarita	1.01	0.9-1.10	0.61	≤ 10
ASR-1 (SMTIW)	Santa Margarita	1.04	0.9-1.10	1.82	≤ 10
Seaside Middle School	Santa Margarita	0.84	0.9-1.10	-8.23	≤ 10
FO-7 Deep	Santa Margarita	1.04	0.9-1.10	1.94	≤ 10
ASR MW-1	Santa Margarita	1.037	0.9-1.10	1.82	≤ 10
Paralta	Both	1.016	0.9-1.10	0.80	≤ 10
Ord Grove	Both	2.00	0.9-1.10	-0.12	≤ 10
ASR Injectate	Treated Surface Water	1.02	0.9-1.10	0.81	≤ 10
GWR Pilot Water	GWR Pilot Plant	1.05	0.9-1.10	2.50	≤ 10

 Table 13.
 Charge and Cation-Anion Balance for Groundwater Data Accuracy

As shown in Table 13, most of the data are within acceptable limits for both the cation/anion ratio and the charge balance. Wells with data slightly outside of the target accuracy limits (shaded values on Table 13 for either cation/anion ratio or charge balance) include Darwin, FO-7 shallow, PRTIW Mission, ASR-2, ASR-3, Seaside Middle School, and Ord Grove. In addition, the groundwater sample from FO-7 Shallow was associated with elevated turbidity that has likely interfered with the metals analytical data and impacted the accuracy check above. Results indicate that the data for wells that do not meet accuracy criteria are most susceptible to inaccurate metals analysis, but are still usable for overall water chemistry. For the purposes of this analysis, all data summarized in Table 13 are presented and reviewed; where water chemistry interpretations are consistent with other data sets in the same aquifer, data are judged reasonable for inclusion. Metals concentrations for the samples that do not meet accuracy criteria are judged less reliable and are not used solely for characterizations of water quality.

7.3.2.3. 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) from the combined database were plotted as Stiff diagrams and displayed on a Proposed Project Injection Well Facilities study area map as shown on Figure 16. Diagrams are color-coded to indicate the well construction and 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 screens in both aquifers. Also shown on the map is a Stiff diagram representing the treated Carmel River water injectate for the ASR wellfields (labeled ASR injectate).

The stiff diagrams on Figure 16 show differences in the groundwater signatures between the shallow (Paso Robles) and deep (Santa Margarita) aquifers in the Seaside Basin. In general, wells screened in the Paso Robles Aquifer show lower concentrations of major ions, especially sodium (Na) and potassium (K), calcium (Ca), chloride (Cl), and bicarbonate (HCO₃). 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 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. The 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 content than most wells in the Paso Robles Aquifer. Although not clearly demonstrated by the Stiff diagrams on Figure 16, recent TDS concentrations in the ASR-1 and ASR-2 wells indicate mixing with the injectate (HydroMetrics, March 2014).

Trilinear (Piper) Diagrams allow characterization of water chemistry and comparison of water quality analyses. Cation (Ca, magnesium (Mg), and Na+K) 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 (carbonate (CO₃)+HCO₃, sulfate (S), and Cl) 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 the Proposed Project Injection Well Facilities study area wells are plotted on the Trilinear diagram on Figure 17. Data from wells screened in the Paso Robles (yellow) Aquifer, the Santa Margarita Aquifer (green), and both aquifers (orange) are color-coded on the diagram to facilitate aquifer comparisons. Data from an ASR injectate sample (blue) and a sample from the Proposed Project recycled water (GWR) pilot plant (purple) are also included for comparison. Details of the sample from the GWR pilot plant are provided in section 7.3.4.

The Trilinear diagram (Figure 17) 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 that shallow aquifer groundwater is mixing with deep aquifer groundwater. 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 17).

The ASR injectate appears slightly different from 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 GWR pilot plant recycled water plots as sodium-potassium-type and bicarbonatecarbonate-type mostly because of the added calcium carbonate, calcium chloride and carbon dioxide gas used to stabilize the AWTF water. The signature appears more chemically distinct and plots near the edge of other data points.

Schoeller (Water Source/Fingerprint) Diagrams. Although the Trilinear diagram may be used to differentiate between some water chemistry signatures, differences are often indistinguishable except in percentage amounts. Schoeller diagrams plot the actual concentrations in meq/L of specific cations and anions and can offer a more detailed assessment of water chemistry. Schoeller diagrams are therefore 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. Cations and anions are shown on the diagram's x-axis while actual concentrations are depicted on the diagram's y-axis. Concentration points are then connected providing a "linear" pattern or "fingerprint" for each analysis.

Figure 18 shows the Schoeller diagram analysis for the Proposed Project Injection Well Facilities study area wells. Samples are color-coded similar to the Trilinear diagram to facilitate analysis. ASR injectate and GWR pilot plant recycled 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 well 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. GWR pilot plant recycled water, shown for future comparison purposes only, has a unique signature with lower concentrations of Mg and SO₄. This signature is similar to Schoeller signatures for advanced treated (RO) water samples that Todd Groundwater has observed for other recycled water projects.

Brine Differentiation (BDP) Plots. The Brine Differentiation Plot (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. 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. The BDP also allows for waters to be plotted in a finite range from 0 to 1.0 on both axes and to determine mixing lines if present. Also, fields for brines, evaporates (i.e., precipitated salts), and seawater can be delineated. 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.⁹ To determine different water sources, the BDP can be used in conjunction with the Schoeller Diagram.

The BDP on Figure 19 for study area wells shows scattered analytical data without a discernible straight- or curve-line mixing of groundwater. However, the ASR injectate plots close to the ASR wells as expected and plots in a distinct area from 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). Finally, it is important to note that the GWR pilot plant sample signature is quite distinctive and separate, confirming the Schoeller Diagram signature. These data indicate that Proposed Project product water will be sufficiently distinct from groundwater to allow for use as an intrinsic tracer in tracking the injected recycled water in the subsurface. An *intrinsic tracer* refers to a naturally occurring constituent or compounds already present in water that can distinguish the sample from ambient groundwater. The term is used in opposition to an *extrinsic tracer* – one that is artificially introduced into groundwater (e.g., boron). Per the SWRCB Regulations, the tracer study conducted to validate residence time can use an intrinsic tracer if approved by the Division of Drinking Water and with a safety factor applied (0.67 month credit per month of time estimated using the intrinsic tracer).

7.3.2.4. Concentrations of TDS in Groundwater

As indicated from the geochemical analysis, the ionic concentrations and water chemistry signatures are generally distinct between the Paso Robles and the Santa Margarita aquifers. This interpretation is also mirrored in the concentrations of TDS in groundwater in the Proposed Project Injection Well Facilities study area. Figure 20 shows a map of recent (2012 - 2014) TDS concentration ranges for the samples used in the analysis.

Using the data ranges in the legend, Figure 20 indicates that all of the TDS measurements in the wells were below the California secondary maximum contaminant level (MCL) Upper

⁹ End members are waters having two distinct isotopic or chemical compositions with other samples ranging between the two.

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). 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 20). Most of the Santa Margarita wells have recent concentrations above 500 mg/L (yellow on Figure 20), except Paralta (screened in both aquifers), SMS Deep, ASR-3, and FO-7 Deep. The wells did not show a wide variation in TDS concentrations over time.

7.3.3. 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 defined for this assessment as regulated constituents (those with MCLs) and constituents associated with former military activities at Fort Ord. Some of these constituents had not been analyzed previously in groundwater beneath the Proposed Project Injection Well Facilities area. To address this data gap, groundwater from the six wells sampled in the field program (Table 12 in Section 7.2.1.3) have been analyzed for more than 300 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.

7.3.3.1. Constituents Exceeding California Primary MCLs

For the more than 300 constituents and parameters analyzed in each of the six wells for this monitoring event, only two wells, FO-7 Shallow and MRWPCA MW-1, detected any constituents that did not meet the California primary MCLs for drinking water standards. These detections, along with turbidity values, are summarized in Table 14.

Analyte	Method	Units	MDL	FO-7 Deep	FO-7 Shallow	MRWPCA MW-1	California Primary MCL
Turbidity	SM2130B	NTU	0.040	10	550	71	5*
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

Table 14. Constituents Exceeding California Primary MCLs

*5 NTU is a secondary MCL; turbidity is included on the table for comparison purposes only.

Proposed Project Recharge Impacts Assessment Report As shown in Table 14, the only constituents that were analyzed 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 (MRWPCA MW-1) also detected elevated turbidity (71 NTU). FO-7 Deep 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 (see Appendix D, Table D-1B). No exceedances of primary MCLs were recorded in any of the wells with turbidity values of 10 NTU or less.

Due to the relatively slow velocities within groundwater systems and the natural filtering associated with aquifer materials, groundwater does not typically contain solids that would 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 representative of actual concentrations in groundwater.

As previously discussed, the small-diameter casings and deep water table have limited the ability to develop these three monitoring wells in order to produce a turbid-free groundwater sample for analysis. As such, future sampling programs will incorporate techniques such as field filtering to minimize the effects of turbidity.

7.3.3.2. Former Fort Ord Constituents

Given the historical land use of the former Fort Ord lands, the MRWPCA field program included groundwater analyses for chemicals of concern associated with former Fort Ord activities. The six groundwater samples from the MRWPCA 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 drinking water MCLs and California Notification Levels (NLs)¹⁰ and are summarized in Table 15.

¹⁰ NLs are non-regulatory, health-based advisory levels established by the SWRCB Division of Drinking Water (formerly CDPH) for contaminants in drinking water for which MCLs have not been established. A NL represents the concentration of a contaminant in drinking water that the Division of Drinking Water has determined does not pose a significant health risk, but warrants notification to the local governing body.

Table 15. Groundwater Analyses for Explosives and Associated Metals

Constituent	Wells with Detections*	Minimum Reporting Limit (RL)	Detected or Reported Concentration	California Primary MCL	California NL	Comments	
Explosives*							
HMX (cyclotetramethylene tetranitramine)	None	0.099-0.12	ND	None	350		
RDX (cyclotrimethylene trinitramine) (cyclonite)	None	0.099-0.12	ND	None	0.3		
1,3,5- TNB (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		
TETRYL (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		
2,4,6-trinitrotoluene (TNT)	None	0.098-0.11	ND	None	1		
	FO-7 Shallow	0.20	0.070***	None	None	high turbidity	
2,6-DNT (dinitrotoluene)	FO-7 Deep	0.23	0.064***	None	None	slightly turbid	
	ASR MW-1	0.10	0.037***	None	None		
2,4-DNT (dinitrotoluene)	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		
NG (nitroglycerine) (triniroglycerol)	None	0.99-1.2	ND	None	None		
pentaerythritol tetranitrate	None	0.49-0.56	ND	None	None		
Metals**							
	ASR-2	0.050	0.7				
Beryllium (Be)	FO-7 Shallow	0.020	0.68	4.0		high turbidity	
	MRWPCA MW-1	0.020	0.044			turbid	
	ASR-1	0.020	0.78				
	ASR-2	0.010	3.0				
	FO-7 Shallow	0.020	42.0			high turbidity	
Lead (Pb)	FO-7 Deep	0.080	1.3	15.0		slightly turbid	
	PRTIW: Mission Memorial	0.020	0.061		10.0		
	MRWPCA MW-1	0.020	1.3			turbid	
	Paralta	0.001	3.0				

Notes:

* 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.

** Metals by U.S. EPA Method 200.8 analyzed by Alpha Analytical Laboratory, Ukiah, CA, February 5-11, 2014.

***Constituent also detected in laboratory blank indicating a laboratory contaminant that may not be present in

groundwater. All detections were below Reporting Limits (J values) and are not quantifiable.

ug/L = micrograms per liter or parts per billion (ppb)

MCL = Maximum Contaminant Level for drinking water

ND = Not detected above the method detection level for any of the samples from the six wells.

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As shown in Table 15, 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.

For the metals analysis, 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 MRWPCA MW-1, although all of the detections met the California Primary MCL for drinking water. 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, MRWPCA MW-1, and Paralta. The detection in FO-7 Shallow (42 ug/L) was above the MCL (15 ug/L), but appears anomalous with respect to other detections of lead in the database. The concentration of 42 ug/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 ug/L (also included on Table 15). 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 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 Proposed Project Injection Well Facilities site.

7.3.3.3. Constituents of Emerging Concern

As defined in the Recycled Water Policy, constituents of emerging concern (CECs) are chemicals in personal care products (PCPs), pharmaceuticals including antibiotics,

Proposed Project Recharge Impacts Assessment Report 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 recharge of recycled water.

The SWRCB Recycled Water Policy CEC monitoring requirements were based on the recommendations of an expert panel. As part of the SWRCB Regulations for injection projects, a project sponsor must recommend CECs for monitoring in recycled water and groundwater in the Engineering Report in addition to the Recycled Water Policy CEC requirements. 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). The following CECs are health-based indicators, treatment/performance based indicators, or both as shown below:

- 17-*B*-estradiol steroid hormone (health-based indicator)
- Caffeine stimulant (health-based and performance-based indicator)
- N-nitrosodimethylamine (NDMA) disinfection byproduct (health-based and performance-based indicator)
- Triclosan antimicrobial (health-based indicator)
- N,N-diethyl-metatoluamide (DEET) personal care product (performancebased 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 0.01 $\mu g/L$

To provide baseline conditions for these CECs in the Seaside Groundwater Basin, the six wells sampled in the recent MRWPCA field program were analyzed for the six CECs and other pharmaceuticals/PCPs 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 MRWPCA MW-1. Full results are provided in Appendix D, Table D-1N. Detections of the six CECs are summarized in Table 16.

Table 16. Groundwater Sample Analyses for CECs

Constituent*	Wells with Detections**	Minimum Reporting Limit (RL)	Detected or Reported Concentration	Comments		
		μg/L***				
NDMA (nitrosodimethylamine)	PRTIW (Mission Memorial)	0.002	0.0054	NL =0.01		
17-β-estradiol	None	0.001	ND			
Triclosan	None	0.002	ND			
Coffeine	FO-7 Deep	0.001	0.0027			
Carrenne	MRWPCA MW-1	0.001	0.0068			
DEET	FO-7 Deep	0.001	0.0023			
(n,n-diethyl-m-toluamide)	MRWPCA MW-1	0.001	0.0060			
Sucralose	None	0.005	ND			

Notes:

* NDMA by EPA Method 1625M; 17-β-estradiol and triclosan by EPA Method 1694-APCI; caffeine, DEET, and sucralose by U.S. EPA 1694-ESI+.

** Groundwater analyzed from wells ASR-1, City of Seaside 4, FO-7 Shallow, FO-7 Deep, PRTIW Mission Memorial, and MRWPCA MW-1.

*** Analyses reported on laboratory analytical data sheets in nanograms per liter (ng/L) or parts per trillion. Converted to micrograms per liter (μ g/L) or parts per billion (ppb).

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.

MCL = Maximum Contaminant Level for drinking water.

ND = Not detected.

NL = Notification level.

As indicated in Table 16, NDMA was detected in groundwater collected from the PRTIW well at 0.0054 μ g/L (below the NL); caffeine was detected in FO-7 Deep and MRWPCA MW-1 at 0.0027 and 0.0068 μ g/L, respectively (below the Drinking Water Equivalent Level [DWEL] of 0.35 μ g/L per Anderson et al., 2010).¹¹ DEET was detected in FO-7 Deep and MRWPCA MW-1 at 0.0023 and 0.0060 μ g/L, respectively (below the DWEL of 81 μ g/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 support the monitoring program proposed in the Proposed Project's Engineering Report. Nonetheless, only a few constituents were detected at very low levels (all less than 0.01 ug/L) and meet advisory or safe health concentrations.

¹¹ The DWEL is the amount of a substance in drinking water that can be ingested daily over a lifetime without appreciable risk.

7.3.3.4. Local Anthropogenic Impacts or Contaminant Plumes

A search of the study area was conducted on the California Department of Toxic Substances Control (DTSC) *EnviroStor* web site (<u>www.envirostor.dtsc.ca.gov</u>) and the SWRCB *Geotracker* web site (<u>http://geotracker.waterboards.ca.gov</u>). 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 in the Proposed Project Injection Well Facilities study area.

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 and are located about 1.8 miles to the northeast. However, both sites are outside of the groundwater basin and are not a threat to groundwater in the Proposed Project Injection Well Facilities area.

Other environmental sites have been identified in the basin, including numerous leaking underground storage tank sites, but none were in the Proposed Project Injection Well Facilities area. Specifically, there were no environmental contaminant sites identified in the area between Proposed Project recharge and downgradient extraction wells. Replenishment activities would not be expected to impact any contaminant plumes, if any, located outside of this area.

7.3.4. Proposed Project Recycled Water Quality

Trussell Technologies, Inc. (Williams, et al., 2014) provided recycled water samples to Todd Groundwater in support of the MRWPCA field program. The samples were developed to represent the Proposed Project product water quality for the purposes of laboratory tests and geochemical analyses. The samples were RO permeate collected from the MRWPCA GWR 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 proposed AWTF.

To develop the bench-scale water samples, Trussell Technologies used several strategies for full-scale RO permeate stabilization to mimic goals established for the OCWD's Groundwater Replenishment System (GWRS), a similar project that used advanced treatment to meet regulatory requirements. (See Section 3.3.6.2, for more information on the OCWD's GWRS) The first chemical stabilization step consisted of the addition of calcium as calcium chloride (CaCl₂) and sodium hydroxide (NaOH) to increase alkalinity. Then, CO₂ gas was bubbled into the RO water to decrease the pH to a target goal. This process produced approximately 32 L of product water for incorporation into the field program.

These samples - referred to herein as stabilized pilot water samples or pilot water - closely represent the final Proposed Project recycled 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 the following sections). Details of the leaching tests and geochemical modeling results are presented in a separate report on the field program (Todd Groundwater, February 2015).

To support the EIR impacts analysis herein, the GWR pilot plant water samples were also analyzed for general minerals, physical characteristics, and metals. The GWR pilot plant water was analyzed by McCampbell Analytical Laboratory. The analytical methods and sample results are presented in Table 17.

Analyte	Method	Units	Reporting Limit (RL)	Results	MCL or NL	Basin Plan Objective or Guideline ^e
Inorganics:						
Alkalinity (total)	SM 2320B	mg/L	0.10	37.4		
Ammonia (NH ₃) (total as nitrogen)	EPA 350.1	mg/L	0.10	1.3		<5
Bicarbonate (HCO₃ [−])	SM 2320B	mg/L	1.00	37.4		<90
Carbonate (CO ₃ ^{2–})	SM 2320B	mg/L	1.00	ND		
Chloride (Cl ⁻)	EPA 300.15	mg/L	1.00	21.0	250 ^b	<106
Chlorine (Cl ₂)	SM 4500-CI DE	mg/L	0.40	2.9		
Dissolved oxygen (DO) @ 21.8 °C	SM 4500 OG	mg DO/L	1.00	8.94		
Hydroxide (OH⁻)	SM 2320B	mg/L	1.00	ND		
Sulfate*		mg/L	0.5	ND	250 ^b	
Physical Parameters:		•	•			
Langelier Saturation Index @ 21.8 °C	calculated	-	-	-1.6		
Oxidation-Reduction Potential (ORP)	SM 2580B	mV	10.0	629.0		
pH@25℃	SM 4500H+B	pH units	0.05	7.45		Normal Range
Specific conductivity (EC) @ 25 °C	SM 2510B	μmohs/cm	10.0	127.0	900 ^b	<750
Total Dissolved Solids (TDS)	SM 2540C	mg/L	10.0	74.0	500 ^b	480
Metals (cations):		0,				
Antimony (Sb)	EPA 200.8	ug/L	0.50	ND	6°	
Arsenic (As)	EPA 200.8	ug/L	0.50	ND	10 ^c	100
Barium (Ba)	EPA 200.8	μg/L	5.0	ND	1,000 ^c	
Beryllium (Be)	EPA 200.8	μg/L	0.50	ND	4 ^c	100
Cadmium (Cd)	EPA 200.8	μg/L	0.25	ND	5°	10
Calcium (Ca)	EPA 200.8	μg/L	1,000	9,200		
Chromium (Cr)	EPA 200.8	μg/L	0.50	ND	50 ^c	100
Cobalt (Co)	EPA 200.8	μg/L	0.50	ND		50
Copper (Cu)	EPA 200.8	μg/L	0.50	ND	1,000ª	200
Iron (Fe)	EPA 200.8	μg/L	20.0	ND	300ª	5,000
Lead (Pb)	EPA 200.8	μg/L	0.50	ND	15°	5,000
Magnesium (Mg)	EPA 200.8	μg/L	20.0	ND		
Manganese (Mn)	EPA 200.8	μg/L	20.0	ND	50ª	200
Mercury (Hg)	EPA 200.8	μg/L	0.025	0.032	2 ^c	10
Molybdenum (Mo)	EPA 200.8	μg/L	0.50	ND		10
Nickel (Ni)	EPA 200.8	μg/L	0.50	ND	100 ^c	200
Selenium (Se)	EPA 200.8	μg/L	0.50	ND	50 ^c	20
Silver (Ag)	EPA 200.8	μg/L	0.19	ND	100ª	
Sodium (Na)	EPA 200.8	μg/L	1,000	18,000		<69,000
Thallium (TI)	EPA 200.8	μg/L	0.50	ND	2 ^c	
Vanadium (V)	EPA 200.8	μg/L	0.50	ND	50 ^d	100
Zinc (Zn)	EPA 200.8	μg/L	5.0	5.5	5,000ª	

Table 17.Stabilized Pilot Water Analysis

Proposed Project Recharge Impacts Assessment Report Notes:

GWR pilot plant water provided by Trussell Technologies, Oakland, CA delivered to TODD Groundwater on February 12, 2014.

Received and analyzed by McCampbell Analytical, Inc., Pittsburg, CA on February 13-26, 2014.

* Sulfate (SO₄) analysis proved by Trussell Technologies.

 μ g/L = micrograms per liter or parts per billion (ppb). mg/L = milligrams per liter or parts per million (ppm).

mV = millivolts. µmohs/cm = micomohs per centimeter equivalent to microSiemans per centimeter (µS/cm).

EC = Electrical conductivity. EPA = U.S. Environmental Protection Agency. ND = Not detected or below reporting limit (RL). SM = Standard Method.

- a. Secondary MCL.
- b. Secondary MCL recommended range.
- c. Primary MCL.
- d. NL.
- e. Groundwater objectives for protection of the 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.

7.3.5. Geochemical Compatibility Analysis

When two water types with different water chemistry are mixed (such as the Proposed Project recycled water and groundwater), the compatibility of the waters requires examination. Geochemical reactions in the groundwater system in the vicinity of the well and in the aquifer beyond could potentially result in precipitation or dissolution of constituents (e.g., precipitation of silica or dissolution of metals). These reactions could contribute to clogging in the well and/or pore throats or alter groundwater quality thorough dissolution in the vadose zone or aquifer. In particular, injection in the vadose zone could lead to leaching of natural or anthropogenic constituents that could impact groundwater quality. A geochemical assessment is also helpful in identifying potential adverse reactions that may lead to well scaling or biofouling.

The potential for geochemical incompatibility would be addressed at the proposed AWTF by including a stabilization step in the treatment process to ensure that recycled water is stabilized and non-corrosive. Other injection projects such as the OCWD GWRS provide chemical stabilization for these purposes. Further, no adverse impacts have been observed at the nearby ASR wellfields where ASR injectate has a different water chemistry than native groundwater; this injectate has some similar components of water chemistry to the Proposed Project recycled water that are relevant to compatibility.

To estimate geochemical issues that would need to be addressed through treatment design or operational adjustments at the AWTF, a geochemical assessment was performed using the data from the MRWPCA field program (Todd Groundwater, February 2015). The GWR pilot plant water was provided to McCampbell Laboratories under chain of custody protocol to use in laboratory leaching tests on vadose zone core samples. Stabilized GWR pilot plant water was used for the laboratory extraction process of nine core samples and analyzed for a suite of constituents to provide a preliminary estimate of leaching potential. These tests provide a conservative estimate of the potential for leaching constituents from the vadose zone during injection associated with the Proposed Project. The analysis is considered conservative because the GWR pilot plant water is slightly more aggressive (as indicated by the negative value of the Langelier Saturation Index on Table 17) than the anticipated final AWTF water.

Due to the unconsolidated nature of the core samples and limitations with extraction methods, the laboratory results were compromised by elevated turbidity in some of the leachate samples (Todd Groundwater, February 2015). Notwithstanding the limitations of the results, the leaching tests provided valuable information on which constituents represented the highest potential for leaching and identified potential geochemical reactions that warranted further investigation through geochemical modeling.

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). The modeling was used to analyze the potential for dissolution (leaching) of chromium, arsenic, and lead from the vadose zone sediments (including samples from the Aromas Sand and Paso Robles Aquifer).

The modeling indicated that trace amounts of chromium adsorbed onto the hydrous ferric oxide coatings of the sand grains represented the highest potential for leaching. However, this leaching does not represent a long-term effect due to the limited total amount of chromium available in the sediments. The maximum concentration in the zone of saturation was estimated to be about 4.0 ug/L after one year of injection – a concentration substantially below the total chromium MCL of 50 ug/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 μ g/L for arsenic and approximately 0.7 μ g/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 would 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 AWTF product water would 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 would be released into solution, and those results can reasonably be extended to injection of recycled water.

None of the modeling results indicated that groundwater would be geochemically incompatible with AWTF 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 MRWPCA field program (Todd Groundwater, February 2015).

In addition to this work, to support the assessment of compliance with the SWRCB Regulations and the CRWQCB and the pilot testing, a one-year monitoring program was conducted from July 2013 to June 2014 for five of the potential source waters. 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.

An assessment conducted by Nellor (2015) reviewed the analytical results of source water monitoring, the water quality results of the GWR pilot plant testing (using ozone, MF, and RO), the stabilized RO sample (see Table 17 in this report), information on the predicted performance and water quality of the proposed full-scale AWT Facility based on other existing groundwater replenishment projects, and related research/studies. Based on the results of that assessment, the Proposed Project will comply with the:

- SWRCB Regulations (for groundwater replenishment), including MCLs, NLs, total organic carbon, and other numeric water quality-based requirements; and
- Central Coast Water Quality Control Plan objectives and guidelines for protection of groundwater uses (municipal and domestic water supply, agricultural water supply, and industrial use).

7.3.6. Salt and Nutrient Management Plan

A Salt and Nutrient Management Plan (SNMP) has been prepared for the Seaside Basin to comply with requirements in the SWRCB's Recycled Water Policy (HydroMetrics, March 2014). The SNMP was developed with basin stakeholder input through the Seaside Basin Watermaster and has been adopted by the MPWMD Board. The final SNMP has been submitted to the CRWQCB.

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. As indicated by the water quality analyses of the stabilized GWR pilot plant water (discussed above), TDS, nitrate, and chloride all meet Basin Plan objectives. Further, these concentrations are generally lower than average concentrations in groundwater. As such, recharge of the Seaside Basin using the Proposed Project recycled water would not adversely impact salt and nutrient loading in the basin and would provide benefits to local groundwater quality.

7.4. POTENTIAL GROUNDWATER QUALITY IMPACTS

The assessment of potential impacts from the Proposed Project on local groundwater resources is based on the preceding characterization of groundwater and recycled water.

7.4.1. Thresholds of Significance

Appendix G of the 2013 CEQA Guidelines provides the primary question relating to potential GWR impacts on groundwater quality is as follows:

Would the project violate any water quality standards or otherwise degrade water quality?

The following factors were developed for the Proposed Project to clarify how this question would be applied in the impact analyses. Implementation of the Proposed Project would be considered to have a significant impact on groundwater quality if:

- The Proposed Project, taking into consideration the proposed treatment processes and groundwater attenuation and dilution, were to:
 - Impact groundwater so that it would not meet a water quality standard (e.g., Basin Plan beneficial uses and water quality objectives, including drinking water MCLs established to protect public health).
 - Degrade groundwater quality subject to California Water Code statutory requirements for the Division of Drinking Water, and to the SWRCB Antidegradation Policy and Recycled Water Policy.
- The Proposed Project were to result in changes to basin recharge such that it would adversely affect groundwater quality by exacerbating seawater intrusion.

7.4.2. Potential Degradation of Groundwater Quality

As described in the previous sections, the Proposed Project recycled water would be treated and stabilized to meet all drinking water quality objectives. As shown on Table 17 and discussed above, TDS (74 mg/L) and nitrogen (1.3 mg/L as total N) would also meet Basin Plan objectives. Further, the Proposed Project recycled water is expected to be higher quality water than ambient groundwater with respect to TDS, chloride, and nitrate. As such, the Proposed Project would not result in the groundwater failing to meet groundwater objectives or beneficial uses. Rather, the Proposed Project recycled water would have a beneficial effect on local groundwater quality from the injection of high quality water that meets objectives and has low TDS and chloride concentrations.

7.4.3. Impacts on Seawater Intrusion

As demonstrated by the modeling by HydroMetrics (Appendix C) and discussed above (Section 7.1.2.2.2), the Proposed Project is not expected to cause water levels to fall below elevations that are protective against seawater intrusion.

The Proposed Project would incorporate operational monitoring to track impacts on water levels from recharge and pumping. Real-time modifications can be incorporated into the operation of the Proposed Project to address any short-term water level declines, if needed. For example, during the primary pumping period, more water can be directed to the deeper aquifer where existing water level declines are more widespread.

The Proposed Project would provide basin replenishment to meet the primary objective of increasing basin production to replace a portion of the CalAm water supply as required by state orders. The impact analysis indicates that the Proposed Project would not exacerbate seawater intrusion. However, it is noted that seawater intrusion cannot be prevented by this project alone. Water levels are below sea level at the coast in the Santa Margarita Aquifer and the Proposed Project would not raise levels over the long term. However, the short term rise in water levels associated with the Proposed Project during the winter when pumping is less will prevent significant water level declines during the summer when Proposed Project is provided in the TM in Appendix C.

7.4.4. Geochemical Compatibility of GWR Product Water and Groundwater

As discussed in Section 7.3.5 above, the results of the MRWPCA field program and geochemical modeling indicate that injection of project recycled water through both vadose zone wells and deep injection wells will not have a significant adverse impact on groundwater quality (Todd Groundwater, February 2015). A brief summary of key conclusions from the analysis are provided below:

- Chemicals associated with the former Fort Ord activities, including soluble nitroaromatic compounds (explosives), perchlorate, or certain organic constituents, were not detected in core samples or groundwater samples and are not expected to impact groundwater quality.
- Potential changes in injected recycled water quality beneath vadose zone wells from geochemical reactions between recycled water and formation materials along vertical flow paths are small. The analysis of leaching of chromium, arsenic, and lead indicated that concentrations in the zone of saturation are expected to be very low and would meet water quality standards.
- Aquifer clogging by calcite precipitation is unlikely to be a problem for the Proposed Project. In the Aromas Sand, calcium and bicarbonate concentrations are below saturation levels. Ambient groundwater in the Paso Robles Formation is at saturation with respect to calcite, but given the pH of the injected water, calcite would not be expected to precipitate.
- Biofouling would not likely pose a problem for the injection wells because the injected water is very low in nitrogen and phosphorus and would not tend to stimulate microbial growth.
- Based on the water chemistry of the GWR pilot plant water and observations from the ASR wellfield, adverse impacts from geochemical incompatibility are unlikely in the Santa Margarita Aquifer in the vicinity of the deep injection wells.

7.4.5. Conclusions of the Impacts Assessment for Groundwater Quality

Based on the groundwater characterization, recent groundwater sampling results, stabilized pilot water quality/chemistry and projected AWTF water quality (i.e., highly treated recycled water), and results from the MRWPCA field program, the following conclusions are offered:

- Stabilized GWR pilot plant water samples and projected AWTF product water meet SWRCB Regulations for groundwater replenishment projects and Basin Plan groundwater quality standards, including drinking water MCLs. Further, the treatment processes that would be incorporated into the AWTF would be selected and operated to ensure that all water quality standards would be met in both the recycled water and groundwater. A monitoring program would document project performance.
- Stabilized GWR pilot plant water samples and projected AWTF product water exhibit much lower concentrations of TDS and chloride than in ambient groundwater and would be expected to provide a localized benefit to groundwater quality. Such a benefit would expand over time with continuous injection from the Proposed Project wells.
- No documented groundwater contamination or contaminant plumes have been identified in the Proposed Project area. Therefore, injection associated with the Proposed Project would not exacerbate existing groundwater contamination or cause plumes of contaminants to migrate.
- Injection of AWTF recycled water would not degrade groundwater quality. A monitoring plan would be implemented to meet CRWQCB and SWRCB Division of Drinking Water requirements.
- The Proposed Project recycled water would be stabilized as part of the AWTF to ensure no adverse geochemical impacts. Geochemical modeling associated with the MRWPCA field program indicated that no adverse groundwater quality impacts are expected from leaching or other geochemical reactions.
- The Proposed Project would result in both higher and lower water levels in wells throughout the basin at various times. Although water levels would be slightly lower during some time periods, the difference is generally small and judged insignificant.
- Modeling indicates that the Proposed Project would not lower water levels below protective levels in coastal wells and would not exacerbate seawater intrusion.

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FIGURES

TODD GROUNDWATER







Notes: 1994 - 2001 data by Reporting Period (July 1- June 30). 2001 - 2013 data by Water Year (October 1 - September 30). Pumping data do not include ASR injection or recovery amounts.












GROUNDWATER

Project Area

Water Levels in Paralta Test Well















November 2014



Figure 13 Modeled Flowpaths Proposed Project

Source: Hydrometrics, November 2014 (See Technical Memorandum in Appendix C)















APPENDIX A

Todd Groundwater Technical Memorandum Selection of Recharge Location for GWR Project, Seaside Groundwater Basin, May 29, 2014



May 29, 2014

TECHNICAL MEMORANDUM

То:	Bob Holden, PE Monterey Regional Water Pollution Control Agency (MRWPCA)
From:	Phyllis Stanin, Vice President/Principal Geologist
Re:	Selection of Recharge Location for GWR Project Seaside Groundwater Basin

Monterey Regional Water Pollution Control Agency (MRWPCA) has been developing the Groundwater Replenishment (GWR) Project (also, Proposed Project), which involves advanced treatment of various water sources for conveyance and recharge into the Seaside Groundwater Basin (Seaside Basin). In that basin, declining water levels and overdraft conditions have placed drinking water aquifers at risk of seawater intrusion. These conditions have resulted in court-imposed limits on groundwater extraction for drinking water. The Proposed Project offers a reliable source of recharge to increase basin yield without exacerbating the risk of seawater intrusion.

Over the last several years, MRWPCA has considered various locations for recharge in the Seaside Basin. Two preliminary recharge locations were identified and evaluated in 2009 during early project development. The western-most location consists of two parcels along Highway 1 and is referred to as the former Coastal Location (Figure A-1). An eastern location, referred to as the former Inland Location, was delineated as a strip of land along Eucalyptus Road, which crossed the northern boundary of the Seaside Groundwater Basin (Figure A-1). As shown on Figure A-1, the current proposed location is a curved strip of land about 2,000 feet southwest of the former Inland Location. The purpose of this memorandum is to document the selection of the proposed location for implementation of the GWR project.

BACKGROUND

In 2013, the former Inland Location was re-located to an adjacent parcel approximately 2,000 feet southwest based on hydrogeologic and engineering criteria including:

- ensure that recharged water remains within the Seaside Basin
- locate recharge immediately upgradient of pumping depressions to mitigate declining water levels
- decrease conveyance and pumping costs by re-locating to areas of lower ground surface elevations.

The proposed recharge location (or *proposed location*) consists of a relatively narrow strip of land approximately 3,000 feet in length (Figure A-1). The strip is located along a parcel boundary between proposed development by the City of Seaside and open space associated with former Fort Ord lands. The parcel, currently owned by the Fort Ord Reuse Authority (FORA), will be conveyed to the City of Seaside when remediation activities on certain other former Fort Ord lands have been completed.

Although both the proposed location and former Coastal Location have benefits for the development of the Proposed Project, the proposed location on Figure A-1 has been selected for implementation. That location is currently under evaluation in an Environmental Impact Report (EIR) being prepared by MRWPCA. The selection of the proposed location instead of the former Coastal Location also involved hydrogeologic, engineering, and cost considerations.

In July 2013, the Seaside Basin Watermaster (Watermaster) conducted an evaluation of recharge at various inland and coastal locations, including the southern parcel of the former Coastal Location (Figure A-2). For that evaluation, HydroMetrics WRI (HydroMetrics), applied a basin-wide groundwater flow model to simulate changes in water levels resulting from recharge of various amounts and at various locations within the basin (HydroMetrics, July 19, 2013). That analysis provided technical information relevant to the selection of the proposed location. The results of the Watermaster modeling and the selection of the proposed location are described in this memorandum.

PROJECT OBJECTIVES

In order to meet the Proposed Project's primary objective of providing recharge to the Seaside Groundwater Basin to replace a portion of Cal-Am's water supply, the Proposed Project must:

- be cost effective
- comply with water quality regulations
- meet Cal-Am's scheduling needs.

Secondary project objectives include:

- assist in preventing seawater intrusion in the Seaside Basin
- assist in diversifying Monterey County's water supply portfolio
- provide additional water that could be used for crop irrigation through the Salinas Valley Reclamation Project and Castroville Seawater Intrusion Project system.

HYDROGEOLOGIC CONSIDERATIONS

Hydrogeologic conditions at the former Coastal Location were compared to the proposed location in order to select the optimal site for GWR project development as summarized in the following sections.

Injection Capacity is less certain at the former Coastal Location.

Different characteristics in hydrostratigraphy of the Santa Margarita Aquifer have been documented at the former Coastal Location that could impact implementation of the Proposed Project. A 2007 field investigation conducted by the Watermaster resulted in an improved understanding of the coastal hydrostratigraphy near the former Coastal Location (Feeney, 2007). During that investigation, four deep monitoring wells were installed along the coast as part of a sentinel monitoring program to protect against seawater intrusion. Two of these wells, SBWM-3 and SBWM-4, are within 2,000 feet and 1,350 feet from the former Coastal Location, respectively. Figure A-2 shows these two wells and the outline of the southern parcel of the former Coastal Location (labeled *MRWPCA South Location*) (HydroMetrics, July 19, 2013).

Data from these two wells indicate significant differences in the Santa Margarita Aquifer compared to inland areas. In brief, the Santa Margarita Aquifer – the primary target for the Proposed Project – may be thin or absent at the former Coastal Location. This interpretation is illustrated on a cross section developed by Feeney (2007). A portion of that cross section including the two monitoring wells close to the former Coastal Location is shown on Figure A-3. The approximate location of the former Coastal Location is projected onto the section. As shown on the figure, the Santa Margarita Aquifer is interpreted to be very thin (less than 100 feet thick) in SBWM-4 and absent in SBWM-3. The section is replaced with a relatively thick sequence of the Purisima Formation. Although the Purisima Formation appears to be hydraulically connected to the Santa Margarita Aquifer and may also function as an aquifer, the formation appears to be less permeable based on geologic and geophysical logs (Feeney, 2007). In addition, the permeability of this unit was assigned a lower hydraulic conductivity value in the basin-wide groundwater flow model (HydroMetrics, 2009).

Decreased permeability would likely result in a lower injection rate, which would require more wells than are currently planned at the proposed location for the same amount of recharge. In addition, injection wells in a low permeability formation may be more susceptible to clogging. Deep aquifers may have limited storage if porosity is also lower. At a minimum, the former Coastal Location would require an additional deep aquifer testing program to determine the feasibility of deep injection wells prior to project implementation. Such a program would negatively impact project objectives by affecting both the cost and schedule of the Proposed Project.

In contrast, the Santa Margarita Aquifer near the proposed location is approximately 300 feet thick, with relatively high permeability. Within about 1,000 feet to 1,300 feet of the proposed location, four successful ASR wells are screened in the Santa Margarita Aquifer and operated for both injection and recovery. These wells have relatively high transmissivity values of about 100,000 gallons per day per foot (gpd/ft) and relatively high specific capacities that range from about 27 gallons per minute per foot of drawdown (gpm/ft dd) to more than 60 gpm/ft dd (Padre, 2002; Pueblo, 2012). These observations suggest that fewer wells would be needed at the proposed location, reducing project costs.

The Proposed Location is upgradient of existing production wells.

The water level contour map on Figure A-2 shows contours of the potentiometric surface of the Santa Margarita Aquifer (equivalent to the *Deep Zone* as labeled on the map). Contours indicate that water levels are below sea level throughout the Northern Coastal Subarea and are deeper than -60 feet below mean sea level (msl) in the area of numerous production wells (black circles), forming a pumping depression (Figure A-2). The proposed location is located upgradient of numerous production wells and closer to the pumping depression than the former Coastal Location. Most of the production wells shown in this area are owned and operated by Cal-Am and will be pumped to recover recycled water being recharged by the Proposed Project. Essentially all of the recharged water will flow toward these wells under existing groundwater flow conditions.

Deeper water table at the proposed location allows more storage in the vadose zone.

The water table beneath the proposed location occurs at an average depth of about 400 feet below ground surface (bgs). Further, data from a recent MRWPCA field program indicate very high porosity and permeability values in the vadose zone, providing a large storage volume for recharge of recycled water.

In contrast, the water table beneath the former Coastal Location is only about 115 feet bgs. The relatively shallow water table limits vadose zone storage. Under these conditions, mounding of the recharge water could reduce injection rates over time.

Recharge at the Former Coastal Location would result in project water being lost to ocean outflow.

Injection in both deep and shallow wells will result in groundwater mounding and radial groundwater flow away from the injection wells. Depending on the then-current water levels, recharged water would flow both inland toward the pumping depression and coastal toward the ocean. This groundwater flow pattern would result in some amount of recharge being lost to ocean outflow that could not be recovered through existing wells. The mound would provide some protection against seawater intrusion that would allow water levels to be lowered inland through increased pumping. However, there is uncertainty associated with the lateral and vertical extent of mounding at the former Coastal Location; it is unclear what adverse impacts would result from allowing water levels to decline inland. In summary, a portion of the recharged water may not be recoverable.

ENGINEERING AND COST CONSIDERATIONS

In addition to the hydrogeologic considerations, several components of the preliminary GWR project design were factors in the location selection process. For example, a conceptual project design developed in 2009 indicated higher project costs with the former Coastal Location. At that time, both the former Inland and Coastal locations were assumed to connect to the proposed Regional Urban Water Augmentation Pipeline (RUWAP), which enters the basin along General Jim Moore Boulevard as shown on Figure A-1 (see the purple line labeled proposed pipeline). For the former Coastal Location, a connecting pipeline would have to be routed through residential and urban development and then across both

parcels of the former Coastal Location. For the former Inland Location (and the proposed location), a connecting pipeline could be routed to Eucalyptus Road. Preliminary costs developed for the water supply lines indicated higher costs for the routing to the former Coastal Location. Given the hydrogeologic uncertainty at the former Coastal Location, more project wells would have to be connected and maintained, also resulting in increased costs.

GROUNDWATER MODELING

The groundwater modeling conducted by the Watermaster allowed comparison of the effectiveness of various recharge locations for protection against seawater intrusion. Although these simulations were not conducted specifically to evaluate the Proposed Project, the modeling simulates the aquifer response to injection at both inland and coastal locations similar to those evaluated for the Proposed Project. Model results were summarized in a Technical Memorandum titled *Groundwater Modeling Results of Coastal Injection in the Seaside Basin* (HydroMetrics, July 2013). Relevant sections of that memorandum are summarized below.

Two modeling scenarios, referred to as Scenario 0 and Scenario 1, simulated 1,000 AFY of injection at each of two locations including an inland and coastal location. Figure A-2 shows a map from the HydroMetrics memorandum that identifies the modeled injection locations. The simulated coastal locations are shown by red parcels labeled "Modeled Coastal Injection Locations¹" in the map legend of Figure A-2. The simulated inland location is shown by an arrow (labeled *Inland Injection Location* on Figure A-2) and coincides with the ASR wellfield located near the proposed GWR project location (also labeled on Figure A-2).

The effectiveness of each injection location was judged by the ability to raise water levels in coastal wells to levels protective of seawater intrusion. These protective levels had been established by the Watermaster in previous evaluations (HydroMetrics, December 2013). To illustrate the model results, simulated water levels in a nearby coastal monitoring well cluster, MSC Shallow and MSC Deep, are shown on Figure A-4. Results for other coastal wells vary, but Scenarios 0 and 1 track similarly (with a difference of only a few feet or less) for the four wells presented in the memorandum (HydroMetrics, July 2013). Although the figure contains results from numerous model scenarios (Scenarios 0 through 7 as shown on the legend), Scenario 0 and Scenario 1 are the comparable results from the coastal and inland injection locations. Except for Baseline and Scenario 0, all scenarios involve injection at the coastal location and vary amounts and timing of recharge. Although the curves are difficult to differentiate on Figure A-4, the curves from Scenarios 0 and 1 are labeled and track very closely for both of the well clusters.

Results of the simulations indicate that injection at the former Coastal Location raises coastal water levels higher and faster than inland injection, but only by a small amount (less

¹ The HydroMetrics northernmost coastal location is the same as the southern parcel of the former GWR Coastal Location – compare Figures A-1 and A-2. HydroMetrics reports that modeling results were very similar between the two coastal locations shown on Figure A-2.

than two feet). The memorandum concludes that coastal injection achieves protective water levels one to ten years faster than inland injection, depending on the well. This means that the coastal injection curves labeled on Figure A-4 for both MSC Shallow and Deep reach the line labeled Protective Water Level before the inland injection curves (also labeled on Figure A-4). While this conclusion is correct, the inland injection curves are very close to the line and demonstrate that injection inland is also effective at raising water levels near the coast.

Further, Scenario 5 shows that coastal injection of 1,900 AFY raises water levels very high in both clusters, and within about 35 feet of the ground surface. With the GWR project injection of approximately 3,500 AFY, water levels would rise even higher, suggesting that the former Coastal Location has limited storage. Scenario 4 indicated that protective water levels at the coast could be maintained at about 850 AFY, significantly below the water available for injection for the Proposed Project. In addition, a significant portion of the injected water leaves the basin as coastal outflow, potentially limiting the amount of water that could be recovered.

While the modeling suggests that the former Coastal Location may be slightly more effective at achieving protective water levels in a shorter amount of time, the inland location also raises water levels along the coast and has more storage.

SUMMARY

Based on the hydrogeologic analysis, preliminary project design including costs, and recent groundwater modeling by the Watermaster, the following conclusions can be made.

- The proposed location provides more hydrogeologic certainty than the former Coastal Location for project development. The Santa Margarita Aquifer may be thin or absent at the former Coastal Location.
- A deep aquifer testing program to reduce this uncertainty would adversely impact the project's schedule and cost.
- More injection wells may be required at the former Coastal Location for the same amount of recharge at an inland location, reducing the cost effectiveness of the project.
- The proposed location is close to proven ASR wells in the Santa Margarita Aquifer with favorable injection rates.
- The proposed location is adjacent to and upgradient of most of the water supply wells that will recover the Proposed Project's recharged water.
- The proposed location provides sufficient storage to accommodate all of the GWR project water. Both locations are not needed. Storage at the former Coastal Location is less certain.
- Injection at the former Coastal Location would increase loss of GWR water to ocean outflow, potentially reducing the amount of GWR water that could be recovered.
- Water supply lines and conveyance costs may be more expensive for the former Coastal Location.

- The proposed location is more supportive of the primary project objectives than the former Coastal Location.
- Although the former Coastal Location may be more effective at meeting the secondary project objective of assistance in preventing seawater intrusion, the proposed location also meets that objective. Specifically, the proposed location supports an increase in basin production without exacerbating the risk for seawater intrusion.

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APPENDIX A: MPWMD HISTORIC AND PROJECTED ASR WELL SITE INJECTION

			Carmel River Water ASR sites ava		vailable for					
			1			Injection		extraction		
Model Stress	Model	Historic	Monthly	Santa Margarita Site	Seaside Middle School Site	ASR Wells Available for GWR	Active Injection Santa	Active Injection Seaside Middle	Santa Margarita Available for	Santa Margarita Available for
Period	Date	Date	Injection	Injection	Injection	extraction	Margarita	School	Extraction	Extraction
			(AF)	(AF)	(AF)	(Yes/NO)	(Y/N)	(Y/N)	(Y/N)	(Y/N)
Before	Oct-86	1986/10	0	0	0	YES	N	N	Y	Y
Before	Nov-86	1986/11	0	0	0	YES	N	N	Y	Y
Before	Dec-86	1986/12	0	0	0	YES	N	N	Y	Y
Before	Jan-87	1987/1	0	0	0	YES	N	N	Y	Y
Before	Feb-87	1987/2	40	26	14	NO	Y	Y	N	N
Before	Mar-87	1987/3	0	0	0	NO	N	N	N	N
Before	Apr-87	1987/4	0	0	0	NO	N	N	N	N
Before	May-87	1987/5	0	0	0	YES	N	N	Y	Y
Before	Jun-87	1987/6	0	0	0	YES	N	N	Y	Y
Before	Jul-87	1987/7	0	0	0	YES	N	N	Y	Y
Before	Aug-87	1987/8	0	0	0	YES	N	N	Y	Y
Before	Sep-87	1987/9	0	0	0	YES	N	N	Y	Y
Before	Oct-87	1987/10	0	0	0	YES	N	N	Y	Y
Before	Nov-87	1987/11	0	0	0	YES	N	N	Y	Y
Before	Dec-87	1987/12	0	0	0	YES	N	N	Y	Y
Before	Jan-88	1988/1	0	0	0	YES	N	N	Y	Y
Before	Feb-88	1988/2	0	0	0	YES	N	N	Y	Y
Before	Mar-88	1988/3	0	0	0	YES	N	N	Y	Y
Before	Apr-88	1988/4	0	0	0	YES	N	N	Y	Y
Before	May-88	1988/5	0	0	0	YES	N	N	Y	Y
Before	Jun-88	1988/6	0	0	0	YES	N	N	Y	Y
Before	Jul-88	1988/7	0	0	0	YES	N	N	Y	Y
Before	Aug-88	1988/8	0	0	0	YES	N	N	Y	Y
Before	Sep-88	1988/9	0	0	0	YES	N	N	Y	Y
Before	Oct-88	1988/10	0	0	0	YES	N	N	Y	Y
Before	Nov-88	1988/11	0	0	0	YES	N	N	Y	Y
Before	Dec-88	1988/12	0	0	0	YES	N	N	Y	Y
Before	Jan-89	1989/1	0	0	0	YES	Ν	N	Y	Y
Before	Feb-89	1989/2	0	0	0	YES	Ν	Ν	Y	Y
Before	Mar-89	1989/3	0	0	0	YES	Ν	Ν	Y	Y
Before	Apr-89	1989/4	0	0	0	YES	Ν	Ν	Y	Y
Before	May-89	1989/5	0	0	0	YES	Ν	Ν	Y	Y
Before	Jun-89	1989/6	0	0	0	YES	N	N	Y	Y
Before	Jul-89	1989/7	0	0	0	YES	N	Ν	Y	Y
Before	Aug-89	1989/8	0	0	0	YES	N	Ν	Y	Y
Before	Sep-89	1989/9	0	0	0	YES	N	Ν	Y	Y
Before	Oct-89	1989/10	0	0	0	YES	Ν	Ν	Y	Y

							Carmel River Water		ASR sites available for	
							Injection		extraction	
Model				Santa Margarita	Seaside Middle School	ASR Wells Available	Active Injection	Active Injection Seaside	Santa Margarita Available	Santa Margarita Available
Stress	Model	Historic	Monthly	Site	Site	for GWR	Santa	Middle	for	for
Period	Date	Date	Injection	Injection	Injection	extraction	Margarita	School	Extraction	Extraction
D.	N. 00	1000/11	(AF)	(AF)	(AF)	(Yes/NO)	(Y/N)	(Y/N)	(Y/N)	(Y/N)
Before	Nov-89	1989/11	0	0	0	YES	IN N	IN N	I V	I V
Before	Dec-89	1989/12	0	0	0	YES	IN N	IN N	I V	I V
Before	Jan-90	1990/1	0	0	0	YES	IN N	IN N	I V	Y Y
Before	Feb-90	1990/2	0	0	0	YES	N	N	Y	Y V
Before	Mar-90	1990/3	0	0	0	YES	N	N	Y	Y
Before	Apr-90	1990/4	0	0	0	YES	N	N	Y	Y
Before	May-90	1990/5	0	0	0	YES	N	N	Y	Y
Before	Jun-90	1990/6	0	0	0	YES	N	N	Y	Y
Before	Jul-90	1990/7	0	0	0	YES	N	N	Y	Y
Before	Aug-90	1990/8	0	0	0	YES	N	N	Y	Y
Before	Sep-90	1990/9	0	0	0	YES	N	N	Y	Y
Before	Oct-90	1990/10	0	0	0	YES	N	N	Y	Y
Before	Nov-90	1990/11	0	0	0	YES	N	N	Y	Y
Before	Dec-90	1990/12	0	0	0	YES	N	N	Y	Y
Before	Jan-91	1991/1	0	0	0	YES	N	N	Y	Y
Before	Feb-91	1991/2	0	0	0	YES	N	N	Y	Y
Before	Mar-91	1991/3	280	182	98	NO	Y	Y	N	N
Before	Apr-91	1991/4	100	65	35	NO	Y	Y	N	N
Before	May-91	1991/5	0	0	0	NO	N	N	N	N
Before	Jun-91	1991/6	0	0	0	NO	N	N	N	N
Before	Jul-91	1991/7	0	0	0	YES	N	N	Y	Y
Before	Aug-91	1991/8	0	0	0	YES	N	N	Y	Y
Before	Sep-91	1991/9	0	0	0	NO	N	N	Y	Y
Before	Oct-91	1991/10	0	0	0	YES	N	N	Y	Y
Before	Nov-91	1991/11	0	0	0	YES	N	N	Y	Y
Before	Dec-91	1991/12	0	0	0	YES	N	N	Y	Y
Before	Jan-92	1992/1	0	0	0	YES	N	N	Y	Y
Before	Feb-92	1992/2	380	247	133	NO	Y	Y	N	Ν
Before	Mar-92	1992/3	480	312	168	NO	Y	Y	N	Ν
Before	Apr-92	1992/4	0	0	0	NO	N	N	N	Ν
Before	May-92	1992/5	0	0	0	NO	N	Ν	Ν	Ν
Before	Jun-92	1992/6	0	0	0	YES	Ν	Ν	Y	Y
Before	Jul-92	1992/7	0	0	0	YES	N	Ν	Y	Y
Before	Aug-92	1992/8	0	0	0	NO	N	Ν	Y	Y
Before	Sep-92	1992/9	0	0	0	NO	N	N	Y	Y
Before	Oct-92	1992/10	0	0	0	YES	N	Ν	Y	Y
Before	Nov-92	1992/11	0	0	0	YES	N	Ν	Y	Y

						Carmel R	iver Water	ASR sites a	vailable for	
							Inje	ction	extra	ction
Maha				Santa	Seaside Middle	ASR Wells	Active	Active Injection	Santa Margarita	Santa Margarita
Model	Model	Historia	Monthly	Margarita	School	Available	Injection	Seaside	Available	Available
Period	Date	Date	Injection	Injection	Injection	extraction	Margarita	School	Extraction	Extraction
			(AF)	(AF)	(AF)	(Yes/NO)	(Y/N)	(Y/N)	(Y/N)	(Y/N)
Before	Dec-92	1992/12	0	0	0	YES	N	N	Y	Ŷ
Before	Jan-93	1993/1	520	338	182	NO	Y	Y	N	N
Before	Feb-93	1993/2	560	364	196	NO	Y	Y	N	N
Before	Mar-93	1993/3	620	403	217	NO	Y	Y	Ν	Ν
Before	Apr-93	1993/4	540	351	189	NO	Y	Y	Ν	Ν
Before	May-93	1993/5	0	0	0	NO	N	Ν	N	Ν
Before	Jun-93	1993/6	0	0	0	NO	N	Ν	N	Ν
Before	Jul-93	1993/7	0	0	0	YES	N	N	Y	Y
Before	Aug-93	1993/8	0	0	0	NO	N	N	Y	Y
Before	Sep-93	1993/9	0	0	0	NO	N	N	Y	Y
Before	Oct-93	1993/10	0	0	0	NO	N	N	Y	Y
Before	Nov-93	1993/11	0	0	0	YES	N	N	Y	Y
Before	Dec-93	1993/12	0	0	0	YES	N	N	Y	Y
Before	Jan-94	1994/1	0	0	0	YES	N	N	Y	Y
Before	Feb-94	1994/2	140	91	49	NO	Y	Y	N	N
Before	Mar-94	1994/3	0	0	0	NO	N	N	N	N
Before	Apr-94	1994/4	0	0	0	NO	N	N	N	N
Before	May-94	1994/5	0	0	0	YES	N	N	Y	Y
Before	Jun-94	1994/6	0	0	0	YES	N	N	Y	Y
Before	Jul-94	1994/7	0	0	0	YES	N	N	Y	Y
Before	Aug-94	1994/8	0	0	0	NO	N	N	Y	Y
Before	Sep-94	1994/9	0	0	0	NO	N	N	Y	Y
Before	Oct-94	1994/10	0	0	0	YES	N	N	Y	Y
Before	Nov-94	1994/11	0	0	0	YES	N	N	Y	Y
Before	Dec-94	1994/12	0	0	0	YES	N	N	Y	Y
Before	Jan-95	1995/1	480	312	168	NO	Y	Y	N	N
Before	Feb-95	1995/2	440	286	154	NO	Y	Y	N	N
Before	Mar-95	1995/3	580	377	203	NO	Y	Y	N	N
Before	Apr-95	1995/4	600	390	210	NO	Y	Y	N	N
Before	May-95	1995/5	620	403	217	NO	Y	Y	N	N
Before	Jun-95	1995/6	0	0	0	NO	N	N	N	N
Before	Jul-95	1995/7	0	0	0	NO	N	N	N	N
Before	Aug-95	1995/8	0	0	0	NO	N	N	Y	Y
Before	Sep-95	1995/9	0	0	0	NO	N	N	Y	Y
Before	Oct-95	1995/10	0	0	0	NO	N	N	Y	Y
Before	Nov-95	1995/11	0	0	0	YES	N	N	Y	Y
Before	Dec-95	1995/12	0	0	0	YES	N	Ν	Y	Y

				Carmel River Water		ASR sites available for				
					1	Inje	ction	extraction		
Model				Santa Margarita	Seaside Middle School	ASR Wells Available	Active	Active Injection Seaside	Santa Margarita Available	Santa Margarita Available
Stress	Model	Historic	Monthly	Site	Site	for GWR	Santa	Middle	for	for
Period	Date	Date	Injection	Injection	Injection	extraction	Margarita	School	Extraction	Extraction
			(AF)	(AF)	(AF)	(Yes/NO)	(Y/N)	(Y/N)	(Y/N)	(Y/N)
Before	Jan-96	1996/1	180	117	63	NO	Y	Y	N	Ν
Before	Feb-96	1996/2	580	377	203	NO	Y	Y	N	Ν
Before	Mar-96	1996/3	620	403	217	NO	Y	Y	N	Ν
Before	Apr-96	1996/4	480	312	168	NO	Y	Y	N	Ν
Before	May-96	1996/5	60	39	21	NO	Y	Y	N	Ν
Before	Jun-96	1996/6	0	0	0	NO	N	N	N	Ν
Before	Jul-96	1996/7	0	0	0	NO	Ν	N	N	Ν
Before	Aug-96	1996/8	0	0	0	NO	Ν	Ν	Y	Y
Before	Sep-96	1996/9	0	0	0	NO	Ν	Ν	Y	Y
Before	Oct-96	1996/10	0	0	0	NO	Ν	Ν	Y	Y
Before	Nov-96	1996/11	0	0	0	YES	Ν	Ν	Y	Y
Before	Dec-96	1996/12	360	234	126	NO	Y	Y	N	Ν
Before	Jan-97	1997/1	620	403	217	NO	Y	Y	N	Ν
Before	Feb-97	1997/2	560	364	196	NO	Y	Y	N	Ν
Before	Mar-97	1997/3	100	65	35	NO	Y	Y	N	Ν
Before	Apr-97	1997/4	0	0	0	NO	Ν	N	N	Ν
Before	May-97	1997/5	0	0	0	NO	Ν	Ν	N	Ν
Before	Jun-97	1997/6	0	0	0	YES	Ν	Ν	Y	Y
Before	Jul-97	1997/7	0	0	0	YES	Ν	Ν	Y	Y
Before	Aug-97	1997/8	0	0	0	NO	Ν	N	Y	Y
Before	Sep-97	1997/9	0	0	0	NO	N	N	Y	Y
Before	Oct-97	1997/10	0	0	0	NO	Ν	Ν	Y	Y
Before	Nov-97	1997/11	0	0	0	YES	Ν	Ν	Y	Y
Before	Dec-97	1997/12	120	78	42	NO	Y	Y	N	Ν
Before	Jan-98	1998/1	500	325	175	NO	Y	Y	N	Ν
Before	Feb-98	1998/2	560	364	196	NO	Y	Y	N	Ν
Before	Mar-98	1998/3	620	403	217	NO	Y	Y	N	Ν
Before	Apr-98	1998/4	600	390	210	NO	Y	Y	N	Ν
Before	May-98	1998/5	620	403	217	NO	Y	Y	N	Ν
Before	Jun-98	1998/6	0	0	0	NO	Ν	N	N	Ν
Before	Jul-98	1998/7	0	0	0	NO	N	N	N	Ν
Before	Aug-98	1998/8	0	0	0	NO	N	N	Y	Y
Before	Sep-98	1998/9	0	0	0	NO	N	N	Y	Ŷ
Before	Oct-98	1998/10	0	0	0	NO	N	N	Y	Ŷ
Before	Nov-98	1998/11	0	0	0	YES	N	N	Y	Ŷ
Before	Dec-98	1998/12	0	0	0	YES	N	N	Y	Ŷ
Before	Jan-99	1999/1	100	65	35	NO	Y	Y	N	N

				Carmel River Water		ASR sites available for				
					1	Inje	ction	extra	ction	
					Seaside			Active	Santa	Santa
Nr. 1.1				Santa	Middle	ASR Wells	Active	Injection	Margarita	Margarita
Stress	Model	Historic	Monthly	Sito	School	Available	Santa	Seaside	Available	Available
Period	Date	Date	Injection	Injection	Injection	extraction	Margarita	School	Extraction	Extraction
			(AF)	(AF)	(AF)	(Yes/NO)	(Y/N)	(Y/N)	(Y/N)	(Y/N)
Before	Feb-99	1999/2	480	312	168	NO	Y	Y	N	N
Before	Mar-99	1999/3	440	286	154	NO	Y	Y	N	N
Before	Apr-99	1999/4	600	390	210	NO	Y	Y	Ν	Ν
Before	May-99	1999/5	300	195	105	NO	Y	Y	N	Ν
Before	Jun-99	1999/6	0	0	0	NO	Ν	Ν	Ν	Ν
Before	Jul-99	1999/7	0	0	0	NO	N	N	N	N
Before	Aug-99	1999/8	0	0	0	NO	N	N	Y	Y
Before	Sep-99	1999/9	0	0	0	NO	N	N	Y	Y
Before	Oct-99	1999/10	0	0	0	NO	N	N	Y	Y
Before	Nov-99	1999/11	0	0	0	YES	N	N	Y	Y
Before	Dec-99	1999/12	0	0	0	YES	N	N	Y	Y
Before	Jan-00	2000/1	180	117	63	NO	Y	Y	Ν	Ν
Before	Feb-00	2000/2	520	338	182	NO	Y	Y	N	Ν
Before	Mar-00	2000/3	620	403	217	NO	Y	Y	Ν	Ν
Before	Apr-00	2000/4	320	208	112	NO	Y	Y	Ν	Ν
Before	May-00	2000/5	0	0	0	NO	Ν	Ν	Ν	Ν
Before	Jun-00	2000/6	0	0	0	NO	Ν	Ν	N	Ν
Before	Jul-00	2000/7	0	0	0	YES	Ν	Ν	Y	Y
Before	Aug-00	2000/8	0	0	0	NO	Ν	Ν	Y	Y
Before	Sep-00	2000/9	0	0	0	NO	Ν	Ν	Y	Y
Before	Oct-00	2000/10	0	0	0	NO	Ν	Ν	Y	Y
Before	Nov-00	2000/11	0	0	0	YES	Ν	Ν	Y	Y
Before	Dec-00	2000/12	0	0	0	YES	Ν	Ν	Y	Y
Before	Jan-01	2001/1	140	91	49	NO	Y	Y	Ν	Ν
Before	Feb-01	2001/2	340	221	119	NO	Y	Y	Ν	Ν
Before	Mar-01	2001/3	560	364	196	NO	Y	Y	Ν	Ν
Before	Apr-01	2001/4	180	117	63	NO	Y	Y	N	N
Before	May-01	2001/5	0	0	0	NO	N	N	N	Ν
Before	Jun-01	2001/6	0	0	0	NO	N	N	N	Ν
Before	Jul-01	2001/7	0	0	0	YES	N	N	Y	Y
Before	Aug-01	2001/8	0	0	0	NO	N	N	Y	Y
Before	Sep-01	2001/9	0	0	0	NO	N	N	Y	Y
Before	Oct-01	2001/10	0	0	0	NO	N	N	Y	Ŷ
Before	Nov-01	2001/11	0	0	0	YES	Ν	Ν	Y	Y
Before	Dec-01	2001/12	220	143	77	NO	Y	Y	Ν	Ν
Before	Jan-02	2002/1	240	156	84	NO	Y	Y	N	N
Before	Feb-02	2002/2	0	0	0	NO	N	N	N	Ν

					Carmel River Water		ASR sites available for			
					[Inje	ction	extra	ction	
Model	Model	Historic	Monthly	Santa Margarita Site	Seaside Middle School Site	ASR Wells Available	Active Injection Santa	Active Injection Seaside Middle	Santa Margarita Available for	Santa Margarita Available for
Period	Date	Date	Injection	Injection	Injection	extraction	Margarita	School	Extraction	Extraction
			(AF)	(AF)	(AF)	(Yes/NO)	(Y/N)	(Y/N)	(Y/N)	(Y/N)
Before	Mar-02	2002/3	0	0	0	NO	N	N	N	N
Before	Apr-02	2002/4	0	0	0	YES	N	N	Y	Y
Before	May-02	2002/5	0	0	0	YES	N	N	Y	Y
Before	Jun-02	2002/6	0	0	0	YES	N	N	Y	Y
Before	Jul-02	2002/7	0	0	0	YES	N	Ν	Y	Y
Before	Aug-02	2002/8	0	0	0	NO	Ν	Ν	Y	Y
Before	Sep-02	2002/9	0	0	0	NO	Ν	Ν	Y	Y
Before	Oct-02	2002/10	0	0	0	NO	Ν	Ν	Y	Y
Before	Nov-02	2002/11	0	0	0	YES	N	Ν	Y	Y
Before	Dec-02	2002/12	340	221	119	NO	Y	Y	N	Ν
Before	Jan-03	2003/1	500	325	175	NO	Y	Y	N	Ν
Before	Feb-03	2003/2	0	0	0	NO	N	N	N	Ν
Before	Mar-03	2003/3	100	65	35	NO	Y	Y	N	Ν
Before	Apr-03	2003/4	360	234	126	NO	Y	Y	N	Ν
Before	May-03	2003/5	400	260	140	NO	Y	Y	N	Ν
Before	Jun-03	2003/6	0	0	0	NO	N	N	N	Ν
Before	Jul-03	2003/7	0	0	0	NO	N	N	N	N
Before	Aug-03	2003/8	0	0	0	NO	N	N	Y	Y
Before	Sep-03	2003/9	0	0	0	NO	N	N	Y	Y
Before	Oct-03	2003/10	0	0	0	NO	N	N	Y	Y
Before	Nov-03	2003/11	0	0	0	YES	N	N	Y	Y
Before	Dec-03	2003/12	40	26	14	NO	Y	Y	N	N
Before	Jan-04	2004/1	100	65	35	NO	Y	Y	N	N
Before	Feb-04	2004/2	280	182	98	NO	Y	Y	N	N
Before	Mar-04	2004/3	300	195	105	NO	Y	Y	N	N
Before	Apr-04	2004/4	0	0	0	NO	N	N	N	N
Before	May-04	2004/5	0	0	0	NO	N	N	N	N
Before	Jun-04	2004/6	0	0	0	YES	N	N	Y	Y
Before	Jul-04	2004/7	0	0	0	YES	N	N	Y	Y
Before	Aug-04	2004/8	0	0	0	NO	N	N	Y	Y
Before	Sep-04	2004/9	0	0	0	NO	N	N	Y	Y
Before	Oct-04	2004/10	0	0	0	NO	N	N	Y	Y
Before	Nov-04	2004/11	0	0	0	YES	N	N	Y	Y
Before	Dec-04	2004/12	60	39	21	NO	Y	Y	N	N
Before	Jan-05	2005/1	620	403	217	NO	Y	Y	N	N
Before	Feb-05	2005/2	560	364	196	NO	Y	Y	N	N
Before	Mar-05	2005/3	620	403	217	NO	Y	Y	N	Ν
							Carmel R	iver Water	ASR sites a	vailable for
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		1					Inje	ction	extra	ction
Madal				Santa	Seaside Middle School	ASR Wells	Active	Active Injection	Santa Margarita	Santa Margarita
Stress	Model	Historic	Monthly	Site	Site	for GWR	Santa	Middle	for	for
Period	Date	Date	Injection	Injection	Injection	extraction	Margarita	School	Extraction	Extraction
			(AF)	(AF)	(AF)	(Yes/NO)	(Y/N)	(Y/N)	(Y/N)	(Y/N)
Before	Apr-05	2005/4	600	390	210	NO	Y	Y	Ν	Ν
Before	May-05	2005/5	460	299	161	NO	Y	Y	N	Ν
Before	Jun-05	2005/6	0	0	0	NO	N	Ν	N	Ν
Before	Jul-05	2005/7	0	0	0	NO	Ν	N	N	Ν
Before	Aug-05	2005/8	0	0	0	NO	Ν	N	Y	Y
Before	Sep-05	2005/9	0	0	0	NO	N	N	Y	Y
Before	Oct-05	2005/10	0	0	0	NO	N	N	Y	Y
Before	Nov-05	2005/11	0	0	0	YES	N	Ν	Y	Y
Before	Dec-05	2005/12	20	13	7	NO	Y	Y	N	Ν
Before	Jan-06	2006/1	400	260	140	NO	Y	Y	N	Ν
Before	Feb-06	2006/2	40	26	14	NO	Y	Y	N	Ν
Before	Mar-06	2006/3	620	403	217	NO	Y	Y	N	Ν
Before	Apr-06	2006/4	600	390	210	NO	Y	Y	N	Ν
Before	May-06	2006/5	620	403	217	NO	Y	Y	Ν	Ν
Before	Jun-06	2006/6	0	0	0	NO	Ν	Ν	Ν	Ν
Before	Jul-06	2006/7	0	0	0	NO	Ν	Ν	Ν	Ν
Before	Aug-06	2006/8	0	0	0	NO	Ν	Ν	Y	Y
Before	Sep-06	2006/9	0	0	0	NO	Ν	Ν	Y	Y
Before	Oct-06	2006/10	0	0	0	NO	Ν	Ν	Y	Y
Before	Nov-06	2006/11	0	0	0	YES	Ν	Ν	Y	Y
Before	Dec-06	2006/12	0	0	0	YES	Ν	Ν	Y	Y
Before	Jan-07	2007/1	0	0	0	YES	Ν	Ν	Y	Y
Before	Feb-07	2007/2	40	26	14	NO	Y	Y	Ν	Ν
Before	Mar-07	2007/3	40	26	14	NO	Y	Y	N	Ν
Before	Apr-07	2007/4	0	0	0	NO	Ν	N	N	Ν
Before	May-07	2007/5	0	0	0	NO	Ν	N	N	Ν
Before	Jun-07	2007/6	0	0	0	YES	Ν	Ν	Y	Y
Before	Jul-07	2007/7	0	0	0	YES	N	Ν	Y	Y
Before	Aug-07	2007/8	0	0	0	NO	Ν	Ν	Y	Y
Before	Sep-07	2007/9	0	0	0	NO	Ν	N	Y	Y
Before	Oct-07	2007/10	0	0	0	NO	Ν	Ν	Y	Y
Before	Nov-07	2007/11	0	0	0	YES	N	Ν	Y	Y
Before	Dec-07	2007/12	0	0	0	YES	N	Ν	Y	Y
Before	Jan-08	2008/1	200	130	70	NO	Y	Y	Ν	N
Before	Feb-08	2008/2	500	325	175	NO	Y	Y	Ν	N
Before	Mar-08	2008/3	260	169	91	NO	Y	Y	N	N
Before	Apr-08	2008/4	0	0	0	NO	Ν	Ν	N	N

							Carmel R	iver Water	ASR sites a	vailable for
	[1	1			1	Inje	ction	extra	ction
					Seaside			Active	Santa	Santa
Madal				Santa	Middle	ASR Wells	Active	Injection	Margarita	Margarita
Model	Model	Historic	Monthly	Margarita Sito	School	Available	Injection	Seaside Middle	Available	Available
Period	Date	Date	Injection	Injection	Injection	extraction	Margarita	School	Extraction	Extraction
			(AF)	(AF)	(AF)	(Yes/NO)	(Y/N)	(Y/N)	(Y/N)	(Y/N)
Before	May-08	2008/5	0	0	0	NO	N	N	N	N
Before	Jun-08	2008/6	0	0	0	YES	N	N	Y	Y
Before	Jul-08	2008/7	0	0	0	YES	Ν	Ν	Y	Y
Before	Aug-08	2008/8	0	0	0	YES	N	Ν	Y	Y
Before	Sep-08	2008/9	0	0	0	NO	Ν	Ν	Y	Y
Before	Oct-08	2008/10	0	0	0	NO	N	N	Y	Y
Before	Nov-08	2008/11	0	0	0	NO	N	N	Y	Y
Before	Dec-08	2008/12	0	0	0	NO	N	N	Y	Y
1	Jan-09	1987/1	0	0	0	YES	N	N	Y	Y
2	Feb-09	1987/2	40	26	14	NO	Y	Y	N	Ν
3	Mar-09	1987/3	0	0	0	NO	N	N	N	Ν
4	Apr-09	1987/4	0	0	0	NO	Ν	N	N	Ν
5	May-09	1987/5	0	0	0	YES	Ν	N	Y	Y
6	Jun-09	1987/6	0	0	0	YES	N	N	Y	Y
7	Jul-09	1987/7	0	0	0	YES	Ν	Ν	Y	Y
8	Aug-09	1987/8	0	0	0	YES	N	N	Y	Y
9	Sep-09	1987/9	0	0	0	YES	Ν	Ν	Y	Y
10	Oct-09	1987/10	0	0	0	YES	Ν	N	Y	Y
11	Nov-09	1987/11	0	0	0	YES	N	N	Y	Y
12	Dec-09	1987/12	0	0	0	YES	Ν	N	Y	Y
13	Jan-10	1988/1	0	0	0	YES	Ν	Ν	Y	Y
14	Feb-10	1988/2	0	0	0	YES	Ν	N	Y	Y
15	Mar-10	1988/3	0	0	0	YES	Ν	Ν	Y	Y
16	Apr-10	1988/4	0	0	0	YES	N	N	Y	Y
17	May-10	1988/5	0	0	0	YES	Ν	N	Y	Y
18	Jun-10	1988/6	0	0	0	YES	Ν	Ν	Y	Y
19	Jul-10	1988/7	0	0	0	YES	Ν	N	Y	Y
20	Aug-10	1988/8	0	0	0	YES	N	N	Y	Y
21	Sep-10	1988/9	0	0	0	YES	N	N	Y	Y
22	Oct-10	1988/10	0	0	0	YES	N	N	Y	Y
23	Nov-10	1988/11	0	0	0	YES	N	N	Y	Y
24	Dec-10	1988/12	0	0	0	YES	N	N	Y	Y
25	Jan-11	1989/1	0	0	0	YES	N	N	Y	Y
26	Feb-11	1989/2	0	0	0	YES	N	N	Y	Y
27	Mar-11	1989/3	0	0	0	YES	N	N	Y	Y
28	Apr-11	1989/4	0	0	0	YES	N	N	Y	Y
29	May-11	1989/5	0	0	0	YES	Ν	Ν	Y	Y

Injection	
nijetuori	extraction
ModelFigure 1ModelSeasideSeasideActiveSeasideModelMargaritaSchoolAvailableInjectionMargaritaStressModelHistoricMonthlySiteSitefor GWRSantaMiddleBraisedDataDataInjectionInjectionInjectionSchoolFigure 2	anta Santa rgarita Margarita ailable Available for for
Period Date Date Injection Injection Injection extraction Margarita School Extr	(A) (A)
(AF) (AF) (AF) (Yes/NO) (Y/N) (Y/N) (1)	(γN) (γN)
30 Jun-11 1989/6 0 0 0 YES N N	Y Y
31 Jul-11 1989/7 0 0 0 YES N N	Y Y
32 Aug-11 1989/8 0 0 0 YES N N	Y Y
33 Sep-11 1989/9 0 0 0 YES N N	Y Y
34 Oct-11 1989/10 0 0 0 YES N N	Y Y
35 NOV-11 1989/11 0 0 0 YES N N	Y Y
36 Dec-11 1989/12 0 0 0 YES N N 27 Lm 12 1000/1 0 0 0 YES N N	Y Y
37 Jan-12 1990/1 0 0 0 YES N N	Y Y
38 Feb-12 1990/2 0 0 0 YES N N 20 Mar 12 1000/2 0 0 0 YES N N	
39 Mar-12 1990/3 0 0 0 YES N N 40 Arr 12 1000/4 0 0 0 YES N N	
40 Apr-12 1990/4 0 0 0 1ES N N	
41 May-12 1990/5 0 0 0 1E5 N N	
42 Jun-12 1990/6 0 0 0 YES N N	Y Y
43 Jul-12 1990/7 0 0 0 YES N N	Y Y
44 Aug-12 1990/8 0 0 0 1ES N N	
45 Sep-12 1990/9 0 0 0 YES N N	Y Y
46 Oct-12 1990/10 0 0 0 YES N N	Y Y
47 NOV-12 1990/11 0 0 0 1ES N N	
48 Dec-12 1990/12 0 0 0 YES N N	Y Y
$\begin{array}{c ccccccccccccccccccccccccccccccccccc$	
50 Feb-13 1991/2 0 0 0 1E5 N N	I I N N
51 Mar-13 1991/3 280 182 98 NO I I	IN IN
52 Apr-13 1991/4 100 65 55 NO 1 1	IN IN
53 May-13 1991/5 0 0 0 NO N N	IN IN
$\begin{array}{c ccccccccccccccccccccccccccccccccccc$	\mathbf{v} \mathbf{v}
$\begin{array}{c ccccccccccccccccccccccccccccccccccc$	γ γ γ
57 Sap 13 1991/9 0 0 0 NO N N	
57 Sep-13 1991/2 0 0 0 NO N N	
59 Nov-13 1991/11 0 0 0 VES N N	v v
60 Dec.13 1991/12 0 0 0 VES N N	
$\begin{array}{c ccccccccccccccccccccccccccccccccccc$	$\gamma $ γ
$\begin{array}{ c c c c c c c c c c c c c c c c c c c$	N N
$\begin{array}{ c c c c c c c c c c c c c c c c c c c$	N N
$\begin{array}{c ccccccccccccccccccccccccccccccccccc$	N N
$\begin{array}{ c c c c c c c c c c c c c c c c c c c$	N N
66 Jun-14 1992/6 0 0 0 YES N N	$\gamma \gamma \gamma$

							Carmel R	iver Water	ASR sites a	vailable for
		1	1				Inje	ction	extra	ction
Model Stress Poriod	Model	Historic	Monthly	Santa Margarita Site	Seaside Middle School Site Injection	ASR Wells Available for GWR	Active Injection Santa Margarita	Active Injection Seaside Middle School	Santa Margarita Available for Extraction	Santa Margarita Available for Extraction
Terrou	Date	Date				(Voc/NO)				
(7	1.1.1.4	1002/7	(AF)	(AF)	(AF)	(Tes/NO)	(1/N)	(1/N)	(1/N)	(1/N)
67	Jui-14	1992/7	0	0	0	1E5	IN N	IN N	Y Y	I V
68	Aug-14	1992/8	0	0	0	NO	N	IN N	Y V	Y
69	Sep-14	1992/9	0	0	0	NU	IN N	IN N	Y	Y
70	Oct-14	1992/10	0	0	0	YES	N	N	Y	Y
71	Nov-14	1992/11	0	0	0	YES	N	N	Y	Y
72	Dec-14	1992/12	0	0	0	YES	N	N	Y	Y
73	Jan-15	1993/1	520	338	182	NO	Y	Y	N	N
	Feb-15	1993/2	560	364	196	NO	Y	Y	N	N
75	Mar-15	1993/3	620	403	217	NO	Y	Y	N	N
76	Apr-15	1993/4	540	351	189	NO	Y	Y	N	N
77	May-15	1993/5	0	0	0	NO	N	N	N	N
78	Jun-15	1993/6	0	0	0	NO	N	N	N	N
	Jul-15	1993/7	0	0	0	YES	N	N	Y	Y
80	Aug-15	1993/8	0	0	0	NO	N	N	Y	Y
81	Sep-15	1993/9	0	0	0	NO	N	N	Y	Y
82	Oct-15	1993/10	0	0	0	NO	N	N	Y	Y
83	Nov-15	1993/11	0	0	0	YES	N	N	Y	Y
	Dec-15	1993/12	0	0	0	YES	N	N	Y	Y
85	Jan-16	1994/1	0	0	0	YES	N	N	Y	Y
86	Feb-16	1994/2	140	91	49	NO	Y	Y	N	N
87	Mar-16	1994/3	0	0	0	NO	N	N	N	N
88	Apr-16	1994/4	0	0	0	NO	N	N	N	N
89	May-16	1994/5	0	0	0	YES	N	N	Y	Y
90	Jun-16	1994/6	0	0	0	YES	N	N	Y	Y
91	Jul-16	1994/7	0	0	0	YES	N	N	Y	Y
92	Aug-16	1994/8	0	0	0	NO	N	N	Y	Y
93	Sep-16	1994/9	0	0	0	NO	N	N	Y	Y
	Oct-16	1994/10	0	0	0	YES	N	N	Y	Y
95	Nov-16	1994/11	0	0	0	YES	N	N	Y	Y
96	Dec-16	1994/12	0	0	0	YES	N	N	Y	Y
	Jan-17	1995/1	480	312	168	NO	Y	Y	N	N
98	Feb-17	1995/2	440	286	154	NO	Y	Y	N	N
99	Mar-17	1995/3	580	377	203	NO	Y	Y	N	N
100	Apr-17	1995/4	600	390	210	NO	Y	Y	N	N
101	May-17	1995/5	620	403	217	NO	Y	Y	N	N
102	Jun-17	1995/6	0	0	0	NO	N	N	N	N
103	Jul-17	1995/7	0	0	0	NO	N	N	N	Ν

							Carmel R	iver Water	ASR sites a	vailable for
					C 1 .		IIJe		Canto	Conto
				Santa	Middle	ASR Wells	Active	Injection	Santa Margarita	Santa Margarita
Model				Margarita	School	Available	Injection	Seaside	Available	Available
Stress	Model	Historic	Monthly	Site	Site	for GWR	Santa	Middle	for	for
Period	Date	Date	Injection	Injection	Injection	extraction	Margarita	School	Extraction	Extraction
			(AF)	(AF)	(AF)	(Yes/NO)	(Y/N)	(Y/N)	(Y/N)	(Y/N)
104	Aug-17	1995/8	0	0	0	NO	N	N	Y	Y
105	Sep-17	1995/9	0	0	0	NO	N	N	Y	Y
106	Oct-17	1995/10	0	0	0	NO	N	N	Y	Y
107	Nov-17	1995/11	0	0	0	YES	N	N	Y	Y
108	Dec-17	1995/12	0	0	0	YES	N	Ν	Y	Y
109	Jan-18	1996/1	180	117	63	NO	Y	Y	N	N
110	Feb-18	1996/2	580	377	203	NO	Y	Y	N	N
111	Mar-18	1996/3	620	403	217	NO	Y	Y	N	Ν
112	Apr-18	1996/4	480	312	168	NO	Y	Y	N	N
113	May-18	1996/5	60	39	21	NO	Y	Y	N	N
114	Jun-18	1996/6	0	0	0	NO	N	N	N	Ν
115	Jul-18	1996/7	0	0	0	NO	N	N	N	N
116	Aug-18	1996/8	0	0	0	NO	N	N	Y	Y
117	Sep-18	1996/9	0	0	0	NO	N	N	Y	Y
118	Oct-18	1996/10	0	0	0	NO	N	N	Y	Y
119	Nov-18	1996/11	0	0	0	YES	N	N	Y	Y
120	Dec-18	1996/12	360	234	126	NO	Y	Y	N	N
121	Jan-19	1997/1	620	403	217	NO	Y	Y	N	N
122	Feb-19	1997/2	560	364	196	NO	Y	Y	N	N
123	Mar-19	1997/3	100	65	35	NO	Y	Y	N	N
124	Apr-19	1997/4	0	0	0	NO	N	N	N	N
125	Mav-19	1997/5	0	0	0	NO	N	N	N	N
126	Iun-19	1997/6	0	0	0	YES	N	N	Y	Ŷ
127	Jul-19	1997/7	0	0	0	YES	N	N	Ŷ	Ŷ
128	Α11σ-19	1997/8	0	0	0	NO	N	N	Y	Ŷ
129	Sep-19	1997/9	0	0	0	NO	N	N	Y	Ŷ
130	Oct-19	1997/10	0	0	0	NO	N	N	Y	Ŷ
131	Nov-19	1997/11	0	0	0	YES	N	N	Ŷ	Ŷ
132	Dec-19	1997/12	120	78	42	NO	Y	Ŷ	N	N
132	Ian-20	1998/1	500	325	175	NO	Y	Ŷ	N	N
130	Feb-20	1998/2	560	361	196	NO	V	v I	N	N
134	Mar_20	1998/2	620	403	2170	NO	V	ı V	N	N
133	$\Delta pr 20$	1990/3	600	400 200	217 210	NO	I V	ı V	N	IN N
130	May 20	1009/5	620	402	210	NO	I V	ı v	IN N	IN N
13/	Iviay-20	1770/3	020	405	21/	NO	I N	I NT		IN N
100	Juii-20	1770/0	0	0	0	NO	IN N	IN N		IN N
1.39	Jui-20	1770//	0	0	0	NO	IN N	IN N		IN V
140	Aug-20	1998/8	U	U	U	NU	IN	IN	Y	Ŷ

							Carmel R	iver Water	ASR sites a	vailable for
							Inje	ction	extra	ction
Model				Santa Margarita	Seaside Middle School	ASR Wells Available	Active Injection	Active Injection Seaside	Santa Margarita Available	Santa Margarita Available
Stress	Model	Historic	Monthly	Site	Site	for GWR	Santa	Middle	for Extraction	for Extraction
renou	Date	Date	(AE)	(AE)	(AE)	(Ver/NO)				
1.41	6 20	1000/0	(AF)	(AF)	(AF)	(Tes/NO)	(1/N)	(1/N)	(1/N)	(1/N)
141	Sep-20	1998/9	0	0	0	NO	N N	N	Y Y	Y
142	Oct-20	1998/10	0	0	0	NU	N	N	Y V	Y
143	Nov-20	1998/11	0	0	0	YES	N	N	Y	Y
144	Dec-20	1998/12	100	0	0	YES	N	N	Y N	Y
145	Jan-21	1999/1	100	65	35	NO	Y	Y	N	N
146	Feb-21	1999/2	480	312	168	NO	Y	Y	N	N
147	Mar-21	1999/3	440	286	154	NO	Y	Y	N	N
148	Apr-21	1999/4	600	390	210	NO	Y	Y	N	N
149	May-21	1999/5	300	195	105	NO	Y	Y	N	N
150	Jun-21	1999/6	0	0	0	NO	N	N	N	N
151	Jul-21	1999/7	0	0	0	NO	N	N	N	N
152	Aug-21	1999/8	0	0	0	NO	N	N	Y	Y
153	Sep-21	1999/9	0	0	0	NO	N	N	Y	Y
154	Oct-21	1999/10	0	0	0	NO	N	N	Y	Y
155	Nov-21	1999/11	0	0	0	YES	N	N	Y	Y
156	Dec-21	1999/12	0	0	0	YES	N	N	Y	Y
157	Jan-22	2000/1	180	117	63	NO	Y	Y	N	N
158	Feb-22	2000/2	520	338	182	NO	Y	Y	N	N
159	Mar-22	2000/3	620	403	217	NO	Y	Y	N	N
160	Apr-22	2000/4	320	208	112	NO	Y	Y	N	N
161	May-22	2000/5	0	0	0	NO	N	N	N	N
162	Jun-22	2000/6	0	0	0	NO	N	N	N	N
163	Jul-22	2000/7	0	0	0	YES	N	N	Y	Y
164	Aug-22	2000/8	0	0	0	NO	N	N	Y	Y
165	Sep-22	2000/9	0	0	0	NO	N	N	Y	Y
166	Oct-22	2000/10	0	0	0	NO	N	N	Y	Y
167	Nov-22	2000/11	0	0	0	YES	N	N	Y	Y
168	Dec-22	2000/12	0	0	0	YES	N	N	Y	Y
169	Jan-23	2001/1	140	91	49	NO	Y	Y	<u>N</u>	N
170	Feb-23	2001/2	340	221	119	NO	Y	Y	N	N
171	Mar-23	2001/3	560	364	196	NO	Y	Y	N	N
172	Apr-23	2001/4	180	117	63	NO	Y	Y	N	N
173	May-23	2001/5	0	0	0	NO	N	N	N	N
174	Jun-23	2001/6	0	0	0	NO	N	N	N	N
175	Jul-23	2001/7	0	0	0	YES	N	N	Y	Y
176	Aug-23	2001/8	0	0	0	NO	N	N	Y	Y
177	Sep-23	2001/9	0	0	0	NO	N	Ν	Y	Y

							Carmel River Water ASR sites av		vailable for	
	T	[[[Inje	ction	extra	ction
Model Stress	Model	Historic	Monthly	Santa Margarita Site	Seaside Middle School Site	ASR Wells Available for GWR	Active Injection Santa	Active Injection Seaside Middle	Santa Margarita Available for	Santa Margarita Available for
Period	Date	Date	Injection	Injection	Injection	extraction	Margarita	School	Extraction	Extraction
			(AF)	(AF)	(AF)	(Yes/NO)	(Y/N)	(Y/N)	(Y/N)	(Y/N)
178	Oct-23	2001/10	0	0	0	NO	N	N	Y	Y
179	Nov-23	2001/11	0	0	0	YES	N	N	Y	Y
180	Dec-23	2001/12	220	143	77	NO	Y	Y	N	N
181	Jan-24	2002/1	240	156	84	NO	Y	Y	N	N
182	Feb-24	2002/2	0	0	0	NO	N	N	N	N
183	Mar-24	2002/3	0	0	0	NO	N	N	N	N
184	Apr-24	2002/4	0	0	0	YES	N	N	Y	Y
185	May-24	2002/5	0	0	0	YES	N	N	Y	Y
186	Jun-24	2002/6	0	0	0	YES	N	N	Y	Y
187	Jul-24	2002/7	0	0	0	YES	N	N	Y	Y
188	Aug-24	2002/8	0	0	0	NO	N	N	Y	Y
189	Sep-24	2002/9	0	0	0	NO	N	N	Y	Y
190	Oct-24	2002/10	0	0	0	NO	N	N	Y	Y
191	Nov-24	2002/11	0	0	0	YES	N	N	Y	Y
192	Dec-24	2002/12	340	221	119	NO	Y	Y	N	N
193	Jan-25	2003/1	500	325	175	NO	Y	Y	N	N
194	Feb-25	2003/2	0	0	0	NO	N	N	N	N
195	Mar-25	2003/3	100	65	35	NO	Y	Y	N	N
196	Apr-25	2003/4	360	234	126	NO	Y	Y	N	N
197	May-25	2003/5	400	260	140	NO	Y	Y	N	N
198	Jun-25	2003/6	0	0	0	NO	N	N	N	N
199	Jul-25	2003/7	0	0	0	NO	N	N	N	N
200	Aug-25	2003/8	0	0	0	NO	N	N	Y	Y
201	Sep-25	2003/9	0	0	0	NO	N	N	Y	Y
202	Oct-25	2003/10	0	0	0	NO	N	N	Y	Y
203	Nov-25	2003/11	0	0	0	YES	N	N	Y	Y
204	Dec-25	2003/12	40	26	14	NO	Y	Y	N	N
205	Jan-26	2004/1	100	65	35	NO	Y	Y	N	N
206	Feb-26	2004/2	280	182	98	NO	Y	Y	N	N
207	Mar-26	2004/3	300	195	105	NO	Y	Y	N	N
208	Apr-26	2004/4	0	0	0	NO	N	N	N	N
209	May-26	2004/5	0	0	0	NO	N	N	N	N
210	Jun-26	2004/6	0	0	0	YES	N	N	Y	Y
211	Jul-26	2004/7	0	0	0	YES	N	N	Y	Y
212	Aug-26	2004/8	0	0	0	NO	N	N	Y	Y
213	Sep-26	2004/9	0	0	0	NO	N	N	Y	Y
214	Oct-26	2004/10	0	0	0	NO	N	Ν	Y	Y

							Carmel R	iver Water	ASR sites a	vailable for
							Inje	ction	extra	ction
Model Stress Period	Model	Historic	Monthly	Santa Margarita Site Injection	Seaside Middle School Site Injection	ASR Wells Available for GWR extraction	Active Injection Santa Margarita	Active Injection Seaside Middle School	Santa Margarita Available for Extraction	Santa Margarita Available for Extraction
Teriou	Date	Date		(AE)	(AE)	(Voc/NO)				
215	No. 26	2004/11		(AF)	(AF)	(Tes/NO)	(1/IN) NI	(1/IN)	(1/IN) V	(1/N)
213	Dec 26	2004/11	60	20	0	I ES	IN V	IN V	I NI	I N
210	Lop 27	2004/12	620	402	21	NO	I V	I V	IN N	IN N
217	Jaii-27	2005/1	560	403	106	NO	I V	I V	IN NI	IN N
210	red-27	2005/2	620	304 402	190	NO	I V	I V	IN N	IN N
219	Mar-27	2005/5	620	405 200	217	NO	I V	I V	IN N	IN N
220	Apr-27	2005/4	460	390 200	210	NO	I V	I V	IN N	IN N
221	May-27	2005/5	460	299	161	NO	I N	I N	IN N	IN N
222	Jun-27	2005/6	0	0	0	NO	IN N	IN N	IN N	N
223	Jui-27	2005/7	0	0	0	NO	IN N	N N	N N	N
224	Aug-27	2005/8	0	0	0	NO	N	N	Y	Y
225	Sep-27	2005/9	0	0	0	NO	N	IN N	Y	Y
226	Oct-27	2005/10	0	0	0	NO	N	N	Y	Y
227	Nov-27	2005/11	0	0	0	YES	N	N	Y	Y
228	Dec-27	2005/12	20	13	7	NO	Y	Y	N	N
229	Jan-28	2006/1	400	260	140	NO	Y	Y	N	N
230	Feb-28	2006/2	40	26	14	NO	Y	Y	N	N
231	Mar-28	2006/3	620	403	217	NO	Y	Y	N	N
232	Apr-28	2006/4	600	390	210	NO	Y	Y	N	N
233	May-28	2006/5	620	403	217	NO	Y	Y	N	N
234	Jun-28	2006/6	0	0	0	NO	N	N	N	N
235	Jul-28	2006/7	0	0	0	NO	N	N	N	N
236	Aug-28	2006/8	0	0	0	NO	N	N	Y	Y
237	Sep-28	2006/9	0	0	0	NO	N	N	Y	Y
238	Oct-28	2006/10	0	0	0	NO	N	N	Y	Y
239	Nov-28	2006/11	0	0	0	YES	N	N	Y	Y
240	Dec-28	2006/12	0	0	0	YES	N	N	Y	Y
241	Jan-29	2007/1	0	0	0	YES	N	N	Y	Y
242	Feb-29	2007/2	40	26	14	NO	Y	Y	N	N
243	Mar-29	2007/3	40	26	14	NO	Y	Y	N	N
244	Apr-29	2007/4	0	0	0	NO	N	N	N	N
245	May-29	2007/5	0	0	0	NO	N	N	N	N
246	Jun-29	2007/6	0	0	0	YES	N	N	Y	Y
247	Jul-29	2007/7	0	0	0	YES	N	N	Y	Y
248	Aug-29	2007/8	0	0	0	NO	N	N	Y	Y
249	Sep-29	2007/9	0	0	0	NO	N	N	Y	Y
250	Oct-29	2007/10	0	0	0	NO	N	N	Y	Y
251	Nov-29	2007/11	0	0	0	YES	Ν	Ν	Y	Y

							Carmel R	iver Water	ASR sites a	vailable for
							Inje	ction	extra	ction
Model Stress Period	Model Date	Historic Date	Monthly Injection	Santa Margarita Site Injection	Seaside Middle School Site Iniection	ASR Wells Available for GWR extraction	Active Injection Santa Margarita	Active Injection Seaside Middle School	Santa Margarita Available for Extraction	Santa Margarita Available for Extraction
			(AF)	(AF)	(AF)	(Yes/NO)	(Y/N)	(Y/N)	(Y/N)	(Y/N)
252	Dec-29	2007/12	0	0	0	VFS	N	N	(1/14) V	(1/11) V
253	Ian-30	2008/1	200	130	70	NO	Y	Y	N	N
250	Feb-30	2000/1	500	325	175	NO	Y	Y	N	N
255	Mar-30	2008/3	260	169	91	NO	Y	Ŷ	N	N
256	Apr-30	2008/4	0	0	0	NO	N	N	N	N
257	May-30	2008/5	0	0	0	NO	N	N	N	N
258	Iun-30	2008/6	0	0	0	YES	N	N	Ŷ	Ŷ
259	Jul-30	2008/7	0	0	0	YES	N	N	Ŷ	Ŷ
260	Aug-30	2008/8	0	0	0	YES	N	N	Y	Y
261	Sep-30	2008/9	0	0	0	NO	N	N	Y	Y
262	Oct-30	2008/10	0	0	0	NO	N	N	Y	Y
263	Nov-30	2008/11	0	0	0	NO	N	N	Y	Y
264	Dec-30	2008/12	0	0	0	NO	N	N	Y	Y
265	Jan-31	1987/1	0	0	0	YES	N	N	Y	Y
266	Feb-31	1987/2	40	26	14	NO	Y	Y	N	N
267	Mar-31	1987/3	0	0	0	NO	N	N	N	N
268	Apr-31	1987/4	0	0	0	NO	N	Ν	Ν	Ν
269	May-31	1987/5	0	0	0	YES	N	N	Y	Y
270	Jun-31	1987/6	0	0	0	YES	N	N	Y	Y
271	Jul-31	1987/7	0	0	0	YES	N	N	Y	Y
272	Aug-31	1987/8	0	0	0	YES	N	N	Y	Y
273	Sep-31	1987/9	0	0	0	YES	Ν	Ν	Y	Y
274	Oct-31	1987/10	0	0	0	YES	N	N	Y	Y
275	Nov-31	1987/11	0	0	0	YES	N	N	Y	Y
276	Dec-31	1987/12	0	0	0	YES	N	N	Y	Y
277	Jan-32	1988/1	0	0	0	YES	N	N	Y	Y
278	Feb-32	1988/2	0	0	0	YES	N	N	Y	Y
279	Mar-32	1988/3	0	0	0	YES	N	N	Y	Y
280	Apr-32	1988/4	0	0	0	YES	N	N	Y	Y
281	May-32	1988/5	0	0	0	YES	N	N	Y	Y
282	Jun-32	1988/6	0	0	0	YES	N	N	Y	Y
283	Jul-32	1988/7	0	0	0	YES	N	N	Y	Y
284	Aug-32	1988/8	0	0	0	YES	N	N	Y	Y
285	Sep-32	1988/9	0	0	0	YES	N	N	Y	Y
286	Oct-32	1988/10	0	0	0	YES	N	N	Y	Y
287	Nov-32	1988/11	0	0	0	YES	N	N	Y	Y
288	Dec-32	1988/12	0	0	0	YES	N	Ν	Y	Y

							Carmel R	iver Water	ASR sites a	vailable for
	1						Inje	ction	extra	ction
Model Stress	Model	Historic	Monthly	Santa Margarita Site	Seaside Middle School Site	ASR Wells Available for GWR	Active Injection Santa	Active Injection Seaside Middle	Santa Margarita Available for	Santa Margarita Available for
Period	Date	Date	Injection	Injection	Injection	extraction	Margarita	School	Extraction	Extraction
			(AF)	(AF)	(AF)	(Yes/NO)	(Y/N)	(Y/N)	(Y/N)	(Y/N)
289	Jan-33	1989/1	0	0	0	YES	N	N	Y	Y
290	Feb-33	1989/2	0	0	0	YES	N	N	Y	Y
291	Mar-33	1989/3	0	0	0	YES	N	N	Y	Y
292	Apr-33	1989/4	0	0	0	YES	N	N	Y	Y
293	May-33	1989/5	0	0	0	YES	N	N	Y	Y
294	Jun-33	1989/6	0	0	0	YES	N	N	Y	Y
295	Jul-33	1989/7	0	0	0	YES	N	N	Y	Y
296	Aug-33	1989/8	0	0	0	YES	N	N	Y	Y
297	Sep-33	1989/9	0	0	0	YES	N	N	Y	Y
298	Oct-33	1989/10	0	0	0	YES	N	N	Y	Y
299	Nov-33	1989/11	0	0	0	YES	N	N	Y	Y
300	Dec-33	1989/12	0	0	0	YES	N	N	Y	Y
301	Jan-34	1990/1	0	0	0	YES	N	N	Y	Y
302	Feb-34	1990/2	0	0	0	YES	N	N	Y	Y
303	Mar-34	1990/3	0	0	0	YES	N	N	Y	Y
304	Apr-34	1990/4	0	0	0	YES	Ν	N	Y	Y
305	May-34	1990/5	0	0	0	YES	N	N	Y	Y
306	Jun-34	1990/6	0	0	0	YES	N	N	Y	Y
307	Jul-34	1990/7	0	0	0	YES	N	N	Y	Y
308	Aug-34	1990/8	0	0	0	YES	N	N	Y	Y
309	Sep-34	1990/9	0	0	0	YES	N	N	Y	Y
310	Oct-34	1990/10	0	0	0	YES	Ν	N	Y	Y
311	Nov-34	1990/11	0	0	0	YES	Ν	N	Y	Y
312	Dec-34	1990/12	0	0	0	YES	N	N	Y	Y
313	Jan-35	1991/1	0	0	0	YES	Ν	N	Y	Y
314	Feb-35	1991/2	0	0	0	YES	Ν	N	Y	Y
315	Mar-35	1991/3	280	182	98	NO	Y	Y	N	N
316	Apr-35	1991/4	100	65	35	NO	Y	Y	N	Ν
317	May-35	1991/5	0	0	0	NO	N	Ν	N	Ν
318	Jun-35	1991/6	0	0	0	NO	N	Ν	N	Ν
319	Jul-35	1991/7	0	0	0	YES	N	Ν	Y	Y
320	Aug-35	1991/8	0	0	0	YES	N	N	Y	Y
321	Sep-35	1991/9	0	0	0	NO	N	N	Y	Y
322	Oct-35	1991/10	0	0	0	YES	N	N	Y	Y
323	Nov-35	1991/11	0	0	0	YES	N	N	Y	Y
324	Dec-35	1991/12	0	0	0	YES	N	N	Y	Y
325	Jan-36	1992/1	0	0	0	YES	N	N	Y	Y

							Carmel R	iver Water	ASR sites a	vailable for
	1						Inje	ction	extra	ction
Model Stress Period	Model	Historic	Monthly	Santa Margarita Site Injection	Seaside Middle School Site Injection	ASR Wells Available for GWR	Active Injection Santa Margarita	Active Injection Seaside Middle School	Santa Margarita Available for Extraction	Santa Margarita Available for Extraction
Terrou	Date	Date								
	E L O(1000/0	(AF)	(AF)	(AF)	(Yes/NO)	(Y/N)	(Y/N)	(Y/N)	(Y/N)
326	Feb-36	1992/2	380	247	133	NO	Y	Y	N	N
327	Mar-36	1992/3	480	312	168	NO	Y	Y	N	N
328	Apr-36	1992/4	0	0	0	NO	N	N	N	N
329	May-36	1992/5	0	0	0	NO	N	N	N	N
330	Jun-36	1992/6	0	0	0	YES	N	N	Y	Y
331	Jul-36	1992/7	0	0	0	YES	N	N	Y	Y
332	Aug-36	1992/8	0	0	0	NO	N	N	Y	Y
333	Sep-36	1992/9	0	0	0	NO	N	N	Y	Y
334	Oct-36	1992/10	0	0	0	YES	N	N	Y	Y
335	Nov-36	1992/11	0	0	0	YES	N	N	Y	Y
336	Dec-36	1992/12	0	0	0	YES	N	N	Y	Y
337	Jan-37	1993/1	520	338	182	NO	Y	Y	N	N
338	Feb-37	1993/2	560	364	196	NO	Y	Y	N	N
339	Mar-37	1993/3	620	403	217	NO	Y	Y	N	N
340	Apr-37	1993/4	540	351	189	NO	Y	Y	N	N
341	May-37	1993/5	0	0	0	NO	N	N	N	N
342	Jun-37	1993/6	0	0	0	NO	N	N	N	N
343	Jul-37	1993/7	0	0	0	YES	N	N	Y	Y
344	Aug-37	1993/8	0	0	0	NO	N	N	Y	Y
345	Sep-37	1993/9	0	0	0	NO	N	N	Y	Y
346	Oct-37	1993/10	0	0	0	NO	N	N	Y	Y
347	Nov-37	1993/11	0	0	0	YES	N	N	Y	Y
348	Dec-37	1993/12	0	0	0	YES	N	N	Y	Y
349	Jan-38	1994/1	0	0	0	YES	N	N	Y	Y
350	Feb-38	1994/2	140	91	49	NO	Y	Y	N	N
351	Mar-38	1994/3	0	0	0	NO	Ν	N	N	Ν
352	Apr-38	1994/4	0	0	0	NO	N	N	N	N
353	May-38	1994/5	0	0	0	YES	N	N	Y	Y
354	Jun-38	1994/6	0	0	0	YES	Ν	Ν	Y	Y
355	Jul-38	1994/7	0	0	0	YES	N	N	Y	Y
356	Aug-38	1994/8	0	0	0	NO	N	Ν	Y	Y
357	Sep-38	1994/9	0	0	0	NO	N	N	Y	Y
358	Oct-38	1994/10	0	0	0	YES	N	N	Y	Y
359	Nov-38	1994/11	0	0	0	YES	N	N	Y	Y
360	Dec-38	1994/12	0	0	0	YES	N	N	Y	Y
361	Jan-39	1995/1	480	312	168	NO	Y	Y	N	N
362	Feb-39	1995/2	440	286	154	NO	Y	Y	N	N

							Carmel R	iver Water	ASR sites a	vailable for
							Inje	ction	extra	ction
Model Stress	Model	Historic	Monthly	Santa Margarita Site	Seaside Middle School Site	ASR Wells Available for GWR	Active Injection Santa	Active Injection Seaside Middle	Santa Margarita Available for	Santa Margarita Available for
Period	Date	Date	Injection	Injection	Injection	extraction	Margarita	School	Extraction	Extraction
			(AF)	(AF)	(AF)	(Yes/NO)	(Y/N)	(Y/N)	(Y/N)	(Y/N)
363	Mar-39	1995/3	580	377	203	NO	Y	Y	N	N
364	Apr-39	1995/4	600	390	210	NO	Y	Y	N	Ν
365	May-39	1995/5	620	403	217	NO	Y	Y	N	N
366	Jun-39	1995/6	0	0	0	NO	N	N	N	N
367	Jul-39	1995/7	0	0	0	NO	N	N	N	N
368	Aug-39	1995/8	0	0	0	NO	N	N	Y	Y
369	Sep-39	1995/9	0	0	0	NO	N	N	Y	Y
370	Oct-39	1995/10	0	0	0	NO	N	N	Y	Y
371	Nov-39	1995/11	0	0	0	YES	N	N	Y	Y
372	Dec-39	1995/12	0	0	0	YES	N	N	Y	Y
373	Jan-40	1996/1	180	117	63	NO	Y	Y	N	N
374	Feb-40	1996/2	580	377	203	NO	Y	Y	N	N
375	Mar-40	1996/3	620	403	217	NO	Y	Y	N	N
376	Apr-40	1996/4	480	312	168	NO	Y	Y	N	N
377	May-40	1996/5	60	39	21	NO	Y	Y	N	N
378	Jun-40	1996/6	0	0	0	NO	N	N	N	N
379	Jul-40	1996/7	0	0	0	NO	N	N	N	N
380	Aug-40	1996/8	0	0	0	NO	N	N	Y	Y
381	Sep-40	1996/9	0	0	0	NO	N	N	Y	Y
382	Oct-40	1996/10	0	0	0	NO	N	N	Y	Y
383	Nov-40	1996/11	0	0	0	YES	N	N	Y	Y
384	Dec-40	1996/12	360	234	126	NO	Y	Y	N	N
385	Jan-41	1997/1	620	403	217	NO	Y	Y	N	N
386	Feb-41	1997/2	560	364	196	NO	Y	Y	N	N
387	Mar-41	1997/3	100	65	35	NO	Y	Y	N	N
388	Apr-41	1997/4	0	0	0	NO	N	N	N	N
389	May-41	1997/5	0	0	0	NO	N	N	N	N
390	Jun-41	1997/6	0	0	0	YES	N	N	Y	Y
391	Jul-41	1997/7	0	0	0	YES	N	N	Y	Y
392	Aug-41	1997/8	0	0	0	NO	N	N	Y	Y
393	Sep-41	1997/9	0	0	0	NO	N	N	Y	Y
394	Oct-41	1997/10	0	0	0	NO	N	N	Y	Y
395	Nov-41	1997/11	0	0	0	YES	N	N	Y	Y
396	Dec-41	1997/12	120	78	42	NO	Y	Y	Ν	Ν

APPENDIX D

Todd Groundwater

Groundwater Quality Analytical Program – Laboratory Summary Tables D-1 and D-1A through D-1P

Table D-1: Groundwater Quality Analytical Program -Laboratory Summary

Laboratory	Analytes	Tables
Alpha Analytical Laboratory	Anions	D-1A
Alpha Analytical Laboratory/McCampbell Analytical	Metals (Including Major Cations) and Cr(VI)	D-1B
Alpha Analytical Laboratory	Conventional Chemistry and Other Parameters	D-1C
Alpha Analytical Laboratory	Chlorinated Pesticides and PCBs	D-1D
Alpha Analytical Laboratory	Nitrogen and Phosphorus Pesticides	D-1E
Alpha Analytical Laboratory	Organic Analytes	D-1F
Alpha Analytical Laboratory	Chlorinated Acids	D-1G
Alpha Analytical Laboratory	Carbamates	D-1H
Alpha Analytical Laboratory	Other Organic Compounds	D-1I
Alpha Analytical Laboratory	Volatile Organic Compounds (VOCs)	D-1J
Alpha Analytical Laboratory UL Laboratory and Pace Analytical	Semivolatile Organic Compounds (VOCs)+Dioxin	D-1K
Alpha Analytical Laboratory	Haloacetic Acids	D-1L
ALS Environmental	Nitroaromatics and Nitramines (Explosives)	D-1M
Weck Laboratories, Inc.	Pharmaceuticals and Personal Care Products (PPCPs)	D-1N
UL Laboratory and GEL Laboratories	Radiogenic: Gross Alpha, Beta; Radium 226 and 228, Strontium 90	D-10
ZyMax Forensics	Stable Isotopes of oxygen and hydrogen in water, nitrogen and oxygen in nitrate	D-1P
Asbestos TEM Laboratories, Inc.	Asbestos	D-1C
Isotech	Tritium (enriched)	D-10

Notes:

For abbreviation explanations see notes at end of Table D-1P.

Table D-1A: Anions

Analyte	Method	MDL	City of Seaside 4	FO-7 Deep	FO-7 Shallow	MRWPCA MW-1	PRTIW Mission Memorial	ASR MW-1	R Re	egulatory quirements
					r	ng/L				Туре
Bicarbonate (HCO3 ⁻)	SM2320B	0.060	66	210	68	70	130	270	-	-
Bromate (BrO ₃ -)	EPA 300.1	0.005	ND	ND	ND	ND	ND	ND	0.010	CSMCL-ESMCL
Chloride (Cl⁻)	EPA 300.0	0.30	59	100	44	79	86	120	250	CSMCL-ESMCL
Chlorite (ClO ₂ ⁻)	EPA 300.0	0.020	ND	ND	ND	ND	ND	ND	1.0	CSMCL-ESMCL
Fluoride (F ⁻)	EPA 300.0	0.070	ND	ND	ND	ND	ND	0.15	2.0/4.0	CPMCL/EPMCL
Nitrite as N	EPA 300.0	0.02	ND	ND	ND	ND	ND	ND	1.0	CPMCL/EPMCL
Nitrate as NO₃⁻	EPA 300.0	0.20	13	0.60	2.4	2.7	11	0.42	45	CPMCL/EPMCL
Sulfate (SO ₄ ^{2–})	EPA 300.0	0.090	14	24	13	9.9	89	73	250	CPMCL/EPMCL

Analyte	Method	Units	MDL	City of Seaside 4	FO-7**** Deep	FO-7**** Shallow	MRWPCA MW-1****	PRTIW Mission Memorial	ASR MW-1	Regulatory	y Requirements
Aluminum (Al)	EPA 200.8	µg/L	8.0	ND	170****	3,700****	2,700****	4.3	4.8	1,000/200	CPMCL/CMCL
Antimony (Sb)	EPA 200.8	µg/L	0.080	ND	0.75	3.7	0.51	0.033	0.34	6	CPMCL-EPMCL
Arsenic (As)	EPA 200.8	µg/L	0.28	1.2	7.6****	210****	2.8****	1.6	1.6	10	CPMCL-EPMCL
Barium (Ba)	EPA 200.8	µg/L	0.12	26	72****	1,200****	40****	59	66	1,000/2000	CPMCL/EPMCL
Beryllium (Be) (Total)	EPA 200.8	µg/L	0.080	ND	ND	0.68	0.044	ND	ND	4	CPMCL-EPMCL
Boron (B)	EPA 200.8	µg/L	24	42***	140***	25***	36***	32***	90***	_	-
Cadmium (Cd) Total	EPA 200.8	µg/L	0.080	ND	ND	3.3	0.15	0.10	0.51	5	CPMCL-EPMCL
Calcium (Ca) Total	EPA 200.7	mg/L	0.010	14	53	29	17	37	76	_	-
Chromium (Cr) Total	EPA 200.8	µg/L	0.32	3.6	1.7	790****	13****	3.4	ND	50/100	CPMCL/CMCL
Cr(VI)	EPA 218.6	µg/L	0.050*	3.4	ND	1.7	1.1	1.6	ND	10	CPMCL**
Copper (Cu) Total	EPA 200.8	µg/L	0.16	1.1	1.6	14****	3.7	1.9	4.3	1,300/1,000	CPMCL-EPMCL/ CSMCL-ESMCL
Iron (Fe) Total	EPA 200.8	µg/L	7.2	ND	1100****	80,000****	4,000****	67	21	300	CSMCL-ESMCL
Lead (Pb) Total	EPA 200.8	µg/L	0.080	ND	1.3****	42****	1.3****	0.061	0.78	15	CPMCL-EPMCL
Magnesium (Mg) Total	EPA 200.7	mg/L	0.0080	6.5	6.8	3.8	6.5	10	22	_	CPMCL-EPMCL
Manganese (Mn) Total	EPA 200.8	µg/L	0.12	0.25	83****	20,000****	150****	1.1	23	50	CSMCL-ESMCL
Mercury (Hg) Total	EPA 245.1	µg/L	0.060	ND	ND	0.11	ND	ND	0.85	2	CPMCL-EPMCL
Nickel (Ni) Total	EPA 200.8	µg/L	0.24	0.54	2.8****	26****	8.1****	1.3	4.0	100	CPMCLC
Potassium (Total)	EPA 200.7	mg/L	0.0080	2.0	3.7	3.6	3.4	3.1	5.1	-	-
Selenium (Se) Total	EPA 200.8	µg/L	0.28	0.66***	1.8	1.3***	1.5***	2.2	1.8***	50	CPMCL-EPMCL
Silver (Ag) Total	EPA 200.8	µg/L	0.080	ND	ND	0.11	0.028	ND	ND	2	CPMCL-EPMCL
Sodium (Na) Total	EPA 200.7	mg/L	0.020	43	86	38	50	64	91	_	-
Thallium (TI)	EPA 200.8	µg/L	0.080	ND	ND	0.19	0.027	0.045	ND	2	CPMCL-EPMCL
Uranium (U)	EPA 200.8	pCi/l	0.080	ND	1.6	0.62	0.33	0.20	1.3	20	CPMCL
Vanadium (V)	EPA 200.8	µg/L	1.2	2.5	5.8****	34****	9.5****	1.6	0.76	-	_
Zinc (Zn)	EPA 200.8	µg/L	2.0	2.9	52***	300***	69***	75***	25***	5,000	CPMCL-EPMCL

Table D-1B: Metals (Including Major Cations)

Notes: * Reporting Level or RL. ** Proposed April 15, 2014. *** Reported in laboratory blank. ****Analysis questionable due to high turbidity (see Table D-1C)

Groundwater Analytical Results

MRWPCA Field Program

Analyte	Method	Units	MDL	City of Seaside 4	FO-7 Deep	FO-7 Shallow	MRWPCA MW-1	PRTIW Mission Memorial	ASR MW-1	Regulato	ory Requirement
				Concentration							
Asbestos by TEM (chrysotile/amphibole)*	EPA 100.2	MFL	0.1-1.1	ND	ND	ND	ND	ND	ND	7.0	CSMCL-ESMCL
Bicarbonate (HCO3⁻)	SM2320B	mg/L	0.060	66	210	68	70	130	270	-	-
Color	SM2120B	Color Units	3.0	ND	4.0	4.0	28	6.0	3.0	15	CSMCL
MBAS, calculated as LAS, mw 340	SM5540C	mg/L	0.030	ND	ND	ND	ND	ND	ND	5.0	CSMCL-ESMCL
Odor	EPA 140.1	T.O.N.		ND	ND	ND	1.4	ND	ND	3	CSMCL-ESMCL
Perchlorate (ClO₄ [−])	EPA 314.0	µg/L	0.90	ND**	1.9**	ND**	ND**	1.1**	ND**	6.0	CPMCL
Specific Conductance (EC)	SM2510B	μmhos/cm or μS/cm	1.0	340	660	280	270	440	900	900	CSMCL
Total Dissolved Solids (TDS)	SM2540C	mg/L	5.0	250	460	190	220	350	560	500	CSMCL-ESMCL
Turbidity	SM2130B	NTU	0.040	0.32	10	550	71	0.98	0.37	1/5	CPMCL-EPMCL/ CSMCL-ESMCL
Nitrate + Nitrite as N	EPA 300.0	mg/L	0.0086	3.0	0.13	0.55	0.61	2.4	0.094	10	CSMCL-ESMCL
Total Organic Carbon (TOC)	SM5310C	mg/L	0.100	0.274	0.190	0.768	0.898**	0.519**	0.627	-	-
Cyanide (CN⁻)	10-204-00-1X	mg/L	0.0020	0.0028	0.0023	ND	ND	ND	ND	0.15/0.20	CPMCL/EPMCL

Note:

* Calculated asbestos structures >10 micrometers (μm)

** Detected in Laboratory Blank

Analyte	Method	MDL	City of Seaside 4	FO-7 Deep	FO-7 Shallow	MRWPCA MW-1	PRTIW Mission Memorial	ASR MW-1	Regulatory Requirements		
						µg/L				Туре	
Aldrin	EPA 508	0.10	ND	ND	ND	ND	ND	ND	-	_	
Chloroneb	EPA 508	0.20	ND	ND	ND	ND	ND	ND	_	_	
Chlorbenzilate	EPA 508	2.0	ND	ND	ND	ND	ND	ND	_	_	
Chlorothalonil	EPA 508	0.030	ND	ND	ND	ND	ND	ND	_	_	
DCPA	EPA 508	0.020	ND	ND	ND	ND	ND	ND			
4,4'-DDD	EPA 508	0.020	ND	ND	ND	ND	ND	ND	_	_	
4,4'-DDE	EPA 508	0.020	ND	ND	ND	ND	ND	ND	_	-	
4,4'-DDT	EPA 508	0.020	ND	ND	ND	ND	ND	ND	-	_	
Dieldrin	EPA 508	0.010	ND	ND	ND	ND	ND	ND	_	_	
Endosulfan I	EPA 508	0.020	ND	ND	ND	ND	ND	ND	_	-	
Endosulfan II	EPA 508	0.020	ND	ND	ND	ND	ND	ND	-	-	
Endosulfan sulfate	EPA 508	0.020	ND	ND	ND	ND	ND	ND	_	_	
Endrin	EPA 508	0.030	ND	ND	ND	ND	ND	ND	2.0	CPMCL-EPMCL	
Endrin aldehyde	EPA 508	0.020	ND	ND	ND	ND	ND	ND	-	_	
HCH-alpha (α-BHC)	EPA 508	0.010	ND	ND	ND	ND	ND	ND	-	_	
HCH-beta (β-BHC)	EPA 508	0.020	ND	ND	ND	ND	ND	ND	1	-	
HCH-delta (δ-BHC)	EPA 508	0.030	ND	ND	ND	ND	ND	ND	_	-	
HCH-gamma (γ- BHC) (Lindane)	EPA 508	0.010	ND	ND	ND	ND	ND	ND	0.2	CPMCL-EPMCL	
Heptachlor	EPA 508	0.010	ND	ND	ND	ND	ND	ND	0.01/0.4	CPMCL/EPMCL	
Heptachlor epoxide	EPA 508	0.010	ND	ND	ND	ND	ND	ND	0.01/0.2	CPMCL/EPMCL	

Groundwater Analytical Results

MRWPCA Field Program

Analyte	Method	MDL	City of Seaside 4	FO-7 Deep	FO-7 Shallow	MRWPCA MW-1	PRTIW Mission Memorial	ASR MW-1	R	Regulatory equirements
					Туре					
Hexachlorobenzene	EPA 508	0.010	ND	ND	ND	ND	ND	ND	1.0	CPMCL-EPMCL
Hexachlorocyclo- pentadiene	EPA 508	0.040	ND	ND	ND	ND	ND	ND	50	CPMCL-EPMCL
Methoxychlor	EPA 508	0.020	ND	ND	ND	ND	ND	ND	30/40	CPMCL/EPMCL
cis-Permethrin	EPA 508	0.070	ND	ND	ND	ND	ND	ND	-	-
trans-Permethrin	EPA 508	0.090	ND	ND	ND	ND	ND	ND	_	-
Propachlor	EPA 508	0.070	ND	ND	ND	ND	ND	ND	_	-
Trifluralin	EPA 508	0.020	ND	ND	ND	ND	ND	ND	-	-
PCB (Aroclor)-1016	EPA 508	0.030	ND	ND	ND	ND	ND	ND	0.5	CPMCL-EPMCL
PCB (Aroclor)-1221	EPA 508	0.030	ND	ND	ND	ND	ND	ND	0.5	CPMCL-EPMCL
PCB (Aroclor)-1232	EPA 508	0.030	ND	ND	ND	ND	ND	ND	0.5	CPMCL-EPMCL
PCB (Aroclor)-1242	EPA 508	0.030	ND	ND	ND	ND	ND	ND	0.5	CPMCL-EPMCL
PCB (Aroclor)-1248	EPA 508	0.030	ND	ND	ND	ND	ND	ND	0.5	CPMCL-EPMCL
PCB (Aroclor)-1254	EPA 508	0.030	ND	ND	ND	ND	ND	ND	0.5	CPMCL-EPMCL
PCB -(Aroclor)1260	EPA 508	0.030	ND	ND	ND	ND	ND	ND	0.5	CPMCL-EPMCL
Total PCBs	EPA 508	0.30	ND	ND	ND	ND	ND	ND	0.5	CPMCL-EPMCL
Toxaphene	EPA 508	0.40	ND	ND	ND	ND	ND	ND	3	CPMCL-EPMCL
Chlordane (tech)	EPA 508	0.030	ND	ND	ND	ND	ND	ND	0.1/2	CPMCL/EPMCL

Table 1D: Chlorinated Pesticides and PCBs (continued)

Groundwater Analytical Results MRWPCA Field Program

Analyte	Method	MDL	City of Seaside 4	FO-07 Deep	FO-07 Shallow	MRWPCA MW-1	PRTIW Mission Memorial	ASR MW-1	R	Regulatory equirements
			μg/L							
Alachlor	EPA 507	0.50	ND	ND	ND	ND	ND	ND	2.0	CPMCL-EPMCL
Atrazine	EPA 507	0.30	ND	ND	ND	ND	ND	ND	_	_
Bromacil	EPA 507	0.50	ND	ND	ND	ND	ND	ND	_	_
Butachlor	EPA 507	0.40	ND	ND	ND	ND	ND	ND	_	_
Dimethoate	EPA 507	0.20	ND	ND	ND	ND	ND	ND	_	_
Metolachlor	EPA 507	0.30	ND	ND	ND	ND	ND	ND	_	-
Metribuzin	EPA 507	0.40	ND	ND	ND	ND	ND	ND	Ι	-
Molinate	EPA 507	0.20	ND	ND	ND	ND	ND	ND	20	CPMCL
Prometryn	EPA 507	0.50	ND	ND	ND	ND	ND	ND	-	-
Propachlor	EPA 507	0.30	ND	ND	ND	ND	ND	ND	-	_
Simazine	EPA 507	0.30	ND	ND	ND	ND	ND	ND	4.0	CPMCL-EPMCL
Thiobencarb	EPA 507	0.20	ND	ND	ND	ND	ND	ND	70/1	CPMCL/CSMCL

Table D-1E: Nitrogen and Phosphorus Pesticides

Table D-1F: Organic Analytes

Analyte	Method	MDL	City of Seaside 4	FO-07 Deep	FO-07 Shallow	MRWPCA MW-1	PRTIW Mission Memorial	ASR MW-1	R	Regulatory equirements		
			μg/L									
1,2-Dibromo-3- chloropropane	EPA 504.1	0.0040	ND	ND	ND	ND	ND	ND	0.2	CPMCL-EPMCL		
1,2-Dibromoethane (EDB)	EPA 504.1	0.0050	ND	ND	ND	ND	ND	ND	0.5	CPMCL-EPMCL		

Table D-1G: Chlorinated Acids

Analyte	Method	MDL	City of Seaside 4	FO-7 Deep	FO-7 Shallow	MRWPCA MW-1	PRTIW Mission Memorial	ASR MW-1	R	Regulatory Requirements		
			μg/L									
2,4,5-T	EPA 515.1	0.40	ND	ND	ND	ND	ND	ND	_	_		
2,4,5-TP (Silvex)	EPA 515.1	0.50	ND	ND	ND	ND	ND	ND				
2,4-D	EPA 515.1	0.80	ND	ND	ND	ND	ND	ND	-	-		
2,4-DB	EPA 515.1	4.0	ND	ND	ND	ND	ND	ND	-	-		
4-Nitrophenol	EPA 515.1	0.70	ND	ND	ND	ND	ND	ND	-	_		
Acifluorfen	EPA 515.1	0.50	ND	ND	ND	ND	ND	ND	_	—		
Bentazon	EPA 515.1	0.40	ND	ND	ND	ND	ND	ND	18	CPMCL		
Dicamba	EPA 515.1	0.40	ND	ND	ND	ND	ND	ND	_	_		
Dichlorprop	EPA 515.1	1.0	ND	ND	ND	ND	ND	ND	-	—		
Dinoseb	EPA 515.1	0.80	ND	ND	ND	ND	ND	ND	7	CPMCL-EPMCL		
Pentachlorophenol	EPA 515.1	0.20	ND	ND	ND	ND	ND	ND	1	CPMCL-EPMCL		
Picloram	EPA 515.1	0.50	ND	ND	ND	ND	ND	ND	500	CPMCL-EPMCL		

Table D-1H: Carbamates

Analyte	Method	MDL	City of Seaside 4	FO-7 Deep	FO-7 Shallow	MRWPCA MW-1	PRTIW Mission Memorial	ASR MW-1	F Re	Regulatory Requirements	
			μg/L								
3-Hydroxycarbofuran	EPA 531.1	0.90	ND	ND	ND	ND	ND	ND	_	—	
Aldicarb	EPA 531.1	0.70	ND	ND	ND	ND	ND	ND	3	EPMCL	
Aldicarb sulfone	EPA 531.1	0.70	ND	ND	ND	ND	ND	ND	3	EPMCL	
Aldicarb sulfoxide	EPA 531.1	0.80	ND	ND	ND	ND	ND	ND	4	EPMCL	
Carbaryl	EPA 531.1	0.70	ND	ND	ND	ND	ND	ND	-	-	
Carbofuran	EPA 531.1	2.0	ND	ND	ND	ND	ND	ND	18/40	CPMCL/EPMCL	
Methiocarb	EPA 531.1	2.0	ND	ND	ND	ND	ND	ND	—	—	
Methomyl	EPA 531.1	2.0	ND	ND	ND	ND	ND	ND	_	-	
Oxamyl	EPA 531.1	0.80	ND	ND	ND	ND	ND	ND	50/200	CPMCL/EPMCL	
Propoxur (Baygon)	EPA 531.1	2.0	ND	ND	ND	ND	ND	ND	_	_	

Table D-11: Other Organic Compounds

Analyte	Method	MDL	City of Seaside 4	FO-7 Deep	FO-7 Shallow	MRWPCA MW-1	PRTIW Mission Memorial	ASR MW-1	R Re	legulatory quirements
						µg/L				Туре
Diquat	EPA 549.2	2.0	ND	ND	ND	ND	ND	ND	20	CPMCL- EPMCL
Endothall	EPA 548.1	2.0	ND	ND	ND	ND	ND	ND	100	CPMCL- EPMCL
Glyphosate	EPA 547	3.0	ND	ND	ND	ND	ND	ND	700	CPMCL- EPMCL

Analyte	Method	MDL	City of Seaside 4	FO-7 Deep	FO-7 Shallow	MRWPCA MW-1	PRTIW Mission Memorial	ASR MW-1	F Re	Regulatory equirements
						µg/L	•			Туре
Acetone	EPA 524.2	0.80	ND	ND	2.0	ND	ND	ND	_	_
Acrylonitrile	EPA 524.2	0.20	ND	ND	ND	ND	ND	ND	_	_
Benzene	EPA 524.2	0.20	ND	ND	ND	ND	ND	ND	1/5	CPMCL/EPMCL
Bromobenzene	EPA 524.2	0.10	ND	ND	ND	ND	ND	ND	-	-
Bromochloromethane	EPA 524.2	0.20	ND	ND	ND	ND	ND	ND	_	-
Bromodichloromethane	EPA 524.2	0.50	ND	ND	ND	ND	ND	ND	80	CPMCL-EPMCL
Bromoform	EPA 524.2	0.50	ND	ND	ND	ND	ND	ND	80	CPMCL-EPMCL
Bromomethane	EPA 524.2	0.20	ND	ND	ND	ND	ND	ND	_	-
n-Butylbenzene	EPA 524.2	0.10	ND	ND	ND	ND	ND	ND	-	-
Sec-Butylbenzene	EPA 524.2	0.10	ND	ND	ND	ND	ND	ND	100/10	CPMCL-EPMCL
Tert-Butylbenzene	EPA 524.2	0.10	ND	ND	ND	ND	ND	ND	-	_
Carbon disulfide	EPA 524.2	0.20	ND	ND	ND	ND	ND	ND	-	—
Carbon tetrachloride	EPA 524.2	0.30	ND	ND	ND	ND	ND	ND	0.5/5	CPMCL/EPMCL
Chlorobenzene	EPA 524.2	0.20	ND	ND	ND	ND	ND	ND	70/100	CPMCL/EPMCL
Chloroethane	EPA 524.2	0.10	ND	ND	ND	ND	ND	ND	_	-
Chloroform	EPA 524.2	0.50	ND	ND	ND	ND	1.2	0.87	80	CPMCL-EPMCL
Chloromethane	EPA 524.2	0.20	ND	ND	ND	ND	ND	ND	_	-
2-Chlorotoluene	EPA 524.2	0.20	ND	ND	ND	ND	ND	ND	_	-
4-Chlorotoluene	EPA 524.2	0.10	ND	ND	ND	ND	ND	ND	_	-
Dibromochloromethane	EPA 524.2	0.50	ND	ND	ND	ND	ND	ND	80	CPMCL-EPMCL
1,2-Dibromo-3-chloropropane	EPA 524.2	0.36	ND	ND	ND	ND	ND	ND	0.2	CPMCL-EPMCL
1,2-Dibromethane (EDB)	EPA 524.2	0.14	ND	ND	ND	ND	ND	ND	0.05	CPMCL-EPMCL
1,2-Dichlorobenzene	EPA 524.2	0.20	ND	ND	ND	ND	ND	ND	600	CPMCL-EPMCL
1,3-Dichlorobenzene	EPA 524.2	0.20	ND	ND	ND	ND	ND	ND	_	_
1,4-Dichlorobenzene	EPA 524.2	0.10	ND	ND	ND	ND	ND	ND	5/75	CPMCL/EPMCL
Trans-1.4-Dichloro-2-butene	EPA 524.2	0.095	ND	ND	ND	ND	ND	ND	_	_

Table D-1J: Volatile Organic Compounds (VOCs)

Groundwater Analytical Results MRWPCA Field Program

Analyte	Method	MDL	City of Seaside 4	FO-7 Deep	FO-7 Shallow	MRWPCA MW-1	PRTIW Mission Memorial	ASR MW-1	Regulato	ry Requirements
						µg/L				Туре
Dichlorodifluoromethane	EPA 524.2	0.20	ND	ND	ND	ND	ND	ND	_	—
1,1-Dichloroethane	EPA 524.2	0.10	ND	ND	ND	ND	ND	ND	5	CPMCL
1,2-Dichloroethane	EPA 524.2	0.20	ND	ND	ND	ND	ND	ND	0.5/5	CPMCL/EPMCL
1,1-Dichloroethene	EPA 524.2	0.10	ND	ND	ND	ND	ND	ND	5	CPMCL
Cis-1,2,-Dichloroethene	EPA 524.2	0.20	ND	ND	ND	ND	ND	ND	6/70	CPMCL/EPMCL
Trans-1,2-Dichloroethene	EPA 524.2	0.20	ND	ND	ND	ND	ND	ND	10/100	CPMCL/EPMCL
1,2-Dichloropropane	EPA 524.2	0.20	ND	ND	ND	ND	ND	ND	10/100	CPMCL/EPMCL
1,3-Dichloropropane	EPA 524.2	0.20	ND	ND	ND	ND	ND	ND	_	_
2,2-Dichloropropane	EPA 524.2	0.10	ND	ND	ND	ND	ND	ND	_	_
1,1-Dichloropropene	EPA 524.2	0.10	ND	ND	ND	ND	ND	ND	_	_
Cis-1,3-Dichloropropene	EPA 524.2	0.20	ND	ND	ND	ND	ND	ND	0.5	CPMCL
Trans-1,3,Dichloropropene	EPA 524.2	0.20	ND	ND	ND	ND	ND	ND	-	-
1,3-Dichloropropene(total)	EPA 524.2	0.20	ND	ND	ND	ND	ND	ND	—	_
2-Hexanone	EPA 524.2	0.097	ND	ND	ND	ND	ND	ND	_	_
Ethylbenzene	EPA 524.2	0.10	ND	ND	ND	ND	ND	ND		
Hexachlorobuteadiene	EPA 524.2	0.30	ND	ND	ND	ND	ND	ND	1,200	CPMCL
Isopropylbenzene	EPA 524.2	0.20	ND	ND	ND	ND	ND	ND	-	_
p-Isopropyltoluene	EPA 524.2	0.10	ND	ND	ND	ND	ND	ND	-	_
Methyl ethyl ketone	EPA 524.2	0.40	ND	ND	ND	ND	ND	ND	_	-
Methyl iodide	EPA 524.2	0.12	ND	ND	ND	ND	ND	ND	-	_
Methyl isobutyl ketone	EPA 524.2	0.30	ND	ND	ND	ND	ND	ND	—	_
Methylene chloride	EPA 524.2	0.40	ND	ND	ND	ND	ND	ND	5/5	CPMCL/EPMCL
Naphthalene	EPA 524.2	0.20	ND	ND	ND	ND	ND	ND	—	_
n-Propylbenzene	EPA 524.2	0.20	ND	ND	ND	ND	ND	ND	_	_
Styrene	EPA 524.2	0.10	ND	ND	ND	0.18	ND	ND	100/100	CPMCL/EPMCL
1,1,1,2-Tetrachloroethane	EPA 524.2	0.20	ND	ND	ND	ND	ND	ND	_	_
1,1,2,2-Tetrachloroethane	EPA 524.2	0.20	ND	ND	ND	ND	ND	ND	1	CPMCL
Tetrachloroethane	EPA 524.2	0.20	ND	ND	ND	ND	0.20	ND	5/5	CPMCL/EPMCL

Table D-1J: Volatile Organic Compounds (VOCs) (continued)

Groundwater Analytical Results

MRWPCA Field Program

Analyte	Method	MRL	City of Seaside 4	FO-7 Deep	FO-7 Shallow	MRWPCA MW-1	PRTIW Mission Memorial	ASR MW-1	Regulator	y Requirements
					μ	g/L				Туре
Toluene	EPA 524.2	0.10	ND	ND	ND	2.0	ND	ND	150/1000	CPMCL/EPMCL
1,2,3-Trichlorobenzene	EPA 524.2	0.10	ND	ND	ND	ND	ND	ND	_	—
1,2,4-Trichlorobenzene	EPA 524.2	0.20	ND	ND	ND	ND	ND	ND	5/70	CPMCL/EPMCL
1,1,1-Trichloroethane	EPA 524.2	0.20	ND	ND	ND	ND	ND	ND	200/200	CPMCL/EPMCL
1,1,2-Trichloroethane	EPA 524.2	0.20	ND	ND	ND	ND	ND	ND	5/5	CPMCL/EPMCL
Trichloroethene	EPA 524.2	0.20	ND	ND	ND	ND	ND	ND	_	_
Trichlorofluoromethane	EPA 524.2	0.20	ND	ND	ND	ND	ND	ND	150	CPMCL
Trichlorotrifluoroethane	EPA 524.2	0.20	ND	ND	ND	ND	ND	ND	_	_
1,2,3-Trichloropropane	EPA 524.2	0.13	ND	ND	ND	ND	ND	ND	_	_
1,2,4- Trimethylbenzene	EPA 524.2	0.10	ND	ND	ND	ND	ND	ND	_	_
1,3,5- Trimethylbenzene	EPA 524.2	0.10	ND	ND	ND	ND	ND	ND	_	_
Vinyl chloride	EPA 524.2	0.10	ND	ND	ND	ND	ND	ND	0.5/2	CPMCL/EPMCL
m,p-Xylene	EPA 524.2	0.20	ND	ND	ND	ND	ND	ND	_	_
o-Xylene	EPA 524.2	0.10	ND	ND	ND	ND	ND	ND	_	_
Xylenes (total)	EPA 524.2	0.20	ND	ND	ND	ND	ND	ND	1,750/10,0 00	CPMCL/EPMCL
Trihalomethanes (total)	EPA 524.2	0.50	ND	ND	ND	ND	1.2	0.87	_	_
Methyl tert-butyl ether	EPA 524.2	0.50	ND	ND	ND	ND	ND	ND	-	_
Ethyl tert-butyl ether	EPA 524.2	0.20	ND	ND	ND	ND	ND	ND	-	_
Tert-amyl methyl ether	EPA 524.2	0.20	ND	ND	ND	ND	ND	ND	_	_

Table D-1J: Volatile Organic Compounds (VOCs) (continued)

Groundwater Analytical Results MRWPCA Field Program

Table D-1K: Semivolatile Organic Compounds (SVOCs)

Analyte	Method	MRL	City of Seaside 4	FO-7 Deep	FO-7 Shallow	MRWPCA MW-1	PRTIW Mission Memorial	ASR MW-1	Regulato	ry Requirements					
						µg/L				Туре					
Benzo (a) pyrene	EPA 525.2	0.080	ND	ND	ND	ND	ND	ND	-	-					
Di(2-ethylhexyl)adipate	EPA 525.2	0.40	ND	ND	ND	ND	ND	ND	400/400	CPMCL/EPMCL					
Di(2-ethylhexyl)phthalate	EPA 525.2	0.20	ND	ND	ND	0.29	ND	ND	4/6	CPMCL/EPMCL					
2,3,7,8-Tetrachlorodibenzo- p-Dioxin*	EPA 1613	0.000005	ND	ND	ND	ND	ND	ND	0.00003	CPMCL-EPMCL					

Note:

* Dioxin reported in pg/L; converted to μ g/L

Table D-1L: Haloacetic Acids

Analyte	Methods	MRL	City of Seaside 4	FO-07 Deep	FO-07 Shallow	MRWPCA MW-1	PRTIW Mission Memorial	ASR MW-1	Regulate	ory Requirement
				Туре						
Monobromoacetic Acid	EPA 552.2	0.8	ND	ND	ND	ND	ND	ND	60	CPMCL-EPMCL
Monochloroacetic Acid	EPA 552.2	1.1	ND	ND	ND	ND	ND	ND	60	CPMCL-EPMCL
Dibromoacetic Acid	EPA 552.2	0.8	ND	ND	ND	ND	ND	ND	60	CPMCL-EPMCL
Dichloroacetic Acid	EPA 552.2	1.0	ND	ND	ND	ND	ND	ND	60	CPMCL-EPMCL
Trichloroacetic Acid	EPA 552.2	1.0	ND	ND	ND	ND	ND	ND	60	CPMCL-EPMCL
Total Haloacetic Acids (HAA5)	EPA 552.2	1.0	ND	ND	ND	ND	ND	ND	*	*

Note:

* See individual analytes for regulatory requirements.

Analyte	Methods	MRL	City of Seaside 4	FO-7 Deep	FO-7 Shallow	MRWPCA MW-1	PRTIW Mission Memorial	ASR MW-1	Reg Requ	ulatory irement
						µg/L				Туре
HMX	8330B	0.098	ND	ND	ND	ND	ND	ND	_	_
RDX	8330B	0.098	ND	ND	ND	ND	ND	ND	_	-
1,3,5- Trinitrobenzene	8330B	0.20	ND	ND	ND	ND	ND	ND	-	_
1,3-Dinitrobenzene	8330B	0.098	ND	ND	ND	ND	ND	ND	-	-
3,5-Dinitroaniline	8330B	0.098	ND	ND	ND	ND	ND	ND	_	-
Tetryl	8330B	0.10	ND	ND	ND	ND	ND	ND	_	_
Nitrobenzene	8330B	0.098	ND	ND	ND	ND	ND	ND	_	_
4-Amino-2,6- dinitrotoluene	8330B	0.098	ND	ND	ND	ND	ND	ND	_	_
2-Amino-4,6- dinitrotoluene	8330B	0.098	ND	ND	ND	ND	ND	ND	—	_
2,4,6-Trinitrotoluene	8330B	0.098	ND	ND	ND	ND	ND	ND	_	-
2,6-Dinitrotoluene	8330B	0.20	ND	0.064*	0.070*	ND	ND	0.037*	_	-
2,4-Dinitrotoluene	8330B	0.098	ND	ND	ND	ND	ND	ND	_	-
2-Nitrotoluene	8330B	0.10	ND	ND	ND	ND	ND	ND	_	-
4-Nitrotoluene	8330B	0.098	ND	ND	ND	ND	ND	ND	_	_
3-Nitrotoluene	8330B	0.098	ND	ND	ND	ND	ND	ND	_	_
Nitroglycerin	8330B	0.98	ND	ND	ND	ND	ND	ND	_	_
Pentaerythritol Tetranitrate	8330B	0.49	ND	ND	ND	ND	ND	ND	-	-

Table D-1M: Nitroaromatics and Nitramines (Explosives)

Note:

* Detected in laboratory blank sample; estimated J value.

Groundwater Analytical Results MRWPCA Field Program

		MDI	City of	FO-7	FO-7	MRWPCA	PRTIW	ASR	Regi	ulatory
Analyte	Method		Seaside 4	Deep	Shallow	MW-1	Mission	MW-1	Requi	rements
						µg/L				Туре
N-nitrosodiethylamine	EPA 1625M	0.002	ND	ND	NA	ND	ND	ND	-	-
N-nitrosodimethylamine	EPA 1625M	0.002	ND*	ND*	NA	ND	0.0054	ND	0.01	NL
N-nitrosodi-n-butylamine	EPA 1625M	0.002	ND	ND	NA	ND	ND	ND	-	-
N-nitrosodimethylethylene	EPA 1625M	0.002	ND	ND	NA	ND	ND	ND	-	-
N-Nitrosomorpholine	EPA 1625M	0.002	ND	ND	NA	ND	ND	ND	-	_
N-nitrosopiperdine	EPA 1625M	0.002	ND	ND	NA	ND	ND	ND	-	_
N-Nitrosopyrrolidine	EPA 1625M	0.002	ND	ND	NA	ND	ND	ND	-	_
17-α-ethynlestradiol	EPA 1694M-API	0.001	ND	ND	ND	ND	ND	ND	-	_
17-β-estradiol	EPA 1694M-API	0.001	ND	ND	ND	ND	ND	ND	-	-
Esdtrone	EPA 1694M-API	0.001	ND	ND	ND	ND	ND	ND	0.0009-1.8	DWEL
Progesterone	EPA 1694M-API	0.001	ND	ND	ND	ND	ND	ND	-	_
Testosterone	EPA 1694M-API	0.001	ND	ND	ND	ND	ND	ND	-	-
Bisphenol A	EPA 1694M-ESI-	0.001	0.009*	0.062*	ND*	0.390*	ND*	1.400*	—	_
Gemfibrozil	EPA 1694M-ESI-	0.001	ND	ND	ND	ND	ND	ND	-	_
Ibuprofen	EPA 1694M-ESI-	0.001	ND	ND	ND	ND	ND	ND	_	_
lopromide	EPA 1694M-ESI-	0.005	ND	ND	ND	ND	ND	ND	-	-
Naproxen	EPA 1694M-ESI-	0.001	ND	ND	ND	ND	ND	ND	-	_
Salicylic acid	EPA 1694M-ESI-	0.050	52	ND	ND	ND	ND	ND	_	_
Triclosan	EPA 1694M-ESI-	0.002	ND	ND	ND	ND	ND	ND	0.35-2,600	DWEL
Aceltaminophen	EPA 1694M/ESI+	0.020	ND	ND	ND	ND	ND	ND	-	-
Amoxicillin	EPA 1694M=ESI+	0.001	ND	ND	ND	0.014	ND	ND	-	-
Atenolol	EPA 1694M-ESI+	0.001	ND	ND	ND	ND	ND	ND	-	_
Atorvastatin	EPA 1694M-ESI+	0.001	ND	ND	ND	ND	ND	ND	_	_
Azithromycin	EPA 1694M-ESI+	0.010	ND	ND	ND	ND	ND	ND	_	_
Caffeine	EPA 1694M-ESI+	0.001	ND	0.0027	ND	0.0068	ND	ND	0.35	DWEL
Carbamazepine	EPA 1694M-ESI+	0.001	ND	ND	ND	ND	ND	ND	-	_
Ciprofloxacin	EPA 1694M-ESI+	0.005	ND	ND	ND	0.0059	ND	ND	_	_
Cotinine	EPA 1694M-ESI+	0.002	ND	ND	ND	ND	ND	ND	_	_

Table D-1N: Pharmaceutical and Personal Care Products (PPCPs)

Groundwater Analytical Results

MRWPCA Field Program

Analyte	Method	MRL	City of Seaside 4	FO-7 Deep	FO-7 Shallow	MRWPCA MW-1	PRTIW Mission Memorial	ASR MW-1	Regulatory Requireme	/ ent
						µg/L				Туре
DEET	EPA 1694M-ESI+	0.001	ND	0.0023	ND	0.006	ND	ND	2.5-6,300	DWEL
Diazepam	EPA 1694M-ESI+	0.001	ND	ND	ND	ND	ND	ND	-	-
Fluoxetine	EPA 1694M-ESI+	0.001	ND	ND	ND	ND	ND	ND	-	—
Methadone	EPA 1694M-ESI+	0.001	ND	ND	ND	ND	ND	ND	-	-
Oxybenzone	EPA 1694M-ESI+	0.001	ND	ND	0.0012	0.087	ND	ND	-	_
Phenyloin	EPA 1694M-ESI+	0.001	ND	ND	ND	ND	ND	ND	-	_
Primidone	EPA 1694M-ESI+	0.001	ND	ND	ND	ND	ND	ND	-	-
Sucralose	EPA 1694M-ESI+	0.005	ND	ND	ND	ND	ND	ND	175,000	DWEL
Sulfamethoxazolke	EPA 1694M-ESI+	0.001	ND	ND	ND	ND	ND	ND	-	-
TCEP	EPA 1694M-ESI+	0.001	0.0067	ND	ND	0.0064	ND	ND	-	-
ТСРР	EPA 1694M-ESI+	0.001	0.0052*	0.0025*	0.0026*	0.011*	0.0032*	0.0016*	-	-
TDCPP	EPA 1694M-ESI+	0.001	0.0011	0.0031	ND	0.0038	ND	ND	_	_
Trimethoprim	EPA 1694M-ESI+	0.001	ND	ND	ND	ND	ND	ND	-	-

Table D-1N: Pharmaceutical and Personal Care Products (PPCPs) (continued)

Notes:

Laboratory analytical data sheets reported detected values in ng/L; converted to µg/L.

* Detected in laboratory blank sample

NA = Not analyzed for FO-7 Shallow because laboratory instrumental problems resulted in unsuccessful runs; insufficient sample volume remaining for re-analysis.

Table D-10: Radiogenic

Analyte	Method	DL	City of Seaside 4	FO-7 Deep**	FO-7 Shallow**	MRWPCA MW-1**	PRTIW Mission Memorial	ASR MW-1	Re Re	egulatory quirement
						pCi/L				Туре
Gross Alpha	7110B	3.00	0.29±0.39	3.0±0.5	125±5	6.3±1.2	8.7±1.2	2.8±1.1	15	CPMCL-EPMCL
Gross Beta	7110B	4.0	1.4±0.5	4.5±0.5	114±2	7.5±1.1	8.8±0.9	5.6±1.0	50	CPMCL-EPMCL
Radium 226	7500-RaB	1.00	0.48±0.46	0.47±0.43	22±2.2	0.62±0.31	1.9±0.9	0.73±0.42	††	_
Radium 228	7500-Ra D	1.00	0.11±0.38	0.44±0.38	16.3±1.2	-0.08±0.51	2.2±07	0.45±0.45	††	-
Combined Radium	calculated	1.00	0.59±	0.91±0.57	38.3±2.4	0.54±0.60	4.1±0.7	1.18±0.62	5 ††	CPMCL-EPMCL
Strontium 90	905.0	2.00*	0.339±0.692	-0.439±0.720	0.748±1.140	0.090±1.070	-1.27±0.850	-0.883±0.948	8	CPMCL-EPMCL
Tritium***	Enriched	-	0.07±0.1 (0.2233)	<1.0 (<3.19)	<1.00 (<3.19)	<1.0 (<3.19)	0.75±0.16 (2.39)	<1.00 (<2.19)	(20,000)	CPMCL
Uranium	200.8	0.080	ND	1.6	0.62	0.33	0.20	1.3	20/30†	CPMCL/EPMCL†

Notes:

* MRL for strontium 90

** Turbid sample

*** Tritium (enriched) reported in tritium units (TU) where 1.0 TU = 3.19 pCi/L. Values in parenthesis are in pCi/L.

† In micrograms per liter (μg/L)

tt MCL for combined concentrations of Radium 226 and Radium 228

		Wate	r (H₂O)			Nitrat	e (NO₃⁻)	
Sample	δ ¹⁸	0	δ	C	δ1	⁵N	δ1	°O
	‰	1σ	‰	1σ	‰	1σ	‰	1σ
Monitoring Wells:								
City of Seaside 4	-6.62	0.06	-44.27	0.32	1.4	0.2	0.7	0.4
FO-7 Deep	-7.18	0.06	-48.55	0.32	*	0.2	*	0.4
FO-7 Shallow	-6.36	0.06	-45.44	0.32	8.7	0.2	4.2	0.4
MRWPCA MW-1	-6.56	.0.06	-43.87	0.32	8.9	0.2	4.4	0.4
PRTIW Mission Memorial	-6.14	0.06	-40.68	0.32	2.5	0.2	1.3	0.4
ASR MW-1	-6.4	0.06	-45.90	0.32	*	0.2	*	0.4

Table D-1P: Stable Isotopes in Water and Nitrate

Notes:

* Analysis did not produce a reliable compound specific isotope analysis (CSIA) value.

 δD = ratio of deuterium to hydrogen (D/H) against Vienna Standard Mean Ocean Water (VSMOW) standard δ^{18} O = ratio of 1⁸O/¹⁶O against VSMOW standard δ^{15} N = ratio of 1⁵N/¹⁴N against standard of nitrogen in air

‰ = per mil or parts per thousand

 1σ = analytical precision of one sigma

General Notes for Tables D-1A to D-1P:

Samples collected from January 29-30, 2014 and February 3, 2014; received and analyzed, unless otherwise noted, by Alpha Analytical Laboratory, Inc., Ukiah, CA

- (dash) = no data reported

EPA = U.S. Environmental Protection Agency

CPMCL = California Department of Public Health (CDPH) Primary Maximum Contaminant Level

CSMCL = California Department of Public Health (CDPH) Secondary Maximum Contaminant Level DWEL = U.S. EPA Drinking Water Equivalent Level; advisory only and not to be construed as legally

enforceable Federal standards.

EPMCL = U.S. Environmental Protection Agency Primary Maximum Contaminant Level

ESMCL = U.S. Environmental Protection Agency Secondary Maximum Contaminant Level

NL = CDPH Notification Level – advisory in nature and not an enforceable standard

California MCL for Gross Beta = 50 pCi/L; U.S. EPA Primary MCL (EPMCL) = 4 millirems per year (mrem/yr) CU = Color Units

MFL = Millions of fibers per liter

 μ g/L = micrograms per liter or parts per billion (ppb)

µS/cm = microSiemans per centimeter (formerly µmohs/cm)

mg/L = milligrams per liter or parts per million (ppm)

pg/L = picograms per liter or parts per quadtrillion (ppq)

pCi/L = picoCuries per liter

TU = tritium units

NTU = Nephelometric Turbidity Units

SM = Standard Method

MFL = Millions of fibers per liter

MRL = Minimum Reporting Limit

ND = Not detected or below MRL

TEM = Transmission Electron Microscope

APPENDIX E

Source Water Sampling Program Water Quality Data Summary

Sampling Constituent	Contaminant List	Analytical	Units	DDW	RTP Efflu	ent	Ag Wash	Water	Blanco D	rain	Lake El E	istero	Tembladero
		Method		MCL/NL	Median (Range)	Detected / Measured	Median (Range)	Detected / Measured	Median (Range)	Detected / Measured	Median (Range)	Detected / Measured	Slough
General Water Quality Parameters		I											
Aggressiveness index		SM2330	-		12.4 (12-12.4)	4/4	11.6 (11.3-12)	3/3	13.3 (13.2-14)	4/4	13.0 (12.8-13.1)	2/2	13.3
Alkalinity (in CaCO3 units)		SM 2330B	mg/L		316 (277-344)	12 / 12	168 (157-260)	3/3	356 (327-373)	4/4	185 (157-212)	2/2	363
-Bicarbonate alkalinity as HCO3		SM 2330B	mg/L		384 (338-420)	9/9	205 (192-310)	3/3	427 (399-455)	4/4	226 (192-259)	2 / 2	443
Ammonia as N		SM 4500NH3F,G	mg/L		32.6 (31.3-39.7)	11 / 11	5.0 (2.4-7.5)	2 / 2	(<0.05-<0.5)	1/3	<0.05	0 / 1	<0.5
Anion sum		SM 1030E	meq/L		14.49 (14.05-15.91)	9/9	16 (13.51-16.1)	3/3	30.36 (17.46-30.89)	4/4	15.18	1/1	
BOD, 5-day @ 20°C		SM 5210B	mg/L	-	84 (10-160)	12 / 12	483 (56-656)	10 / 10	<2 (<2 -5)	4 / 11	14	1/1	<2
Bromide		EPA 300.0	mg/L		<0.2 (<0.1- 0.5)	10 / 11	<0.2 (<0.1- 4.6)	6/9	1.9 (1.2-2.9)	10 / 10	0.6	1/1	2.5
Calcium		EPA 200.7	mg/L		58 (54-62)	12 / 12	81 (76-100)	10 / 10	155 (128-169)	11 / 11	100 (77-122)	2 / 2	166
Cation sum		SM 1030E	meq/L		14.19 (13-15.28)	9/9	18 (15.25-18.01)	3/3	28.87 (19.32-30.18)	4/4	14.2	1/1	
Chemical Oxygen Demand (COD)		EPA 410.4/Hach 8000	mg/L		110 (33-158)	12 / 12	1004 (250-1152)	10 / 10	48 (<5-163)	9 / 11	92	1/1	23
Chloride	sMCL	EPA 300.0	mg/L	250	217 (183-235)	12 / 12	237 (154-292)	9/9	274 (241-307)	10 / 10	423 (332-514)	2 / 2	394
Color	sMCL	SM 2120B	units	15	60 (45-75)	4/4	170 (150-175)	3/3	73 (45-85)	4/4	75	1/1	175
Conductivity (Specific Conductance)	sMCL	SM 2510B	µS/cm	900	1578 (1508-1623)	12 / 12	1625 (1279-1830)	10 / 10	2861 (2647-2929)	11 / 11	2083 (1607-2559)	2/2	2939
Copper	sMCL, EPA PP	EPA 200.8	mg/L	1.3/1.0	<0.0095 (0.009 -<0.01)	2/4	0.012 (<0.01-0.073)	2/3	<0.01 (<0.01 -0.013)	2/4	<0.009 (0.008 -<0.01)	1 / 2	<0.01
Dissolved organic carbon (DOC)		SM 5310C	mg/L		14 (12-14)	10 / 10	280 (100-320)	9/9	3.2 (2.6-8.2)	10 / 10	11	1/1	7.9
Dissolved oxygen (DO)		Field/SM4500-O	mg/L		7.6 (5.8-10.5)	11 / 11	7.9 (3.9-8.5)	9/9	9.5 (6.9-13.3)	10 / 10	10.9	1/1	6.8
Foaming Agents (MBAS)	sMCL	SM 5540C	mg/L	0.5	0.17 (0.16-0.18)	2/2	0.066 (0.05-0.082)	2/3	0.11 (0.07-0.14)	2/2		0 / 1	
Iron	sMCL	EPA 200.7	mg/L	0.3	0.339 (0.175-0.537)	12 / 12	0.43 (0.3-0.875)	3/3	1.563 (0.639-3.891)	4/4	0.355 (0.202-0.508)	2 / 2	2.962
Langelier index (15C)		SM 2330B	-		0.44 (0.41-0.48)	4/4	0.34	1/1	1.22 (1.07-1.9)	4/4	1.22 (1.06-1.37)	2 / 2	
Magnesium		EPA 200.7	mg/L		22 (20-24)	12 / 12	34 (28-39)	4/4	146 (140-177)	5/5	42 (32-52)	2/2	159
Manganese	sMCL, NL	EPA 200.8	mg/L	0.5/0.5	0.045 (0.034-0.051)	12 / 12	0.049 (0.039-0.051)	3/3	0.243 (0.06-0.449)	4/4	0.281 (0.219-0.342)	2/2	0.108
Nitrate (as NO3)	pMCL	EPA 300.0	mg/L	45	21.5 (<1-42)	11 / 12	22.5 (<1.1 -28)	9 / 10	292 (70.3-352)	11 / 11	<1	0 / 2	255
Nitrite (as N)	pMCL	EPA 300.0	mg-N/L	1	1.4 (0.4-2.2)	12 / 12	0.6 (<0.1 -1.5)	3 / 5	0.3 (0.2-0.8)	6/6	<0.1	0 / 2	0.5
Nitrate+Nitrite (sum as N)	pMCL	EPA 300.0	mg-N/L	10	6.5 (2.3-11)	11 / 11	6.2 (<0.1-7.7)	4 / 5	69.6 (63-77.3)	6/6	<0.1 (<0.1 -0.1)	1 / 2	58
Odor-Threshold	sMCL	SM 2150B	units	3	19 (8-200)	4/4	300 (200-350)	3/3	7 (2-40)	4/4	2	1/1	2
Oil and Grease		EPA 1664	mg/L		<5	0 / 4	<5 (<5 -7)	1/3	<5	0 / 4	<5	0 / 1	
pH		SM 2330B/SM4500H +B	pН		7.75 (7.34-8)	12 / 12	6.95 (6.46-7.3)	10 / 10	8.1 (7.7-8.6)	11 / 11	8.3	2/2	8
Phosphate (Orthophosphate as P)		EPA 300.0	mg/L		3.1 (2.2-13)	11 / 11	15.8 (3.1-47.2)	9/9	<0.1 (<0.1 -0.2)	2 / 10	<0.1	0 / 2	<0.1
Potassium		EPA 200.7	mg/L		21 (19-23)	12 / 12	36 (32-42)	5/5	2.3 (1-2.7)	6/6	7.8 (6.2-9.3)	2/2	4.9
Sampling Constituent	Contaminant List	Analytical	Units	DDW	RTP Efflue	ent	Ag Wash	Water	Blanco D	rain	Lake El E	stero	Tembladero
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		Method		MCL/NL	Median (Range)	Detected / Measured	Median (Range)	Detected / Measured	Median (Range)	Detected / Measured	Median (Range)	Detected / Measured	Slough
Settleable Solids		SM 2540F	mL/L		<0.1 (<0.1- 0.2)	2/4	0.7 (<0.1-1.75)	2/3	<0.1 (<0.1 -0.2)	1/4	<0.1	0 / 1	<0.1
Silica		EPA 200.7	mg/L		40.5 (39-44)	12 / 12	44 (41-48)	10 / 10	29 (26-63)	11 / 11	<0.5	0 / 1	30
Silver	sMCL, EPA PP	EPA 200.8	mg/L	0.1	<0.01	0 / 4	<0.01	0/3	<0.01	0/4	<0.01	0 / 2	<0.01
Sodium		EPA 200.7	mg/L		161 (144-173)	12 / 12	177 (133-201)	9/9	241 (196-266)	10 / 10	235 (174-296)	2/2	333
Sulfate	sMCL	EPA 300.0	mg/L	250	89 (83-151)	12 / 12	170 (153-172)	3/3	523 (498-530)	4/4	157 (127-186)	2/2	412
Temperature		Field/SM 2550B	°C		12.3 (6.1-25.8)	10 / 11	12.9 (7.7-16)	9/9	15.5 (9.7-25)	10 / 10	19	1/1	18
Total Dissolved Solids (TDS)	sMCL	EPA 160.1/SM 2540C	mg/L	500	793 (771-803)	12 / 12	1282 (797-1591)	10 / 10	2003 (1822-2066)	11 / 11	1226 (946-1506)	2/2	1968
Total hardness as CaCO3		SM 2340B	mg/L		233 (220-250)	10 / 10	358 (318-420)	4/4	981 (908-1118)	5/5	422 (324-519)	2 / 2	1069
Total Kjehldahl Nitrogen (TKN)		EPA 351.2/SM 4500B,C	mg/L		37.2 (23.8-42.7)	12 / 12	19.5 (12.5-43.6)	10 / 10	<0.5 (<0.2 -8.8)	4 / 11	1.2	1/1	<1
Total Nitrogen		calculation	mg/L		44.2 (26.6-50.5)	12 / 12	25.3 (19-51.1)	5/5	70.1 (63-77.3)	6/6	1.3	1/1	58
Total Organic Carbon (TOC)		SM 5310C	mg/L		15 (12-17)	12 / 12	295 (66-340)	10 / 10	3 (2.5-11)	11 / 11	14	1/1	8.8
Total Phosphorus as P		SM 4500- PE/EPA 365.1	mg/L		3.9 (3.4-4.3)	4 / 4	45 (6.9-45)	3/3	0.36 (0.3-0.66)	4/4	0.39	1/1	0.82
Dissolved Phosphorus		SM 4500- PE/EPA 365.1	mg/L		4.1 (3.4-8.6)	4 / 4	17 (6.4-27)	2 / 2	0.27 (0.26-0.47)	3/3	0.26	1/1	0.65
Total Suspended Solids (TSS)		SM 2540D	mg/L		<6 (9 -<10)	11 / 12	98 (54-140)	10 / 10	48 (16-335)	11 / 11	18	1/1	62
Turbidity	sMCL	EPA 180.1	NTU	5	3.2 (1.5-4.8)	12 / 12	51 (28-72)	10 / 10	28 (7.1-150)	11 / 11	15 (12-18)	2/2	50
UV-254 Absorbance		SM 5910	cm ⁻¹		0.208 (0.189-0.226)	12 / 12	0.278 (0.207-0.488)	3/3	0.225 (0.198-0.253)	4/4	0.279	1/1	0.318
UV Transmittance		calculation	%		62% (59%-65%)	12 / 12	53% (33%-62%)	3/3	60% (56%-63%)	4/4	0.526	1/1	48.10%
Zinc	sMCL, EPA PP	EPA 200.8	mg/L	5	<0.018 (0.016 -<0.05)	1/4	0.112 (0.062-0.135)	3/3	(<0.01-<0.05)	1/4	0.032 (0.022-0.042)	2 / 2	
Microbiological Quality													
Cryptosporidium	-	EPA 1623	oocysts/L	тт	0.39 (<0.10-0.9)	3 / 4	<0.38	0/3	<0.19 (<0.18-0.2)	1/4	<0.3	0 / 1	<0.09
Giardia		EPA 1623	cysts/L	-	<0.1 (<0.1-0.2)	1/4	<0.38	0/3	<0.18	0 / 4	<0.3	0 / 1	<0.09
Total coliform ¹	pMCL	SM 9223B	MPN/100mL	тт	7.3x10 ⁶	9 / 11	7.7x10 ⁶ (6.2x10 ⁵ -9.6x10 ⁷)	2/3	7.3x10 ⁴ (8.4x10 ³ -2.0x10 ⁶)	4/4	3.5x10 ³	1/1	1.7x10⁵
E. coli ¹	pMCL	SM 9223B	MPN/100mL	тт	1.8x10 ⁵	11 / 11	$<2x10^{1}$ (1 8×10 ¹ -<1 0×10 ²)	1/3	2.7x10 ² (7.5x10 ¹ -2.0x10 ³)	4/4	<1.0x10 ²	0 / 1	7.5x10 ²
Enterococcus ¹	-	SM 9230B	MPN/100 mL	-	1.95x10 ⁴	4/4	<2x10 ¹	2/3	1.6x10 ²	4/4	2.0x10 ²	1/1	8.4x10 ¹
DDW Drinking Water Maximum Con	taminant Levels (MCLs)	primary MCLs (p	MCLs) and s	econdary MC	CLs (sMCLs)		12.0210		(1.0210-2.2210)				
MCLs Inorganics	-												-
Aluminum	pMCL, sMCL, EPA CCL	EPA 200.8	mg/L	1/0.2	0.048 (0.021-0.256)	10 / 11	0.237 (0.14-0.598)	3/3	0.77 (0.26-2.04)	4/4	0.296 (0.189-0.402)	2/2	1.54
Antimony	pMCL, EPA PP	EPA 200.8	mg/L	0.006	<0.001	0 / 4	<0.001	0/3	<0.001	0/4	<0.001 (<0.001 -0.001)	1 / 2	0.001
Arsenic	pMCL, EPA PP	EPA 200.8	mg/L	0.01	0.0025 (0.002-0.0041)	4 / 4	0.0039 (0.003-0.004)	3/3	0.0075 (0.007-0.0085)	4/4	0.004	2/2	0.011
Asbestos	pMCL, EPA PP	EPA 100.2	MFL	7	<6.4 (<4.02-<6.8)	0 / 4	<6.4 (<4.02-<6.8)	0/3	<6.4 (<4.02-<6.8)	0/4	1	1/1	<6.7
Barium	pMCL	EPA 200.8	mg/L	1	0.012 (0.011-0.026)	4 / 4	0.096 (0.082-0.109)	3/3	0.068 (0.054-0.079)	4/4	0.086 (0.065-0.107)	2/2	0.119
Beryllium	pMCL, EPA PP	EPA 200.8	mg/L	0.004	<0.001	0 / 4	<0.001	0/3	<0.001	0/4	<0.001	0 / 2	<0.001

Sampling Constituent	Contaminant List	Analytical	Units	DDW	RTP Efflu	ent	Ag Wash	Water	Blanco D	rain	Lake El E	istero	Tembladero
		Method		MCL/NL	Median (Range)	Detected / Measured	Median (Range)	Detected / Measured	Median (Range)	Detected / Measured	Median (Range)	Detected / Measured	Slough
Cadmium	pMCL, EPA PP	EPA 200.8	mg/L	0.005	<0.0005	0 / 4	<0.0005 (<0.0005 -0.002)	1/3	<0.0005	0 / 4	<0.0005 (<0.0005 -0.0005)	1/2	<0.0005
Chromium	pMCL, EPA PP, UCMR 3	EPA 200.8	mg/L	0.05	0.0016 (0.00092-0.003)	4/4	0.009 (0.0049-0.01)	3 / 3	0.0046 (0.0017-0.019)	4 / 4	0.0025 (0.002-0.003)	2 / 2	0.019
Cyanide	pMCL, EPA PP	SM 4500CN-F	mg/L	0.15	0.049 (0.006-0.13)	4/4	0.075 (0.011-0.089)	3/3	<0.005 (<0.005 -0.127)	1/4	<0.005	0 / 1	<0.005
Fluoride	pMCL	SM 4500F-C/EPA 300.0	mg/L	2	0.6 (0.4-0.8)	4/4	0.3 (<0.1-31.9)	2 / 3	0.7 (0.66-0.9)	4 / 4	0.3	2/2	0.7
Mercury	pMCL, EPA PP	EPA 245.1	mg/L	0.002	<0.0002	0 / 4	<0.0002	0/3	<0.0002	0 / 4	<0.0002	0 / 2	<0.0002
Nickel	pMCL, EPA PP	EPA 200.8	mg/L	0.1	<0.01	0/4	<0.01 (<0.01 -0.01)	1/3	0.025 (0.02-0.038)	4/4	<0.0085 (0.007- <0.01)	1 / 2	0.034
Perchlorate	pMCL, UCMR 1	EPA 314	mg/L	0.006	<0.002	0/4	<0.002	0/3	<0.002	0/4	<0.002	0/1	<0.002
Selenium	pMCL, EPA PP	EPA 200.8	mg/L	0.05	0.0025 (0.002-<0.005)	3/4	<0.005 (<0.005 -0.005)	2 / 3	0.013 (0.0092-0.018)	4/4	0.0055 (0.005-0.006)	2 / 2	0.015
Thallium	pMCL, EPA PP	EPA 200.8	mg/L	0.002	<0.001	0/4	<0.001	0/3	<0.001 (<0.001- 0.001)	1/4	<0.001	0 / 2	<0.001
MCLs - Volative Organic Chemicals	(VOCs)						•						•
1,1-Dichloroethane	pMCL, EPA PP, UCMR 3	EPA 524.2	µg/L	5	<0.5	0 / 4	<0.5	0/3	<0.5	0 / 4	<0.5	0 / 1	<0.5
1,1-Dichloroethylene	pMCL, EPA PP	EPA 524.2	µg/L	6	<0.5	0/4	<0.5	0/3	<0.5	0/4	<0.5	0/1	<0.5
1,1,1-Trichloroethane	pMCL, EPA PP	EPA 524.2	µg/L	200	<0.5	0/4	<0.5	0/3	<0.5	0/4	<0.5	0/1	<0.5
1,1,2-Trichloro-1,2,2-Trifluoroethane (Freon 113)	pMCL	EPA 524.2	µg/L	1,200	<0.5	0/4	<0.5	0/3	<0.5	0/4	<0.5	0 / 1	<0.5
1,1,2-Trichloroethane	pMCL, EPA PP	EPA 524.2	µg/L	5	<0.5	0/4	<0.5	0/3	<0.5	0/4	<0.5	0/1	<0.5
1,1,2,2-Tetrachloroethane	pMCL, EPA PP	EPA 524.2	µg/L	1	<0.5	0/4	<0.5	0/3	<0.5	0/4	<0.5	0/1	<0.5
1,2-Dichlorobenzene	pMCL, EPA PP	EPA 524.2	µg/L	600	<0.5	0/4	<0.5	0/3	<0.5	0 / 4	<0.5	0 / 1	<0.5
1,2-Dichloroethane	pMCL, EPA PP	EPA 524.2	µg/L	0.5	<0.5	0 / 4	<0.5	0/3	<0.5	0 / 4	<0.5	0/1	<0.5
1,2-Dichloropropane	pMCL, EPA PP	EPA 524.2	µg/L	5	<0.5	0/4	<0.5	0/3	<0.5	0 / 4	<0.5	0 / 1	<0.5
1,2,4-Trichlorobenzene	pMCL, EPA PP	EPA 524.2	µg/L	5	<0.5	0 / 4	<0.5	0/3	<0.5	0 / 4	<0.5	0 / 1	<0.5
1,3-Dichloropropene	pMCL, PoLI, EPA PP	EPA 524.2	µg/L	0.5	<0.5	0 / 4	<0.5 (<0.5 -0.7)	1/3	<0.5 (<0.5 -0.62)	1/4	<0.5	0 / 1	<0.5
1,4-Dichlorobenzene	pMCL, EPA PP	EPA 524.2	µg/L	5	<0.5	0 / 4	<0.5	0/3	<0.5	0 / 4	<0.5	0/1	<0.5
Benzene	pMCL, EPA PP	EPA 524.2	µg/L	1	<0.5	0 / 4	<0.5	0/3	<0.5	0 / 4	<0.5	0 / 1	<0.5
Carbon Tetrachloride	pMCL, EPA PP	EPA 524.2	µg/L	0.5	<0.5	0 / 4	<0.5 (<0.5 -0.52)	1/3	<0.5	0 / 4	<0.5	0 / 1	<0.5
cis-1,2-Dichloroethylene	pMCL	EPA 524.2	µg/L	6	<0.5	0 / 4	<0.5	0/3	<0.5	0 / 4	<0.5	0/1	<0.5
Dichloromethane	pMCL, EPA PP	EPA 524.2	µg/L	5	<0.5	0 / 4	<0.5 (<0.5 -0.94)	1/3	<0.5	0 / 4	<0.5	0 / 1	<0.5
Ethylbenzene	pMCL, EPA PP	EPA 524.2	µg/L	300	<0.5	0/4	<0.5	0/3	<0.5	0 / 4	<0.5	0/1	<0.5
Methyl-tert-butyl ether (MTBE)	pMCL, sMCL, UCMR 1	EPA 524.2	µg/L	13	<0.5	0/4	<0.5	0/3	<0.5	0/4	<0.5	0/1	<0.5
Monochlorobenzene	pMCL	EPA 524.2	µg/L	70	<0.5	0/4	<0.5	0/3	<0.5	0 / 4	<0.5	0/1	<0.5
Styrene	pMCL	EPA 524.2	µg/L	100	<0.5	0/4	<0.5	0/3	<0.5	0/4	<0.5	0/1	<0.5
Tetrachloroethylene	pMCL, EPA PP	EPA 524.2	µg/L	5	<0.5	0/4	<0.5	0/3	<0.5	0/4	<0.5	0/1	<0.5
Toluene	pMCL, EPA PP	EPA 524.2	µg/L	150	<0.5	0/4	<0.5	0/3	<0.5	0 / 4	<0.5	0/1	<0.5
trans-1,2-Dichloroethylene	pMCL	EPA 524.2	µg/L	10	<0.5	0/4	<0.5	0/3	<0.5	0/4	<0.5	0/1	<0.5
Trichloroethylene	pMCL, EPA PP	EPA 524.2	µg/L	5	<0.5	0/4	<0.5	0/3	<0.5	0/4	<0.5	0/1	<0.5
Trichlorofluoromethane	pMCL	EPA 524.2	µg/L	150	<0.5	0/4	<0.5	0/3	<0.5	0/4	<0.5	0/1	<0.5
Vinyl Chloride	pMCL, EPA PP	EPA 524.2	µg/L	0.5	<0.3	0/4	<0.3	0/3	<0.3	0/4	<0.3	0/1	<0.3
xyienes	pMCL	EPA 524.2	µg/L	1,750	<0.5	0/4	<0.5	0/3	<0.5	0/4	<0.5	0/1	<0.5
MCLs - Non-Volatile Synthetic Organ	nic Chemicals (SOCs)	, , , , , , , , , , , , , , , , , , ,			0.00	1				1			
2,4-D	pMCL	EPA 515.4	µg/L	70	0.29 (<0.1 -0.78)	2/4	<0.1	0/3	<0.1	0 / 4	<0.1	0 / 1	<0.1
Alachlor	pMCL, UCMR 2	EPA 505	µg/L	2	<0.1	0/4	<0.1	0/3	<0.1	0/9	<0.1	0/1	<0.05

Sampling Constituent	Contaminant List	Analytical	Units	DDW	RTP Efflue	ent	Ag Wash	Water	Blanco D	rain	Lake El E	stero	Tembladero
		Method		MCL/NL	Median (Range)	Detected / Measured	Median (Range)	Detected / Measured	Median (Range)	Detected / Measured	Median (Range)	Detected / Measured	Slough
Atrazine	pMCL	EPA 525.2	µg/L	1	<0.05	0 / 4	<0.05	0/3	<0.05	0 / 4	<0.05	0 / 1	<0.05
Bentazon	pMCL	EPA 515.4	µg/L	18	<0.5	0 / 4	<0.5	0/3	<0.5	0/4	<0.5	0/1	<0.5
Benzo(a)pyrene	pMCL, EPA PP	EPA 525.2	µg/L	0.2	<0.02	0 / 4	<0.02	0/3	<0.02	0/4	<0.02	0/1	<0.02
Carbofuran	pMCL	EPA 531.2	µg/L	18	<0.5	0/4	<0.5	0/3	<0.5	0/4	<0.5	0/1	<0.5
Chlordane	pMCL, EPA PP	EPA 505	µg/L	0.1	<0.1	0 / 4	<0.1	0/3	<0.1	0/9	<0.1	0/1	<0.1
Chlordane	pMCL, EPA PP	EPA 608	µg/L	0.1			<0.05	0 / 1	<0.05	0 / 1	<0.05	0 / 1	<0.05
Dalapon	pMCL	EPA 515.4	µg/L	200	<1	0 / 4	<1	0/3	<1	0/4	<1	0/1	<1
Di(2-ethylhexyl)adipate	pMCL	EPA 525.2	µg/L	400	<0.6	0 / 4	<0.6 (<0.6- 0.95)	1/3	<0.6	0 / 4	<0.6	0 / 1	<0.6
Di(2-ethylhexyl)phthalate	pMCL, EPA PP	EPA 525.2	µg/L	4	1.5 (1-78)	4/4	3.2 (<0.6-5.9)	2/3	<0.6	0 / 4	<0.6	0 / 1	78
Di(2-ethylhexyl)phthalate	pMCL, EPA PP	EPA 8720C	µg/L	4	<4	0 / 4	10 (<4-16)	2/3	<4	0 / 4	<4	0 / 1	<4
Dibromochloropropane	pMCL	EPA 551.1	µg/L	0.2	<0.01	0 / 4	<0.01	0/3	<0.01	0/4	<0.01	0 / 1	<0.01
Dinoseb	pMCL	EPA 515.4	µg/L	7	<0.2	0 / 4	<0.2	0/3	<0.2	0/4	<0.2	0 / 1	<0.2
Diquat	pMCL, PoLI	EPA 549.2	µg/L	20	<0.4	0 / 4	<0.4	0/3	<0.4	0/4	<0.4	0 / 1	<0.4
Endothall	pMCL	EPA 548.1	µg/L	100	<20	0 / 4	<20	0/3	<20	0/4	<20	0 / 1	<20
Endrin	pMCL	EPA 505	µg/L	2	<0.01	0 / 4	<0.01	0/3	<0.01	0/9	<0.01	0/1	<0.01
Ethylene Dibromide	pMCL	EPA 551.1	µg/L	0.05	<0.01	0/4	<0.01	0/3	<0.01	0 / 4	<0.01	0/1	<0.01
Glyphosate	pMCL, PoLI	EPA 547	µg/L	700	<6	0 / 4	<6	0/3	7.5 (<6-9.2)	2/4	<6	0 / 1	<6
Heptachlor	pMCL, EPA PP	EPA 505	µg/L	0.01	<0.01	0 / 4	<0.01	0/3	<0.01	0/9	<0.01	0 / 1	<0.01
Heptachlor Epoxide	pMCL, EPA PP	EPA 505	µg/L	0.01	<0.01	0 / 4	<0.01	0/3	<0.01	0/9	<0.01	0 / 1	<0.01
Hexachlorobenzene	pMCL	EPA 525.2	µg/L	1	<0.05	0 / 4	<0.05	0/3	<0.05	0 / 4	<0.05	0 / 1	<0.05
Hexachlorocyclopentadiene	pMCL	EPA 525.2	µg/L	50	<0.05	0 / 4	<0.05	0/3	<0.05	0/4	<0.05	0 / 1	<0.05
Lindane	pMCL, PoLI	EPA 505	µg/L	0.2	<0.01	0 / 4	<0.01	0/3	<0.01	0/9	<0.01	0 / 1	<0.01
Methoxychlor	pMCL	EPA 505	µg/L	30	<0.05	0 / 4	<0.05	0/3	<0.05	0/9	<0.05	0 / 1	<0.05
Methoxychlor	pMCL	EPA 608	µg/L	30			<0.01	0 / 1	<0.01	0/1	<0.01	0 / 1	<0.01
Molinate	pMCL, UCMR 1	EPA 525.2	µg/L	20	<0.1	0 / 4	<0.1	0/3	<0.1	0/4	<0.1	0 / 1	<0.1
Oxamyl	pMCL, PoLI	EPA 531.2	µg/L	50	<0.5	0 / 4	<0.5	0/3	<0.5 (<0.5 -2.4)	1/4	<0.5	0 / 1	<0.5
Pentachlorophenol	pMCL, EPA PP	EPA 515.4	µg/L	1	<0.04	0 / 4	<0.04	0/3	<0.04 (<0.04 -0.06)	1/4	0.06	1/1	<0.04
Picloram	pMCL	EPA 515.4	µg/L	500	<0.1	0/4	<0.1	0/3	<0.1	0/4	<0.1	0/1	<0.1
Polychlorinated Biphenyls	pMCL	EPA 505	µg/L	0.5	<0.1	0/4	<0.1	0/3	<0.1	0/7	<0.1	0/1	<0.1
Simazine	pMCL, PoLI	EPA 525.2	µg/L	4	<0.05	0/4	<0.05	0/3	<0.05	0 / 4	<0.05	0/1	<0.05
Thiobencarb	pMCL, sMCL, PoLI	EPA 525.2	µg/L	70	<0.2	0/4	<0.2	0/3	<0.2	0/4	<0.2	0/1	<0.2
Toxaphene	pMCL, EPA PP	EPA 505	µg/L	3	<0.5	0/4	<0.5	0/3	<0.5	0/8	<0.5	0/1	<0.5
2,3,7,8-TCDD (Dioxin)	pMCL, EPA PP	EPA 1613	µg/L	3.00E-05	<2.1E-06	0/4	<1.90E-06	0/3	<1.9E-06	0/4	<1.9E-06	0/1	<1.9E-06
2,4,5-TP (Silvex)	pMCL	EPA 515.4	µg/L	50	<0.2	0/4	<0.2	0/3	<0.2	0/4	<0.2	0/1	<0.2
MCLs - Radionuclides Gross Alpha Particle (excluding radon and uranium)	pMCL	EPA 900.0	pCi/L	15	<2.02±0.95 (<1.35±0.828- 4.55±2.07)	1/4	2.4±1.3 (<2.07±1.27- 6.32±2.64)	2/3	8.9±2.21 (4.47±2.21- 9.62+2.47)	4/4	2.15±1.33	1/1	1.81±5.89
Gross Beta			pCi/L	4 mrem/yr	15±4.5 (14.9±1.59-16±2.45)	4/4	21±2.3 (17.6±2.09- 25±2.41)	2/2	3.8±3.0 (<3±3.7-4.68±2.29)	1 / 2	15.2±2.05	1/1	<6.110±3.66
Radium-226	pMCL	EPA 903.1	pCi/L	5	<0.906±0.364 (0.318±0.38 - <0.94±0.552)	1/4	(<0.764±0.479-<0.827±0.487)	0/3	(<0.51±0.374- <0.923±0.398)	0 / 4	<0.784±0.549	0/1	<0.602±0.311
Radium-228	pMCL	EPA 904.0	pCi/L	(Combined)	(<0.82±0.388- <0.971±0.484)	0 / 4	<0.95±0.403 (<0.671±0.333- 0.95±0.504)	1/3	(<0.609±0.266- <0.976±0.439)	0 / 4	<0.814±0.394	0 / 1	<0.991±0.452
Strontium-90	pMCL	EPA 905.0	pCi/L	8	(<0.38±0.204- <1.44±0.569)	0 / 4	(<0.545±0.29- <1.26±0.584)	0/3	(<0.756±0348- <1.7±0.872)	0/4	<0.571±0.225	0 / 1	<0.738±0.409

Sampling Constituent	Contaminant List	Analytical	Units	DDW	RTP Efflue	ent	Ag Wash	Water	Blanco D	rain	Lake El E	stero	Tembladero
		Methoa		WICL/NL	Median (Range)	Detected / Measured	Median (Range)	Detected / Measured	Median (Range)	Detected / Measured	Median (Range)	Detected / Measured	Slough
Tritium	pMCL	EPA 906.0	pCi/L	20,000	(<193±112-<222±127)	0 / 4	(<204±107- <215±118)	0/3	(<213±115- <217±129)	0 / 4	<230±126	0 / 1	<225±124
Uranium	pMCL	EPA 900.0	pCi/L	20	2.15 (1.9-2.4)	4 / 4	5.7 (3.2-6.7)	3/3	12.5 (11-13)	4/4	1.4	1/1	10
MCLs - Disinfection By-Products (DB	BPs)								1				
Bromate	pMCL	EPA 317	µg/L	10	<1	0 / 4	<1	0/3	<1	0/4	<1	0/1	<1
Chlorite	pMCL	EPA 300.1	µg/L	1,000	<10	0 / 4	<10	0/3	<10	0/4	<10	0 / 1	<10
Total Haloacetic acids (HAAs)	pMCL	SM6251B	µg/L	60	3.7 (2.4-4.4)	4/4	200 (62-390)	3/3	<2	0 / 4	<2	0 / 1	2.6
Total trihalomethanes (TTHM)	pMCL	EPA 551.1	µg/L	80	<0.5 (<0.5 -0.82)	1/4	63 (2.6-160)	3 / 3	<0.5	0 / 4	<0.5	0 / 1	<0.5
DDW Drinking Water Notification Lev	vels												
Boron	NL	EPA 200.7	µg/L	1,000	300 (290-350)	4 / 4	210 (190-290)	3/3	670 (590-700)	4/4	180 (110-240)	2/2	510
n-Butylbenzene	NL	EPA 524.2	µg/L	260	<0.5	0 / 4	<0.5	0/3	<0.5	0 / 4	<0.5	0/1	<0.5
sec-Butylbenzene	NL, EPA CCL	EPA 524.2	µg/L	260	<0.5	0 / 4	<0.5	0/3	<0.5	0/4	<0.5	0/1	<0.5
tert-Butylbenzene	NL	EPA 524.2	µg/L	260	<0.5	0 / 4	<0.5	0/3	<0.5	0/4	<0.5	0 / 1	<0.5
Carbon disulfide	NL	EPA 524.2	µg/L	160	<0.5	0 / 4	<0.5 (<0.5 -0.67)	1/3	<0.5	0 / 4	<0.5	0 / 1	<0.5
Chlorate	NL, UCMR 3	EPA 300.1	µg/L	800	<20	0 / 4	<20 (<20- 420)	1/3	<20	0 / 4	3.9	1/1	<20
2-Chlorotoluene	NL	EPA 524.2	µg/L	140	<0.5	0 / 4	<0.5	0/3	<0.5	0/4	<0.4	0 / 1	<0.5
4-Chlorotoluene	NL	EPA 524.2	µg/L	140	<0.5	0 / 4	<0.5	0/3	<0.5	0/4	<0.5	0/1	<0.5
Diazinon	NL, UCMR 1, PoLI	EPA 525.2	µg/L	1.2	<0.1	0/4	<0.1	0/3	<0.1	0/11	<0.1	0/1	<0.1
Dichlorodifluoromethane (Freon 12)	NL	EPA 524.2	µg/L	1,000	<0.5	0/4	<0.5	0/3	<0.5	0/4	<0.5	0/1	<0.5
1,4-Dioxane	NL, UCMR 3	EPA 522	µg/L	1	(<1- 1.2)	4 / 11	<1	0 / 10	<1	0 / 11	<1	0/1	<1
Ethylene glycol	NL	EPA 8270C	µg/L	14,000	<40	0/4	<40	0/3	<40	0/4	<40	0/1	<40
Formaldehyde	NL, EPA CCL	EPA 556	µg/L	100	(9.7-13)	4/4	(6.9-120)	3/3	(<5- 6.3)	1/4	5.3	1/1	<5
HMX (or Octogen)	NL	LC-MS-MS	µg/L	350	<0.1	0/4	<0.1	0/3	<0.1	0/4	<0.1	0/1	<0.1
Isopropylbenzene	NL	EPA 524.2	µg/L	//0	<0.5	0/4	<0.5	0/3	<0.5	0/4	<0.5	0/1	<0.5
Methyl Isobutyl ketone (MIBK)	NL	EPA 524.2	µg/L	120	<5	0/4	<5	0/3	<5	0/4	<5	0/1	<5
N-Nitrosodiethvamine (NDEA)	NL. UCMR 2	EPA 524.2 EPA 521	ng/L	17	<0.3 2.1	2/4	<0.3	1/3	<0.3	0/4	<0.3	0/1	<0.3
N-Nitrosodimethylamine (NDMA)	NL, EPA PP, UCMR 2	EPA 521	ng/L	10	(<2-3.7) 5.1 (20.40)	11 / 11	(<2-3.2) 10	7 / 10	<2	1/11	<2	0/1	<2
N-Nitrosodi-n-propylamine (NDPA)	NL, EPA PP, UCMR 2	EPA 521	ng/L	10	(2.0-16)	1/4	(<2-340) <2	0/3	(<2 -2.4) <2	0/4	<2	0/1	<2
Propachlor	NI	EPA 525 2	ug/l	90	(<2- 6.9)	0/4	<0.05	0/3	<0.05	0/4	<0.05	0/1	<0.05
n-Propylbenzene	NL	EPA 524 2	μg/L μα/Ι	260	<0.00	0/4	<0.5	0/3	<0.00	0/4	<0.00	0/1	<0.00
RDX (Hexahydro-1,3,5-trinitro-1,3,5- triazine)	NL, UCMR 1&2	LC-MS-MS	μg/L	0.3	<0.1	0/4	<0.1	0/3	<0.1	0/4	<0.1	0/1	<0.1
Tertiary butyl alcohol (TBA)	NL	EPA 524.2m	µg/L	12	2.9 (2.6-3.3)	4/4	<2 (<2- 3)	1/3	<2 (<2 -2)	1/4	<2	0 / 1	<2
1,2,3-Trichloropropane (1,2,3-TCP)	NL	EPA 524.2m	µg/L	0.005	< 0.005	0 / 4	<0.005	0/3	<0.005	0/4	<0.005	0/1	<0.005
1,2,4-Trimethylbenzene	NL, EPA PP	EPA 524.2	µg/L	330	<0.5	0 / 4	<0.5	0/3	<0.5	0/4	<0.5	0 / 1	<0.5
1,3,5-Trimethylbenzene	NL	EPA 524.2	µg/L	330	<0.5	0 / 4	<0.5	0/3	<0.5	0 / 4	<0.5	0 / 1	<0.5
2,4,6-Trinitrotoluene (TNT)	NL, UCMR 2	LC-MS-MS	µg/L	1	<0.1	0 / 4	<0.1	0/3	<0.1	0/4	<0.1	0/1	<0.1
Vanadium	NL, UCMR 3	EPA 200.8	µg/L	50	4 (3.4-9.8)	4/4	16 (13-18)	3/3	16 (13-30)	4 / 4	3.3	1/1	21
DDW Drinking Water Archived Advis	ory Levels												
3-Hydroxycarbofuran	EPA CCL 3	EPA 531.2	µg/L		1.5 (1.4-2.1)	4/4	<0.5	0/3	<0.5	0 / 4	<0.5	0 / 1	<0.5

Sampling Constituent	Contaminant List	Analytical	Units	DDW	RTP Efflu	ent	Ag Wash	Water	Blanco D	rain	Lake El E	Estero	Tembladero
		Method		MCL/NL	Median (Range)	Detected / Measured	Median (Range)	Detected / Measured	Median (Range)	Detected / Measured	Median (Range)	Detected / Measured	Slough
Aldicarb	aNL	EPA 531.2	µg/L	7	<0.5	0/4	<0.5	0/3	<0.5	0/4	<0.5	0/1	<0.5
Aldrin	aNL	EPA 505	µg/L	0.002	<0.01	0/4	<0.01	0/3	<0.01	0/8	<0.01	0/1	<0.01
Baygon	aNL	EPA 531.2	µg/L	30	<0.5	0/4	<0.5	0/3	<0.5	0/5	<0.5	0/1	<0.5
alpha-BHC	aNL	EPA 8081A	µg/L	0.015	<0.05	0/4	<0.05	0/3	<0.05	0/4	<0.05	0/1	<0.05
alpha-BHC	aNL	EPA 608	µg/L	0.015			<0.01	0 / 1	<0.01	0/1	<0.01	0/1	<0.01
beta-BHC	aNL	EPA 8081A	µg/L	0.025	<0.05	0/4	<0.05	0/3	<0.05	0/4	<0.05	0/1	<0.05
beta-BHC	aNL	EPA 608	µg/L	0.025			<0.005	0 / 1	<0.005	0/1	<0.005	0/1	<0.005
Captan	aNL, EPA CCL, PoLI	EPA 8081/8082	µg/L	15	<0.05	0/3	<0.05	0 / 2	<0.05	0/4	<0.05	0/1	<0.05
Carbaryl	aNL, PoLI	EPA 531.2	µg/L	700	<0.5	0/4	<0.5	0/3	<0.5	0/4	<0.5	0/1	<0.5
Chloropicrin	aNL, PoLI	EPA 551.1	µg/L	50	<0.5	0 / 4	<0.5 (<0.5 -0.51)	1/3	<0.5	0 / 4	<0.5	0 / 1	<0.5
Chloropropham (CIPC)	aNL	EPA 8321	µg/L	1,200	<2	0/4	<2	0/3	<2	0/4	<2	0/1	<2
1,3-Dichlorobenzene	aNL	EPA 8270C	µg/L	600	<5	0/4	<5	0/3	<5	0/4	<5	0/1	<5
Dieldrin	aNL, EPA PP	EPA 525.2	ng/L	2	<200	0 / 4	<200	0/3	<200	0 / 11	<200	0 / 1	<200
Dieldrin	EPA PP, aNL	EPA 505	ng/L	2	<10	0 / 4	<10	0/3	17 (<10-28)	8 / 9	<10	0 / 1	<10
Dieldrin	aNL, EPA PP	EPA 8081/8082	ng/L	2	<50	0/4	<50	0/3	<50	0/4	<50	0/1	<50
Dieldrin	aNL, EPA PP	EPA 608	ng/L	2			<10	0 / 1	31	1/1	<10	0/1	<10
Dimethoate	aNL, UCMR 2, PoLI	EPA 525.2	µg/L	1	<0.1	0/4	<0.1	0/3	<0.1	0/4	<0.1	0/1	<0.1
2,4-Dimethylphenol	aNL, EPA PP	EPA 8270C	µg/L	100	<5	0/4	<5	0/3	<5	0/4	<5	0/1	<5
Diphenamide	aNL	EPA 8141	µg/L	200	<0.1	0/3	<0.1	0 / 2	<0.1	0 / 4	<0.1	0/1	<0.1
Ethion	aNL	EPA 8141	µg/L	4	<0.1	0/4	<0.1	0/3	<0.1	0/4	<0.1	0/1	<0.1
Malathion	aNL, PoLI	EPA 525.2	µg/L	160	<0.1	0 / 4	<0.1	0/3	<0.1 (<0.1 -0.14)	1/4	<0.1	0 / 1	<0.1
Methylisothiocyanate	aNL	EPA 131	µg/L	190	<1 (<1 -7.4)	1/4	<1	0/3	<1	0 / 4	<1	0 / 1	<1
Methyl parathion	aNL	EPA 8141	µg/L	2	<0.1	0 / 4	<0.1	0/3	<0.1	0 / 4	<0.1	0 / 1	<0.1
Parathion	aNL	EPA 525.2	µg/L	40	<0.1	0 / 4	<0.1	0/3	<0.1	0 / 4	<0.1	0 / 1	<0.1
Pentachloronitrobenzene	aNL	EPA 8270C	µg/L	20	<10	0 / 4	<10	0/3	<10	0 / 4	<10	0/1	<10
Phenol	aNL, EPA PP	EPA 8270C	µg/L	4,200	<5	0 / 4	<5	0/3	<5	0 / 4	<1	0 / 1	<5
2,3,5,6-Tetrachloroterephthalate (DCPA)	aNL	EPA 515.4	µg/L	3,500	0.56 (0.52-0.66)	4 / 4	<0.1 (<0.1 -0.16)	1/3	38 (36-40)	4/4	<0.1	0 / 1	17
Trithion	aNL	EPA 8081/8082	µg/L	7	<0.05	0 / 2	<0.05	0 / 2	<0.05	0/3	<0.05	0/1	
EPA Unregulated Contaminant Moni	toring Rule (UCMR) List	s 1 through 3											
1,1-Dichloroethane	UCMR 3	EPA 524.3	µg/L		<0.03	0 / 4	<0.03	0/3	<0.03	0 / 4	<0.03	0/1	<0.03
1,2,3-Trichloropropane (1,2,3-TCP)	UCMR 3	EPA 524.3	µg/L		<0.03	0 / 4	<0.03	0/3	<0.03	0 / 4	<0.03	0/1	<0.03
1,3-Butadiene	UCMR 3	EPA 524.3	µg/L		<0.1	0 / 4	<0.1	0/3	<0.1	0 / 4	<0.1	0 / 1	<0.1
1,3-Dinitrobenzene	UCMR 2	EPA 8270C	µg/L		<10	0 / 4	<10	0/3	<10	0 / 4	<10	0/1	<10
2,2',4,4'-tetrabromodiphenyl ether (BDE-47)	UCMR 2	EPA 527	µg/L		<0.3	0 / 4	<0.3	0/3	<0.3	0 / 4	<0.3	0 / 1	<0.3
2,2',4,4',5-pentabromodiphenyl ether (BDE-99)	UCMR 2	EPA 527	µg/L		<0.9	0 / 4	<0.9	0/3	<0.9	0 / 4	<0.9	0 / 1	<0.9
2,2',4,4',5,5'-hexabromobiphenyl (HBB)	UCMR 2	EPA 527	µg/L		<0.7	0 / 4	<0.7	0/3	<0.7	0 / 4	<0.7	0 / 1	<0.7
2,2',4,4',5,5'-hexabromodiphenyl ether (BDE-153)	UCMR 2	EPA 527	µg/L		<0.8	0 / 4	<0.8	0/3	<0.8	0 / 4	<0.8	0 / 1	<0.8
2,2',4,4',6-pentabromodiphenyl ether (BDE-100)	UCMR 2	EPA 527	µg/L		<0.5	0 / 4	<0.5	0/3	<0.5	0 / 4	<0.5	0 / 1	<0.5
2-methyl-Phenol (o-cresol)	UCMR 1	EPA 8270C	µg/L		<5	0 / 4	<5	0/3	<5	0 / 4	<1	0 / 1	<5
4-androstene-3,17-dione	CECs	EPA 539	µg/L		0.0040 (0.002-0.0047)	4/4	0.00062 (<0.0003-0.0011)	2/3	<0.0003 (<0.0003 -0.00044)	1/4	<0.0003	0 / 1	<0.0003
Acetochlor	UCMR 1&2	EPA 525.2	µg/L		<0.01	0 / 4	<0.01	0/3	<0.01	0/4	<0.1	0/1	<0.1
Acetochlor ethanesulfonic acid (ESA)	UCMR 2	EPA 535	µg/L		<1	0 / 4	<1	0/3	<1	0/4	<1	0/1	<1
Acetochlor oxanilic acid (OA)	UCMR 2	EPA 535	µg/L		<2	0/4	<2	0/3	<2	0/4	<2	0/1	<2

Sampling Constituent	Contaminant List	Analytical	Units	DDW	RTP Efflu	ent	Ag Wash	Water	Blanco D	rain	Lake El E	Estero	Tembladero
		Method		MCL/NL	Median (Range)	Detected / Measured	Median (Range)	Detected / Measured	Median (Range)	Detected / Measured	Median (Range)	Detected / Measured	Slough
Alachlor ethanesulfonic acid (ESA)	UCMR 1&2	EPA 535	µg/L		<1	0/4	<1	0/3	<1	0/4	<1	0/1	<1
Alachlor oxanilic acid (OA)	UCMR 2	EPA 535	µg/L		<2	0/4	<2	0/3	<2	0/4	<2	0/1	<2
Chromium-6	UCMR 3	EPA 218.6	µg/L		<0.02	0 / 4	3.8 (<0.02-4.9)	2/3	0.53 (0.36-1.1)	4/4	0.082	1/1	0.72
Cobalt	UCMR 3	EPA 200.8	µg/L		<1	0 / 4	<1 (<1 -2.1)	1/3	1.6 (1.3-3.8)	4 / 4	<1	0 / 1	<1
DCPA mono and di-acid degradate	UCMR 1	EPA 515.4	µg/L		0.56 (0.52-0.66)	4/4	<0.1 (<0.1 -0.16)	1/3	38 (36-40)	4 / 4	<0.1	0 / 1	17
Disulfoton	UCMR 1	EPA 8270C	µg/L		<0.1	0 / 4	<0.1	0/3	<0.1	0 / 4	<10	0/1	<0.1
Diuron	UCMR 2	EPA 8321	µg/L		<1	0 / 4	<1	0/3	<1	0 / 4	<1	0/1	1
EPTC	UCMR 1, PoLI	EPA 525.2	µg/L		<0.1	0 / 4	<0.1	0/3	<0.1	0 / 4	<0.1	0/1	<0.1
Equilin	UCMR 3	EPA 539	µg/L		<0.004	0 / 4	<0.004	0/3	<0.004	0 / 4	<0.004	0 / 1	<0.004
Estradiol (17-beta estradiol)	UCMR 3	EPA 539	µg/L		0.0044 (0.0026-0.0091)	4/4	<0.0004	0/3	<0.0004	0 / 4	<0.0004	0 / 1	<0.0004
Estriol	UCMR 3	EPA 539	µg/L		<0.0022 (<0.0008 -0.0042)	3 / 4	<0.0008	0/3	<0.0008	0 / 4	<0.0008	0 / 1	<0.0008
Estrone	UCMR 3	EPA 539	µg/L		0.21 (0.084-0.35)	4/4	<0.002 (<0.002 -0.0037)	1/3	<0.002 (<0.002- 0.0022)	1/4	<0.002	0 / 1	<0.005
Ethinyl Estradiol (17-alpha ethynyl estradiol)	UCMR 3	EPA 539	µg/L		<0.0009 (<0.0009- 0.011)	1/4	<0.0009	0/3	<0.0009	0/4	<0.0009	0/1	<0.0009
Fonofos	UCMR 1	EPA 526	µg/L		<0.5	0/4	<0.5	0/3	<0.5	0/4	<0.5	0/1	<0.5
Halon 1011 (bromochloromethane)	UCMR 3	EPA 524.3	µg/L		<0.06	0/4	0.075 (<0.06-0.26)	2/3	<0.06	0/4	<0.06	0 / 1	<0.06
Halon 1011 (bromochloromethane)	UCMR 3	EPA 524.2	µg/L		<0.5	0/3	<0.5	0 / 2	<0.5	0/3	<0.5	0/1	<0.5
HCFC-22 (Chlorodifluoromethane)	UCMR 3	EPA 524.3	µg/L		<0.08	0/4	<0.08	0/3	<0.08	0/4	<0.08	0/1	<0.08
Linuron	UCMR 1	EPA 8321	µg/L		<1	0/4	<1	0/3	<1	0/4	<1	0/1	<1
Metolachlor	UCMR 2	EPA 525.2	µg/L		<0.05	0/4	<0.05	0/3	<0.05	0/4	<0.05	0/1	<0.05
Metolachlor ethanesulfonic acid (ESA)	UCMR 2	EPA 535	µg/L		<1	0/4	<1	0/3	<1	0/4	<1	0 / 1	<1
Metolachlor oxanilic acid (OC)	UCMR 2	EPA 535	µg/L		<2	0 / 4	<2	0/3	<2	0 / 4	<2	0/1	<2
Molybdenum	UCMR 3	EPA 200.8	µg/L		6.8 (4-13)	4/4	43 (23-78)	3/3	105 (92-220)	4/4	12	1/1	62
N-nitroso-di-n-butylamine (NDBA)	UCMR 2	EPA 521	ng/L		4.3 (<2-6.7)	3 / 4	<2	0/3	<2	0 / 4	<2	0 / 1	<2
N-nitroso-methylethylamine (NMEA)	UCMR 2	EPA 521	ng/L		<2	0 / 4	<2	0/3	<2	0 / 4	<2	0 / 1	<2
N-Nitrosopyrrolidine (NPYR)	UCMR 2	EPA 521	ng/L		2.05 (<2-2.5)	2 / 4	<2 (<2- 4.7)	1/3	<2	0 / 4	<2	0 / 1	<2
N-Nitrosomorpholine		EPA 8270C	µg/L		<10	0 / 4	<10	0/3	<10	0 / 4	<10	0/1	<10
N-Nitrosopiperidine (NPIP)		EPA 8270C	µg/L		<10	0 / 4	<10	0/3	<10	0 / 4	<10	0 / 1	<10
Perfluorooctane sulfonic acid (PFOS)	UCMR 3	EPA 537	µg/L		<0.04	0 / 4	0.073 (<0.04-0.3)	2/3	<0.04	0 / 4	<0.04	0 / 1	<0.04
Perfluorooctanoic acid (PFOA)	UCMR 3	EPA 537	µg/L		<0.02	0 / 4	<0.02	0/3	<0.02	0 / 4	0.021	1/1	<0.02
Perfluorononanoic acid (PFNA)	UCMR 3	EPA 537	µg/L		<0.02	0 / 4	<0.02	0/3	<0.02	0 / 4	<0.02	0 / 1	<0.02
Perfluorohexanesulfonic acid (PFHxS)	UCMR 3	EPA 537	µg/L		<0.03	0 / 4	<0.03	0/3	<0.03	0 / 4	<0.03	0 / 1	<0.03
Perfluoroheptanoic acid (PFHpA)	UCMR 3	EPA 537	µg/L		<0.01	0 / 4	<0.01	0/3	<0.01	0 / 4	<0.01	0 / 1	<0.01
Perfluorobutanesulfonic acid (PFBS)	UCMR 3	EPA 537	µg/L		<0.09	0 / 4	<0.09	0/3	<0.09	0 / 4	<0.09	0 / 1	<0.09
Prometon	UCMR 1	EPA 526	µg/L		<0.5	0 / 4	<0.5	0/3	<0.5	0 / 4	<0.5	0/1	<0.5
Strontium	UCMR 3	EPA 200.8	µg/L		365 (290-740)	4 / 4	580 (510-1300)	3/3	1250 (990-2200)	4 / 4	500	1/1	1800
Terbacil	UCMR 1	EPA 525.2	µg/L		<0.1	0/4	<0.1	0/3	<0.1	0/4	<0.1	0/1	<0.1
Terbufos	UCMR 1	EPA 526	µg/L		<0.5	0 / 4	<0.5	0/3	<0.5	0 / 4	<0.5	0/1	<0.5
Terbufos sulfone	UCMR 2	EPA 527	µg/L		<0.4	0 / 4	<0.4	0/3	<0.4	0/4	<0.4	0/1	<0.4
EPA Clean Water Act Priority Polluta	nts (PPs)												
1,2-diphenylhydrazine	EPA PP, UCMR 1	EPA 8270C	µg/L		<10	0/4	<10	0/3	<10	0/4	<1	0/1	<10
1,2-trans-dichloroethylene	EPA PP	EPA 524.2	µg/L		<0.5	0 / 4	<0.5	0/3	<0.5	0 / 4	<0.5	0 / 1	<0.5

Sampling Constituent	Contaminant List	Analytical	Units	DDW	RTP Efflue	ənt	Ag Wash V	Water	Blanco D	rain	Lake El E	stero	Tembladero
		wethod		MCL/NL	Median (Range)	Detected / Measured	Median (Range)	Detected / Measured	Median (Range)	Detected / Measured	Median (Range)	Detected / Measured	Slough
1,3-dichlorobenzene	EPA PP	EPA 524.2	µg/L		<0.5	0 / 4	<0.5	0/3	<0.5	0 / 4	<0.5	0 / 1	<0.5
2-chloroethyl vinyl ethers	EPA PP	EPA 524.2	µg/L		<0.5	0/6	<0.5	0/5	<0.5	0/8	<0.5	0 / 1	<0.5
2-chloronaphthalene	EPA PP	EPA 8270C	µg/L		<5	0/4	<5	0/3	<5	0 / 4	<1	0 / 1	<5
2-chlorophenol	EPA PP	EPA 8270C	µg/L		<5	0 / 4	<5	0/3	<5	0 / 4	<1	0 / 1	<5
2-nitrophenol	EPA PP	EPA 8270C	µg/L		<5	0/4	<5	0/3	<5	0 / 4	<5.1	0 / 1	<5
2,4-dichlorophenol	EPA PP, UCMR 1	EPA 8270C	µg/L		<5	0 / 4	<5	0/3	<5	0 / 4	<1	0 / 1	<5
2,4-dinitrophenol	EPA PP, UCMR 1	EPA 8270C	µg/L		<50	0/4	<50	0/3	<50	0 / 4	<5.1	0 / 1	<50
2,4-dinitrotoluene	EPA PP, UCMR 1	EPA 525.2	µg/L		<0.1	0/4	<0.1	0/3	<0.1	0 / 4	<1	0 / 1	<0.1
2,4,6-trichlorophenol	EPA PP, UCMR 1	EPA 8270C	µg/L		<5	0/4	<5	0/3	<5	0 / 4	<1	0 / 1	<5
2,6-dinitrotoluene	EPA PP, UCMR 1	EPA 525.2	µg/L		<0.1	0/4	<0.1	0/3	<0.1	0 / 4	<0.1	0 / 1	<0.1
3,3-dichlorobenzidine	EPA PP	EPA 8270C	µg/L		<50	0/4	<50	0/3	<50	0 / 4	<2	0 / 1	<50
4-bromophenyl phenyl ether	EPA PP	EPA 8270C	µg/L		<5	0 / 4	<5	0/3	<5	0 / 4	<5.1	0 / 1	<5
4-chlorophenyl phenyl ether	EPA PP	EPA 8270C	µg/L		<5	0 / 4	<5	0/3	<5	0 / 4	<1	0 / 1	<5
4-nitrophenol	EPA PP	EPA 8270C	µg/L		<10	0 / 4	<10	0/3	<10	0 / 4	<5.1	0 / 1	<10
4,4-DDD	EPA PP	EPA 525.2	µg/L		<0.1	0/4	<0.1	0/4	<0.1	0/4	<0.1	0/1	<0.1
4,4-DDD	EPA PP	EPA 8081A/8082	µg/L		<0.05	0 / 4	<0.05	0/4	<0.05	0 / 4	<0.05	0 / 1	<0.05
4,4-DDD	EPA PP	EPA 608	µg/L				<0.01	0/1	<0.01	0/1	<0.01	0/1	<0.01
4,4-DDE	EPA PP, UCMR 1	EPA 525.2	µg/L		<0.1	0 / 4	<0.1	0 / 4	<0.1	0 / 4	<0.1	0 / 1	<0.1
4,4-DDE	EPA PP, UCMR 1	EPA 8081A/8082	µg/L		<0.05	0/4	<0.05	0/4	<0.05	0/4	<0.05	0/1	<0.05
4,4-DDE	EPA PP, UCMR 1	EPA 608	µg/L				<0.01	0 / 1	0.021	1/1	<0.01	0 / 1	0.012
4,4-DDT	EPA PP	EPA 525.2	µg/L		<0.1	0 / 4	<0.1	0/4	<0.1	0 / 4	<0.1	0 / 1	<0.1
4,4-DDT	EPA PP	EPA 8081A/8082	µg/L		<0.05	0/4	<0.05	0/4	<0.05	0 / 4	<0.05	0 / 1	<0.05
4,4-DDT	EPA PP	EPA 608	µg/L				<0.01	0 / 1	<0.01	0/1	<0.01	0 / 1	<0.01
4,6-dinitro-o-cresol	EPA PP	EPA 8270C	µg/L		<50	0 / 4	<50	0/3	<50	0 / 4	<5.1	0 / 1	<50
Acenaphthene	EPA PP	EPA 525.2	µg/L		<0.1	0 / 4	<0.1	0/3	<0.1	0 / 4	<0.1	0 / 1	<0.1
Acenaphthylene	EPA PP	EPA 525.2	µg/L		<0.1	0 / 4	<0.1	0/3	<0.1	0/4	<0.1	0 / 1	<0.1
Acrolein	EPA PP, EPA CCL	EPA 624	µg/L		<2	0 / 4	4.8 (<2-22)	2/3	<2	0 / 4	<2	0 / 1	<2
Acrylonitrile	EPA PP	EPA 624	µg/L		<2	0 / 4	3.6 (<2-4.2)	2/3	<2	0 / 4	<2	0 / 1	<2
Aldrin	EPA PP	EPA 505	µg/L		<0.01	0 / 4	<0.01	0/3	<0.01	0/4	<0.01	0 / 1	<0.01
Alpha-BHC	EPA PP	EPA 525.2	µg/L		<0.1	0 / 4	<0.1	0/3	<0.1	0/4	<0.1	0 / 1	<0.1
Alpha-endosulfan	EPA PP	EPA 525.2	µg/L		<0.1	0 / 4	<0.1	0/3	<0.1	0/4	<0.1	0 / 1	<0.1
Alpha-endosulfan	EPA PP	EPA 608	µg/L				<0.01	0 / 1	<0.01	0/1	<0.01	0 / 1	<0.01
Anthracene	EPA PP	EPA 525.2	µg/L		<0.02	0 / 4	<0.02	0/3	<0.02	0/4	<0.02	0 / 1	<0.02
Benzidine	EPA PP	EPA 8270C	µg/L		<50	0 / 4	<50	0/3	<50	0/4	<5.1	0 / 1	<50
benzo(a) anthracene	EPA PP	EPA 525.2	µg/L		<0.05	0 / 4	<0.05	0/3	<0.05	0/4	<0.05	0 / 1	<5
Benzo(b) fluoranthene	EPA PP	EPA 525.2	µg/L		<0.02	0 / 4	<0.02	0/3	<0.02	0/4	<0.02	0 / 1	<0.02
Benzo(ghi) perylene	EPA PP	EPA 525.2	µg/L		<0.05	0/4	<0.05	0/3	<0.05	0/4	<0.05	0 / 1	<0.05
Benzo(k) fluoranthene	EPA PP	EPA 525.2	µg/L		<0.02	0 / 4	<0.02	0/3	<0.02	0/4	<0.02	0 / 1	<0.02
Beta-BHC	EPA PP	EPA 525.2	µg/L		<0.1 (<0.1- 0.15)	1/4	<0.1	0/3	<0.1	0 / 4	<0.1	0 / 1	<0.1
Beta-endosulfan	EPA PP	EPA 525.2	µg/L		<0.1	0 / 4	<0.1	0/3	<0.1	0/4	<0.1	0 / 1	<0.1
Beta-endosulfan	EPA PP	EPA 608	µg/L				<0.01	0 / 1	<0.01	0/1	<0.01	0 / 1	<0.01
Bis(2-chloroethoxy) methane	EPA PP	EPA 8270C	µg/L		<10	0 / 4	<10	0/3	<10	0/4	<1	0 / 1	<10
Bis(2-chloroethyl) ether	EPA PP	EPA 8270C	µg/L		<10	0/4	<10	0/3	<10	0/4	<1	0 / 1	<10
Bis(2-chloroisopropyl) ether	EPA PP	EPA 8270C	µg/L		<10	0 / 4	<10	0/3	<10	0/4	<1	0 / 1	<10
Bromoform	EPA PP	EPA 524.2	µg/L		<0.5	0 / 4	0.95 (<0.5-2.4)	2/3	<0.5	0/4	<0.5	0 / 1	<0.5
Bromoform	EPA PP	EPA 551.1	µg/L		<0.5	0 / 4	1.2 (<0.5 -1.8)	2/3	<0.5	0 / 4	<0.5	0 / 1	<0.5

Sampling Constituent	Contaminant List	Analytical	Units	DDW	RTP Efflu	ent	Ag Wash	Water	Blanco D	rain	Lake El E	stero	Tembladero
		Method		MCL/NL	Median (Range)	Detected / Measured	Median (Range)	Detected / Measured	Median (Range)	Detected / Measured	Median (Range)	Detected / Measured	Slough
Butyl benzyl phthalate	EPA PP	EPA 525.2	µg/L		<0.5	0 / 4	1.2 (<0.5-1.9)	2/3	<0.5	0 / 4	<0.5	0 / 1	<0.5
Chlorobenzene	EPA PP	EPA 524.2	µg/L		<0.5	0 / 4	<0.5	0/3	<0.5	0/4	<0.5	0 / 1	<0.5
Chlorodibromomethane	EPA PP	EPA 524.2	ua/L		<0.5	0/4	2.2	2/3	<0.5	0/4	<0.5	0/1	<0.5
Chless diberry states			F-3		-0.5	0/4	(<0.5-11) 3.6		-0.5	0/4	10.5	0/4	10.5
	EPA PP	EPA 551.1	µg/L		<0.5	0/4	(<0.5 -8.3)	2/3	<0.5	0/4	<0.5	0/1	<0.5
Chloroethane	EPAPP	EPA 524.2	µg/L		<0.5	0/4	<0.5	0/3	<0.5	0/4	<0.5	0/1	<0.5
Chloroform	EPA PP	EPA 524.2	µg/L		(<0.5- 0.76)	1/4	(2.5-96)	3/3	<0.5	0 / 4	<0.5	0 / 1	<0.5
Chloroform	EPA PP	EPA 551.1	µg/L		<0.5 (<0.5 -0.82)	1/4	49 (2.6-150)	3/3	<0.5	0 / 4	<0.5	0 / 1	<0.5
Chrysene	EPA PP	EPA 525.2	µg/L		<0.02	0/4	<0.02	0/3	<0.02	0/4	<0.02	0/1	<0.02
Delta-BHC	EPA PP	EPA 525.2	µg/L		<0.1	0/4	<0.1	0/3	<0.1	0/4	<0.1	0/1	<0.1
Delta-BHC	EPA PP	EPA 608	µg/L				<0.005	0 / 1	<0.005	0/1	<0.005	0 / 1	<0.005
Di-N-Butyl Phthalate	EPA PP	EPA 8270C	µg/L		<10	0/4	<10	0/3	<10	0/4	<1	0 / 1	<10
Di-n-octyl phthalate	EPA PP	EPA 8270C	µg/L		<10	0/4	<10	0/3	<10	0/4	<2	0 / 1	<10
Dibenz(a,h) anthracene	EPA PP	EPA 525.2	µg/L		<0.05	0/4	<0.05	0/3	<0.05	0/4	<0.05	0/1	<0.05
Dichlorobromomethane	EPA PP	EPA 524.2	µg/L		<0.5	0 / 4	5.8 (0.52-26)	3/3	<0.5	0 / 4	<0.5	0 / 1	<0.5
Dichlorobromomethane	EPA PP	EPA 551.1	µg/L		<0.5	0 / 4	<0.5 (<0.5 -9)	1/3	<0.5	0 / 4	<0.5	0 / 1	<0.5
Diethyl Phthalate	EPA PP	EPA 525.2	µg/L		<0.5	0/4	<0.5	0/3	<0.5	0/4	<0.5	0/1	<0.5
Dimethyl phthalate	EPA PP	EPA 525.2	ua/L		<0.5	0/4	<0.5	0/3	<0.5	0/4	<0.5	0/1	<0.5
Endosulfan sulfate	EPA PP	EPA 525.2	ua/L		<0.1	0/4	<0.1	0/3	<0.1	0/4	<0.1	0/1	<0.1
Endosulfan sulfate	EPA PP	EPA 608	ua/L			-	<0.01	0/1	<0.01	0/1	< 0.01	0/1	<0.01
Endrin	EPA PP	EPA 525.2	ua/L		<0.2	0/4	<0.2	0/3	<0.2	0/5	<0.2	0/1	<0.2
Endrin	FPA PP	EPA 608	ug/l				<0.01	0/1	<0.01	0/1	<0.01	0/1	<0.01
Endrin aldehvde	FPA PP	EPA 525.2	ug/l		<0.1	0/4	<0.1	0/3	<0.1	0/4	<0.1	0/1	<0.1
Endrin aldehyde	EPA PP	EPA 608	ug/L		0.7	• • •	<0.01	0/1	<0.01	0/1	<0.01	0/1	<0.01
Eluoranthene	EPA PP	EPA 525.2	µg/L		<0.1	0/4	<0.01	0/3	<0.1	0/4	<0.01	0/1	<0.01
Fluorene	EPA PP	EPA 525.2	µg/L		<0.05	0/4	<0.05	0/3	<0.05	0/4	<0.05	0/1	<0.05
Gamma BHC		EDA 505	µg/L		<0.03	0/4	<0.03	0/3	<0.03	0/4	<0.03	0/1	<0.05
Hovashlorobonzono		EPA 9270C	µg/L		<0.01	0/4	<0.07	0/3	<0.07	0/4	<0.01	0/1	<0.01
		EPA 52/00	µg/L		-0.5	0/4	-0.5	0/3	<0.5	0/4	<0.5	0/1	<0.5
Hexaciliorobulaciene		EPA 324.2	µg/L		<0.5	0/4	<0.5	0/3	<0.5	0/4	<0.5	0/1	<0.5
Hexachloroevelepentediepe		EPA 62700	µg/L		<0.05	0/4	<0.05	0/3	<0.05	0/4	<0.05	0/1	<0.05
		EPA 525.2	µg/L		<0.05	0/4	<0.03	0/3	<0.05	0/4	<0.05	0/1	<0.05
Indeno (1,2,3-cd) pyrene	EPA PP	EPA 525.2	µg/L		<0.05	0/4	<0.05	0/3	<0.05	0/4	<0.05	0/1	<0.05
Lead	EPA PP EPA PP	EPA 525.2 EPA 200.8	µg/L µg/L		<0.5	0/4	<0.5 0.93	3/3	0.5	2/4	<0.5 3	1/1	<0.5 1.8
Methyl bromide	EPA PP UCMR 3 Pol L	EPA 524 2	µg/L		<0.5	0/4	(0.6-1.3) <0.5	0/3	<u>(<0.5-0.98)</u> <0.5	0/4	<0.5	0/1	<0.5
Methyl chloride	EPA PP. UCMR 3	EPA 524.2	ua/L		0.51	2/4	<0.5	2/3	<0.5	0/4	<0.5	0/1	<0.5
Methyl chloride	EPA PP LICMR 3	EPA 524 3	ug/l		(<0.5 -0.54) <0.2	0/4	(<0.5-1.7) 0.37	2/3	<0.2	0/4	<0.2	0/1	<0.2
Nitrobenzene	EPA PP. UCMR 1	EPA 8270C	ua/L		<5	0/4	(<0.2 -0.404) <5	0/3	<5	0/4	<1	0/1	<5
N-nitrosodiphenylamine	FPA PP FPA CCI	EPA 8270C	ua/l		<5	0/4	<5	0/3	<5	0/4	<1	0/1	<5
Nanhthalene	FPA PP	EPA 525 2	P9'-		<5	0/4	<5	0/3	<5	0/4	<0.3	0/1	<0.3
Parachlorometa cresol (p-Chloro-m-	EPA PP	EPA 8270C	ua/L		<5	0/4	<5	0/3	<5	0/4	<5	0/1	<5
cresol) PCB–1016 (Arochlor 1016)	EPA PP	EPA 505	ua/L		<0.08	0/4	<0.08	0/3	<0.08	0/9	<0.08	0/1	<0.08
PCB-1221 (Arochlor 1221)	EPAPP	EPA 505	ua/L		<0.1	0/4	<0.1	0/3	<0.1	0/9	<0.1	0/1	<0.1
PCB–1232 (Arochlor 1232)	EPA PP	EPA 505	μg/L		<0.1	0/4	<0.1	0/3	<0.1	0/9	<0.1	0 / 1	<0.1

Sampling Constituent	Contaminant List	Analytical	Units	DDW	RTP Efflu	ent	Ag Wash	Water	Blanco D	rain	Lake El E	stero	Tembladero
		Method		MCL/NL	Median (Range)	Detected / Measured	Median (Range)	Detected / Measured	Median (Range)	Detected / Measured	Median (Range)	Detected / Measured	Slough
PCB–1242 (Arochlor 1242)	EPA PP	EPA 505	µg/L		<0.1	0/4	<0.1	0/3	<0.1	0/9	<0.1	0 / 1	<0.1
PCB–1248 (Arochlor 1248)	EPA PP	EPA 505	µg/L		<0.1	0 / 4	<0.1	0/3	<0.1	0/9	<0.1	0 / 1	<0.1
PCB–1254 (Arochlor 1254)	EPA PP	EPA 505	µg/L		<0.1	0 / 4	<0.1	0/3	<0.1	0/9	<0.1	0 / 1	<0.1
PCB-1260 (Arochlor 1260)	EPA PP	EPA 505	µg/L		<0.1	0/4	<0.1	0/3	<0.1	0/9	<0.1	0/1	<0.1
Phenanthrene	EPA PP	EPA 525.2	µg/L		<0.04	0/4	<0.04	0/3	<0.04	0/4	<0.04	0/1	<0.04
Pyrelle Pasticidas of Local Interest (Pol I)	EFAFF	EPA 525.2	µg/L		<0.05	074	<0.05	0/3	<0.05	0/4	<0.05	0/1	<0.05
Chlorothalonil (Draconil, Bravo)	PoLI	EPA 525.2	µg/L		<0.1	0 / 4	<0.1	1/3	<0.1	0 / 4	<0.1	0 / 1	<0.1
Chlorpyrifos	PoLI	EPA 525.2	µg/L		<0.05	0/4	<0.05	0/3	<0.05	0 / 11	<0.05	0/1	<0.05
Chlorthal-Dimethyl (DCPA)	PoLI	EPA 515.4	µg/L		0.56 (0.52-0.66)	4/4	<0.1 (<0.1 -0.16)	1/3	38 (36-40)	4/4	<0.1	0 / 1	17
Glyphosate, Isopropylamine Salt	PoLI	EPA 547	µg/L		<6	0 / 4	<6	0/3	7.5 (<6-9.2)	2 / 4	<6	0 / 1	8.1
Methidathion	PoLI	EPA 8141	µg/L		<0.1	0/3	<0.1	0 / 2	<0.1	0 / 4	<0.1	0 / 1	<0.5
Methomyl	PoLI	EPA 531.2	µg/L		<0.5 (<0.5 -0.53)	1/4	<0.5	0/3	<0.5	0 / 4	<0.5	0 / 1	<0.5
Naled	PoLI	EPA 8141	µg/L		<0.5	0 / 4	<0.5	0/3	<0.5	0 / 4	<0.5	0 / 1	<0.5
Oxydemeton-Methyl (Demeton)	PoLI	EPA 8141A	µg/L		<0.2	0 / 4	<0.2	0/3	<0.2	0 / 4	<0.2	0 / 1	<0.2
Sulfur	PoLI	EPA 200.7	mg/L		38 (36-41)	4 / 4	68 (62-80)	3/3	200 (200-210)	4 / 4	50	1/1	140
Contaminants of Emerging Concern	(CECs)												_
1,7-Dimethylxanthine	CECs	LC-MS-MS	ng/L		125 (<10-1100)	2 / 4	<10	0/3	<10	0 / 4	<10	0 / 1	<10
2,4-D	CECs	LC-MS-MS	ng/L		<5	0 / 4	<5 (<5- 17)	1/3	<5	0 / 4	<5	0 / 1	<5
4-nonylphenol - semi quantitative	CECs	LC-MS-MS	ng/L		<100 (<100- 860)	1/4	<100	0/3	<100	0 / 4	<100	0 / 1	<100
4-tert-octylphenol	CECs	LC-MS-MS	ng/L		95 (<50-790)	2 / 4	<50 (<50- 53)	1/3	<50	0 / 4	<50	0 / 1	<50
Acesulfame-K	CECs	LC-MS-MS	ng/L		(22000-85000)	4/4	38 (22-44)	3/3	(580-3000)	4/4	140	1/1	3100
Acetaminophen	CECs	LC-MS-MS	ng/L		<5 (<5- 350)	1/4	<5	0/3	<5	0 / 4	<5	0 / 1	<5
Albuterol	CECs	LC-MS-MS	ng/L		14 (<5-33)	2/4	<5	0/3	<5	0 / 4	<5	0 / 1	<5
Amoxicillin (semi-quantitative)	CECs	LC-MS-MS	ng/L		(2000-3700)	4/4	<20	0/3	<20	0 / 4	<20	0 / 1	<20
Andorostenedione	CECs, UCMR 3	LC-MS-MS	ng/L		<5	0/4	<5	0/3	<5	0 / 4	<5	0 / 1	<5
Atenolol	CECs	LC-MS-MS	ng/L		330 (<5- 540)	3 / 4	<5	0/3	<5	0 / 4	<5	0 / 1	<5
Atrazine	CECs	LC-MS-MS	ng/L		<5	0/4	<5	0/3	<5	0/4	<5	0 / 1	<5
Azithromycin	CECs	LC-MS-MS	ng/L		(<20-20000)	2/4	<20	0/3	<20	0/4	48	1/1	<20
Bendroflumethiazide	CECs	LC-MS-MS	ng/L		<5	0/4	<5	0/3	<5	0/4	<5	0/1	<5
Bezafibrate	CECs	LC-MS-MS	ng/L		(<5-120)	2/4	<5	0/3	<5	0 / 4	<5	0 / 1	<5
BPA	CECs	LC-MS-MS	ng/L		(<10 -71)	1/4	(<10-59)	2/3	<10	0 / 4	<10	0 / 1	<10
Bromacil	CECs	LC-MS-MS	ng/L		<5	0/4	<5	0/3	<5	0 / 4	<5	0 / 1	<5
Butalbital	CECs	LC-MS-MS	ng/L		<5	0/4	<5	0/3	<5 (<5- 100)	1/4	<5	0/1	<5
Butylparben	CECs	LC-MS-MS	ng/L		<5	0/4	<5	0/3	<5	0/4	<5	0/1	<5
Caffeine	CECs	LC-MS-MS	ng/L		1065 (820-2800)	4/4	(39-200)	3/3	6.3 (<5-8.3)	2/4	110	1/1	63
Carbadox	CECs	LC-MS-MS	ng/L		<5	0/4	<5	0/3	<5	0/4	<5	0/1	<5
Carbamazepine	CECs	LC-MS-MS	ng/L		(120-360)	4/4	<5	0/3	<5	0 / 4	<5	0 / 1	<5

Sampling Constituent	Contaminant List	Analytical	Units	DDW	RTP Efflu	ent	Ag Wash	Water	Blanco D	rain	Lake El E	stero	Tembladero
		Method		MCL/NL	Median (Range)	Detected / Measured	Median (Range)	Detected / Measured	Median (Range)	Detected / Measured	Median (Range)	Detected / Measured	Slough
Carisoprodol	CECs	LC-MS-MS	ng/L		106 (<5-770)	3 / 4	<5	0/3	<5 (<5 -5.1)	1/4	<5	0 / 1	<5
Chloramphenicol	CECs	LC-MS-MS	ng/L		<10	0 / 4	<10	0/3	<10	0 / 4	<10	0 / 1	<10
Chloridazon	CECs	LC-MS-MS	ng/L		<5	0/4	<5	0/3	<5 (<5 -59)	1/4	<5	0 / 1	<5
Chlorotoluron	CECs	LC-MS-MS	ng/L		<5	0/4	<5	0/3	<5	0/4	<5	0 / 1	<5
Cimetidine	CECs	LC-MS-MS	ng/L		98 (<5-430)	2/4	<5	0/3	<5	0 / 4	<5	0 / 1	<5
Clofibric Acid	CECs	LC-MS-MS	ng/L		<5	0/4	<5	0/3	<5	0/4	<5	0 / 1	<5
Cotinine	CECs	LC-MS-MS	ng/L		115 (25-240)	4/4	16 (<10-24)	2/3	<10	0 / 4	86	1/1	<10
Cyanazine	CECs	LC-MS-MS	ng/L		<5	0/4	<5	0/3	<5	0 / 4	<5	0 / 1	<5
DACT	CECs	LC-MS-MS	ng/L		<5	0/4	<5 (<5 -370)	1/3	<5	0 / 4	<5	0 / 1	58
DEA	CECs	LC-MS-MS	ng/L		<5 (<5- 16)	1/4	<5	0/3	<5	0 / 4	<5	0 / 1	<5
DEET	CECs	LC-MS-MS	ng/L		325 (120-1400)	4/4	<10 (<10 -11)	1/3	<10 (<10 -14)	1/4	15	1/1	15
Dehydronifedipine	CECs	LC-MS-MS	ng/L		67 (62-150)	4/4	<5	0/3	<5	0 / 4	<5	0 / 1	<5
DIA	CECs	LC-MS-MS	ng/L		<5	0/4	<5	0/3	<5	0 / 4	<5	0 / 1	<5
Diazepam	CECs	LC-MS-MS	ng/L		<5 (<5- 12)	1/4	<5	0/3	<5 (<5- 5)	1/4	<5	0 / 1	<5
Diclofenac	CECs	LC-MS-MS	ng/L		37 (<5-81)	2 / 4	<5	0/3	<5	0 / 4	<5	0 / 1	<5
Dilantin	CECs	LC-MS-MS	ng/L		140 (120-180)	4/4	<20	0/3	<20	0 / 4	<20	0 / 1	<20
Diuron	CECs	LC-MS-MS	ng/L		45 (<5-96)	3 / 4	<5	0/3	<5	0 / 4	38	1/1	450
Erythromycin	CECs, EPA CCL	LC-MS-MS	ng/L		30 (<10-120)	2/4	<10	0/3	<10	0 / 4	<10	0 / 1	<10
Estradiol	CECs, UCMR 3	LC-MS-MS	ng/L		<5	0 / 4	<5	0/3	<5	0 / 4	<5	0 / 1	<5
Estrone	CECs, UCMR 3	LC-MS-MS	ng/L		90 (12-300)	4/4	<5	0/3	<5	0 / 4	<5	0 / 1	<5
Ethinyl Estradiol - 17 alpha	CECs, UCMR 3	LC-MS-MS	ng/L		<5	0/4	<5	0/3	<5	0 / 4	<5	0 / 1	<5
Ethylparaben	CECs	LC-MS-MS	ng/L		<20	0 / 4	<20	0/3	<20	0/4	<20	0 / 1	<20
Flumeqine	CECs	LC-MS-MS	ng/L		<10	0/4	<10	0/3	<10	0 / 4	<10	0 / 1	<10
Fluoxetine	CECs	LC-MS-MS	ng/L		30 (<10-57)	3 / 4	<10	0/3	<10	0 / 4	<10	0 / 1	<10
Gemfibrozil	CECs	LC-MS-MS	ng/L		1150 (<5-1500)	3 / 4	<5	0/3	<5	0 / 4	<5	0 / 1	11
Ibuprofen	CECs	LC-MS-MS	ng/L		<10	0/4	<10	0/3	<10	0 / 4	<10	0 / 1	<10
Iohexal	CECs	LC-MS-MS	ng/L		11700 (7800-40000)	4 / 4	<10	0/3	105 (<10-370)	2 / 4	<10	0 / 1	190
lopromide	CECs	LC-MS-MS	ng/L		1400 (<5-1600)	3 / 4	<5	0/3	<5 (<5- 16)	1/4	<5	0 / 1	<5
Isobutylparaben	CECs	LC-MS-MS	ng/L		<5	0 / 4	7 (<5-74)	2/3	<5	0 / 4	<5	0 / 1	<5
Isoproturon	CECs	LC-MS-MS	ng/L		<100	0 / 4	<100	0/3	<100	0 / 4	<100	0 / 1	<100
Ketoprofen	CECs	LC-MS-MS	ng/L		68 (<5-170)	2 / 4	<5	0/3	<5	0 / 4	6.9	1/1	<5
Ketorolac	CECs	LC-MS-MS	ng/L		<5 (<5- 17)	1/4	<5	0/3	<5	0 / 4	<5	0 / 1	<5
Lidocaine	CECs	LC-MS-MS	ng/L		485 (260-800)	4/4	<5	0/3	<5	0 / 4	<5	0 / 1	<5
Lincomycin	CECs	LC-MS-MS	ng/L		26 (<10-51)	2/4	<10	0/3	<10	0 / 4	<10	0 / 1	<10
Linuron	CECs, PoLI	LC-MS-MS	ng/L		<5	0/4	<5 (<5 -5.3)	1/3	<5	0 / 4	<5	0 / 1	9.2

Sampling Constituent	Contaminant List	Analytical	Units	DDW	RTP Efflu	ent	Ag Wash	Water	Blanco Di	rain	Lake El E	stero	Tembladero
		Method		MCL/NL	Median (Range)	Detected / Measured	Median (Range)	Detected / Measured	Median (Range)	Detected / Measured	Median (Range)	Detected / Measured	Slough
Lopressor	CECs	LC-MS-MS	ng/L		610 (<20-1200)	3 / 4	<20	0/3	<20	0 / 4	<20	0/1	<20
Meclofenamic Acid	CECs	LC-MS-MS	ng/L		<5	0 / 4	<5	0/3	<5	0 / 4	<5	0 / 1	<5
Meprobamate	CECs	LC-MS-MS	ng/L		395 (220-730)	4/4	<5	0/3	<5	0/4	<5	0/1	<5
Metazachlor	CECs	LC-MS-MS	ng/L		<5	0 / 4	<5	0/3	<5	0/4	<5	0/1	<5
Methylparaben	CECs	LC-MS-MS	ng/L		<20	0 / 4	<20	0/3	<20	0/4	<20	0 / 1	<20
Metolachlor	CECs	LC-MS-MS	ng/L		<5	0 / 4	<5	0/3	<5	0 / 4	<5	0 / 1	<5
Naproxen	CECs	LC-MS-MS	ng/L		<10 (<10- 41)	1/4	<10	0/3	<10	0 / 4	<10	0 / 1	<10
Nifedipine	CECs	LC-MS-MS	ng/L		<20	0 / 4	<20	0/3	<20	0/4	<20	0 / 1	<20
Norethisterone	CECs	LC-MS-MS	ng/L		<5 (<5- 25)	1/4	<5	0/3	<5	0 / 4	<5	0/1	<5
Oxolinic Acid	CECs	LC-MS-MS	ng/L		<10	0 / 4	<10	0/3	<10	0 / 4	<10	0/1	<10
Pentoxifylline	CECs	LC-MS-MS	ng/L		14 (<5-80)	3 / 4	<5	0/3	<5	0 / 4	<5	0 / 1	<5
Phenazone	CECs	LC-MS-MS	ng/L		<5 (<5- 37)	1/4	<5	0/3	<5	0 / 4	<5	0/1	<5
Primidone	CECs	LC-MS-MS	ng/L		49 (31-94)	4 / 4	<5	0/3	<5	0 / 4	<5	0 / 1	<5
Progesterone	CECs	LC-MS-MS	ng/L		5 (<5-59)	2 / 4	<5	0/3	<5	0 / 4	<5	0/1	<5
Propazine	CECs	LC-MS-MS	ng/L		<5	0 / 4	<5	0/3	<5	0/4	<5	0/1	<5
Propylparaben	CECs	LC-MS-MS	ng/L		<5	0 / 4	<5	0/3	<5	0 / 4	<5	0 / 1	<5
Quinoline	CECs, EPA CCL	LC-MS-MS	ng/L		<5	0 / 4	<5 (<5- 12)	1/3	<5	0 / 4	<5	0 / 1	<5
Simazine	CECs	LC-MS-MS	ng/L		<5	0 / 4	<5	0/3	<5	0/4	<5	0 / 1	<5
Sucralose	CECs	LC-MS-MS	ng/L		37500 (35000-44000)	4 / 4	280 (<100-1100)	2/3	765 (110-2700)	4 / 4	130	1/1	1600
Sulfachloropyridazine	CECs	LC-MS-MS	ng/L		<5	0 / 4	<5	0/3	<5	0/4	<5	0 / 1	<5
Sulfadiazine	CECs	LC-MS-MS	ng/L		<5 (<5 -9.4)	1/4	<5	0/3	<5	0 / 4	<5	0 / 1	<5
Sulfadimethoxine	CECs	LC-MS-MS	ng/L		<5	0 / 4	<5	0/3	<5	0/4	<5	0 / 1	<5
Sulfamerazine	CECs	LC-MS-MS	ng/L		<5	0 / 4	<5	0/3	<5	0 / 4	<5	0 / 1	<5
Sulfamethazine	CECs	LC-MS-MS	ng/L		<5	0 / 4	<5	0/3	<5	0 / 4	<5	0 / 1	<5
Sulfamethizole	CECs	LC-MS-MS	ng/L		<5	0 / 4	<5	0/3	<5	0 / 4	<5	0 / 1	<5
Sulfamethoxazole	CECs	LC-MS-MS	ng/L		860 (470-1500)	4/4	<5	0/3	<5	0 / 4	<5	0 / 1	<5
Sulfathiazole	CECs	LC-MS-MS	ng/L		<5	0 / 4	<5	0/3	<5	0/4	<5	0 / 1	<5
ТСЕР	CECs	LC-MS-MS	ng/L		120 (<10-320)	3 / 4	<10 (<10 -15)	1/3	<10 (<10- 13)	1/4	33	1/1	<10
ТСРР	CECs	LC-MS-MS	ng/L		570 (440-720)	4 / 4	<100	0/3	<100	0 / 4	<100	0/1	<100
TDCPP	CECs	LC-MS-MS	ng/L		635 (510-880)	4 / 4	<100	0/3	<100	0 / 4	<100	0/1	<100
Testosterone	CECs, UCMR 3	LC-MS-MS	ng/L		<5	0 / 4	<5 (<5- 18)	1/3	<5	0 / 4	<5	0/1	<5
Theobromine	CECs	LC-MS-MS	ng/L		<10 (<10 -700)	1/4	<10	0/3	<10	0 / 4	<10	0/1	<10

Sampling Constituent	Contaminant List	Analytical	Units	DDW	RTP Efflu	ent	Ag Wash	Water	Blanco D	rain	Lake El E	stero	Tembladero
		Method		MCL/NL	Median (Range)	Detected / Measured	Median (Range)	Detected / Measured	Median (Range)	Detected / Measured	Median (Range)	Detected / Measured	Slough
Theophylline	CECs	LC-MS-MS	ng/L		225 (<20-2200)	2/4	<20	0/3	<20	0 / 4	<20	0 / 1	<20
Triclosan	CECs	LC-MS-MS	ng/L		325 (180-1600)	4/4	<10	0/3	<15 (<10 -67)	1/4	<10	0 / 1	<10
Trimethoprim	CECs	LC-MS-MS	ng/L		505 (48-1700)	4/4	<5	0/3	<5	0 / 4	<5	0 / 1	<5
Warfarin	CECs	LC-MS-MS	ng/L		<5	0/4	<5	0/3	<5	0/4	<5	0/1	<5

¹ Values for total coliform, *E. coli*, and enterococcus are in the format geometric mean (range)

List of Acronyms:

cm: centimeter

EPA: Environmental Protection Agency

SM: Standard Methods for the Examination of Water and Wastewater LC-MS-MS: Liquid Chromatography, tandem Mass Spectrometry

L: Liter

MFL: Million Fibers per Liter mg: milligram

mL: milliliter

MPN: Most Probably Number

ng: nanogram

NTU: Nephelometric Turbidity Units

pCi: picocuries

TT: Treatment Technique

UV: ultraviolet

µg: microgram

APPENDIX F

Central Coast Regional Water Quality Control Board Order No. R3-2018-0017, NPDES No. CA0048551, for the Monterey One Water Regional Wastewater Treatment Plant





Central Coast Regional Water Quality Control Board

ORDER NO. R3-2018-0017 NPDES NO. CA0048551

WASTE DISCHARGE REQUIREMENTS FOR THE MONTEREY ONE WATER REGIONAL WASTEWATER TREATMENT PLANT AND ADVANCED WATER PURIFICATION FACILITY DISCHARGE TO THE PACIFIC OCEAN

The following Discharger is subject to waste discharge requirements (WDRs) set forth in this Order:

Discharger	Monterey One Water ¹
Name of Facility Regional Wastewater Treatment Plant (WWTP) and Advanced Water Purification Facility (AWPF), Marina, Monterey County	
	14811 Del Monte Boulevard
Facility Address	Marina, CA 93933
	Monterey County

Table 1. Discharger Information

Table 2. Discharge Location

Discharge Point	Effluent Description	Discharge Point Latitude (North)	Discharge Point Longitude (West)	Receiving Water
001	Secondary Treated Wastewater, Saline Waste, and Reverse Osmosis (RO) Concentrate	36.72778°	-121.83750°	Pacific Ocean
002	Disinfected Tertiary Recycled Municipal Wastewater	_	_	Reclamation Use

¹ Monterey One Water (abbreviated M1W) was formerly called the "Monterey Regional Water Pollution Control Agency." Prior orders issued for this facility used this name for the Discharger. DR. JEAN-PIERRE WOLFF, CHAIR | JOHN M. ROBERTSON, EXECUTIVE OFFICER

DR. JEAN-PIERRE WOLFF, CHAIR | JOHN M. ROBERTSON, EXECUTIVE OFFICER

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Table 3. Administrative Information

This Order was adopted on:	December 6, 2018
This Order shall become effective on:	April 1, 2019
This Order shall expire on:	March 31, 2024
The Discharger shall file a Report of Waste Discharge as an application for reissuance of WDRs in accordance with title 23, California Code of Regulations, and an application for reissuance of a National Pollutant Discharge Elimination System (NPDES) permit no later than:	September 30, 2023
The U.S. Environmental Protection Agency (U.S. EPA) and the California Regional Water Quality Control Board, Central Coast Region have classified this discharge as follows:	Major discharge

I, John M. Robertson, Executive Officer, do hereby certify that this Order with all attachments is a full, true, and correct copy of an Order adopted by the California Regional Water Quality Control Board, Central Coast Region on the date indicated above.

John M. Robertson, Executive Officer

DR. JEAN-PIERRE WOLFF, CHAIR | JOHN M. ROBERTSON, EXECUTIVE OFFICER

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I. FACILITY INFORMATION

Information describing the Regional Wastewater Treatment Plant (WWTP) and Advanced Water Purification Facility (AWPF) (Facility) is summarized in Table 1 and in sections I and II of the Fact Sheet (Attachment F). Section I of the Fact Sheet also includes information regarding the Facility's permit application.

II. FINDINGS

The California Regional Water Quality Control Board, Central Coast Region (Central Coast Water Board) finds:

- A. Legal Authorities. This Order serves as waste discharge requirements (WDRs) pursuant to article 4, chapter 4, division 7 of the California Water Code (commencing with section 13260). This Order is also issued pursuant to section 402 of the federal Clean Water Act (CWA) and implementing regulations adopted by the U.S. EPA and chapter 5.5, division 7 of the Water Code (commencing with section 13370). It shall serve as a National Pollutant Discharge Elimination System (NPDES) permit authorizing the Discharger to discharge into waters of the United States at the discharge location described in Table 2 subject to the WDRs in this Order.
- **B.** Background and Rationale for Requirements. The Central Coast Water Board developed the requirements in this Order based on information submitted as part of the application, through monitoring and reporting programs, and other available information. The Fact Sheet (Attachment F), which contains background information and rationale for the requirements in this Order, is hereby incorporated into and constitutes Findings for this Order. Attachments A through E are also incorporated into this Order.
- **C. Provisions and Requirements Implementing State Law.** The provisions/requirements in subsections IV.B, IV.C, V.B, VI.C.5.d, and VI.C.5.c. of this Order and Sections VI and VII of the Monitoring and Reporting Program are included to implement state law only. These provisions/requirements are not required or authorized under the federal CWA; consequently, violations of these provisions/requirements are not subject to the enforcement remedies that are available for NPDES violations.
- **D.** Notification of Interested Persons. The Central Coast Water Board has notified the Discharger and interested agencies and persons of its intent to prescribe WDRs for the discharge and has provided them with an opportunity to submit their written comments and recommendations. Details of the notification are provided in the Fact Sheet.
- E. Consideration of Public Comment. The Central Coast Water Board, in a public meeting, heard and considered all comments pertaining to the discharge. Details of the public hearing are provided in the Fact Sheet.

THEREFORE, IT IS HEREBY ORDERED that Order No. R3-2014-0013 is revoked and rescinded upon the effective date of this Order except for enforcement purposes and that, in order to meet the provisions contained in division 7 of the Water Code (commencing with section 13000) and regulations adopted thereunder and the provisions of the CWA and regulations and guidelines adopted thereunder, the Discharger shall comply with the requirements in this Order. This action in no way prevents the Central Coast Water Board from taking enforcement action for violations of the previous Order.

III. DISCHARGE PROHIBITIONS

A. Discharge of treated wastewater to the Pacific Ocean at a location other than as described by this Order at 36.72778° latitude, -121.83750° longitude is prohibited.

- **B.** The secondary effluent dry weather average monthly rate of discharge from the WWTP shall not exceed 29.6 million gallons per day (MGD).
- **C.** The influent flow to the secondary treatment system shall not exceed 29.6 MGD average dry weather flow and 75.6 MGD peak wet weather flow.
- **D.** The rate of discharge to Monterey Bay shall not exceed 81.2 MGD.
- E. The overflow or bypass of wastewater from the Discharger's collection, treatment, or disposal facilities and the subsequent discharge of untreated or partially treated wastewater, except as provided for in Attachment D, Standard Provision I.A.7 (Bypass), is prohibited
- F. Discharge of any waste in any manner other than as described by this Order, excluding storm water regulated by General Permit No. CAS000001 (Waste Discharge Requirements for Discharges of Storm Water Associated with Industrial Activities), is prohibited.
- **G.** The discharge of any radiological, chemical, or biological warfare agent or high-level radioactive waste into the ocean is prohibited.
- **H.** Federal law prohibits the discharge of sludge by pipeline to the ocean. The discharge of municipal or industrial waste sludge directly to the ocean or into a waste stream that discharges to the ocean is prohibited. The discharge of sludge digester supernatant, without further treatment, directly to the ocean or to a waste stream that discharges to the ocean is prohibited.

IV. EFFLUENT LIMITATIONS AND DISCHARGE SPECIFICATIONS

A. Effluent Limitations – Discharge Point 001

1. Effluent Limitations – Discharge Point 001

a. The Discharger shall maintain compliance with the following effluent limitations at Discharge Point 001, with compliance measured at Monitoring Location EFF-001 as described in the Monitoring and Reporting Program, Attachment E:

Parameter	Units	Average Monthly	Average Weekly	Maximum Daily	Instantaneous Minimum	Instantaneous Maximum
Oil and Grassa	mg/L	25	40	75		
On and Grease	lbs/day ^[1]	6,200	10,000	19,000		
Settleable Solids	mL/L	1.0	1.5			3.0
Turbidity	NTU	75	100			230
pH ^[2]	standard units				6.0	9.0

Table 4. Effluent Limitations – Discharge Point 001

^[1] The mass-based (lbs/day) effluent limitations in this table are based on the average dry weather flow design capacity of 29.6 MGD for the treatment facility and are therefore only good up to this flow. For flows above 29.6 MGD, mass-based effluent limitations shall be calculated individually using the concentration-based effluent limitations and the observed flow at the time of sampling per the following equation:

lbs/day = 0.00834 x Ce x Q

where:

Ce = the effluent concentration limit in μ g/L

Q = observed flow rate in MGD

- ^[2] Excursions from the effluent limit range are permitted subject to the following limitations (40 C.F.R. § 401.17):
 - a. The total time during which the pH values are outside the required range of pH values shall not exceed 7 hours and 26 minutes in any calendar month, and
 - b. No individual excursion from the range of pH values shall exceed 60 minutes. Note: 40 C.F.R. section 401.17(2)(c) notes that, for the purposes of 40 C.F.R. section 401.17, "excursion" is defined as "an unintentional and temporary incident in which the pH value of discharge wastewater exceeds the range set forth in the applicable effluent limitations guidelines." The State Board may adjust the requirements set forth in paragraph 40 C.F.R. section 401.17 (a) with respect to the length of individual excursions from the range of pH values, if a different period of time is appropriate based upon the treatment system, plant configuration, or other technical factors.
 - **b.** The Discharger shall maintain compliance with the following effluent limitations with compliance measured at Monitoring Location EFF-001A as described in the Monitoring and Reporting Program, Attachment E:

		Effluent Limitations				
Parameter	Units	Average Monthly	Average Weekly	Maximum Daily	Instantaneous Minimum	Instantaneous Maximum
Oarthan a sa a sua Dia shamia sh	mg/L	25	40	85		
Carbonaceous Biochemical	lbs/day ^[1]	6,200	10,000	21,000		
20°C (CBOD ₅)	% removal	not less than 85 ^[2]		-		
	mg/L	30	45	90		
Total Suspended Solids	lbs/day ^[1]	7,400	11,000	22,000		
(TSS)	% removal	not less than 85 ^[2]				
pH ^[3]	standard units				6.0	9.0

Table 5. Effluent Limitations at EFF-001A

^[1] The mass-based (lbs/day) effluent limitations in this table are based on the average dry weather flow design capacity of 29.6 MGD for the WWTP and are therefore only good up to this flow. For flows above 29.6 MGD, mass-based effluent limitations shall be calculated individually using the concentration-based effluent limitations and the observed flow at the time of sampling per the following equation:

lbs/day = 0.00834 x Ce x Qwhere: Ce = the effluent concentration limit in µg/L Q = observed flow rate in MGD

- ^[2] The average monthly percent removal of CBOD₅ and TSS shall not be less than 85 percent.
- ^[3] Excursions from the effluent limit range are permitted subject to the following limitations (40 C.F.R. § 401.17):
 - a. The total time during which the pH values are outside the required range of pH values shall not exceed 7 hours and 26 minutes in any calendar month, and
 - b. No individual excursion from the range of pH values shall exceed 60 minutes. Note: 40 C.F.R. section 401.17(2)(c) notes that, for the purposes of 40 C.F.R. section 401.17, "excursion" is defined as "an unintentional and temporary incident in which the pH value of discharge wastewater exceeds the range set forth in the applicable effluent limitations guidelines." The State Board may adjust the requirements set forth in paragraph 40 C.F.R. section 401.17 (a) with respect to the length of individual excursions from the range of pH

values, if a different period of time is appropriate based upon the treatment system, plant configuration, or other technical factors.

c. Toxic Pollutants

The Discharger shall maintain compliance with the following effluent limitations for toxic pollutants at Discharge Point 001, with compliance measured at Monitoring Location EFF-001B, as described in the attached MRP.

Table 6. Effluent Limitations for the Protection of Marine Aquatic Life – Discharge Point 001

		Effluent Limitations			
Parameter	Units	6-Month Median ^[1]	Daily Maximum ^[2]	Instantaneous Maximum ^[3]	
Codmium Total Decoverable	µg/L	1.0	4.0	10	
Cadmium, Total Recoverable	lbs/day ^[4]	36	140	360	
Load Total Bosovorable	µg/L	2.0	8.0	20	
	lbs/day ^[4]	72	290	720	
Silver, Total Receiverable	µg/L	0.7	2.8	7.0	
	lbs/day ^[4]	20	95	250	
Cyanida Tatal ^[5]	µg/L	1.0	4.0	10	
Cyanide, Totais	lbs/day ^[4]	36	140	360	
Total Basidual Chlorina ^[6] ^[7]	µg/L	2.0	8.0	60	
Total Residual Chiofineta (1)	lbs/day ^[4]	72	290	2,200	
Ammonia Total (as NI)	µg/L	600	2,400	6,000	
Ammonia, Total (as N)	lbs/day ^[4]	22,000	87,000	220,000	
Acute Toxicity ^[8]	Pass/Fail, % Effect		Pass		
Chronic Toxicity ^[9]	Pass/Fail, % Effect		Pass		
	µg/L	0.009	0.018	0.027	
Endosuliantis	lbs/day ^[4]	0.32	0.65	0.97	
Endrin	µg/L	0.002	0.004	0.006	
Endrin	lbs/day ^[4]	0.071	0.14	0.21	
Hexachlorocyclohexanes	µg/L	0.004	0.008	0.012	
(HCH) ^[11]	lbs/day ^[4]	0.14	0.29	0.43	
Radioactivity Not to exceed limits specifie Regulations, title 22, division		mits specified in Ca 22, division 4, cha section 64443	alifornia Code of pter 15, article 5,		

^[1] The six-month median shall apply as a moving median of daily values for any 180-day period in which daily values represent flow-weighted average concentrations within a 24-hour period. For intermittent discharges, the daily value shall be considered to equal zero for days on which no discharge occurred. The six-month median limit on daily mass emissions shall be determined using the six-month median effluent concentration as Ce and the observed flow rate Q in millions of gallons per day (each variable referring to Equation 3 of the Ocean Plan).

^[2] The daily maximum shall apply to flow-weighted 24-hour composite samples except total chlorine residual, ammonia, acute toxicity and chronic toxicity which are collected as grab samples. The daily maximum mass emission shall be determined using the daily maximum effluent concentration limit as Ce and the observed flow rate Q in millions of gallons per day (each variable referring to Equation 3 of the Ocean Plan).

MONTEREY ONE WATER REGIONAL WWTP AND AWPF

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- ^[3] The instantaneous maximum shall apply to grab sample determinations.
- ^[4] The mass-based (lbs/day) effluent limitations in this table are based on the average dry weather flow design capacity of 29.6 MGD for the treatment facility and are therefore only good up to this flow. For flows above 29.6 MGD, mass-based effluent limitations shall be calculated individually using the concentration-based effluent limitations and the observed flow at the time of sampling per the following equation:

lbs/day = 0.00834 x Ce x Q

where:

 $Ce = the effluent concentration limit in \mu g/L$

Q = observed flow rate in MGD

- ^[5] If the Discharger can demonstrate to the satisfaction of the Central Coast Water Board (subject to U.S. EPA approval) that an analytical method is available to reliably distinguish between strongly and weakly complexed cyanide, effluent limitations for cyanide may be met by the combined measurement of free cyanide, simple alkali metal cyanides, and weakly complexed organometallic cyanide complexes. In order for the analytical method to be acceptable, the recovery of free cyanide from metal complexes must be comparable to that achieved by the approved method in 40 C.F.R. part 136, as revised May 14, 1999.
- ^[6] Water quality objectives for total chlorine residual applying to intermittent discharges not exceeding two hours shall be determined using the following equation:

 $log_y=-0.43(log_x)+1.8$ where: y = the water quality objective (in $\mu g/L$) to apply when chlorine is being discharged; and

x = the duration of uninterrupted chlorine discharge in minutes.

The applicable effluent limitation must then be determined using Equation No. 1 from the Ocean Plan.

- ^[7] The Discharger is not required to disinfect secondary effluent due to treatment system performance and outfall configuration and placement. The total chlorine residual effluent limitations are retained in this Order in the event the Discharger implements chlorine-based disinfection in the future and to verify compliance with Ocean Plan Table 1 pollutant monitoring requirements which include total chlorine residual.
- ^[8] As specified in section VII.G of this Order and section V of the MRP (Attachment E).
- ^[9] As specified in section VII.G of this Order and section V of the MRP (Attachment E).
- ^[10] Endosulfan shall mean the sum of endosulfan-alpha and –beta and endosulfan sulfate.
- ^[11] HCH shall mean the sum of the alpha, beta, gamma (lindane) and delta isomers of hexachlorocyclohexane.
- ^[12] For compliance determination with effluent limitations, except acute and chronic toxicity, the Discharger shall report the calculated Co instantaneous maximum, daily maximum, and 6-month median results for comparison to effluent limitations.

The Co shall be calculated and reported using the equation below:

$$Co = \frac{Ce + DmCs}{1 + Dm}$$

where:

- Co = the concentration at the completion of initial dilution to be compared to effluent limitations in Table 6 of this Order for compliance determination.
- Ce = effluent concentration reported for Monitoring Location EFF-001.
- Cs = background seawater concentration provided in Table 3 of the 2015 Ocean Plan (with all metals expressed as total recoverable concentration, μg/L
- Dm = the minimum probable initial dilution corresponding to Concentrate Waste Dilution Ratio as follows:

Ratio of RO Concentrate + Hauled Saline Waste to Total Effluent	Dm for Compliance with Ocean Plan Table 1 Parameters (except acute toxicity)
0-0.127	145
0.128 - 0.421	259
0.422 - 0.744	388
≥ 0.745	473

^[13] For Acute and Chronic Toxicity, the Discharger shall calculate and report Pass/Fail at the Instream Waste Concentration (IWC) where the IWC is determined in the following table:

Ratio of RO Concentrate + Hauled Saline Waste to Total	Dm for Com Whole Efflu Lir	npliance with Jent Toxicity nits	IWC (%) ^[3]	
Effluent ^[1]	Acute Toxicity ^[2]	Chronic Toxicity	Acute Toxicity	Chronic Toxicity
0-0.127	14.5	145	6.4	0.68
0.128 - 0.421	25.9	259	3.7	0.38
0.422 – 0.744	38.8	388	2.5	0.26
≥ 0.745	47.3	473	2.0	0.21

Table 7. Instream Waste Concentration (IWC)

^[1] Where the toxicity test requires sample collection on multiple days, the Discharger shall base the IWC on the lowest anticipated concentrate waste dilution ratio over the course of the discharge. The minimum probable initial dilution is expressed as parts seawater per part wastewater. For example, a Dm of 145 represents 1 part solute to 145 parts dilutant for a total of 146 parts.

^[2] Dm (acute toxicity) = 10% of Dm ^[3] IWC = $\frac{1}{Dm+1} \times 100$

Table 8. Effluent Limitations for the Protection of Human Health – (Non-Carcinogens)

Parameter	Units	Average Monthly
Aarolain	μg/L	220
Actolem	lbs/day ^[1]	7,900
Antimony	µg/L	1,200
Antimony	lbs/day ^[1]	43,000
Big(2 Chloroothoxy)Mothono	µg/L	4.4
Bis(2-Chioroethoxy)Methane	lbs/day ^[1]	160
	µg/L	1,200
Bis(2-Chioroisopropyi)Ether	lbs/day ^[1]	43,000
Chlorobonzono	µg/L	570
Chlorobenzene	lbs/day ^[1]	21,000
	µg/L	3,500
DI-n-Butyi Phthalate	lbs/day ^[1]	130,000
Dichlorohonzonoo	µg/L	5,100
Dichlorobenzenes	lbs/day ^[1]	180,000
Diethyl Phthalate	μg/L	33,000

Parameter	Units	Average Monthly
	lbs/day ^[1]	1,200,000
Dimethyl Phthalate	µg/L	820,000
	lbs/day ^[1]	30,000,000
2 Mathyl 4 6 Dinitrophonal	µg/L	220
	lbs/day ^[1]	7,900
2.4 Dipitrophonol	µg/L	4.0
2,4-Dinitrophenol	lbs/day ^[1]	140
Ethylhonzono	µg/L	4,100
Ethylbenzene	lbs/day ^[1]	150,000
Fluerenthene	µg/L	15
Fidoralitiene	lbs/day ^[1]	540
Hexachlorocyclopentadiene	µg/L	58
	lbs/day ^[1]	2,100
Nitrobenzene	µg/L	4.9
	lbs/day ^[1]	180
Thellium	µg/L	2.0
Inallium	lbs/day ^[1]	72
Toluene	µg/L	85,000
	lbs/day ^[1]	3,100,000
Tributyltin	µg/L	0.0014
	lbs/day ^[1]	0.050
1 1 1 Trichlaraathana	µg/L	540,000
1, 1, 1-1 richioroethane	lbs/day ^[1]	19,000,000

^[1] The mass-based (lbs/day) effluent limitations in this table are based on the average dry weather flow design capacity of 29.6 MGD for the treatment facility and are therefore only good up to this flow. For flows above 29.6 MGD, mass-based effluent limitations shall be calculated individually using the concentration-based effluent limitations and the observed flow at the time of sampling per the following equation:

lbs/day = $0.00834 \times Ce \times Q$ where: Ce = the effluent concentration limit in $\mu g/L$ Q = observed flow rate in MGD

Table 9. Effluent Limitations for the Protection of Human Health – (Carcinoge	ns)
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Parameter	Units	Average Monthly
Acridonitrilo	μg/L	0.1
Acryionithie	lbs/day ^[1]	3.6
Aldrin	µg/L	0.000022
Aldin	lbs/day ^[1]	0.00079
Ponzono	µg/L	5.9
Benzene	lbs/day ^[1]	210
Ponzidino	µg/L	0.000069
Denziume	lbs/day ^[1]	0.0025
Beryllium	µg/L	0.033

Parameter	Units	Average Monthly
	lbs/day ^[1]	1.2
Bis(2-Chloroethyl)Ether	µg/L	0.045
	lbs/day ^[1]	1.6
	µg/L	3.5
Bis(2-Ethylnexyl)Phthalate	lbs/day ^[1]	130
Carbon Tatraphlarida	µg/L	0.90
Carbon letrachloride	lbs/day ^[1]	32
	µg/L	0.000023
	lbs/day ^[1]	0.00083
<u>Oble ve dib ve ve eve eth eve e</u>	µg/L	8.6
	lbs/day ^[1]	310
Chloroform	μg/L	130
	lbs/day ^[1]	4,700
1.4 Diablarabarrara	µg/L	18
1,4 Dichlorobenzene	lbs/day ^[1]	650
	µg/L	0.0081
3,3'-Dichlorobenzidine	lbs/day ^[1]	0.29
	µg/L	28
1,2-Dichloroethane	lbs/day ^[1]	1,000
	µg/L	0.9
I,1-Dichloroethylene	lbs/day ^[1]	32
	µg/L	6.2
Dichlorobromomethane	lbs/day ^[1]	220
Dichloromethane (Methylene	µg/L	450
Chloride)	lbs/day ^[1]	16,000
2	µg/L	0.00004
Dieldrin	lbs/day ^[1]	0.0014
	μg/L	2.6
2,4-Dinitrotoluene	lbs/day ^[1]	94
	μg/L	0.16
i,2-Diphenyihydrazine	lbs/day ^[1]	5.8
1-1	μg/L	130
Talomethanes ^{13]}	lbs/day ^[1]	4,700
	μg/L	0.00005
-eptachlor	lbs/day ^[1]	0.0018
	μg/L	0.00002
Heptachlor Epoxide	lbs/day ^[1]	0.00072
	μα/L	0.00021
Hexachlorobenzene	lbs/dav ^[1]	0.0076
Hexachlorobutadiene	ua/L	14
	lbs/dav ^[1]	500
Hexachloroethane	uq/l	25

Parameter	Units	Average Monthly
	lbs/day ^[1]	90
leephorene	μg/L	730
Isophorone	lbs/day ^[1]	26,000
	μg/L	7.3
N-Nitrosodimetriylarnine	lbs/day ^[1]	260
N Nitropodi n Bronylamina	μg/L	0.38
N-Nillosodi-II-Propylamine	lbs/day ^[1]	14
N. Nitropodiphonylamina	μg/L	2.5
N-Nitrosodiphenylamine	lbs/day ^[1]	90
Relyableringted Piphanyla (PCPa) ^[4]	μg/L	0.000019
Polychionnated Biphenyis (PCBS)	lbs/day ^[1]	0.00068
	μg/L	3.9E-09
I CDD Equivalents ¹³	lbs/day ^[1]	1.4E-07
	μg/L	2.3
1, 1, 2, 2-1 etrachioroetriane	lbs/day ^[1]	83
Tetrachloroethylene	μg/L	2.0
	lbs/day ^[1]	72
Toyonhono	μg/L	0.00021
Toxaphene	lbs/day ^[1]	0.0076
Trichloroothylopo	μg/L	27
l richioroethylene	lbs/day ^[1]	970
1,1,2-Trichloroethane	µg/L	9.4
	lbs/day ^[1]	340
2.4.6 Triphlerenhanel	μg/L	0.29
2,4,0-111010100110100	lbs/day ^[1]	10
Vinyl Chlorida	μg/L	36
	lbs/day ^[1]	1,300

^[1] The mass-based (lbs/day) effluent limitations in this table are based on the average dry weather flow design capacity of 29.6 MGD for the treatment facility and are therefore only good up to this flow. For flows above 29.6 MGD, mass-based effluent limitations shall be calculated individually using the concentration-based effluent limitations and the observed flow at the time of sampling per the following equation:

lbs/day = 0.00834 x Ce x Q

where:

Ce = the effluent concentration limit in μ g/L

Q = observed flow rate in MGD

- ^[2] Chlordane shall mean the sum of chlordane-alpha, chlordane-gamma, chlordane-alpha, chlordane-gamma, nonachlor-alpha, nonachlor-gamma, and oxychlordane.
- ^[3] Halomethanes shall mean the sum of bromoform, bromomethane (methyl bromide), and chloromethane (methyl chloride).
- ^[4] Polychlorinated biphenyls (PCBs) shall mean the sum of chlorinated biphenyls whose analytical characteristics resemble those of Aroclor-1016, Aroclor-1221, Aroclor-1232, Aroclor-1242, Aroclor-1248, Aroclor-1254, and Aroclor-1260.
- ^[5] TCDD Equivalents shall mean the sum of the concentrations of chlorinated dibenzodioxins (2,3,7,8-CDDs) and chlorinated dibenzofurans (2,3,7,8-CDFs) multiplied by their respective toxicity factors, as shown below:

	Toxicity Equivalence
Isomer Group	Factor
	1 40101
2,3,7,8-tetra CDD	1.0
2,3,7,8-penta CDD	0.5
2,3,7,8-hexa CDDs	0.1
2,3,7,8-hepta CDD	0.01
octa CDD	0.001
2,3,7,8 tetra CDF	0.1
1,2,3,7,8 penta CDF	0.05
2,3,4,7,8 penta CDF	0.5
2,3,7,8 hexa CDFs	0.1
2,3,7,8 hepta CDFs	0.01
octa CDF	0.001

- **d. Bacteria.** The following total coliform, fecal coliform, and enterococcus effluent limits apply at Discharge Point 001 (with compliance measured at Monitoring Location EFF-001B) if the Executive Officer concludes from a bacterial assessment (described in Receiving Water Limitation A.1) that the discharge consistently exceeds Receiving Water Limitation A.1.
 - i. The daily maximum total coliform density shall not exceed 10,000 MPN/100 mL.
 - ii. The daily maximum fecal coliform density shall not exceed 400 MPN/100 mL.
 - iii. The daily maximum enterococcus density shall not exceed 104 MPN/100 mL.
- e. Minimum Initial Dilution. The minimum initial dilution of treated effluent at the point of discharge to Monterey Bay shall not be less than the minimum probable initial dilution (Dm) values in Table 10. The allowable Dm value corresponds to the associated ratio of seawater to the combined volume of AWPF reverse osmosis (RO) concentrate, hauled saline waste, and secondary effluent.

B. Land Discharge Specifications – Discharge Point – Not Applicable

C. Recycling Specifications - Discharge Point 002

Water reclamation requirements have been added to this permit to allow the Discharger to produce disinfected tertiary recycled water at the Salinas Valley Reclamation Project (SVRP) as per the September 12, 2017 State Water Resources Control Board's Division of Drinking Water approval.

 Reclamation and use of tertiary treated wastewater shall adhere to applicable requirements of CWC sections 13500-13577 (Water Reclamation); California Code of Regulations title 17, sections 7583-7586; title 17 sections 7601-7605; and title 22, sections 60301-60355 (Uniform Statewide Recycling Criteria). Production and reuse of recycled water at the facility is currently regulated separately under Water Reclamation Requirements Order No. 94-082. Specifications related to recycled water production are also included here. The Central Coast Water Board intends to rescind Order No. 94-082 and regulate the production of recycled water by this Order.

- 2. Recycled water production shall comply with a title 22 engineering report approved by the Division of Drinking Water that demonstrates or defines compliance with the Uniform Statewide Recycling Criteria (and amendments).
- **3.** Recycled water shall be disinfected tertiary recycled water, as defined by title 22, section 60301.230.
- 4. Recycled water shall be adequately oxidized, filtered, and disinfected, as defined in title 22.
- **5.** The Discharger shall comply with the following specifications at Discharge Point No. 002 for reclamation of tertiary treated secondary wastewater, with compliance measured at Monitoring Location REC-001, as described in the attached MRP.

		Effluent Limitations	
Parameter	Units	Average Monthly	Maximum Daily
BOD₅	mg/L	10	20
TSS	mg/L	10	20

 Table 9. Disinfected Tertiary Recycled Water Limitations

- 6. The rate of filtration through the tertiary filters at INT-001 shall not exceed 7.5 gpm/ft^2 of surface area.
- **7.** Filtered recycled water at INT-002 shall not exceed any of the following turbidity limits:
 - a. An average of 2 NTU within a 24-hour period,
 - b. 5 NTU more than 5 percent of the time within a 24-hour period, and
 - c. 10 NTU at any time.
- **8.** The concentration of total coliform bacteria measured at REC-001 (after disinfection) shall not exceed the following limits:
 - **a.** A median MPN of 2.2 per 100 mL utilizing the bacteriological results of the last seven days for which analyses have been completed,
 - **b.** An MPN of 23 per 100 mL in more than one sample in any 30-day period, and
 - c. An MPN of 240 total coliform bacteria per 100 mL in any one sample.
- **9.** Freeboard shall always exceed two feet in all recycled water storage ponds owned and operated by the Discharger.
- **10.** The Discharger shall discontinue delivery of recycled water to distributors and users during any period in which it has reason to believe that the limits established in this Order are not being met. The delivery of recycled water shall not be resumed until all conditions that caused the limits to be violated have been corrected.

- **11.** Recycled water disinfected with chlorine shall have a CT value (chlorine concentration time modal contact time) of not less than 450 mg-min/L at all times with a modal contact time of at least 90 minutes.
- 12. In lieu of 11 above, recycled water may be disinfected by a process that when combined with the filtration process, has been demonstrated to inactivate and/or remove 99.999 percent of the plaque forming units of F-specific bacteriophage MS2, or polio virus in the wastewater. A virus that is at least as resistant to disinfection as polio virus may be used for purposes of the demonstration.
- **13.** Recycled water shall be confined to areas of authorized use at the WWTP and permitted construction projects without discharge to surface waters or drainage ways.
- **14.** Personnel involved in producing, transporting, or using recycled water shall be informed of possible health hazards that may result from contact and use of recycled water.
- **15.** Spray irrigation of recycled water at the WWTP or construction sites shall be accomplished at a time and in a manner to minimize ponding and contact with the public.
- **16.** Delivery of recycled water shall be discontinued when these recycling specifications cannot be met.
- **17.** All recycled water reservoirs and other areas with public access shall be posted with signs in English and an international symbol to warn the public that recycled wastewater is being stored or used.
- **18.** Recycled water systems at the WWTP site shall be properly labeled and regularly inspected to ensure proper operation, absence of leaks, and absence of illegal connections.

V. RECEIVING WATER LIMITATIONS

A. Surface Water Limitations

The following receiving water limitations are based on water quality objectives contained in the Ocean Plan and are a required part of this Order. Compliance shall be determined from samples collected at stations representative of the area within the waste field where initial dilution is completed. The discharge shall not cause the following in the Pacific Ocean.

1. Bacterial Characteristics

a. Within a zone bounded by the shoreline and a distance of 1,000 feet from the shoreline or the 30-foot depth contour, whichever is further from the shoreline, and in areas outside this zone used for water contact sports, as determined by the Central Coast Water Board, but including all kelp beds, the following bacteriological objectives shall be maintained throughout the water column.

30-Day Geometric Mean – The following standards are based on the geometric mean of the five most recent samples from each receiving water monitoring location.

i. Total coliform density shall not exceed 1,000 MPN per 100 mL, nor shall a single sample density;

- ii. Fecal coliform density shall not exceed 200 MPN per 100 mL; and
- iii. Enterococcus density shall not exceed 35 MPN per 100 mL.

Single Sample Maximum (SSM) – The following standards are allowable single sample maximums.

- i. Total coliform density shall not exceed 10,000 MPN per 100 ml;
- ii. Fecal coliform density shall not exceed 400 MPN per 100 mL;
- iii. Enterococcus density shall not exceed 104 MPN per 100 mL; and
- iv. Total coliform density shall not exceed 1,000 MPN per 100 mL when the fecal coliform to total coliform ratio exceeds 0.1

2. Shellfish Harvesting Standards

At all areas where shellfish may be harvested for human consumption, as determined by the Central Coast Water Board, the following bacteriological objectives shall be maintained throughout the water column:

a. The median total coliform density shall not exceed 70 organisms per 100 mL, and in not more than 10 percent of samples shall coliform density exceed 230 organisms per 100 mL.

3. Physical Characteristics

- a. Floating particulates and grease and oil shall not be visible.
- **b.** The discharge of waste shall not cause aesthetically undesirable discoloration of the ocean surface.
- **c.** Natural light shall not be significantly reduced at any point outside the initial dilution zone as the result of the discharge of waste.
- **d.** The rate of deposition of inert solids and the characteristics of inert solids in ocean sediments shall not be changed such that benthic communities are degraded.
- e. Discharges shall not cause exceedances of water quality objectives for ocean waters of the State established in Table 1 of the Ocean Plan.

4. Chemical Characteristics

- **a.** The dissolved oxygen concentration shall not, at any time, be depressed more than 10 percent from that which occurs naturally as a result of the discharge of oxygen-demanding waste.
- **b.** The pH shall not be changed at any time more than 0.2 units from that which occurs naturally.
- **c.** The dissolved sulfide concentrations of waters in and near sediments shall not be significantly increased above those present under natural conditions.
- **d.** The concentrations of substances set forth in Ocean Plan, Table 1, shall not be increased to levels in marine sediments that would degrade indigenous biota.

- e. The concentration of organic materials in marine sediments shall not be increased to that which would degrade marine life.
- **f.** Nutrient materials shall not cause objectionable aquatic growth or degrade indigenous biota.

5. Biological Characteristics

- **a.** Marine communities, including vertebrate and plant species, shall not be degraded.
- **b.** The natural taste, odor, and color of fish, shellfish, or other marine resources used for human consumption shall not be altered.
- **c.** The concentration of organic materials in fish, shellfish, or other marine resources used for human consumption shall not bioaccumulate to levels that are harmful to human health.

6. Radioactivity

- a. Discharge of radioactive waste shall not degrade marine life.
- **b.** Radionuclides shall not be present in concentrations that are deleterious to human, plant, animal, or aquatic life; or result in the accumulation of radionuclides in the food web to an extent that presents a hazard to human, plant, animal, or aquatic life.

7. General Standards

- a. The discharge shall not cause a violation of any applicable water quality objective or standard for receiving waters adopted by the Central Coast Water Board or State Water Resources Control Board (State Water Board), as required by the CWA and regulations adopted thereunder.
- **b.** Waste management systems that discharge to the ocean must be designed and operated in a manner that will maintain the indigenous marine life and a healthy and diverse marine community.
- **c.** Waste effluents shall be discharged in a manner that provides sufficient initial dilution to minimize the concentrations of substances not removed in the treatment.

B. Groundwater Limitations

Activities at the WWTP shall not cause exceedance/deviation from the following water quality objectives for groundwater established by the Basin Plan.

- 1. Groundwater shall not contain taste or odor producing substances in concentrations that adversely affect beneficial uses.
- 2. Radionuclides shall not be present in concentrations that are deleterious to human, plant, animal, or aquatic life; or result in the accumulation of radionuclides in the food web to an extent that presents a hazard to human, plant, animal, or aquatic life.

VI. PROVISIONS

A. Standard Provisions

1. The Discharger shall comply with all Standard Provisions included in Attachment D.

- 2. The Discharger shall comply with all Central Coast Water Board specific Standard Provisions also included in Attachment D of this Order.
- **3.** Before changing the point of discharge, place of use, or purpose of use of treated wastewater that results in a decrease of flow in any portion of an inland watercourse, in any way, the Discharger shall file a petition with the State Water Board, Division of Water Rights, and receive approval for such a change (Water Code section 1211).

B. Monitoring and Reporting Program (MRP) Requirements

Pursuant to Water Code sections 13267 and 13383, the Discharger shall comply with the MRP, and future revisions thereto, in Attachment E of this Order, and all notification and general reporting requirements throughout this Order and Attachment D. Where notification or general reporting requirements conflict with those stated in the MRP (e.g., annual report due date), the Discharger shall comply with the MRP requirements. All monitoring shall be conducted according to 40 C.F.R. part 136, *Guidelines Establishing Test Procedures for Analysis of Pollutants*.

The Discharger is required to provide technical or monitoring reports because it is the owner and operator responsible for the waste discharge and compliance with this Order. The Central Coast Water Board needs the information to determine the Discharger's compliance with this Order, assess the need for further investigation or enforcement action, and to protect public health and safety and the environment.

C. Special Provisions

1. Reopener Provisions

a. This Order may be reopened for modification to include an effluent limitation if monitoring establishes that the discharge causes, has the reasonable potential to cause, or contributes to an excursion above a California Ocean Plan (Ocean Plan) Table 1 water quality objective.

2. Special Studies, Technical Reports and Additional Monitoring Requirements

a. Toxicity Reduction Evaluation Requirements

This Provision requires the Discharger to investigate the causes of, and identify corrective actions to reduce or eliminate effluent toxicity. If the discharge consistently exceeds an effluent limitation for toxicity specified in Section IV of this Order, the Discharger shall conduct a Toxicity Reduction Evaluation (TRE) in accordance with the Discharger's approved TRE Work Plan.

A TRE is a study conducted in a step-wise process designed to identify the causative agents of effluent toxicity, evaluate the effectiveness of toxicity control options, and then confirm the reduction in effluent toxicity. The first steps of the TRE consist of the collection of data relevant to the toxicity, including additional toxicity testing, and an evaluation of facility operations and maintenance practices, and best management practices. A Toxicity Identification Evaluation (TIE) may be required as part of the TRE, if appropriate. A TIE is a set of procedures to identify the specific chemical(s) responsible for toxicity. These procedures are performed in three phases: characterization; identification; and confirmation using aquatic organism toxicity tests. The TRE shall include all reasonable steps to identify the

source of toxicity. The Discharger shall take all reasonable steps to reduce toxicity to the required level once the source of toxicity is identified.

- **TRE Work Plan.** Within ninety days of the permit effective date, the i. Discharger shall prepare and submit an updated copy of their TRE Work Plan to the Central Coast Water Board and U.S. EPA Region 9 for review and approval. The TRE Work Plan shall be prepared in accordance with Toxicity Reduction Evaluation Guidance for Municipal Wastewater Treatment Plants (EPA/833/B-99-022). This TRE Work Plan shall include steps the Discharger intends to implement if toxicity is measured above an effluent limitation and should include, at minimum: a) a description of the investigation and evaluation techniques that would be used to identify potential causes and sources of toxicity, effluent variability, and treatment system efficiency, b) a description of methods for maximizing in-house treatment system efficiency, good housekeeping practices, and a list of all chemicals used in operations at the facility, and c) if a TIE is necessary, an indication of who would conduct the TIEs (i.e., an in-house expert or outside contractor).
- ii. Accelerated Monitoring and TRE Initiation. When an effluent limitation for acute or chronic toxicity is exceeded during regular whole effluent toxicity (WET) monitoring, the Discharger shall initiate accelerated monitoring as required in the Accelerated Monitoring Specifications of this Provision. The Discharger shall initiate a TRE to address effluent toxicity if any WET test results exceeds the acute or chronic effluent limit during accelerated monitoring. The Discharger shall take all reasonable steps to reduce toxicity once the source of toxicity is identified.
- **b.** Accelerated Monitoring Specifications: If the chronic toxicity effluent limit is exceeded during regular chronic toxicity monitoring, the Discharger shall initiate accelerated monitoring within 14 days of notification by the laboratory of the exceedance.

i. The following protocol shall be used for accelerated monitoring and TRE initiation.

- (a) If accelerated monitoring is triggered on the basis of an acute or chronic toxicity effluent limit exceedance, accelerated WET testing shall utilize a 5-concentration plus control dilution series bracketing the discharge instream waste concentration (IWC), thus permitting an evaluation of magnitude of effect through point estimate (i.e., EC25) analysis.
- (b) If the acute toxicity effluent limit is exceeded during regular acute toxicity monitoring, the Discharger shall immediately resample the effluent and retest for acute toxicity.
- (c) If the toxicity effluent limit is exceeded and the source of toxicity is known (e.g., a temporary plant upset), the Discharger shall make necessary corrections to the facility and shall conduct one additional toxicity test using the same species and test method that exhibited toxicity. If the additional toxicity test does not

exceed the toxicity effluent trigger, then the Discharger may return to their regular testing frequency. However, notwithstanding the accelerated monitoring results, if there is evidence of a pattern of recurring effluent toxicity, the Executive Officer may require that the Discharger initiate a TRE.

- (d) If the toxicity effluent limit is exceeded and the source of toxicity is not known, the Discharger shall conduct five additional toxicity tests conducted once every two weeks using the same species and test method that exhibited toxicity. If none of the additional toxicity tests exceed the toxicity trigger, then the Discharger may return to their regular testing frequency. However, notwithstanding the accelerated monitoring results, if there is evidence of a pattern of recurring effluent toxicity, the Executive Officer may require that the Discharger initiate a TRE.
- (e) If the result of any accelerated toxicity test exceeds the acute or chronic effluent limit, the Discharger shall cease accelerated monitoring and begin a TRE to investigate the cause(s) of, and identify corrective actions to reduce or eliminate effluent toxicity. Within thirty days of notification by the laboratory of any test result exceeding the acute or chronic effluent limit during accelerated monitoring, the Discharger shall develop and implement a TRE Action Plan which shall include at a minimum: a) specific actions the Discharger will take to investigate, identify, and correct the causes of toxicity, b) specific actions the Discharger will take to mitigate the impact of the discharge and prevent the recurrence of toxicity, and c) a schedule for these actions. This TRE Action Plan and schedule are subject to approval and modification by the Executive Officer. A failure to conduct TRE-related toxicity tests or a TRE within an approved period may result in the establishment of numerical effluent limitations for chronic toxicity in a permit or appropriate enforcement action. While in a TRE, TRE-related toxicity testing conducted as part of the TRE investigation will not be subject to enforcement action.
- (f) Results of the initial failed test and any toxicity monitoring results subsequent to the failed test shall be reported as soon as reasonable to the Central Coast Water Board EO. The EO will determine whether it is appropriate to initiate enforcement action, require the Discharger to implement TRE requirements (sections VI.C.2.a of this Order), or implement other measures.

c. Water Contact Monitoring (Bacterial Characteristics)

In accordance with Ocean Plan section III.D.1.b, if a single sample exceeds any of the bacteriological SSM standards contained within section V.A.1 of this Order, repeat sampling at that location shall be conducted to determine the extent and persistence of the exceedance. The Executive Officer (EO) shall be notified within 24 hours of receiving analytical results and repeat sampling shall be conducted within 24 hours of receiving analytical results and continued based per a sampling frequency as directed by the EO until the sample result is less than the SSM standard or until a sanitary survey is conducted to determine the source of the high bacterial densities.

When repeat sampling is required because of an exceedance of any one single sample density, values from all samples collected during that 30-day period will be used to calculate the geometric mean.

(This requirement is also footnoted in Table E-14 of section VIII.A of Attachment E Monitoring and Reporting Program.)

d. Brine Waste Disposal Study

Prior to increasing the volume of desalination brine waste discharged through the ocean outfall beyond 375,000 gallons maximum daily flow, the Discharger shall submit a brine waste disposal study to the Executive Officer for approval. The study shall include, at a minimum, the following elements: (1) a projection of the desalination brine volume and characteristics, (2) an assessment of the impact of the increased desalination brine volume on permit compliance. (3) an assessment of the impact of the increased desalination brine volume on the minimum probable initial dilution at the point of discharge, (4) a detailed description of any desalination brine waste disposal facilities that are proposed to accommodate the increased desalination brine volume and facilitate blended secondary effluent and desalination brine wastes flow metering and sampling, and (5) a schedule for the design and construction of the new desalination brine disposal facilities. The Order includes a requirement to send a copy of the study to the Monterey Bay National Marine Sanctuary (MBNMS).

e. Ocean Outfall and Diffuser Monitoring

The Discharger shall conduct a dye dilution study once per year for 4 years to visually inspect the entire outfall structure to determine whether there are leaks, potential leaks, or malfunctions. This inspection shall be conducted along the outfall pipe/diffuser system from landfall to its ocean terminus. During year 5, a physical outfall inspection will be conducted to check the structural integrity and possible external blockage of ports by rocks or sand deposition. Results of the dye studies and outfall inspections shall be reported in the applicable annual reports.

3. Best Management Practices and Pollution Prevention

a. Pollutant Minimization Program

The Discharger shall develop and conduct a Pollutant Minimization Program (PMP) as further described below when there is evidence (e.g., sample results reported as DNQ when the effluent limitation is less than the MDL, sample results from analytical methods more sensitive than those methods required by this Order, presence of whole effluent toxicity, health advisories for fish consumption, results of benthic or aquatic organism tissue sampling) that a pollutant is present in the effluent above an effluent limitation and either:

i. The concentration of the pollutant is reported as DNQ and the effluent limitation is less than the reported ML;

- **ii.** The concentration of the pollutant is reported as ND and the effluent limitation is less than the MDL, using definitions described in Attachment A and reporting protocols described in MRP section X.B.4.
- **iii.** There is evidence showing that the pollutant is present in the effluent above the calculated effluent limitation. Such evidence may include: health advisories for fish consumption; presence of whole effluent toxicity; results of benthic or aquatic organism tissue sampling; sample results from analytical methods more sensitive than methods included in the permit; and the concentration of the pollutant is reported as DNQ and the effluent limitation is less than the MDL.

The PMP shall include, but not be limited to, the following actions and submittals acceptable to the Central Coast Water Board:

- i. An annual review and semi-annual monitoring of potential sources of the reportable pollutant(s), which may include fish tissue monitoring and other bio-uptake sampling;
- **ii.** Quarterly monitoring for the reportable pollutant(s) in the influent to the wastewater treatment system;
- **iii.** Submittal of a control strategy designed to proceed toward the goal of maintaining concentrations of the reportable pollutant(s) in the effluent at or below the effluent limitation;
- iv. Implementation of appropriate cost-effective control measures for the reportable pollutant(s), consistent with the control strategy; and
- v. An annual status report that shall be sent to the Central Coast Water Board including:
 - a) All PMP monitoring results for the previous year;
 - b) A list of potential sources of the reportable pollutant(s);
 - c) A summary of all actions undertaken pursuant to the control strategy; and
 - d) A description of actions to be taken in the following year.

4. Construction, Operation and Maintenance Specifications

a. The Facility shall be operated as specified under Standard Provision I.D of Attachment D.

5. Special Provisions for Publicly Owned Treatment Works (POTWs)

a. Biosolids Management

Provisions regarding sludge handling and disposal ensure that such activity will comply with all applicable regulations. 40 C.F.R. part 503 sets forth U.S. EPA's final rule for the use and disposal of biosolids, or sewage sludge, and governs the final use or disposal of biosolids. The intent of this federal program is to ensure that sewage sludge is used or disposed of in a way that protects both human health and the environment. U.S. EPA's regulations require that producers of sewage sludge meet certain reporting, handling, and disposal requirements. As the U.S. EPA has not delegated the authority to implement the sludge program to the State of California, the

enforcement of sludge requirements that apply to the Discharger remains under U.S. EPA's jurisdiction at this time. U.S. EPA, not the Regional Water Board, will oversee compliance with 40 C.F.R. part 503.

b. Pretreatment

The Discharger shall be responsible for the performance of all pretreatment requirements contained in 40 C.F.R. part 403 and shall be subject to enforcement actions, penalties, fines, and other remedies by the U.S. EPA, or other appropriate parties, as provided in the CWA, as amended (33 USA 1351 et seq.). The Discharger shall implement and enforce its Approved Publicly Owned Treatment Works (POTW) Pretreatment Program. Implementation of the Discharger's Approved POTW Pretreatment Program is hereby made an enforceable condition of this permit. U.S. EPA may initiate enforcement action against an industrial user for noncompliance with applicable standards and requirements as provided in the CWA.

The Discharger shall enforce the requirements promulgated under sections 307 (b), (c), & (d) and 402 (b) of the CWA. The Discharger shall cause industrial users subject to Federal Categorical Standards to achieve compliance no later than the date specified in those requirements or, in the case of a new industrial user, upon commencement of the discharge. The Discharger shall perform the pretreatment functions as required in 40 C.F.R. part 403, including, but not limited to:

- i. Implement necessary legal authorities as provided in 40 C.F.R. section 403.8 (f)(1);
- **ii.** Enforce the pretreatment requirements under 40 C.F.R. sections 403.5 and 403.6;
- iii. Implement the programmatic functions as provided in 40 C.F.R. 403.8 (f)(2); and,
- iv. Provide the requisite funding and personnel to implement the pretreatment program as provided in 40 C.F.R. section 403.8 (f)(3).

The Discharger shall submit annually a report to the U.S. EPA - Region 9, the Central Coast Water Board, and the State Water Board describing the Discharger's pretreatment activities over the previous twelve months. In the event that the Discharger is not in compliance with conditions or requirements of this permit affected by the pretreatment program, it shall also include reasons for non-compliance and a statement how and when it shall comply. This annual report is due by March 1 of each year and shall contain, but not be limited to, the contents described in the "Pretreatment Reporting Requirements" contained in the Monitoring and Reporting Program No. R3-2018-0017.

c. Collection System

The Discharger is subject to the requirements of, and must comply with State Water Resources Control Board (State Water Board) Order 2006-0003-DWQ, Statewide General Waste Discharge Requirements for Sanitary Sewer Systems, including monitoring and reporting requirements as amended by State Water Board Order WQ 2013-0058-EXEC and any subsequent order.
d. Resource Recovery from Anaerobically Digestible Material

If the Discharger will receive hauled-in anaerobically digestible material for injection into an anaerobic digester, the Discharger shall notify the Central Coast Water Board and develop and implement Standard Operating Procedures for this activity. The Standard Operation Procedures shall be developed prior to receiving hauled-in anaerobically digestible material. The Standard Operating Procedures shall address material handling, including unloading, screening, or other processing prior to anaerobic digestion; transportation; spill prevention; and spill response. In addition, the Standard Operating Procedures shall address avoidance of the introduction of materials that could cause interference, pass-through, or upset of the treatment processes; avoidance of prohibited material; vector control; odor control; operation and maintenance; and the disposition of any solid waste segregated from introduction to the digester. The Discharger shall train its staff on the Standard Operating Procedures and shall maintain records for a minimum of five years for each load received, describing the hauler, waste type, and quantity received. In addition, the Discharger shall maintain records for a minimum of five years for the disposition, location, and quantity of cumulative pre-digestion-segregated solid waste hauled offsite.

6. Other Special Provisions

a. Discharges of Storm Water

For the control of storm water discharged from the site of the wastewater treatment and disposal facilities, if applicable, the Discharger shall seek authorization to discharge under and meet the requirements of the State Water Resources Control Board's Water Quality Order 2014-0057- DWQ, NPDES General Permit No. CAS000001, Waste Discharge Requirements for Discharges of Storm Water Associated with Industrial Activities Excluding Construction Activities.

b. Concentrate Waste Dilution Ratio

For compliance with Ocean Plan Table 1 effluent limitations at Discharge Point 001, the Discharger will report a calculated concentration using an appropriate Dm, according to instructions in the MRP sections IV.B. The Dm is assigned on a given day based on the ratio of RO concentrate, and hauled saline waste from reverse osmosis or ion exchange regeneration systems to total effluent, referred to in this permit as the concentrate waste dilution ratio (see Table 10). Calculated concentrations are reported for Monitoring Location EFF-001B. Compliance is then determined by comparing limitations or Ocean Plan Table 1 objectives at Discharge Point 001 to calculated results at Monitoring Location EFF-001B. In addition, raw effluent monitoring results shall be reported for Monitoring Location EFF-001.

Ratio of RO Concentrate + Hauled Saline Waste to Total Effluent	Dm for Compliance with Ocean Plan Table 1 Parameters
0-0.127	145
0.128 - 0.421	259
0.422 – 0.744	388
≥ 0.745	473

Table 10. Concentrate Waste Dilution Ratio Ranges and Corresponding Dilution^[1]

^[1] Minimum probable initial dilution expressed as parts seawater per part wastewater.

7. Compliance Schedules – Not Applicable

VII. COMPLIANCE DETERMINATION

Compliance with the effluent limitations contained in Section IV of this Order will be determined as specified below:

A. General

Compliance with effluent limitations for reportable pollutants shall be determined using sample reporting protocols defined in the MRP and Attachment A of this Order. For purposes of reporting and administrative enforcement by the Central Coast and State Water Boards, the Discharger shall be deemed out of compliance with effluent limitations if the concentration of the reportable pollutant in the monitoring sample is greater than the effluent limitation and greater than or equal to the reported Minimum Level (ML).

B. Multiple Sample Data

When determining compliance with a measure of central tendency (arithmetic mean, geometric mean, median, etc.) of multiple samples analyses and the data set contains one or more reported determinations of "Detected, but Not Quantified" ("DNQ", or "Not Detected" (ND), the Discharger shall compute the median in place of the arithmetic mean in accordance with the following procedure:

- 1. The data set shall be ranked from low to high, ranking the reported ND determinations lowest, DNQ determinations next, followed by quantified values (if any). The order of the individual ND or DNQ determinations is unimportant.
- 2. The median value of the data set shall be determined. If the data set has an odd number of data points, then the median is the middle value. If the data set has an even number of data points, then the median is the average of the two values around the middle unless one or both of the points are ND or DNQ, in which case the median value shall be the lower of the two data points where DNQ is lower than a value and ND is lower than DNQ.

C. Average Monthly Effluent Limitation (AMEL)

If the average of daily discharges over a calendar month exceeds the AMEL for a given parameter, an alleged violation will be flagged and the Discharger will be considered out of compliance for each day of that month for that parameter (e.g., resulting in 31 days of non-compliance in a 31-day month). The average of daily discharges over the calendar month that exceeds the AMEL for a parameter will be considered out of compliance for that month only. If only a single sample is taken during the calendar month and the analytical result for that sample exceeds the

AMEL, the Discharger will be considered out of compliance for that calendar month. For any one calendar month during which no sample (daily discharge) is taken, no compliance determination can be made for that calendar month.

D. Average Weekly Effluent Limitation (AWEL)

If the average of daily discharges over a calendar week exceeds the AWEL for a given parameter, an alleged violation will be flagged and the Discharger will be considered out of compliance for each day of that week for that parameter, resulting in 7 days of non-compliance. The average of daily discharges over the calendar week that exceeds the AWEL for a parameter will be considered out of compliance for that week only. If only a single sample is taken during the calendar week and the analytical result for that sample exceeds the AWEL, the Discharger will be considered out of compliance for that calendar week. For any one calendar week during which no sample (daily discharge) is taken, no compliance determination can be made for that calendar week.

E. Maximum Daily Effluent Limitation (MDEL)

If a daily discharge exceeds the MDEL for a given parameter, an alleged violation will be flagged and the Discharger will be considered out of compliance for that parameter for that 1 day only within the reporting period. For any 1 day during which no sample is taken, no compliance determination can be made for that day.

F. Acute and Chronic Toxicity

The discharge is subject to determination of "Pass" or "Fail" from an acute or chronic toxicity test using the Test of Significant Toxicity (TST) statistical t-test approach described in *National Pollutant Discharge Elimination System Test of Significant Toxicity Implementation Document* (EPA 833-R-10-004, 2010), Appendix A, Figure A-1 and Table A-1, and Appendix B, Table B-1. The null hypothesis (Ho) for the TST statistical approach is: Mean discharge "in-stream" waste concentration (IWC) response $\leq 0.75 \times$ Mean control response. A test result that rejects this null hypothesis is reported as "Pass." A test result that does not reject this null hypothesis is reported as "Fail." Acute and chronic WET testing is to be performed with only two test concentrations, the laboratory control and a single effluent treatment (the IWC). As discussed in Fact Sheet section IV.C.6, evaluation of concentration-response does not apply to single-concentration (IWC) tests where the TST is applied. Concentration-response is required during accelerated monitoring tests.

The MDEL for acute or chronic toxicity is exceeded and a violation will be flagged when an acute or chronic toxicity test, analyzed using the TST statistical approach, results in "Fail."

The acute and chronic toxicity MDELs are set at the IWC for the discharge and expressed in units of the TST statistical approach ("Pass" or "Fail"). The IWC will depend on the concentrate waste dilution ratio and applicable Dm as provided in Table 11 below.

Ratio of RO Concentrate +	Dm for Com Effluer	pliance with t Limits	I	IWC	
Effluent ^[1]	Acute Toxicity ^[2]	Chronic Toxicity	Acute Toxicity	Chronic Toxicity	
0-0.127	14.5	145	6.4	0.69	
0.128 – 0.421	25.9	259	3.7	0.39	
0.422 – 0.744	38.8	388	2.5	0.26	
≥ 0.745	47.3	473	2.0	0.21	

Table 11. Instream Waste Concentration (IWC)

 Where toxicity test requires sample collection on multiple days, the Discharger shall base the IWC on the lowest anticipated concentrate waste dilution ratio over the course of the discharge.
Based on Equation 2 in section III.C.4.b of the California Ocean Plan.

G. 6-Month Median

For compliance with effluent limitations expressed as a 6-month median, the Discharger shall calculate a moving 6-month median concentration from the results reported for Monitoring Location EFF-001B and compare them to the effluent limitations at Discharge Point 001. Other requirements for compliance determination are provided in the MRP section X.B.

ATTACHMENT A – DEFINITIONS

Acute Toxicity (not applicable to Test of Significant Toxicity hypothesis testing)

a. Acute Toxicity (TUa) Expressed in Toxic Units Acute (TUa)

$$TUa = \frac{100}{96-hr LC 50\%}$$

b. Lethal Concentration 50% (LC50)

LC50 (percent waste giving 50% survival of test organisms) shall be determined by static or continuous flow bioassay techniques using standard marine test species as specified in Ocean Plan Appendix III. If specific identifiable substances in wastewater can be demonstrated by the discharger as being rapidly rendered harmless upon discharge to the marine environment, but not as a result of dilution, the LC50 may be determined after the test samples are adjusted to remove the influence of those substances.

When it is not possible to measure the 96-hour LC50 due to greater than 50 percent survival of the test species in 100 percent waste, the toxicity concentration shall be calculated by the expression:

$$TUa = \frac{\log (100 - S)}{1.7}$$

where:

S = percentage survival in 100% waste. If S > 99, TUa shall be reported as zero.

Areas of Special Biological Significance (ASBS)

Those areas designated by the State Water Resources Control Board (State Water Board) as ocean areas requiring protection of species or biological communities to the extent that alteration of natural water quality is undesirable. All Areas of Special Biological Significance are also classified as a subset of State Water Quality Protection Areas.

Average Monthly Effluent Limitation (AMEL)

The highest allowable average of daily discharges over a calendar month, calculated as the sum of all daily discharges measured during a calendar month divided by the number of daily discharges measured during that month.

Average Weekly Effluent Limitation (AWEL)

The highest allowable average of daily discharges over a calendar week (Sunday through Saturday), calculated as the sum of all daily discharges measured during a calendar week divided by the number of daily discharges measured during that week.

Brine Waste

Waste with total dissolved solids greater than seawater. For the Central Coast of California this means total dissolved solids concentrations greater than about 33,000 mg/L.

Chlordane

Shall mean the sum of chlordane-alpha, chlordane-gamma, chlordene-alpha, chlordene-gamma, nonachlor-alpha, nonachlor-gamma, and oxychlordane.

Chronic Toxicity (not applicable to Test of Significant Toxicity hypothesis testing):

This parameter shall be used to measure the acceptability of waters for supporting a healthy marine biota until improved methods are developed to evaluate biological response.

a. Chronic Toxicity (TUc)

Expressed as Toxic Units Chronic (TUc)

$$TUc = \frac{100}{NOEL}$$

b. No Observed Effect Level (NOEL)

The NOEL is expressed as the maximum percent effluent or receiving water that causes no observable effect on a test organism, as determined by the result of a critical life stage toxicity test listed in Ocean Plan Appendix II.

Concentrate Waste Dilution Ratio

The ratio of reverse osmosis concentrate from the Pure Water Monterey Advanced Water Purification Facility plus hauled saline waste from reverse osmosis or ion exchange regeneration systems to total effluent.

Daily Discharge

Daily Discharge is defined as either: (1) the total mass of the constituent discharged over the calendar day (12:00 am through 11:59 pm) or any 24-hour period that reasonably represents a calendar day for purposes of sampling (as specified in the permit), for a constituent with limitations expressed in units of mass or; (2) the unweighted arithmetic mean measurement of the constituent over the day for a constituent with limitations expressed in other units of measurement (e.g., concentration).

The daily discharge may be determined by the analytical results of a composite sample taken over the course of one day (a calendar day or other 24-hour period defined as a day) or by the arithmetic mean of analytical results from one or more grab samples taken over the course of the day.

For composite sampling, if 1 day is defined as a 24-hour period other than a calendar day, the analytical result for the 24-hour period will be considered as the result for the calendar day in which the 24-hour period ends.

DDT

Shall mean the sum of 4,4'DDT, 2,4'DDT, 4,4'DDE, 2,4'DDE, 4,4'DDD, and 2,4'DDD.

Degrade

Degradation shall be determined by comparison of the waste field and reference site(s) for characteristic species diversity, population density, contamination, growth anomalies, debility, or supplanting of normal species by undesirable plant and animal species. Degradation occurs if there are significant differences in any of three major biotic groups, namely, demersal fish, benthic invertebrates, or attached algae. Other groups may be evaluated where benthic species are not affected, or are not the only ones affected.

Detected, but Not Quantified (DNQ)

Sample results that are less than the reported Minimum Level, but greater than or equal to the laboratory's MDL. Sample results reported as DNQ are estimated concentrations.

Dichlorobenzenes

Shall mean the sum of 1,2- and 1,3-dichlorobenzene.

Downstream Ocean Waters

Waters downstream with respect to ocean currents.

Dredged Material

Any material excavated or dredged from the navigable waters of the United States, including material otherwise referred to as "spoil."

Enclosed Bays

Indentations along the coast that enclose an area of oceanic water within distinct headlands or harbor works. Enclosed bays include all bays where the narrowest distance between headlands or outermost harbor works is less than 75 percent of the greatest dimension of the enclosed portion of the bay. This definition includes but is not limited to: Humboldt Bay, Bodega Harbor, Tomales Bay, Drakes Estero, San Francisco Bay, Morro Bay, Los Angeles Harbor, Upper and Lower Newport Bay, Mission Bay, and San Diego Bay.

Endosulfan

The sum of endosulfan-alpha and -beta and endosulfan sulfate.

Estuaries and Coastal Lagoons are waters at the mouths of streams that serve as mixing zones for fresh and ocean waters during a major portion of the year. Mouths of streams that are temporarily separated from the ocean by sandbars shall be considered as estuaries. Estuarine waters will generally be considered to extend from a bay or the open ocean to the upstream limit of tidal action but may be considered to extend seaward if significant mixing of fresh and salt water occurs in the open coastal waters. The waters described by this definition include but are not limited to the Sacramento-San Joaquin Delta as defined by Section 12220 of the California Water Code, Suisun Bay, Carquinez Strait downstream to Carquinez Bridge, and appropriate areas of the Smith, Klamath, Mad, Eel, Noyo, and Russian Rivers.

Halomethanes shall mean the sum of bromoform, bromomethane (methyl bromide) and chloromethane (methyl chloride).

HCH shall mean the sum of the alpha, beta, gamma (lindane) and delta isomers of hexachlorocyclohexane.

Initial Dilution

The process that results in the rapid and irreversible turbulent mixing of wastewater with ocean water around the point of discharge.

For a submerged buoyant discharge, characteristic of most municipal and industrial wastes that are released from the submarine outfalls, the momentum of the discharge and its initial buoyancy act together to produce turbulent mixing. Initial dilution in this case is completed when the diluting wastewater ceases to rise in the water column and first begins to spread horizontally.

For shallow water submerged discharges, surface discharges, and non-buoyant discharges, characteristic of cooling water wastes and some individual discharges, turbulent mixing results primarily from the momentum of discharge. Initial dilution, in these cases, is considered to be completed when the momentum induced velocity of the discharge ceases to produce significant mixing of the waste, or the diluting plume reaches a fixed distance from the discharge to be specified by the Central Coast Water Board, whichever results in the lower estimate for initial dilution.

Instantaneous Maximum Effluent Limitation

The highest allowable value for any single grab sample or aliquot (i.e., each grab sample or aliquot is independently compared to the instantaneous maximum limitation).

Instantaneous Minimum Effluent Limitation

The lowest allowable value for any single grab sample or aliquot (i.e., each grab sample or aliquot is independently compared to the instantaneous minimum limitation).

"In-stream" Waste Concentration (IWC)

The concentration of a toxicant of effluent in the receiving water expressed as percent after mixing (the inverse of the dilution factor). A discharge of 100% effluent will be considered the IWC whenever mixing zones or dilution credits are not authorized by the applicable Water Board.

Kelp Beds

For purposes of the bacteriological standards of the Ocean Plan, are significant aggregations of marine algae of the genera <u>Macrocystis</u> and <u>Nereocystis</u>. Kelp beds include the total foliage canopy of <u>Macrocystis</u> and <u>Nereocystis</u> plants throughout the water column.

Mariculture

The culture of plants and animals in marine waters independent of any pollution source.

Material

(a) In common usage: (1) the substance or substances of which a thing is made or composed (2) substantial; (b) For purposes of the Ocean Plan relating to waste disposal, dredging and the disposal of dredged material and fill, MATERIAL means matter of any kind or description which is subject to regulation as waste, or any material dredged from the navigable waters of the United States. See also, DREDGED MATERIAL.

Maximum Daily Effluent Limitation (MDEL)

The highest allowable daily discharge of a pollutant.

Method Detection Limit (MDL)

The minimum concentration of a substance that can be reported with 99 percent confidence that the measured concentration is distinguishable from method blank results, as defined in 40 C.F.R. part 136, Attachment B.

Minimum Level (ML)

The concentration at which the entire analytical system must give a recognizable signal and acceptable calibration point. The ML is the concentration in a sample that is equivalent to the concentration of the lowest calibration standard analyzed by a specific analytical procedure, assuming that all the method specified sample weights, volumes, and processing steps have been followed.

Natural Light

Reduction of natural light may be determined by the Central Coast Water Board by measurement of light transmissivity or total irradiance, or both, according to the monitoring needs of the Central Coast Water Board.

Not Detected (ND)

Those sample results less than the laboratory's MDL.

Ocean Waters

The territorial marine waters of the state as defined by California law to the extent these waters are outside of enclosed bays, estuaries, and coastal lagoons. If a discharge outside the territorial waters of the state could affect the quality of the waters of the state, the discharge may be regulated to assure no violation of the Ocean Plan will occur in ocean waters.

PAHs (polynuclear aromatic hydrocarbons)

The sum of acenaphthylene, anthracene, 1,2-benzanthracene, 3,4-benzofluoranthene, benzo[k]fluoranthene, 1,12-benzoperylene, benzo[a]pyrene, chrysene, dibenzo[ah]anthracene, fluorene, indeno[1,2,3-cd]pyrene, phenanthrene and pyrene.

PCBs (polychlorinated biphenyls)

The sum of chlorinated biphenyls whose analytical characteristics resemble those of Aroclor-1016, Aroclor-1221, Aroclor-1232, Aroclor-1242, Aroclor-1248, Aroclor-1254 and Aroclor-1260.

Pollutant Minimization Program (PMP)

PMP means waste minimization and pollution prevention actions that include, but are not limited to, product substitution, waste stream recycling, alternative waste management methods, and education of the public and businesses. The goal of the PMP shall be to reduce all potential sources of Ocean Plan Table 1 pollutants through pollutant minimization (control) strategies, including pollution prevention measures as appropriate, to maintain the effluent concentration at or below the water quality-based effluent limitation. Pollution prevention measures may be particularly appropriate for persistent bioaccumulative priority pollutants where there is evidence that beneficial uses are being impacted. The Central Coast Water Board may consider cost effectiveness when establishing the requirements of a PMP. The completion and implementation of a Pollution Prevention Plan, if required pursuant to Water Code section 13263.3(d), shall be considered to fulfill the PMP requirements.

Reported Minimum Level

The reported ML (also known as the Reporting Level or RL) is the ML (and its associated analytical method) chosen by the Discharger for reporting and compliance determination from the MLs included in this Order, including an additional factor if applicable as discussed herein. The MLs included in this Order correspond to approved analytical methods for reporting a sample result that are selected by the Central Coast Water Board either from Appendix II of the Ocean Plan in accordance with section III.C.5.a. of the Ocean Plan or established in accordance with section III.C.5.b. of the Ocean Plan. The ML is based on the proper application of method-based analytical procedures for sample preparation and the absence of any matrix interferences. Other factors may be applied to the ML depending on the specific sample preparation steps employed. For example, the treatment typically applied in cases where there are matrix-effects is to dilute the sample or sample aliquot by a factor of ten. In such cases, this additional factor must be applied to the ML in the computation of the reported ML.

RO Concentrate

Concentrate from Reverse Osmosis process at the Advanced Water Purification Facility (AWPF).

Saline Waste

Wastewaters hauled to the WWTP from water treatment facilities. The saline waste includes the concentrate from reverse osmosis and the waste solutions from ion exchange regeneration. This waste is generally less salty than brine but more salty than wastewater.

Shellfish

Organisms identified by the California Department of Health Services as shellfish for public health purposes (i.e., mussels, clams and oysters).

Significant Difference

Defined as a statistically significant difference in the means of two distributions of sampling results at the 95 percent confidence level.

Six-Month Median Effluent Limitation

The highest allowable moving median of all daily discharges for any 180-day period.

State Water Quality Protection Areas (SWQPAs)

Non-terrestrial marine or estuarine areas designated to protect marine species or biological communities from an undesirable alteration in natural water quality. All AREAS OF SPECIAL BIOLOGICAL SIGNIFICANCE (ASBS) that were previously designated by the State Water Board in Resolutions 74-28, 74-32, and 75-61 are now also classified as a subset of State Water Quality Protection Areas and require special protections afforded by the Ocean Plan.

TCDD Equivalents

The sum of the concentrations of chlorinated dibenzodioxins (2,3,7,8-CDDs) and chlorinated dibenzofurans (2,3,7,8-CDFs) multiplied by their respective toxicity factors, as shown in the table below.

Isomer Group	Toxicity Equivalence Factor
-	1.0
2.3.7.8-tetra CDD	
2,3,7,8-penta CDD	0.5
2,3,7,8-hexa CDDs	0.1
2,3,7,8-hepta CDD	0.01
octa CDD	0.001
2,3,7,8 tetra CDF	0.1
1,2,3,7,8 penta CDF	0.05
2,3,4,7,8 penta CDF	0.5
2,3,7,8 hexa CDFs	0.1
2,3,7,8 hepta CDFs	0.01
octa CDF	0.001

Test of Significant Toxicity (TST)

The statistical approach described in the NPDES Test of Significant Toxicity Implementation Document (EPA 833-R10-003, 2010). TST was developed by the US EPA for analyzing WET and ambient toxicity data. Using the TST approach, the sample is declared toxic if there is greater than or equal to a 25% effect in chronic tests, or if there is greater than or equal to a 20% effect in acute tests at the permitted Instream Waste Concentration (IWC) [referred to as the toxic regulatory management decision (RMD)]. The sample is declared non-toxic if there is less than or equal to a 10% effect at the IWC in acute or chronic tests (referred to as the non-toxic RMD).

Toxicity Reduction Evaluation (TRE)

A study conducted in a step-wise process designed to identify the causative agents of effluent or ambient toxicity, isolate the sources of toxicity, evaluate the effectiveness of toxicity control options, and then confirm the reduction in toxicity. The first steps of the TRE consist of the collection of data relevant to the toxicity, including additional toxicity testing, and an evaluation of facility operations and maintenance practices, and best management practices. A Toxicity Identification Evaluation (TIE) may be required as part of the TRE, if appropriate. (A TIE is a set of procedures to identify the specific chemical(s) responsible for toxicity. These procedures are performed in three phases (characterization, identification, and confirmation) using aquatic organism toxicity tests.)

Waste

As used in the Ocean Plan, waste includes a Discharger's total discharge, of whatever origin, <u>i.e.</u>, gross, not net, discharge.

Water Recycling

The treatment of wastewater to render it suitable for reuse, the transportation of treated wastewater to the place of use, and the actual use of treated wastewater for a direct beneficial use or controlled use that would not otherwise occur.



ATTACHMENT B - MAP OF WWTP (WITH MONITORING LOCATIONS IDENTIFIED)

ATTACHMENT B - REGIONAL MAP



ATTACHMENT C - FLOW SCHEMATIC



ATTACHMENT D – STANDARD PROVISIONS

I. STANDARD PROVISIONS – PERMIT COMPLIANCE

A. Duty to Comply

- The Discharger must comply with all of the terms, requirements, and conditions of this Order. Any noncompliance constitutes a violation of the Clean Water Act (CWA) and the California Water Code and is grounds for enforcement action; permit termination, revocation and reissuance, or modification; denial of a permit renewal application; or a combination thereof. (40 C.F.R. § 122.41(a); Wat. Code, §§ 13261, 13263, 13265, 13268, 13000, 13001, 13304, 13350, 13385.)
- 2. The Discharger shall comply with effluent standards or prohibitions established under Section 307(a) of the CWA for toxic pollutants within the time provided in the regulations that establish these standards or prohibitions, even if this Order has not yet been modified to incorporate the requirement. (40 C.F.R. § 122.41(a)(1).)

B. Need to Halt or Reduce Activity Not a Defense

It shall not be a defense for a Discharger in an enforcement action that it would have been necessary to halt or reduce the permitted activity in order to maintain compliance with the conditions of this Order. (40 C.F.R. § 122.41(c).)

C. Duty to Mitigate

The Discharger shall take all reasonable steps to minimize or prevent any discharge in violation of this Order that has a reasonable likelihood of adversely affecting human health or the environment. (40 C.F.R. § 122.41(d).)

D. Proper Operation and Maintenance

The Discharger shall at all times properly operate and maintain all facilities and systems of treatment and control (and related appurtenances) which are installed or used by the Discharger to achieve compliance with the conditions of this Order. Proper operation and maintenance also includes adequate laboratory controls and appropriate quality assurance procedures. This provision requires the operation of backup or auxiliary facilities or similar systems that are installed by a Discharger only when necessary to achieve compliance with the conditions of this Order. (40 C.F.R. § 122.41(e).)

E. Property Rights

- 1. This Order does not convey any property rights of any sort or any exclusive privileges. (40 C.F.R. § 122.41(g).)
- 2. The issuance of this Order does not authorize any injury to persons or property or invasion of other private rights, or any infringement of state or local law or regulations. (40 C.F.R. § 122.5(c).)

F. Inspection and Entry

The Discharger shall allow the Central Coast Water Board, State Water Board, U.S. EPA, and/or their authorized representatives (including an authorized contractor acting as their representative), upon the presentation of credentials and other documents, as may be required by law, to (33 U.S.C. § 1318(a)(4)(b); 40 C.F.R. § 122.41(i); Wat. Code, §§ 13267, 13383):

- Enter upon the Discharger's premises where a regulated facility or activity is located or conducted, or where records are kept under the conditions of this Order (33 U.S.C. § 1318(a)(4)(b)(i); 40 C.F.R. § 122.41(i)(1); Wat. Code, §§ 13267, 13383);
- Have access to and copy, at reasonable times, any records that must be kept under the conditions of this Order (33 U.S.C. § 1318(a)(4)(b)(ii); 40 C.F.R. § 122.41(i)(2); Wat. Code, §§ 13267, 13383);
- Inspect and photograph, at reasonable times, any facilities, equipment (including monitoring and control equipment), practices, or operations regulated or required under this Order (33 U.S.C. § 1318(a)(4)(b)(ii); 40 C.F.R. § 122.41(i)(3); Wat. Code, §§ 13267, 13383); and
- 4. Sample or monitor, at reasonable times, for the purposes of assuring Order compliance or as otherwise authorized by the CWA or the Water Code, any substances or parameters at any location. (33 U.S.C. § 1318(a)(4)(b); 40 C.F.R. § 122.41(i)(4); Wat. Code, §§ 13267, 13383.)

G. Bypass

- 1. Definitions
 - **a.** "Bypass" means the intentional diversion of waste streams from any portion of a treatment facility. (40 C.F.R. § 122.41(m)(1)(i).)
 - b. "Severe property damage" means substantial physical damage to property, damage to the treatment facilities, which causes them to become inoperable, or substantial and permanent loss of natural resources that can reasonably be expected to occur in the absence of a bypass. Severe property damage does not mean economic loss caused by delays in production. (40 C.F.R. § 122.41(m)(1)(ii).)
- 2. Bypass not exceeding limitations. The Discharger may allow any bypass to occur which does not cause exceedances of effluent limitations, but only if it is for essential maintenance to assure efficient operation. These bypasses are not subject to the provisions listed in Standard Provisions Permit Compliance I.G.3, I.G.4, and I.G.5 below. (40 C.F.R. § 122.41(m)(2).)
- **3.** Prohibition of bypass. Bypass is prohibited, and the Central Coast Water Board may take enforcement action against a Discharger for bypass, unless (40 C.F.R. § 122.41(m)(4)(i)):

a. Bypass was unavoidable to prevent loss of life, personal injury, or severe property damage (40 C.F.R. § 122.41(m)(4)(i)(A));

- **b.** There were no feasible alternatives to the bypass, such as the use of auxiliary treatment facilities, retention of untreated wastes, or maintenance during normal periods of equipment downtime. This condition is not satisfied if adequate back-up equipment should have been installed in the exercise of reasonable engineering judgment to prevent a bypass that occurred during normal periods of equipment downtime or preventive maintenance (40 C.F.R. § 122.41(m)(4)(i)(B)); and
- **c.** The Discharger submitted notice to the Central Coast Water Board as required under Standard Provisions Permit Compliance I.G.5 below. (40 C.F.R. § 122.41(m)(4)(i)(C).)
- 4. The Central Coast Water Board may approve an anticipated bypass, after considering its adverse effects, if the Central Coast Water Board determines that it will meet the three

conditions listed in Standard Provisions – Permit Compliance I.G.3 above. (40 C.F.R. § 122.41(m)(4)(ii).)

- 5. Notice
 - a. Anticipated bypass. If the Discharger knows in advance of the need for a bypass, it shall submit prior notice, if possible at least 10 days before the date of the bypass. The notice shall be sent to the Central Coast Water Board. As of December 21, 2020, all notices must be submitted electronically to the initial recipient defined in Standard Provisions Reporting V.J below. Notices shall comply with 40 C.F.R. part 3, 40 C.F.R. § 122.22, and 40 C.F.R. part 127. (40 C.F.R. § 122.41(m)(3)(i).)
 - b. Unanticipated bypass. The Discharger shall submit a notice of an unanticipated bypass as required in Standard Provisions Reporting V.E below (24-hour notice). The notice shall be sent to the Central Coast Water Board. As of December 21, 2020, all notices must be submitted electronically to the initial recipient defined in Standard Provisions Reporting V.J below. Notices shall comply with 40 C.F.R. part 3, 40 C.F.R. § 122.22, and 40 C.F.R. part 127. (40 C.F.R. § 122.41(m)(3)(ii).)

H. Upset

Upset means an exceptional incident in which there is unintentional and temporary noncompliance with technology-based permit effluent limitations because of factors beyond the reasonable control of the Discharger. An upset does not include noncompliance to the extent caused by operational error, improperly designed treatment facilities, inadequate treatment facilities, lack of preventive maintenance, or careless or improper operation. (40 C.F.R. § 122.41(n)(1).)

- Effect of an upset. An upset constitutes an affirmative defense to an action brought for noncompliance with such technology-based permit effluent limitations if the requirements of Standard Provisions – Permit Compliance I.H.2 below are met. No determination made during administrative review of claims that noncompliance was caused by upset, and before an action for noncompliance, is final administrative action subject to judicial review. (40 C.F.R. § 122.41(n)(2).)
- 2. Conditions necessary for a demonstration of upset. A Discharger who wishes to establish the affirmative defense of upset shall demonstrate, through properly signed, contemporaneous operating logs or other relevant evidence that (40 C.F.R. § 122.41(n)(3)):
 - a. An upset occurred and that the Discharger can identify the cause(s) of the upset (40 C.F.R. § 122.41(n)(3)(i));
 - b. The permitted facility was, at the time, being properly operated (40 C.F.R. § 122.41(n)(3)(ii));
 - c. The Discharger submitted notice of the upset as required in Standard Provisions Reporting V.E.2.b below (24-hour notice) (40 C.F.R. § 122.41(n)(3)(iii)); and
 - d. The Discharger complied with any remedial measures required under Standard Provisions Permit Compliance I.C above. (40 C.F.R. § 122.41(n)(3)(iv).)
- **3.** Burden of proof. In any enforcement proceeding, the Discharger seeking to establish the occurrence of an upset has the burden of proof. (40 C.F.R. § 122.41(n)(4).)

II. STANDARD PROVISIONS – PERMIT ACTION

A. General

This Order may be modified, revoked and reissued, or terminated for cause. The filing of a request by the Discharger for modification, revocation and reissuance, or termination, or a notification of planned changes or anticipated noncompliance does not stay any Order condition. (40 C.F.R. § 122.41(f).)

B. Duty to Reapply

If the Discharger wishes to continue an activity regulated by this Order after the expiration date of this Order, the Discharger must apply for and obtain a new permit. (40 C.F.R. § 122.41(b).)

C. Transfers

This Order is not transferable to any person except after notice to the Central Coast Water Board. The Central Coast Water Board may require modification or revocation and reissuance of the Order to change the name of the Discharger and incorporate such other requirements as may be necessary under the CWA and the Water Code. (40 C.F.R. §§ 122.41(I)(3), 122.61.)

III. STANDARD PROVISIONS – MONITORING

- A. Samples and measurements taken for the purpose of monitoring shall be representative of the monitored activity. (40 C.F.R. § 122.41(j)(1).)
- B. Monitoring must be conducted according to test procedures approved under 40 C.F.R. part 136 for the analyses of pollutants unless another method is required under 40 C.F.R. chapter 1, subchapter N. Monitoring must be conducted according to sufficiently sensitive test methods approved under 40 C.F.R. part 136 for the analysis of pollutants or pollutant parameters or as required under 40 C.F.R. chapter 1, subchapter N. For the purposes of this paragraph, a method is sufficiently sensitive when:
 - 1. The method minimum level (ML) is at or below the level of the most stringent effluent limitation established in the permit for the measured pollutant or pollutant parameter, and either the method ML is at or below the level of the most stringent applicable water quality criterion for the measured pollutant or pollutant parameter or the method ML is above the applicable water quality criterion but the amount of the pollutant or pollutant parameter in the facility's discharge is high enough that the method detects and quantifies the level of the pollutant or pollutant parameter in the discharge; or
 - 2. The method has the lowest ML of the analytical methods approved under 40 C.F.R. part 136 or required under 40 C.F.R. chapter 1, subchapter N for the measured pollutant or pollutant parameter.

In the case of pollutants or pollutant parameters for which there are no approved methods under 40 C.F.R. part 136 or otherwise required under 40 C.F.R. chapter 1, subchapter N, monitoring must be conducted according to a test procedure specified in this Order for such pollutants or pollutant parameters. (40 C.F.R. §§ 122.21(e)(3),122.41(j)(4), 122.44(i)(1)(iv).)

IV. STANDARD PROVISIONS – RECORDS

A. The Discharger shall retain records of all monitoring information, including all calibration and maintenance records and all original strip chart recordings for continuous monitoring instrumentation, copies of all reports required by this Order, and records of all data used to complete the application for this Order, for a period of at least three (3) years from the date of

the sample, measurement, report or application. This period may be extended by request of the Central Coast Water Board Executive Officer at any time. (40 C.F.R. § 122.41(j)(2).)

- **B.** Records of monitoring information shall include:
 - The date, exact place, and time of sampling or measurements (40 C.F.R. § 122.41(j)(3)(i));
 - **2.** The individual(s) who performed the sampling or measurements (40 C.F.R. § 122.41(j)(3)(ii));
 - 3. The date(s) analyses were performed (40 C.F.R. § 122.41(j)(3)(iii));
 - 4. The individual(s) who performed the analyses (40 C.F.R. § 122.41(j)(3)(iv));
 - 5. The analytical techniques or methods used (40 C.F.R. § 122.41(j)(3)(v)); and
 - 6. The results of such analyses. (40 C.F.R. § 122.41(j)(3)(vi).)
- **C.** Claims of confidentiality for the following information will be denied (40 C.F.R. § 122.7(b)):
 - 1. The name and address of any permit applicant or Discharger (40 C.F.R. § 122.7(b)(1)); and
 - **2.** Permit applications and attachments, permits and effluent data. (40 C.F.R. § 122.7(b)(2).)

V. STANDARD PROVISIONS – REPORTING

A. Duty to Provide Information

The Discharger shall furnish to the Central Coast Water Board, State Water Board, or U.S. EPA within a reasonable time, any information which the Central Coast Water Board, State Water Board, or U.S. EPA may request to determine whether cause exists for modifying, revoking and reissuing, or terminating this Order or to determine compliance with this Order. Upon request, the Discharger shall also furnish to the Central Coast Water Board, State Water Board, or U.S. EPA copies of records required to be kept by this Order. (40 C.F.R. § 122.41(h); Wat. Code, §§ 13267, 13383.)

B. Signatory and Certification Requirements

- All applications, reports, or information submitted to the Central Coast Water Board, State Water Board, and/or U.S. EPA shall be signed and certified in accordance with Standard Provisions – Reporting V.B.2, V.B.3, V.B.4, V.B.5, and V.B.6 below. (40 C.F.R. § 122.41(k).)
- 2. All permit applications shall be signed by either a principal executive officer or ranking elected official. For purposes of this provision, a principal executive officer of a federal agency includes: (i) the chief executive officer of the agency, or (ii) a senior executive officer having responsibility for the overall operations of a principal geographic unit of the agency (e.g., Regional Administrators of U.S. EPA). (40 C.F.R. § 122.22(a)(3).).
- 3. All reports required by this Order and other information requested by the Central Coast Water Board, State Water Board, or U.S. EPA shall be signed by a person described in Standard Provisions Reporting V.B.2 above, or by a duly authorized representative of that person. A person is a duly authorized representative only if:
 - **a.** The authorization is made in writing by a person described in Standard Provisions Reporting V.B.2 above (40 C.F.R. § 122.22(b)(1));

- b. The authorization specifies either an individual or a position having responsibility for the overall operation of the regulated facility or activity such as the position of plant manager, operator of a well or a well field, superintendent, position of equivalent responsibility, or an individual or position having overall responsibility for environmental matters for the company. (A duly authorized representative may thus be either a named individual or any individual occupying a named position.) (40 C.F.R. § 122.22(b)(2)); and
- **c.** The written authorization is submitted to the Central Coast Water Board and State Water Board. (40 C.F.R. § 122.22(b)(3).)
- 4. If an authorization under Standard Provisions Reporting V.B.3 above is no longer accurate because a different individual or position has responsibility for the overall operation of the facility, a new authorization satisfying the requirements of Standard Provisions Reporting V.B.3 above must be submitted to the Central Coast Water Board and State Water Board prior to or together with any reports, information, or applications, to be signed by an authorized representative. (40 C.F.R. § 122.22(c).)
- **5.** Any person signing a document under Standard Provisions Reporting V.B.2 or V.B.3 above shall make the following certification:

"I certify under penalty of law that this document and all attachments were prepared under my direction or supervision in accordance with a system designed to assure that qualified personnel properly gather and evaluate the information submitted. Based on my inquiry of the person or persons who manage the system or those persons directly responsible for gathering the information, the information submitted is, to the best of my knowledge and belief, true, accurate, and complete. I am aware that there are significant penalties for submitting false information, including the possibility of fine and imprisonment for knowing violations." (40 C.F.R. § 122.22(d).)

6. Any person providing the electronic signature for documents described in Standard Provisions – V.B.1, V.B.2, or V.B.3 that are submitted electronically shall meet all relevant requirements of Standard Provisions – Reporting V.B, and shall ensure that all relevant requirements of 40 C.F.R. part 3 (Cross-Media Electronic Reporting) and 40 C.F.R. part 127 (NPDES Electronic Reporting Requirements) are met for that submission. (40 C.F.R § 122.22(e).)

C. Monitoring Reports

- 1. Monitoring results shall be reported at the intervals specified in the Monitoring and Reporting Program (Attachment E) in this Order. (40 C.F.R. § 122.41(I)(4).)
- 2. Monitoring results must be reported on a Discharge Monitoring Report (DMR) form or forms provided or specified by the Central Coast Water Board or State Water Board. As of December 21, 2016, all reports and forms must be submitted electronically to the initial recipient defined in Standard Provisions Reporting V.J and comply with 40 C.F.R. part 3, 40 C.F.R. § 122.22, and 40 C.F.R. part 127. (40 C.F.R. § 122.41(I)(4)(i).)
- **3.** If the Discharger monitors any pollutant more frequently than required by this Order using test procedures approved under 40 C.F.R. part 136, or another method required for an industry-specific waste stream under 40 C.F.R. chapter 1, subchapter N, the results of such monitoring shall be included in the calculation and reporting of the data submitted in the DMR or reporting form specified by the Central Coast Water Board or State Water Board. (40 C.F.R. § 122.41(I)(4)(ii).)

4. Calculations for all limitations, which require averaging of measurements, shall utilize an arithmetic mean unless otherwise specified in this Order. (40 C.F.R. § 122.41(I)(4)(iii).)

D. Compliance Schedules

Reports of compliance or noncompliance with, or any progress reports on, interim and final requirements contained in any compliance schedule of this Order, shall be submitted no later than 14 days following each schedule date. (40 C.F.R. § 122.41(I)(5).)

E. Twenty-Four Hour Reporting

1. The Discharger shall report any noncompliance which may endanger health or the environment. Any information shall be provided to the Central Coast Water Board permitting staff and the MBNMS 24-hour emergency phone number (831-236-6797) orally within 24 hours from the time the Discharger becomes aware of the circumstances for spills into MBNMS. A report shall also be provided to the Central Coast Water Board within five (5) days of the time the Discharger becomes aware of the circumstances. The report shall contain a description of the noncompliance and its cause; the period of noncompliance, including exact dates and times, and if the noncompliance has not been corrected, the anticipated time it is expected to continue; and steps taken or planned to reduce, eliminate, and prevent reoccurrence of the noncompliance.

For noncompliance events related to combined sewer overflows, sanitary sewer overflows, or bypass events, these reports must include the data described above (with the exception of time of discovery) as well as the type of event (i.e., combined sewer overflow, sanitary sewer overflow, or bypass event), type of overflow structure (e.g., manhole, combined sewer overflow outfall), discharge volume untreated by the treatment works treating domestic sewage, types of human health and environmental impacts of the event, and whether the noncompliance was related to wet weather.

As of December 21, 2020, all reports related to combined sewer overflows, sanitary sewer overflows, or bypass events must be submitted to the Central Coast Water Board and must be submitted electronically to the initial recipient defined in Standard Provisions – Reporting V.J. The reports shall comply with 40 C.F.R. part 3, 40 C.F.R. section 122.22, and 40 C.F.R. part 127. The Central Coast Water Board may also require the Discharger to electronically submit reports not related to combined sewer overflows, sanitary sewer overflows, or bypass events under this section. (40 C.F.R. § 122.41(l)(6)(i).)

- 2. The following shall be included as information that must be reported within 24 hours:
 - **a.** Any unanticipated bypass that exceeds any effluent limitation in this Order. (40 C.F.R. § 122.41(I)(6)(ii)(A).)
 - **b.** Any upset that exceeds any effluent limitation in this Order. (40 C.F.R. § 122.41(l)(6)(ii)(B).)
- **3.** The Central Coast Water Board may waive the above required written report on a caseby-case basis if an oral report has been received within 24 hours. (40 C.F.R. § 122.41(I)(6)(ii)(B).)

F. Planned Changes

The Discharger shall give notice to the Central Coast Water Board as soon as possible of any planned physical alterations or additions to the permitted facility. Notice is required under this provision only when (40 C.F.R. § 122.41(l)(1)):

- The alteration or addition to a permitted facility may meet one of the criteria for determining whether a facility is a new source in section 122.29(b) (40 C.F.R. § 122.41(l)(1)(i)); or
- 2. The alteration or addition could significantly change the nature or increase the quantity of pollutants discharged. This notification applies to pollutants that are not subject to effluent limitations in this Order. (40 C.F.R. § 122.41(I)(1)(ii).)

G. Anticipated Noncompliance

The Discharger shall give advance notice to the Central Coast Water Board of any planned changes in the permitted facility or activity that may result in noncompliance with this Order's requirements. (40 C.F.R. § 122.41(I)(2).)

H. Other Noncompliance

The Discharger shall report all instances of noncompliance not reported under Standard Provisions – Reporting V.C, V.D, and V.E above at the time monitoring reports are submitted. The reports shall contain the information listed in Standard Provision – Reporting V.E above. For noncompliance events related to combined sewer overflows, sanitary sewer overflows, or bypass events, these reports shall contain the information described in Standard Provision – Reporting V.E and the applicable required data in appendix A to 40 C.F.R. part 127. The Central Coast Water Board may also require the Discharger to electronically submit reports not related to combined sewer overflows, or bypass events under this section. (40 C.F.R. § 122.41(l)(7).)

I. Other Information

When the Discharger becomes aware that it failed to submit any relevant facts in a permit application, or submitted incorrect information in a permit application or in any report to the Central Coast Water Board, State Water Board, or U.S. EPA, the Discharger shall promptly submit such facts or information. (40 C.F.R. § 122.41(I)(8).)

J. Initial Recipient for Electronic Reporting Data

The owner, operator, or the duly authorized representative is required to electronically submit NPDES information specified in appendix A to 40 C.F.R. part 127 to the initial recipient defined in 40 C.F.R. § 127.2(b). U.S. EPA will identify and publish the list of initial recipients on its website and in the Federal Register, by state and by NPDES data group [see 40 C.F.R. § 127.2(c)]. U.S. EPA will update and maintain this listing. (40 C.F.R. § 122.41(I)(9).)

VI. STANDARD PROVISIONS - ENFORCEMENT

A. The Central Coast Water Board is authorized to enforce the terms of this permit under several provisions of the Water Code, including, but not limited to, sections 13268, 13385, 13386, and 13387.

VII. ADDITIONAL PROVISIONS – NOTIFICATION LEVELS

A. Publicly Owned Treatment Works (POTWs)

All POTWs shall provide adequate notice to the Central Coast Water Board of the following (40 C.F.R. § 122.42(b)):

1. Any new introduction of pollutants into the POTW from an indirect discharger that would be subject to sections 301 or 306 of the CWA if it were directly discharging those pollutants (40 C.F.R. § 122.42(b)(1)); and

- 2. Any substantial change in the volume or character of pollutants being introduced into that POTW by a source introducing pollutants into the POTW at the time of adoption of the Order. (40 C.F.R. § 122.42(b)(2).)
- **3.** Adequate notice shall include information on the quality and quantity of effluent introduced into the POTW as well as any anticipated impact of the change on the quantity or quality of effluent to be discharged from the POTW. (40 C.F.R. § 122.42(b)(3).)

VIII. CENTRAL COAST WATER BOARD STANDARD PROVISIONS

A. Central Coast Standard Provision – Prohibitions

- 1. Introduction of "incompatible wastes" to the treatment system is prohibited.
- **2.** Discharge of high-level radiological waste and of radiological, chemical, and biological warfare agents is prohibited.
- **3.** Discharge of "toxic pollutants" in violation of effluent standards and prohibitions established under section 307(a) of the Clean Water Act (CWA) is prohibited.
- 4. Discharge of sludge, sludge digester or thickener supernatant, and sludge drying bed leachate to drainageways, surface waters, or the ocean is prohibited.
- 5. Introduction of pollutants into the collection, treatment, or disposal system by an "indirect discharger" that:
 - **a.** Inhibit or disrupt the treatment process, system operation, or the eventual use or disposal of sludge; or,
 - b. Flow through the system to the receiving water untreated; and,
 - **c.** Cause or "significantly contribute" to a violation of any requirement of this Order, is prohibited.
- 6. Introduction of "pollutant free" wastewater to the collection, treatment, and disposal system in amounts that threaten compliance with this order is prohibited.

B. Central Coast Standard Provision – Provisions

- 1. Collection, treatment, and discharge of waste shall not create a nuisance or pollution, as defined by California Water Code (CWC) 13050.
- 2. All facilities used for transport or treatment of wastes shall be adequately protected from inundation and washout as the result of a 100-year frequency flood.
- **3.** Operation of collection, treatment, and disposal systems shall be in a manner that precludes public contact with wastewater.
- 4. Collected screenings, sludges, and other solids removed from liquid wastes shall be disposed in a manner approved by the Executive Officer.
- 5. Wastewater treatment plants shall be supervised and operated by persons possessing certificates of appropriate grade pursuant to Title 23 of the California Code of Regulations.
- **6.** After notice and opportunity for a hearing, this order may be terminated for cause, including, but not limited to:
 - a. Violation of any term or condition contained in this order;

- **b.** Obtaining this order by misrepresentation, or by failure to disclose fully all relevant facts;
- **c.** A change in any condition or endangerment to human health or environment that requires a temporary or permanent reduction or elimination of the authorized discharge; and,
- d. A substantial change in character, location, or volume of the discharge.
- 7. Provisions of this permit are severable. If any provision of the permit is found invalid, the remainder of the permit shall not be affected.
- **8.** After notice and opportunity for hearing, this order may be modified or revoked and reissued for cause, including:
 - **a.** Promulgation of a new or revised effluent standard or limitation;
 - **b.** A material change in character, location, or volume of the discharge;
 - **c.** Access to new information that affects the terms of the permit, including applicable schedules;
 - d. Correction of technical mistakes or mistaken interpretations of law; and,
 - e. Other causes set forth under Sub-part D of 40 CFR Part 122.
- **9.** Safeguards shall be provided to ensure maximal compliance with all terms and conditions of this permit. Safeguards shall include preventative and contingency plans and may also include alternative power sources, stand-by generators, retention capacity, operative procedures, or other precautions. Preventative and contingency plans for controlling and minimizing the effect of accidental discharges shall:
 - **a.** Identify possible situations that could cause "upset," "overflow," or "bypass," or other noncompliance. (Loading and storage areas, power outage, waste treatment unit outage, and failure of process equipment, tanks and pipes should be considered).
 - **b.** Evaluate the effectiveness of present facilities and procedures and describe procedures and steps to minimize or correct any adverse environmental impact resulting from noncompliance with the permit.
- **10.** Physical Facilities shall be designed and constructed according to accepted engineering practice and shall be capable of full compliance with this order when properly operated and maintained. Proper operation and maintenance shall be described in an Operation and Maintenance Manual. Facilities shall be accessible during the wet-weather season.
- 11. The discharger shall at all times properly operate and maintain all facilities and systems of treatment and control (and related appurtenances) that are installed or used by the discharger to achieve compliance with the conditions of this order. Electrical and mechanical equipment shall be maintained in accordance with appropriate practices and standards, such as NFPA 70B, *Recommended Practice for Electrical Equipment Maintenance*; NFPA 70E, *Standard for Electrical Safety in the Workplace*; ANSI/NETA MTS *Standard for Maintenance: Testing Specifications for Electrical Power Equipment and Systems*, or procedures established by insurance companies or industry resources.
- If the discharger's facilities are equipped with SCADA or other systems that implement wireless, remote operation, the discharger should implement appropriate safeguards against unauthorized access to the wireless systems. Standards such as NIST SP 800-53, *Recommended Security Controls for Federal Information Systems*, can provide guidance.

13. Production and use of recycled water is subject to the approval of the Central Coast Board. Production and use of recycled water shall be in conformance with reclamation criteria established in Chapter 3, Title 22, of the California Code of Regulations and Chapter 7, Division 7, of the CWC An engineering report pursuant to section 60323, Title 22, of the California Code of Regulations is required and a waiver or water reclamation requirements from the Central Coast Board is required before recycled water is supplied for any use, or to any user, not specifically identified and approved either in this Order or another order issued by this Board.

C. Central Coast Standard Provisions – General Monitoring Requirements

 If results of monitoring a pollutant appear to violate effluent limitations based on a weekly, monthly, 30-day, or six-month period, but compliance or non-compliance cannot be validated because sampling is too infrequent, the frequency of sampling shall be increased to validate the test within the next monitoring period. The increased frequency shall be maintained until the Executive Officer agrees the original monitoring frequency may be resumed.

For example, if copper is monitored annually and results exceed the six-month median numerical effluent limitation in the permit, monitoring of copper must be increased to a frequency of at least once every two months (Central Coast Standard Provisions – Definitions I.G.13.). If suspended solids are monitored weekly and results exceed the weekly average numerical limit in the permit, monitoring of suspended solids must be increased to at least four (4) samples every week (Central Coast Standard Provisions – Definitions I.G.14.).

- 2. Water quality analyses performed in order to monitor compliance with this permit shall be by a laboratory certified by the State Water Board for the constituent(s) being analyzed. Bioassay(s) performed in order to monitor compliance with this permit shall be in accord with guidelines approved by the State Water Board and the State Department of Fish and Wildlife.
- 3. Samples and measurements taken for the purpose of monitoring shall be representative of the monitored activity. Samples shall be taken during periods of peak loading conditions. Influent samples shall be samples collected from the combined flows of all incoming wastes, excluding recycled wastes. Effluent samples shall be samples collected downstream of the last treatment unit and tributary flow and upstream of any mixing with receiving waters.
- 4. All monitoring instruments and devices used by the discharger to fulfill the prescribed monitoring program shall be properly maintained and calibrated as necessary to ensure their continued accuracy.

D. Central Coast Standard Provisions – General Reporting Requirements

- 1. Reports of marine monitoring surveys conducted to meet receiving water monitoring requirements of the Monitoring and Reporting Program shall include at least the following information:
 - **a.** A description of climatic and receiving water characteristics at the time of sampling (weather observations, floating debris, discoloration, wind speed and direction, swell or wave action, time of sampling, tide height, etc.).
 - **b.** A description of sampling stations, including differences unique to each station (e.g., station location, grain size, rocks, shell litter, calcareous worm tubes, evident life, etc.).

- **c.** A description of the sampling procedures and preservation sequence used in the survey.
- **d.** A description of the exact method used for laboratory analysis. In general, analysis shall be conducted according to Central Coast Standard Provisions C.1 above, and Federal Standard Provision Monitoring III.B. However, variations in procedure are acceptable to accommodate the special requirements of sediment analysis. All such variations must be reported with the test results.
- **e.** A brief discussion of the results of the survey. The discussion shall compare data from the control station with data from the outfall stations. All tabulations and computations shall be explained.
- 2. Reports of compliance or noncompliance with, or any progress reports on, interim and final requirements contained in any compliance schedule shall be submitted within 14 days following each scheduled date unless otherwise specified within the permit. If reporting noncompliance, the report shall include a description of the reason, a description and schedule of tasks necessary to achieve compliance, and an estimated date for achieving full compliance. A second report shall be submitted within 14 days of full compliance.
- **3.** The "Discharger" shall file a report of waste discharge at least 180 days before making any material change or proposed change in the character, location, or plume of the discharge.
- 4. Within 120 days after the discharger discovers, or is notified by the Central Coast Water Board, that monthly average daily flow will or may reach design capacity of waste treatment and/or disposal facilities within four (4) years, the discharger shall file a written report with the Central Coast Water Board. The report shall include:
 - **a.** the best estimate of when the monthly average daily dry weather flow rate will equal or exceed design capacity; and,
 - **b.** a schedule for studies, design, and other steps needed to provide additional capacity for waste treatment and/or disposal facilities before the waste flow rate equals the capacity of present units.

In addition to complying with Federal Standard Provision – Reporting V.B., the required technical report shall be prepared with public participation and reviewed, approved and jointly submitted by all planning and building departments having jurisdiction in the area served by the waste collection, treatment, or disposal facilities.

5. All "Dischargers" shall submit reports electronically to the:

State Water Board's California Integrated Water Quality System (CIWQS) database:

http://ciwqs.waterboards.ca.gov/

In addition, "Dischargers" with designated major discharges shall submit a copy of each document to: USEPA, Region 9's Discharge Monitoring Report (NetDMR) database:

https://netdmr.epa.gov/netdmr/public/login.htm

Other correspondence may be sent to the Central Coast Region at:

centralcoast@waterboards.ca.gov

- 6. Transfer of control or ownership of a waste discharge facility must be preceded by a notice to the Central Coast Water Board at least 30 days in advance of the proposed transfer date. The notice must include a written agreement between the existing "Discharger" and proposed "Discharger" containing specific date for transfer of responsibility, coverage, and liability between them. Whether a permit may be transferred without modification or revocation and reissuance is at the discretion of the Board. If permit modification or revocation and reissuance is necessary, transfer may be delayed 180 days after the Central Coast Water Board's receipt of a complete permit application. Please also see Federal Standard Provision Permit Action II.C.
- 7. Except for data determined to be confidential under CWA §308 (excludes effluent data and permit applications), all reports prepared in accordance with this permit shall be available for public inspection at the office of the Central Coast Water Board or Regional Administrator of USEPA. Please also see Federal Standard Provision Records IV.C.
- 8. By January 30 of each year, the discharger shall submit an annual report to the Central Coast Water Board. The report (in CIWQS) shall contain the following:
 - **a.** Both tabular and graphical summaries of the monitoring data obtained during the previous year.
 - **b.** A discussion of the previous year's compliance record and corrective actions taken, or which may be needed, to bring the discharger into full compliance.
 - **c.** An evaluation of wastewater flows with projected flow rate increases over time and the estimated date when flows will reach facility capacity.
 - **d.** A discussion of operator certification and a list of current operating personnel and their grades of certification.
 - e. The date of the facility's Operation and Maintenance Manual (including contingency plans as described in Provision B.9), the date the manual was last reviewed, and whether the manual is complete and valid for the current facility.
 - **f.** A discussion of the laboratories used by the discharger to monitor compliance with effluent limits and a summary of performance relative to Section C, General Monitoring Requirements.
 - **g.** If the facility treats industrial or domestic wastewater and there is no provision for periodic sludge monitoring in the Monitoring and Reporting Program, the report shall include a summary of sludge quantities, analyses of its chemical and moisture content, and its ultimate destination.
 - h. If appropriate, the report shall also evaluate the effectiveness of the local source control or pretreatment program using the State Water Resources Control Board's "Guidelines for Determining the Effectiveness of Local Pretreatment Program."

E. Central Coast Standard Provisions – General Pretreatment Provisions

- Discharge of pollutants by "indirect dischargers" in specific industrial sub-categories (appendix C, 40 CFR Part 403), where categorical pretreatment standards have been established, or are to be established, (according to 40 CFR Chapter 1, Subchapter N), shall comply with the appropriate pretreatment standards:
 - **a.** By the date specified therein;
 - **b.** If a new indirect discharger, upon commencement of discharge.

F. Central Coast Standard Provision – Enforcement

- 1. Any person failing to file a report of waste discharge or other report as required by this permit shall be subject to a civil penalty not to exceed \$5,000 per day.
- 2. Upon reduction, loss, or failure of the treatment facility, the "Discharger" shall, to the extent necessary to maintain compliance with this permit, control production or all discharges, or both, until the facility is restored or an alternative method of treatment is provided.

G. Central Coast Standard Provisions – Definitions (Not otherwise included in Attachment A to this Order)

- 1. A "composite sample" is a combination of no fewer than eight (8) individual samples obtained at equal time intervals (usually hourly) over the specified sampling (composite) period. The volume of each individual sample is proportional to the flow rate at the time of sampling. The period shall be specified in the Monitoring and Reporting Program ordered by the Executive Officer.
- 2. "Daily Maximum" limit means the maximum acceptable concentration or mass emission rate of a pollutant measured during a calendar day or during any 24-hour period reasonably representative of the calendar day for purposes of sampling. It is normally compared with results based on "composite samples" except for ammonia, total chlorine, phenolic compounds, and toxicity concentration. For all exceptions, comparisons will be made with results from a "grab sample".
- **3.** "Discharger", as used herein, means, as appropriate: (1) the Discharger, (2) the local sewering entity (when the collection system is not owned and operated by the Discharger), or (3) "indirect discharger" (where "Discharger" appears in the same paragraph as "indirect discharger", it refers to the discharger.)
- 4. "Duly Authorized Representative" is one where:
 - **a.** the authorization is made in writing by a person described in the signatory paragraph of Federal Standard Provision V.B.;
 - **b.** the authorization specifies either an individual or the occupant of a position having either responsibility for the overall operation of the regulated facility, such as the plant manager, or overall responsibility for environmental matters of the company; and,
 - c. the written authorization was submitted to the Central Coast Water Board.
- 5. A "grab sample" is defined as any individual sample collected in less than 15 minutes. "Grab samples" shall be collected during peak loading conditions, which may or may not be during hydraulic peaks. It is used primarily in determining compliance with the daily maximum limits identified in Central Coast Standard Provision – Provision G.2. and instantaneous maximum limits.
- **6.** "Hazardous substance" means any substance designated under 40 CFR Part 116 pursuant to Section 311 of the Clean Water Act.
- 7. "Incompatible wastes" are:
 - **a.** Wastes which create a fire or explosion hazard in the treatment works;
 - **b.** Wastes which will cause corrosive structural damage to treatment works or wastes with a pH lower than 5.0 unless the works is specifically designed to accommodate such wastes;

- **c.** Solid or viscous wastes in amounts which cause obstruction to flow in sewers, or which cause other interference with proper operation of treatment works;
- **d.** Any waste, including oxygen demanding pollutants (BOD, etc), released in such volume or strength as to cause inhibition or disruption in the treatment works and subsequent treatment process upset and loss of treatment efficiency; and,
- e. Heat in amounts that inhibit or disrupt biological activity in the treatment works or that raise influent temperatures above 40°C (104°F) unless the treatment works is designed to accommodate such heat.
- **8.** "Indirect Discharger" means a non-domestic discharger introducing pollutants into a publicly owned treatment and disposal system.
- **9.** "Log Mean" is the geometric mean. Used for determining compliance of fecal or total coliform populations, it is calculated with the following equation:

 $Log Mean = (C1 \times C2 \times ... \times Cn)1/n,$

in which "n" is the number of days samples were analyzed during the period and any "C" is the concentration of bacteria (MPN/100 ml) found on each day of sampling. "n" should be five or more.

10. "Mass emission rate" is a daily rate defined by the following equations:

mass emission rate (lbs/day) = $8.34 \times Q \times C$; and,

mass emission rate $(kg/day) = 3.79 \times Q \times C$,

where "C" (in mg/L) is the measured daily constituent concentration or the average of measured daily constituent concentrations and "Q" (in MGD) is the measured daily flowrate or the average of measured daily flow rates over the period of interest.

- **11.** The "Maximum Allowable Mass Emission Rate," whether for a month, week, day, or sixmonth period, is a daily rate determined with the formulas in paragraph G.10, above, using the effluent concentration limit specified in the permit for the period and the average of measured daily flows (up to the allowable flow) over the period.
- **12.** "Maximum Allowable Six-Month Median Mass Emission Rate" is a daily rate determined with the formulas in Central Coast Standard Provision Provision G.10, above, using the "six-month Median" effluent limit specified in the permit, and the average of measured daily flows (up to the allowable flow) over a 180-day period.
- **13.** "Median" is the value below which half the samples (ranked progressively by increasing value) fall. It may be considered the middle value, or the average of two middle values.
- **14.** "Monthly Average" (or "Weekly Average", as the case may be) is the arithmetic mean of daily concentrations or of daily mass emission rates over the specified 30-day (or 7-day) period.

Average = (X1 + X2 + ... + Xn) / n

in which "n" is the number of days samples were analyzed during the period and "X" is either the constituent concentration (mg/l) or mass emission rate (kg/day or lbs/day) for each sampled day. "n" should be four or greater.

15. "Municipality" means a city, town, borough, county, district, association, or other public body created by or under State law and having jurisdiction over disposal of sewage, industrial waste, or other waste.

- **16.** "Overflow" means the intentional or unintentional diversion of flow from the collection and transport systems, including pumping facilities.
- **17.** "Pollutant-free wastewater" means inflow and infiltration, stormwaters, and cooling waters and condensates which are essentially free of pollutants.
- **18.** "Primary Industry Category" means any industry category listed in 40 CFR Part 122, Appendix A.
- **19.** "Removal Efficiency" is the ratio of pollutants removed by the treatment unit to pollutants entering the treatment unit. Removal efficiencies of a treatment plant shall be determined using "Monthly averages" of pollutant concentrations (C, in mg/l) of influent and effluent samples collected about the same time and the following equation (or its equivalent):

 $C_{Effluent}$ Removal Efficiency (%) = 100 x (1 - $C_{effluent} / C_{influent})$

- **20.** "Severe property damage" means substantial physical damage to property, damage to treatment facilities which causes them to become inoperable, or substantial and permanent loss to natural resources which can reasonably be expected to occur in the absence of a "bypass". It does not mean economic loss caused by delays in production.
- **21.** "Sludge" means the solids, residues, and precipitates separated from, or created in, wastewater by the unit processes of a treatment system.
- 22. To "significantly contribute" to a permit violation means an "indirect discharger" must:
 - **a.** Discharge a daily pollutant loading in excess of that allowed by contract with the "Discharger" or by Federal, State, or Local law;
 - **b.** Discharge wastewater which substantially differs in nature or constituents from its average discharge;
 - **c.** Discharge pollutants, either alone or in conjunction with discharges from other sources, which results in a permit violation or prevents sewage sludge use or disposal; or
 - **d.** Discharge pollutants, either alone or in conjunction with pollutants from other sources that increase the magnitude or duration of permit violations.
- **23.** "Toxic Pollutant" means any pollutant listed as toxic under Section 307 (a) (1) of the Clean Water Act or under 40 CFR Part 122, Appendix D. Violation of maximum daily discharge limitations are subject to 24-hour reporting (Federal Standard Provisions V.E.).
- **24.** "Zone of Initial Dilution" means the region surrounding or adjacent to the end of an outfall pipe or diffuser ports whose boundaries are defined through calculation of a plume model verified by the State Water Board.

ATTACHMENT E – MONITORING AND REPORTING PROGRAM

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ATTACHMENT E – MONITORING AND REPORTING PROGRAM (MRP)

Section 308 of the federal Clean Water Act (CWA) and sections 122.41(h), (j)-(l), 122.44(i), and 122.48 of title 40 of the Code of Federal Regulations (40 C.F.R.) require that all NPDES permits specify monitoring and reporting requirements. Water Code sections 13267 and 13383 also authorize the Central Coast Water Board to establish monitoring, inspection, entry, reporting, and recordkeeping requirements. This MRP establishes monitoring, reporting, and recordkeeping requirements that implement the federal and California laws and/or regulations.

I. GENERAL MONITORING PROVISIONS

- A. Laboratory Certification. Laboratories analyzing monitoring samples shall be certified by the State Water Resources Control Board (State Water Board), in accordance with the provision of Water Code section 13176, and must include quality assurance/quality control data with their reports.
- **B.** Samples and measurements taken as required herein shall be representative of the volume and nature of the monitored discharge. All samples shall be taken at the monitoring locations specified below and, unless otherwise specified, before the monitored flow joins or is diluted by any other waste stream, body of water, or substance. Monitoring locations shall not be changed without notification to and approval of the Central Coast Water Board.
- C. Appropriate flow measurement devices and methods consistent with accepted scientific practices shall be selected and used to ensure the accuracy and reliability of measurements of the volume of monitored discharges. The devices shall be installed, calibrated, and maintained to ensure that the accuracy of the measurements is consistent with the accepted capability of that type of device. Devices selected shall be capable of measuring flows with a maximum deviation of less than ±10 percent from true discharge rates throughout the range of expected discharge volumes. Guidance in selection, installation, calibration, and operation of acceptable flow measurement devices can be obtained from the following references.
 - A Guide to Methods and Standards for the Measurement of Water Flow, U.S. Department of Commerce, National Bureau of Standards, NBS Special Publication 421, May 1975, 96 pp. (Available from the U.S. Government Printing Office, Washington, D.C. 20402. Order by SD Catalog No. C13.10:421.)
 - 2. Water Measurement Manual, U.S. Department of Interior, Bureau of Reclamation, Second Edition, Revised Reprint, 1974, 327 pp. (Available from the U.S. Government Printing Office, Washington D.C. 20402. Order by Catalog No. 172.19/2:W29/2, Stock No. S/N 24003-0027.)
 - Flow Measurement in Open Channels and Closed Conduits, U.S. Department of Commerce, National Bureau of Standards, NBS Special Publication 484, October 1977, 982 pp. (Available in paper copy or microfiche from National Technical Information Services (NTIS) Springfield, VA 22151. Order by NTIS No. PB-273 535/5ST.)
 - 4. NPDES Compliance Sampling Manual, U.S. Environmental Protection Agency, Office of Water Enforcement, Publication MCD-51, 1977, 140 pp. (Available from the General Services Administration (8FFS), Centralized Mailing Lists Services, Building 41, Denver Federal Center, CO 80225.)
- D. All monitoring instruments and devices used by the Discharger to fulfill the prescribed monitoring program shall be properly maintained and calibrated as necessary to ensure their continued accuracy. All flow measurement devices shall be calibrated at least once per year to ensure continued accuracy of the devices.

- E. Monitoring results, including noncompliance, shall be reported at intervals and in a manner specified in this MRP.
- F. Unless otherwise specified by this MRP, all monitoring shall be conducted according to test procedures established at 40 C.F.R. part 136, *Guidelines Establishing Test Procedures for Analysis of Pollutants*. All analyses shall be conducted using the lowest practical quantitation limit achievable using the specified methodology. Where effluent limitations are set below the lowest achievable quantitation limits, pollutants not detected at the lowest practical quantitation limits will be considered in compliance with effluent limitations. Analysis for toxics listed by the California Toxics Rule shall also adhere to guidance and requirements contained in the *Policy for Implementation of Toxics Standards for Inland Surface Waters, Enclosed Bays, and Estuaries of California* (2005). Analyses for toxics listed in Table 1 of the California Ocean Plan (2015) shall adhere to guidance and requirements contained in that document.
- **G.** The Discharger shall ensure that the results of the Discharge Monitoring Report-Quality Assurance (DMR-QA) Study or the most recent Water Pollution Performance Evaluation Study are submitted annually to the State Water Board at the following address:

State Water Resources Control Board Quality Assurance Program Officer Office of Information Management and Analysis 1001 I Street, Sacramento, CA 95814

II. MONITORING LOCATIONS

The Discharger shall establish the following monitoring locations to demonstrate compliance with the effluent limitations, discharge specifications, and other requirements in this Order:

Discharge Point Name	Monitoring Location Name	Monitoring Location Description	
	INF-001	Influent wastewater with a domestic component (this excludes hauled saline wastes) prior to treatment and following all significant inputs to the collection system or to the headworks of untreated wastewater and inflow and infiltration where representative samples of wastewater influent can be obtained.	
	INF-002	Influent saline waste via haulers to the saline waste storage facility prior to blending with secondary effluent as applicable.	
	INT-001	Influent water to the SVRP.	
	INT-002	Filtered effluent prior to disinfection at the SVRP.	
002	REC-001	Location where representative sample of final disinfected tertiary recycled water can be collected at the SVRP (prior to storage).	
	EFF-001 ^[1]	Location where representative effluent sample may be collected This includes the total component of RO concentrate, hauled saline wastes and secondary effluent that will be discharged through the ocean outfall, after treatment and before contact wit receiving water (final effluent sampling station). Latitude: 36.7075° Longitude: -121.771°	
	EFF-001A	Location where representative secondary effluent sample may be collected prior to commingling with any other waste stream. Latitude: 36.7075° Longitude: -121.771°	

Table E-1. Monitoring Station Locations

Discharge Point Name	Monitoring Location Name	Monitoring Location Description
001	EFF-001B ^[1]	The calculated concentrations of effluent after minimum probable initial dilution using concentrations from Monitoring Location EFF-001.
		Latitude: 36.7075° Longitude: -121.771°
	RSW-A	Shoreline monitoring station – 900 feet north of the outfall, 1,000 feet offshore.
		Latitude: 36.7265° Longitude: -121.8119°
	RSW-B	Shoreline monitoring station – adjacent to the outfall, 1,000 feet offshore.
		Latitude: 36.72325° Longitude: -121.81185°
	RSW-C	Shoreline monitoring station – 900 feet south of the outfall, 1,000 feet offshore.
		Latitude: 36.72018° Longitude: -121.81203°
	RSW-D	Shoreline monitoring station – 1,800 feet south of the outfall, 1,000 feet offshore. Latitude: 36.7168° Longitude: -121.81203°

^[1] The Discharger's outfall and saline waste discharge facilities currently do not allow for aggregate flow metering or sampling of as-discharged combined secondary effluent and saline wastes at high secondary effluent flows (during wet season when recycling is not being implemented) above what is required for blending to safely meet the prescribed effluent limitations.

During the dry season, when the Discharger is recycling essentially 100% of the wastewater flow, the facility is not capable of aggregate flow metering and sampling prior to entering the outfall, however, the Final Effluent Sampling Station is currently in design and proposed for construction prior to completion of the Pure Water Monterey AWPF. During the dry season, saline waste discharge flows (with minimum required secondary effluent blending) and high volume secondary effluent flows are currently metered separately and are sampled separately via grab samples that are manually composited based on the as-discharged flow proportions entering the outfall.

Effluent monitoring per the Discharger's current facility configuration and effluent monitoring protocol is acceptable until the Final Effluent Sampling Station is constructed to facilitate year-round sampling and flow metering of combined saline waste, RO concentrate, and secondary effluent.

The north latitude and west longitude information in Table E-1 are approximate for administrative purposes.

III. INFLUENT MONITORING REQUIREMENTS

A. Monitoring Location INF-001

The Discharger shall monitor the untreated wastewater at Monitoring Location INF-001 as follows:

Parameter	Units	Sample Type	Minimum Sampling Frequency
Daily Flow	MGD	Metered or Calculated ^[1]	Daily
Instantaneous Maximum Flow	MGD	Metered or Calculated ^[1]	Daily
Mean Daily Flow	MGD	Metered or Calculated ^[1]	Monthly
CBOD ₅	mg/L	24-hr Composite	Weekly
TSS	mg/L	24-hr Composite	Weekly

Table E-2. Influent Monitoring at INF-001

Pretreatment Requirements ^{[2], [3]}				
Requirements ^{[2], [3]}				
	 	 	-	

- ^[1] Metered at the treatment facility headworks or calculated based on the summation of collection system pump station flow metering which is more accurate at low flow rates.
- ^[2] Those pollutants identified in Table 1 of the Ocean Plan (2015). Analyses, compliance determination, and reporting for these pollutants shall adhere to applicable provisions of the Ocean Plan, including the Standard Monitoring Procedures presented in Appendix III of the Ocean Plan. The Discharger shall establish calibration standards (or require that their contract laboratory do so) so that the minimum levels (MLs) presented in Appendix II of the Ocean Plan are the lowest calibration standards. The Discharger and its analytical laboratory shall conduct analyses using sufficiently sensitive methods, as described in section X.B.4 of the MRP.
- ^[3] See section VI.C.5.b of the Order and section IX.C of the MRP.

B. Monitoring Location INF-002

1. The Discharger shall monitor saline waste delivered to the facility at Monitoring Location INF-002 (Saline) as follows:

Parameter	Units	Sample Type	Minimum Sampling Frequency
Weekly Volume Received	G (gallons)	Metered or Calculated ^[1]	Daily
Monthly Volume Received	G	Metered or Calculated ^[1]	Daily
Annual Volume Received	MG	Metered or Calculated ^[1]	Monthly
Volume Routed to Emergency Storage ^[1]	G	Metered or Calculated ^[1]	Weekly
Other	The Discharger shall report all saline waste sampling data collected as part of the saline waste facility operation (i.e., analytical data used to characterize saline waste and determine appropriate blending ratios for discharge).		

Table E-3. Influent Saline Waste Monitoring at INF-002

^[1] Sludge holding lagoons and drying beds or other storage as noted on the monitoring reports.

IV. EFFLUENT MONITORING REQUIREMENTS

A. Monitoring Location EFF-001

1. The Discharger shall monitor effluent discharged at Discharge Point 001 at Monitoring Location EFF-001 as follows.

Parameter	Units	Sample Type ^[2]	Minimum Sampling Frequency
Daily Flow ^[3]	MGD	Metered or Calculated	Daily
Instantaneous Max Flow ^[3]	MGD	Metered or Calculated	Daily
Maximum Daily Flow ^[3]	MGD	Metered or Calculated	Monthly
Mean Daily Flow ^[3]	MGD	Calculated	Monthly
рН	pH Units	Grab	Daily
Total & Fecal Coliform ^{[5],[6]}	MPN/100mL	Grab	3X/Permit Term ^[4]
Enterococci Organisms ^{[5],[7]}	MPN/100mL	Grab	3X/Permit Term ^[4]

Table E-4. Effluent Monitoring at EFF-001^[1]
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Parameter	Units	Sample Type ^[2]	Minimum Sampling Frequency	
Temperature	°F	Measured ^[8]	Weekly	
Settleable Solids	mL/L/hr.	Grab	Weekly	
Total Residual Chlorine ^[9]	mg/L	Continuous	4/Year	
Turbidity	NTUs	Grab	Weekly	
Oil and Grease	mg/L	Grab	Weekly	
Orthophosphate	mg/L	Grab	Monthly	
Ammonia, Total (as N)	mg/L	Grab	Monthly	
Nitrate Nitrogen, Total (as N)	mg/L	Grab	Monthly	
Urea	mg/L	Grab	Monthly	
Silicate	mg/L	Grab	Monthly	
Conductivity	μS/cm	Grab	Monthly ^[10]	
Sodium	mg/L	Grab	4/Year ^{[10], [11]}	
Chloride	mg/L	Grab	4/Year ^{[10], [11]}	
Iron	mg/L	Grab	4/Year ^{[10], [11]}	
Magnesium	mg/L	Grab	4/Year ^{[10], [11]}	
Hardness	mg/L	Grab	4/Year ^{[10], [11]}	
Cyanide, Total (as CN)	μg/L	24-hr composite	4/Year ^{[10], [11]}	
Acute Toxicity ^[12]	"Pass"/"Fail" (Test of Significant Toxicity) ^[13]	Grab	4/Year ^{[10], [14]}	
Chronic Toxicity ^[12]	"Pass"/"Fail" (Test of Significant Toxicity) ^[13]	Grab	4/Year ^{[10], [14]}	
Ocean Plan Table 1 Metals ^[15]	µg/L	24-hr composite ^{[16] [17]}	4/Year ^{[10], [14]}	
Ocean Plan Table 1 Pollutants	µg/L	24-hr composite ^{[15] [16] [17]}	4/Year ^{[10], [14]}	
Dissolved Oxygen	mg/L	Grab	3x / Permit Term ^[19]	
Nitrite Plus Nitrate (as N)	mg/L	Grab	Monthly	
Total Kjeldahl Nitrogen (TKN)	mg/L	Grab	Monthly	
Phosphorus (Total)	mg/L	Grab	3x / Permit Term ^[19]	
Remaining Priority Pollutants ^[18]	µg/L	24-hr composite [15] [16] [17]	3x / Permit Term ^[19]	

^[1] The Discharger shall report monitoring results without dilution calculation. Effluent sampling per the Discharger's current saline waste and outfall facility configuration and sampling protocols is acceptable until the Final Effluent Sampling Station is constructed to facilitate year-round sampling and flow metering of combined saline waste, RO concentrate, and secondary effluent.

- ^[2] Effluent sampling per the Discharger's current configuration and sampling protocols is acceptable until the brine waste disposal facility is upgraded to handle anticipated increases in brine flows and facilitate year-round blended secondary effluent and brine waste monitoring (see Table E-1).
- ^[3] The Discharger shall report the daily average and daily maximum flow for each day. In addition, the Discharger shall report the mean daily flow and maximum daily flow for each month. Individual reporting for secondary effluent and saline waste effluent flows are required along with as-discharged combined flow for blended secondary effluent and saline waste. The calculation of combined effluent flow per the Discharger's current saline waste and outfall facility configuration is acceptable until the brine waste disposal facility is upgraded to handle anticipated increases in brine flows and facilitate year-round blended secondary effluent and brine waste flow metering (see Table E-1).
- ^[4] Weekly total coliform, fecal coliform, and enterococcus effluent monitoring apply if the Executive Officer concludes from a bacterial assessment (V.A.1 of the Order) that the discharge consistently exceeds the Receiving Water Limitation of the Order. If weekly sampling is not required the Discharger must monitor total coliform in the effluent a minimum of three times as required for permit renewal EPA Form 2A, Part A. A.12.
- ^[5] For all bacterial analyses, sample dilutions should be performed so the range of bacterial density values extends from 200 to 160,000 /100 mL. The detection methods used for each analysis shall be reported with the results of the analysis.

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- ^[6] Detection methods used for coliforms (total and fecal) shall be those presented in Table 1A of 40 C.F.R. part 136 (revised edition of May 14, 1999), unless alternate methods have been approved in advance by U.S. EPA pursuant to 40 C.F.R. part 136.
- ^[7] Detection methods used for enterococcus shall be those presented in U.S. EPA publication EPA 600/4-85/076, *Test Methods for Escherichia coli and Enterococci in Water by Membrane Filter Procedure*, or any improved method determined by the Central Coast Water Board to be appropriate.
- ^[8] Until the new Final Effluent Sampling Station is constructed to handle the anticipated increases in saline flows and facilitate year-round blending of RO concentrate, saline waste, and secondary effluent (see Table E-1), saline waste samples shall be collected per a minimum weekly sampling frequency and be manually composited per the Discharger's current sampling protocols.
- ^[9] The Discharger is not required to disinfect whole effluent prior to discharge and currently does not do so. However, the Discharger is required to monitor for chlorine residual four times per year as part of the Ocean Plan Table 1 Pollutants monitoring. If disinfection is implemented, daily monitoring for total chlorine residual will be required.
- ^[10] The Discharger shall ensure that sampling is conducted so that actual discharges from each concentrate waste dilution ratio range are represented by at least one sample per calendar year. Sampling shall correspond to the four different Dm values within the calendar year: 145, 259, 388, and 473. The Dm values are determined from the concentrate waste dilution ratio as described in footnote 3 of Table E-7. If a Dm does not occur within the calendar year the Discharger is not responsible for monitoring at that Dm, but must still monitor four times within the calendar year.
- ^[11] The frequency shall remain at 4/year for as long as the permit is in effect.
- ^[12] Whole effluent, acute and chronic toxicity monitoring shall be conducted according to the requirements established in section V. of this Monitoring and Reporting Program.
- ^[13] For compliance determination, chronic and acute toxicity results shall be reported as "Pass" or "Fail." For monitoring purpose only, chronic and acute toxicity results shall also include "Percent Effect."
- ^[14] After the first year, the Central Coast Water Board and MBNMS will evaluate results and may notify the Discharger, in writing, that the sample frequency may be reduced to semi-annually during days when Dms, specified by the Central Coast Water Board, apply. Until the Permitted receives such written notice from the Central Coast Water Board, the required frequency will remain at 4/year, representative of all four Dm conditions.
- ^[15] For those metals (Sb, As, Cd, Cr, Cu, Pb, Hg, Ni, Se, Ag, and Zn) with applicable water quality objectives established by Table 1 of the Ocean Plan analysis shall be for total recoverable metals.
- ^[16] Procedures, calibration techniques, and instrument/reagent specifications shall conform to 40 C.F.R. part 136 and applicable provisions of the Ocean Plan, including the Standard Monitoring Procedures presented in Appendix III. The Discharger shall instruct its analytical laboratory to establish calibration standards so that the Minimum Levels reflect sufficiently sensitive methods as described in section X.B.4 of this MRP. For Ocean Plan Table 1 parameters, the Discharger shall ensure its analytical laboratory uses the MLs presented in Ocean Plan Appendix II as the lowest calibration standards. The Discharger shall select the lowest ML necessary to enable comparison with Ocean Plan objectives. If effluent limitations are less than the lowest ML, then the Discharger shall use the lowest ML.
- ^[17] In order to collect representative samples from each of the 4 Dms 24-hour composite samples may be collected to monitor Ocean Plan and Remaining Priority Pollutants. All PCB congeners shall be reported in addition to Aroclors. The Discharger shall utilize the integrative high-volume water sampling (IHVWS) such as SPMD or those deployed by CCLEAN to meet the CCLEAN monitoring obligations.
- ^[18] The "Remaining Priority Pollutants" (see Table E-5 below) consist of the priority pollutants listed in Part D of EPA Form 3510-2A (Rev. 1-99) that currently do not have ocean criteria (water quality objectives) per Table 1 of the Ocean Plan. A complete EPA Form 3510-2A is required for all new and renewal NPDES permit applications pursuant to 40 C.F.R. § 122.21. Expanded Effluent Testing Data per Part D of EPA Form 3510-2A is required for all treatment works with design flows greater than or equal to 1.0 MGD or with a pretreatment program (or required to have a pretreatment program), or otherwise required by the permitting authority to provide the data.

Parameter
Volatile Organic Compounds
Bromoform
Chloroethane
2-Chloroethyl Vinyl Ether
1,1-Dichloroethane
Trans-1,2-Dichloroethylene
1,2-Dichloropropane
1,3-Dichloropropylene
Methyl Bromide
Methyl Chloride
Acid Extractable Compounds
P-Chloro-m-Cresol
2-Chlorophenol
2,4-Dichlorophenol
2,4-Dimethylphenol
4,6-Dinitro-o-Cresol
2-Nitrophenol
4-Nitrophenol
Pentachlorophenol
Phenol
Base-Neutral Compounds
Acenaphthene
Acenaphthylene
Anthracene
Benzo(a)Anthracene
Benzo(a)Pyrene
3,4-Benzo-Fluoranthene
Benzo(ghi)Perylene
Benzo(k)Fluoranthene
4-Bromophenyl Phenyl Ether
Butyl Benzyl Phthalate
2-Chloronaphthalene
4-Chlorophenyl Phenyl Ether
Chrysene
Di-n-Octyl Phthalate
Dibenzo(a,h) Anthracene
1,4-Dichlorobenzene
2,6-Dinitrotoluene
Fluorene

Table E-5. Remaining Priority Pollutants

Parameter
Indeno(1,2,3-CD)Pyrene
Naphthalene
Phenanthrene
Pyrene
1,2,4-Trichlorobenzene

^[19] At a minimum, effluent testing data must be based on at three pollutant scans with one sample on days with Dms of 145, 259, and 388, so that a total of three samples are collected and are representative of these three Dms. The effluent testing must be no more than four and one-half years old at the time the re-application submittal is due.

B. Monitoring Location EFF-001A

1. The Discharger shall monitor secondary effluent at Monitoring Location EFF-001A as follows.

Parameter	Units	Sample Type	Minimum Sampling Frequency	
Daily Flow ^[1]	MGD	Metered or Calculated	Daily	
CBOD ₅ ^[2]	mg/L	24-hr Composite	Weekly	
Total Organic Carbon (TOC)	mg/L	24-hr Composite	Weekly	
TSS ^[2]	mg/L	24-hr Composite	Weekly	
рН	pH Units	Metered	Weekly	

Table E-6. Effluent Monitoring at EFF-001A

^[1] The Discharger shall report the daily average flow for each day.

^[2] The Discharger shall also report in units of lbs/day.

C. Monitoring Location EFF-001B

1. The Discharger shall calculate the Concentrate Waste Dilution Ratio and commingled RO concentrate, hauled saline waste, and secondary effluent quality at Monitoring Location EFF-001B as follows:

Parameter	Units	Sample Type	Minimum Sampling Frequency
Daily AWPF RO Concentrate Flow ^[1]	MGD	Metered or Calculated	Daily
Daily Total Flow ^[1]	MGD	Metered or Calculated	Daily
Daily Hauled Saline Waste Flow ^[1]	MGD	Metered or Calculated	Daily
Concentrate Waste Dilution Ratio ^[2]		Calculated	Daily
Dm Value ^[3]		Report	Daily
Total Residual Chlorine ^[4]	mg/L	Calculated ^[5]	Daily
Ammonia	mg/L	Calculated ^[5]	Monthly
Cyanide	µg/L	Calculated ^[5]	4/Year ^[6]
Total & Fecal Coliform	MPN/100mL	Calculated	3X/Permit Term
Enterococci Organisms	MPN/100mL	Calculated	3X/Permit Term
Remaining Ocean Plan Table 1 Metals ^[8]	µg/L	Calculated ^[5]	4/Year ^[7]
Ocean Plan Table 1 Pollutants	μg/L	Calculated ^[5]	4/Year [7]

Table E-7. Effluent Monitoring at EFF-001B

^[1] The Discharger shall report the daily average flow for each day a corresponding parameter is reported.

AWPF RO Concentrate (MGD)+Hauled Saline Waste (MGD)

Total Effluent (MGD)

[2]

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[3]	Dm corresponds	to the Concentrate	Waste Dilution	Ratio as follows:
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Ratio of RO Concentrate + Hauled Saline Waste to Total Effluent	Dm for Compliance with Ocean Plan Table 1 Parameters (except acute toxicity)	Dm for Compliance with Acute Toxicity Limit
0-0.127	145	14.5
0.128 – 0.421	259	25.9
0.422 – 0.744	388	38.8
≥ 0.745	473	47.3

- ^[4] When applicable the Discharger is not required to disinfect whole effluent prior to discharge and currently does not do so. However, the Discharger is required to monitor for chlorine residual semiannually per the Ocean Plan Table 1 Pollutants monitoring.
- ^[5] The Co shall be calculated and reported using the equation below:

$$Co = \frac{Ce + DmCs}{1 + Dm}$$

where:

- Co = the concentration at the completion of initial dilution to be compared to effluent limitations in Table 6 of this Order for compliance determination.
- Ce = effluent concentration reported for Monitoring Location EFF-001.
- Cs = background seawater concentration provided in Table 3 of the 2015 Ocean Plan (with all metals expressed as total recoverable concentration, μg/L
- Dm = the minimum probable initial dilution corresponding to Concentrate Waste Dilution Ratio in footnote 3.

For compliance determination with effluent limitations, the Discharger shall report the calculated instantaneous maximum, daily maximum, and 6-month median results for comparison to effluent limitations.

- ^[6] The Discharger shall ensure that sampling is conducted so that actual discharges from each Concentrate Waste Dilution ratio range are represented by at least one sample per calendar year. Sampling shall correspond to the four different Dm values within the calendar year: 145, 259, 388, and 473. The Dm values are determined from the Concentrate Waste Dilution ratio as described in footnote 3. If a Dm does not occur within the calendar year the Discharger is not responsible for monitoring at that Dm, but must still monitor four times within the calendar year.
- ^[7] After the first year, the Central Coast Water Board and MBNMS will evaluate results and may notify the Discharger, in writing, that the sample frequency may be reduced to semi-annually during days where Dms, specified by the Central Coast Water Board, apply. Until the Permitted receives such written notice from the Central Coast Water Board, the required frequency will remain at 4/year, representative of all four Dm conditions.
- ^[8] For those metals (Sb, As, Cd, Cr, Cu, Pb, Hg, Ni, Se, Ag, and Zn) with applicable water quality objectives established by Table 1 of the Ocean Plan analysis shall be for total recoverable metals. If analyzing for total chromium to demonstrate compliance with the hexavalent chromium objective, the Discharger shall analyze for total recoverable chromium.

V. WHOLE EFFLUENT TOXICITY TESTING REQUIREMENTS

A. Whole Effluent Toxicity (WET) Testing Requirements

The WET refers to the overall aggregate toxic effect to aquatic organisms from all pollutants contained in a facility's wastewater (effluent). The control of WET is one approach this Order uses to control the discharge of toxic pollutants. WET tests evaluate the 1) aggregate toxic effects of all chemicals in the effluent including additive, synergistic, or antagonistic effects; 2) the effects of unmeasured chemicals in the effluent; and 3) variability in bioavailability of the chemicals in the effluent.

Monitoring to assess the overall toxicity of the effluent is required to answer the following questions:

(1) Does the effluent comply with permit effluent limitations for toxicity thereby ensuring that water quality standards are achieved in the receiving water?

(2) If the effluent does not comply with permit effluent limitations for toxicity, is the observed toxicity causing risk to aquatic life?

(3) If the effluent does not comply with permit effluent limitations, is the observed toxicity caused by one or more pollutants that are measured or unmeasured?

B. Acute Toxicity

1. Sample Volume and Holding Time

The total sample volume shall be determined by the specific toxicity test method used. Sufficient sample volume shall be collected to perform the required toxicity test. Sufficient sample volume shall also be collected during accelerated monitoring for subsequent TIE studies, if necessary. All toxicity tests shall be conducted as soon as possible following sample collection. No more than 36 hours shall elapse before the conclusion of sample collection and test initiation.

2. Discharge In-stream Waste Concentration (IWC) for Acute Toxicity

The acute IWC is calculated by dividing 100 percent by the acute toxicity Dm+1. The acute toxicity Dm corresponds to the Concentrate Waste Dilution Ratio as described in section VI.C.6.b of the Order multiplied by 0.1, and shall be based on flows recorded on the first day of testing. The acute toxicity IWC is one of the values in the table below.

Dm for Compliance with Ocean Plan Acute Toxicity	Instream Waste Concentration (%)
14.5	6.4
25.9	3.7
38.8	2.5
47.3	2.0

Table E-8. U.S. Instream Waste Concentrations Associated with Dm^[1]

^[1] Minimum probable initial dilution (expressed as parts seawater per part wastewater) multiplied by 0.1, according to Equation 2 in section III.C.4.b of the 2015 California Ocean Plan.

3. Acute Toxicity Test Species and Methods

Species and short-term test methods for estimating the acute toxicity of NPDES effluents are generally found in the fifth edition of *Methods for Measuring the Acute Toxicity of Effluents and Receiving Waters to Freshwater and Marine Organisms* (EPA/821/R-02/012, 2002; Table IA, 40 CFR 136).

For this Order/Permit, the Discharger shall conduct 96-hour static renewal toxicity tests using a standard marine test species as specified in EPA-821-R-02-012 and as noted in the following table.

Species	Scientific Name	Effect	Test Duration	
Shrimp	Holmesimysis costata	Survival	96 hours	
Shrimp	Mysidopsis bahia	Survival	96 hours	

Table E-9. Approved Tests – Acute Toxicity (TUa)

Species	Scientific Name	Effect	Test Duration	
Silversides	Menidia beryllina	Survival	96 hours	
Sheepshead Minnow	Cyprinodon variegatus	Percent Survival	96 hours	

4. Quality Assurance and Additional Requirements

The Discharger shall perform toxicity tests on final effluent samples. If the effluent is to be discharged to a marine or estuarine system (e.g., salinity values in excess of 1,000 mg/L) and originates from a freshwater supply, salinity of the effluent must be increased with dry ocean salts (e.g., FORTY FATHOMS®) to match salinity of the receiving water. This modified effluent shall then be tested using marine species.

Reference toxicant test results shall be submitted with the effluent sample test results. Both tests must satisfy the test acceptability criteria specified in EPA-821-R-02-012. If the test acceptability criteria are not achieved, the sample shall be retaken and retested within 14 days of the failed sampling event. The retest results shall be reported in accordance with EPA-821-R-02-012 (chapter on report preparation) and the results shall be attached to the next monitoring report.

When toxicity monitoring finds acute toxicity in the effluent above the effluent limitation established by this Order, the Discharger shall immediately resample the effluent, if the discharge is continuing, and retest for acute toxicity. Results of the initial failed test and any toxicity monitoring results subsequent to the failed test shall be reported as soon as reasonable to the Central Coast Water Board Executive Officer (EO). The EO will determine whether it is appropriate to initiate enforcement action, require the Discharger to implement toxicity reduction evaluation (TRE) requirements (sections VI.C.2.a of this Order), or implement other measures.

5. Accelerated Monitoring and TRE Initiation Toxicity Testing and TRE/TIE Process for Acute Toxicity

When an effluent limitation for acute toxicity is exceeded during regular whole effluent toxicity (WET) monitoring, the Discharger shall initiate accelerated monitoring as required in the Accelerated Monitoring Specifications of this permit (section VI.C.2.b). As specified in Section VI.C.2.b, the Discharger shall initiate accelerated monitoring within 14 days of notification by the laboratory of the exceedance. The Discharger shall initiate a TRE to address effluent toxicity if any WET test result exceeds the acute effluent limit during accelerated monitoring, as specified in section VI.C.2.b.i.(e).

C. Chronic Toxicity

1. Discharge In-stream Waste Concentration (IWC) for Chronic Toxicity

The chronic IWC is calculated by dividing 100 percent by the dilution ratio, Dm. The Dm will be based on the Concentrate Waste Dilution Ratio as described in section VI.C.6.b of the Order and shall be based on flows recorded on the first day of testing. The chronic toxicity IWC will be one of values in the table below.

Dm for Compliance with Ocean Plan Table 1 Parameters	Chronic Toxicity Instream Waste Concentration (%)
145	0.69
259	0.39
388	0.26
473	0.21

	Table	E-10.	U.S.	Instream	Waste	Concentrations	Associated	with Dm ^[1]
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^[1] Minimum probable initial dilution expressed as parts seawater per part wastewater.

2. Chronic Marine Species and Test Methods

The presence of chronic toxicity shall be estimated as specified in *Short Term Methods* for *Estimating the Chronic Toxicity of Effluents and Receiving Waters to West Coast Marine and Estuarine Organisms*, EPA-821/600/R-95/136; *Short Term Methods for Estimating the Chronic Toxicity of Effluents and Receiving Waters to Marine and Estuarine Organisms*, EPA-821-R-02-104 or *Procedures Manual for Conducting Toxicity Tests developed by the Marine Bioassay Project*, SWRCB 1996, 96-1WQ; and/or *Short Term Methods for Estimating the Chronic Toxicity of Effluents and Receiving Waters to Marine and Estuarine Organisms*, EPA-600/4-87-028 or subsequent editions.

In accordance with the 2015 Ocean Plan, Appendix III, Standard Monitoring Procedures, the Discharger shall use the critical life stage toxicity tests specified in Table E-11 to measure chronic toxicity. Other species or protocols may be added to the list after the State Water Board review and approval.

Species	Effect	Tier ^[1]	Reference ^[2]
Giant Kelp, Macrocystic pyrifera	Percent germination; germ tube length	1	a, c
Red abalone, Haliotis rufesens	Abnormal shell development	1	a, c
Oyster, <i>Crassostrea gigas</i> ; Mussels, <i>Mytilus spp</i>	Abnormal shell development percent survival	1	a, c
Urchin, Strongylocentrotus purpuratus; Sand dollar, Dendraster excentricus	Percent normal development	1	a, c
Urchin, Strongylocentrotus purpuratus; Sand dollar, Dendraster excentricus	percent fertilization	1	a, c
Shrimp, Holmesimysis costata	Percent survival; growth	1	a, c
Shrimp, Mysidopsis bahia	Percent survival; growth; fecundity	2	b, d
Topsmelt, Atherinops affinis	Larval growth rate; percent survival	1	a, c
Silversides, Menidia beryllina	Larval growth rate; percent survival	2	b, d

Table E-11. Approved Tests – Chronic Toxicity

^[1] First tier methods are preferred for compliance monitoring. If first tier organisms are not available, the Discharger can use a second-tier test method following approval by the Central Coast Water Board.

^[2] Protocol References:

- Chapman, G.A., D.L. Denton, and J.M. Lazochak. 1995. Short-term methods for estimating the chronic toxicity of effluents and receiving waters to west coast marine and estuarine organisms. U.S. EPA Report No. EPA/600/R-95/136.
- b. Klemm, D.J., G.E. Morrison, T.J. Norberg-King, W.J. Peltier, and M.A. Heber. 1994. Short-term methods for estimating the chronic toxicity of effluents and receiving waters to marine and estuarine organisms. U.S. EPA Report No. EPA-600-4-91-003.
- c. SWRCB 1996. Procedures Manual for Conducting Toxicity Tests Developed by the Marine Bioassay Project. 96-1WQ.
- d. Weber, C.I., W.B. Horning, I.I., D.J. Klemm, T.W. Neiheisel, P.A. Lewis, E.L. Robinson, J. Menkedick and F. Kessler (eds). 1988. Short-term Methods for Estimating the Chronic Toxicity of Effluents and Receiving Waters to Marine and Estuarine Organisms. EPA/600/4-87/028. National Information Service, Springfield, VA.

3. Species Sensitivity Screening

To select the most sensitive species for the term of this Order, species sensitivity screening shall be performed one time for the low and high concentrate waste dilution scenarios when effluent Dms of 145 and 473 apply (see section VI.C.6.b of the Order). For each screening event, the Discharger shall collect a single effluent sample to initiate and concurrently conduct three toxicity tests using a fish, an invertebrate, and an alga species, to be selected from the list of approved tests referenced in Table E-11. This sample shall also be analyzed for the parameters required on a monthly frequency for the discharge during that given month. For those tests that require collection of additional renewal samples (as specified in the listed test method protocols), a second and third sample shall be collected. If the results of all three species for both dilution scenarios is "Pass," then the species that exhibited the highest "Percent Effect" regardless of dilution scenario shall be used for routine monitoring during this Order cycle. If the results of all three species for both dilution scenarios results in a single "Fail," then that species resulting in the Fail shall be used for routine monitoring during this Order cycle. Likewise, if the results of all three species for both dilution scenarios results in two or more species with a "Fail," then the species that exhibits the highest "Percent Effect" shall be used for routine monitoring during this Order cycle.

The species used to conduct routine chronic toxicity effluent monitoring shall be the most sensitive species from the most recent species sensitivity screening. To select the most sensitive species for the term of the next Order, rescreening shall be conducted prior to permit reissuance and the results submitted with the report of waste discharge.

Toxicity results obtained during the species screening may be used to evaluate compliance with the chronic toxicity maximum daily effluent limitation (MDEL). During the calendar month, toxicity tests used to determine the most sensitive test species shall be reported as effluent compliance monitoring results for the chronic toxicity MDEL.

D. Quality Assurance and Additional Requirements

Quality assurance measures, instructions, and other recommendations and requirements are found in the test methods manuals previously referenced. Additional requirements are specified below.

- The Discharger shall perform toxicity tests on final effluent samples. If the effluent is to be discharged to a marine or estuarine system (e.g., salinity values in excess of 1,000 mg/L) and originates from a freshwater supply, salinity of the effluent must be increased with dry ocean salts (e.g., FORTY FATHOMS®) to match salinity of the receiving water. This modified effluent shall then be tested using marine species.
- 2. Reference toxicant test results shall be submitted with the effluent sample test results. Both tests must satisfy the test acceptability criteria specified in EPA-821-R-02-012. If the test acceptability criteria are not achieved, the sample shall be retaken and retested within 14 days of the failed sampling event. The retest results shall be reported in accordance with EPA-821-R-02-012 (chapter on report preparation) and the results shall be attached to the next monitoring report.
- 3. The discharge is subject to determination of "Pass" or "Fail" from an acute or chronic toxicity test using the Test of Significant Toxicity (TST) statistical t-test approach described in *National Pollutant Discharge Elimination System Test of Significant Toxicity Implementation Document* (EPA 833-R-10-003, 2010), Appendix A, Figure A-1 and Table A-1 and Appendix B, Table B-1. The null hypothesis (Ho) for the TST statistical approach is:

Mean discharge IWC response ≤0.75 × Mean control response

A test result that rejects this null hypothesis is reported as "Pass." A test result that does not reject this null hypothesis is reported as "Fail." The relative "Percent Effect" at the discharge IWC is defined and reported as:

((Mean control response - Mean discharge IWC response) ÷ Mean control response) × 100

Acute and Chronic WET testing is to be performed with only two test concentrations, the laboratory control and a single effluent treatment (the IWC). As discussed in Fact Sheet section IV.C.6, evaluation of concentration-response does not apply to single-concentration (IWC) tests where the TST is applied.

- 4. If the effluent toxicity test does not meet all test acceptability criteria (TAC) specified in the referenced test method manuals (Tables E-9 and E-11), the test should be declared invalid, then the Discharger must resample and re-test within 14 days of test termination.
- 5. Dilution water and control water, including brine controls, shall be uncontaminated natural water, as specified in the test methods manual. If dilution water and control water is different from test organism culture water, then a second control using culture water shall also be used.
- 6. Monthly reference toxicant testing is sufficient.
- 7. The Discharger shall perform toxicity tests on final effluent samples. Chlorine and ammonia shall not be removed from the effluent sample prior to toxicity testing, unless explicitly authorized by the Executive Officer.

E. Accelerated Monitoring Schedule for Maximum Daily Single Result: "Fail."

When an effluent limitation for acute or chronic toxicity is exceeded during regular WET monitoring, the Discharger shall initiate accelerated monitoring as required in the Accelerated Monitoring Specifications of this permit (Section VI.C.2.b). As specified in Section VI.C.2.b., the Discharger shall notify the Central Coast Water Board and U.S. EPA Region 9 and initiate accelerated monitoring within 14 days of notification by the laboratory of the exceedance. The Discharger shall initiate a TRE to address effluent toxicity if any WET test result exceeds the acute or chronic effluent limit during accelerated monitoring, as specified in Section VI.C.2.a.ii.

F. Toxicity Reporting

- 1. The Discharger shall include a full report of toxicity test results with the regular quarterly monitoring report and include the following information.
 - a. Toxicity test results,
 - b. Dates of sample collection and initiation of each toxicity test, and
 - c. And/or toxicity discharge limitations (or value).
- 2. Summary water quality measurements for each toxicity test (e.g., pH, dissolved oxygen, temperature, conductivity, hardness, salinity, chlorine, ammonia).
- 3. Toxicity test results shall be reported according to the appropriate guidance Methods for Measuring the Acute Toxicity of Effluents and Receiving Waters to Freshwater and Marine Organisms, Fifth Edition, U.S. EPA Office of Water, EPA-821-R-01-012 (2002) or the latest edition or Short-Term Methods for Estimating the Chronic Toxicity of Effluents and Receiving Waters to Freshwater and Marine Organisms, EPA-821-R-02-012 (2002) or subsequent editions.

- 4. If the TRE Action Plan is used to determine that additional (accelerated) toxicity testing is unnecessary, these results shall be submitted with the monitoring report for the time period in which the investigation conducted under the TRE Action Plan occurred.
- 5. Statistical program (e.g., TST calculator, CETIS, etc.) output results, including graphical plots, for each toxicity test.
- **6.** Graphical plots and tables clearly showing the laboratory's performance for the reference toxicant for the previous 20 tests.
- **7.** Any additional quality assurance/quality control (QA/QC) documentation or any additional chronic toxicity-related information, upon written request from the Central Coast Water Board and/or U.S. EPA, Region 9.
- 8. The report shall also include:
 - a. The valid toxicity test results for the TST statistical approach, reported as "Pass" or "Fail" and "Percent Effect" at the acute and chronic toxicity IWC for the discharge. All toxicity test results (whether identified as valid or otherwise) conducted during the calendar quarter shall be reported on the SMR due date specified in Table E-16.
 - **b.** The statistical analysis used in *National Pollutant Discharge Elimination System Test of Significant Toxicity Implementation Document* (EPA 833-R-10-003, 2010) Appendix A, Figure A-1 and Table A-1, and Appendix B, Table B-1.

VI. LAND DISCHARGE MONITORING REQUIREMENTS - NOT APPLICABLE

VII. RECYCLING MONITORING REQUIREMENTS

The Discharger shall comply with applicable state and local requirements regarding the production of recycled wastewater, including requirements of California Water Code (CWC) sections 13500 – 13577 (Water Reclamation) and regulations at title 22, sections 60301 – 60357 of the California Code of Regulations (Water Recycling Criteria).

A. MONITORING LOCATIONS REC-001

1. When producing recycled water, the discharger shall monitor recycled water at location REC-001 as follows.

Parameter	Units	Sample Type	Minimum Sampling Frequency
Daily Flow ^[1]	MGD	Metered	Daily
Maximum Daily Flow ^[1]	MGD		Monthly
Mean Daily Flow ^[1]	MGD	Calculated	Monthly
Total Coliform	MPN/100mL	Grab	Daily
Biochemical Oxygen Demand, 5-day	mg/L	24-hr Composite	Weekly
Total Non-Filterable Residue (Suspended Solids)	mg/L	24-hr Composite	Weekly
Total Dissolved Solids	mg/L	24-hr Composite	Weekly
рН	standard units	Grab	1/Day
Settleable Solids	ml/l/hr	Grab	Daily
Chlorine Residual ^[2]	mg/L	Metered	Continuous

Table E-12. Recycled Water Monitoring

^[1] Flow shall be metered at the distribution system pump station to provide a record of the quantity of reclaimed water used each day (per normal irrigation period).

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- ^[2] Report daily maximum and daily minimum values prior to discharge and at the end of the chlorine contact chamber. Compliance shall be determined by daily minimum values measured within the chlorine contact zone at the end of the chlorine contact chamber.
 - 2. In the event the Producer is unable to comply with the conditions of the water recycling requirements and prohibitions, the Producer shall immediately notify the Central Coast Water Board by telephone and submit a written follow-up report with two weeks of the noncompliance. The written report shall include pertinent information explaining reasons for the noncompliance and shall indicate what steps are being taken to prevent the problems from recurring.
 - **3.** An annual self-monitoring report shall be submitted to the Central Coast Water Board by January 30 of the following year. The report shall include:
 - **a.** A letter transmitting self-monitoring reports should accompany each report. The letter shall include a discussion of violations found during the reporting period and actions taken or planned for correcting noted violations, such as operation or facility modifications. If the Producer has previously submitted a report describing corrective actions or a time schedule for implementing corrective actions, reference to the previous correspondence will be satisfactory. The transmittal letter shall contain a statement by the Producer or the Producer's authorized agent, under penalty of perjury, that to the best of the signer's knowledge the report is true, accurate, and complete.
 - **b.** Tabulations of the results of each required analysis by the Producer specified in Table E-12 by date, time, type of sample, and station.

B. MONITORING LOCATIONS INT-001, INT-002

1. The Discharger shall monitor water at the SVRP as follows:

Parameter	Units	Sample Type	Minimum Sampling Frequency	Location
Influent Loading Rate ^[1]	gpm/ft ²	Metered	Continuous	INT-001
Turbidity ^[2]	NTU	Metered	Continuous	INT-002

Table E-13. SVRP Process Monitoring

[1] Report daily maximum values. Influent loading rate to filters shall be measured.

^[2] Report daily maximum and daily mean values. Turbidity samples shall be obtained after filtration, but prior to disinfection.

VIII. RECEIVING WATER MONITORING REQUIREMENTS

A. Bacteria Monitoring – Monitoring Locations RSW-A, RSW-B, RSW-C, and RSW-D

Bacteria monitoring shall be conducted to assess bacteriological conditions in areas used for body contact recreation (e.g., swimming) and to assess conditions of aesthetics for general recreation use (e.g., picnicking, boating). Bacteria monitoring shall be conducted along the 30-foot contour at Monitoring Locations RSW-A, RSW-B, RSW-C, and RSW-D. Bacteria monitoring shall be conducted in accordance with the following table. Latitude and Longitude shall be provided for all stations when reporting.

Parameter	Units	Sampling Station	Sampling Frequency
Total and Fecal Coliform			
Bacteria ^{[1], [2], [3],}	MPN/100ml	RSW-A, B, C, D	Monthly
Enterococcus Bacteria ^{[1], [3], [4]}	MPN/100ml	RSW-A, B, C, D	Monthly
Visual Monitoring ^[5]	Narrative	RSW-A, B, C, D	Monthly

Table E-14. Triggered Shoreline Bacteria Monitoring Schedule

^[1] For all bacterial analyses, sample dilutions shall be performed so the range of values extends from 2 to 16,000 MPN/100ml. The detection methods used for each analysis shall be reported with the results of the analysis.

^[2] Detection methods used for coliforms (total and fecal) shall be those presented in Table 1A of 40 C.F.R. part 136, unless alternate methods have been approved in advance by U.S. EPA pursuant to 40 C.F.R. part 136.

- ^[3] If a single sample exceeds any of the bacteriological single sample maximum (SSM) standards contained within section V.A.1 of the Order, repeat sampling at that location shall be conducted to determine the extent and persistence of the exceedance. Repeat sampling shall be conducted within 24 hours of receiving analytical results and continued daily until the sample result is less than the SSM standard or until a sanitary survey is conducted to determine the source of the high bacterial densities. When repeat sampling is required because of an exceedance of any one single sample density, values from all samples collected during that 30-day period will be used to calculate the geometric mean. Shore stations (immediately inshore of 30-foot contour sites) shall be sampled concurrent with 30-foot contour repeat sampling.
- [4] Detection methods used for enterococcus shall be those presented in U.S. EPA publication EPA 600/4-85/076, Test Methods for Escherichia coli and Enterococci in Water by Membrane Filter Procedure, or any improved method determined by the Central Coast Water Board (and approved by U.S. EPA) to be appropriate.
- ^[5] Visual monitoring shall include observations of wind (direction and speed), weather (e.g., cloudy, sunny, rainy), antecedent rainfall (7-day), sea state, and tidal conditions (e.g., high, slack, or low tide). Observations of water discoloration, floating oil and grease, turbidity, odor, material of sewage origin in the water or on the beach, and temperature (°C) shall be recorded and reported.

These requirements also satisfy the CCLEAN 30-foot contour bacteriological monitoring requirements noted in Table E-15, below.

IX. OTHER MONITORING REQUIREMENTS

A. Central Coast Long-Term Environmental Assessment Network (CCLEAN)

- 1. The Discharger shall participate in the implementation of the CCLEAN Regional Monitoring Program in order to fulfill receiving water compliance monitoring requirements and support the following CCLEAN Program objectives.
 - **a.** Obtain high-quality data describing the status and long-term trends in the quality of nearshore waters, sediments, and associated beneficial uses.
 - **b.** Determine whether nearshore waters and sediments are in compliance with the Ocean Plan.
 - c. Determine sources of contaminants to nearshore waters.
 - **d.** Provide legally defensible data on the effects of wastewater discharges in nearshore waters.
 - e. Develop a long-term database on trends in the quality of nearshore waters, sediments, and associated beneficial uses.

- **f.** Ensure that the nearshore component database is compatible with other regional monitoring efforts and regulatory requirements.
- **g.** Ensure that nearshore component data are presented in ways that are understandable and relevant to the needs of stakeholders.
- 2. Monitoring requirements of the CCLEAN Program in effect as of the date of this order are outlined in the following table. The CCLEAN Quality Assurance Project Plan (QAPP) for each year will be submitted for staff approval prior to initiation of CCLEAN sampling. A detailed technical study design description, including specific location of sampling sites and a description of the specific contents of the CCLEAN Annual Report, shall be provided as a component of the CCLEAN QAPP. Any year-to-year modifications to the program (including implementation of subsequent program phases) shall be identified in the QAPP and/or Annual Report.

Sample Matrix	Sampling Frequency	Sampling Technique	Parameter Sampled	Applicable Water Quality Stressors and Program Objectives	
		30-day flow	PAHs		
		proportioned samples	DDTs	Sources, loads, trends,	
		using automated	Dieldrin	effects and permit	
	Two times per	pumping and solid-	Chlordanes	compliance for:	
Effluent –	Two times per	phase-extraction	PCBs	POP _c	
Santa Cruz,	dry soason)	(particle filter + XAD	Dioxins/Furans	FOFS	
Watsonville,	ury season)	resin)	PBDEs		
Monterey One		Two day, four liter	Pyrethroids	Trends of:	
Water, Carmel Area		Two-day, Tour-liter	Fipronils	Emerging contaminants of	
Wastewater District)		composites	Neonicotinoids	concern	
in effluent			Ammonia		
			Nitrate	Sources, loads, trends and	
	Monthly	Grab	Silica	permit compliance for:	
			Ortho-Phosphate	Nutrients	
			Urea		
Influent – Watsonville	Once per year (dry season)	Same as effluent	Same as effluent	Efficiency of: POP removal	
		30-day flow	PAHs		
		proportioned samples	DDTs	Sources, loads, trends, effects and permit compliance for:	
Rivers –		using automated pumping and solid- phase-extraction (particle filter + XAD resin)	Dieldrin		
San Lorenzo	Two times per		Chlordanes		
			PCBs		
			PBDEs	POPs	
	year (wet and	The standard for a literat	Pyrethroids	Trends of:	
Rivers –	dry season)	I wo-day, lour-liter	Fipronils	Emerging contaminants of	
San Lorenzo		composites	Neonicotinoids	concern	
Pajaro			Ammonia		
Salinas		Queh	Nitrate	Effects of:	
Carmel		Grab	Silicate	Nutrients	
			Ortho-Phosphate		
Monterey Bay –	Manthlysan		Total coliform	Sources trends effects	
(Receiving water)			Fecal coliform	and permit compliance for	
Santa Cruz Watsonville MOW	weekly, as required by each NPDES permit	Grab	Enterococcus	Fecal Indicator Bacteria (FIB) pathogen indicators	

Table E-15. CCLEAN Monitoring Requirements

Sample Matrix	Sampling Frequency	Sampling Technique	Parameter Sampled	Applicable Water Quality Stressors and Program Objectives
Monterey Bay – (Open water) North South	Two times per year (wet and dry season)	30-day flow proportioned samples using automated pumping and solid- phase-extraction (particle filter + XAD resin)	PAHs DDTs Dieldrin Chlordanes PCBs PBDEs TSS FIBs Ammonia Nitrate Silica Ortho-Phosphate	Sources, loads, trends, effects and permit compliance for: POPs Effects of: Nutrients and FIBs
	Every 5 years	Database satellite ocean color imagery	Chlorophyll a	
Sediments – Six sites along the 80m contour in Monterey Bay, Santa Cruz Inner Harbor, Moss Landing Harbor	Annually in the fall	Sediment Grab	DDTs Dieldrin Chlordanes PCBs PBDEs Grain size TOC	Status, effects and alert level comparisons for POPs
Six sites along the 80m contour in Monterey Bay	Every five years in the fall		Benthic infauna	Status and trends of benthic communities
Mussels – Five rocky intertidal sites in Monterey Bay	Annually in the wet season	1 composite of 30-40 mussels 1 composite of 30-40 mussels	Lipid content DDTs Dieldrin Chlordanes PCBs PBDEs Fecal indicator bacteria	Status, trends, effects and alert level comparisons for: POPs and pathogen indicators

B. Biosolids Monitoring, Notification, and Reporting

1. Biosolids Monitoring

a. Biosolids shall be tested for the metals required in 40 C.F.R. section 503.16 (for land application) or section 503.26 (for surface disposal), using the methods in *Test Methods for Evaluating Solid Waste, Physical/Chemical Methods* (SW-846), as required in 503.8(b)(4), at the following minimum frequencies:

Volume (dry metric tons) ^[1]	Sampling and Analysis Frequency ^[2]
0-290	Once per year
290-1,500	Once per quarter
1,200-15,000	Once per 60 days
>15,000	Once per month

Table E	-16.	Biosolids	Monitorina	Frequency
I able E	-10.	DIUSUIIUS	womening	riequency

- ^[1] For accumulated, previously untested biosolids, the Permittee shall develop a representative sampling plan, including number and location of sampling points, and collect representative samples.
- ^[2] Test results shall be expressed in mg pollutant per kg biosolids on a 100% dry weight basis. Biosolids to be land applied shall be tested for organic-N, ammonium-N, and nitrate-N at the frequencies required above.
 - **b.** Prior to land application, the Permittee shall demonstrate that the biosolids meet Class A or Class B pathogen reduction levels by one of the methods listed in 40 C.F.R. section 503.32. Prior to disposal in a surface disposal site, the Permittee shall demonstrate that the biosolids meet Class B levels or shall ensure that the site is covered at the end of each operating day. If pathogen reduction is demonstrated using a "Process to Significantly/Further Reduce Pathogens," the Permittee shall maintain daily records of the operating parameters used to achieve this reduction. If pathogen reduction is demonstrated by testing for fecal coliforms and/or pathogens, samples must be drawn at the frequency in Table E-14 above. For fecal coliform, at least seven grab samples must be drawn during each monitoring event and a geometric mean calculated from these seven samples.
 - **c.** For biosolids that are land applied or placed in a surface disposal site, the Permittee shall track and keep records of the operational parameters used to achieve Vector Attraction Reduction requirements in 40 C.F.R. section 503.33(b).
 - **d.** Class 1 facilities (facilities with pretreatment programs or others designated as Class 1 by the Regional Administrator) and federal facilities with greater than five million gallons per day (MGD) influent flow shall sample biosolids for pollutants listed under Section 307(a) of the Clean Water Act (as required in the pretreatment section of the permit for POTW's with pretreatment programs). Class 1 facilities and federal facilities greater than five MGD shall test dioxins/dibenzofurans using a detection limit of less than one pg/g at the time of their next priority pollutant scan if they have not done so within the past five years, and once per five years thereafter.
 - e. The biosolids shall be tested annually, or more frequently if necessary, to determine hazardousness in accordance 40 C.F.R. part 261.
 - **f.** If biosolids are placed in a surface disposal site (dedicated land disposal site or monofill), a qualified groundwater scientist shall develop a groundwater monitoring program for the site, or shall certify that the placement of biosolids on the site will not contaminate an aquifer.
 - **g.** Biosolids placed in a municipal landfill shall be tested by the Paint Filter Liquids Test (EPA Method 9095) at the frequency in 11 (a) above or more often if necessary to demonstrate that there are no free liquids.

2. Biosolids Notification

The Permittee, either directly or through contractual arrangements with their biosolids management contractors, shall comply with the following notification requirements:

a. Notification of non-compliance: The Permittee shall notify U.S. EPA Region 9, the Central Coast Water Board, and the regional board located in the region where the biosolids are used or disposed, of any non-compliance within 24 hours if the non-compliance may seriously endanger health or the environment. For other instances of non-compliance, the Permittee shall notify U.S. EPA Region 9 and the affected regional boards of the non-compliance in writing within five working days of becoming aware of the non-compliance. The Permittee shall require their biosolids

management contractors to notify U.S. EPA Region 9 and the affected regional boards of any non-compliance within the same timeframes. See Attachment F for Central Coast Water Board contact information.

- b. If biosolids are shipped to another State or to Indian Lands, the Permittee must send 60 days prior notice of the shipment to the permitting authorities in the receiving State or Indian Land (the U.S. EPA Regional Office for that area and the State/Indian authorities).
- **c.** For land application: Prior to reuse of any biosolids from this facility to a new or previously unreported site, the Permittee shall notify U.S. EPA and the Central Coast Water Board. The notification shall include a description and topographic map of the proposed site(s), names and addresses of the applier, and site owner and a listing of any state or local permits which must be obtained. The plan shall include a description of the crops or vegetation to be grown, proposed loading rates and determination of agronomic rates. If any biosolids within a given monitoring period do not meet 40 C.F.R. section 503.13 metals concentration limits, the Permittee (or its contractor) must pre-notify U.S. EPA, and determine the cumulative metals loading at that site to date, as required in section 503.12.
- **d.** The Permittee shall notify the applier of all the applier's requirements under 40 C.F.R. part 503, including the requirement that the applier certify that the management practices, site restrictions, and any applicable vector attraction reduction requirements have been met. The Permittee shall require the applier to certify at the end of 38 months following application of Class B biosolids that the harvesting restrictions in effect for up to 38 months have been met.
- e. For surface disposal: Prior to disposal to a new or previously unreported site, the Permittee shall notify U.S. EPA and the Regional Board. The notice shall include description and topographic map of the proposed site, depth to groundwater, whether the site is lined or unlined, site operator, site owner, and any state or local permits. The notice shall describe procedures for ensuring public access and grazing restrictions for three years following site closure. The notice shall include a groundwater monitoring plan or description of why groundwater monitoring is not required.

3. Biosolids Reporting

The Permittee shall submit an annual biosolids report to the U.S. EPA CDX e-reporting system and Central Coast Water Board by February 19 of each year for the period covering the previous calendar year. The report shall include:

- **a.** The amount of biosolids generated during the reporting period, in dry metric tons, and the amount accumulated from previous years;
- b. Results of all pollutant and pathogen monitoring required in IX.B.1.b of the Monitoring and Reporting Program of this Order. Results must be reported on a 100% dry weight basis for comparison with 40 C.F.R. part 503 limits;
- **c.** Descriptions of pathogen reduction methods and vector attraction reduction methods, including supporting time and temperature data, and certifications, as required in 40 C.F.R. sections 503.17 and 503.27;
- **d.** Names, mailing addresses, and street addresses of persons who received biosolids for storage, further treatment, disposal in a municipal waste landfill, or for other use or disposal methods not covered above, and volumes delivered to each.

- e. For land application sites, the following information must be submitted by the Permittee, unless the Permittee requires its biosolids management contractors to report this information directly to the U.S. EPA Region 9 Biosolids Coordinator:
 - i. Locations of land application sites (with field names and numbers) used that calendar year, size of each field applied to, applier, and site owner;
 - **ii.** Volumes applied to each field (in wet tons and dry metric tons), nitrogen applied, calculated plant available nitrogen;
 - iii. Crop planted, dates of planting and harvesting;
 - iv. For any biosolids exceeding 40 C.F.R. section 503.13 Table 3 metals concentrations: the locations of sites where applied and cumulative metals loading at that site to date;
 - v. Certifications of management practices in section 503.14; and
 - vi. Certifications of site restrictions in section 503(b)(5).
- f. For surface disposal sites:
 - i. Locations of sites, site operator, site owner, size of parcel on which disposed;
 - ii. Results of any required groundwater monitoring;
 - iii. Certifications of management practices in section 503.24; and
 - **iv.** For closed sites, date of site closure and certifications of management practices for the three years following site closure.
- g. For all biosolids used or disposed at the Permittee's facilities, the site and management practice information and certification required in sections 503.17 and 503.27; and
- **h.** For all biosolids temporarily stored, the information required in section 503.20 required to demonstrate temporary storage.

Reports shall be submitted to:

Executive Officer Central Coast Regional Water Quality Control Board <u>centralcoast@waterboards.ca.gov</u>

i. All the requirements of 40 C.F.R. part 503 and Title 23 CCR chapter 15 are enforceable by the U.S. EPA and this Regional Board whether or not the requirements are stated in an NPDES permit or any other permit issued to the discharger.

C. Pretreatment Monitoring and Reporting

At least once per year, influent, effluent, and biosolids shall be sampled and analyzed for the priority pollutants identified under Section 307(a) of the Clean Water Act. By March 1st of each year, the Discharger shall submit an annual report to the Regional Board, State Board, and USEPA describing the Discharger's pretreatment activities over the previous calendar

year. In the event that the Discharger is not in compliance with any conditions or requirements of this permit affected by the pretreatment program, including any noncompliance with pretreatment audit or compliance inspection requirements, then the Discharger shall also include the reasons for noncompliance and state how and when the Discharger shall comply with such conditions and requirements. This report shall contain, but not be limited to, the following information:

- A summary of analytical results from representative, flow-proportioned, 24-hour composite sampling of the plant's influent and effluent for those pollutants U.S. EPA has identified under section 307(a) of the Act which are known or suspected to be discharged by industrial users. The Discharger is not required to sample and analyze for asbestos until U.S. EPA promulgates an applicable analytical technique under 40 C.F.R. part 136.
- 2. Biosolids shall be sampled during the same 24-hour period and analyzed for the same pollutants as the influent and effluent sampling and analysis. The biosolids analyzed shall be a composite sample of a minimum of twelve discrete samples taken at equal time intervals over the 24-hour period. Wastewater and biosolids sampling and analysis shall be performed a minimum of annually and not less than the frequency specified in the required monitoring program for the plant. The Discharger shall also provide any influent, effluent, or biosolids monitoring data for nonpriority pollutants which the Discharger believes may be causing or contributing to interference, pass-through, or adversely impacting biosolids quality. Sampling and analysis shall be performed in accordance with the techniques prescribed in 40 C.F.R. part 136 and amendments thereto. Biosolids are dried on-site, samples shall be composited from at least twelve discrete samples from twelve representative locations.
- **3.** A discussion of upset, interference, or pass-through incidents, if any, at the POTW which the Discharger knows or suspects were caused by industrial users of the POTW system. The discussion shall include the reasons why the incidents occurred, corrective actions taken and, if known, the name and address of the industrial user(s) responsible. Discussions shall also include a review of applicable pollutant limitations to determine whether any additional limitations or changes to existing requirements may be necessary to prevent pass-through, interference, or noncompliance with sludge disposal requirements.
- 4. The cumulative number of industrial users that the Discharger has notified regarding Baseline Monitoring Reports, and the cumulative number of industrial user responses.
- 5. An updated list of the Discharger's industrial users, including their names and addresses, or a list of deletions and additions keyed to a previously submitted list. The Discharger shall provide a brief explanation for each deletion. The list shall identify the industrial users subject to Federal Categorical Standards by specifying which set(s) of standards are applicable. The list shall indicate which categorical industries, or specific pollutants from each industry, are subject to local limitations that are more stringent than the Federal Categorical Standards. The Discharger shall also list the non-categorical industrial users that are subject only to local discharge limitations. The Discharger shall characterize the compliance status of each industrial user by employing the following descriptions:
 - a. In compliance with Baseline Monitoring Report requirements (where applicable);
 - b. Consistently achieving compliance;
 - c. Inconsistently achieving compliance;

- **d.** Significantly violated applicable pretreatment requirements as defined by 40 C.F.R. section 403.8(f)(2)(vii);
- e. On a schedule to achieve compliance (include the date final compliance is required);
- f. Not achieving compliance and not on a compliance schedule; or
- **g.** The Discharger does not know the industrial user's compliance status.
- **6.** A summary of inspection and sampling activities conducted by the Discharger during the past year to gather information and data regarding industrial users. The summary shall include:
 - **a.** Names and addresses of the industrial users subject to surveillance by the Discharger and an explanation of whether they were inspected, sampled, or both, and the frequency of these activities at each user; and
 - b. Conclusions or results from the inspection or sampling of each industrial user.
- **7.** A summary of compliance and enforcement activities during the past year. The summary shall include names and addresses of the industrial users affected by the following actions:
 - Warning letters or notices of violation regarding the industrial users' apparent noncompliance with Federal Categorical Standards or local discharge limitations. For each industrial user, identify whether the apparent violation concerned the Federal Categorical Standards or local discharge limitations;
 - **b.** Administrative Orders regarding the industrial users' noncompliance with Federal Categorical Standards or local discharge limitations. For each industrial user, identify whether the violation concerned the Federal Categorical Standards or local discharge limitations:
 - **c.** Civil actions regarding the industrial users' noncompliance with Federal Categorical Standards or local discharge limitations. For each industrial user, identify whether the violation concerned the Federal Categorical Standards or local discharge limitations;
 - **d.** Criminal actions regarding the industrial user's noncompliance with Federal Categorical Standards or local discharge limitations. For each industrial user, identify whether the violation concerned Federal Categorical Standards or local discharge limitations;
 - e. Assessment of monetary penalties. For each industrial user, identify the amount of the penalties;
 - f. Restriction of flow to the POTW; or
 - g. Disconnection from discharge to the POTW.
- 8. Description of any significant changes in operating the pretreatment program which differ from the information in the Discharger's Approved POTW Pretreatment Program, including but not limited to changes concerning: the program's administrative structure; local industrial discharge limitations; monitoring program or monitoring frequencies; legal authority or enforcement policy; funding mechanisms; resource requirements; or staffing levels.
- **9.** A summary of the annual pretreatment budget, including the costs of pretreatment program functions and equipment purchases.

- **10.** A summary of public participation activities to involve and inform the public.
- **11.** A description of any changes in biosolids disposal methods and a discussion of any concerns not described elsewhere in the report.
- **12.** Reports shall be signed by a principal executive officer, ranking elected official, or other duly authorized employee if such employee is responsible for overall operation of the POTW. Signed copies of these reports shall be submitted to the U.S. EPA and the State at the following addresses:

CIWQS database: <u>http://ciwqs.waterboards.ca.gov/</u>

State Water Resources Control Board Regulation Unit P.O. Box 100 Sacramento, CA 95812-0100

US EPA, Region 9 <u>R9Pretreatment@epa.gov</u>

D. Outfall Inspection

The Discharger shall conduct an annual dye study for four years and then conduct a visual (dive) inspection during the fifth year. The dye study and visual inspection results shall summarize the outfall's physical integrity and be included in the applicable Annual Report.

E. MBNMS Spill Reporting

In accordance with Standard Provision VI.E. (Attachment D), within 24 hours, the Discharger shall report all sewage spills under its control that are likely to enter ocean waters, directly to the Monterey Bay National Marine Sanctuary (MBNMS) office at 831-236-6797. A report shall also be provided to the Central Coast Water Board within five days of the time the Discharger becomes aware of the circumstances.

X. REPORTING REQUIREMENTS

A. General Monitoring and Reporting Requirements

The Discharger shall comply with all Standard Provisions (Attachment D) related to monitoring, reporting, and recordkeeping.

B. Self-Monitoring Reports (SMRs)

1. The Discharger shall electronically submit SMRs using the State Water Board's California Integrated Water Quality System (CIWQS) Program website at <<u>http://www.waterboards.ca.gov/water_issues/programs/ciwqs/</u>>. The CIWQS website will provide additional information for SMR submittal in the event there will be a planned service interruption for electronic submittal. The Discharger shall use the current version of the Permittee Entry Template (PET) tool to configure data into the applicable CIWQS Data Format, and shall update that template according to this Order (e.g., add/delete parameters, revise limits, update monitoring locations, etc). Blank versions of the latest PET tool are available at

http://www.waterboards.ca.gov/water_issues/programs/ciwqs/chc_npdes.shtml.

2. The Discharger shall report in the SMR the results for all monitoring specified in this MRP under sections III through IX. The Discharger shall submit monthly, quarterly, semiannual, and annual SMRs including the results of all required monitoring using U.S.

EPA-approved test methods or other test methods specified in this Order. SMRs are to include all new monitoring results obtained since the last SMR was submitted. If the Discharger monitors any pollutant more frequently than required by this Order, the results of this monitoring shall be included in the calculations and reporting of the data submitted in the SMR.

3. Monitoring periods and reporting for all required monitoring shall be completed according to the following schedule:

Sampling Frequency	Monitoring Period Begins On	Monitoring Period	SMR Due Date
Continuous	Effective Permit date (see Table 3)	All	First day of the second month following the month of sampling (e.g., reports for sampling conducted in January are due no later than March 1)
Hourly	Effective Permit date (see Table 3)	Hourly	Submit with monthly SMR
Daily	Effective Permit date (see Table 3)	(Midnight through 11:59 PM) or any 24-hour period that reasonably represents a calendar day for purposes of sampling.	Submit with monthly SMR
Weekly	Sunday following permit effective date or on permit effective date if on a Sunday	Sunday through Saturday	Submit with monthly SMR
Monthly	First day of calendar month following permit effective date or on permit effective date if that date is first day of the month	1 st day of calendar month through last day of calendar month	Submit with monthly SMR
Quarterly	Closest of January 1, April 1, July 1, or October 1 following (or on) permit effective date	January 1 through March 31 April 1 through June 30 July 1 through September 30 October 1 through December 31	First day of the second month following the quarter of sampling (e.g., reports for sampling conducted in the first quarter (Jan 1 – Mar 31) are due no later than May 1)
4 times/year corresponding to each dilution scenario, if it occurs.	Effective Permit date (see Table 3)	Dependent upon concentrate waste dilution ratio	Submit with next monthly SMR
Semiannually	Closest of January 1 or July 1 following (or on) permit effective date	January 1 through June 30 July 1 through December 31	First day of the second month following the quarter of sampling (e.g., reports for sampling conducted in the first quarter (Jan 1 – Mar

Sampling Frequency	Monitoring Period Begins On	Monitoring Period	SMR Due Date
			31) are due no later than May 1)
Annually	January 1 following (or on) permit effective date	January 1 through December 31	Submit with Annual Report (due no later than 1/30)
3 / Permit Term	January 1 following (or on) permit effective date	January 1 through December 31	Submit with Annual Report and permit renewal application Form 2A.

- 4. Section III.B of the Standard Provisions (Attachment D) includes the standard provisions for test procedures. U.S. EPA published regulations for the Sufficiently Sensitive Methods Rule (SSM Rule) which became effective September 18, 2015. For the purposes of the NPDES program, when more than one test procedure is approved under 40 C.F.R. part 136 for the analysis of a pollutant or pollutant parameter, the test procedure must be sufficiently sensitive as defined at 40 C.F.R. sections 122.21(e)(3) and 122.44(i)(1)(iv). Both 40 C.F.R. sections 122.21(e)(3) and 122.44(i)(1)(iv) apply to the selection of a sufficiently sensitive analytical method for the purposes of monitoring and reporting under NPDES permits, including review of permit applications. A U.S. EPA-approved analytical method is sufficiently sensitive where:
 - **a.** The Minimum Level (reported ML, also known as the Reporting Level, or RL) is at or below both the level of the applicable water quality criterion/objective and this Order limitation for the measured pollutant or pollutant parameter; or
 - **b.** In permit applications, the ML is above the applicable water quality criterion/objective, but the amount of the pollutant or pollutant parameter in a facility's discharge is high enough that the method detects and quantifies the level of the pollutant or pollutant parameter in the discharge; or
 - c. The method has the lowest ML of the U.S. EPA-approved analytical methods where none of the U.S. EPA-approved analytical methods for a pollutant can achieve the MLs necessary to assess the need for effluent limitations or to monitor compliance with a permit limitation. The MLs in Ocean Plan Appendix II remain applicable. However, there may be situations when analytical methods are published with MLs that are more sensitive than the MLs for analytical methods listed in the Ocean Plan. For instance, U.S. EPA Method 1631E for mercury is not currently listed in Ocean Plan Appendix II, but it is published with an ML of 0.5 ng/L that makes it a sufficiently sensitive analytical method. Similarly, U.S. EPA Method 245.7 for mercury is published with an ML of 5 ng/L.
- 5. Reporting Protocols. The Discharger shall report with each sample result the applicable reported Minimum Level (reported ML, also known as the Reporting Level, or RL) and the current Method Detection Limit (MDL), as determined by the procedure in 40 C.F.R. part 136.

The Discharger shall report the results of analytical determinations for the presence of chemical constituents in a sample using the following reporting protocols:

a. Sample results greater than or equal to the reported ML shall be reported as measured by the laboratory (i.e., the measured chemical concentration in the sample).

b. Sample results less than the reported ML, but greater than or equal to the laboratory's MDL, shall be reported as "Detected, but Not Quantified," or DNQ. The estimated chemical concentration of the sample shall also be reported.

For the purposes of data collection, the laboratory shall write the estimated chemical concentration next to DNQ. The laboratory may, if such information is available, include numerical estimates of the data quality for the reported result. Numerical estimates of data quality may be percent accuracy (± a percentage of the reported value), numerical ranges (low to high), or any other means considered appropriate by the laboratory.

- **c.** Sample results less than the laboratory's MDL shall be reported as "Not Detected," or ND.
- **d.** Dischargers are to instruct laboratories to establish calibration standards so that the ML value (or its equivalent if there is differential treatment of samples relative to calibration standards) is the lowest calibration standard. At no time is the Discharger to use analytical data derived from extrapolation beyond the lowest point of the calibration curve.
- e. Compliance Determination. Compliance with effluent limitations for reportable pollutants shall be determined using sample reporting protocols defined above and in Attachment A. For purposes of reporting and administrative enforcement by the Central Coast Water Board and State Water Board, the Discharger shall be deemed out of compliance with effluent limitations if the concentration of the reportable pollutant in the monitoring sample is greater than the effluent limitation and greater than or equal to the reported ML.
- 6. Multiple Sample Data. When determining compliance with a measure of central tendency (arithmetic mean, geometric mean, median, etc.) of multiple sample analyses and the data set contains one or more reported determinations of "Detected, but Not Quantified" (DNQ) or "Not Detected" (ND), the Discharger shall compute the median in place of the arithmetic mean in accordance with the following procedure:
 - **a.** The data set shall be ranked from low to high, ranking the reported ND determinations lowest, DNQ determinations next, followed by quantified values (if any). The order of the individual ND or DNQ determinations is unimportant.
 - **b.** The median value of the data set shall be determined. If the data set has an odd number of data points, then the median is the middle value. If the data set has an even number of data points, then the median is the average of the two values around the middle unless one or both of the points are ND or DNQ, in which case the median value shall be the lower of the two data points where DNQ is lower than a value and ND is lower than DNQ.
- 7. The Discharger shall submit SMRs in accordance with the following requirements:
 - a. The Discharger shall arrange all reported data in a tabular format. The data shall be summarized to clearly illustrate whether the facility is operating in compliance with interim and/or final effluent limitations. The Discharger is not required to duplicate the submittal of data that is entered in a tabular format within CIWQS. When electronic submittal of data is required and CIWQS does not provide for entry into a tabular format within the system, the Discharger shall electronically submit the data in a tabular format as an attachment.

b. The Discharger shall attach a cover letter to the SMR. The information contained in the cover letter shall clearly identify violations of the waste discharge requirements; discuss corrective actions taken or planned; and the proposed time schedule for corrective actions. Identified violations must include a description of the requirement that was violated and a description of the violation.

C. Discharge Monitoring Reports (DMRs)

 DMRs are U.S. EPA reporting requirements. The Discharger shall electronically certify and submit DMRs together with SMRs using Electronic Self-Monitoring Reports module eSMR 2.5 or any upgraded version. Electronic DMR submittal shall be in addition to electronic SMR submittal. Information about electronic DMR submittal is available at the DMR website at:

<http://www.waterboards.ca.gov/water_issues/programs/discharge_monitoring>.

D. Other Reports

 The Discharger shall report the results of any special monitoring, TREs, or other data or information that results from the Special Provisions – VI.C of the Order. The Discharger shall submit reports with the first monthly SMR scheduled to be submitted on or immediately following the report due date.

ATTACHMENT F – FACT SHEET

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ATTACHMENT F – FACT SHEET

As described in section II.B of this Order, the Central Coast Water Board incorporates this Fact Sheet as findings of the Central Coast Water Board supporting the issuance of this Order. This Fact Sheet includes the legal requirements and technical rationale that serve as the basis for the requirements of this Order.

This Order has been prepared under a standardized format to accommodate a broad range of discharge requirements for dischargers in California. Only those sections or subsections of this Order that are specifically identified as "not applicable" have been determined not to apply to this Discharger. Sections or subsections of this Order not specifically identified as "not applicable" are fully applicable to this Discharger.

I. PERMIT INFORMATION

The following table summarizes administrative information related to the facility.

WDID	3 270118002
Discharger	Monterey One Water
Name of Facility	Regional Wastewater Treatment Plant and Advanced Water Purification Facility
	14811 Del Monte Boulevard
Facility Address	Marina, California 93933
	Monterey County
Facility Contact, Title and Phone	Richard L. Gilliam, Interim Plant O&M Manager, (831) 883-1118 x114
Authorized Person to Sign and Submit Reports	Tamsen McNarie, Assistant General Manager, (831) 883-6125
Mailing Address	5 Harris Court, Building D, Monterey, California 93940
Billing Address	5 Harris Court, Building D, Monterey, California 93940
Type of Facility	POTW
Major or Minor Facility	Major
Threat to Water Quality	2
Complexity	A
Pretreatment Program	Yes
Recycling Requirements	Producer
Facility Permitted Flow	29.6 MGD (Average Dry Weather Flow [ADWF]) ^[1]
Facility Design Flow	75.6 MGD (PWWF) ^[1]
Watershed	Lower Salinas Valley HA (309.10)
Receiving Water	Pacific Ocean (Monterey Bay National Marine Sanctuary)
Receiving Water Type	Ocean waters

Table F-1. Facility Information

^[1] Based on secondary treatment capacity and hydraulic capacity at the Regional WWTP.

A. The Discharger changed its name from Monterey Regional Water Pollution Control Agency (MRWPCA) to Monterey One Water in June 2017. Monterey One Water (M1W, hereinafter Discharger) is the owner and operator of the Regional Wastewater Treatment Plant (WWTP) and Advanced Water Purification Facility (hereinafter Facility), a publicly owned treatment works (POTW).

For the purposes of this Order, references to the "discharger" or "permittee" in applicable federal and state laws, regulations, plans, or policy are held to be equivalent to references to the Discharger herein.

- **B.** The Facility discharges wastewater to the Pacific Ocean, a water of the United States. The Discharger was previously regulated by Order No. R3-2014-0013 and National Pollutant Discharge Elimination System (NPDES) Permit No. CA0048551, adopted on May 22, 2014, with an expiration date of July 31, 2019. Attachment B provides a map of the area around the Facility. Attachment C provides a flow schematic of the Facility.
- **C.** The Discharger filed a report of waste discharge and submitted an application for reissuance of its waste discharge requirements (WDRs) and NPDES permit on November 21, 2017. The application was deemed complete on December 5, 2017.
- D. Regulations at 40 C.F.R. section 122.46 limit the duration of NPDES permits to a fixed term not to exceed five years. Accordingly, Table 3 of this Order limits the duration of the discharge authorization. However, pursuant to California Code of Regulations, title 23, section 2235.4, the terms and conditions of an expired permit are automatically continued pending reissuance of the permit if the Discharger complies with all federal NPDES requirements for continuation of expired permits.

II. FACILITY DESCRIPTION

A. Description of Wastewater and Biosolids Treatment and Controls

The Facility, which currently serves a population of approximately 279,000, 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. Each member entity retains ownership and operating/maintenance responsibility for wastewater collection and transport systems up to the point of connection with interceptors owned and operated by the Discharger. Residential, commercial, and industrial wastewater is conveyed to the Facility. The collection system is 100% separate. The Discharger implements a pretreatment program.

The Discharger operates an existing secondary treatment plant and is constructing an advanced water purification facility (AWPF) to be completed by the third quarter of 2019 as part of the Pure Water Monterey project. The project involves treating secondary effluent with the AWPF (see description below) and then injecting this purified recycled water into the Seaside groundwater basin, with subsequent withdrawal for use as a municipal water supply. The AWPF will also provide purified recycled water for landscape irrigation by the Marina Coast Water District. The WWTP also provides secondary treated wastewater for further tertiary treatment and recycling for agricultural irrigation in the northern Salinas valley as part of the Castroville Seawater Intrusion Project. Details on the Regional WWTP and AWPF are provided below.

1. Regional WWTP Secondary Treatment

As part of the Pure Water Monterey project, new sources of urban and agricultural land runoff in surface water bodies, will be directed to the Regional WWTP headworks to increase the supply of recycled water for agricultural irrigation after treatment by the SVRP, and for landscape irrigation and groundwater replenishment after treatment through the AWPF. The source waters are composed of agricultural wash water from the City of Salinas, stormwater flows from the City of Salinas, stormwater and agricultural runoff from Blanco Drain, and stormwater and agricultural runoff from the Reclamation Ditch, which drains a series of natural lakes through lateral ditches and pumps. The new source waters will be mixed with existing domestic sewage (including storm water, dry season urban runoff, and industrial wastewater) from the member agencies.

The Facility currently accepts 30,000 to 50,000 gallons per day (gpd) of saline wastes by truck from business entities that would otherwise be discharging to the sanitary sewer system. Such wastewaters include softener regenerant wastes and reverse osmosis (RO) concentrate, which are now trucked to the Regional WWTP instead of being discharged to the collection system. Because irrigation uses of recycled wastewater are sensitive to elevated levels of salts, the Discharger segregates these high-salt wastewaters from the rest of the influent flow to the Regional WWTP. These hauled saline wastes are held in a 375,000-gallon (approximate) lined pond and mixed with secondary effluent at the Regional WWTP. These hauled saline wastes are ultimately discharged with secondary effluent to the Pacific Ocean through Discharge Point 001.

Wastewater treatment at the Regional WWTP includes screening, aerated grit removal, primary sedimentation, secondary treatment through trickling filters, solids contact (i.e., bio-flocculation), and secondary clarification. Undisinfected secondary clarifier effluent is discharged through Discharge Point 001. Sludge/biosolids are anaerobically digested and sent to two screw presses. The holding lagoons and some of the drying beds may still be utilized in emergency situations. Dried solids are then hauled to the Monterey Regional Waste Management District's landfill in Marina, California, adjacent to the Regional WWTP, where they are used for daily cover.

2. Advanced Water Purification Facility (AWPF)

The AWPF will receive secondary effluent from the Regional WWTP and will provide full advanced treatment including ozone, membrane filtration, RO, advanced oxidation using ultraviolet light and hydrogen peroxide, and finished water stabilization. The AWPF is designed to produce 5 MGD of recycled water for groundwater injection in the Seaside basin and urban landscape irrigation by Marina Coast Water District. The RO concentrate will be mixed with hauled saline waste and secondary effluent (when available) from the Regional WWTP and discharged at Discharge Point 001. Membrane backwash produced by the AWPF will be sent to the Regional WWTP headworks for treatment. This Order addresses the discharge of AWPF RO concentrate with hauled saline waste and secondary effluent at Discharge Point 001. The groundwater injection operations of the AWPF are governed by WDRs-WRRs Order No. R3-2017-0003.

3. Salinas Valley Reclamation Project (SVRP)

The SVRP is a tertiary treatment plant adjacent to the Regional WWTP that receives secondary effluent from the Regional WWTP and provides recycled water for irrigation of 12,000 acres of farmland in the northern Salinas Valley. The SVRP provides tertiary treatment (through coagulation, flocculation, filtration, and disinfection) of secondary effluent for design flows of up to 29.6 MGD. The SVRP holds tertiary treated wastewater in an 80-acre-foot storage pond before it is distributed to farmland by the Castroville Seawater Intrusion Project. Production of disinfected tertiary recycled water at the SVRP portion of the Regional WWTP is governed by this Order. The SVRP does not contribute any wastewater to Discharge Point 001. The use of recycled water for irrigation is regulated via separate water recycling requirements.

4. Flows

The new source waters will result in additional influent flow to the WWTP and the addition of the AWPF will increase the recycling capacity. At the peak operating capacity, the AWPF will receive approximately 6.85 MGD of secondary effluent as source water (of that 0.68 MGD will be returned to the headworks as filter backwash) and will achieve approximately 73 percent overall recovery to produce 5 MGD of recycled water for irrigation and groundwater injection. The RO concentrate waste component will result in an additional flow of up to 1.17 MGD to Discharge Point 001. If the secondary effluent is produced at the permitted flow of 29.6 MGD, 6.85 MGD of this becomes influent to the AWPF, and 0.68 MGD of the AWPF influent is returned to the WWTP headworks, a maximum of 23.4 MGD of secondary effluent remains available for delivery to the SVRP or blending with RO concentrate through Discharge Point 001. The total discharge flow through Discharge Point 001 will not exceed the permitted flows of 29.6 MGD (ADWF) and 75.6 MGD (PWWF). Table F-2 lists the predicted flows from the WWTP and the AWPF.

Wast	tewater Sources	Effluent Flow (MGD)	Ocean Outfall Maximum Permitted Flow (MGD)
	Trucked in saline wastes	0.03 - 0.05	
WWTP	Secondary Effluent	18.53 (annual average) 29.6 (ADWF) 75.6 (PWWF)	81.2
AWPF	RO Concentrate	0.83-1.17 (Maximum)	

Table F-2.	Flows	Contributing	to Discharge	Point 001

5. Dilution Factors

The addition of the RO concentrate to the WWTP secondary effluent will change the character of the effluent waste stream discharged to Monterey Bay. Effluent quality will be a function of the amount of secondary effluent commingled with the AWPF RO concentrate and hauled saline waste. Additional minimum probable initial dilution factors (Dms), expressed as parts seawater per part wastewater, in the NPDES permit represent the changed effluent quality and the impacts of the discharge to the Monterey Bay National Marine Sanctuary. Secondary effluent from the Regional WWTP will be (1) treated through the AWPF to produce purified water for groundwater recharge or urban landscape irrigation, (2) treated at the Salinas Valley Reclamation Project (SVRP)—as currently done—to produce tertiary recycled water for agricultural irrigation, or (3) blended with AWPF RO concentrate and hauled saline waste discharged to the ocean. The amount of secondary effluent diverted to the outfall will vary throughout the year, with many months having essentially no secondary effluent discharged because all water is recycled. Because of the variability in composition and flow, four dilution factors have been developed to implement water quality standards in this permit.

The Discharger used the EPA-approved Visual Plumes UM3 Model to conduct modeling of the discharge through the ocean outfall. In conducting modeling, the Discharger used conservative assumptions and inputs for temperature and density profile (highly stratified) and zero velocity for ambient current. In addition, the Discharger ran the model under three separate oceanic conditions: upwelling, oceanic, and Davidson. Of the three

oceanic conditions, the upwelling conditions produced the lowest (most conservative) results. Using the upwelling model results, the Discharger developed dilution estimates for 36 scenarios of RO concentrate, hauled saline wastes, and secondary effluent volumes. Of the 36 Dm scenarios, the Discharger proposed four Dms, shown in Table F-3 below, for use in implementing effluent limitations.

Total Flow (MGD)	Secondary Effluent (MGD)	Dm
1.57	0.4	473.4
2.77	1.6	388.3
9.17	8.0	258.7
29.6	29.5	145 ¹

Table F-3. Dilution Factors for I	nplementing	g Effluent	Limitations
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The modeling results indicated a Dm of 169.3 would correspond to the total effluent flow of 29.6 MGD; however, the Discharger proposed the more conservative Dm of 145, which is the allowable dilution in Order R3-2014-0013.

More secondary treated water that is recycled results in less secondary treated water being discharged through the ocean outfall. Because the secondary treated wastewater volume is large relative to the volume of AWPF RO concentrate and hauled saline waste, the volume of secondary effluent discharge essentially controls Dms. Lower flows through the outfall experience greater mixing and therefore have larger Dm values. The Central Coast Water Board used the four Dms in Table F-3 to determine the need for water quality-based effluent limitations and to calculate those limitations.

B. Discharge Points and Receiving Waters

Discharges of secondary effluent, hauled saline waste, and AWPF RO concentrate at Discharge Point 001 occurs through an 11,260-foot outfall/diffuser system that terminates at a depth of approximately 100 feet in the Pacific Ocean (Monterey Bay) at 36.72778° latitude and 121.83750° longitude. The receiving water is part of the Monterey Bay National Marine Sanctuary, designated as such on September 15, 1992. The purpose of the National Marine Sanctuaries Program is to protect areas of the marine environment which possess conservation, recreational, ecological, historical, research, educational, or aesthetic qualities of special national significance. The first priority of the program is the long-term protection of resources within designated sanctuaries. The Monterey Bay Sanctuary has been recognized for its unique and diverse biological and physical characteristics. The Facility's outfall/diffuser system is located outside the Monterey Bay National Marine Sanctuary Zone of Prohibition.

C. Summary of Existing Requirements and Self-Monitoring Report (SMR) Data

Effluent limitations contained in the existing Order for discharges from Discharge Point 001 (Monitoring Location EFF-001) and representative monitoring data from the term of the previous Order are as follows:

Table F-4. Historic Effluent Limitations and Monitoring Data, Secondary Treatment Standards and Ocean Plan Table 1 Limitations – Discharge Point 001

		Effluent Limitation			Monitoring Data (From June 1, 2014 – December 31, 2017)		
Parameter	Units	Average Monthly	Average Weekly	Maximum Daily	Highest Average Monthly Discharge	Highest Average Weekly Discharge	Highest Daily Discharge
	mg/L	25	40	85	24	41	42
CBOD ₅	lb/day ^[1]	6,200	10,000	21,000	3,252	5,673	5,741
	% Removal ^[2]	85			93		
	mg/L	30	45	90	22	37	41
TSS	lb/day ^[1]	7,400	11,000	22,000	2,976	5,141	5,741
	% Removal ^[2]	85			94		
Oil and	mg/L	25	40	75	6.0	9.0	9.0
Grease	lb/day ^[1]	6,200	10,000	19,000	994	1,824	1,824
Settleable Solids	ml/L	1.0	1.5	3.0 ^[3]	0.10	0.2	0.5
Turbidity	NTU	75	100	230 ^[3]	21	37	39
рН	pH units	6.0 -	9.0 at all tim	1es ^{[4], [5]}		6.3-8.2 ^[4]	

^[1] The mass-based (lbs/day) effluent limitations in this table are based on the average dry weather flow design capacity of 29.6 MGD for the treatment facility and are therefore only good up to this flow. For flows above 29.6 MGD, mass-based effluent limitations shall be calculated individually using the concentration-based effluent limitations and the observed flow at the time of sampling per the following equation:

lbs/day = 0.00834 x Ce x Q

where:

Ce = the effluent concentration limit in μ g/L

Q = observed flow rate in MGD

- ^[2] Limitations and historic results are the minimum percent removal.
- ^[3] Instantaneous Maximum.
- ^[4] Instantaneous Minimum-Maximum.
- ^[5] Excursions from the effluent limit range are permitted subject to the following limitations (40 C.F.R. section 401.17):
 - a. The total time during which the pH values are outside the required range of pH values shall not exceed 7 hours and 26 minutes in any calendar month; and
 - b. No individual excursion from the range of pH values shall exceed 60 minutes.

Note: 40 C.F.R. section 401.17(2)(c) notes that, for the purposes of 40 C.F.R. section 401.17, "excursion" is defined as "an unintentional and temporary incident in which the pH value of discharge wastewater exceeds the range set forth in the applicable effluent limitations guidelines." The State Board may adjust the requirements set forth in paragraph 40 C.F.R. section 401.17 (a) with respect to the length of individual excursions from the range of pH values, if a different period of time is appropriate based upon the treatment system, plant configuration, or other technical factors.

Table F-5. Histo	pric Effluent Limitations	and Monitoring Data f	or Protection of Marine A	quatic Life

Doromotor	Unito	Ef	fluent Limitati	on	Monitoring Data (From June 1, 2014 – December 31, 2017)		
Parameter	Units	6-Month Median	Maximum Daily	Instant Max	Highest 6- Month Median	Highest Maximum Daily	Highest Instant Max
Cadmium,	µg/L	150	580	1,500	ND	0.086 ^[1]	0.086 ^[1]
Total Recoverable	lb/day ^[2]	36	140	360	ND	ND	ND
Chromium	µg/L	290	1,200	2,900	11	11	11
(VI) ^[3]	lb/day ^[2]	72	290	720	0.44	0.44	0.44
Lead, Total	µg/L	290	1,200	2,900	0.11 ^[1]	0.35 ^[1]	0.35 ^[1]
Recoverable	lb/day ^[2]	72	290	720	ND	ND	ND
Selenium,	µg/L	2,200	8,800	22,000	25	44	44
Total Recoverable	lb/day ^[2]	540	2,200	5,400	1.0	0.57	0.57
Silver, Total	µg/L	79	390	1,000	0.14 ^[1]	0.14 ^[1]	0.14 ^[1]
Recoverable	lb/day ^[2]	20	95	250	ND	ND	ND
Cyanide ^[4] ,	µg/L	150	580	1,500	60.5	81	81
Total (as CN)	lb/day ^[2]	36	140	360	8.7	14	14
Total Residual	µg/L	290	1,200	8,800	ND	ND	ND
Chlorine ^[5]	lb/day ^[2]	72	290	2,200	ND	ND	ND
Acute Toxicity	TUa		4.7			0.4	
Chronic Toxicity	TUc		150			625	
Phenolic	µg/L	4,400	18,000	44,000	11	11	11
compounds (non- chlorinated)	lb/day ^[2]	1,100	4,300	11,000	1.1	1.1	1.1
Endoquifon	µg/L	1.3	2.6	3.9	ND	ND	ND
Endosulian	lb/day ^[2]	0.32	0.65	0.97	ND	ND	ND
Endrin	µg/L	0.29	0.58	0.88	ND	ND	ND
	lb/day ^[2]	0.072	0.14	0.22	ND	ND	ND
	µg/L	0.58	1.2	1.8	ND	0.0058	0.0058
	lb/day ^[2]	0.14	0.29	0.43	ND	0.00032	0.00032

^[1] Estimated concentration. The parameter was detected at a concentration greater than the method detection level (MDL), but lower than the minimum level (ML).

^[2] The mass-based (lbs/day) effluent limitations in this table are based on the average dry weather flow design capacity of 29.6 MGD for the treatment facility and are therefore only good up to this flow. For flows above 29.6 MGD, mass-based effluent limitations shall be calculated individually using the concentration-based effluent limitations and the observed flow at the time of sampling per the following equation: lbs/day = 0.00834 x Ce x Q

where:

Ce = the effluent concentration limit in $\mu g/L$

Q = observed flow rate in MGD

^[3] The Discharger may at its option meet this objective as a total chromium objective.

^[4] If a discharger can demonstrate to the satisfaction of the Central Coast Water Board (subject to EPA approval) that an analytical method is available to reliably distinguish between strongly and weakly complexed cyanide, effluent limitations for cyanide may be met by the combined measurement of free cyanide, simple alkali metal cyanides, and weakly complexed organometallic cyanide complexes. In order for the analytical

method to be acceptable, the recovery of free cyanide from metal complexes must be comparable to that achieved by the approved method in 40 C.F.R. part 136, as revised May 14, 1999.

^[5] Water quality objectives for total chlorine residual applying to intermittent discharges not exceeding two hours shall be determined using the following equation:

logy=-0.43(logx)+1.8 where: y = the water quality objective (in μ g/L) to apply when chlorine is being discharged; and

x = the duration of uninterrupted chlorine discharge in minutes.

- The applicable effluent limitation must then be determined using Equation No. 1 from the Ocean Plan.
 The Discharger is not required to disinfect secondary effluent due to treatment system performance and outfall configuration and placement. The total chlorine residual effluent limitations are retained in this Order in the event the Discharger implements chlorine-based disinfection in the future and to verify compliance with semiannual Table 1 Pollutant monitoring requirements which include total chlorine residual.
- ^[7] See Attachment A for applicable definitions.

Table F-6. Historic Effluent Limitations and Monitoring Data for the Protection of Human Health

Parameter	Units	30-Day Average Effluent Limitation	Monitoring Data (From June 1, 2014 – December 31, 2017) Highest 30-Day
Non-Carcinogens			Average
Non-Oarcinogens	ua/l	32,000	ND
Acrolein	µg/∟ lb/dav[1]	7 900	ND
	ua/l	180,000	0.98
Antimony	µg/∟ lb/day[1]	43.000	0.90
	lo/udy: 1	43,000	0.0040
Bis(2-Chioroethyoxy)	µy/∟ lb/dav[1]	160	
	lo/uay	190,000	
Bis(2-Chloroisopropyl) Ether	µy/∟	180,000	
	ID/Uay ¹	43,000	
Chlorobenzene	µy/L	03,000	
	ID/Uay ¹¹	21,000	ND
Di-n-Butyl Phthalate	μg/L	510,000	ND
	ID/day.	130,000	ND
Dichlorobenzenes	µg/L	740,000	0.074 ^[2]
	Ib/day	180,000	ND
Diethyl Phthalate	µg/L	4,800,000	ND
-	Ib/day ^[1]	1,200,000	ND
Dimethyl Phthalate	µg/L	120,000,000	ND
	lb/day ^[1]	30,000,000	ND
2-Methyl-4 6-Dinitrophenol	µg/L	32,000	30 ^[2]
	lb/day ^[1]	7,900	ND
2 4-Dinitrophenol	μg/L	580	ND
	lb/day ^[1]	140	ND
Ethylbenzene	µg/L	600,000	ND
	lb/day ^[1]	150,000	ND
Eluoranthono	µg/L	2,200	0.0032 ^[2]
	lb/day ^[1]	540	ND
Hexachlorocyclopentadiene	μg/L	8,500	ND

MONTEREY ONE WATER REGIONAL WWTP AND AWPF

Parameter	Units	30-Day Average Effluent Limitation	Monitoring Data (From June 1, 2014 – December 31, 2017) Highest 30-Day	
	lb/day[1]	2 100	Average	
	ib/uay	2,100		
Nitrobenzene	μg/L lb/dox ^[1]	120		
	ib/uay	180		
Thallium	μg/∟ lb/day[1]	290		
		12 000 000		
Toluene	μg/∟ lb/day[1]	2 100 000		
	ib/uay	3,100,000		
Tributyltin	μ <u>μ</u> γμ	0.20		
	ID/Uay ¹¹	0.05		
1,1,1-Trichloroethane	μg/L	79,000,000	ND	
Canain a nama	ID/day	19,000,000	ND	
Carcinogens		45	ND	
Acrylonitrile	µg/L	15	ND	
-	ID/day.	3.6	ND	
Aldrin	µg/L	0.0032	ND	
	lb/day ^[1]	0.00079	ND	
Benzene	µg/L	860	ND	
	lb/day ^[1]	210	ND	
Benzidine	µg/L	0.010	ND	
	lb/day ^[1]	0.0025	ND	
Bervllium	µg/L	4.8	ND	
	lb/day ^[1]	1.2	ND	
Bis(2-Chloroethyl)Ether	μg/L	6.6	ND	
	lb/day ^[1]	1.6	ND	
Bis(2-Ethylbeyyl)Phthalate	μg/L	510	1.1 ^[2]	
	lb/day ^[1]	130	ND	
Carbon Tetrachloride	µg/L	130	ND	
	lb/day ^[1]	32	ND	
Chlordane	µg/L	0.0034	ND	
	lb/day ^[1]	0.00083	ND	
Chlorodibromomethane	µg/L	1,300	0.28 ^[2]	
Chiorodibromomethane	lb/day ^[1]	310	ND	
Chloroform	µg/L	19,000	0.78	
Chlorolom	lb/day ^[1]	4,700	0.0072	
1 1-Dichlorobenzono	µg/L	2,600	ND	
	lb/day ^[1]	650	ND	
2 2'Dioblorobon-iding	μg/L	1.2	ND	
	lb/day ^[1]	0.29	ND	
1.2 Diablara athara	µg/L	4,100	ND	
i,∠-Dichloroethane	lb/day ^[1]	1,000	ND	
1,1-Dichloroethylene	µg/L	130	ND	
Parameter	Units	30-Day Average Effluent Limitation	Monitoring Data (From June 1, 2014 – December 31, 2017) Highest 30-Day Average	
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-	lb/dav ^[1]	32	ND	
	ua/L	0.0058	ND	
Dieldrin		0.0014	ND	
	ua/L	380	ND	
2,4-Dinitrotoluene	lb/dav ^[1]	94	ND	
	ua/L	23	ND	
1,2-Diphenylhydrazine	lb/day ^[1]	5.8	ND	
	ua/L	19.000	0.38 ^[2]	
Halomethanes	lb/dav ^[1]	4,700	ND	
	ua/L	0.0073	ND	
Heptachlor	lb/day ^[1]	0.0018	ND	
Heptachlor Epoxide	µg/L	0.0029	ND	
	lb/day ^[1]	0.00072	ND	
Hexachlorobenzene	μg/L	0.031	ND	
-	lb/day ^[1]	0.0076	ND	
Hexachlorobutadiene	μg/L	2,000	ND	
-	lb/day ^[1]	500	ND	
Hexachloroethane	µg/L	370	ND	
	lb/day ^[1]	90	ND	
Isophorone	µg/L	110,000	ND	
	lb/day ^[1]	26,000	ND	
N-Nitrosodimethylamine	µg/L	1,100	ND	
	lb/day ^[1]	260	ND	
N-Nitrosodi-n-Propylamine	µg/L	55	ND	
	lb/day ^[1]	14	ND	
N-Nitrosodiphenylamine	µg/L	370	ND	
	lb/day ^[1]	90	ND	
PAHs (total)	µg/L	1.3	0.20	
	lb/day ^[1]	0.32	0.00094	
PCBs	μg/L	0.0028	ND	
	lb/day ^[1]	0.00068	ND	
TCDD Equivalents	µg/L	5.7 x 10 ⁻⁷	2.91 x 10 ^{-8 [2]}	
	lb/day ^[1]	1.4 x 10 ⁻⁷	ND	
1,1,2,2-Tetrachloroethane	µg/L	340	ND	
	lb/day ^[1]	83	ND	
Tetrachloroethylene	µg/L	290	ND	
	lb/day ^[1]	72	ND	
Toxaphene	µg/L	0.031	ND	
	lb/day ^[1]	0.0076	ND	
Trichloroethylene	µg/L	3,900	ND	
	lb/day ^[1]	970	ND	

Parameter	Units	30-Day Average	Monitoring Data (From June 1, 2014 – December 31, 2017)	
			Highest 30-Day Average	
1,1,2-Trichloroethane	µg/L	1,400	ND	
	lb/day ^[1]	340	ND	
2,4,6-Trichlorophenol	µg/L	42	ND	
	lb/day ^[1]	10	ND	
Vinyl Chloride	μg/L	5,300	0.19 ^[2]	
	lb/day ^[1]	1,300	ND	

^[1] The mass-based (lbs/day) effluent limitations in this table are based on the average dry weather flow design capacity of 29.6 MGD for the treatment facility and are therefore only good up to this flow. For flows above 29.6 MGD, mass-based effluent limitations shall be calculated individually using the concentration-based effluent limitations and the observed flow at the time of sampling per the following equation:

lbs/day = 0.00834 x Ce x Q

where:

Ce = the effluent concentration limit in μ g/L

Q = observed flow rate in MGD

^[2] Estimated concentration. The parameter was detected at a concentration greater than the MDL, but lower than the ML.

D. Compliance Summary

A summary of the violations that occurred during the term of Order No. R3-2014-0013 are included in the table below.

Date	Violation Type	Pollutant	Reported Value	Permit Limitation	Units
February 23, 2016	Single Sample Maximum	Chronic Toxicity	625	150	TUc
December 4, 2016	Weekly Average	CBOD₅	41	40	mg/L
August 16, 2016	Single Sample Maximum	Chronic Toxicity	625	150	TUc
August 30, 2016	Single Sample Maximum	Chronic Toxicity	625	150	TUc

Table F-7. Compliance Summary

For the chronic toxicity violation on February 23, 2016, the Discharger conducted a source investigation and determined that the exceedance was caused by an upset sludge digester that overflowed and was washed down into the storm pond. Following the toxicity exceedance in August 2016, the Permittee conducted a TRE. The TRE concluded that the non-routine practice of pumping restaurant grease to the headworks in lieu of directly to the digesters, due to limited digester capacity, was responsible for the violations.

E. Planned Changes

The Discharger expects to complete construction of the AWPF by the third quarter of 2019. In addition, the Discharger has been requested by California America Water (Cal Am) to conduct planning, infrastructure design, and water quality analysis required prior to the Discharger's accepting brine from Cal Am's proposed desalination plant that is a component of the Monterey Peninsula Water Supply Project. Cal Am has proposed to construct the desalination

plant near the Facility and to use subsurface slant wells near the coast for feed water. The desalination plant could provide an additional water supply that would enable Cal Am to meet State Water Board requirements to decrease pumping from the Carmel River. Cal Am has proposed to convey desalination brine from the Cal Am desalination plant to a new brine mixing structure for blending with the existing wastewater in the outfall from the Facility and then discharged through a redesigned and relocated Effluent Point 001.

Cal Am is currently seeking regulatory approvals and has estimated the desalination plant will begin operation in 2021. Because of uncertainty in the scope of the desalination plant, the probability that the Ocean Outfall diffuser ports would need to be modified, and the amount of time necessary to obtain regulatory approvals, the Discharger is not requesting the permit include Cal Am brine wastes at this time. A new ROWD would be submitted prior to consideration of the permit and compliance for discharging any amount of desalination brine.

III. APPLICABLE PLANS, POLICIES, AND REGULATIONS

The requirements contained in this Order are based on the requirements and authorities described in this section.

A. Legal Authorities

This Order serves as WDRs pursuant to article 4, chapter 4, division 7 of the California Water Code (commencing with section 13260). This Order is also issued pursuant to section 402 of the federal Clean Water Act (CWA) and implementing regulations adopted by the U.S. EPA and chapter 5.5, division 7 of the Water Code (commencing with section 13370). It shall serve as an NPDES permit authorizing the Discharger to discharge into waters of the United States at the discharge location described in Table 2 subject to the WDRs in this Order.

B. California Environmental Quality Act (CEQA)

The addition of the AWPF is part of the Pure Water Monterey Groundwater Replenishment Project is subject to CEQA. As the lead agency, Monterey One Water issued a Notice of Preparation of an EIR on May 31, 2013, and a supplemental Notice of Preparation on December 9, 2014. Monterey One Water certified the Final EIR and approved the project on October 8, 2015. On October 30, 2017, Monterey One Water prepared and approved an addendum to the EIR, reflecting a change in design capacity of the AWPF from 4.0 MGD to 5.0 MGD.

C. State and Federal Laws, Regulations, Policies, and Plans

1. Water Quality Control Plan. The Central Coast Water Board adopted the *Water Quality Control Plan for the Central Coastal Basin* (hereinafter Basin Plan) that designates beneficial uses, establishes water quality objectives, and contains implementation programs and policies to achieve those objectives for the Pacific Ocean. The Basin Plan implements State Water Board Resolution No. 88-63, which establishes State policy that all waters, with certain exceptions, should be considered suitable or potentially suitable for municipal or domestic supply (MUN). Because of very high levels of total dissolved solids (TDS) in the Pacific Ocean, including Monterey Bay, the receiving waters for discharges from the Facility meet an exception to Resolution No. 88-63, which precludes waters with TDS levels greater than 3,000 mg/L from the MUN designation. Requirements in this Order implement the Basin Plan.

Beneficial uses applicable to coastal waters between the Salinas River and Point Pinos are as follows:

Discharge Point	Receiving Water Name	Beneficial Use(s)
001	Pacific Ocean	Water Contact and Non-Contact Recreation
		Industrial Service Supply
		Navigation
		Marine Habitat
		Shellfish Harvesting
		Commercial and Sport Fishing
		Wildlife Habitat

Table F-8. Basin Plan Beneficial Uses

- 2. Thermal Plan. The State Water Board adopted the *Water Quality Control Plan for Control of Temperature in the Coastal and Interstate Waters and Enclosed Bays and Estuaries of California* (Thermal Plan) on January 7, 1971, and amended this plan on September 18, 1975. This plan contains temperature objectives for coastal waters. "Elevated temperature waste discharges shall comply with limitations necessary to assure protection of beneficial uses." The California Ocean Plan defines elevated temperature wastes as "Liquid, solid, or gaseous material discharged at a temperature higher than the natural temperature of receiving water." Requirements of this Order implement the Thermal Plan.
- 3. California Ocean Plan. The State Water Board adopted the *Water Quality Control Plan for Ocean Waters of California*, California Ocean Plan (Ocean Plan) in 1972 and amended it in 1978, 1983, 1988, 1990, 1997, 2000, 2005, 2009, 2012, and 2015. The State Water Board adopted the latest amendment on May 6, 2015, and it became effective on April 7, 2016. The Ocean Plan is applicable, in its entirety, to point source discharges to the ocean. The Ocean Plan identifies beneficial uses of ocean waters of the state to be protected as summarized below:

Discharge Point	Receiving Water	Beneficial Uses
001	Pacific Ocean	Industrial water supply; water contact and non-contact recreation, including aesthetic enjoyment; navigation; commercial and sport fishing; mariculture; preservation and enhancement of designated Areas of Special Biological Significance (ASBS); rare and endangered species; marine habitat; fish spawning and shellfish harvesting

Table	F-9 .	Ocean	Plan	Beneficial	Uses
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In order to protect the beneficial uses, the Ocean Plan establishes water quality objectives and a program of implementation. Requirements of this Order implement the Ocean Plan.

4. Antidegradation Policy. Federal regulation 40 C.F.R. § 131.12 requires that the state water quality standards include an antidegradation policy consistent with the federal policy. The State Water Board established California's antidegradation policy in State Water Board Resolution No. 68-16 ("Statement of Policy with Respect to Maintaining High Quality of Waters in California"). Resolution No. 68-16 is deemed to incorporate the federal antidegradation policy where the federal policy applies under federal law. Resolution No. 68-16 requires that existing water quality be maintained unless degradation is justified based on specific findings. The Central Coast Water Board's Basin Plan implements, and incorporates by reference, both the state and federal antidegradation policies. The permitted discharge must be consistent with the

antidegradation provision of section 131.12 and State Water Board Resolution No. 68-16.

- **5.** Anti-Backsliding Requirements. Sections 402(o) and 303(d)(4) of the CWA and federal regulations at 40 C.F.R. § 122.44(l) restrict backsliding in NPDES permits. These antibacksliding provisions require that effluent limitations in a reissued permit must be as stringent as those in the previous permit, with some exceptions in which limitations may be relaxed.
- 6. Endangered Species Act Requirements. This Order does not authorize any act that results in the taking of a threatened or endangered species or any act that is now prohibited, or becomes prohibited in the future, under either the California Endangered Species Act (Fish and Game Code, §§ 2050 to 2097) or the Federal Endangered Species Act (16 U.S.C.A. §§ 1531 to 1544). This Order requires compliance with effluent limits, receiving water limits, and other requirements to protect the beneficial uses of waters of the state, including protecting rare and endangered species. The Discharger is responsible for meeting all requirements of the applicable Endangered Species Act.
- 7. Sewage Sludge and Biosolids. This Order does not authorize any act that results in violation of requirements administered by U.S. EPA to implement 40 C.F.R. part 503, Standards for the Use or Disposal of Sewage Sludge. These standards regulate the final use or disposal of sewage sludge that is generated during the treatment of domestic sewage in a municipal wastewater treatment facility. The Discharger is responsible for meeting all applicable requirements of 40 C.F.R. part 503 that are under U.S. EPA's enforcement authority.

D. Impaired Water Bodies on the CWA section 303(d) List

CWA section 303 (d) requires states to identify specific water bodies where water quality standards are not expected to be met after implementation of technology-based effluent limitations on point sources. For all 303(d) listed water bodies and pollutants, the Central Coast Water Board must develop and implement Total Maximum Daily Loads (TMDLs) that will specify waste load allocations for point sources and load allocations for non-point sources.

The main body of Monterey Bay is not identified on the 303 (d) List as impaired. According to the State's 2012 303 (d) list of impaired water bodies, which was approved by U.S. EPA on July 30, 2015, the closest receiving water impairments are described below.

- The Salinas River Lagoon is listed as impaired due to nutrients and toxicity. The
 nutrient impairment is addressed through the Lower Salinas River Watershed Nutrient
 TMDL, adopted by the Central Coast Water Board in 2013. Impairment due to toxicity
 is addressed through the Salinas River Watershed Sediment Toxicity and Pyrethroid
 Pesticides in Sediment TMDL, adopted by the Central Coast Water Board in 2017.
 The discharge covered by this Order is not located in receiving waters addressed by
 this TMDL and is therefore not subject to the TMDL requirements.
- Moss Landing Harbor is listed as impaired due to chlorpyrifos, diazinon, low dissolved oxygen, nickel, pathogens, pesticides, pH, sediment toxicity, and sedimentation/siltation. TMDLs to address the impairments are scheduled for 2021.
- Monterey Harbor is identified as impaired by metals and sediment toxicity. The estimated date of completion for TMDLs is 2021.

On December 9, 2016, the Central Coast Water Board submitted the 2014 303(d) list with recommended changes from the 2012 303(d) list. In addition to the impairments discussed above, the 2014 303(d) list includes an additional listing for bacteria.

• The Pacific Ocean at Monterey State Beach is listed as impaired for Enterococcus and total coliform bacteria. Currently, no bacteria TMDL is scheduled.

The 2014 303(d) list, including the added bacteria impairment does not replace the 2012 303(d) list until both the State Water Board and U.S. EPA approve the changes.

E. Other Plans, Polices and Regulations

- 1. Discharges of Storm Water. For the control of storm water discharged from the site of the wastewater treatment and disposal facilities, the Order requires, if applicable, the Discharger to seek authorization to discharge under and meet the requirements of the State Water Resources Control Board's Water Quality Order 2014-0057-DWQ, NPDES General Permit No. CAS000001, *Waste Discharge Requirements for Discharges of Storm Water Associated with Industrial Activities Excluding Construction Activities.*
- 2. Sanitary Sewer System Requirements. Water Quality Order 2006-0003-DWQ, adopted on May 2, 2006 and amended by State Water Board Order WQ 2013-0058-EXEC, is applicable to all "federal and state agencies, municipalities, counties, districts, and other public entities that own or operate sanitary sewer systems greater than one mile in length that collect or convey untreated or partially treated wastewater to a publicly owned treatment facility in the State of California." The purpose of Water Quality Order 2006-0003-DWQ is to promote the proper and efficient management, operation, and maintenance of sanitary sewer systems and to minimize the occurrences and impacts of sanitary sewer overflows.

IV. RATIONALE FOR EFFLUENT LIMITATIONS AND DISCHARGE SPECIFICATIONS

The CWA requires point source dischargers to control the amount of conventional, nonconventional, and toxic pollutants that are discharged into the waters of the United States. The control of pollutants discharged is established through effluent limitations and other requirements in NPDES permits. There are two principal bases for effluent limitations in the Code of Federal Regulations: 40 C.F.R. § 122.44(a) requires that permits include applicable technology-based limitations and standards; and 40 C.F.R. § 122.44(d) requires that permits include water qualitybased effluent limitations to attain and maintain applicable numeric and narrative water quality criteria to protect the beneficial uses of the receiving water.

A. Discharge Prohibitions

This permit implements discharge prohibitions that are applicable under sections III.I.1.a, III.I.3.a, and III.I.4.a of the California Ocean Plan.

- 1. Discharge Prohibition II.A (No discharge to Monterey Bay at a location other than as described by the Order). The Order authorizes a single, specific point of discharge to Monterey Bay; and this prohibition reflects CWA section 402 prohibition against discharges of pollutants except in compliance with the Act's permit requirements, effluent limitations, and other enumerated provisions. This prohibition is also retained from the previous permit.
- 2. Discharge Prohibition II.B (The rate of secondary effluent dry weather average monthly rate of discharge from the WWTP shall not exceed 29.6MGD) This prohibition reflects the design capacity of the secondary treatment system and is intended to limit influent wastewater flows to that of the treatment facility design flows.

- 3. Discharge Prohibition II.C (The influent flow to the secondary treatment system shall not exceed 29.6 MGD average dry weather flow and 75.6 MGD peak wet weather flow). This prohibition reflects the design capacity of the secondary treatment system and is intended to limit influent wastewater flows to that of the treatment facility design flows.
- 4. Discharge Prohibition II.D (The rate of discharge to Monterey Bay shall not exceed 81.2 MGD). This prohibition reflects the design capacity of the ocean outfall and allows the discharge of blended secondary effluent, RO concentrate, and hauled saline waste above the design flow capacity of the secondary treatment facility.
- 5. Discharge Prohibition II.E (Overflows and bypasses prohibited). The discharge of untreated or partially treated wastewater from the Discharger's collection, treatment, or disposal facilities represents an unauthorized bypass pursuant to 40 C.F.R. § 122.41(m) or an unauthorized discharge, which poses a threat to human health and/or aquatic life, and therefore, is explicitly prohibited by this Order.
- 6. Discharge Prohibition II.F (Discharges in a manner, except as described by the Order are prohibited). Because limitations and conditions of the Order have been prepared based on specific information provided by the Discharger and specific wastes described by the Discharger, the limitations and conditions of the Order do not adequately address waste streams not contemplated during drafting of the Order. To prevent the discharge of such waste streams that may be inadequately regulated, the Order prohibits the discharge of any waste that was not described by the Central Coast Water Board during the process of permit issuance.
- 7. Discharge Prohibition II.G (Discharges of radiological, chemical, or biological warfare agent or high level radioactive waste to the Ocean is prohibited). This prohibition restates a discharge prohibition established in section III. H of the Ocean Plan.
- 8. Discharge Prohibition II.H (Federal law prohibits the discharge of sludge by pipeline to the Ocean. The discharge of municipal or industrial waste sludge directly to the Ocean or into a waste stream that discharges to the Ocean is prohibited. The discharge of sludge digester supernatant, without further treatment, directly to the Ocean or to a waste stream that discharges to the Ocean, is prohibited.) This prohibition reflects the prohibition in Chapter III.I.3.a of the Ocean Plan.

B. Technology-Based Effluent Limitations

1. Scope and Authority

Section 301(b) of the CWA and implementing U.S. EPA permit regulations at 40 C.F.R. § 122.44 require that permits include conditions meeting applicable technology-based requirements at a minimum, and any more stringent effluent limitations necessary to meet applicable water quality standards.

This Order includes limitations based on the minimum level of effluent quality attainable by secondary treatment, as established at 40 C.F.R. part 133. The secondary treatment regulation includes the following limitations applicable to all POTWs.

Devenueter	Effluent Limitation						
Parameter	30-Day Average	7-Day Average	Percent Removal ^[1]				
CBOD ₅ ^[2]	25 mg/L	40 mg/L	85				
TSS	30 mg/L	45 mg/L	85				
рН	6.0-9.0						

 Table F-10. Secondary Treatment Requirements

- ^[1] The 30-day average percent removal shall not be less than 85 percent.
- ^[2] The regulations at 40 C.F.R. section 133.104(b) allow the permitting authority to set effluent limitations for TOC instead of BOD₅ if a long-term correlation has been demonstrated.

Table 2 of the Ocean Plan establishes technology-based requirements, applicable to POTWs and industrial discharges for which Effluent Limitations Guidelines have not been established. The Table 2 Ocean Plan effluent limitations are summarized below.

Deveneter	Unite	Effluent Limitation				
Parameter	Units	30-Day Average	7-Day Average	Instantaneous Maximum		
Oil and Grease	mg/L	25	40	85		
Settleable Solids	ml/L	1.0	1.5	3.0		
Turbidity	NTU	75	100	225		

 Table F-11. Ocean Plan Table 2 Requirements

Table 2 of the Ocean Plan establishes effluent limitations for pH, which require pH to be within 6.0 and 9.0 pH units at all times. Further, Table 2 establishes a 75 percent minimum removal requirement for suspended solids, unless the effluent limitation is less than 60 mg/L. This Order implements the more stringent 85 percent suspended solids removal limitation based on the Secondary Treatment Standards at 40 C.F.R. part 133.

2. Applicable Technology-Based Effluent Limitations

Title 40 C.F.R. section 122.45(f)(1) requires effluent limitations be expressed in terms of mass, with some exceptions, and 40 C.F.R. section 122.45(f)(2) allows pollutants that are limited in terms of mass to additionally be limited in terms of other units of measurement. This Order includes effluent limitations expressed in terms of mass and concentration. Mass-based effluent limitations were calculated based upon the permitted average daily discharge flow of the POTW of 29.6 MGD. In addition, pursuant to the exceptions to mass limitations provided in 40 C.F.R. section 122.45(f)(1), some effluent limitations are not expressed in terms of mass, such as pH and temperature.

Secondary Effluent Standards reflect the minimum level of treatment to be achieved through municipal wastewater treatment. The point of compliance determination must therefore be located prior to commingling with other wastestreams. This Order includes a new monitoring location, EFF-001A, for compliance determination with CBOD₅, TSS, and pH.

The Ocean Plan, p. 13 specifies that Table 2 limitations apply to a discharger's total effluent, of whatever origin (i.e., gross, not net, discharge). Therefore, compliance with Table 2 limitations is determined at Monitoring Location EFF-001. RO concentrate and hauled saline wastes may have an impact on total effluent pH, therefore, the pH limitation and compliance monitoring is retained at EFF-001 (in addition to EFF-001A) to meet the Ocean Plan objective that states the discharge may not cause a pH change in the Ocean of more than 0.2 units.

The following tables summarize technology-based effluent limitations established by the Order.

		Effluent Limitation					
Parameter	Units	Average Monthly	Average Weekly	Maximum Daily	Instantaneous Maximum		
Oil and Crassa	mg/L	25	40	75			
Oil and Grease	lbs/day ^[1]	6,200	10,000	19,000			
Settleable Solids	ml/L	1.0	1.5		3.0		
Turbidity	NTU	75	100		230		
pH ^[3]	standard units	6.0 – 9.0 at all times					

Table F-12. Summary of Technology-Based Effluent Limitations – EFF-001

^[1] The mass-based (lbs/day) effluent limitations in this table are based on the average dry weather flow design capacity of 29.6 MGD for the treatment facility and are therefore only good up to this flow. For flows above 29.6 MGD, mass-based effluent limitations shall be calculated individually using the concentration-based effluent limitations and the observed flow at the time of sampling per the following equation:

lbs/day = 0.00834 x Ce x Q where:

Ce = the effluent concentration limit in μ g/L

Q = observed flow rate in MGD

^[2] Excursions from the effluent limit range are permitted subject to the following limitations (40 C.F.R. 401.17):

- a. The total time during which the pH values are outside the required range of pH values shall not exceed 7 hours and 26 minutes in any calendar month; and
- b. No individual excursion from the range of pH values shall exceed 60 minutes. Note: 40 C.F.R. section 401.17(2)(c) notes that, for the purposes of 40 C.F.R. section 401.17, "excursion" is defined as "an unintentional and temporary incident in which the pH value of discharge wastewater exceeds the range set forth in the applicable effluent limitations guidelines." The State Board may adjust the requirements set forth in paragraph 40 C.F.R. section 401.17 (a) with respect to the length of individual excursions from the range of pH values, if a different period of time is appropriate based upon the treatment system, plant configuration, or other technical factors.

			Effluent Limitation				
Parameter	Units	Average Monthly	Average Weekly	Maximum Daily	Instantaneous Maximum		
	mg/L	25	40	85			
	lbs/day ^[2]	6,200	10,000	21,000			
CDOD ₅ , y	% removal	not less than 85 ^[2]					
	mg/L	30	45	90			
	lbs/day ^[2]	7,400	11,000	22,000			
	% removal	not less than 85 ^[2]					
pH ^[3]	standard units	6.0 – 9.0 at all times					

Table F-13. Summar	y of Technology-Based	Effluent Limitations	– EFF-001A
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^[1] 30-day average percent removal shall not be less than 85%.

^[2] The mass-based (lbs/day) effluent limitations in this table are based on the average dry weather flow design capacity of 29.6 MGD for the treatment facility and are therefore only good up to this flow. For flows above 29.6 MGD, mass-based effluent limitations shall be calculated individually using the concentration-based effluent limitations and the observed flow at the time of sampling per the following equation:

lbs/day = 0.00834 x Ce x Q

where:

Ce = the effluent concentration limit in μ g/L

Q = observed flow rate in MGD

- ^[3] Excursions from the effluent limit range are permitted subject to the following limitations (40 C.F.R. 401.17):
 - a. The total time during which the pH values are outside the required range of pH values shall not exceed 7 hours and 26 minutes in any calendar month; and
 - b. No individual excursion from the range of pH values shall exceed 60 minutes. Note: 40 C.F.R. section 401.17(2)(c) notes that, for the purposes of 40 C.F.R. section 401.17, "excursion" is defined as "an unintentional and temporary incident in which the pH value of discharge wastewater exceeds the range set forth in the applicable effluent limitations guidelines." The State Board may adjust the requirements set forth in paragraph 40 C.F.R. section 401.17 (a) with respect to the length of individual excursions from the range of pH values, if a different period of time is appropriate based upon the treatment system, plant configuration, or other technical factors.

C. Water Quality-Based Effluent Limitations (WQBELs)

1. Scope and Authority

CWA Section 301(b) and 40 C.F.R. section 122.44(d) require that permits include limitations more stringent than applicable federal technology-based requirements where necessary to achieve applicable water quality standards.

Section 122.44(d)(1)(i) of 40 C.F.R. requires that permits include effluent limitations for all pollutants that are or may be discharged at levels that have the reasonable potential to cause or contribute to an exceedance of a water quality standard, including numeric and narrative objectives within a standard. Where reasonable potential has been established for a pollutant, but there is no numeric criterion or objective for the pollutant, WQBELs must be established using: (1) U.S. EPA criteria guidance under CWA section 304(a), supplemented where necessary by other relevant information; (2) an indicator parameter for the pollutant of concern; or (3) a calculated numeric water quality criterion, such as a proposed state criterion or policy interpreting the state's narrative criterion, supplemented with other relevant information, as provided in section 122.44(d)(1)(vi).

The process for determining reasonable potential and calculating WQBELs when necessary is intended to protect the designated uses of the receiving water as specified in the Basin Plan and achieve applicable water quality objectives and criteria that are contained in other state plans and policies or any applicable water quality criteria contained in the Ocean Plan.

2. Applicable Beneficial Uses and Water Quality Criteria and Objectives

Beneficial uses for ocean waters of the Central Coast Region are established by the Basin Plan and California Ocean Plan and are described in section III.C.1 and III.C.3, respectively, of the Fact Sheet. The water quality objectives (WQOs) from the California Ocean Plan are incorporated as receiving water limitations in this Order.

Water quality objectives applicable to ocean waters of the Central Coast region include water quality objectives for bacterial characteristics, physical characteristics, chemical characteristics, biological characteristics, and radioactivity. In addition, Table 1 of the California Ocean Plan contains numeric water quality objectives for 83 toxic pollutants for the protection of marine aquatic life and human health. Pursuant to NPDES regulations at 40 C.F.R. section 122.44(d)(1) and in accordance with procedures established by the California Ocean Plan, the Central Coast Water Board has performed a reasonable potential analysis (RPA) to determine the need for effluent limitations for the Table 1 toxic pollutants.

3. Determining the Need for WQBELs

Procedures for performing an RPA for ocean dischargers are described in Section III.C and Appendix VI of the California Ocean Plan. The procedure is a statistical method that projects an effluent data set while taking into account the averaging period of WQOs, the long-term variability of pollutants in the effluent, limitations associated with sparse data sets, and uncertainty associated with censored data sets. The procedure assumes a lognormal distribution of the effluent data set and compares the 95th percentile concentration at 95th percent confidence of each Table 1 pollutant, accounting for dilution, to the applicable water quality criterion. The RPA results in one of three following endpoints.

- Endpoint 1 There is "reasonable potential." An effluent limitation must be developed for the pollutant. Effluent monitoring for the pollutant, consistent with the monitoring frequency in Appendix III (Ocean Plan), is required.
- Endpoint 2 There is no "reasonable potential." An effluent limitation is not required for the pollutant. Appendix III (Ocean Plan) effluent monitoring is not required for the pollutant; the Central Coast Board, however, may require occasional monitoring for the pollutant or for whole effluent toxicity as appropriate.
- Endpoint 3 The RPA is inconclusive. Monitoring for the pollutant or whole effluent toxicity testing, consistent with the monitoring frequency in Appendix III, is required. An existing effluent limitation for the pollutant shall remain in the permit, otherwise the permit shall include a reopener clause to allow for subsequent modification of the permit to include an effluent limitation if monitoring establishes that the discharge causes, has the reasonable potential to cause, or contribute to an excursion above a Table 1 water quality objective.

The State Water Board has developed a reasonable potential calculator, which is available at:

http://www.waterboards.ca.gov/water_issues/programs/ocean/docs/trirev/stakeholde r050505/rpcalc22_setup.zip

The calculator (RPcalc 2.2) was used in the development of this Order and considers several pathways in the determination of reasonable potential.

i. First Path

If available information about the receiving water or the discharge supports a finding of reasonable potential without analysis of effluent data, the Central Coast Water Board may decide that WQBELs are necessary after a review of such information. Such information may include: the facility or discharge type, solids loading, lack of dilution, history of compliance problems, potential toxic effects, fish tissue data, 303(d) status of the receiving water, the presence of threatened or endangered species or their critical habitat, or other information.

ii. Second Path

If any pollutant concentration, adjusted to account for dilution, is greater than the most stringent applicable WQO, there is reasonable potential for that pollutant.

iii. Third Path

If the effluent data contains three or more detected and quantified values (i.e., values that are at or above the minimum level (ML), and all values in the data set are at or above the ML, a parametric RPA is conducted to project the range of possible effluent values. The 95th percentile concentration is determined at 95 percent confidence for each pollutant and compared to the most stringent applicable water quality objective to determine reasonable potential. A parametric analysis assumes that the range of possible effluent values is distributed log-normally. If the 95th percentile value is greater than the most stringent applicable water quality objective, there is reasonable potential for that pollutant.

iv. Fourth Path

If the effluent data contains three or more detected and quantified values (i.e., values that are at or above the ML), but at least one value in the data set is less than the ML, a parametric RPA is conducted according to the following steps:

- i. If the number of censored values (those expressed as a "less than" value) account for less than 80 percent of the total number of effluent values, calculate the ML (the mean of the natural log of transformed data) and SL (the standard deviation of the natural log of transformed data) and conduct a parametric RPA, as described above for the Third Path.
- **ii.** If the total number of censored values account for 80 percent of the total number of effluent values, conduct a non-parametric RPA, as described below for the Fifth Path. (A non-parametric analysis becomes necessary when the effluent data is limited, and no assumptions can be made regarding its possible distribution).
- v. Fifth Path

A non-parametric RPA is conducted when the effluent data set contains less than three detected and quantified values, or when the effluent data set contains three or more detected and quantified values but the number of censored values accounts for 80 percent or more of the total of effluent values. A non-parametric analysis is conducted by ordering the data, comparing each result to the applicable WQO, and accounting for ties. The sample number is reduced by one for each tie, when the dilution-adjusted method detection limit (MDL) is greater than the water quality objective. If the adjusted sample number, after accounting for ties, is greater than 15, the pollutant has no reasonable potential to exceed the WQO. If the sample number is 15 or less, the RPA is inconclusive, monitoring is required, and any existing effluent limits in the expiring permit are retained.

An RPA was conducted using effluent monitoring data reported for June 2014 through December 2017. The implementation provisions for Table 1 in Section III.C of the Ocean Plan specify that the minimum initial dilution is the lowest average initial dilution within any single month of the year. Dilution estimates shall be based on observed waste flow characteristics, observed receiving water density structure, and the assumption that no currents of sufficient strength to influence the initial dilution process flow across the discharge structure. Order No. R3-2014-0013 established the minimum initial dilution factor (Dm) for the discharge to be 145 to 1 (seawater to effluent). The addition of the AWPF will result in varying conditions of discharge quality that will affect dilution characteristics. The amount of secondary effluent commingled with the RO concentrate and hauled saline waste will influence the buoyancy of the plume and the boundary interactions with the ambient receiving water.

As described in section II.A of this Fact Sheet, the Discharger conducted modeling to simulate worst case dilution under various blend scenarios of RO concentrate, hauled saline waste, and secondary effluent. From modeling results four Dms were selected to represent different blend amounts (Table F-3). By assigning multiple Dm values, the commingled effluent is characterized into four types of effluent waste streams that will be permitted for discharge. Representative conditions are therefore applied to each type of effluent waste stream to adequately assess the impacts of these discharges to Monterey Bay. The most conservative Dm of 145 was used to determine reasonable potential. This Dm reflects conditions of high secondary effluent, which accurately describes the discharge during the term of the existing permit.

A summary of the RPA results is provided below. As shown in the table, due to insufficient data, the RPA frequently leads to Endpoint 3 meaning that the RPA was inconclusive. In these circumstances, the Ocean Plan requires that existing effluent limitations for those pollutants (for which the RPA is inconclusive) remain in the reissued permit. When the RPA leads to Endpoint 2, meaning there is no reasonable potential for that pollutant, the limit has been removed for this permit term.

When using all available data for the past permit term, the RPA displayed "reasonable potential," indicated by a result of Endpoint 1, for ammonia, cyanide, acute toxicity, and chronic toxicity. RPA results that did not result in Endpoint 3 are bolded in the following.

Parameter	Most Stringent WQO (µg/L)	N ^[1]	Number of Non- Detects	Max Effluent Conc. (µg/L) ^{[2], [3]}	RPA Result/Comment ^[4]			
Objectives for Protection of Marine Aquatic Life								
Arsenic, Total Recoverable	8	7	0	3.7 ^[6]	Endpoint 2 – Effluent limitation not required.			
Cadmium, Total Recoverable	1	7	6	0.086 ^[6]	Endpoint 3 – RPA is inconclusive.			
Chromium (VI), Total	2	15	10	11	Endpoint 2 – Effluent limitation not required.			
Copper, Total Recoverable	3	7	0	12 ^[6]	Endpoint 2 – Effluent limitation not required.			
Lead, Total Recoverable	2	7	4	0.35 ^[6]	Endpoint 3 – RPA is inconclusive.			
Mercury, Total Recoverable	0.04	7	5	0.069 ^[6]	Endpoint 3 – RPA is inconclusive.			
Nickel, Total Recoverable	5	7	1	7.6 ^[6]	Endpoint 2 – Effluent limitation not required.			
Selenium, Total Recoverable	15	15	2	44	Endpoint 2 – Effluent limitation not required.			
Silver, Total Recoverable	0.7	7	6	0.14 ^[6]	Endpoint 3 – RPA is inconclusive.			
Zinc, Total Recoverable	20	7	1	170	Endpoint 2 – Effluent limitation not required.			
Cyanide, Total	1	15	1	81	Endpoint 1 – Effluent limitation is necessary.			
Total Chlorine, Residual	2	3	3	<0.2	Endpoint 3 – RPA is inconclusive.			

Table F-14. RPA Results for Discharges to the Pacific Ocean

Parameter	Most Stringent WQO (µq/L)	N ^[1]	Number of Non- Detects	Max Effluent Conc. (µg/L) ^{[2], [3]}	RPA Result/Comment ^[4]
Ammonia (as N)	600	59	0	47.900	Endpoint 1 – Effluent
			_	,	Imitation is necessary.
Acute Toxicity	0.3	7	4	0.4	limitation is necessary. ^[5]
Chronic Toxicity	1	16	0	625	Endpoint 1 – Effluent limitation is necessary.
Non-Chlorinated Phenolic Compounds	30	7	0	11	Endpoint 2 – Effluent limitation not required.
Chlorinated Phenolic Compounds	1	7	6	2.7 ^[6]	Endpoint 3 – RPA is inconclusive.
Endosulfan	0.009	7	7	<0.00046	Endpoint 3 – RPA is inconclusive.
Endrin	0.002	7	7	<0.00018	Endpoint 3 – RPA is inconclusive.
НСН	0.004	7	4	0.036	Endpoint 3 – RPA is inconclusive.
Radioactivity					
Objec	ctives for Pro	otection	of Human H	lealth – Non-Card	cinogens
Acrolein	220	7	7	<2.5	Endpoint 3 – RPA is
	4.000	•			Endpoint 3 – RPA is
Antimony	1,200	6	3	0.98	inconclusive.
Bis(2-chloroethoxy) Methane	4.4	7	7	0.29	Endpoint 3 – RPA is inconclusive.
Bis(2-chloroisopropyl) Ether	1,200	7	7	<0.27	Endpoint 3 – RPA is inconclusive.
Chlorobenzene	570	7	7	<0.05	Endpoint 3 – RPA is inconclusive.
Chromium (III)	190,000	6	0	10	Endpoint 2 – Effluent limitation not required.
Di-n-butyl Phthalate	3,500	7	7	<0.29	Endpoint 3 – RPA is inconclusive.
Dichlorobenzenes	5,100	7	6	0.074 ^[6]	Endpoint 3 – RPA is inconclusive.
Diethyl Phthalate	33,000	7	7	<0.14	Endpoint 3 – RPA is inconclusive.
Dimethyl Phthalate	820,000	7	7	<0.17	Endpoint 3 – RPA is inconclusive.
4,6-dinitro-2-methylphenol	220	12	10	30 ^[6]	Endpoint 3 – RPA is inconclusive.
2,4-dinitrophenol	4	7	7	<0.87	Endpoint 3 – RPA is inconclusive.
Ethylbenzene	4,100	7	7	<0.05	Endpoint 3 – RPA is inconclusive.
Fluoranthene	15	7	6	0.0032 ^[6]	Endpoint 3 – RPA is inconclusive.
Hexachlorocyclopentadiene	58	7	7	<1.1	Endpoint 3 – RPA is inconclusive.
Nitrobenzene	4.9	7	7	<0.31	Endpoint 3 – RPA is inconclusive.

Parameter	Most Stringent WQO (µq/L)	N ^[1]	Number of Non- Detects	Max Effluent Conc. (μg/L) ^{[2], [3]}	RPA Result/Comment ^[4]
Thallium	2	7	7	<0.04	Endpoint 3 – RPA is
	2	,	,	\0.0 4	inconclusive.
Toluene	85,000	7	1	0.47 ^[6]	Endpoint 3 – RPA is inconclusive.
	0.004.4	0	0	0.01.1	Endpoint 3 – RPA is
i ributyitin	0.0014	6	6	<0.014	inconclusive.
1 1 1-trichloroothano	540.000	7	7	<0.05	Endpoint 3 – RPA is
	540,000	1	1	<0.05	inconclusive.
Ob	jectives for l	Protecti	on of Huma	n Health – Carcin	ogens
Acrylonitrile	0.1	7	7	<1	Endpoint 3 – RPA is
	0.1	'			inconclusive.
Aldrin	0.000022	7	7	<0.00028	Endpoint 3 – RPA is
Benzene	5.9	7	7	<0.051	Endpoint 3 – RPA is
Benzidine	0.000069	7	7	<0.28	Endpoint 3 – RPA is
					Endpoint 3 – PPA is
Beryllium	0.033	7	7	<0.07	inconclusive
					Endpoint 3 – RPA is
Bis(2-chloroethyl) Ether	0.045	7	7	<0.23	inconclusive
		_	_		Endpoint 3 – RPA is
Bis(2-ethlyhexyl) Phthalate	3.5	1	5	1.1	inconclusive.
Carbon Totrachlarida	0.0	7	7	-0.060	Endpoint 3 – RPA is
Carbon Tetrachionde	0.9	1	1	<0.069	inconclusive.
Chlordana	0.000023	6	6	~0.002	Endpoint 3 – RPA is
Chiordane	0.000023	0	0	<0.002	inconclusive.
Chlorodibromomethane	86	7	6	0 28[6]	Endpoint 3 – RPA is
	0.0	· _		0.20	inconclusive.
Chloroform	130	7	1	0.78	Endpoint 3
DDT	0.00017	7	7	<0.00018	Endpoint 3 – RPA is
1,4-dichlorobenzene	18	7	7	<0.072	Endpoint 3 – RPA is
					Endnoint 2 DDA in
3,3'-dichlorobenzidine	0.0081	7	7	<0.13	inconclusive
					Endpoint 3 – RPA is
1,2-dichloroethane	28	7	7	<0.09	inconclusive.
		_	_	0.000	Endpoint 3 – RPA is
1,1-dichloroethylene	0.9	1	1	<0.086	inconclusive.
Dichlorobromomethane	6.2	7	7	<0.2	Endpoint 3 – RPA is
Dichlorobiomomethane	0.2	'	'	<0.2	inconclusive.
Dichloromethane	450	6	3	0.22	Endpoint 3 – RPA is
(Methylene Chloride)					inconclusive.7
1,3-dichloropropene	8.9	7	7	<0.09	Endpoint 3 – RPA is
					Inconclusive.
Dieldrin	0.00004	7	7	<0.0001	inconclusive.
	0.0	_	_	0.40	Endpoint 3 – RPA is
∠,4-ainitrotoiuene	2.6	/	/	<0.16	inconclusive.

Parameter	Most Stringent WQO (μg/L)	N ^[1]	Number of Non- Detects	Max Effluent Conc. (μg/L) ^{[2], [3]}	RPA Result/Comment ^[4]
1,2-diphenylhydrazine	0.16	7	7	<0.15	Endpoint 3 – RPA is inconclusive.
Halomethanes	130	7	4	0.38 ^[6]	Endpoint 3 – RPA is inconclusive.
Heptachlor	0.00005	7	7	<0.0004	Endpoint 3 – RPA is inconclusive.
Heptachlor Epoxide	0.00002	7	7	<0.00025	Endpoint 3 – RPA is inconclusive.
Hexachlorobenzene	0.00021	7	7	<0.17	Endpoint 3 – RPA is inconclusive.
Hexachlorobutadiene	14	7	7	<0.085	Endpoint 3 – RPA is inconclusive.
Hexachloroethane	2.5	7	7	<0.06	Endpoint 3 – RPA is inconclusive.
Isophorone	730	7	7	<0.31	Endpoint 3 – RPA is inconclusive.
N-nitrosodimethylamine	7.3	7	7	<0.71	Endpoint 3 – RPA is inconclusive.
N-nitrosodi-N-propylamine	0.38	7	7	<0.33	Endpoint 3 – RPA is inconclusive.
N-nitrosodiphenylamine	2.5	7	7	<0.17	Endpoint 3 – RPA is inconclusive.
PAHs	0.0088	7	2	0.2	Endpoint 2 – Effluent limitation not required.
PCBs	0.000019	7	7	<0.0015	Endpoint 3 – RPA is inconclusive.
TCDD equivalents	3.9E-09	7	0	2.9E-08 ^[6]	Endpoint 3 – RPA is inconclusive.
1,1,2,2-tetrachloroethane	2.3	7	7	<0.11	Endpoint 3 – RPA is inconclusive.
Tetrachloroethylene (Tetrachloroethene)	2	7	7	<0.082	Endpoint 3 – RPA is inconclusive.
Toxaphene	0.00021	7	7	<0.002	Endpoint 3 – RPA is inconclusive.
Trichloroethylene	27	7	7	<0.06	Endpoint 3 – RPA is inconclusive.
1,1,2-trichloroethane	9.4	7	7	<0.08	Endpoint 3 – RPA is inconclusive.
2,4,6-trichlorophenol	0.29	7	7	<0.23	Endpoint 3 – RPA is inconclusive.
Vinyl Chloride	36	7	6	0.19 ^[6]	Endpoint 3 – RPA is inconclusive.

NR indicates that effluent data were not reported.

^[1] Number of data points available for the RPA.

^[2] If there is a detected value, the highest reported value is summarized in the table. If there are no detected values, the lowest MDL is summarized in the table.

^[3] Note that the reported MEC does not account for dilution. The RPA does account for dilution; therefore, it is possible for a parameter with an MEC in exceedance of the most stringent criteria not to present a RP (i.e., Endpoint 1).

[4] Endpoint 1 – RP determined, limit required, monitoring required.
 Endpoint 2 – Discharger determined not to have RP, monitoring may be established.
 Endpoint 3 – RPA was inconclusive, carry over previous limits if applicable, establish monitoring.
 [5] Endpoint 1 has been determined on the basis of Stan 12 (BPI) of the Ocean RDA procedure.

- ^[5] Endpoint 1 has been determined on the basis of Step 13 (BPJ) of the Ocean Plan RPA procedure.
- ^[6] Estimated concentration. The result was detected at a concentration higher than the MDL and lower than the ML.

4. WQBEL Calculations

Using the results of the RPA, the Central Coast Water Board is establishing WQBELs for ammonia, cyanide, acute toxicity, and chronic toxicity based on a conclusion of Endpoint 1. An Endpoint 2 was concluded for chromium VI, selenium, non-chlorinated phenols, and PAHs, which have limitations in Order R3-2014-0013. Endpoint 2 resulted for arsenic, chromium III, copper, nickel, and zinc, which do not have limitations in Order R3-2014-0013. No new limitations are established for these pollutants. All other California Ocean Plan Table 1 pollutants resulted in an Endpoint 3 and the limits for these pollutants are retained in this Order, with the exception of DDT and mercury, which did not have limitations in the previous permit.

As described by Section III. C of the California Ocean Plan, effluent limitations for Table 1 pollutants are calculated according to the following equation.

Ce = Co + Dm (Co - Cs)

Where

Ce = the effluent limitation (μ g/L)

- Co = the concentration (the water quality objective) to be met at the completion of initial dilution (μ g/L).
- Cs= background seawater concentration (µg/L)
- Dm = minimum probable initial dilution expressed as parts seawater per part wastewater (here Dm = 145, 259, 388, or 473)

Initial dilution is the process that results in the rapid and irreversible turbulent mixing of wastewater with ocean water around the point of discharge. As described in section II.A.5 of this Fact Sheet, the Facility has four Dms to represent multiple RO concentrate, hauled saline waste, and effluent blend scenarios. In order to facilitate reporting of the six-month median results, effluent limitations in this Order are set equal to the Ocean Plan objectives and the Facility is allowed to use the appropriate Dm to calculate the concentrations that would result after dilution (C_{ZID}). Compliance is then determined by comparing the calculated concentration after dilution (C_{ZID}) to the Ocean Plan objective. In this way, C_{ZID} , the value reported for compliance determination, is substituted for Co and the Ocean Plan equation above is re-arranged as follows:

 $C_{ZID} = (Ce + DmCs)/(1+Dm)$

As site-specific water quality data are not available, in accordance with Table 1 implementing procedures, Cs equals zero for all pollutants, except the following.

Table F-15. Background Concentrations (Cs) – California Ocean Plan (Table 3)

Pollutant	Background Seawater Concentration
Arsenic	3 μg/L
Copper	2 µg/L
Mercury	0.0005 µg/L
Silver	0.16 μg/L
Zinc	8 µg/L

Applicable water quality objectives from Table 1 of the California Ocean Plan are as follows:

Pollutant	Units	6-Month Median	Daily Maximum	Instantaneous Maximum
Arsenic	µg/L	8	32	80
Cadmium	µg/L	1	4	10
Chromium (VI)	μg/L	2	8	20
Copper	µg/L	3	12	30
Lead	µg/L	2	8	20
Mercury	µg/L	0.04	0.16	0.4
Nickel	µg/L	5	20	50
Selenium	μg/L	15	60	150
Silver	μg/L	0.7	2.8	7
Zinc	μg/L	20	80	200
Cyanide	μg/L	1	4	10
Total Chlorine Residual	µg/L	2	8	60
Ammonia	µg/L	600	2,400	6,000
Acute Toxicity	TUa		0.3	
Chronic Toxicity	TUc		1	
Non-Chlorinated Phenolic Compounds	μg/L	30	120	300
Chlorinated Phenolics	µg/L	1	4	10
Endosulfan	μg/L	0.009	0.018	0.027
Endrin	μg/L	0.002	0.004	0.006
HCH	µg/L	0.004	0.008	0.012
Radioactivity	µg/L			

Table F-16. Water Quality Objectives (Co) – California Ocean Plan (Table 1) Objectives for
Protection Aquatic Life

Table F-17. Quality Objectives (Co) – California Ocean Plan (Table 1) Objectives for HumanHealth

Pollutant	Units	6-Month Median				
Non	Noncarcinogens					
Acrolein	µg/L	220				
Antimony	µg/L	1,200				
Bis(2- Chloroethoxy)Methane	µg/L	4.4				
Bis(2-Chloroisopropyl)Ether	µg/L	1,200				
Chlorobenzene	µg/L	570				
Chromium (III)	µg/L	190,000				
Di-n-Butyl Phthalate	µg/L	3,500				
Dichlorobenzenes	µg/L	5,100				
Diethyl Phthalate	μg/L	33,000				

Pollutant	Units	6-Month Median
Dimethyl Phthalate	µg/L	820,000
2-Methyl-4,6-Dinitrophenol	µg/L	220
2,4-Dinitrophenol	µg/L	4
Ethylbenzene	µg/L	4,100
Fluoranthene	µg/L	15
Hexachlorocyclopentadiene	µg/L	58
Nitrobenzene	µg/L	4.9
Thallium	µg/L	2
Toluene	µg/L	85,000
Tributyltin	µg/L	0.0014
1,1,1-Trichloroethane	µg/L	540,000
Ca	arcinogens	
Acrylonitrile	µg/L	0.1
Aldrin	µg/L	0.000022
Benzene	µg/L	5.9
Benzidine	µg/L	0.000069
Beryllium	µg/L	0.033
Bis(2-Chloroethyl)Ether	µg/L	0.045
Bis(2-Ethylhexyl)Phthalate	µg/L	3.5
Carbon Tetrachloride	µg/L	0.9
Chlordane	µg/L	0.000023
Chlorodibromomethane	µg/L	8.6
Chloroform	µg/L	130
DDT (total)	µg/L	0.00017
1,4 Dichlorobenzene	µg/L	18
3,3'-Dichlorobenzidine	µg/L	0.0081
1,2-Dichloroethane	µg/L	28
1,1-Dichloroethylene	µg/L	0.9
Dichlorobromomethane	µg/L	6.2
Methylene Chloride	µg/L	450
1,3-Dichloropropylene	µg/L	8.9
Dieldrin	µg/L	0.00004
2,4-Dinitrotoluene	µg/L	2.6
1,2-Diphenylhydrazine	µg/L	0.16
Halomethanes	µg/L	130
Heptachlor	µg/L	0.00005
Heptachlor Epoxide	µg/L	0.00002
Hexachlorobenzene	µg/L	0.00021
Hexachlorobutadiene	µg/L	14
Hexachloroethane	µg/L	2.5
Isophorone	µg/L	730
N-Nitrosodimethylamine	µg/L	7.3
N-Nitrosodi-n-Propylamine	µg/L	0.038
N-Nitrosodiphenvlamine	ua/L	2.5

Pollutant	Units	6-Month Median
PAHs (total)	μg/L	0.0088
PCBs	μg/L	0.000019
TCDD Equivalents	μg/L	0.000000039
1,1,2,2-Tetrachloroethane	µg/L	2.3
Tetrachloroethylene	µg/L	2
Toxaphene	μg/L	0.00021
Trichloroethylene	µg/L	27
1,1,2-Trichloroethane	µg/L	9.4
2,4,6-Trichlorophenol	μg/L	0.29
Vinyl Chloride	µg/L	36

With the exception of acute and chronic toxicity, the Ocean Plan objectives in Tables F-15, F-16, and F-17 are applied as effluent limitations to be met after applying appropriate Concentrate Waste Dilution Ratios as described in Special Provision VI.C.6.b of the Order and section IV.C of the MRP. Acute and chronic toxicity limitations are retained from Order R3-2014-0013.

5. Bacteria

This Order includes new effluent limitations for total and fecal coliform and enterococcus bacteria that apply if the Executive Officer concludes from a bacterial assessment (described in Receiving Water Limitation A.1) that the discharge consistently exceeds the geometric mean bacteria Receiving Water Limitation in A.1. The effluent limitations are based on the Ocean Plan objectives but compliance is determined using the applicable Dm.

6. Whole Effluent Toxicity (WET)

Whole effluent toxicity (WET) limitations protect receiving water quality from the aggregate toxic effect of a mixture of pollutants in the effluent. WET tests measure the degree of response of exposed aquatic test organisms to an effluent. The WET approach allows for protection of the narrative "no toxics in toxic amounts" criterion while implementing numeric criteria for toxicity. There are two types of WET tests - acute and chronic. An acute toxicity test is conducted over a short time period and measures mortality. A chronic toxicity test is conducted over a longer period of time and may measure mortality, reproduction, and growth.

The Basin Plan requires that all waters shall be maintained free of toxic substances in concentrations which are toxic to, or which produce detrimental physiological responses in, human, plant, animal, or aquatic life. Survival of aquatic organisms in surface waters subjected to a waste discharge or other controllable water quality conditions shall not be less than that for the same water body in areas unaffected by the waste discharge or for another control water.

a. Effluent acute toxicity collected from August 2014 through December 2017 exhibited a maximum value of 0.4 TUa. Using the Ocean Plan Equation 2 and the most conservative proposed dilution factor of 145, the discharge does not exceed the Ocean Plan objective. However, the California Ocean Plan requires consideration of all available information, including the "potential toxic impact of the discharge" to determine if WQBELs are necessary, notwithstanding the statistical procedure with which the RPA is conducted for most pollutants. Due to the multiple residential, commercial, and industrial contributors to the influent flow of the Facility, and

because the cumulative effects of various pollutants present at low levels in the discharge are unknown, acute toxicity limitations and monitoring requirements are retained from the previous permit. The acute toxicity limitation is also retained to be protective of potential toxicity that may result from future brine/secondary effluent blends. The Regional Water Board believes the acute TST test is protective of beneficial uses in the Ocean Plan. By incorporating the acute toxicity limit using the TST approach, acute toxicity monitoring and reporting is simplified, as the test only has to be run at one concentration and the control, as opposed to multiple dilutions required to measure the LC50. In light of multiple Dm conditions, the simplified tests may reduce the potential for error associated with dilutions used in tests.

To determine an effluent limitation for acute toxicity, the Ocean Plan allows a mixing zone that is ten percent of the distance from the edge of the outfall structure to the edge of the chronic mixing zone (the zone of initial dilution); and therefore, the effluent limitation for acute toxicity is determined by the following equation:

Ce = Co + (0.1) Dm (Co)

- b. Chronic toxicity data collected from August 2014 through December 2017 exhibited a maximum value of 625 TUc. Using this effluent data, RPCalc software, and the most conservative proposed dilution factor of 145, the discharge exhibits reasonable potential to exceed the Ocean Plan objective for chronic toxicity. Therefore, this Order includes an effluent limitation and monitoring requirements for chronic toxicity.
- The Ocean Plan's approach to acute and chronic toxicity WQBELs is based on a C. "toxic unit" derived from one multi-concentration toxicity test. In 2010, U.S. EPA endorsed the TST statistical approach in National Pollutant Discharge Elimination System Test of Significant Toxicity Implementation Document (EPA 833-R-10-003, 2010) used in this NPDES permit. Compliance with these toxicity effluent limitations (i.e., determination of "pass" or "fail") shall be evaluated using the Test of Significant Toxicity (TST) statistical approach at the discharge "in-stream" waste concentration (IWC), as described in section VII.F of this Order and section V of the MRP (Attachment E). The TST statistical approach is described in the National Pollutant Discharge Elimination System Test of Significant Toxicity Implementation Document (EPA 833-R-10-003, 2010), Appendix A, Figure A-1 and Table A-1, The TST null hypothesis shall be "mean discharge IWC response $\leq 0.75 \times$ mean control response." A test that rejects this null hypothesis shall be reported as "pass." A test that does not reject this null hypothesis shall be reported as "fail." Discharger shall also report the "Percent Effect" as part of chronic toxicity result.

Section III.F of the 2015 Ocean Plan provides for more stringent requirements if necessary to protect the designated beneficial uses of ocean waters. Diamond et al. (2013) examined the side-by-side comparison of No-Observed-Effect-Concentration (NOEC) and TST results using California chronic toxicity test data (including data from POTWs) for the West Coast marine methods and test species required under this Order. See Table 1 (method types 1 through 5) on page 1103 in Diamond D, Denton D, Roberts, J, Zheng L. 2013. *Evaluation of the Test of Significant Toxicity for Determining the Toxicity of Effluents and Ambient Water Samples*. Environ Toxicol Chem 32:1101-1108. This comparison shows that while the TST and NOEC statistical approaches perform similarly most of the time, the TST performs better in identifying toxic and nontoxic samples, a desirable characteristic for chronic toxicity testing conducted under this Order. This examination also signals that the test methods' false positive rate (β no higher than 0.05 at a mean effect of 10%) and

false negative rate (α no higher than 0.05 (0.25 for topsmelt) at a mean effect of 25%) are indeed low. This highlights that using the TST in this Order - in conjunction with other Ocean Plan requirements (West Coast WET method/test species for monitoring and limiting chronic toxicity, the IWC representing the critical condition for water quality protection, the initial dilution procedure, and a single test for compliance)—provides increased assurance that statistical error rates are more directly addressed and accounted for in decisions regarding chronic toxicity in the discharge. As a result, and in accordance with Ocean Plan section III.F, the Central Coast Water Board is exercising its discretion to use the TST statistical approach for this discharge. U.S. EPA, Region 9 agrees with the Central Coast Water Board's determination.

Compliance with acute and chronic toxicity requirements contained in this Order shall be determined in accordance to section VII.G of this Order. Nevertheless, this Order contains a reopener to require the Central Coast Water Board and U.S. EPA, Region 9 to modify this Order, if necessary, to make it consistent with any new policy, law, or regulation.

In January 2010, U.S. EPA published a guidance document entitled; EPA Regions 8, 9 and 10 Toxicity Training Tool, which among other things discusses permit limitation expression for chronic toxicity. The document acknowledges that NPDES regulations at 40 C.F.R. section 122.45(d) require that all permit limits be expressed, unless impracticable, as an average weekly effluent limitation (AWEL) and average monthly effluent limitation (AMEL) for POTWs. Following section 5.2.3 of the Technical Support Document (TSD), the use of an AWEL and AMEL is not appropriate for WET. In lieu of an AWEL and AMEL for POTWs, U.S. EPA recommends establishing a maximum daily effluent limitation (MDEL) for toxic pollutants and pollutants in water quality permitting, including WET. This is appropriate for two reasons. The basis for the average weekly and average monthly requirement for POTWs derives from secondary treatment regulations and is not related to the requirement to assure achievement of water quality standard. Moreover, an average weekly and average monthly requirement comprising up to seven and thirty-one daily samples, respectively, could average out daily peak toxic concentrations for WET and therefore, the discharge's potential for causing acute and chronic effects would be missed. It is impracticable to use an AWEL and AMEL. because short-term spikes of toxicity levels that would be permissible under the 7day and 31-day average scheme, respectively, would not be adequately protective of all beneficial uses. The MDEL is the highest allowable value for the discharge measured during a calendar day or 24-hour period representing a calendar day. This approach is comparable to that of the Ocean Plan, which calls for a daily maximum chronic toxicity limit.

Later in June 2010, U.S. EPA published another guidance document titled, *National Pollutant Discharge Elimination System Test of Significant Toxicity Implementation Document* (EPA 833-R-10-003, June 2010), in which the following was recommended: "Permitting authorities should consider adding the TST approach to their implementation procedures for analyzing valid WET data for their current NPDES WET Program." The TST approach is another statistical option for analyzing valid WET test data. Use of the TST approach does not result in any changes to U.S. EPA's WET test methods. Section 9.4.1.2 of U.S. EPA's *Short-term Methods for Estimating the Chronic Toxicity of Effluents and Receiving Waters to Freshwater Organisms* (EPA/821/R-02/013, 2002), recognizes that, "the statistical methods in this manual are not the only possible methods of statistical analysis." The TST approach can be applied to acute (survival) and chronic (sublethal) endpoints and is appropriate to use for both freshwater and marine EPA WET test methods.

The U.S. EPA's WET testing program and acute and chronic WET methods rely on the measurement result for a specific test endpoint, not upon achievement of specified concentration-response patterns to determine toxicity. U.S. EPA's WET methods do not require achievement of specified effluent or ambient concentration response patterns prior to determining that toxicity is present.¹ Nevertheless, U.S. EPA's acute and chronic WET methods require that effluent and ambient concentration-response patterns generated for multi-concentration acute and chronic toxicity tests be reviewed—as a component of test review following statistical analysis-to ensure that the calculated measurement result for the toxicity test is interpreted appropriately. (EPA-821-R-02-012, section 12.2.6.2; EPA-821-R02-013, section 10.2.6.2). In 2000, EPA provided guidance for such reviews to ensure that test endpoints for determining toxicity based on the statistical approaches utilized at the time the guidance was written (no-observed-effect concentration (NOEC), percent waste giving 50 percent survival of test organisms (lethal concentration 50, LC50), effects concentration at 25 percent (EC25) were calculated appropriately (EPA 821-B-00-004).

U.S. EPA designed its 2000 guidance as a standardized step-by step review process that investigates the causes for ten commonly observed concentration-response patterns and provides for the proper interpretation of the test endpoints derived from these patterns for NOECs, LC50, and EC25, thereby reducing the number of misclassified test results. The guidance provides one of three determinations based on the review steps: that calculated effect concentrations are reliable and should be reported, that calculated effect concentrations are anomalous and should be explained, or that the test was inconclusive and should be repeated with a newly collected sample. The standardized review of the effluent and receiving water concentration-response patterns provided by U.S. EPA's 2000 guidance decreased discrepancies in data interpretation for NOEC, LC50, and EC25 test results, thereby lowering the chance that a truly nontoxic sample would be misclassified and reported as toxic.

Appropriate interpretation of the measurement result from U.S. EPA's TST statistical approach ("Pass"/"Fail") for effluent and receiving water samples is, by design, independent from the concentration-response patterns of the toxicity tests for those samples. Therefore, when using the TST statistical approach, application of U.S. EPA's 2000 guidance on effluent and receiving waters concentration-response patterns will not improve the appropriate interpretation of TST results as long as all Test Acceptability Criteria and other test review procedures-including those related to quality assurance for effluent and receiving water toxicity tests, reference toxicity tests, and control performance (mean, standard deviation, and coefficient of variation)-described by the WET test methods manual and TST guidance, are followed. The 2000 guidance may be used to identify reliable, anomalous, or inconclusive concentration-response patterns and associated statistical results to the extent that the guidance recommends review of test procedures and laboratory performance already recommended in the WET test methods manual. The guidance does not apply to single-concentration (IWC) and control statistical t-tests and does not apply to the statistical assumptions on which the TST is based. The Central

¹ See Supplementary Information in support of the Final Rule establishing WET test methods at 67 Fed. Reg. 69952, 69963, Nov. 19, 2002.

Coast Water Board and U.S. EPA, Region 9 will not consider a concentrationresponse pattern as sufficient basis to determine that a TST t- test result for a toxicity test is anything other than valid, absent other evidence. In a toxicity laboratory, unexpected concentration-response patterns should not occur with any regular frequency and consistent reports of anomalous or inconclusive concentration-response patterns or test results that are not valid will require an investigation of laboratory practices.

Any Data Quality Objectives or Standard Operating Procedure used by the toxicity testing laboratory to identify and report valid, invalid, anomalous, or inconclusive effluent or receiving water toxicity test measurement results from the TST statistical approach which include a consideration of concentration-response patterns and/or Percent Minimum Significant Differences (PMSDs) must be submitted for review by the Central Coast Water Board, in consultation with U.S. EPA, Region 9 and the State Water Board's Quality Assurance Officer and Environmental Laboratory Accreditation Program (ELAP) (40 C.F.R. section 122.44(h)). As described in the bioassay laboratory audit directives to the San Jose Creek Water Quality Laboratory from the State Water Board dated August 7, 2014, and from the U.S. EPA dated December 24, 2013, the PMSD criteria only apply to compliance for NOEC and the sublethal endpoints of the NOEC, and therefore are not used to interpret TST results.

E. Final Effluent Limitation Considerations

Final technology-based and water quality-based effluent limitations established by the Order are discussed in the preceding sections of the Fact Sheet.

1. Anti-Backsliding Requirements

The final effluent limitations in this Order/Permit are at least as stringent as the effluent limitations in the previous Order/Permit, Order No. R3-2014-0013, with a few exceptions. Section 402(0)1/303(d)(4) of the Clean Water Act (CWA) provides statutory exceptions to the general prohibition of backsliding contained in CWA section 402(0)(1)/303(d)(4). Based on new monitoring data, the California Ocean Plan's Appendix VI procedure resulted in a finding of endpoint 2 (i.e., "no reasonable potential") for chromium VI, selenium, non-chlorinated phenols, and PAHs. Consistent with the California Ocean Plan, effluent limitations are not required for pollutants resulting in an Endpoint 2. The removal of the effluent limitations for these constituents will therefore not authorize a change in the mass emission rates or a relaxation in the treatment of the discharge and meets the backsliding exception under CWA section 402(0)(1)/303(d)(4)(B).

This Order also allows less stringent, tiered, concentration-based effluent limitations under certain blends of brine waste and secondary effluent. The less stringent effluent limitations are the result of new dilution factors developed to account for operation of the AWPF. Because the brine waste is higher in salinity, it will affect the dilution characteristics of the blended effluent. Using EPA approved models, the Discharger estimated the dilution available under worst case conditions for the entire range of expected concentrate waste dilution scenarios. From the range of associated dilution factors, four Dms were selected to develop tiered concentration limits. The limitations in Order No. R3-2014-0013 are retained in this Order for the most restrictive Dm, which is characterized by high secondary effluent flow. For lower ratios of RO concentrate and saline waste to total effluent, higher dilution factors have been granted and therefore, higher effluent concentration limitations are allowed. Despite the higher concentration limitations are allowed. Despite the higher concentration limitations and therefore and saline waste limitations from Order No. R3-2014-0013 remain the same under all

concentrate waste dilution ratios and dilution factors. Under CWA sections 403(o)(1)/303(d)(4)(B) for waters in attainment, the less stringent effluent tiered limitations for Ocean Plan Table 1 parameters is allowable because the action is consistent with the California antidegradation policy in Resolution No. 68-16, as described in section IV.D.2 of this Fact Sheet. In addition, CWA section 402(o)(2) allows backsliding where new information is available that was not available at the time of permit issuance and would have justified a less stringent effluent limitation. The addition of the AWPF and associated changes in recycled water and RO concentrate production, as well as the dilution factors based on new modeling constitute new information to further support an exception to anti-backsliding.

2. Antidegradation Policies

The final effluent limitations from the previous order have been retained in this Order/Permit, with the exception of selenium, non-chlorinated phenols, and chromium VI. This Order also allows less stringent concentration-based effluent limitations under certain blends of RO concentrate, saline waste, and secondary effluent. As described in section IV.D.1 above, the less stringent effluent limitations are the result of new dilution factors developed to account for operation of the AWPF and the addition of the concentrate to the discharge.

The most restrictive Dm in Order No. R3-2014-0013 is retained in this Order. Despite the higher Dms, mass limitations from Order R3-2014-0013 remain the same under all Concentrate Waste dilution ratios and dilution factors. As such, this Order does not allow an increase in mass discharged. The AWPF will treat new, additional agricultural and stormwater runoff source water which will allow the Discharger to provide irrigation water and purified water for injection into the Seaside Groundwater Basin for use as a municipal water supply. As the Blanco Drain and Reclamation Ditch source waters are impaired for some parameters, the diversion and treatment through the WWTP and AWPF will improve the quality of runoff entering the Salinas River and Monterey Bay.

Under CWA sections 403(o)(1)/303(d)(4)(B) for waters in attainment, removal of the final effluent limitations for these parameters is consistent with the State's antidegradation policy because the discharge is in compliance with existing water quality objectives for the Pacific Ocean. The Order's limitations and conditions ensure maintenance of the existing quality of receiving waters. Therefore, provisions of the Order are consistent with applicable antidegradation policy expressed by NPDES regulations at 40 C.F.R. section 131.12 and State Water Board Resolution 68-16.

3. Stringency of Requirements for Individual Pollutants

This Order contains both technology-based and water quality-based effluent limitations for individual pollutants. The technology-based effluent limitations consist of restrictions on CBOD₅, TSS, pH, oil and grease, settleable solids, and turbidity. Restrictions on these pollutants are discussed in section IV.B of this Fact Sheet. This Order's technology-based pollutant restrictions implement the minimum, applicable federal technology-based requirements.

Water quality-based effluent limitations have been derived to implement water quality objectives that protect beneficial uses. Both the beneficial uses and the water quality objectives have been approved pursuant to federal law and are the applicable federal water quality standards. The procedures for calculating the individual water quality-based effluent limitations are based on the Ocean Plan, which was approved by U.S. EPA on February 14, 2006 and has since been further amended. All beneficial uses and water quality objectives contained in the Basin Plan were approved under state law and

submitted to and approved by U.S. EPA prior to May 30, 2000. Any water quality objectives and beneficial uses submitted to U.S. EPA prior to May 30, 2000, but not approved by U.S. EPA before that date, are nonetheless "applicable water quality standards for purposes of the CWA" pursuant to 40 C.F.R. section 131.21(c)(1). Collectively, this Order's restrictions on individual pollutants are no more stringent than required to implement the requirements of the CWA.

Final, technology and water quality-based effluent limitations are summarized in sections IV.B and IV.C of this Fact Sheet

F. Interim Effluent Limitations – Not Applicable

G. Land Discharge Specifications – Not Applicable

H. Recycling Specifications

The Order allows the production of disinfected tertiary recycled wastewater in compliance with applicable State and local requirements regarding the production and use of recycled wastewater, including those requirements established by the Division of Drinking Water at title 22, sections 60301 - 60357 of the California Code of Regulations, Water Recycling Rationale for Receiving Water Limitations

I. Surface Water

Receiving water quality is a result of many factors, some unrelated to the discharge. This Order considers these factors and is designed to minimize the influence of the discharge on the receiving water. Receiving water limitations within this Order are retained from the previous Order.

J. Groundwater

Groundwater limitations established by the Order include general objectives for groundwater established by the Basin Plan for the Central Coast Region.

V. RATIONALE FOR PROVISIONS

A. Standard Provisions

Standard Provisions, which apply to all NPDES permits in accordance with 40 C.F.R. § 122.41, and additional conditions applicable to specified categories of permits in accordance with 40 C.F.R. § 122.42, are provided in Attachment D to the order.

Sections 122.41(a)(1) and (b) through (n) of 40 C.F.R. establish conditions that apply to all State-issued NPDES permits. These conditions must be incorporated into the permits either expressly or by reference. If incorporated by reference, a specific citation to the regulations must be included in the Order. Section 123.25(a)(12) allows the state to omit or modify conditions to impose more stringent requirements. In accordance with 40 C.F.R. § 123.25, this Order omits federal conditions that address enforcement authority specified in 40 C.F.R. §§ 122.41(j)(5) and (k)(2) because the enforcement authority under the Water Code is more stringent. In lieu of these conditions, this Order incorporates by reference Water Code section 13387(e).

B. Special Provisions

1. Reopener Provisions

This Order may be reopened and modified in accordance with NPDES regulations at 40 C.F.R. parts 122 and 124, as necessary, to include appropriate conditions or limits based on newly available information, or to implement any, new state water quality

objectives that are approved by U.S. EPA. As effluent is further characterized through additional monitoring, and if a need for additional effluent limitations becomes apparent after additional effluent characterization, the Order will be reopened to incorporate such limitations.

2. Special Studies, Technical Reports and Additional Monitoring Requirements

a. Toxicity Reduction Requirements

The requirements in section VI.C.2.a and b of the Order address requirements necessary to ensure compliance with Ocean Plan objectives for toxicity. The Ocean Plan section III.C.10 requires that if a discharge consistently exceeds an effluent limitation based on a toxicity objective, a TRE is required. The requirement to submit a TRE Workplan (section VI.C.2.a of this Order) is necessary to prevent delays in initiating the TRE, so that the Discharger can diagnose and remedy toxicity in the shortest time practicable. Accelerated monitoring included in the Order section VI.C.2.b is required in order to determine if an exceedance of a toxicity limitation is consistent versus sporadic and would provide information for the Central Coast Water Board to determine if a TRE is necessary. The toxicity reduction requirements in section VI.C.2.a-b are retained from the previous Order.

b. Water Contact (Bacterial Characteristics)

The requirement for repeat water-contact bacteriological monitoring is established in accordance with California Ocean Plan section III.D.1.b for exceedance of a single sample maximum bacteria standard contained within section IV.A.1 of this Order. This provision is retained from the previous permit.

c. Brine Waste Disposal Study

The limitations and conditions in this permit are based on the assumption of the RO concentrate, hauled saline waste, and secondary effluent as described in the ROWD. As such, the permit may not account for changes in composition or volume associated with additional brine wastes. Prior to discharging additional brine waste beyond what is described in this permit, the Discharger must provide information to the Central Coast Water Board that is necessary to determine if the permit adequately regulates the discharge or if additional requirements and/or permit modification is necessary.

d. Ocean Outfall and Diffuser Monitoring

Dye studies and outfall inspections are required to ensure a periodic assessment of the integrity of the outfall pipes.

3. Best Management Practices and Pollution Prevention

a. Pollutant Minimization Program

The 2015 California Ocean Plan establishes guidelines for the Pollutant Minimization Program (PMP). At the time of the proposed adoption of this Order no known evidence was available that would require the Discharger to immediately develop and conduct a PMP. The Central Coast Water Board will notify the Discharger in writing if such a program becomes necessary

4. Construction, Operation, and Maintenance Specifications

The Facility shall be operated as specified under Standard Provision D of Attachment D.

5. Special Provisions for Publicly Owned Treatment Works (POTWs)

a. Biosolids Management

Provisions regarding sludge handling and disposal ensure that such activity will comply with all applicable regulations.

Part 503 of 40 C.F.R. sets forth U.S. EPA's final rule for the use and disposal of biosolids, or sewage sludge, and governs the final use or disposal of biosolids. The intent of this federal program is to ensure that sewage sludge is used or disposed of in a way that protects both human health and the environment.

U.S. EPA's regulations require that producers of sewage sludge meet certain reporting, handling, and disposal requirements. As the U.S. EPA has not delegated the authority to implement the sludge program to the State of California, the enforcement of sludge requirements that apply to the Discharger remains under U.S. EPA's jurisdiction at this time. U.S. EPA, not the Central Coast Water Board, will oversee compliance with 40 C.F.R. part 503.

40 C.F.R. section 503.4 (Relationship to other regulations) states that the disposal of sewage sludge in a municipal solid waste landfill unit, as defined in 40 C.F.R. section 258.2, that complies with the requirements in 40 C.F.R. part 258 constitutes compliance with section 405 (d) of the CWA. Any person who prepares sewage sludge that is disposed in a municipal solid waste landfill unit must ensure that the sewage sludge meets the applicable requirements of 40 C.F.R. part 503.

b. Pretreatment

Pretreatment requirements for POTWs are contained within 40 C.F.R. part 403. Per 40 C.F.R. § 403.8, any POTW (or combination of POTWs operated by the same authority) with a total design flow greater than 5 MGD and receiving, from industrial users, pollutants which pass through or interfere with the operation of the POTW or are otherwise subject to pretreatment standards will be required to establish a POTW pretreatment program unless the NPDES state exercises its option to assume local responsibilities as provided for in section 403.10(e). The Executive Officer may require that a POTW with a design flow of 5 MGD or less develop a POTW pretreatment program if he or she finds that the nature or volume of the industrial influent, treatment process upsets, violations of POTW effluent limitations, contamination of municipal sludge, or other circumstances warrant in order to prevent interference with the POTW or pass through as defined in 40 C.F.R. § 403.3.

The Order retains pretreatment requirements as the Facility has total effluent flows in excess of 5 MGD. The Monitoring and Reporting Program includes additional reporting requirements in sections IX.C.3 through 12 of the MRP that reflect federal pretreatment requirements under 40 C.F.R. part 403.

c. Collection System

The State Water Board issued General Waste Discharge Requirements for Sanitary Sewer Systems, Water Quality Order 2006-0003-DWQ (General Order) on May 2, 2006. The State Water Board amended the Monitoring and Reporting Program for the General Order through Order WQ 2013-0058-EXEC on August 6, 2013. The General Order requires public agencies that own or operate sanitary sewer systems with sewer lines one mile of pipe or greater to enroll for coverage and comply with the General Order. The General Order requires agencies to develop sanitary sewer management plans and report all sanitary sewer overflows, among other requirements and prohibitions. The General Order contains requirements for operation and maintenance of collection systems and for reporting and mitigating sanitary sewer overflows that are more extensive, and therefore, more stringent than the requirements under federal standard provisions. The Discharger and public agencies that are discharging wastewater into the facility's collection system were required to obtain enrollment for regulation under the General Order by December 1, 2006.

d. Resource Recovery from Anaerobically Digestible Material.

Some POTWs choose to accept organic material such as food waste, fats, oils, and grease into their anaerobic digesters for co-digestion to increase production of methane and other biogases for energy production and to prevent such materials from being discharged into the collection system, which could cause sanitary sewer overflows. The California Department of Resources Recycling and Recovery has proposed an exemption from requiring Process Facility/Transfer Station permits where this activity is regulated under waste discharge requirements or NPDES permits. The proposed exemption is restricted to anaerobically digestible material that has been prescreened, slurried, and processed/conveyed in a closed system to be co-digested with regular POTW sludge. The proposed exemption requires that a POTW develop Standard Operating Procedures for the proper handling, processing, tracking, and management of the anaerobically digestible material before it is received by the POTW.

Standard Operating Procedures are required for POTWs that accept hauled food waste, fats, oil, and grease for injection into anaerobic digesters. The development and implementation of Standard Operating Procedures for management of these materials is intended to allow the California Department of Resources Recycling and Recovery to exempt this activity from separate and redundant permitting programs. If the POTW does not accept food waste, fats, oil, or grease for resource recovery purposes, it is not required to develop and implement Standard Operating Procedures.

6. Other Special Provisions

a. Discharges of Storm Water

The Order does not address discharges of storm water from the treatment and disposal site, except to require coverage by and compliance with applicable provisions of General Permit No. CAS000001 - Waste Discharge Requirements for Discharges of Storm Water Associated with Industrial Activities.

b. Concentrate Waste Dilution Ratios

Upon completion of the AWPF, the discharge will consist of various blends of AWPF RO concentrate, hauled saline waste, and secondary effluent. Throughout the summer months, the AWPF will treat more secondary effluent and produce more RO concentrate than during winter months. In addition, the Discharger blends secondary effluent with RO concentrate and hauled saline waste to ensure that effluent limitations are met. Since the compositions of RO concentrate and hauled saline waste and secondary effluent are very different, with RO concentrate and hauled saline waste having higher TDS and generally more concentrated pollutants, the dispersion of combined effluent in the receiving water will depend on the ratio of RO concentrate and hauled saline waste to total effluent.

The Discharger has conducted modeling to characterize the expected ratios of RO concentrate and hauled saline waste to secondary effluent and has predicted the

dilution factors (Dms) that would be available under these ratios². Because the dilution and waste characteristics may be extremely variable, the limitations in this permit are established for four different dilution factors. While the limitations themselves are set equal to the Ocean Plan objectives, the reported results for compliance determination are based on one of the four tiers of Dms. Table 10 in the Order presents the Discharger's model results—concentrate waste dilution ratios used to develop minimum probable initial dilution factors (Dms). The concentrate waste dilution ratios and corresponding Dms in Table 10 of this Order were calculated as the

(Total waste flow – Secondary effluent flow)/Secondary effluent flow

which is equivalent to

Concentrate Waste Dilution Ratio = $\frac{AWPF RO Concentrate (MGD) + Hauled Saline Waste (MGD)}{Total Effluent (MGD)}$

For reporting compliance with effluent limitations for Ocean Plan Table 1 parameters, the Discharger selects the appropriate Dm based on the calculated concentrate waste dilution ratio on the day of sampling and calculates the concentration at the ZID. The procedures for calculating and reporting compliance with effluent limitations is provided as footnotes to Table E-7 and is discussed in section VI.B. of this Fact Sheet.

7. Compliance Schedules – Not Applicable

VI. RATIONALE FOR MONITORING AND REPORTING REQUIREMENTS

CWA section 308 and 40 C.F.R. §§ 122.41(h), (j)-(l), 122.44(i), and 122.48 require that all NPDES permits specify monitoring and reporting requirements. Water Code sections 13267 and 13383 also authorize the Central Coast Water Board to establish monitoring, inspection, entry, reporting, and recordkeeping requirements. The Monitoring and Reporting Program (MRP), Attachment E of this Order establishes monitoring, reporting, and recordkeeping requirements that implement federal and state requirements. The following provides the rationale for the monitoring and reporting requirements contained in the MRP for this facility.

A. Influent Monitoring

In addition to influent flow monitoring, influent monitoring for CBOD₅ and TSS is required to determine compliance with the Order's 85 percent removal requirement for those pollutants.

B. Effluent Monitoring

Quarterly compliance monitoring for chromium VI and selenium has been removed from this Order because the discharge did not exhibit reasonable potential for these pollutants. The Discharger must still monitor for chromium VI and selenium as Ocean Plan Table 1 parameters specified in Table E-4 of the MRP.

This Order includes new monitoring requirements for bacteria that apply only upon EO determination. Bacteria is mainly monitored through receiving water stations. If the EO determines there are potential exceedances of the Ocean Plan objectives, then additional monitoring of effluent is required to determine the influence of the discharge on the nearby ocean waters.

² Technical Memorandum dated November 15, 2017, submitted by the Discharger to the Central Coast Water Board.

Effluent monitoring for dissolved oxygen, nitrate plus nitrite (as N), total Kjeldahl nitrogen (TKN), and total phosphorus is added to Table E-4 in this Order to align with required monitoring in EPA Form 2A, section B.6. Table E-4 includes monitoring for orthophosphate that was not identified in Table E-4 of Order R3-2014-0013. This is not a new requirement as it was included in Order R3-2014-0013 as part of CCLEAN effluent monitoring requirements.

Secondary effluent standards reflect the minimum level of treatment to be achieved through municipal wastewater treatment. The point of compliance determination must therefore be located prior to commingling with other waste streams. This Order includes a new monitoring location, EFF-001A, for compliance determination with CBOD₅, TSS, and pH. For this Facility, TOC is an indicator of treatment level, similar to CBOD₅. Monitoring requirements for CBOD₅, TSS, pH, and TOC are moved from the final combined effluent location (previously designated M-001) to the new location EFF-001A.

As described in section V.B.6 of this Fact Sheet, the Discharger is required to calculate and report the concentration at edge of the ZID. A new effluent monitoring location EFF-001B has been established for this purpose. The procedures for reporting compliance with effluent limitations at discharge point 001 are as follows:

Step 1: Report raw total effluent data as EFF-001.

Step 2: Calculate Concentrate Waste Dilution Ratio using the Equation 1 below.

Concentrate Waste Dilution Ratio = $\frac{AWPF RO Concentrate (MGD) + Hauled Saline Waste (MGD)}{MGD}$ Equation 1: Total Effluent (MGD)

Step 3: Using column 1 of Table 9 of the Order (Table F-18 below), determine the corresponding Dm

(1) Ratio of RO Concentrate + Hauled Saline Waste to Total Effluent	(2) Dm for Compliance with Ocean Plan Table 1 Parameters	(3) Monitoring Location for Reporting
0-0.127	145	EFF-001B
0.128 – 0.421	259	EFF-001B
0.422 – 0.744	388	EFF-001B
≥ 0.745	473	EFF-001B

Table F-18. Concentrate Waste Dilution Ratio Ranges and Corresponding Dilution ^[1]

[1] Minimum probable initial dilution expressed as parts seawater per part wastewater.

Step 4: Calculate results for Compliance Determination (Co) using Equation 2 below.

Where:

$$Co = \frac{Ce + DmCs}{1 + Dm}$$

Co = the concentration at the completion of initial dilution

- Ce = effluent concentration reported for Monitoring Location EFF-001
- background seawater concentration provided in Table 3 of the Cs = 2015 Ocean Plan (with all metals expressed as total recoverable concentration, µg/L
- Dm = parts seawater per part wastewater, the applicable minimum probable initial dilution from Table F-18

Step 5: Using Co, calculate the 6-month median, daily maximum, and instantaneous maximum concentrations and report these values for EFF-001B.

C. Whole Effluent Toxicity Testing Requirements

This Order contains acute and chronic toxicity effluent limitations as described in sections IV.C.3 and IV.C.5 of this Fact Sheet.

This Order requires the Discharger to conduct additional toxicity testing for exceedances of the toxicity effluent limitations. If the additional tests demonstrate toxicity, the Discharger is required to submit a Toxicity Reduction Evaluation (TRE) Workplan in accordance with the submitted TRE Workplan and U.S. EPA guidance which shall include: further steps taken by the Discharger to investigate, identify, and correct the causes of toxicity; actions the Discharger will take to mitigate the effects of the discharge and prevent the recurrence of toxicity; and a schedule for these actions.

Section III.C.10 of the Ocean Plan requires a TRE if a discharge consistently exceeds an effluent limitation based on a toxicity objective in Table 1 of the Ocean Plan.

Consistent with the requirements of the Ocean Plan, section III.C.5 of the MRP (Attachment E) requires the Discharger to develop an Initial Investigation TRE Workplan and submit the Initial Investigation TRE Workplan within 90 days of the effective date of this Order. The Workplan must describe steps the Discharger intends to follow if the effluent limitation for chronic toxicity is exceeded.

If the effluent limitation for acute or chronic toxicity is exceeded in any one test, the Discharger must conduct a TRE if the toxicity is exceeded in any of the next four succeeding tests performed at 14-day intervals and notify the Central Coast Water Board and U.S. EPA, Region 9. The requirement for a minimum of four succeeding tests performed at 14-day intervals is based on the probability of encountering at least one toxicity exceedance assuming a true, but unknown level of occurrence. After the toxicity exceedance, the Discharger must continue to conduct the routine monthly monitoring for acute and chronic toxicity as required in Monitoring and Reporting Program (Attachment E). The TRE shall be conducted in accordance with the approved TRE Workplan and available U.S. EPA guidance documents. The Discharger must also implement a Toxicity Identification Evaluation (TIE), as necessary, based upon the magnitude and persistence of toxicity effluent limitation exceedances. Once the source of toxicity is identified, the Discharger must take all reasonable steps to reduce the toxicity to meet the chronic toxicity effluent limitation identified in section IV.A of this Order.

Within 30 days of completion of the TRE, the Discharger must submit the results of the TRE, including a summary of the findings, data generated, a list of corrective actions taken or planned to achieve consistent compliance with all the toxicity limitations of this Order and prevent recurrence of exceedances of those limitations, and a time schedule for implementation of any planned corrective actions. The Discharger must implement any planned corrective actions in the TRE Final Report in accordance with the specified time schedule, unless otherwise directed in writing by the Central Coast Water Board and/or U.S.EPA, Region 9. The corrective actions and time schedule must be modified at the direction of the Central Coast Water Board and/or U.S. EPA, Region 9.

Refer to section V of the MRP (Attachment E).

D. Recycled Water Monitoring

The Discharger shall comply with applicable State and local requirements regarding the production and use of recycled wastewater, including those requirements established by the State Water Board Division of Drinking Water at title 22, sections 60301 - 60355 of the California Code of Regulations, Water Recycling Criteria. The requirement in section IV.C.13

of the Order is included to clarify that the Order does not permit the discharge of recycled water.

E. Receiving Water Monitoring

1. Surface Water

Receiving water monitoring is carried over from Order No. R3-2014-0013 as necessary to determine compliance with receiving water limitations and for the protection of public health. Benthic sediment and benthic biota monitoring of the receiving water has been established in the Order to establish a baseline of the current conditions surrounding the diffuser for future permitting efforts.

2. Groundwater – Not Applicable

F. Other Monitoring Requirements

1. CCLEAN

This Order retains the requirement to participate in CCLEAN monitoring. The CCLEAN is a coordinated monitoring effort to address receiving water in the Monterey Bay and in necessary to assess whether beneficial uses are affected by discharges. The CCLEAN requirements specified in this Order are updated to reflect current program methods and pollutants of concern, and to align with requirements for other Permittees participating in the program.

2. Biosolids Monitoring

Biosolids monitoring requirements have been retained from the previous order and are based on the requirements of 40 C.F.R. part 503.

3. Pretreatment Monitoring.

This Order retains the requirements of the previous permit to conduct pretreatment monitoring and reporting.

4. Outfall Inspection.

This Order retains the requirement of the previous permit to conduct annual, visual inspections (including dye tracer tests) of the outfall structure and report to the Central Coast Water Board regarding its physical integrity.

5. MBNMS Spill Reporting.

This Order retains the requirement of the previous permit to report all sewage spills under its control that are likely to enter ocean waters, directly to the MBNMS office.

6. Discharge Monitoring Report-Quality Assurance (DMR-QA) Study Program

Under the authority of section 308 of the CWA (33 U.S.C. § 1318), U.S. EPA requires major and selected minor dischargers under the NPDES Program to participate in the annual DMR-QA Study Program. The DMR-QA Study evaluates the analytical ability of laboratories that routinely perform or support self-monitoring analyses required by NPDES permits. There are two options to satisfy the requirements of the DMR-QA Study Program: (1) The Discharger can obtain and analyze a DMR-QA sample as part of the DMR-QA Study; or (2) Per the waiver issued by U.S. EPA to the State Water Board, the Discharger can submit the results of the most recent Water Pollution Performance Evaluation Study from its own laboratories or its contract laboratories. A Water Pollution Performance Evaluation Study is similar to the DMR-QA Study. Thus, it also evaluates a laboratory's ability to analyze wastewater samples to produce quality data that ensure

the integrity of the NPDES Program. The Discharger shall ensure that the results of the DMR-QA Study or the results of the most recent Water Pollution Performance Evaluation Study are submitted annually to the State Water Board. The State Water Board's Quality Assurance Program Officer will send the DMR-QA Study results or the results of the most recent Water Pollution Performance Evaluation Study to U.S. EPA's DMR-QA Coordinator and Quality Assurance Manager.

VII. PUBLIC PARTICIPATION

The Central Coast Water Board considered the issuance of WDRs that serve as an NPDES permit for the Monterey One Water Regional WWTP and AWPF. As a step in the WDR adoption process, Central Coast Water Board staff developed tentative WDRs and encouraged public participation in the WDR adoption process.

A. Notification to Interested Persons

The Central Coast Water Board notified the Discharger and interested agencies and persons of its intent to prescribe WDRs for the discharge and provided an opportunity to submit written comments and recommendations. Notification was provided through **publication in the Monterey County Herald on June 18, 2018, and September 3, 2018.**

The public had access to the agenda and any changes in dates and locations through the Central Coast Water Board's website at: http://www.waterboards.ca.gov/centralcoast/

B. Written Comments

Interested persons were invited to submit written comments concerning the tentative WDRs as provided through the notification process. Comments were encouraged to be sent via email to centralcoast@waterboards.ca.gov. Comments may also have been submitted in person, or by mail, to the Executive Officer at the Central Coast Water Board at:

Central Coast Water Board 895 Aerovista Place, Suite 101 San Luis Obispo, CA 93401-7906

To be fully responded to by staff and considered by the Central Coast Water Board, the written comments were due at the Central Coast Water Board office by 5:00 p.m. on **July 20, 2018**.

Non-substantive comments and edits were received from the MBNMS and the Discharger that improved the clarity and readability of the Order. Staff received substantive written comments from Steve Shimek of The Otter Project on July 20, 2018. The comment letter is included as Attachment 2 of the staff report. The comments are summarized, along with staff's response to the comments, as follows:

1. The Otter Project suggests that the Monterey One Water discharge could be related to harmful algal blooms (HABs) and requests Monterey One Water analyze effluent samples for total nitrogen, Kjeldahl nitrogen, and ammonia and report monthly.

<u>Staff Response:</u> Nutrient loading from Monterey One Water's WWTP is much lower than from runoff and far smaller than the nutrient loading from naturally occurring processes such as upwelling. Central Coast Water Board staff has reviewed HAB work and assessments made by independent scientists in the Monterey Bay region. Central Coast Water Board staff concurs with the assessment that nutrient loads from the Monterey One Water discharge are unrelated to the

frequency or intensity of the algal blooms occurring along this stretch of coastline. Several lines of evidence support this conclusion including:

• HABs initiated within Monterey Bay occur mostly in the fall (Ryan et al. 2008, Schulien et al. 2017), which is the dry season when the Monterey One Water discharge is negligible or zero.

• HABs initiated within Monterey Bay start in the northeast corner, spatially separated from the Monterey One Water ocean outfall offshore off Marina (Pennington and Chavez 2000, Ryan et al. 2008, Ryan et al. 2009).

• HABs are also advected into Monterey Bay from the North American west coast shelf. These blooms are started by large-scale climate events resulting in 1) stratification of offshore waters, 2) bloom development following upwelling episodes, and 3) advection into coastal bays such as Monterey Bay following wind events (Trainer et al. 2000, Ryan et al. 2008, Ryan et al. 2009, Du et al. 2015, McCabe et al. 2016, Du et al. 2016).

• Both HABs initiated within and outside Monterey Bay are preceded by and fueled by large nutrient infusions such as from upwelling, Monterey Bay Canyon nutrient pumping, and the Elkhorn Slough plume (Trainer et al. 2000, Fischer et al. 2014, Ryan et al. 2014, McCabe et al. 2016).

• A small-sized bloom (5 km²) in Monterey Bay needs a daily input of 8.75×10^4 kg N, whereas a large-size bloom (80 km²) needs on the order of 1.4×10^6 kg N, to sustain the bloom (Ryan et al. 2008). The N load from Monterey One Water discharge during the dry season is up to 125 kg per day, representing 0.14% of the daily N needed to sustain a small-sized bloom, and 0.009 % of the daily N necessary to sustain a large-sized fall bloom, in Monterey Bay.

• HAB bloom development in Monterey Bay is not associated with riverine or wastewater effluent discharge as these sources are not at a scale large enough to fuel blooms (Schulien et al. 2017). However, once developed, riverine sources of nutrients may partially sustain nearshore filaments of blooms (Lane et al. 2009).

Although there is no clear connection between wastewater effluent discharge and these blooms, staff agrees that monitoring could provide scientifically valid or usable information relevant to the prediction or management of algal blooms. Staff has proposed requirements in the draft order to increase the monitoring and reporting frequency to a monthly basis for total nitrogen, Kjeldahl nitrogen, and ammonia.

2. The Otter Project requested development of a total nitrogen limitation for the Order.

<u>Staff Response</u>: The State Water Board develops ocean discharge limits through periodic reviews of the California Ocean Plan. As such, the State Water Board Ocean Plan triennial review process is the appropriate venue to request development of total nitrogen limits, as opposed to a Central Coast Water Board permit adoption process. Although monitoring is proposed in the draft order, staff recommends not applying effluent limits for total nitrogen and Kjeldahl nitrogen until the State Water Board updates the Ocean Plan to include discharge limits for those pollutants. Without discharge limits, these pollutants will not be used for compliance assessments under the permit.

3. The Otter Project requested the development of a time schedule order that requires elimination of the ocean discharge or denitrification of the facility's effluent.

Staff Response: Staff does not recommend that a time schedule order be required in this Order. The Pure Water Monterey project will help remove nitrate and other pollutants that would normally flow untreated into surface waters and then enter the MBNMS (see Attachment 3 of the staff report). The Pure Water Monterey project is an environmentally beneficial project that will treat waste waters and increase water recycling in the region. During the dry season, almost all wastewater is recycled, and there is little discharge through the ocean outfall. Although yearround zero discharge is an outstanding goal, currently this is not possible. Without Pure Water Monterey, almost all the nitrogen loading from the Reclamation Ditch, Tembladero Slough, Blanco Drain, and the Salinas Pump Station and Treatment Facility diversions would continue to flow downstream and affect water quality. The majority of nitrogen in these surface waters is currently released to Elkhorn Slough via the Old Salinas River Channel, or, during times when the Salinas River sand bar is breached, part of this loading flows directly to Monterey Bay via the Blanco Drain. With Pure Water Monterey, the total nitrogen pollutant loading to the Monterey Bay nearshore region via the Elkhorn Slough plume may be substantially reduced compared to existing conditions. The Elkhorn Slough plume has been hypothesized to fuel HABs in the northeast corner of Monterey Bay during the dry season (Fischer et al. 2014) and this project will have a quantifiable beneficial impact related to the total pollutant load to Monterey Bay.

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McCabe RM, Hickey BM, Kudela RM, Lefebvre KA, Adams NG, Bill BD, Gulland FMD, Thomson RE, Cochlan WP, Trainer VL (2016) An unprecedented coastwide toxic algal bloom linked to anomalous ocean conditions. Geophys. Res. Lett. 43: 10,366–10,376

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Schulien J, Peacock MB, Hayashi K, Raimondi P, Kudela RM (2017) Phytoplankton and microbial abundance and bloom dynamics in the upwelling shadow of Monterey Bay, California, from 2006 to 2013. Mar. Ecol. Prog. Ser. 572: 43-56.

Trainer VL, Adams NG, Bill BD et al. (2000) Domoic acid production near California coastal upwelling zones, June 1998. Limnol. Oceanogr. 45: 1818-1833.

C. Public Hearing

The Central Coast Water Board held a public hearing on the tentative WDRs during its regular meeting on the following date and time and at the following location:

Date:	December 6-7, 2018
Time:	9:00 a.m.
Location:	Central Coast Water Board Offices
	895 Aerovista Place, Suite 101
	San Luis Obispo, CA 93401

Interested persons were invited to attend. At the public hearing, the Central Coast Water Board heard testimony pertinent to the discharge, WDRs, and permit. For accuracy of the record, important testimony was requested in writing.

D. Reconsideration of Waste Discharge Requirements

Any person aggrieved by this action of the Central Coast Water Board may petition the State Water Board to review the action in accordance with Water Code section 13320 and California Code of Regulations, title 23, sections 2050 and following. The State Water Board must receive the petition by 5:00 p.m., within 30 calendar days of the date of adoption of this Order at the following address, except that if the thirtieth day following the date of this Order falls on a Saturday, Sunday, or state holiday, the petition must be received by the State Water Board by 5:00 p.m. on the next business day:

State Water Resources Control Board Office of Chief Counsel P.O. Box 100, 1001 I Street Sacramento, CA 95812-0100

Or by email at <u>waterqualitypetitions@waterboards.ca.gov</u>

For instructions on how to file a petition for review, see: <<u>http://www.waterboards.ca.gov/public_notices/petitions/water_quality/wqpetition_instr.shtml></u>

E. Information and Copying

The Report of Waste Discharge, other supporting documents, and comments received are on file and may be inspected at the address above at any time between 8:00 a.m. and 5:00 p.m., Monday through Friday. Copying of documents may be arranged through the Central Coast Water Board by calling (805) 549-3147.

F. Register of Interested Persons

Any person interested in being placed on the mailing list for information regarding the WDRs and NPDES permit should contact the Central Coast Water Board, reference this facility, and

provide a name, address, and phone number.

G. Additional Information

Requests for additional information or questions regarding this order should be directed to Peter von Langen at (805) 549-3688 or <u>peter.vonlangen@waterboards.ca.gov</u> or Phil Hammer at (805) 549-3882 or <u>phillip.hammer@waterboards.ca.gov</u>.

APPENDIX G

Groundwater Sampling Procedures and Protocols

GROUNDWATER SAMPLING PROCEDURES AND PROTOCOLS[†]

Standard California procedures should be followed when collecting groundwater samples from monitoring wells. These include purging the well for at least three well volumes until pH, conductivity, and temperature are stabilized within 10 percent.

Groundwater samples should be collected at each site in the order of importance as indicated in **Table 2** below.

Collection Order	Analysis	Required Laboratory	Shipment in Cooler Required/Recommended
1st	Organics including VOCs, SVOCs, and PPCPs	ELAP	Yes (cooler with bagged or blue ice)
2nd	Inorganics (general and trace minerals/ions)	ELAP	Yes (cooler with bagged or blue ice)
3rd	Major water quality cations and anions	ELAP	Yes (cooler with bagged or blue ice)
5th	Stable isotopes: $\delta^{18}O$ and δD in water $\delta^{15}N$ and $\delta^{18}O$ in water	lsotope	Yes (cooler with bagged or blue ice)
4th	Metals	ELAP	Yes (cooler with bagged or blue ice)
5th	Cyanide	ELAP	Yes (cooler with bagged or blue ice)
6th	Tritium alone	lsotope	Yes (at least 1 plastic bottle; plastic cooler required; bagged ice not necessary with shipment)
7th	Radionuclides	ELAP	Yes (cooler with bagged or blue ice)

Table 1: Groundwater Sample Collection Order

Note: ELAP = California Environmental Laboratory Accreditation Program **Reference**: Cal/EPA-DTSC (2008)

All groundwater sample collection should be under the direct supervision of a California Professional Geologist (PG), Certified Hydrogeologist (CHG), Certified Engineering Geologist (CEG) or Professional Engineer (PE) using appropriate U.S. EPA or Standard Method (SM) protocol including holding times and chain-of-custody forms. Also, we recommend collection of appropriate trip blanks and duplicate samples. Pre-cleaned sample containers should be obtained from the analytical laboratory with the appropriate preservative if required. All sample containers should be labeled with the following information:

[†] Protocol outline is a guideline only; the analytical laboratory should be contacted regarding specific protocols per their procedures and requirements.

- (1) Unique sample identification (ID)
- (2) Company (client) name
- (3) Samplers name or initials
- (4) Collection date and time
- (5) Type of preservative used (if any)

Glass sample containers should be appropriately pack or packaged to assure that breakage will not occur during transport to the laboratory. Airlift shipping of collected groundwater samples is not recommended except for samples that have very short holding times (i.e., nitrate). Therefore, courier transport is recommended.

Sample Protocols for Pharmaceutical and Personal Care Products (PPCPs)

PPCP analyses are extremely sensitive with analytical results returned in in nanogram per liter or parts per trillion concentrations. Therefore, on the day of sampling, analytical laboratories that specialize in the analysis of PPCPs strongly recommend avoidance of the following products either by contact or consumption. If contact or consumption is unavoidable, then collection of field blanks is strongly recommended.

(1) Wastewater compounds, including:

- Soaps and detergents, including antibacterial cleansers
- Insect repellents, particularly those with DEET
- Fragrances (cologne, after shave, perfumes, deodorants
- Sunscreens
- Animal or human urine and/or excrement
- Caffeine (coffee, tea, and colas)
- Tobacco

(2) Pharmaceutical compounds

- Prescription drugs, medications, and hormonal substances
- Over-the counter medications
- Selected human and veterinary antibiotics

Table 2 summarizes protocols for sampling PPCPs in groundwater:

Sampling Parameters	Requirements
Volume	• Either 80 mL for a small test or 16.0 L total for a large test. See <i>container protocol</i> below.
	• Wear powderless nitrile laboratory gloves; change gloves with each change in activity, sample collection, or potential glove contamination.
	Avoid breathing on open sample containers.
	• Avoid direct contact between clothing and sample containers, sampling devices, and processing equipment. Clothing may contain residual detergents, fragrances, and fire retardants.
	• If sampling from tap: make sure that the tap is free of aerators, strainers, or hose attachments. Flush for 3-5 minutes from a constantly flowing tap to obtain a representative sample.
Equipment	• If not sampling from tap: clean all sampling equipment before use using the following:
	 Non-antibacterial detergent Rinse all equipment copiously with de-ionized water (DIW) after detergent wash Follow DIW rinse with methanol rinse. Collect used methanol solution into an appropriate contained for disposal DO NOT clean or field-rinse sample bottles supplied by the laboratory. Sampling and processing equipment should be made from fluorocarbon polymers, glass, aluminum, or stainless steel. Avoid equipment made of Tygon, polyethylene, or other plastics.
	• Use laboratory supplied, pre-cleaned containers only. Do not clean or field- rinse laboratory-supplied sample bottles.
	• For large volume tests use the following number of bottles:
Containers	 two 1.0 L amber glass bottles for PPCP Hormones two 1.0 L amber glass bottles for Negative PPCP two 1.0 L amber glass bottles
	• Fill bottles to the neck, but do not overfill.
	Tightly seal all caps
	• Samples to be cooled to <6 °C
Preservation	• Sodium azide (NaN ₃) and ascorbic acid
	Cool to <6 °C
Storage Life	Unknown
Holding Time	• 28 days

Table 2: Summary for Sampling for PPCPs in Groundwater

Sampling Protocol for General Mineral Water Quality in Groundwater

General mineral water quality analyses are listed below with recommended U.S. EPA methodology. Samples will be collected in the appropriate U.S. EPA method approved containers, using preservation where required, and will meet holding times that are appropriate for the specific analyte. Samples will be labeled and accompanied by a completed chain-of-custody. An anion/cation (error balance) balance should be performed on the general mineral analysis and be within ±5% balance (Hounslow, 1995).

 Table 3 summarizes required general mineral analysis for collected water samples.

Analytes	Recommended U.S. EPA Method
Major Cations	
Calcium	200.7
Magnesium	200.7
Sodium	200.7
Potassium	200.7
Major Anions	
Bicarbonate (as HCO ₃)	300
Chloride	300
Sulfate (as SO ₄)	300
Minor lons	
Iron	200.7
Manganese	200.7
Fluoride	200.7
Nitrate (as NO ₃ [−])	200.7
General Physical Properties ar	nd Miscellaneous Parameters
Alkalinity (as CaCO ₃)	310.1
Color	
Conductance (Electrical	120.1
Conductivity)	
Hardness (as CaCO₃)	200.7
Odor	
рН	9040/9045
Total Dissolved Solids (TDS)	160.1
Turbidity	

Table 3: Required General Mineral Water Quality Analyses* in Groundwater

Sampling Protocol for Volatile Organic Compounds (VOCs) and Methyl-*Tertiary* Butyl Ether (MTBE) and Fuel Oxygenates and Other) in Groundwater

Collected groundwater samples shall be analyzed for five fuel oxygenates: MTBE, *tertiary* butyl alcohol (TBA), *tertiary*-amyl methyl ether (TAME), ethyl *tertiary*-butyl ether (ETBE) and di-isopropyl ether (DIPE). Samples shall be collected in the appropriate U.S. EPA method approved containers (i.e., use 40 mL VOA vials with no headspace, cool to 4° C, and preserve with HCl to pH <2). At least two VOA vials per sample should be collected. This protocol may also apply to other VOCs. Please contact the analytical laboratory before sampling.

Upon completion of sampling, record the required collection information on bottle label and complete chain-of-custody. VOA vials require packing in appropriate foam containers to prevent breakage.

 Table 4 is a summary of organic compound analyses required for collected groundwater samples.

Table 4: Required U.S. EPA Method for MBE and Fuel Oxygenates in Groundwater Samples

Analytes	Recommended EPA Method
Volatile Organic Compounds (VOCs)	
Fuel Oxygenates (5): MTBE, TBA, TAME, ETBE,	524.2
and DIPE	

Sample Protocol for Delta Oxygen-18 (δ^{18} O) and Delta Deuterium (δ D) Stable Isotopes in Groundwater

Sampling for δ^{18} O and δ D isotopes in water is relatively uncomplicated with water collected as a bulk sample in plastic bottles. To avoid and prevent the possibility of evaporation, which could enrich the residual water in the heavier isotopes (¹⁸O and D), the following collection steps are recommended:

- (1) Samples should be collected avoiding agitated or turbulent flow that could form bubbles leading to evaporation and isotope fractionation.
- (2) Partially filled or leaky sealed/capped containers are not acceptable.
- (3) Filled sample containers should be immediately capped: do not set aside without immediate sample capping (i.e., waiting to fill all sample bottles).
- (4) Filled containers should be immediately labeled with required label information.
- (5) Samples should be immediately placed in a cooler or ice chest. Cooling samples to < 6 or 4 °C is not required but recommended to prevent possible evaporation. However, sample cooling is strongly recommended if samples are collected during Summer and early Fall months.

Table 6 summarizes specific collection of groundwater samples for stable oxygen and deuterium isotope analyses.

Sampling Parameters	Requirements
Volume	 Isotope analytical laboratories generally request 1.0 L. Check with the laboratory for more specific information.
Equipment	• Sanitized bailers and/or suction pumps may be used. Avoid excessive agitation to prevent evaporation which might cause isotope fractionation.
	 USGS recommends <u>no</u> field rinsing of bottles prior to sample collection.
	• Plastic screw cap bottle consisting or HDPE, LPE, or PP.
Container	 If samples are to be archived do not use PP; use at least 60 mL clean glass.
	• Caps <u>must</u> be tightly sealed to prevent evaporation.
	 Check with laboratory if they have a preference or wish to supply their own containers.
	• <u>Tightly seal containers</u> to prevent evaporation. Turn bottle upside down and squeeze. If water leaks out reseal bottle.
	• Do not leave any headspace.
	• Filtering not required.
Preservation	• Do not add any chemical treatment or preservative.
	• Cool storage recommended but not essential. Storage at ambient temperatures is acceptable until samples are shipped. <i>Do not freeze bottles if containers are completely filled.</i> If freezing is required for shipment, fill bottles only two-thirds full.
Storage Life	Approximately 3 months.
Holding Time	• None

Table 6: Summary for $\delta^{18}\text{O}$ and δD Stable IsotopesSampling in Groundwater

Notes:

HDPE = high density linear propylene

LPE = linear polyethylene

PP = polypropylene

References: Clark and Fritz (1997); Clark and Aravena (2005); USGS (2004 and 2005).

Suggested Sampling Protocol for Delta Nitrogen-15 ($\delta^{15}N$) and Delta Oxygen-18 ($\delta^{18}O$) Isotopes in Dissolved Nitrate (NO₃⁻) In Water

Sample collection is somewhat more complicated than for δ^{18} O and δ D in water. We suggest contacting the analytical laboratory for their specific protocol. Groundwater is generally collected as bulk samples, although in low nitrate waters, ion exchange resins may be required to concentrate nitrate. If possible, nitrate concentrations should be known prior to sample collection. If this cannot be done a sample split should be separately analyzed for nitrate (NO₃⁻)

Sampling Parameters	Requirements
	• At least 4 mg nitrogen is required for δ^{15} N analysis.
	 If possible nitrate (NO₃⁻) concentrations should have been previously determined and sent to the laboratory.
Volume	 At least 20 to 25 mg NO₃⁻ should be present in sample. Therefore: if 20 to 25 mg/L NO₃⁻ present, collect at least 1.0 L of water if 10 to 12.5 mg/L NO₃⁻ present, collect at least 2.0 L of water if 1.0 to 1.25 mg/L NO₃⁻ present, collect at least 3.0 L water. For lower concentrations a resin cartridge may be required to concentrate NO₃⁻; check with the laboratory.
Fauinment	No special equipment required.
	Bailers and/or suction pumps may be used.
	• Plastic screw cap bottle consisting or HDPE, LPE, or PP.
Container	• Check with laboratory if they have a preference or wish to supply their own containers.
	 Preserve with 1mL/L of chloroform or acidify to pH 2.0 with HCL. Do not use sodium-azide (NaN₃) or nitric (HNO₃) acid as preservatives.
	Sample bottles must be tightly sealed to prevent evaporation.
Preservation	 Immediately store out of sunlight, preferable in an ice chest or cooler. It is recommended that samples be kept in the dark and as cold as possible to prevent evaporation and to minimize biological/bacteriological activity, but do not freeze unless directed otherwise from the laboratory.
Storage Life	Approximately 3 months.

Table7: Summary for Sampling for $\delta^{15}N$ and $\delta^{18}O$ in Nitrate (NO3^-)

Notes:

HDPE = high density linear propylene

LPE = linear polyethylene

PP = polypropylene

References: Clark and Fritz (1997); Clark and Aravena (2005).

Sampling Protocol for Tritium (T) Radiogenic Isotopes for Relative Age Dating in Groundwater

Sampling for tritium <u>only</u> in groundwater is relatively simple with collection in standard plastic bottles. One liter glass bottles may also be used (clear French-square type with Qorpak[™] polyseal-lined caps that have been triple rinsed with water directly from the sampling port) but these are not recommended because they may break during shipment.

Sampling requirements for tritium are discussed below. It may be necessary to determine if tritium levels are likely to be by direct tritium analysis (± 3 to ± 8 tritium units or TU), enriched tritium analysis (± 0.1 to ± 0.8 TU)[‡], ultra low level (ULL) tritium analysis (± 0.1 to ± 0.01 TU), or helium-3 ingrowth analysis (± 0.1 to ± 0.01 TU). However, direct tritium analysis is generally sufficient. Tritium analysis should not be performed in groundwater contains purgeable organic compounds (e.g., total petroleum hydrocarbons as gasoline or diesel) or volatile organic compounds (VOCs) such as trichlroethene (TCE).

Special Requirements for all Tritium Sampling

- (1) For tritium analyses, groundwater samples should be collected from upgradient non-organic contaminated monitoring wells only. This is because high concentrations of organic compounds such as VOCs may cause damage to the tritium analytical equipment. Indicate on chain-of-custody if the collected groundwater samples are from the unconfined zone (and the estimated depth that the sample was drawn from), which would most likely reflect infiltrated precipitation with tritium levels that are between 1.5 TU (for the tropics) to about 10-20 TU (northern hemisphere with seasonal variations).
- (2) All sampling and transfers shall be done outdoors with a required specific ban on samplers wearing glow in the dark-type wrist watches, compasses, or similar device with luminescent dials, "Indiglow[™]", or so called "beta" lights. It is further recommended that such devices not be worn for several days to at least a week prior to sampling because tritium from such devices is absorbed into the body. This tritium has a biological half life of approximately 10 days.

Do not perform indoor transfers because indoor atmospheres may contain water vapor (humidity) ranging to 10,000 TU derived from various luminescent signs and dials. Exposure of sampled water to such air may cause erroneous results.

(3) For indoor transfers (not recommended):

- (a) Dry bottles should be first filled with argon gas.
- (b) Water should never be exposed to indoor air. Pipe the water sample into the middle of, the argon-filled bottle just below the argon level. *Do not pour the argon out of the bottle by tilting the bottle.*
- (c) Add nothing to the water bottle; *Do not freeze*.
- (4) For outdoor transfers (recommended):

[‡] Accuracy and precision depends on the laboratory conducting tritium analysis.

- (a) HDPE bottles should be filled from the sampling port just to the neck leaving a few cm³ of air space. *Do not rinse or overflow*. Replace screw cap tightly; hold bottle upside down and squeeze hard. No leakage should occur.
- (b) If glass bottles are used, fill from the sampling port to just below the threads.
- (c) Add nothing else to the water bottle. *Do not freeze*.

(5) Upon completion of sampling, record information on bottle label and complete laboratory chain-ofcustody form.

(6) Samples shall not be stored near any potential tritium sources (e.g., glowing clocks, watches, or signs).

(7) Ship samples to laboratory packed in an ice chest or cooler (most labs will not return these because of the cost of shipping).

Table 8 is a summary for collection of water samples for tritium isotope analysis.

Sampling Parameters	Requirements
Volume	 1.0 L is recommended; <u>minimum</u> requirements are listed below depending on tritium type (check with the lab before sampling): direct tritium: 25 to 50 mL enriched tritium: 250 to 500 mL ULL tritium: 500 mL to 1.0 L flushed with argon ³He ingrowth: 50 mL, flushed with argon Pace ZymaX Forensics requests at least one 1.0 L bottle.
Equipment	 Same as for δD and δ¹⁸O in water. Thief sampler or pump can be used; minimize contact with ambient air.
	• For direct, enriched, and ULL tritium, at least 1.0 liter HDPE bottles such as U.S. Department of Transportation Spec. DOT-2 or equivalent.
Container	• For ULL tritium samples, glass bottles must be perfectly dry and should have been flushed with high purity dry argon to remove absorbed moisture.
	 HDPE bottles should be clean and dry, preferably factory fresh with good caps, <u>or</u> 1.0 liter glass (e.g., Pyrex with orange PP plug seal cap). For ULL tritium, some labs may require 1.0 L glass.
	• For ³ He ingrowth, tight-sealing glass bottles are recommended.
	• No filtering or preservation required. Fill bottle with raw untreated water sample.
Preservation	• Sample containers should be filled to the top with no head space, tightly sealed and air tight to avoid evaporation. A slight headspace can be allowed for sample expansion during shipping.
	• Do not allow sample bottle to overflow when filling sample.
	Avoid prolonged exposure to ambient air.
Hold Time	None
Other	• Collect groundwater samples from wells uncontaminated by organic compounds such as purgeable organic compounds and VOCs

Table 8: Summary for Tritium (T) Radiogenic Isotope Sampling in Groundwater

Notes:

ULL = Ultra Low Level

HDPE = high density linear propylene

LPE = linear polyethylene

PP = polypropylene

References: Clark and Fritz (1997); Moran, et al. (2002), Heemskerk (1998), University of Miami/RSMAS (2008a, 2008b, and 2008c); USGS (2004).

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APPENDIX H

MRWPCA Advanced Water Treatment Demonstration Facility Operational Water Quality Parameters and Checklists

G DRAFT - MRWPCA Pure Water Monterey Demo Ops Water Quality Monitoring Schedule

Parameter	Method	Location of Sample	Sample Type	Frequency	Reason	Level of Concern
		RO Feed	Grab	Monthly	Meter Verification ⁺	+/- 10% of analyzer value
Conductivity	Handheld Meter	RO Permeate	Grab	+/- 10% of analyzer value		
	(Myron L Comp. UltraMeter II)	UV/AOP Effluent	Grab	Weekly	Verify calcite filter performance	Difference of 200 ± 100
		Faucet	Grab	Weekly	Verify calcite filter performance	
		DO ₃ #1 Sample Line	Grab	Daily*	Meter Verification ⁺	+/- 10% of analyzer value
Dissolved Ozone	Hach DR900	Ozone Effluent	Grab	Daily*	Meter Verification ⁺	>0.05 mg/L or +/-10% of analyzer value
H ₂ O ₂	Hach DR900	UV Reactor Feed Water	Grab	Weekly	Verify peroxide dose	< 2 mg/L
Nitrito		Secondary Effluent	24-h Comp.	Daily*	Understanding ozone demand	n/a
Nitrite	Hach DR900	Ozone Influent	Grab	Daily*	Understanding ozone demand	n/a
ORP	Handheld Meter (Myron L Comp. UltraMeter II)	UF Feed	Grab	Weekly	Meter Verification ⁺	+/- 10% of analyzer value
		UF Feed	Grab	Monthly	Meter Verification ⁺	+/- 10% of analyzer value
۳H	Handheld Meter	RO Feed	Grab	Daily*	Meter Verification ⁺	+/- 10% of analyzer value
рп	(Myron L Comp. UltraMeter II)	UV/AOP Effluent	Grab	Weekly	Verify calcite filter performance	Differential of 1 ± 0.5
		Faucet	Grab	Weekly	Verify calcite filter performance	
		UF Feed	Grab	Monthly	Meter Verification ⁺	+/- 10% of analyzer value
Tomporaturo	Hand held thermometer	RO Feed	Grab	Monthly	Meter Verification ⁺	+/- 10% of analyzer value
remperature	nana nela trermometer	UV/AOP Effluent	Grab	Weekly	Verify calcite filter performance	Difference of $5 \pm 4/2$
		Faucet	Grab	Weekly	Verify calcite filter performance	Difference of 5 +7- 2
Total Cl ₂	Hach DR900	UF Feed	Grab	Daily*	Verify Chlorine Dose	Outside 3-5 mg/L
Turbidity	Hach 21000 field motor	UF Feed	Grab	Monthly	Meter Verification ⁺	+/- 10% of analyzer value
Turbluity	hach 2100Q heid meter	UF Filtrate	Grab	Monthly	Meter Verification ⁺	+/- 10% of analyzer value
UVT	Portable RealTech	UV/AOP Feed	Grab	Weekly	Meter Verification ⁺	+/- 10% of analyzer value

Operator readings

*Daily is 5 days per week

[†]Record meter reading when sample is collected to compare to WQ result

Lab readings

Alkalinity	Titration (SM2220B)	UV/AOP Effluent	Grab	Weekly	Verify calcite filter performance	dAlk < 40 mg/l as CaCO		
Alkalillity		Faucet	Grab	Weekly	Verify calcite filter performance	$dAik < 40 Hig/L as CaCO_3$		
Calcium	IC	UV/AOP Effluent	Grab	Weekly	Verify calcite filter performance	$dC_{2} < 40 mg/L_{2} < C_{2}C_{2}$		
Calcium		Faucet	Grab	Weekly	Verify calcite filter performance	$dCa < 40 \text{ mg/L} as CaCO_3$		
TDC	Filtration mathed (SM2E40C)	UV/AOP Effluent	Grab	Weekly	Verify calcite filter performance	difference of EQ 1/ 40		
103	Filtration method (SW2540C)	Faucet	Grab	Weekly	Verify calcite filter performance	umerence 01 50 +/- 40		
		Ozone Influent	Grab	3/week	Understanding TOC variability	n/a		
TOC	TOC Analyzer (SM5310B)	Faucet	Grah	3/week	Understanding future regulatory	> 0.5 mg/l		
		Taucet	Glab	J/WEEK	compliance	2 0.5 mg/ L		
Total coliform	Colilert QT (UF Filtrate)	UF Filtrate	Grab	Weekly	Verify UF performance	Detactable		
Total comorni	Colilert P/A (Faucet)	Faucet	Grab	Weekly	Verify stabilization sterility	Detactable		
Total Nitrogon	Nitrite (IC), Nitrate (IC) and	Faucat	Crah	Mookhy	Understanding future regulatory	>10 mg/l		
rotal Nitrogen	TKN	Faucet	Grab	veekiy	compliance	>10 mg/L		

G DRAFT - MRWPCA Pure Water Monterey Demo Ozone & Pre-treatment Ops Sheet

Date	Time	Ops	Applied ozone dose (mg/L)	Ozone transfer efficiency (%)	Transferred ozone dose (mg/L)	Ambient ozone (ppm)	Oxygen flowrate (scfh)	Generator power (%)	Applied ozone concentration (g/Nm³)	Flowrate (gpm)	Venturi suction pressure (psi)	Degas ozone concentration (g/Nm³)	DO3 #1 (mg/L)	DO3 #2 (mg/L)	ORP (mV)	Confirm water separator drainage flow	Sample conditioner coalescer water level	Sou nort dewa (in.	uth & th LOX ar level H ₂ O)	Hypo tank level (% full)	Pres rea upstro downs of str (p	sure ling eam & stream ainers si)	Chloramine residual at UF influent (mg/L as Cl ₂)
Level of concern			Atypical (Ex: < 5 or > ~20)	< 80%	Atypical (Ex: < 5 or > ~20)	> 0.10	±1 of setpoint	Atypical (Ex: 0%, < ~40% or 100%)	Atypical (Ex: < ~40)	< 30 if pump valve open	> 20	Atypical (Ex: > ~10)	±0.2 of setpoint	> 0.05 (if DO ₃ #1 used for control)	> ~500 (if setpoint at 475)	No flow	Empty as needed	Rer when	place empty	Fill as needed	dP >	~5 psi	< 3
Example	9:00	JDK	14.4	90.9%	12.7	0.03	60	49%	52.5	34.0	9	5.0	0.26	0.00	420	~	10%	47.5	20	30%	32	32	4



UF System - Operations Log For Monterey, CA





Reverse Osmosis - Log For Monterey, CA

Reverse Osmosis Unit Must be Running For Several Minuets Before Recording Readings WATER TECHNOLOGIES Provide Action of the second Inter Charlo (Rec.) Arealites's Gauge Operators diffe Pre-filler Permearce Cond Conc. Pressure (12,2045) Inlet Hardness Inter Cond (41, 2012) il. Date

Contraction of the second seco

Date	Time	Ops	Flowrate (gpm)	UVT (%)	NDMA log removal	1,4- dioxane log removal	Power (kW)	H ₂ O ₂ pump rate on HMI (gph)	H ₂ O ₂ dose (mg/L)	UV intensity (mW/cm²)	BLP (%)	H ₂ O ₂ tank level (pad)	H₂O₂ pump rate on pump (gph)	H ₂ O ₂ in H ₂ O ₂ skid sump	H ₂ O ₂ line pressures (psi)	UVT analyzer humidity (%)	UVT analyzer temperature (°C)	H ₂ O ₂ kit result after H ₂ O ₂ dosing, A (mg/L)	RO permeate chloramine residual, B (mg/L as CL ₂)	Calculated H ₂ O ₂ residual = A - B*34/71 (mg/L)
Level of concern			> 18 < ~5	< 95%	< 1.2	< 0.5	Atypical	Atypical (Ex: < 0.0088)	Atypical (Ex: < 4)	Atypical	Atypical	Fill/replace as needed	lf ≠ HMI	If H ₂ O ₂ present	Atypical (Ex: > ~10)	> 25%		NA	NA	< 4
Example	14:30	JDK	15.0	97.0%	1.58	0.57	0.94	0.011	5	25.18	92%	Full	0.0113	Empty	4, 4	13%	31	6.0	2.0	5.0

CDRAFT - MRWPCA Pure Water Monterey Demo Stabilization Ops Sheet

Date	Time	Ops	UV lamp on/off	Check flowrate	Calcite level	Chiller on/off	Pre- stabilized pH	Pre- stabilized temperature (°C)	Pre- stabilized conductivity (μS/cm)	Faucet pH	Faucet temperature (°C)	Faucet conductivity (μS/cm)
Level of concern			off	< 0.3 gpm per faucet (replace cartridge filter as needed)	TBD (fill as needed)	off	> 6.0 < 5.0	Atypical	> 60	< 6.0	> 24	< 50
Example	15:30	JDK	on	~	~90%	on	5.60	24.7	39.3	7.10	19.8	565

Pure Water Monterey Pre-Tour Checklist (Day of Tour)

No	Itom	Date	10/13			
NO.	Ir		JDK			
Ozone	e System					
1	DO₃ #1 Sensor ≥ 0.1 mg/L?		\checkmark			
2	Effluent clear in color?		\checkmark			
3	Ambient ozone concentration < 0.1 ppm?		\checkmark			
UF Sys	stem					
1	DIT LRV: ≥ 4 logs?		\checkmark			
2	Filtrate turbidity < 0.2 NTU?		√			
RO Sy	stem					
1	Conductivity rejection ≥ 96.8%?		\checkmark			
2	Permeate conductivity < 60 μS/cm?		\checkmark			
3	Feed pH \geq 5.8?		\checkmark			
UV/A	OP System					
1	NDMA log removal ≥ 1.20?		\checkmark			
2	1,4-dioxane log removal ≥ 0.50?		\checkmark			
3	UVT ≥ 95%?		\checkmark			
Stabil	ization System					
1	UV power on?		\checkmark			
2	Product water conductivity > 150 μS/cm?		\checkmark			
3	Product water temperature < 22°C?		\checkmark			
Wate	r Quality Sampling					
1	Chloramine residual at UF influent \geq 3 mg/L as Cl ₂ ?		\checkmark			
2	H_2O_2 residual at UV/AOP reactor influent \geq 4 mg/L	?	\checkmark			

APPENDIX I

Pure Water Monterey Groundwater Replenishment Project: Draft Hydrogeologic Field Investigation: Monitoring Well Installation, Groundwater Quality Characterization, and Geochemical Assessment



DRAFT

Hydrogeologic Field Investigation: Monitoring Well Installation, Groundwater Quality Characterization, and Geochemical Assessment

February 2015

Monterey Peninsula Groundwater Replenishment (GWR) Project

GROUNDWATER





DRAFT HYDROGEOLOGIC FIELD INVESTIGATION: MONITORING WELL INSTALLATION, GROUNDWATER QUALITY CHARACTERIZATION, AND GEOCHEMICAL ASSESSMENT

MONTEREY PENINSULA GROUNDWATER REPLENISHMENT (GWR) PROJECT

February 28, 2015



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Draft MRWPCA Hydrogeologic Field Investigation Monterey Peninsula GWR Project

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EXECUTIVE SUMMARY

Monterey Regional Water Pollution Control Agency (MRWPCA), in partnership with Monterey Peninsula Water Management District (MPWMD), is developing the proposed Groundwater Replenishment (GWR) project to provide an additional safe and reliable source of water supply for the Monterey Peninsula. Proposed recharge is designed to benefit the two primary water supply aquifers in the Seaside Basin - the Paso Robles Aquifer and the underlying Santa Margarita Aquifer – and will be accomplished by injecting recycled water through a combination of shallow vadose zone and deep injection wells.

To support ongoing GWR project planning, MRWPCA recently completed a hydrogeologic field investigation in the vicinity of the proposed GWR project recharge site. Key field activities included the drilling and construction of a dedicated GWR project monitoring well (MRWPCA MW-1) screened in the upper Paso Robles Aquifer using the sonic drilling method and collection of groundwater quality samples from MRWPCA MW-1 and five other local wells. Selected core samples were laboratory analyzed for hydraulic, mineralogical, and potential contaminant leaching properties. Groundwater quality samples were analyzed for a comprehensive suite of 300+ constituents/parameters to establish baseline conditions for compliance with future regulatory requirements. Collected data were used to refine the conceptual hydrogeologic model of the GWR project recharge site and evaluate potential groundwater quality impacts from proposed recharge operations through geochemical modeling. This report documents the field investigation activities, hydrogeologic information collected, and the geochemical modeling assessment.

The exploratory boring was drilled to a depth of 535 feet below ground surface (feet-bgs), and MRWPCA MW-1 was completed to a depth of 521 feet-bgs. A total of 75 feet of slotted well screen was installed from 421 to 446 feet-bgs and from 466 to 516 feet-bgs. The groundwater level in MRWPCA MW-1 was measured at 405 feet-bgs.

Subsurface conditions encountered during drilling indicated that the upper 392.5 feet is composed predominately of unconsolidated sand/silty sand with thin lenses of sandy silt. These units are representative of the Aromas Sand. While silt/clay deposits observed in the lower Aromas Sand at MRWPCA MW-1 may occur beneath the GWR project recharge site, such fine-grained deposits likely pinch out to the west (by General Jim Moore Boulevard) and north (by the Golf Course Reservoir Well). A clear lithologic transition was observed at 392.5 feet-bgs, and interpreted as the boundary between the Aromas Sand Formation and underlying Paso Robles Formation. Sediments below this transition are heterogeneous and characterized by relatively thick (10 to 20 feet) alternating fine-grained (silt/clay) and coarse-grained (sand) deposits. Sediments ranged from unconsolidated to semiconsolidated with marine (chert) and terrestrial rock fragments of possibly volcanic origin increasing with depth.

Selected core samples from 19 depth intervals were submitted to Cooper Testing Labs in Palo Alto, California for analysis of hydraulic properties, including (saturated) vertical hydraulic conductivity (Kv) and total and effective porosity. Analytical well hydraulic

equations and laboratory effective porosity and Kv estimates of selected core samples were used to evaluate the geometry of the wetted area and of recycled water recharged through proposed vadose zone wells. Results indicate that the thicknesses of sand deposits either above or below the encountered silt/clay deposits in the lower Aromas Sand are sufficient to accommodate projected injection rates, and that four (or possibly fewer) vadose zone wells can accommodate proposed vadose zone injection rates. Estimated travel time of recycled water through the coarse-grained sediments of the Aromas Sand is likely to be on the order of a few days. However, if vadose zone wells are positioned above fine-grained units in the Aromas Sand (encountered between 295 and 341 feet-bgs), the travel time for recycled water to travel through the Aromas Sand and reach the top of the Paso Robles Formation is estimated at approximately 5.9 years. An additional 3.4 years is required for recycled water to travel through the 12.5 feet of unsaturated Paso Robles Formation before reaching the current water table at 405 feet-bgs.

Water quality data from sampled monitoring and production wells indicate that local groundwater in the Paso Robles Aquifer meets drinking water standards. While some metals and radiogenic parameters were detected above regulatory limits in FO-7 Shallow, MRWPCA MW-1, and PRTIW, exceedances are clearly affected by sample turbidity. Consequently, concentrations of metals and radiogenic parameters in these wells reflect contributions from solid and dissolved phases. Of the State Water Resources Control Board Division of Drinking Water (SWRCB DDW) recycled water quality Contaminants of Emerging Concern (CoECs), NDMA was detected in groundwater collected from the PRTIW well, and caffeine and DEET were detected in MRWPCA MW-1. Although detectable, CoEC concentrations are very low - not exceeding 0.01 μ g/L; this represents the first time that CoECs have been analyzed in the Seaside Basin.

Baseline groundwater quality data indicate that local groundwater in the Santa Margarita Aquifer meets drinking water standards with the exception of FO-7 Deep, for which total iron and manganese exceeded secondary MCLs. However, as mentioned above, the FO-7 Deep groundwater sample was most likely affected by turbidity, with concentrations of metals and radiogenic parameters representative of solid and dissolved phases. Of the SWRCB DDW recycled water quality CoECs, caffeine and DEET were detected in FO-7 Deep at very low concentrations not exceeding $0.01 \,\mu$ g/L. These constituents do not have California MCLs but have been designated as recycled water surrogates, which are required in recycled water project monitoring. Future groundwater sampling will confirm whether these CoECs continue to be detected at low concentrations or fall below laboratory detection or reporting limits.

Soluble nitroaromatic compounds (explosives) detected in soils in the Inland Ranges were not present in any of the soil cores analyzed for this field investigation. Likewise, groundwater quality samples analyzed for this investigation indicate that the Paso Robles and Santa Margarita aquifers have not been impacted locally from explosives associated with former Fort Ord activities. Accordingly, nitroaromatic compounds were not further evaluated in the geochemical modeling assessment.
Geochemical modeling was applied to selected constituents including chromium, lead, arsenic and calcite. Modeling results indicate that reactions between recycled water and formation materials along vertical flow paths could potentially result in recycled water quality changes beneath vadose zone wells with respect to chromium. However, geochemical modeling results revealed that concentration changes are likely to be small, because only trace amounts of chromium are adsorbed onto the hydrous ferric oxides coating individual quartz sand grains within the Aromas Sand. Simulation results (using pilot recycled water with pH of 7.7) indicate that almost all of the adsorbed chromium would desorb relatively quickly into solution as recharge water flows through the Aromas Sand, producing a transient initial effect. However, because the amount of chromium sorbed onto hydrous ferric oxide coatings is small, chromium concentrations would decrease following initial flushes of recharge water through the wetted zone. Arsenic and lead are adsorbed more strongly to the hydrous ferrous oxides than chromium. Therefore, the rate at which arsenic and lead desorb into solution as the injected recharge water flows through the Aromas Sand is slower but more sustained than for chromium. Estimated arsenic and lead concentrations in recharged recycled water through the Aromas Sand are predicted to be low - at about 4 μ g/L for arsenic and 0.7 μ g/L for lead.

Geochemical modeling further indicates that aquifer clogging by calcite precipitation is unlikely in the Aromas Sand because calcium and bicarbonate concentrations are far below levels approaching saturation. The potential for biofouling in the injection wells is low, because the injected water is very low in nitrogen and phosphorus and, therefore, would not tend to stimulate microbial growth.

Based on information collected and analyses conducted for this field investigation, the following conclusions can be made:

- The available storage capacity and hydraulic parameters of the Aromas Sand at the GWR project recharge site can accommodate proposed recycled water injection rates through four (or possibly fewer) vadose zone wells.
- The estimated vertical travel time of recycled water to flow through the Aromas Sand is dependent on the final depth of vadose zone well screens relative to potential silt/clay deposits in the lower Aromas Sand. Assuming that subsurface conditions at the GWR project recharge site are similar to those at MRWPCA MW-1, injected recycled water is estimated to reach the top of the Paso Robles Formation in a matter of a few days if vadose zone wells are screened below silt/clay deposits. If vadose zone wells are screened above any silt/clay deposits, injected recycled water is estimated to reach the top of Paso Robles Formation after 5.9 years. An estimated 3.4 years is needed for recycled water to flow through the upper 12.5 feet of unsaturated Paso Robles Formation before reaching the current water table. However, the water table is expected to rise to or above the geologic contact between the Aromas Sand and Paso Robles Formation following the initial years of GWR project operation.

- Baseline groundwater quality data indicate that local groundwater in the Paso Robles Aquifer generally meets drinking water standards. Apparent elevated concentrations of some metals and radiogenic parameters detected in the FO-7 Shallow, FO-07 Deep, MRWPCA MW-1, and PRTIW wells are impacted by turbidity in groundwater quality samples and are not considered representative.
- SWRCB DDW recycled water CoECs detected at very low concentrations in sampled wells include NDMA (PRTIW well), caffeine (MRWPCA MW-1 and FO-07 Deep), and DEET (MRWPCA MW-1 and FO-07 Deep). Future groundwater sampling, supporting the GWR monitoring program, will confirm either the continued presence or absence of these constituents.
- Metallic elements that could potentially be desorbed from mineral surfaces in the Aromas Sand include chromium (VI), arsenic, and lead. Geochemical modeling results indicate that these metals would not be leached in sufficient quantities to significantly impact the Paso Robles Aquifer.
- The potential for trace metal desorption during direct injection of recycled water into the Santa Margarita Aquifer is low and should not significantly impact groundwater quality in the Santa Margarita Aquifer.
- The potential for calcite clogging and/or biofouling in shallow vadose zone and deep injection wells is low and should not affect proposed recharge operations.

Based on the findings from this field investigation, the following are recommended to support ongoing GWR project planning:

- During the drilling of initial vadose zone and deep injection wells for the GWR project, subsurface lithologic data should be collected to evaluate the extent and thickness of potential fine-grained sediments in the lower Aromas Sand. Findings will be critical to the final design of vadose zone wells (specifically, the placement of well screen intervals).
- An additional round of groundwater quality sampling from MRWPCA MW-1 and both FO-7 wells is recommended at a minimum to establish baseline groundwater quality conditions in the vicinity of the GWR project recharge site. To obtain representative groundwater quality samples, groundwater from MRWPCA MW-1 should be pumped using a 3-inch diameter submersible pump (0.75-horsepower Grundfos 5SQE 07-320 used for well development or similar) with water quality samples collected after groundwater is determined to be turbidity-free. For all samples, groundwater should be filtered in the field through 0.45-micron filter to remove suspended solids, and collection bottles should be preservative-free to minimize potential digestion of solids in the sample prior to analysis.

1. INTRODUCTION

Monterey Regional Water Pollution Control Agency (MRWPCA), in partnership with Monterey Peninsula Water Management District (MPWMD), is developing the proposed Groundwater Replenishment (GWR) project to provide an additional safe and reliable source of water supply for the Monterey Peninsula. MRWPCA plans to construct and operate an advanced water treatment facility (AWTF) that will produce highly-purified recycled water for recharge in the Seaside Subarea of the larger Salinas Valley Groundwater Basin (referred to herein as the Seaside Basin). The GWR project will address historical overdraft conditions in the Seaside Basin and increase basin yield without increasing the risk of seawater intrusion. Proposed recharge is designed to benefit the two primary water supply aquifers in the Seaside Basin - the Paso Robles Aquifer and the underlying Santa Margarita Aquifer – and will be accomplished by injecting recycled water through a combination of shallow vadose zone and deep injection wells.

To support ongoing GWR project planning, MRWPCA recently completed a hydrogeologic field investigation in the vicinity of the proposed GWR project recharge site. Key field activities included the drilling of a deep soil boring using the sonic drilling method; construction of a dedicated GWR project monitoring well (MRWPCA MW-1) that allows for monitoring of groundwater levels and water quality in the upper Paso Robles Aquifer; and collection of groundwater quality samples from MRWPCA MW-1 and five other wells in the vicinity of the GWR recharge site. Selected sediment core samples recovered during drilling were laboratory analyzed for hydraulic, mineralogical, and potential contaminant leaching properties. Groundwater quality samples were analyzed to establish baseline conditions for a comprehensive suite of drinking water and recycled water-related parameters and additional site-specific constituents of concern. Data collected from the field were used to refine the conceptual hydrogeologic model of the GWR project recharge site and evaluate potential groundwater quality impacts from proposed recharge operations through geochemical modeling.

This report documents the field program and presents key hydrogeologic information, including laboratory data and results of geochemical model simulations used to assess the potential of GWR project-related groundwater quality impacts. Conclusions pertinent to the final design and operation of proposed recharge facilities and recycled water stabilization goals are presented along with recommendations to address existing knowledge gaps.

1.1. Hydrogeologic Setting

The GWR project recharge site is located in the Seaside Basin, identified by the Department of Water Resources (DWR) as a subarea of the larger Salinas Valley Groundwater Basin. As shown on **Figure 1**, the Seaside Basin has been further divided into subareas based on geologic faulting, hydrostratigraphy, groundwater flow directions, and other factors (Yates, et al., 2005). The proposed well site is located within the northeastern subarea, referred to as the Northern Inland Subarea. The northern basin boundary is based on a groundwater divide that is subject to movement with changing conditions in groundwater flow (Yates, et al., 2005).

al., 2005; Hydrometrics, 2010). A zoomed-in map of the GWR project recharge site is shown on **Figure 2**.

Tertiary- and Quaternary-age sedimentary units deposited within the basin contain most of the usable groundwater in storage. These units overlie the Miocene-age Monterey Formation, which is composed of low permeability shale and considered the base of the groundwater basin. Surficial units are composed of unconsolidated to semi-consolidated Quaternary-age dune sands. The dune deposits are underlain by older Pleistocene sediments of the Aromas Sand Formation (Aromas Sand). In this area, the Aromas Sand is a fine- to coarse-grained, friable sandstone (Harding ESE, 2001). Collectively, the dune sands/Aromas Sand deposits are about 350 to 400 feet thick, lie above the regional water table, and are the target units for this field investigation.

Two semi-consolidated sedimentary units, the Paso Robles Formation and the Santa Margarita Sandstone, underlie the Aromas Sand and are the primary aquifer systems in the basin. **Figure 3** shows the local configuration of these geologic units using down-hole resistivity logs from two nearby wells. Included on the cross section is a generalized schematic of the monitoring well that was constructed for this field investigation (MRWPCA MW-1). The locations of the cross section and wells are shown on **Figure 2**. The Aromas Sand, Paso Robles Aquifer and Santa Margarita Aquifer are described in more detail below.

1.1.1. Aromas Sand

As shown on the cross section in **Figure 3**, the Aromas Sand thickens to the east and is approximately 400 feet thick beneath the proposed monitoring well (MRWPCA MW-1) site; it is likely to be unsaturated across the GWR project area. Because the sand is not a major aquifer unit in the basin, it has not been the focus of past hydrogeologic evaluations, and several key data gaps exist. The geologic log for FO-7 indicates the predominance of sand throughout the interval with only minor silt layers. The presence of fine-grained units that could perch or impede recharge water may influence the design of GWR project recharge facilities (e.g., elevation of vadose zone injection well screens).

1.1.2. Paso Robles Aquifer

The Paso Robles Aquifer is composed of a series of continental (fluvial and alluvial fan) deposits of inter-bedded sand, gravel, and clay mixtures. Units within the aquifer system are heterogeneous and not readily correlated throughout the basin. As shown on **Figure 3**, the thickness of the unit in the GWR project area ranges from about 250 feet to more than 350 feet.

The Paso Robles Aquifer is the shallow-most aquifer in this area, and groundwater in the unit is considered unconfined. Based on recent monitoring events, the local water table is estimated to occur close to mean sea level.

1.1.3. Santa Margarita Aquifer

The Santa Margarita Aquifer is a Miocene-age sandstone of shallow marine origin and is the most prolific aquifer system in the Seaside Basin. As shown on **Figure 3**, the unit has an

average thickness of about 300 feet in the GWR project area and consists of poorlyconsolidated sand. The sandstone is transitional to the underlying Monterey Shale, which was penetrated by SMTIW No. 1 (**Figure 3**). The Santa Margarita Aquifer was not tested during this field investigation.

1.1.4. Groundwater Flow Directions

Groundwater flow beneath the GWR project area is generally westerly toward Monterey Bay. Groundwater production in both aquifers has altered the regional flow directions, especially in the vicinity of General Jim Moore Boulevard where numerous water supply wells are located. **Figure 4** shows water level contours in the shallow aquifer (Paso Robles Aquifer) (Hydrometrics, 2010). Existing groundwater flow directions beneath the proposed monitoring well location are toward the west to southwest toward the pumping wells.

1.2. GWR PROJECT BACKGROUND

Since 2005, MRWPCA has been developing the proposed GWR project to provide a safe and reliable source of water to replenish the Seaside Basin. The GWR project involves the recharge of approximately 3,500 acre-feet per year (AFY) of advanced-treated recycled water from a new AWTF to be located at the MRWPCA Regional Treatment Plant (RTP). The feed water for treatment at the new AWTF will be secondary effluent from the MRWPCA RTP. The AWTF recycled water will be conveyed by pipeline from the AWTF to newly-constructed injection wells located within the former Ford Ord military base in the western portion of the Northern Inland Subarea of the Seaside Basin (**Figure 1**). Recharged water will be stored in the groundwater basin for subsequent extraction by California American Water Company (Cal-Am) using existing downgradient production wells (**Figure 2**). The GWR project will increase the basin yield and allow Cal-Am to reduce Carmel River diversions in compliance with a state order to secure additional water supplies (MRWPCA, May 2013).

The proposed GWR project recharge site is located within an approximate 150-foot wide corridor of land about 3,000 feet long (**Figure 2**). The corridor begins approximately 1,200 feet south of Eucalyptus Road and extends south-southwest for approximately 3,000 feet toward General Jim Moore Boulevard. The southwestern end of the project is approximately 200 feet east of the road. The property is situated along dirt roads of former Fort Ord lands and along the edge of a property that is proposed for conveyance from the Fort Ord Reuse Authority (FORA) to the City of Seaside. According to the City of Seaside, this parcel edge functions as a utility right-of-way, such that injection wells would not interfere with future land development.

While other sites were evaluated, the proposed GWR project recharge site was selected as the preferred location, because it offered the following key advantages:

- Consistent with planned future development and approved by the City of Seaside
- Relatively flat, graded surface that is level with the elevation of the sidewalk
- Sufficiently large to contain drill rig and support equipment
- Upgradient of water supply wells in the basin

- Sufficiently far from water supply wells to comply with State Water Resources Control Board Division of Drinking Water (SWRCB DDW) regulations
- Within the groundwater basin subarea boundary (and away from a groundwater divide to the north)
- Within close proximity to key monitoring wells for both aquifers
- Reasonably close to General Jim Moore Boulevard and the proposed pipeline alignment

As shown in **Figure 2**, proposed injection wells include shallow vadose zone wells for indirect recharge of the Paso Robles Aquifer via the overlying Aromas Sand Formation and deep injection wells for direct recharge of the Santa Margarita Aquifer. While the number and spacing of wells shown on the figure are assumed fixed for planning purposes, the future basis of well design will be based on findings from this investigation and possibly later refined after installation and testing of the initial vadose zone and deep injection wells.

As shown on **Figure 2**, the proposed monitoring well (MRWPCA MW-1) is located along Eucalyptus Road approximately 1,200 feet north of the eastern end of the proposed GWR recharge corridor. Results of recent groundwater model flow simulations (Hydrometrics WRI, 2014) used to assess hydraulic impacts from the GWR project indicate that recycled water injected into the most northeastern proposed vadose zone well will flow towards and across MRWPCA MW-1.

1.3. PROJECT GOALS AND OBJECTIVES

The primary objectives of the field program were to collect representative hydrogeologic information in the vicinity of the proposed GWR project recharge site in order to 1) evaluate the technical feasibility of recharging advanced-treated recycled water to benefit target aquifers using shallow vadose zone and deep injection wells, 2) establish baseline groundwater level and quality conditions and a permanent monitoring point to comply with monitoring requirements set forth in the SWRCB DDW draft regulations for indirect potable reuse of advanced treated recycled water; and 3) support refinement of AWTF treatment objectives and recharge facility design and operational criteria.

To achieve these objectives, the field program focused on addressing the following key hydrogeologic issues:

- 1. Groundwater occurrence (depth to water table) in the GWR project area.
- 2. Lithologic and hydraulic properties (storage capacity and permeability) of vadose zone sediments and travel time of recycled water to the water table beneath vadose zone wells.
- 3. Potential recycled water quality changes beneath vadose zone wells as a product of geochemical reactions between recycled water and formation materials along vertical flow paths.

- 4. Potential local groundwater quality impacts in the Paso Robles Aquifer beneath vadose zone wells as a result of mixing between recycled water and shallow groundwater.
- 5. Potential local groundwater quality impacts in the Santa Margarita Aquifer in the vicinity of deep injection wells as a result of mixing between recycled water and shallow groundwater.
- 6. Existing ambient and future projected groundwater quality in the Paso Robles and Santa Margarita aquifers in comparison to drinking water standards and SWRCB DDW recycled water recharge guidelines.
- 7. Presence of site specific constituents of concern in unsaturated sediments and groundwater beneath vadose zone wells (potential for leaching by recycled water and subsequent groundwater quality impacts).

The monitoring well installed for this investigation was screened across the water table to allow tracking of advanced treated recycled water that will be recharged through vadose zone wells. Although the GWR project anticipates injection into both the Paso Robles Aquifer and the underlying deep Santa Margarita Aquifer, the shallow system was the primary focus of this field program. However, potential groundwater quality impacts in the Santa Margarita Aquifer as a result of direction injection of recycled water were also evaluated.

This investigation does not provide a quantitative assessment of the GWR project impacts on water levels, other production wells, and basin subsurface outflow to the ocean. To address such issues, the basin-wide numerical groundwater flow (MODFLOW) model developed by the Seaside Basin Watermaster is being used. HydroMetrics WRI (HydroMetrics), consultants to the Seaside Basin Watermaster, has been retained to simulate the proposed project including project alternatives in support of the EIR impacts assessment. Results of the modeling are presented in a series of separate technical memoranda (Hydrometrics, 2013 and 2014), which are also referenced and included as appendices in the GWR Project Recharge Impacts Assessment Report (Todd Groundwater, 2015).

1.4. SCOPE OF WORK

The scope of work developed for this field program included the following tasks:

- 1. Drill a deep exploratory soil boring penetrating the water table in the vicinity of the proposed GWR project recharge site.
- 2. Analyze selected soil cores for key lithologic, hydraulic, mineralogical, and contaminant leaching properties to support geochemical modeling objectives.

- 3. Design and install a dedicated GWR project monitoring well to monitor water table elevations and shallow groundwater quality.
- 4. Collect groundwater samples from the newly constructed monitoring well and other key wells in the vicinity of the GWR project recharge site to characterize the existing groundwater quality in the Paso Robles and Santa Margarita aquifers for drinking water, recycled water recharge, and additional site-specific constituents of concern.
- 5. Refine the site conceptual hydrogeologic model at the GWR recharge site; evaluate vertical and horizontal flowpaths and provide estimated subsurface travel times and mixing volumes between recycled water and groundwater.
- 6. Assess the compatibility of advanced-treated recycled water with local groundwater and the risk of potential groundwater quality impacts from proposed recharge operations through geochemical modeling.

1.5. REPORT ORGANIZATION

This report documents the field investigation activities, collected hydrogeologic information including laboratory analysis results, and the geochemical modeling assessment. Section 2 of this report describes the technical approach for drilling, pre-drilling planning, and key activities completed in the field. Section 3 summarizes the results of hydraulic, solid core mineralogy, core leaching, and groundwater quality analyses. Section 4 presents the refined conceptual hydrogeologic model of the GWR project recharge site and findings from the geochemical assessment used to evaluate potential groundwater quality impacts in target aquifers as a result of recycled water injection. Conclusions and recommendations are provided in Section 5, and key references are provided in Section 6.

Additional documentation of the field program is provided in appendices to this report. Appendix A includes copies of the FORA access/right-of-entry permit, City of Seaside Use/Minor Use and Encroachment permits, and Monterey County Health Department well drilling permit. Appendices B and C contain the downhole geophysical log and Department of Water Resources (DWR) well completion report for MRWPCA MW-1, respectively. Appendices D, E, and F respectively include the certified laboratory reports and chain-ofcustody forms from Cooper Testing (core hydraulic testing), McCampbell Analytical (core mineralogical and leaching testing), and Alpha Analytical (groundwater quality). Detailed documentation of the geochemical modeling approach, data inputs, and simulation results are presented in Appendix G. Selected photographs of the field program are included in Appendix H.

2. FIELD INVESTIGATION ACTIVITIES

This section documents the technical approach and key activities associated with the drilling, logging, and construction of the new monitoring well (MRWPCA MW-1); selection of laboratory analyses and core samples for characterization of hydraulic, mineralogical, and contaminant leaching properties; and groundwater quality sampling of MRWPCA MW-1 and five other local wells for drinking water, recycled water, and site-specific constituents of concern.

2.1. MONITORING WELL DRILLING AND CONSTRUCTION

2.1.1. Technical Approach

The sonic drilling method was selected for the drilling and installation of MRWPCA MW-1. The sonic drilling method is a dual-casing drilling method that uses high-frequency, resonant energy to advance an outer steel casing and inner steel core barrel into the subsurface. Commonly, no drilling fluid is needed during sonic drilling; however, water is sometimes added inside the drill string to prevent hydraulic surging and unconsolidated formation materials from entering the drill string. No water was needed for the drilling of MRWPCA MW-1.

The sonic drilling method provided the following advantages for the field investigation:

- Provides continuous, relatively undisturbed cores of the subsurface with high recovery rates and good sample integrity
- Requires little to no drilling fluid, preventing onsite storage in a sensitive environment and hauling large quantities of water to the drilling site
- Produces less waste material (approximately 80 percent less than conventional drilling methods such as mud rotary)
- Does not damage the borehole-formation interface, because there is no deposition of drilling muds; results in a more efficient well and requires less development time than other drilling methods.

To minimize the friction between the active outer drill casing and native materials, a telescopic borehole design was used for this investigation. Specifically, such an approach requires an outer casing to be advanced and left in place at a relatively shallow depth. A second smaller diameter outer casing is then advanced beyond the initial outer casing (and left in place to allow for a third smaller diameter casing, and repeated as needed). For this investigation, three outer casing strings (9, 8, and 7 inches in diameter) were used to achieve the total depth of drilling.

Because the entire length of the borehole is temporarily supported by steel outer casing at the completion of drilling, conventional downhole geophysical logging using electrical methods was not possible until after MRWPCA MW-1 was constructed and the steel casing

was removed. Prior to well development, a dual induction-natural gamma radiation log of MRWPCA MW-1 was completed.

2.1.2. Permits

Prior to field mobilization, MRWPCA obtained an encroachment permit (Permit #6416) and use/minor use permit (#Up-12-07) from the City of Seaside. Additionally, a right-of-entry permit was obtained from FORA, and a water well construction permit (#13-12301) was obtained from MCHD (copies of each permit are included in **Appendix A**).

In addition to the abovementioned permits, a utility clearance ticket was obtained from Underground Service Alert, and a temporary water use permit was obtained from Marina Coast WD to access water from a fire hydrant located on the southeast corner of General Jim Moore Boulevard and Eucalyptus Road.

2.1.3. MEC Training, Rig Mobilization, and Site Control

On the morning of December 16, 2013, all field personnel from Cascade Drilling Company, Inc. (Cascade) and Todd Groundwater, as well as representatives from MRWPCA, Monterey County MCHD, and City of Seaside participated in a 30-minute Munitions and Explosives of Concern (MEC) training course, coordinated by Arcadis U.S. on behalf of FORA. MEC training was also completed by field personnel from Welenco and Blaine Tech Services on January 27, 2014 prior to geophysical logging and water quality sampling activities performed for this investigation.

Following the MEC training, Cascade mobilized a 600T Sonic drill rig and support vehicles to the MRWPCA MW-1 site. A rectangular-shaped construction zone was delineated around the proposed monitoring well location using traffic pylons and caution tape in accordance with FORA and City of Seaside requirements (see inset on **Figure 2**). The dimensions of the construction zone were 100 feet in length (along Eucalyptus Road) and 75 feet in width (from the road median to approximately 50 feet southeast of the road). Core samples were contained at all times during the field program in the construction zone south of the sidewalk to provide safe access for logging and photography.

Traffic control measures, including Type 1 barricades (e.g., *Bike Lane Closed* and *Road Work Ahead* signs), were placed along Eucalyptus Road both uphill and downhill of the drilling work area in accordance with the City of Seaside traffic control guidelines (see inset of **Figure 2**). Additionally, a public notice describing the field program and associated City of Seaside permits was posted on the locked access gate at the intersection of Eucalyptus Road and General Jim Moore Boulevard and on lamp posts east of the work area. Photographs of the sonic drilling rig setup, site/traffic control measures, and public notice are provided in **Appendix H**.

Prior to the start of both shifts of work on December 16, 2013, Todd Groundwater conducted a health and safety plan (HSP) tailgate meeting with all Cascade field personnel to cover safety topics including the identification of key health and safety personnel,

potential physical hazards, and Personal Protection Equipment (PPE) requirements. Protective actions and the emergency response plan were also reviewed.

2.1.4. Drilling, Coring, and Logging of the Boring

Following hand-auguring of borehole for the first 10 feet for precautionary reasons, sonic drilling was conducted on a 24-hour basis over three days from 1 pm on December 16, 2013 to 11 am on December 19, 2013. A total drilling depth of 535 feet below ground surface (feet-bgs) was achieved. During drilling, the inner casing (core barrel) was vibrated 10 feet ahead of the outer casing to collect relatively undisturbed formation cores. At 10-foot intervals, the core barrel was brought up to the surface, and the soil core was extruded into Visqueen plastic sleeves in 2.5-foot increments and temporarily stored in wooden core boxes. A telescopic borehole design was used, resulting in a boring with decreasing diameter with depth. Specifically, a 9-inch outer diameter casing was advanced to 160 feet, an 8-inch outer casing was advanced to 400 feet, and a 7-inch outer casing was advanced to 530 feet. Sediment cores were extracted in the upper 400 feet of boring with a 7-inch diameter core barrel and from 400 to 535 feet-bgs with a 6-inch core barrel. Based on the final boring diameters and depths, approximately 135 cubic feet (5 cubic yards) of formation material were removed from the boring.

Core samples were examined, described, and photo-logged in the field by a Californialicensed Professional Geologist from Todd Groundwater. **Figure 5** shows the geologic log developed from examination of soil cores for MRWPCA MW-1. Additionally, detailed lithologic descriptions are presented in the DWR well completion report in **Appendix C** and photographs of selected core samples are shown in **Appendix H**. Selected soil cores were transported under chain-of-custody to respective laboratories for additional analysis (see **Section 2.1.8** for details). All remaining soil cores were removed from plastic sleeves and wooden storage boxes and spread evenly within the soil laydown area (south of the sidewalk within the work area) in accordance with FORA requirements.

2.1.5. Well Construction

MRWPCA MW-1 was successfully constructed over a 28-hour period from 12 PM on December 19, 2013 to 4 PM on December 20, 2013. The well profile of MRWPCA MW-1 is provided on **Figure 5**, and well completion details are included on the first page of DWR well completion report in **Appendix C**. As shown in the figure and well completion report, MRWPCA MW-1 was completed to a depth of 521 feet-bgs using 3-inch diameter Schedule 80 PVC well casing (3.5-inch outside diameter with wall thickness of 0.6-inch) and screen. Native material was used to backfill the borehole from 521 to 535 feet-bgs.

A total of 75 feet of 0.020-inch slotted well screen was installed from 421 to 446 feet-bgs and from 466 to 516 feet-bgs opposite coarse-grained sediments below the water table. The water table was measured at 405 feet-bgs following initial placement of the well casing/screen assembly on December 19, 2013 and 405 feet below the top of PVC casing (feet below TOC) following completion of well development on January 28, 2014). The well screen was positioned to maximize the utility of the well to characterize ambient and future groundwater levels and quality. A stainless steel well centralizer was placed at 465 feet on the screen assembly to ensure a consistent thickness of artificial filter pack and bentonite/cement around the PVC casing/screen assembly.

Following placement of the PVC casing and screen assembly, artificial filter pack material (#3-graded Monterey Beach sand) was tremied into the annular space (between the PVC casing and temporary outer steel casing) from the bottom of the well to 10 feet above the top of the upper well screen. Bentonite pellets were then tremied and hydrated to create a well seal from 50 to 411 feet-bgs. Adequate time for hydration (and expansion) of the bentonite pellets was allowed prior to sealing the annulus with cement-bentonite grout from 50 feet-bgs to just below ground surface. A total of 54 bags of 47-pound Portland cement were mixed with 300 gallons of water. A tremie pipe was used to slowly pour the cement-bentonite grout seal while the drive casing was simultaneously removed. The cement seal was tremied into the annulus from approximately 2 to 4 AM on December 20, 2013. The well was completed at the surface with a 12-inch diameter, bolted wellbox vault with locking lid seated in a 36-inch diameter by 14-inch deep cement collar tinted lamp black in color in accordance with City of Seaside requirements. Photographs of the well installation and surface completion are provided in **Appendix H**.

2.1.6. Well Development and Geophysical Logging

Well development activities were performed to ensure that residual sediment and turbidity in the well were removed prior to geophysical logging and groundwater quality sampling. Well development of MRWPCA MW-1 was conducted over a two-day period on January 27 and 28, 2014 using a combination of swabbing, bailing, and pumping. All development water was temporarily stored in holding tanks on the Smeal rig to suspended sediment to settle prior to decanting the partially clarified water from the top of the holding tanks. Development water was discharged to the nearest storm drain inlet on Eucalyptus Road as approved by the City of Seaside. The storm drain system routes water to subsurface infiltration galleries that ultimately recharge the groundwater system.

On the morning of January 27, 2014, Cascade mobilized a well development rig to the MRWPCA MW-1 site. Initial sounding of the well revealed that 20 feet of fine silt had collected at the bottom of the well, which is typical following well construction. This sediment was removed from the well by bailer. Following initial bailing and prior to swabbing, geophysical logging of MRWPCA MW-1 using dual induction-natural gamma radiation detection tools was performed by Welenco from 11:15 AM to 12:45 PM on January 27, 2014. Geophysical logs are reproduced on **Figure 5** to allow cross-referencing with the geologic log and well profile. The original geophysical log printouts are provided in **Appendix B**.

After the geophysical logging, the well was swabbed and bailed for an additional 10 hours (on January 27 and 28, 2014). Swabbing was accomplished using a surge block for the entire length of each well screen interval. Approximately 30 gallons of development water were bailed from the well at the completion of swabbing and stored in temporary holding tanks on the development rig. A 3-inch diameter, 0.75-horsepower submersible pump (Grundfos

5SQE 07-320) was then installed in MRWPCA MW-1 with the pump intake set at 450 feet below TOC. Pumping commenced at a 12:45 PM at a discharge rate of 1.0 gpm. The pumping rate was gradually increased to a maximum rate of 3.8 gpm. The pump was turned off after 3 hours of pumping at 3:45 PM, at which time pumped water was relatively turbidity-free. A total of 400 gallons of development water were bailed/pumped, temporarily stored in tanks, and eventually discharged to the storm drain. Prior to turning off the pump, the water level in the well had stabilized at 411 feet below TOC; the water level in the well recovered to pre-pumping conditions (405 feet below TOC) within 20 minutes after the pump was turned off.

2.1.7. Hydrogeologic Conditions

Figure 5 depicts the subsurface hydrogeologic conditions encountered during drilling and well construction details for MRWPCA MW-1. As illustrated in the figure (and detailed geologic log in **Appendix C**), the upper 392.5 feet of drilling encountered predominately well-sorted, fine to medium-coarse sand and silty sand with occasional thin lenses of sandy silt. Sediment color was consistent and ranged from light brownish-yellow to dark yellowish-brown. The induction log confirms the presence of fine-grained silt in the Aromas Sand Formation from 295 to 300 feet-bgs and silt and silty, sandy clay deposits interbedded with fine- to medium-coarse sand from 317 to 341 feet-bgs. These sediments are representative of the Aromas Sand.

It is possible that the silt/clay lenses observed in the lower Aromas Sand correspond to "sand and clay" units observed in the Aromas Sand at Well FO-07 to the east (see **Figure 2** for well location) from 190 to 210 feet-bgs and from 240 to 260 feet-bgs (MPWMD, 1994). However, geologic information (including electrical resistivity logs) for three wells along General Jim Moore Boulevard – the Paso Robles Test Injection Well (PRTIW), Santa Margarita Test Injection Well (SMTIW), and Seaside Middle School Test Well (see **Figure 2** for well locations) – do not confirm the presence of any silt/clay lenses in the Aromas Sand (Fugro West, Inc., 1998; Padre Associates, Inc., 2002; and Pueblo Water Resources, Inc., 2012). Additionally, the well completion report for the Golf Course Reservoir well adjacent to MRWPCA MW-1 does not indicate any silt or clay in the Aromas Sand. Based on these existing data, it appears that while the silt/clay deposits observed in the lower Aromas Sand at MRWPCA MW-1 may occur beneath the GWR project recharge site, these finer-grained deposits likely pinch out to the west (by General Jim Moore Boulevard) and north (by the Golf Course Reservoir Well).

At 392.5 feet-bgs, a clear lithologic transition was observed in core samples and confirmed in the geophysical logs. Sediments immediately below this transition are composed predominantly of dark grey, dense sandy silt and silty clay. This transition represents the boundary between the Aromas Sand and underlying Paso Robles Formation. Reddish-brown sand deposits observed at FO-7 (see **Figure 2**) and interpreted as the contact between the Aromas Sand and Paso Robles formations (MPWMD, 1994) were not encountered at MRWPCA MW-1. The water table was measured at 405 feet-bgs in MRWPCA MW-1, or about 12.5 feet below the geologic contact between the Aromas Sand and Paso Robles formations. Core samples and geophysical logs indicate that the upper 140 feet of the Paso Robles Formation is highly heterogeneous and characterized by relatively thick (typically 10 to 20 feet), alternating fine-grained and coarse-grained deposits. Well-rounded white chert cobbles up to 2 inches in diameter and partially consolidated sediments were observed from about 488 to 510 feet-bgs. Sediments encountered in the final 15 feet of drilling were composed of semiconsolidated olive grey, sandy-silty clay with white rock fragments (possibly volcanic ash origin) as large as 6 inches in diameter. The fragments were reactive to acid, indicating the presence of calcium carbonate. It is noted that the apparent lithologic anomaly in the induction log from 460 to 470 feet-bgs is caused by the steel centralizer installed on the well casing/screen assembly.

2.2. LABORATORY ANALYSIS OF SELECTED CORE SAMPLES

Figure 6 shows the depth intervals from which soil cores were selected for laboratory analysis. The soil core analysis program was scoped to characterize the hydraulic and geochemical properties of the deep vadose zone at the GWR project recharge site. Hydraulic analyses were used to provide an estimate of vertical percolation rates and storage capacity of the vadose zone. Geochemical analyses supported geochemical modeling to screen for constituents of concern in vadose zone sediments that may be leached by water recharged via vadose zone wells and thus potentially impact local groundwater quality. Additional information on the core analysis program is presented below.

2.2.1. Core Hydraulic Testing

As shown in **Table 1**, core samples from 19 depth intervals (ranging from 27.5 to 420 feetbgs) were submitted to Cooper Testing Labs in Palo Alto, California for analysis of hydraulic properties, including (saturated) vertical hydraulic conductivity and total and effective porosity. Selected core hydraulic analyses provide information necessary to estimate the available storage and subsurface travel time of recycled water in the vadose zone.

Core samples were selected to allow for characterization of the varied lithologies composing the vadose zone. While preliminary design of vadose zone and direct injection wells assume a screen interval below 150 feet-bgs, long-term maintenance will require pumping and disposal of development water in onsite percolation ponds. Thus, the hydraulic and storage properties of sediments in the upper 150 feet of Aromas Sand were also analyzed.

For each selected depth interval, soil samples were extracted from cores contained in sonic drilling core bags using 3-inch diameter, 6-inch long brass tubes and capped with plastic caps and Teflon tape. It is noted that while extraction resulted in minor sample disturbance, the core structure was effectively preserved with minimal re-packing of brass tubes. One brass tube sample for each of the 19 depth intervals was collected and submitted for vertical hydraulic conductivity analysis. Additionally, one brass tube for 15 of the 19 depth intervals was collected and submitted for total and effective porosity analyses.

	Discrete Formation Samples								
Sample Interval (feet-bgs)	USCS Lithology Type	Lithologic Description	(Kv)	Porosity					
27.5 - 30.0	SP	10YR 6/6 Yellowish brown fine sand, moist	x	x					
58.0 - 60.5	SP-SM/SP	58.0-59.0 10YR 5/9 Yellowish brown silty fine sand lenses, dry; 59.0-60.5 10YR 5/9 Yellowish brown fine	x	x					
98.5 - 101	SP-SM	10YR 6/6 Yellowish brown silty fine sand lenses, dry	x	x					
124.5 - 127	SP-SM	10YR 6/6 Yellowish brown silty fine sand, dry	x	x					
139.5 - 142	SP	10YR 5/8 Yellowish brown fine sand, dry	x	x					
174.5 - 177.0	SP	10YR 6/6 Yellowish brown silty fine sand nodules, dry	x	x					
197.0 - 200.0	SM	10YR 6/6 Yellowish brown silty fine sand, dry	x	x					
223.0 - 225.5	SP	10YR 6/6 Yellowish brown fine sand with minor silt, dry	x	x					
259.5 - 262.0	SP	10YR 5/6 Dark yellowish brown fine sand, very moist	x	x					
274.5 - 277.0	SP	10YR 5/6 Dark yellowish brown fine sand, dry	x	x					
297.0 - 298.5	ML	10YR 3/4 Dark yellowish brown dense clayey silt with fine sand, moist	x	NA					
298.5 - 301.0	ML/CL/SP	298.5-300.0 10YR 6/4 Light yellowish brown sense clayey silt with fine sand, moist; 300.0-300.7 10YR 6/4 Light yellowish brown silty clay, moist; 300.7-301.0 10YR 7/3 Very pale brown silty fine sand, dry	x	x					
324.5 - 327	CL/ML	324.5-325.0 10YR 5/4 Yellowish brown silty clay (10/90), moist;	×	x					
337.0 - 339.0	CL	10YR 6/6 Yellowish brown fine sandy, silty, clay (20/20/60), moist	x	NA					
349.5 - 352.0	SP	10YR 5/8 Yellowish brown fine to medium coarse sand (70/30), dry	x	x					
357.0 - 359.5	SW	10YR 6/4 Light yellowish brown fine to coarse sand, dry	x	x					
377.0 - 379.5	SP	10YR 6/6 Yellowish brown very fine sand, dry	x	x					
405.0 - 407.5	ML	10YR 3/1 Very dark gray clayey silt, very dense, dry	x	NA					
417.5 - 420.0	ML	10YR 4/3 Brown fine to medium coarse sandy silt (40/60), dry	x	NA					

Table 1. Summary of Core Hydraulic Testing

Notes:

NA = not analyzed

Vertical K (KV) = saturated vertical hydraulic conductivity feet-bgs = feet below ground surface The four depth intervals not analyzed for porosity represented fine-grained deposits in the vadose zone and sediments below the water table. Saturated vertical hydraulic conductivity testing was performed on the two saturated core samples (below 405 feet-bgs) to provide a basis for estimation of horizontal hydraulic conductivity in the upper Paso Robles Aquifer.

Results of core hydraulic testing are presented in **Section 3** along with discussion of storage capacity and subsurface travel time. Laboratory reports from Cooper Testing and the chain-of-custody form are presented in **Appendix D**.

2.2.2. Solid Core, Extraction, and Leaching Test Analyses

A solid core, extraction, and core leaching test program was developed to assess the potential for anthropogenic and naturally-occurring constituents to be leached or dissolved as a result of proposed GWR project recharge. A subset of core samples was analyzed for various properties to support the geochemical modeling assessment, which was used to predict 1) potential changes in recycled water quality along vertical flow paths through the Aromas Sand and unsaturated portion of the Paso Robles Formation and 2) potential groundwater quality impacts to the Paso Robles Aquifer.

2.2.2.1. Solid Core Analyses

Table 2 summarizes the solid core analyses conducted for this investigation. As shown in the table, soil cores from 10 depth intervals ranging from 27.5 to 474.5 feet-bgs were submitted to McCampbell Analytical in Pittsburg, California for analysis of mineralogical properties and presence of other parameters, including naturally-occurring chemicals found in the Aromas Sand and anthropogenic chemicals that have been detected in soil at the Inland Ranges that may be solubilized. Mineralogical analysis serves to define the overall bulk formation chemistry and character of the vadose zone and the potentially affected Paso Robles Aquifer. It is also needed to understand source(s) of naturally-occurring constituents in the formation that may be dissolved by recharge water and impact shallow groundwater.

2.2.2.2. Hydroxylamine-Hydrochloride Extraction (HA-HCl) Test

As shown in **Table 2**, a Hydroxylamine-Hydrochloride Extraction Test for Ferric Hydroxide (Mahoney Geochemical Modeling, 2013) was also performed on two samples from the Aromas Sand (200.0 - 202.5 feet-bgs and 364.5 - 367.0 feet-bgs). This procedure was selected to measure the amount of hydrous ferric oxide (HFO) in a soil sample, which may be critical in estimating the potential for metals (including arsenic, chromium, and divalent metals) to desorb into solution as recharged water flows through the Aromas Sand.

		Disc	crete Formation Samples					Soil Core	Analyses					
McCampbell					Mineral	logical		Other Parameters						Hydroxylamine-
Analytical Work Order Number	Sample Interval (feet-bgs)	USCS Lithology Type	Lithologic Description	XRD with quantitative phase analysis	Resin impregnation thin section	SEM - EDA Analysis	XRF or Total Dissolution	Exchangable Cations using Ammonium Acetate	Phosphorus	Chromium VI	Perchlorate	TOC - TN by combustion	Nitroaromatic Compounds (explosives)	Hydrochloride (HA-HCl) Extraction for Ferric Hydroxide
	27.5 - 30.0	SP	10YR 6/6 Yellowish brown fine sand, moist	х	х	х	х	х	x	х	х	х	x	NA
	74.0 - 75.5	SP/ML	10YR 6/6 Yellowish brown fine sand with minor silt lenses and nodules, dry (74.0 - 75.0) 10YR 4/6 Dark yellowish brown silt with minor fine sand and clay, dry (75.0 - 75.5)	х	х	x	x	х	x	x	x	x	x	NA
	98.5 - 101.0	SP-SM	10YR 6/6 Yellowish brown silty fine sand lenses, dry	х	х	х	х	Х	х	х	х	х	х	NA
1312545	139.5 - 142.0	SP	10YR 5/8 Yellowish brown fine sand, dry	х	х	х	x	Х	х	х	x	х	х	NA
	200.0 - 202.5	SM	10YR 6/8 Brownish yellow silty fine sand, dry	х	х	x	х	Х	х	х	х	х	х	х
	297.0 - 298.5	ML	10YR 3/4 Dark yellowish brown dense clayey silt with fine sand, moist	х	х	x	x	х	x	x	x	x	x	NA
	364.5 - 367.0	SP	10YR 6/6 Yellowish brown medium coarse to coarse sand, dry	х	х	х	x	х	x	х	x	x	x	х
	398.5 - 401.0	ML	10YR 3/1 Very dark gray clayey silt, very dense, dry	х	х	х	x	Х	x	x	x	x	x	NA
1312650	433.0 - 435.0	SP	10YR 4/4 Dark yellowish brown silty fine sand, moist	х	х	х	x	х	х	x	x	х	x	NA
	472.0 - 475.5	SM-SC/SM	SYR 5/3 Olive silty, clayey fine to medium coarse sand (30/10/60), wet (472.0 - 474.0) SYR 5/3 Olive silty fine sand (40/60), wet (474.0 - 475.5)	х	х	x	x	х	x	x	x	х	x	NA

Table 2. Summary of Solid Core Analyses and Hydroxylamine-Hydrochloride (HA-HCl) Extraction Test

Notes:

NA = Not Analyzed

SEM - EDA = Scanning Electron Microscopy-Energy Dispersive X-Ray Analyzer

TOC = Total organic carbon

TN = Total nitrogen

XRD = Energy Dispersive X-Ray Analysis

XRF = X-Ray Florescence (combined with total dissolution provides major elements as oxides)

2.2.2.3. Core Leaching Test Analysis

Table 3 summarizes the core leaching test analyses conducted for this investigation.

A modified Toxicity Characteristic Leaching Procedure (TCLP) test was performed by McCampbell Analytical on 8 of the 10 core samples analyzed for mineralogical properties. The traditional TCLP is a regulatory procedure principally designed to determine mobility of organic and inorganic analytes in liquid, solid, and multiphasic wastes principally from soil samples to simulate leaching through a landfill. TCLP extraction normally uses an acetic acid extraction under simulated short term (18 and 48 hours) and long-term (48–84 days) conditions.

The leaching test procedure used for this investigation utilizes the same equipment in the USEPA TCLP Extraction method; however, the acetic acid extraction method was determined to be overly aggressive for estimating the leaching potential of recycled water through vadose zone sediments at the GWR recharge site. Therefore, the following modifications were made to provide the most meaningful results in support of the geochemical modeling assessment:

- 1. The acetic acid/sodium hydroxide leaching solution used in the TCLP Extraction method was replaced with stabilized pilot recycled water to more accurately simulate subsurface geochemical conditions during recharge.
- 2. The 1-to-20 ratio of soil-to-leachate solution used in the TCLP Extraction method was increased to 1-to-5 and tumbling time was increased to 7 days (tumbling time for the TCLP Extraction method is 18 hours) to more closely represent actual field conditions during recharge and to increase the sensitivity of the leaching test to characterize leaching potential.
- 3. Collection of final leachate in 60 mL vials and centrifuging at 2,500 rpm for 12 hours (prior to filtering leachate through 0.45-micron filter paper) to address elevated turbidity in leachate observed in leaching test trials.

The eight samples are representative of the varied lithologies in the Aromas Sand and upper Paso Robles Aquifer. Leaching tests were not performed for the shallowest (27.5 - 30.0 feet-bgs) or deepest (472.0 - 474.5 feet-bgs) samples submitted to McCampbell Analytical, as the former sample is above future vadose zone injection well screens, and the latter sample is the deeper of two core samples below the water table.

To provide a reliable estimate of the leaching potential during recharge, stabilized pilot recycled water provided by MRWPCA's AWTF design engineer, Trussell Technologies, Inc. (Oakland, California) was supplied to McCampbell Analytical under chain-of-custody and used in the leaching tests. To mimic the proposed GWR project recycled water, Trussell Technologies collected reverse-osmosis (RO) permeate from the MRWPCA pilot AWTF and stabilized the permeate using a bench-scale, post-treatment stabilization unit to more

		Disc	crete Formation Samples								L	eachate Te	est using Stat	oilized Pi	lot Recycle	d Water						
McCampbell Analytical		116.66		Major	Title 22	Trace			Anions	-	-		_		Other l	ons/Compour	nds		_	Addi	tional Param	eters
Work Order	Sample Interval	Lithology	Lithologic Description	Cations	CAM 17	lons	Nitrate						Chromium		Inorganic					Total and		Langelier
Number	(1000 - 20)	Туре		and Anions	Metals (plus Al)	(Fe, Mn, Li, Sr, Zn)	Nitrite	ткл	Ammonia	Flouride	Bromide	Chlorine	VI	DOC	as CO ₂	Phosphorus	Silicon	Sulfide	Uranium	Alkalinity	Turbidity	Index
	74.0 - 75.5	SP/ML	10YR 6/6 Yellowish brown fine sand with minor silt lenses and nodules, dry (74.0 - 75.0) 10YR 4/6 Dark yellowish brown silt with minor fine sand and clay, dry (75.0 - 75.5)	х	x	x	x	x	x	х	x	x	x	x	x	x	х	x	x	x	х	x
	98.5 - 101.0	SP-SM	10YR 6/6 Yellowish brown silty fine sand lenses, dry	х	х	x	x	х	x	х	x	х	х	х	х	x	х	x	x	x	х	x
1312545	139.5 - 142.0	SP	10YR 5/8 Yellowish brown fine sand, dry	х	х	х	х	х	x	х	х	х	x	х	х	x	х	x	x	х	х	x
	200.0 - 202.5	SM	10YR 6/8 Brownish yellow silty fine sand, dry	х	x	x	x	х	x	х	x	х	x	x	х	x	х	x	x	x	x	x
	297.0 - 298.5	ML	10YR 3/4 Dark yellowish brown dense clayey silt with fine sand, moist	x	x	x	x	x	x	х	x	x	x	x	x	x	х	x	x	х	х	x
	364.5 - 367.0	SP	10YR 6/6 Yellowish brown medium coarse to coarse sand, dry	х	x	x	x	х	х	х	х	х	x	x	х	x	х	x	x	х	х	x
1312650	398.5 - 401.0	ML	10YR 3/1 Very dark gray clayey silt, very dense, dry	x	x	x	x	x	x	х	x	x	x	x	x	x	х	x	x	x	х	х
1312030	433.0 - 435.0	SP	10YR 4/4 Dark yellowish brown silty fine sand, moist	х	x	х	x	х	х	х	x	х	x	х	x	x	х	x	x	х	х	х

Table 3. Summary of Core Leaching Test Analyses

Notes:

Al = aluminum

Ca = Calcium

DOC = Dissolved Organic Carbon

Fe = Iron

Mg = Magnesium

Mn = Manganese

SEM - EDA = Scanning Electron Microscopy-Energy Dispersive X-Ray Analyzer

TKN = Total Kjeldahl Nitrogen

TOC = Total organic carbon

TN = Total nitrogen

XRD = Energy Dispersive X-Ray Analysis

XRF = X-Ray Fluorescence (combined with total dissolution provides major elements as oxides)

closely approximate the water quality anticipated from the full-scale AWTF. Stabilization methods included the addition of calcium as calcium chloride (CaCl₂) and sodium hydroxide (NaOH) to increase alkalinity followed by bubbling of CO₂ gas into the RO water to decrease the pH to a target goal. The Langelier Saturation Index (LSI) and pH thresholds established for full-scale RO permeate stabilization for the Orange County Water District (OCWD) Groundwater Replenishment System (GWRS) were used to guide stabilization. A total of 32 liters of stabilized pilot recycled water was supplied for the leaching tests.

Additional description of the leaching test procedure is provided in the McCampbell Analytical laboratory report provided in **Appendix E**.

Leaching tests provide an estimate of the potential for leaching constituents from the vadose zone during injection. The analysis is conservative, because the stabilized pilot water is slightly more aggressive (as indicated by a negative LSI value) than the proposed final recycled water from the full-scale AWTF. Depending on the results of the leaching analyses and geochemical modeling from this investigation, the stabilization process for the final recycled water may be modified to prevent any potentially undesirable impacts to groundwater quality.

Final leachate was analyzed for the following parameters:

- CCR 17 metals, including arsenic and chromium
- Major cations and anions
- Nitrogen species (nitrate, nitrite, total ammonia, TKN)
- Total and Speciated Alkalinity
- Phosphorus
- Silicon
- Chromium(VI)
- Chlorine
- DOC and Inorganic Carbon as CO₂
- Sulfide
- Oxygen Reduction Potential (ORP)
- pH
- Turbidity

Perchlorate and nitro-aromatic (explosive) compounds were not detected in solid core samples; therefore, these constituents were not analyzed in leachate. Additionally, due to sample volume limitations, leachate was not analyzed for total and dissolved oxygen, specific conductance, and LSI.

Prior to the leaching tests, stabilized pilot water was analyzed for the same parameters analyzed in leachate, including total and dissolved oxygen, specific conductance, and LSI.

Results of core leaching tests are presented in **Section 3**, and pertinent laboratory reports and chain-of-custody forms are provided in **Appendix E**.

2.2.3. Soil Volume Removed from Investigation Site

Overall, approximately 36,000 cubic centimeters (0.05 cubic yards) of formation material were removed from the project site. About 24,000 cubic centimeters (or 0.03 cubic yards) of formation material were removed in 34 brass tubes for hydraulic analysis. An additional 12,000 cubic centimeters (0.02 cubic yards) of formation material were removed in glass sample bottles for mineralogical and leaching test analyses.

2.3. GROUNDWATER QUALITY SAMPLING

Groundwater quality samples were collected from MRWPCA MW-1 and five other wells in the vicinity of the GWR project recharge site for this investigation. All sampling was performed by field technicians from Blaine Tech Services (Blaine Tech) based out of San Jose, California. Sampling was performed over three days (January 29 and 30 and February 3, 2014). To satisfy laboratory minimum holding times for specific analyses, groundwater quality samples were picked up and transported by courier under chain-of-custody to Alpha Analytical Laboratories in Ukiah, CA by 3 PM each day.

2.3.1. Wells Sampled

The five wells sampled in addition to MRWPCA MW-1 include three monitoring wells (FO-07 Shallow, FO-07 Deep, and Santa Margarita ASR MW), one irrigation well (Paso Robles Test Injection Well [PRTIW] at Mission Memorial Cemetery), and one municipal production well (City of Seaside Well 4). Well locations are shown on **Figure 2**. Pertinent well information is provided in **Table 4**.

Table 4.Summary of Groundwater Quality Well Sampling Program

Sample Date	Well	Aquifer	Owner	Туре	Pump	Sampling Method	Casing Material Type	Top Screen (feet-bgs)	Bottom Screen (feet-bgs)	Depth to Water ¹ (feet-TOC)
01/29/14	MRWPCA MW-1	PR	MRWPCA	Monitor	Bladder	LDPE tubing	PVC	421	516	404.7
01/29/14	PRTIW	PR	Mission Memorial	Production	Existing	Inline spigot	STEEL	345	445	
01/30/14	FO-07 Shallow	PR	MPWMD	Monitor	Bladder	LDPE tubing	PVC	600	640	453.4
01/30/04	ASR MW-1	SM	MPWMD	Monitor	Existing	Inline spigot	STEEL	480	700	
02/03/14	FO-07 Deep	SM	MPWMD	Monitor	Bladder	LDPE tubing	PVC	800	840	491.3
02/03/14	City of Seaside #4	PR	City of Seaside	Production	Existing	Inline spigot	STEEL	330	550	

Notes:

There is blank casing from 590 to 610 feet-bgs in ASR MW-1

PVC = poly vinyl chloride

PR = Paso Robles Aquifer

SM = Santa Margarita Aquifer

A brief description of the five wells sampled in addition to MRWPCA MW-1 for this investigation is provided below:

FO-7 Shallow and FO-7 Deep: Owned by MPWMD, FO-7 is a nested well located along Eucalyptus Road approximately 2,000 feet northeast of MRWPCA MW-1. One well (FO-7 Shallow) is screened in the Paso Robles Aquifer (600 to 640 feet-bgs), while the other well (FO-07 Deep) is screened in the Santa Margarita Aquifer (800 to 840 feet-bgs). Both wells have long-term water level measurements and are being used to assess local groundwater flow conditions. Due to the small casing diameter (2-inch) and significant depth to water (>450 feet-TOC) in both wells, water quality samples have not been collected from these wells prior to this field program.

Santa Margarita ASR Monitoring Well MW-1: Owned by MPWMD, this well is a formal Margarita ASR site monitor well and is currently used to monitor groundwater quality for the Santa Margarita ASR project. The well has an upper screen from 480 to 590 feet-bgs and a lower screen from 610 to 700 feet-bgs. The well was sampled from a sampling port (spigot) on the existing discharge line. Water was pumped using the existing pump.

PRTIW at Mission Memorial Cemetery: Owned by Mission Memorial Cemetery, the PRTIW well is located west of General Jim Moore Boulevard across from the Santa Margarita ASR wells. This well is screened in the Paso Robles Aquifer from 345 to 445 feet-bgs. The well was sampled from a spigot using the existing pump.

<u>City of Seaside 4:</u> Owned by the City of Seaside, this well is located southwest of the GWR project recharge site west of General Jim Moore Boulevard and south of San Pablo Avenue. The well is screened is screened from 330 to 550 feet-bgs in the Paso Robles Aquifer. The well was sampled from a spigot using the existing pump.

2.3.2. Sampling Procedures

Blaine Tech utilized a low-flow, micro-purge bladder pump (Model QED ST1102) with disposable low-density polyethylene (LDPE) drop tubing to sample MRWPCA MW-1 and both FO-7 wells. A flow-through cell (YSI Model 556) was placed on the discharge line, providing real-time measurement of ORP, dissolved oxygen, pH, temperature, specific conductance, and turbidity. Groundwater quality samples were collected once stability in field parameters was achieved. Elevated turbidity was observed during sampling of all three wells (~80 NTU for MRWPCA MW-1, ~150 NTU for FO-7 Shallow, and ~40 NTU for FO-7 Deep).

Existing pumps and spigots were used to collect groundwater quality samples from the Santa Margarita ASR Monitoring Well, PRTIW, and City of Seaside 4. For this reason, measurements of ORP, pH, temperature, and turbidity were performed only once. Due to the method of sampling from a spigot and the potential for reaction between the water sample and oxygen in the atmosphere, it is likely that ORP measurements overestimate the oxidation potential of water sampled from these wells.

Groundwater quality samples were not filtered in the field prior to collection in sample bottles provided by Alpha Analytical. To satisfy laboratory minimum holding times for all requested analyses, groundwater quality samples were picked up and transported by courier under chain-of-custody to Alpha Analytical Laboratories in Ukiah, CA.

2.3.3. Laboratory Analyses

The groundwater analytical program developed for this investigation considers former land uses with Fort Ord, regulatory requirements for SWRCB DDW Groundwater Replenishment and Reuse (GRRP) projects, and potential site-specific contamination issues. Objectives of the sampling program included the following:

- Characterize the local water quality of the Paso Robles and Santa Margarita aquifers
- Evaluate the source and age of groundwater and timing of recharge in the Paso Robles Aquifer
- Provide data for SWRCB DDW-required baseline sampling for recycled water recharge
- Test for Fort Ord constituents of concern in the area

SWRCB DDW regulations were used to develop a list of parameters for analysis. At a minimum, the draft regulations require analysis of the following Groundwater Replenishment Reuse Project (GRRP) constituent categories in downgradient monitoring wells:

(1) Priority Toxic Pollutants [chemicals listed in the Water Quality Standards, Establishment of Numeric Criteria for Priority Toxic Pollutants for the State of California, and 40 CFR Part 131, Federal Register 65(97), May 18, 2000, p. 31682] specified by the SWRCB DDW, based on review of the GRRP's engineering report

(2) Chemicals with notification levels that the Department has specified, based on a review of the GRRP's engineering report and the affected groundwater basin(s); and

(3) Other chemicals that the SWRCB DDW may specify based on site-specific conditions.

For item (3) above, a complete suite of inorganic analyses that included major anions and cations and total dissolved solids (TDS) were analyzed, allowing for an overall characterization of the groundwater chemistry. Nitrogen compounds and total organic carbon were also included in the analytical program. Nitroaromatic/nitramine compounds detected in soil in the Inland Ranges and further in selected core samples from this investigation were analyzed in groundwater samples. Finally, general physical parameters including hardness, odor, color and turbidity were also included.

The final component of the analysis program includes analytes that provide information on the timing of natural recharge and provide a source signature for the groundwater sample. These data provide an indication of whether groundwater in nearby wells originates from the same source area and provide insight into flow paths and travel times. For this investigation, stable isotopes (oxygen/hydrogen and nitrogen/oxygen) and radiogenic isotopes (tritium) were analyzed.

3. LABORATORY ANALYTICAL RESULTS

This section presents the results of laboratory core (hydraulic, mineralogical, and leaching test) and groundwater quality analyses conducted for this hydrogeologic investigation. Evaluations of vadose zone storage capacity and estimates for subsurface travel time of recharge water are presented. Additionally, the relevance is discussed of core mineralogical/leaching test results and groundwater quality analyses to the geochemical assessment of recycled water and local groundwater compatibility.

3.1. CORE HYDRAULIC TESTING

Results of the core hydraulic testing are shown in **Table 5**. Statistical measures are discussed for sample groups based on their general lithology. Accordingly, samples of similar lithology are highlighted in the table as follows: coarse-grained sediments (USCS type = SP, SW, or SM) are highlighted in yellow and fine-grained sediments (USCS type = ML or CL) are highlighted in brown.

3.1.1. Total and Effective Porosity

As shown in **Table 5**, the total porosity of Aromas Sand samples (above 405 feet-bgs) falls within a relatively narrow range from 34 to 50 percent. The average total porosity for coarse-grained samples (45 percent) is only slightly higher than that for fine-grained samples (39 percent). In contrast, the effective porosities of Aromas Sand samples cover a relatively broad range from 4 to 40 percent. The average effective porosity for coarse-grained samples in the Aromas Sand (34 percent) is much higher than that for fine-grained samples (9 percent). As shown in the table, the total porosity for each sample can be divided into two components: water-filled and air-filled porosity. Closer examination reveals that the air-filled porosity is similar to the corresponding effective porosity for each sample. This relationship is expected, given that the effective porosity is effectively synonymous with specific yield, which is defined as the amount of water that a unit volume of aquifer (after being saturated) yields by gravity. Due to the smaller pore spaces and limited connection between pores, a fine-grained sediment (silt/clay) typically has a much lower effective porosity/specific yield compared to a coarse-grained sediment (sand).

3.1.2. Vertical Hydraulic Conductivity

As shown in **Table 5**, the estimated (saturated) vertical hydraulic conductivity (Kv) of selected samples covers a broad range (from 0.002 feet per day [feet/day] to greater than 300 feet/day). The average Kv for coarse-grained samples within the Aromas Sand is much higher than that for fine-grained samples. Remarks made in the laboratory reports indicate that laboratory Kv estimates for coarse-grained sediments in the Aromas Sand are likely overestimated as a result of fines migrating out of the sample during the saturation and testing phases. Based on these remarks, a Kv estimate of 20 feet/day for coarse-grained deposits within the Aromas Sand is assumed to be representative of actual in-situ Kv values.

		Discrete Formation Samples	Total Porosity	Air-filled Porosity	Water-filled Porosity	Effective Porosity	Vertical K (K _v)	Lab
Sample Interval (feet-bgs)	USCS Lithology Type	Lithologic Description	%	%	%	%	feet/day	Remarks
27.5 - 30.0	SP	10YR 6/6 Yellowish brown fine sand, moist	46.3	37.9	8.3	39.8	104	а
58.0 - 60.5	SP-SM/SP	58.0-59.0 10YR 5/9 Yellowish brown silty fine sand lenses, dry; 59.0-60.5 10YR 5/9 Yellowish brown fine	47.0	39.3	7.7	36.7	40	а
98.5 - 101	SP-SM	10YR 6/6 Yellowish brown silty fine sand lenses, dry	46.0	39.1	6.9	39.9	54	а
124.5 - 127	SP-SM	10YR 6/6 Yellowish brown silty fine sand, dry	44.6	37.6	7.0	37.5	78	а
139.5 - 142	SP	10YR 5/8 Yellowish brown fine sand, dry	42.6	33.4	9.2	29.5	34	а
174.5 - 177.0	SP	10YR 6/6 Yellowish brown silty fine sand nodules, dry	46.2	40.8	5.4	40.3	52	а
197.0 - 200.0	SM	10YR 6/6 Yellowish brown silty fine sand, dry	44.3	40.4	3.9	36.4	162	а
223.0 - 225.5	SP	10YR 6/6 Yellowish brown fine sand with minor silt, dry	44.7	39.7	5.0	31.1	108	а
259.5 - 262.0	SP	10YR 5/6 Dark yellowish brown fine sand, very moist	47.5	38.9	8.6	35.3	30	а
274.5 - 277.0	SP	10YR 5/6 Dark yellowish brown fine sand, dry	46.0	38.2	7.7	34.6	40	а
297.0 - 298.5	ML	10YR 3/4 Dark yellowish brown dense clayey silt with fine sand, moist	NA	NA	NA	NA	0.01	
298.5 - 301.0	ML/CL/SP	298.5-300.0 10YR 6/4 Light yellowish brown sense clayey silt with fine sand, moist; 300.0-300.7 10YR 6/4 Light yellowish brown silty clay, moist; 300.7-301.0 10YR 7/3 Very pale brown silty fine sand, dry	44.0	3.9	40.2	4.1	0.006	
324.5 - 327	CL/ML	324.5-325.0 10YR 5/4 Yellowish brown silty clay (10/90), moist; 325.0-327.0 10YR 5/4 Yellowish brown clayey silt (20/80), dry	33.7	12.7	21.1	13.1	0.02	
337.0 - 339.0	CL	10YR 6/6 Yellowish brown fine sandy, silty, clay (20/20/60), moist	NA	N/A	NA	NA	0.002	
349.5 - 352.0	SP	10YR 5/8 Yellowish brown fine to medium coarse sand (70/30), dry	41.5	26.3	15.2	26.0	350	а
357.0 - 359.5	SW	10YR 6/4 Light yellowish brown fine to coarse sand, dry	39.8	29.1	10.7	27.7	192	а
377.0 - 379.5	SP	10YR 6/6 Yellowish brown very fine sand, dry	49.5	40.8	8.7	24.3	18	а
405.0 - 407.5	ML	10YR 3/1 Very dark gray clayey silt, very dense, dry	NA	NA	NA	NA	0.11	
417.5 - 420.0	ML	10YR 4/3 Brown fine to medium coarse sandy silt (40/60), dry	NA	NA	NA	NA	0.57	

Table 5. Core Hydraulic Testing Results

Notes:

NA = Not Analyzed

a - Vertical conductivity values influenced by significant amount of fines migrated out of sample during saturation and testing phases.

USCS = Unified Soil Classification System

Vertical K = Vertical Hydraulic Conductivity

feet-bgs = feet below ground surface

As expected, Kv estimates of fine-grained lenses in the Aromas Sand are much lower, ranging from 0.002 feet/day to 0.02 feet/day with a median value of 0.01 feet/day.

3.1.3. Vadose Zone Well Capacity Estimates

Vertical hydraulic conductivity estimates of coarse-grained deposits within the Aromas Sand can be used to evaluate the feasibility of injecting proposed GWR project flows (350 AFY) through vadose zone wells and to optimize well design. Specifically, the well discharge (injection) rate can be estimated by applying the following equation developed by Zangar (Bouwer, 1978):

$$Q = \frac{K}{\left(3ln\left(\frac{Lw}{rw}\right)\right)} * (\pi Lw(3Lw + 2Si))$$

where, K = Hydraulic conductivity of the wetted zone, feet/day

Q = Discharge (injection) rate, feet³/day

Lw = Depth of water in the well, feet

- Rw = Effective radius of well, feet
- Si = Vertical distance from bottom of the well to the water table or impermeable surface, feet

The equation shows that the injection rate is a function of the hydraulic conductivity of the wetted zone at and beneath the injection well, effective radius of the well (equal to the borehole radius), depth of water in the well during active injection, and the vertical distance from the bottom of the well to the water table or impermeable surface.

For the proposed GWR project, an estimated 350 to 370 AFY of recycled water from the AWTF will be recharged through four vadose zone wells at the GWR recharge site. These annual recharge estimates are based on the availability and amounts of source waters, capacity of the AWTF, minimum delivery targets, and operational guidelines evaluated in the Recharge Impacts Assessment Report (Todd, 2015). Table 1 of the Recharge Impacts Report provides the potential recycled water delivery schedules for the project. The vadose zone injection rate is expected to fluctuate seasonally based on the availability of recycled water sources with maximum monthly rates ranging from 217 to 242 gallons per minute [gpm]), depending on the simulated delivery schedules. Assuming four vadose zone wells, the maximum rate of injection in a single vadose zone well is expected to range from about 54 to 61 gpm.

To determine the effective length of well screen and artificial filter pack needed to accommodate a specific injection rate, the Zangar equation can be re-arranged to solve for the depth of the water in the well (Lw). Assuming a maximum injection rate of 65 gpm per vadose zone well, a hydraulic conductivity of 20 feet/day, effective well (borehole) radius of 1.0 feet, and a conservative vertical distance from the bottom of the well to the water table of 10 feet, the depth of water in the well would only be about 22 feet. This depth to water is

the effective length of well screen with artificial filter pack needed to accommodate the 65 gpm injection rate. For perspective, if the actual hydraulic conductivity of the wetted zone was only 10 feet/day (versus 20 feet/day), the depth of water in the well would increase slightly to 35 feet. As an additional comparison, if all of the recycled water (350 AFY) was injected into one vadose zone well (at a rate of 242 gpm), and assuming a hydraulic conductivity of 20 feet/day, then the estimated depth of water in that well would be about 50 feet. These calculations indicate that the thickness of sand deposits either above or below the silt/clay deposits observed in the lower Aromas Sand at MRWPCA MW-1 are sufficient to accommodate projected injection rates, and that four (or possibly fewer) vadose zone wells can accommodate proposed vadose zone injection rates.

3.1.4. Vadose Zone Flow and Travel Time Estimates

During continuous recharge through a homogeneous, isotropic sediment, a vertical hydraulic gradient of 1.0 can be reasonably assumed within the wetted zone. In turn, the downward velocity of infiltrating water will approach the saturated vertical hydraulic conductivity (Kv). If the downward velocity of recharged water for a given volumetric flow rate is known, then the horizontal cross-sectional area needed to accommodate that volumetric flow rate can be calculated. Beneath a vadose zone well, the horizontal cross-sectional area can be assumed to be a circle with a radius, r.

The cross-sectional area necessary to accommodate a specific injection flow rate could be estimated using the volumetric equation for a cylinder with consideration for the effective porosity of sediments in which recycled water will be temporarily stored, as shown below:

 $V = H\pi r^2 / n$

 $r = \sqrt{(Vn)/(H\pi)}$

- where, h = cylinder height (equivalent to the downward velocity of infiltrating water over a specific time period)
 - r = cylinder radius, equivalent to radius of saturation,
 - n = effective porosity

To use a simplified example, assume that recycled water is injected into one vadose zone well at 65 gpm opposite coarse-grained sediments of the Aromas Sand over a one-day period. Over that one day period, 12,513 cubic feet (ft³) of water is injected. If the average downward velocity of water through those coarse-grained sediments of the Aromas Sand is equal to the assumed Kv of 20 feet/day, then the length of the wetted zone after 1 day is equal to 20 feet. Assuming the average effective porosity of 34 percent for coarse-grained sediments in the Aromas Sand, the horizontal cross-sectional area of the wetted zone needed to accommodate the volume of injected water is equivalent to a circle with a radius of 24 feet.

Based on the example above, if the vadose zone well screen is positioned 100 feet above fine-grained deposits in the Aromas Sand (located between 295 and 339 feet-bgs), recycled

water will flow downward at a rate of approximately 20 feet/day within a 24-foot radius cylinder beneath the vadose zone well and reach the uppermost fine-grained deposit within a few days (once saturated flow conditions are established following continuous recharge). Fine-grained deposits in the Aromas Sand have a much lower Kv (on average 0.01 feet/day), and water will migrate through these deposits more slowly. As a consequence, recycled water flowing downward through the highly permeable sands will be partially deflected by and flow on the top of fine-grained deposits. The cross-sectional area of the wetted zone will increase until the volumetric flow rate through fine-grained deposits is equal to the rate of infiltrating water from above the top of the fine-grained deposit.

The vadose zone flow process is dynamic and is a function of several factors, including the horizontal hydraulic conductivity of vadose zone sediments, the variable buildup of hydraulic pressure on top of the fine-grained deposit with distance away from the point below the vadose zone well, and the variability of Kv under variable, partially-saturated conditions). However, a preliminary estimate of the cross-sectional area of the wetted zone through the fine-grained deposits can be calculated in the same manner by applying the volumetric equation for the cylinder. Assuming a Kv for fine-grained sediments in the Aromas Sand of 0.01 feet/day and a vertical hydraulic gradient of 1.0 reveals that the cross-sectional area equivalent to a circle with a radius of 1,100 feet is needed to accommodate 65 gpm flowing through the fine-grained deposits in the lower Aromas Sand.

Similar to the calculations in estimating the cross-sectional area of flow through the lithologic deposits of the Aromas Sand, preliminary estimates of vertical travel time can be calculated by assuming 1-dimensional flow conditions and a unit hydraulic gradient of 1.0. As discussed above, it is reasonable to assume that velocities will approach saturated Kv estimates during periods of consistent recharge. Based on the estimated Kv of 20 feet/day, travel time through the coarse-grained sediments of the Aromas Sand is on the order of a few days. However, if vadose zone wells are positioned above the fine-grained units in the Aromas Sand (encountered between 295 and 341 feet-bgs), the travel time for recycled water to travel through the Aromas Sand and reach the top of the Paso Robles Formation increases significantly. Based on an average Kv of 0.01 feet/day and the total thickness of fine-grained deposits of 21.5 feet (occurring between 295 and 341 feet-bgs), the travel time for recycled water to flow through fine-grained deposits of the Aromas sand is estimated at 5.9 years. An additional 3.4 years is needed for recycled water to travel through the 12.5 feet of unsaturated Paso Robles Formation before reaching the current water table at 405 feet-bgs (assuming a Kv of 0.01 feet/day).

It should be recognized that these preliminary travel time estimates do not consider the time required for saturated conditions within the wetted zone to be established and for recycled water to migrate horizontally on top of fine-grained deposits. However, the travel time estimates are conservative (overestimated) as they do not consider the expected rise of the water table to or above the geologic contact between the Aromas Sand and Paso Robles Formation following the initial years of recharge operations. Furthermore, these estimates assume that fine-grained deposits similar to those encountered at MRWPCA MW-1 extend across the GWR project recharge site with similar thickness and/or are not

significantly tilted to allow recycled water to bypass fine-grained deposits and arrive at the water table more quickly (see Section 2.1.7 for discussion of subsurface conditions in the vicinity of the GWR recharge site).

3.2. CORE MINERALOGICAL RESULTS

3.2.1. Mineralogical Composition

A summary of the mineralogical composition and characteristics of sediments representing the Aromas Sand and Paso Robles Formation based on thin-section examination of core samples is presented in **Table 6**. Results of energy dispersive x-ray by x-ray diffraction and x-ray fluorescence analyses of core samples are presented in **Tables 7 and 8**.

3.2.1.1. Aromas Sand

As shown in the tables, the Aromas Sand is largely unconsolidated lithic arkosic sand with silty and sandy-shale interbeds or layers. The arkosic sands are largely composed of monoand polycrystalline quartz and feldspar with minor amounts of chert and igneous rock fragments such as granite, granodiorite, and rhyolite. Chert and shale, silty shale, and silty mudstone are in the more "shaley" interbedded layers. EcoEngineers (2008) reported that the Aromas Sand ranged from 68 to 71% quartz (SiO₂). X-ray dispersive analysis for this study showed that the Aromas Sand is predominantly silicon dioxide (quartz) which ranges from 46.14% in the more silty interbedded layers to 71.75% in the more guartz-rich layers. Traces of iron oxide and iron hydroxide cement and traces of siderite (iron carbonate) were noted. Minor quantities of clay minerals, largely illite and mixed layered chlorite and smectite (montmorillonite) were also noted. Accessory minerals were detected in trace amounts, including hornblende, biotite, apatite, spinel and epidote; zircon, magnetite, augite, and sphene. Only minor amounts of organic matter were noted. Magnetite and perhaps titanium-bearing ilmenite in the Aromas Sand may contain chromium. In a previous study of the Aromas Aquifer for the Soquel Creek Water District (Todd Engineers, 2002; see also Motzer, 2005), magnetite occurred as a solid solution series with ilmenite.

3.2.1.2. Paso Robles Aquifer

The Paso Robles Aquifer is unconsolidated to semi-consolidated and in places is a consolidated silty mudstone with interbeds of arkosic lithic sand and sandstone. The siltstone is largely matrix supported with partly disaggregated Individual fragments of silty mudstone. Formation mineralogy is more variable than the overlying Aromas Sand consisting (in decreasing order) of monocrystalline and minor polycrystalline quartz, organic matter, feldspar (plagioclase greater than orthoclase), chert, hornblende, mica, and magnetite. Igneous rock fragments when present range from granite to granodiorite. Sedimentary rock fragments consist mostly of mudstone and shale to silty shale. The matrix, when observed in thin sections, shows clay-rich, mixed layered illite and smectite with minor amounts of chlorite and kaolinite. Pyrite (FeS₂) replacement is associated with altered organic matter particles. Feldspars exhibit interparticle dissolution and clay replacement resulting from weathering.

3.2.1.3. Bulk Chemical Analysis

As described in Section 2.2.2.1, a mineralogical analysis serves to define the overall bulk formation chemistry and character of the vadose zone formation and potentially affected aquifer. Bulk sample analysis also contributes to an understanding of naturally-occurring

Formation	Aromas Sand	Paso Robles				
Characteristics	7 samples: 27.5' to 367.0'	3 samples: 398.5' to 474.5 '				
Lithologic Classification	Unconsolidated lithic arkosic sand to arkosic silty with sandy shale (layers)	Silty mudstone to lithic arkosic sandstone				
Textures	 Fine-to medium-grained Well to moderately sorted and very poorly sorted Subangular to subrounded grains 	 Coarse silt to coarse sand Very poorly sorted to moderately sorted sandstone Subangular siltstone fragments Minor scattered quartz-rich sand grains 				
Mean Grain Diameter Range (mm)	0.020 to 0.28	0.045 to 0.53				
Maximum Grain Diameter Range (mm)	0.75 to 1.51	0.33 to 0.85				
Fabric	 Generally unconsolidated to disaggregated sand with minor clay matrix. Silty layers are quartz and feldspar-rich with sand irregularly spaced in shale groundmass Parallel bedded and matrix supported quartz and feldsparrich silt layers 	 Siltstone is matrix supported, partly disaggregated fragments Individual fragments of silty mudstone Sandstone layers 				
Mineralogy: approximate decreasing relative abundance	 Quartz: mono- and polycrystalline Feldspar: plagioclase and orthoclase (plag > ortho) Igneous rock fragment (RF): granite, granodiorite, rhyolite Chert Shale, silty shale, silty mudstone Traces of hornblende, biotite, apatite, spinel and epidote; zircon, magnetite, augite, sphene. Minor organic matter 	 Quartz: monocrystalline and minor polycrystalline Organic matter Feldspar (plag > otho) Igneous RFs: granite to granodiorite Mudstone and shale to silty shale RFs Chert RFs Organic matter Hornblende Mica Magnetite 				
Cements/Matrix Constituents	 Authigenic quartz, feldspar, and siderite Overgrowth on quartz and detrital feldspar Traces of iron oxide and iron hydroxide cement Traces of siderite Clays: illite, mixed layered chlorite, smectite 	 Clay-rich; mixed layered illite/smectite Minor chlorite and kaolinite Pyrite replacement associated with altered organic matter particles Feldspars exhibit interparticle dissolution and clay replacement Pyrite cement 				
Weathering Characteristics	Feldspar corroded and altered to clay with and comingled amorphous iron oxide cement	Interparticle dissolution of feldspar with clay replacement Pyrite cement				

Table 6. Solid Core Analysis Results: Mineralogical Characterization by Thin-Section Examination

Notes:

Sample analyses by Mineralogy, Inc., Tulsa, OK. Complete mineralogical analyses in May 5, 2014 Final Test Reports

	Aromas Sand												
	27.5'-3	0.0'			74.0'-7	75.5′		98.5'-101.0'					
Element	Wt %	Compound	Wt %	Element	Wt %	Compound	Wt %	Element	Wt %	Compound	Wt %		
Carbon (C)	3.90	CO ₂	14.20	Carbon (C)	3.91	CO ₂	14.32	Carbon (C)	2.67	CO ₂	9.77		
Oxygen (O)	53.24	-	-	Oxygen (O)	53.085	-	-	Oxygen (O)	51.975	-	-		
Sodium (Na)	1.92	Na ₂ O	2.58	Sodium (Na)	2.18	Na ₂ O	2.93	Sodium (Na)	2.24	Na ₂ O	3.02		
Aluminum (Al)	5.29	Al ₂ O ₃	9.99	Aluminum (Al)	5.42	Al ₂ O ₃	10.24	Aluminum (Al)	5.78	Al ₂ O ₃	10.91		
Magnesium (Mg)	-	MgO	-	Magnesium (Mg)	-	MgO	-	Magnesium (Mg)	-	MgO	-		
Silicon (Si)	31.84	SiO2	68.12	Silicon (Si)	31.54	SiO2	67.47	Silicon (Si)	33.03	SiOz	70.65		
Sulfur (S)	-	SO₃	-	Sulfur (S)	1.64	SO₃	4.09	Sulfur (S)	-	SO₃	-		
Potassium (K)	1.99	K2O	2.39	Potassium (K)	2.32	K ₂ O	2.8	Potassium (K)	2.35	K ₂ O	2.83		
Calcium (Ca)	0.68	CaO	0.95	Calcium (Ca)	0.66	CaO	0.92	Calcium (Ca)	0.99	CaO	1.38		
Titanium (Ti)	0.12	TiO ₂	0.2	Titanium (Ti)	0.1	TiO ₂	0.17	Titanium (Ti)	0.07	TiO ₂	0.11		
Iron (Fe)	1.03	Fe ₂ O ₃	1.47	Iron (Fe)	0.8	Fe ₂ O ₃	1.15	Iron (Fe)	0.93	Fe ₂ O ₃	1.32		
Total	100.00	Total	100.00	Total	100.00	Total	100.0	Total	100.00	Total	100.0		

Table 7. Solid Cole Analysis Results. Ellergy Dispersive A-Ray Allan	Inalysis
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	Aromas Sand											
	139.5'-14	12.0'			200.0'-2	202.5'		297.0'-298.5'				
Element	Wt %	Compound	Wt %	Element	Wt %	Compound	Wt %	Element	Wt %	Compound	Wt %	
Carbon (C)	3.05	CO ₂	11.17	Carbon (C)	3	CO ₂	10.99	Carbon (C)	8.67	CO ₂	31.78	
Oxygen (O)	52.565	-	-	Oxygen (O)	51.885	-	-	Oxygen (O)	56.185	-	-	
Sodium (Na)	2.04	Na ₂ O	2.76	Sodium (Na)	2.19	Na₂O	2.95	Sodium (Na)	0.84	Na ₂ O	1.13	
Magnesium (Mg)	-	MgO	-	Magnesium (Mg)	-	MgO	-	Magnesium (Mg)	2.18	MgO	3.61	
Aluminum (Al)	5.83	Al ₂ O ₃	11.02	Aluminum (Al)	4.94	Al ₂ O ₃	9.34	Aluminum (Al)	4.34	Al ₂ O ₃	8.19	
Silicon (Si)	32.82	SiO2	70.22	Silicon (Si)	32.58	SiO2	69.69	Silicon (Si)	21.57	SiO2	46.14	
Sulfur (S)	-	SO₃	-	Sulfur (S)	1.64	SO₃	4.09	Sulfur (S)	-	SO₃	I	
Potassium (K)	1.99	K ₂ O	2.39	Potassium (K)	3.03	K ₂ O	3.65	Potassium (K)	1.16	K ₂ O	1.39	
Calcium (Ca)	0.65	CaO	0.91	Calcium (Ca)	1.06	CaO	1.49	Calcium (Ca)	1.93	CaO	2.7	
Titanium (Ti)	0.13	TiO ₂	0.21	Titanium (Ti)	-	TiO ₂	-	Titanium (Ti)	0.23	TiO ₂	0.38	
Iron (Fe)	0.94	Fe ₂ O ₃	1.34	Iron (Fe)	3.33	Fe ₂ O ₃	1.9	Iron (Fe)	2.33	Fe ₂ O ₃	3.33	
Total	100.0	Total	100.0	Total	100.0	Total	100.0	Total	100.0	Total	100	

Notes:

X-Ray Analysis summary from Mineralogy, Incorporated, Tulsa, OK May 5, 2014 Final Test Report

	Aromas	Sand		Paso Robles									
	364.5'-3	67.0'			398.5'-4	401.0'			433.0'-4	35.0'			
Element	Wt %	Compound	Wt %	Element	Wt %	Compound	Wt %	Element	Wt %	Compound	Wt %		
Carbon (C)	2.49	CO ₂	9.13	Carbon (C)	4.62	CO ₂	16.93	Carbon (C)	5.92	CO ₂	21.69		
Oxygen (O)	51.605	—	-	Oxygen (O)	52.785	_	-	Oxygen (O)	53.855	_	_		
Sodium (Na)	1.57	Na₂O	2.11	Sodium (Na)	0.92	Na ₂ O	1.24	Sodium (Na)	1.86	Na ₂ O	2.51		
Magnesium (Mg)	_	MgO	-	Magnesium (Mg)	2.23	MgO	3.7	Magnesium (Mg)	0.79	MgO	1.31		
Aluminum (Al)	5.2	Al ₂ O ₃	9.82	Aluminum (Al)	8.03	Al ₂ O ₃	15.16	Aluminum (Al)	6.09	Al ₂ O ₃	11.5		
Silicon (Si)	33.54	SiO2	71.75	Silicon (Si)	23.14	SiO2	49.49	Silicon (Si)	25.6	SiO2	54.76		
Sulfur (S)	_	SO3	_	Sulfur (S)	1.64	SO₃	4.09	Sulfur (S)	-	SO₃	—		
Potassium (K)	3.56	K ₂ O	4.29	Potassium (K)	0.88	K ₂ O	1.07	Potassium (K)	1.06	K ₂ O	1.28		
Calcium (Ca)	1.09	CaO	1.53	Calcium (Ca)	1.15	CaO	1.61	Calcium (Ca)	1.47	CaO	2.06		
Titanium (Ti)	-	TiO ₂	_	Titanium (Ti)	0.44	TiO ₂	0.74	Titanium (Ti)	0.37	TiO ₂	0.62		
Iron (Fe)	0.96	Fe ² O ₃	1.37	Iron (Fe)	4.17	Fe ₂ O ₃	5.96	Iron (Fe)	2.99	Fe ₂ O ₃	4.28		
Total	100.0	Total	100.0	Total	100.0	Total	100.0	Total	100.0	Total	100.0		

 Table 7.
 Solid Core Analysis Results: Energy Dispersive X-Ray Analysis (continued)

Paso Robles												
472.0'-474.5'												
Element	Wt %	Compound	Wt %									
Carbon (C)	4.2	CO ₂	15.41									
Oxygen (O) 52.945 — —												
Sodium (Na) 1.44 Na ₂ O 1.95												
Magnesium (Mg)	-	MgO	-									
Aluminum (Al)	4.47	Al ₂ O ₃	8.45									
Silicon (Si)	30.84	SiO₂	65.98									
Sulfur (S)	_	SO₃	-									
Potassium (K)	2.25	K ₂ O	2.71									
Calcium (Ca)	1.47	CaO	2.06									
Titanium (Ti)	0.24	TiO ₂	0.4									
Iron (Fe)	2.13	Fe ₂ O ₃	3.05									
Total	100.0	Total	100.0									

Notes:

X-Ray Analysis summary from Mineralogy, Incorporated, Tulsa, OK May 5, 2014 Final Test Report

	Form	nation:				Arom	as Sand				Paso Robles			
Analyte	Method	Units	RL	27.5'- 30.0'	74.0'- 75.5'	98.5'- 101.0'	139.5'- 142.0'	200.0'- 202.5'	297.0"- 298.5'	364.5'- 367.0'	398.5'- 401.0'	433.0'- 435.0'	472.0'- 474.5'	
Major Elements as Oxides (XRF or Total Dissolution)														
Aluminum Oxide (Al ₂ O ₃)	SW6020	wt%	0.280	8.7	10	10	9.8	10	6.6	14	12	9.9	8.0	
Barium Oxide (BaO)	SW6020	wt%	0.056	0.10	0.10	0.10	0.10	0.11	0.062	0.10	ND	0.064	0.078	
Calcium Oxide (CaO)	SW6020	wt%	0.360	0.99	1.1	1.1	0.98	1.3	2.2	1.2	1.8	2.1	1.9	
Iron Oxide (FeO)	SW6020	wt%	0.019	0.70	0.62	0.55	0.72	0.64	1.8	0.68	5.0	2.8	1.6	
Potassium Oxide (K ₂ O)	SW6020	wt%	0.150	2.8	3.1	3.0	2.9	3.2	1.4	2.8	1.6	1.5	1.7	
Magnesium Oxide (MgO)	SW6020	wt%	0.025	0.18	0.17	0.18	0.20	0.22	2.3	0.22	2.7	1.0	0.45	
Manganese Oxide (MnO)	SW6020	wt%	0.026	ND	ND	ND	ND	ND	0.11	ND	0.052	0.028	ND	
Sodium Oxide (Na ₂ O)	SW6020	wt%	0.020	2.00	2.2	2.3	2.0	2.4	1.2	2.10	1.2	2.2	2.0	
Phosphorous pentoxide (P ₂ O ₅)	SW6010B	%	0.0035	0.020	0.027	0.026	0.024	0.035	0.093	0.066	0.13	0.094	0.14	
Silicon Dioxide (SiO ₂)	SW6010B	%	0.032	4.0	1.1	1.4	1.1	1.6	1.4	0.64	1.1	0.78	1.1	
Strontium Oxide (SrO)	SW6020	wt%	0.024	0.028	0.032	0.032	0.029	0.034	0.030	0.032	ND	0.035	0.036	
Titanium Oxide (TiO ₂)	SW6020	wt%	0.025	0.099	0.075	0.068	0.094	0.083	ND	0.080	0.57	0.27	0.14	

Table 8. Solid Core Analysis Results: Major Elements as Oxides from X-Ray Fluorescence Analysis

Notes:

Sum of major elements as oxides are less than expected 100 percent, due to incomplete digestion primarily of silica dioxide, which is typically in the 75 to 99 percent range. (See McCampbell Analytical explanation of issues pertaining to major elements as oxide analysis in Appendix E)

Core samples collected from Sonic Drilling cores collected in MW-1 boring at depth in feet (') below ground surface.

EPA = U.S. Environmental Protection Agency

mg/kg = milligram per kilogram

µg/kg = micrograms per kilogram

wt % = weight percent

ND = Not detected or below method reporting limits (RL)

SM = Standard Method

constituents in the analyzed formations that may be dissolved by recharge water and in turn possibly impact shallow groundwater. These may be essential for both a conceptual and geochemical model.

Table 7 shows results of the x-ray dispersive analysis as conducted by Mineralogy, Inc. The analysis shows the weight percent for detected elements derived from the x-ray dispersive peaks; these were then normalized to give elemental oxide compound formula in weight percent. The sum of both the elemental analyses and compound formula is 100 percent. Their complete report showing the energy dispersive x-ray peaks for each detected element is in **Appendix E**.

X-ray fluorescence analysis was conducted by McCampbell Analytical with their results shown on **Table 8.** It is noted that the results are less than the expected 100 percent for the major oxide analyses. This apparent error is due to incomplete digestion primarily of silica dioxide, which is typically in the 75 to 99 percent range (see McCampbell Analytical explanation of issues pertaining to major elements as oxide analysis in **Appendix E**).

3.2.2. Other Parameters

Table 9 summarizes the results of solid core analyses for exchangeable cations, other ions,and nitroaromatic/nitramine (explosive) compounds.

3.2.2.1. Cation Exchange Capacity (CEC)

Ion exchange in minerals, organic matter and clays depends on the crystalline structure and on the chemical composition of any solution in contact with that structure. Clay minerals are particularly important in ion-exchange reactions because ion exchange reactions in clays are reversible due to chemical reactions taking place between ions attached to the mineral's surface and ions in a solution in contact with that surface. Generally, the excess charge on the mineral is negative; therefore, it attracts cations from solution to neutralize this charge. Ion-exchange capacity is commonly measured in chemical equivalents of a base adsorbed at pH 7. The CEC measures the ability of a soil to adsorb cations in exchangeable forms, and ranges are calculated on the basis of a standard (in milliequivalents per 100 grams or meq/100g) as shown on **Table 10**.

Table 9 contains "raw" or uncorrected CEC data for the extraction that used ammonium acetate as an exchange reagent. The major cations: barium (Ba), calcium (Ca), lithium (Li), magnesium (Mg), sodium (Na), potassium, strontium (Sr) are reported in milligrams per kilograms (mg/kg). This method has been recommended by the Soil Science Society of America (SSSA) because it is highly repeatable, precise, a direct measure of a soil's CEC, and is useful for alkaline (pH greater than 7) soils common in the west where hydrogen ion (H⁺) concentrations do not have taken into account as in acid soils. However, to compare different soil CECs, the uncorrected data must be converted to a standard given in meq/100g. A CEC calculator was used to determine the standard CECs in meq/100g as summarized in **Table 11**.
		Form	ation:			Ar	omas Sar	nd			Paso Robles		
Analyte	Method	Units	RL	27.5'-	74.0'-	98.5'-	139.5'-	200.0'-	297.0"-	364.5'-	398.5'-	433.0'-	472.0'-
		•		30.0′	75.5′	101.0′	142.0'	202.5'	298.5'	367.0'	401.0'	435.0'	474.5′
Exchangeable Cations us	sing Ammoniu	m Aceta	ate (SSS	A Pt 3, C	h 40)								
Barium (Ba)	SW6020	mg/kg	0.50	10	9.5	8.9	20	9.9	17	8.3	12	9.2	12
Calcium (Ca)	SW6020	mg/kg	100	150	450	130	180	180	2,500	220	3,300	2,900	910
Lithium (Li)	SW6020	mg/kg	0.050	ND	ND	ND	ND	ND	ND	ND	0.30	0.24	ND
Magnesium (Mg)	SW6020	mg/kg	20	110	120	91	110	80	780	52	840	750	340
Potassium	SW6020	mg/kg	5.0	15	57	21	32	36	90	22	180	140	78
Sodium (Na)	SW6020	mg/kg	10	60	71	46	64	52	200	52	160	160	99
Strontium (Sr)	SW6020	mg/kg	2.0	3.3	2.9	2.3	4.2	3.1	27	2.3	31	24	11
Other lons:													
Phosphorous (P)	SW6010B	mg/kg	15	88	120	110	110	150	4,000	290	570	410	610
Chromium-6 [Cr(VI)]	SW7199	mg/kg	4.0	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Perchlorate (ClO ₄ ⁻)	EPA 6850	µg/kg	0.10	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Total Nitrogen (N)	EPA 415.1	mg/kg	200	310	210	420	450	380	1,500	770	1,000	560	710
Total Organic Carbon (TOC)	SM 5310Bm	mg/kg	200	ND	ND	ND	ND	ND	19,000	ND	9,300	ND	340
Nitroaromatics and Nitra	amines (Explo	sives):											
2-Am-DNT	SW8330	mg/kg	0.080	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
4-Am-DNT	SW8330	mg/kg	0.080	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
1,3-DNB	SW8330	mg/kg	0.080	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
2,4-DNT	SW8330	mg/kg	0.080	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
2,6-DNT	SW8330	mg/kg	0.080	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
НМХ	SW8330	mg/kg	0.080	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
NB	SW8330	mg/kg	0.080	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
2-NT	SW8330	mg/kg	0.080	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
3-NT	SW8330	mg/kg	0.080	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
4-NT	SW8330	mg/kg	0.080	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
RDX	SW8330	mg/kg	0.080	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
1,3,5-TNB	SW8330	mg/kg	0.080	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
2,4,6-TNT	SW8330	mg/kg	0.080	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Tetyl	SW8330	mg/kg	0.080	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND

Table 9. Solid Core Analysis Results: Exchangeable Cations, Other Ions, Nitroaromatics/Nitramines

Notes: EPA = U.S. Environmental Protection Agency

mg/kg = milligram per kilogram

ND = Not detected or below method reporting limits (RL)

Table 10.Ranges of Cation Exchange Capacity for Different Mineralsand Soils

	CEC	C _11	CEC	
Wineral	(meq/100g)	Soli	(meq/100g)	
Chlorite	10-40	Organic Matter	>200	
Illite	10-40	Sand (general)	2-7	
Kaolinite	3-15	Sand (light colored	3-5	
Smectite (Montmorillonite)	80-150	Sandy loam	2-18	
Vermiculite	100-150	Loam	8-22	
Glauconite	20	Silt loam	9-27	
Palygoskite	20	Clay loam	4-32	
Oxides and hydroxides	2-6	Clay	5-60	

Sources: Carroll (1959); Langmuir, et al. (2004).

Table 11 shows that the Aromas Sand has an average CEC of 4.70 meq/100 g. This is consistent with known sand CEC ranges as shown in **Table 10** and an average CEC of 4.9 meq/100g for Aromas Sand analyses conducted by EcoEngineers (2008) for the Monterey Peninsula Water Management District's Phase 1 ASR project. One depth interval (297.0 to 298.5 feet) had a CEC of 19.859 meq/100g consistent with a silt-clay interval at this depth. The Paso Robles Aquifer had a CEC average of 17.93 common to silt and clays, which dominate the Paso Robles Aquifer.

				Aromas San	d: meq/100	g		
Cation	27.5- 30.0'	74.0- 75.5'	98.5- 101.0'	139.5- 142.0	200.0- 202.5'	297.0- 298.5	364.5- 367.0	Average
Ba ²⁺	0.015	0.014	0.013	0.029	0.014	0.025	0.012	0.02
Ca ²⁺	0.735	2.206	0.637	0.882	0.882	12.255	1.078	2.67
Li+	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.00
Mg ²⁺	0.905	0.749	0.749	0.905	0.658	6.417	0.428	1.54
K+	0.038	0.146	0.054	0.082	0.092	0.230	0.056	0.10
Na⁺	0.261	0.309	0.200	0.278	0.226	0.870	0.226	0.34
Sr ²⁺	0.137	0.007	0.005	0.010	0.007	0.062	0.005	0.03
H⁺	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.00
TOTAL	2.091	3.430	1.658	2.186	1.880	19.859	1.806	4.70

Table 11.Summary of Aromas Sand and Paso Robles Aquifer CationExchange Capacity (CEC)

	F	aso Robles	: meq/100)g
Cation	398.5- 401.0'	433.0- 435.0'	472.0- 476.5	Average
Ba ²⁺	0.017	0.013	0.017	0.02
Ca ²⁺	16.176	14.216	4.461	11.62
Li⁺	0.000	0.004	0.000	0.00
Mg ²⁺	6.911	6.170	2.797	5.29
K+	0.460	0.358	0.200	0.34
Na⁺	0.696	0.696	0.431	0.61
Sr2+	0.055	0.071	0.025	0.05
H⁺	0.000	0.000	0.000	0.00
TOTAL	24.316	21.529	7.931	17.93

Note: CEC reported in mg/kg recalculated in milliequivalents per 100 grams (meq/100g) Sample depth interval in feet (') below ground surface H⁺ input for acid soils only.

3.2.2.2. Percent of Base Saturation

The percent of base saturation is defined as the relative availability of exchangeable cations; it is calculated by dividing each of the cation's CEC in meq/100g by the total amount of meq/100g multiplied by 100. In a leaching environment, a gradual loss of base cations would be expected. **Table 12** shows that for the Aromas Sand and Paso Robles Aquifer, Ca²⁺ dominates as the exchangeable cations as follows:

$$Ca^{2+} > Mg^{2+} > Na^+ > K^+ > Sr^{2+} > Ba^{2+} > Li^+$$

The Aromas Sand has such low CECs that the amount of cations that could be leached and transported is very low. The amount of leachable cations in the Paso Robles (most likely dominated by clays in the mudstone and weathered feldspar) is much higher. Thus, some cation exchange is expected. While the CEC of Paso Robles sediments is higher compared to Aromas Sand, because of its limited unsaturated thickness, CEC processes are not expected to significantly impact groundwater quality with respect to drinking water standards and thus were not further evaluated through geochemical modeling.

Table 12.	Summary of Aromas Sand and Paso Robles Formation
Cation Base	Saturation in Percent (%)

			Arom	as Sand : 🤋	% Base Sat	uration		
Cation	27.5- 30.0'	74.0- 75.5'	98.5- 101.0'	139.5- 142.0	200.0- 202.5'	297.0- 298.5	364.5- 367.0	Average
Ba ²⁺	0.70	0.40	0.78	1.33	0.77	0.12	0.67	0.68
Ca ²⁺	35.16	64.32	38.44	40.36	46.93	61.71	59.71	49.52
Li+	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Mg ²⁺	43.28	21.83	45.16	41.39	35.00	32.31	23.69	34.67
Κ+	1.84	4.25	3.24	3.74	4.90	1.16	3.12	3.18
Na+	12.48	9.00	12.07	12.73	12.03	4.38	12.52	10.75
Sr ²⁺	6.55	0.19	0.32	0.44	0.38	0.31	0.29	1.21
H⁺	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
TOTAL	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00

	Paso	Robles: %	Base Satu	iration
Cation	398.5- 401.0'	433.0- 435.0'	472.0- 476.5	Average
Ba ²⁺	0.07	0.06	0.22	0.12
Ca ²⁺	66.53	66.03	56.25	62.93
Li⁺	0.00	0.02	0.00	0.01
Mg ²⁺	28.42	28.66	35.27	30.78
K+	1.89	1.66	2.52	2.02
Na ⁺	2.86	3.23	5.43	3.84
Sr ²⁺	0.23	0.33	0.32	0.29
H⁺	0.00	0.00	0.00	0.00
TOTAL	100.00	100.00	100.00	100.00

Note: CEC reported in mg/kg recalculated in milliequivalents per 100 grams (meq/100g) (see previous table) and calculated on a percent basis of total exchangeable cations. Sample depth interval in feet (') below ground surface.

3.2.2.3 Other lons and Explosive Compounds

As shown in **Table 9**, concentrations of chromium(VI), perchlorate, and nitroaromatic/nitramine (explosive) compounds in all 10 samples analyzed were below method reporting limits. Chromium as Cr(VI) probably occurs at low concentrations (µg/kg) sorbed to iron oxide-hydroxide coatings either on quartz grains and/or iron oxide-hydroxides in the matrix of the Aromas Sand.

Detectable concentrations of phosphorous occur in the Aromas Sand (88 to 4,000 mg/kg) and Paso Robles Aquifer (410 to 610 mg/kg). Phosphorous commonly occurs in the accessory mineral apatite [hydrated calcium phosphate or $Ca_5(PO_4)_3(OH)$] which has been identified in the mineralogical sample analysis by Mineralogy, Inc. (see **Appendix E**). Phosphorous most likely occurs as phosphate ($PO_4^{2^-}$) and numerous studies have been conducted on adsorption of $PO_4^{2^-}$ to iron oxide and aluminum oxide surfaces (see for example Torrent, et al., 1990; Rene, et al., 2001; Antelo, et al., 2005).

Detectable total nitrogen (N) occurs throughout the Aromas and Paso Robles, most likely occurring either as nitrate (NO_3^2) nitrogen-rich organic compounds either sorbed to quartz grain surfaces or to iron oxide-hydroxide coatings. Total organic carbon (TOC) is present in the Aromas Sand at 19,000 mg/kg and in the Paso Robles at 9,300 mg/kg. The TOC is from organic rock fragments detected in the matrix fraction as identified in the Mineralogical, Inc. report (**Appendix E**).

3.3. Hydroxylamine - Hydrochloride (HA-HCI) Extraction for Ferric Hydroxide (FeOH)

Table 13 summarizes the results of the Hydroxylamine-Hydrochloride Extraction Test conducted on two coarse-grained sand samples from the Aromas Sand. This analytical procedure was developed by Mahoney Geochemical Consulting, LLC (MGH) (Mahoney, 2013). The method allows measurement of the amount of hydrous ferric oxide in a soil sample. Hydrous (amorphous) ferric oxide (HFO) is considered to be the primary sorbent phase for arsenic (As), chromium (Cr), divalent metals, and uranium (U) in soils. Because HA-HCl is a reducing agent, it reduces the sample's HFO. The low pH and high chloride concentration then stabilizes the dissolved ferrous iron. The analyzed HFO concentration can then be used to model trace metal adsorption using PHREEQC surface complexation models. Similarly, manganese oxides (MnO_x) also act as a sorbent, and this procedure may also quantify the amount of manganese oxide. Variations of MGH's procedure have been used in many applications; slight variations are allowed as long as the overall goal is met.

HA-HCl analysis was performed for two Aromas Sand samples, which were analyzed for aluminum (Al), arsenic (As), calcium (Ca), chromium(VI), ferric hydroxide (as iron) (FeOH), lead (Pb), magnesium (Mg), manganese (Mn), mercury (Hg), selenium (Se), uranium (U), and silica (for iron oxide) (SiO₂). Detectable amounts in mg/kg of Al, As, Ca, FeOH, Pb, Mg, Mn and SiO₂ are present in the sorbed iron oxide phases that coated quartz grains or are present as oxide matrices in the Aromas Sand. The detectable As, Cr(VI) and Pb concentrations were used in the geochemical modeling.

			Formation:	Aroma	is Sand
Analyte	Method	Units	RL	200-202.5'	364.5-367.0
Aluminum (Al)	HH/TM-7	mg/kg	50	2,400	1,800
Arsenic (As)	HH/TM-7	mg/kg	0.50	1.8	0.72
Calcium (Ca)	HH/TM-7	mg/kg	100	810	820
Chromium-6 [Cr(VI)]	HH/TM-7	mg/kg	0.40	ND	ND
Ferric Hydroxide as Iron	HH/TM-7	mg/kg	20	3,300	2,500
Lead (Pb)	HH/TM-7	mg/kg	0.50	1.1	0.73
Magnesium (Mg)	HH/TM-7	mg/kg	20	770	590
Manganese (Mn)	HH/TM-7	mg/kg	20	37	37
Mercury	HH/TM-7	mg/kg	0.05	ND	ND
Selenium (Se)	HH/TM-7	mg/kg	0.50	ND	ND
Uranium (U)	HH/TM-7	mg/kg	0.50	ND	ND
Silica for Iron Oxide	HH/TM-7	mg/kg	11.0	6,500	5,200

Table 13. Hydroxylamine-Hydrochloride (HA-HCl) Extraction Test

Notes:

Core samples collected from sonic drilling cores collected in MW-1 boring at depth in feet (') below ground surface.

mg/kg = milligram per kilogram

ND = Not detected or below method reporting limits (RL)

HH/TM-7 = Hydroxylamine-Hydrochloride Extraction Test Procedure (Mahoney Geochemical, 2013)

3.4. CORE LEACHING TEST RESULTS WITH PILOT WATER

3.4.1. Pilot Recycled Water Quality

Water quality results for pilot recycled water used in core leaching tests are presented in **Table 14**. Pilot water was prepared by Trussell Technologies LLC of Oakland, California. As shown in the table, the pilot water is relatively depleted of most minerals and has a TDS concentration of 74 mg/L. Stabilization procedures included the addition of calcium chloride and sodium hydroxide to raw permeate to increase alkalinity followed by bubbling CO₂ below CaCO₃ saturation to reduce pH. The pilot water has a resulting Langelier Saturation Index (LSI) of -1.6, which is slightly more negative (i.e., has a slightly greater leaching potential) than the proposed full-scale stabilized AWTF water. The pilot water also has a relatively high positive oxidation-reduction potential of 629 mV, indicating that the pilot water will oxidize reduced species in its presence.

Detectable cations (Ba^{2+} , Ca^{2+} , N^+ , and K^+) and detectable anions (Cl^- and NO_3^- as N and as nitrate, and SO_4^{2-}) were present, which are to be expected from the addition of calcium chloride ($CaCl_2$) and sodium hydroxide (NaOH) to stabilize the raw permeate. However, it should be noted that the detected anions were also present in the laboratory blank suggesting that some anions may be an artifact of laboratory contamination.

Chromium VI [Cr(VI)] was detected in the analyzed pilot water at 0.21 µg/L. The presence of Cr(VI) may be the result of Cr^{3+} ions in the permeate water subsequently oxidized to Cr^{6+} ions after UV oxidation/ozonization. Ionic Cr^{3+} and/or Cr^{6+} have smaller ionic diameters (0.138 nm and 0.104 nm, respectively; see Railsback, 2004) than the ultrafilter pores (≥3.0 nm in diameter); therefore, it is possible that Cr ions could pass through the utrafilter pores. The detected Cr(VI) was taken into account in the geochemical modeling.

Analyte	Method	Units	RL	Results	
CCR 17 Metals+ Miscellaneous Ele	ements:	•		•	
Aluminum (Al)	EPA 200.8	ug/L	500	ND	
Antimony (Sb)	EPA 200.8	μg/L	5.0	ND	
Arsenic (As)	EPA 200.8	μg/L	5.0	ND	
Barium (Ba)	EPA 200.8	μg/L	50	140	
Beryllium (Be)	EPA 200.8	μg/L	5.0	ND	
Cadmium (Cd)	EPA 200.8	μg/L	2.5	ND	
Calcium (Ca)	EPA 200.8	μg/L	1,000	11,000	
Chromium (Cr)	EPA 200.8	μg/L	5.0	ND	
Cobalt (Co)	EPA 200.8	μg/L	5.0	ND	
Copper (Cu)	EPA 200.8	μg/L	5.0	ND	
Iron (Fe)	EPA 200.8	μg/L	200	ND	
Lead (Pb)	EPA 200.8	μg/L	5.0	ND	
Lithium (Li)	EPA 200.8	μg/L	50	ND	
Magnesium (Mg)	EPA 200.8	μg/L	50	ND	
Manganese (Mn)	EPA 200.8	μg/L	200	ND	
Mercury (Hg)	EPA 200.8	μg/L	0.25	ND	
Molybdenum (Mo)	EPA 200.8	μg/L	5.0	ND	
Nickel (Ni)	EPA 200.8	μg/L	5.0	ND	
Potassium (K)	EPA 200.8	μg/L	500	2,000	
Selenium (Se)	EPA 200.8	μg/L	5.0	ND	
Silver (Ag)	EPA 200.8	μg/L	1.0	ND	
Sodium (Na)	EPA 200.8	μg/L	1,000	19,000	
Strontium (Sr)	EPA 200.8	μg/L	200	ND	
Thallium (TI)	EPA 200.8	μg/L	5.0	ND	
Uranium (U)	EPA 200.8	μg/L	5.0	ND	
Vanadium V)	EPA 200.8	μg/L	5.0	ND	
Zinc (Zn)	EPA 200.8	μg/L	50	ND	
Anions:					
Bromide (Br)	EPA 300.1	mg/L	0.10	ND	
Chloride (Cl)	EPA 300.1	mg/L	0.10	2.0*	
Fluoride (F)	EPA 300.1	mg/L	0.10	ND	
Nitrate (NO₃) as N	EPA 300.1	mg/L	0.10	0.64*	
Nitrate as NO ₃	EPA 300.1	mg/L	0.10	2.8*	
Nitrite (NO ₂) as N	EPA 300.1	mg/L	0.10	ND	
Nitrite as N	EPA 300.1	mg/L	0.10	ND	
Sulfate (SO ₄)	EPA 300.1	mg/L	0.10	0.11*	
Total and Speciated Alkalinity as	CaCO₃:				
Total	SM 2320B	mg CaCO₃/L	1.0	43.0	
Carbonate (CaCO ₃)	SM 2320B	mg CaCO₃/L	1.0	ND	
Bicarbonate (HCO ₃)	SM 2320B	mg CaCO₃/L	1.0	43.0	
Hydroxide (OH)	SM 2320B	mg CaCO₃/L	1.0	ND	
Other Ions/Compounds:					
Phosphorous (P)	EPA 200.7	μg/L	500	ND	
Silicon (Si)	EPA 200.7	μg/L	500	520	
Chromium-6 [Cr(VI)}	EPA 218.6	μg/L	0.20	0.21	
Chlorine (Cl ₂)	SM 4500-CI DE	mg/L	0.40	2.1	
Dissolved Organic Carbon (DOC)	EPA 415.3	μg/L	0.70	1.3	
Inorganic Carbon (IC) as CO ₂	EPA 415.3	mg/L	3.7	40	
Sulfide (S ^{2–})	SM 4500 S-2D	mg/L	0.050	ND	
Total Ammonia as N	EPA 350.1	mg/L	0.10	1.3	
Total Kjeldahl Nitrogen (TKN) as N	EPA 351.2	mg/L	0.30	1.4	

Table 14.Stabilized Pilot Recycled Water Quality

Table 14. Stabilized Pilot Recycled Water Quality (continued)

Analyte	Method	Units	RL	Results
Additional Parameters:				
Dissolved Oxygen (DO)	SM 4500 OG	mg DO/L @ °C	1.00	8.57 @23.1 °C
Oxygen Reduction Potential (ORP)	SM 2580B	±,mV vs. NHE	636	636 @26.3 °C
рН	SM 4500H+B	pH units @ 25 °C	0.05**	7.70
Specific Conductivity (EC)	SM2510B	µmhos/cm @ 25 °C	10.0	139
Langelier Saturation Index (LSI)	calculated	-	—	-1.6

Notes:

Pilot Water sample produced and stabilized by Trussell Technologies, Inc., Oakland, CA. Delivered to Todd Groundwater on February 12, 2014; transported to McCampbell Analytical, Inc. (McCampbell), Pittsburg, CA by Todd Groundwater. Analyzed by McCampbell from April 24, 2014 to May 2, 2014. Final report on May 16, 2014.

* = detected in laboratory method blank

** = accuracy

CCR 17 = California Code of Regulations Title 22 metals also known as California Assessment Manual (CAM) 17 metals

EC = Electrical conductivity or Specific Conductance

EPA = U.S. Environment al Protection Agency

mg/L = milligram per liter or parts per million (ppm)

 μ g/L = micrograms per liter or parts per billion (ppb)

 μ mhos/cm = micro mhos per centimeter equivalent to μ S/cm (microSiemans per centimeter)

ND = Not detected or below method reporting limits (RL)

SM = Standard Method

3.4.2. Core Leaching Test Results

Table 15 summarizes the results from core leaching tests. Key findings summarized by constituent are presented below based on the comparison of leachate concentration and respective drinking water standard. It is noted that measured leachate concentrations represent the concentration of a 5:1 pilot water-to-rock ratio used in the modified TCLP extraction procedure. Assuming 30 percent porosity and a specific gravity of 2.65 for rock, the leaching test concentrations shown in **Table 15** theoretically represent the average concentration of the initial 30.9 pore volumes of pilot water passing through the selected sample. Whether or not initial pore volume average concentrations in leachate would be sustained or decrease following additional flushes of pilot water is dependent on the amount of constituent present and associated reaction geochemistry. The effects of pore water dilution and reaction geochemistry between pilot water and formation materials is considered in the geochemical modeling assessment.

3.4.2.1. Leachate Metals

<u>Aromas Sand Samples</u>: Of the six (6) Aromas Sand leachate samples analyzed, concentrations for the following metals (excluding major cations) were detected within their respective regulatory limit:

- Arsenic (2 samples: 5.5 and 7.6 μg/L in 74.0 75.5 and 364.5 367.0 feet-bgs samples, respectively)
- Barium (4 samples: 8 to 930 μg/L in samples from 74.5 to 367.0 feet-bgs)

- Chromium (total) (2 samples: 24.0 and 6.2 $\mu g/L$ in 297.0 298.5 and 364.5 367.0 feet-bgs samples, respectively)
- Copper (1 sample: 33 μg/L in 297.0 298.5 feet-bgs sample)
- Lead (1 sample: 11 μg/L in 297.0 298.5 feet-bgs sample)
- Zinc (3 samples: 59 to 550 µg/L in samples from 200.0 to 367.0 feet-bgs)

Of the six (6) Aromas Sand leachate samples analyzed, concentrations of the following metals (excluding major cations) exceeded their respective regulatory limit:

- Aluminum (two samples: 4,300 and 4,800 μg/L in 297.0 298.5 and 364.5 367.0 feet-bgs samples, respectively),
- Cadmium (1 sample: 6.0 μg/L in 297.0 298.5 feet-bgs sample)
- Iron (three samples: 1,100 to 8,700 μg/L from 200.0 to 367.0 feet-bgs)
- Manganese (1 sample: 360 μg/L in 297.0 298.5 feet-bgs sample)

<u>Paso Robles Samples:</u> Of the two (2) Paso Robles leachate samples analyzed, concentrations for the following metals (not including major cations) were detected within their respective regulatory limit:

- Aluminum (1 sample: 970 μg/L in 398.5 401.0 feet-bgs sample)
- Barium (2 samples: 50 and 200 μg/L in 398.5 401.0 and 433.0 435.0 feet-bgs samples, respectively)
- Zinc (1 sample: 500 μg/L in 398.5 401.0 feet-bgs sample)

Of the two (2) Paso Robles leachate samples analyzed, concentrations of the following metals exceeded their respective regulatory limit:

- Cadmium (1 sample: 24.0 μg/L in 398.5 401.0 feet-bgs sample)
- Iron (1 sample: 48,000 μg/L in 398.5 401.0 feet-bgs sample)
- Manganese (1 sample: 4,300 μg/L in 398.5 401.0 feet-bgs sample)
- Nickel (1 sample: 1,800 μg/L in 398.5 401.0 feet-bgs sample)

Despite establishment of rigorous protocols to minimize the influence of turbidity in leachate analyses (see **Appendix E** for description on laboratory leaching/extraction methodology and turbidity study), metals concentrations in leachate are likely impacted due to turbidity. Specifically, the strong correlation between "dissolved" concentrations of aluminum, iron, and silicon in the two deepest Aromas Sand samples and shallow Paso Robles sample suggests the digestion of suspended solids (colloids) prior to analysis (extract turbidity measurements are provided at the bottom row of **Table 15**). Additionally, the detections of cadmium, nickel, vanadium, and zinc further support this hypothesis, because these metals would not typically be in solution at the pH levels observed. The presence of turbidity is a product of the tumbling procedure used in the modified TCLP and is not expected in the aquifer.

Notwithstanding the limitations of the metals results, the information provides a preliminary estimate of leaching potential of pilot water through Aromas Sand and Paso

Robles Formation sediments. Together, with the results of the solid core analyses and HA-HCl extraction test, the pilot water leachate tests help to identify potential reactions warranting further evaluation through geochemical modeling.

3.4.2.2. Anions

Of the six (6) Aromas Sand and two (2) Paso Robles leachate samples analyzed, concentrations for chloride, fluoride and nitrate were detected within their respective regulatory limit. Sulfate was detected at 2,000 mg/L concentrations in one sample (398.5 – 401.0 feet-bgs), exceeding the regulatory limit of 250 mg/L. Examination of the Energy Dispersive X-Ray Analysis (**Table 7**) shows that the 398.5 – 401.0 feet-bgs sample is composed of 1.64 percent sulfur by weight, similar to the 74.0 – 75.5 and 200.0 – 202.5 feet-bgs samples. While sulfate is also detected in the latter two samples, leachate concentrations are two orders of magnitude lower in those samples. As summarized in **Table 6** (thin-section mineralogical analysis), pyrite replacement associated with altered organic matter particles is a characteristic of the 398.5 – 401.0 feet-bgs sample. Therefore, it is likely that the elevated sulfate concentration in leachate from this sample is a result of iron sulfide (pyrite) oxidation to sulfate, due to the higher ORP of the pilot water (629 mV; see **Table 14**) compared to local groundwater (409 mV; see MRWPCA MW-1 in **Table 16C**).

3.4.2.3. Other Ions/Compounds

Of the eight (8) leachate samples analyzed, chromium(VI) was detected in six samples (all in the Aromas Sand) at concentrations ranging from 0.6 to 1.6 μ g/L, below the proposed primary MCL of 10 μ g/L.

Chlorine concentrations in leachate range from 0.74 to 1.7 mg/L, slightly less than in the GWR pilot water (2.9 mg/L), suggesting attenuation through volatilization.

With the exception of leachate from the 398.5 - 401.0 feet-bgs sample, leachate pH values are similar to or slightly above the laboratory-measured pH value for the GWR pilot water used in the tests (pH = 7.45) and within the regulatory limit. Based on the consistency of the pH values of leachate from other samples and the range of lithologies represented, the pH value of the leachate from the 398.5 - 401.0 feet-bgs sample (pH = 5.04) is a clear outlier. It is possible that the decrease in pH in leachate from this sample is associated with the oxidation of pyrite to sulfate in the upper Paso Robles.

Table 15.Core Leachate Test Results

			Fo	rmation:				Aromas				Paso Robles		
Analyte	Method	Units	RL	CA Primary MCL**	27.5'- 30.0'	74.0'- 75.5"	98.5'- 101.0'	129.5'- 142.0'	200.0'- 202.5'	297.0''- 298.5'	364.5'- 367.0'	398.5'- 401.0'	433.0'- 435.0'	472.0'- 474.5'
Leachate Metals:														
Aluminum (Al)	EPA 200.8	μg/L	500	1,000	NA	ND	ND	ND	900*	4,300*	4,800*	970*	ND	NA
Antimony (Sb)	EPA 200.8	μg/L	5.0	6.0	NA	ND	ND	ND	ND	ND	ND	ND	ND	NA
Arsenic (As)	EPA 200.8	μg/L	5.0	10	NA	5.5*	ND	ND	ND	ND	7.6*	ND	ND	NA
Barium (Ba)	EPA 200.8	μg/L	50	1,000	NA	8.1*	180*	140*	330*	930*	490*	50*	200*	NA
Beryllium (Be)	EPA 200.8	μg/L	5.0	4.0	NA	ND	ND	ND	ND	ND	ND	ND	ND	NA
Cadmium (Cd)	EPA 200.8	μg/L	2.5	5.0	NA	ND	ND	ND	ND	6.0*	ND	24*	ND	NA
Calcium (Ca)	EPA 200.8	μg/L	1,000	I	NA	14,000*	5,200*	4,300*	6,200*	71,000*	9,400*	540,000*	6,700	NA
Chromium (Cr)	EPA 200.8	μg/L	5.0	50	NA	ND	ND	ND	ND	24*	6.2*	ND	ND	NA
Cobalt (Co)	EPA 200.8	μg/L	5.0	I	NA	ND	ND	ND	ND	ND	ND	240	ND	NA
Copper (Cu)	EPA 200.8	μg/L	5.0	1,300	NA	ND	ND	ND	ND	33*	ND	ND	ND	NA
Iron (Fe)	EPA 200.8	μg/L	200	300(S)	NA	ND	ND	ND	1,100*	8,700*	1,500*	48,000*	ND	NA
Lead (Pb)	EPA 200.8	μg/L	5.0	15	NA	ND	ND	ND	ND	11*	ND	ND	ND	NA
Lithium (Li)	EPA 200.8	μg/L	50	I	NA	ND	ND	ND	ND	ND	ND	140*	ND	NA
Magnesium (Mg)	EPA 200.8	μg/L	200	I	NA	4,700*	2,300*	1,900*	2,000*	18,000*	1,600*	150,000*	1,900*	NA
Manganese (Mn)	EPA 200.8	μg/L	200	50(S)	NA	ND	ND	ND	ND	360*	ND	4,300*	ND	NA
Mercury (Hg)	EPA 200.8	μg/L	0.25	2	NA	ND	ND	ND	ND	ND	ND	ND	ND	NA
Molybdenum (Mo)	EPA 200.8	μg/L	5.0		NA	16*	ND	ND	ND	ND	ND	ND	14*	NA
Nickel (Ni)	EPA 200.8	μg/L	5.0	100	NA	ND	ND	ND	ND	30*	5.5*	1,800*	ND	NA
Potassium (K)	EPA 200.8	μg/L	500		NA	4,600*	2,600*	2,400*	3,600*	2,600*	5,400*	20,000*	2,500*	NA
Selenium (Se)	EPA 200.8	μg/L	5.0	50	NA	ND	ND	ND	ND	ND	ND	ND	ND	NA
Silver (Ag)	EPA 200.8	μg/L	1.9	100(S)	NA	ND	ND	ND	ND	ND	ND	ND	ND	NA
Sodium (Na)	EPA 200.8	μg/L	1,000	I	NA	26,000*	22,000*	22,000*	26,000*	42,000*	36,000*	48,000*	25,000*	NA
Strontium (Sr)	EPA 200.8	μg/L	200	I	NA	ND	ND	ND	ND	680*	ND	3,300*	ND	NA
Thallium (TI)	EPA 200.8	μg/L	5.0	2	NA	ND	ND	ND	ND	ND	ND	ND	ND	NA
Uranium (U)	EPA 200.8	μg/L	5.0	20	NA	ND	ND	ND	ND	ND	ND	ND	ND	NA
Vanadium V)	EPA 200.8	μg/L	5.0	-	NA	6.5*	ND	ND	8.3*	31*	17*	ND	ND	NA
Zinc (Zn)	EPA 200.8	μg/L	50	5,000(S)	NA	ND	ND	ND	59*	550*	62*	500*	ND	NA
Extract Turbidity		NTU			NA	NA	NA	NA	5.7	67.0	7.7	7.0	NA	NA

			For	mation:	Aromas							Paso Robles		
Analyte	Method	Units	RL	CA Primary MCL**	27.5'- 30.0'	74.0'- 75.5"	98.5'- 101.0'	139.5'- 142.0'	200.0'- 202.5'	297.0''- 298.5'	364.5'- 367.0'	398.5'- 401.0'	433.0'- 435.0'	472.0'- 474.5'
Anions:														
Bromide (Br)	EPA 300.1	mg/L	0.10	-	NA	ND	ND	ND	ND	ND	ND	ND	ND	NA
Chloride (Cl)	EPA 300.1	mg/L	1.0	250(S)	NA	20	20	20	20	26	21	22	22	NA
Fluoride (F)	EPA 300.1	mg/L	0.10	2.0	NA	0.31	0.22	0.26	0.28	0.32	0.48	1.1	0.14	NA
Nitrate as N	EPA 300.1	mg/L	0.10	10	NA	0.64	0.64	0.65	0.64	0.67	0.65	0.61	0.67	NA
Nitrate as(NO ₃ ⁻)	EPA 300.1	mg/L	0.45	45	NA	2.8	2.8	2.9	2.8	3.0	2.9	2.7	3.0	NA
Nitrite as N	EPA 300.1	mg/L	0.10	1.0	NA	ND	ND	ND	ND	ND	ND	ND	ND	NA
Nitrite as (NO ₂ ⁻)	EPA 300.1	mg/L	0.33		NA	ND	ND	ND	ND	ND	ND	ND	ND	NA
Sulfate (SO ₄)	EPA 300.1	mg/L	1.0	250(S)	NA	11	0.42	0.93	0.34	20	8.5	2,000	0.88	NA
Total and Speciated Alkalinit	y as CaCO₃:													
Total	SM2320B	mg CaCO₃/L	1.00	-	NA	73.0	40.0	37.0	46.0	170	59.0	1.07	44.7	NA
Carbonate (CaCO ₃)	SM2320B	mg CaCO₃/L	1.00	-	NA	ND	ND	ND	ND	ND	ND	ND	ND	NA
Bicarbonate (HCO ₃)	SM2320B	mg CaCO₃/L	1.00	-	NA	73.0	40.0	37.0	46.0	170	59.0	1.07	44.7	NA
Hydroxide (OH)	SM2320B	mg CaCO₃/L	1.00	-	NA	ND	ND	ND	ND	ND	ND	ND	ND	NA
Other lons/Compounds:														
Phosphorous (P)	EPA 200.7	μg/L	500	—	NA	ND	ND	ND	ND	22,000*	1,000*	ND	ND	NA
Silicon (Si)	EPA 200.7	μg/L	500	-	NA	7,400*	8,900*	11,000*	12,000*	110,000*	28,000*	24,000*	10,000*	NA
Chromium-6 [Cr(VI)]	EPA 218.6	μg/L	0.20	10***	NA	0.86	1.60	2.40	0.61	1.60	0.77	ND	ND	NA
Chlorine	SM4500-CI DE	mg/L	0.40	4.0	NA	1.5	1.6	1.3	1.6	ND	1.7	ND	0.74	NA
Dissolved Organic Carbon (DOC)	EPA 415.3	mg/L	0.70	-	NA	1.4	1.2	1.1	2.2	16	3	6.4	1.2	NA
Inorganic Carbon (IC) as CO ₂	EPA 415.3	mg/L	3.7	-	NA	67	37	34	40	56	43	10	41	NA
Sulfide (S ^{2–})	SM4500 S-2 D	mg/L	0.050	-	NA	ND	ND	ND	ND	ND	ND	ND	ND	NA
Total Ammonia as N	EPA 350.1	mg/L	0.10	-	NA	0.72	0.58	0.44	0.50	ND	0.42	1.8	0.27	NA
Total Kjeldahl Nitrogen (TKN) as N	EPA 351.2	mg/L	0.30	-	NA	0.82	1.4	0.55	0.73	3.1	0.73	2.3	0.39	NA
Additional Parameters:														
Oxygen Reduction Potential (ORP)	SM2580B, MAI	+/- mv vs. NHE	10	-	NA	577 @ 23.9°C	663 @ 23.6°C	665 @ 23.4°C	650 @ 23.9°C	479 @ 25.3°C	666 @ 24.3°C	438 @ 24.3°C	649 @ 26.4°C	NA
рН	SM4500H+B	+/-, pH units @ 25°C	0.05	6.5- 8.5****	NA	8.44	7.65	7.44	7.83	7.95	8.11	5.04	7.84	NA
Extract Turbidity	NTU				NA	NA	NA	NA	5.7	67.0	7.7	7.0	NA	NA

Table 15.Core Leachate Test Results (continued)

Notes:

For pilot water analysis used in standard leaching test (Table 7) see Table 14.

* Concentrations questionable due to high turbidity in leachate (see bottom line in table)

** CA Primary MCL = California Department of Public Health Primary MCL. Dash (-) indicates no listing or no MCL indicated. (S) = secondary MCL

*** Proposed CA Primary MCL Cr(VI) April 15, 2014

**** Range required by U.S. Environmental Protection Agency (U.S.EPA) Secondary MCL

EPA = U.S. Environmental Protection Agency

Core samples collected from Sonic Drilling cores collected in MW-1 boring at depth in feet (') below ground surface.

mg/L = milligram per liter or parts per million (ppm)

 μ g/L = micrograms per liter or parts per billion (ppb)

NA = Not analyzed

ND = Not detected or below method reporting limits (RL)

NTU = nephalometric turbidity unit

SM = Standard Method

3.5. GROUNDWATER QUALITY RESULTS

Table 16 summarizes the groundwater quality analytical program conducted for this investigation. Full laboratory results for the 300+ constituents/parameters analyzed are grouped into common categories and presented in **Tables 16A through 16P**. Data were used to characterize groundwater quality source type and age beneath the GWR project recharge area. Additionally, potential constituents of concern, including former Fort Ord constituents and chemicals of emerging concern (CoECs), were screened to identify which constituents satisfy or exceed respective California drinking water standards. Results of the groundwater quality characterization are described below. Complete copies of the analytical laboratory reports are provided in **Appendix F**.

3.5.1. Source Water Geochemical Plotting and Fingerprinting

3.5.1.1. Stiff Diagrams

Stiff Diagrams are straight-line plots of cation and anion concentrations in milliequivalents per liter (meq/L). Data points are plotted along three 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. **Figure 7** shows Stiff diagrams for each of the six wells sampled for this investigation (diagrams with bold outline) as well as for other local wells in the vicinity. Diagrams are color-coded to indicate the well construction and 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 screens in both aquifers. Also shown on the map is a Stiff diagram representing the treated Carmel River water injectate for the ASR wellfields (labeled ASR injectate) and GWR pilot recycled water.

The stiff diagrams on **Figure 7** depict the unique groundwater signatures for well screened in the Paso Robles and Santa Margarita aquifers in the basin. The four Paso Robles wells sampled (MRWPCA MW-1, FO-7 shallow, PRTIW, and City of Seaside #4) exhibit a sodium-chloride signature. TDS concentrations for the four wells average 252 mg/L. In contrast, the two Santa Margarita wells sampled (FO-7 deep and ASR MW-1) exhibit a relatively balanced calcium/sodium-bicarbonate/chloride signature; the average TDS concentration of the two wells is 510 mg/L. The chemical signature of wells screened in both aquifers more closely resembles the Santa Margarita signature, suggesting that the Santa Margarita Aquifer is contributing more water to the well than the Paso Robles Aquifer.

The ASR injectate and GWR pilot recycled water both have unique geochemical signatures compared to the groundwater signatures in the basin. Because the ASR injectate is shallow groundwater water from the Carmel Valley Alluvial Aquifer and recycled water is highly purified then selectively stabilized, both waters are less mineralized than the native Seaside Basin groundwater, as indicated by the narrow Stiff diagrams for both waters. The signature

of the ASR injectate has a calcium-bicarbonate signature, while the GWR pilot recycled water has a sodium-chloride/bicarbonate signature.

Table 16.	Groundwater Quality Analytical Program –
	Laboratory Summary

Laboratory	Analytes	Tables
Alpha Analytical Laboratory	Anions	16A
Alpha Analytical Laboratory/McCampbell Analytical	Metals (Including Major Cations) and Cr(VI)	16B
Alpha Analytical Laboratory	Conventional Chemistry and Other Parameters	16C
Alpha Analytical Laboratory	Chlorinated Pesticides and PCBs	16D
Alpha Analytical Laboratory	Nitrogen and Phosphorus Pesticides	16E
Alpha Analytical Laboratory	Organic Analytes	16F
Alpha Analytical Laboratory	Chlorinated Acids	16G
Alpha Analytical Laboratory	Carbamates	16H
Alpha Analytical Laboratory	Other Organic Compounds	161
Alpha Analytical Laboratory	Volatile Organic Compounds (VOCs)	16J
Alpha Analytical Laboratory UL Laboratory and Pace Analytical	Semivolatile Organic Compounds (VOCs)+Dioxin	16K
Alpha Analytical Laboratory	Haloacetic Acids	16L
ALS Environmental	Nitroaromatics and Nitramines (Explosives)	16M
Weck Laboratories, Inc.	Pharmaceuticals and Personal Care Products (PPCPs)	16N
UL Laboratory and GEL Laboratories	Radiogenic: Gross Alpha, Beta; Radium 226 and 228, Strontium 90	160
ZyMax Forensics	Stable Isotopes of oxygen and hydrogen in water, nitrogen and oxygen in nitrate	16P
Asbestos TEM Laboratories, Inc.	Asbestos	16C
Isotech	Tritium (enriched)	160

Table 16A: Anions

Analyte	Method	MDL City of Seaside 4 FO-7 Deep FO-7 Shallow MRWPCA MW-1 PRTIW Mission Memorial ASR MW-1 I Ref								egulatory quirements
					r	ng/L				Туре
Bicarbonate (HCO3⁻)	SM2320B	0.060	66	210	68	70	130	270	-	-
Bromate (BrO ₃ ⁻)	EPA 300.1	0.005	ND	ND	ND	ND	ND	ND	0.010	CSMCL-ESMCL
Chloride (Cl ⁻)	EPA 300.0	0.30	59	100	44	79	86	120	250	CSMCL-ESMCL
Chlorite (CIO2 ⁻)	EPA 300.0	0.020	ND	ND	ND	ND	ND	ND	1.0	CSMCL-ESMCL
Fluoride (F ⁻)	EPA 300.0	0.070	ND	ND	ND	ND	ND	0.15	2.0/4.0	CPMCL/EPMCL
Nitrite as N	EPA 300.0	0.02	ND	ND	ND	ND	ND	ND	1.0	CPMCL/EPMCL
Nitrate as NO₃⁻	EPA 300.0	0.20	13	0.60	2.4	2.7	11	0.42	45	CPMCL/EPMCL
Sulfate (SO ₄ ^{2–})	EPA 300.0	0.090	14	24	13	9.9	89	73	250	CPMCL/EPMCL

Analyte	Method	Units	MDL	City of Seaside 4	FO-7**** Deep	FO-7**** Shallow	MRWPCA MW-1****	PRTIW Mission Memorial	ASR MW-1	Regulator	y Requirements
Aluminum (Al)	EPA 200.8	µg/L	8.0	ND	170****	3,700****	2,700****	4.3	4.8	1,000/200	CPMCL/CMCL
Antimony (Sb)	EPA 200.8	µg/L	0.080	ND	0.75	3.7	0.51	0.033	0.34	6	CPMCL-EPMCL
Arsenic (As)	EPA 200.8	µg/L	0.28	1.2	7.6****	210****	2.8****	1.6	1.6	10	CPMCL-EPMCL
Barium (Ba)	EPA 200.8	µg/L	0.12	26	72****	1,200****	40****	59	66	1,000/2000	CPMCL/EPMCL
Beryllium (Be) (Total)	EPA 200.8	µg/L	0.080	ND	ND	0.68	0.044	ND	ND	4	CPMCL-EPMCL
Boron (B)	EPA 200.8	µg/L	24	42***	140***	25***	36***	32***	90***	-	-
Cadmium (Cd) Total	EPA 200.8	µg/L	0.080	ND	ND	3.3	0.15	0.10	0.51	5	CPMCL-EPMCL
Calcium (Ca) Total	EPA 200.7	mg/L	0.010	14	53	29	17	37	76	-	-
Chromium (Cr) Total	EPA 200.8	µg/L	0.32	3.6	1.7	790****	13****	3.4	ND	50/100	CPMCL/CMCL
Cr(VI)	EPA 218.6	µg/L	0.050*	3.4	ND	1.7	1.1	1.6	ND	10	CPMCL**
Copper (Cu) Total	EPA 200.8	µg/L	0.16	1.1	1.6	14****	3.7	1.9	4.3	1,300/1,000	CPMCL-EPMCL/ CSMCL-ESMCL
Iron (Fe) Total	EPA 200.8	µg/L	7.2	ND	1100****	80,000****	4,000****	67	21	300	CSMCL-ESMCL
Lead (Pb) Total	EPA 200.8	µg/L	0.080	ND	1.3****	42****	1.3****	0.061	0.78	15	CPMCL-EPMCL
Magnesium (Mg) Total	EPA 200.7	mg/L	0.0080	6.5	6.8	3.8	6.5	10	22	_	CPMCL-EPMCL
Manganese (Mn) Total	EPA 200.8	µg/L	0.12	0.25	83****	20,000****	150****	1.1	23	50	CSMCL-ESMCL
Mercury (Hg) Total	EPA 245.1	µg/L	0.060	ND	ND	0.11	ND	ND	0.85	2	CPMCL-EPMCL
Nickel (Ni) Total	EPA 200.8	µg/L	0.24	0.54	2.8****	26****	8.1****	1.3	4.0	100	CPMCLC
Potassium (Total)	EPA 200.7	mg/L	0.0080	2.0	3.7	3.6	3.4	3.1	5.1	-	-
Selenium (Se) Total	EPA 200.8	µg/L	0.28	0.66***	1.8	1.3***	1.5***	2.2	1.8***	50	CPMCL-EPMCL
Silver (Ag) Total	EPA 200.8	µg/L	0.080	ND	ND	0.11	0.028	ND	ND	2	CPMCL-EPMCL
Sodium (Na) Total	EPA 200.7	mg/L	0.020	43	86	38	50	64	91	-	-
Thallium (TI)	EPA 200.8	µg/L	0.080	ND	ND	0.19	0.027	0.045	ND	2	CPMCL-EPMCL
Uranium (U)	EPA 200.8	pCi/l	0.080	ND	1.6	0.62	0.33	0.20	1.3	20	CPMCL
Vanadium (V)	EPA 200.8	µg/L	1.2	2.5	5.8****	34****	9.5****	1.6	0.76	_	_
Zinc (Zn)	EPA 200.8	µg/L	2.0	2.9	52***	300***	69***	75***	25***	5,000	CPMCL-EPMCL

Table 16B: Metals (Including Major Cations)

Notes: * Reporting Level or RL. ** Proposed April 15, 2014. *** Reported in laboratory blank. **** Analysis questionable due to high turbidity (see Table 16C)

Table 16C: Conventional Chemistry and Other Parameters

Analyte	Method	Units	MDL	City of Seaside 4	FO-7 Deep	FO-7 Shallow	MRWPCA MW-1	PRTIW Mission Memorial	ASR MW-1	Re Rec	gulatory juirement
						Con	centration				Туре
Asbestos by TEM (chrysotile/amphibole)*	EPA 100.2	MFL	0.1-1.1	ND	ND	ND	ND	ND	ND	7.0	CSMCL-ESMCL
Bicarbonate (HCO3 ⁻)	SM2320B	mg/L	0.060	66	210	68	70	130	270	-	-
Color	SM2120B	Color Units	3.0	ND	4.0	4.0	28	6.0	3.0	15	CSMCL
Dissolved Oxygen (DO)	Field	mg/L	***	NA	4.61	4.83	5.09	NA	NA	-	-
MBAS, calculated as LAS, mw 340	SM5540C	mg/L	0.030	ND	ND	ND	ND	ND	ND	5.0	CSMCL-ESMCL
Odor	EPA 140.1	T.O.N.		ND	ND	ND	1.4	ND	ND	3	CSMCL-ESMCL
Oxygen Reduction Potential (ORP)	Field	mV	***	(332)	396.6	423.3	408.9	(392.0)	(354.0)	-	-
Perchlorate (CIO ₄ ⁻)	EPA 314.0	µg/L	0.90	ND**	1.9**	ND**	ND**	1.1**	ND**	6.0	CPMCL
рН	Field	units	***	(8.25)	7.68	8.11	8.23	(6.39)	(7.09)	6.5-8.5	ESMCL
Specific Conductance (or Electrical	SM2510B	µmhos/cm or	1.0	340	660	280	270	440	900	000	CSMCI
Conductivity (EC)	Field	μS/cm	***	(378)	669	292	409	(630)	(958)	900	CSINCL
Temperature	Field	°C	***	(19.1)	15.5	15.7	18.5	(16.3)	(19.7)	_	_
Total Dissolved Solids (TDS)	SM2540C	mg/L	5.0	250	460	190	220	350	560	500	CSMCL-ESMCL
Turbidity	SM2130P	NTU	0.040	0.32	10	550	71	0.98	0.37	1/5	CPMCL-EPMCL/
Turblatty	31012 1300	NIO	***	1.0	40	150	82.3	6.0	2.0	1/5	CSMCL-ESMCL
Nitrate + Nitrite as N	EPA 300.0	mg/L	0.0086	3.0	0.13	0.55	0.61	2.4	0.094	10	CSMCL-ESMCL
Total Organic Carbon (TOC)	SM5310C	mg/L	0.100	0.274	0.190	0.768	0.898**	0.519**	0.627	-	_
Cyanide (CN⁻)	10-204-00- 1X	mg/L	0.0020	0.0028	0.0023	ND	ND	ND	ND	0.15/0.20	CPMCL/EPMCL

Notes:

* Calculated asbestos structures >10 micrometers (μm)

** Detected in Laboratory Blank

*** Field instruments calibrated to within 10% by Blaine Tech Services. Raw ORP field readings correct using instrument supplied calculator. Field values in parenthesis indicate reading taken at surface access port and not down hole.

Table 16D: Chlorinated Pesticides and PCBs

Analyte	Method	MDL	City of Seaside 4	FO-7 Shallow	PRTIW Mission Memorial	ASR MW-1	Rec Rec	egulatory juirements		
					•	µg/L				Туре
Aldrin	EPA 508	0.10	ND	ND	ND	ND	ND	ND	-	-
Chloroneb	EPA 508	0.20	ND	ND	ND	ND	ND	ND	-	-
Chlorbenzilate	EPA 508	2.0	ND	ND	ND	ND	ND	ND	_	_
Chlorothalonil	EPA 508	0.030	ND	ND	ND	ND	ND	ND	_	_
DCPA	EPA 508	0.020	ND	ND	ND	ND	ND	ND		
4,4'-DDD	EPA 508	0.020	ND	ND	ND	ND	ND	ND	_	_
4,4'-DDE	EPA 508	0.020	ND	ND	ND	ND	ND	ND	-	-
4,4'-DDT	EPA 508	0.020	ND	ND	ND	ND	ND	ND	-	-
Dieldrin	EPA 508	0.010	ND	ND	ND	ND	ND	ND	-	_
Endosulfan I	EPA 508	0.020	ND	ND	ND	ND	ND	ND	-	_
Endosulfan II	EPA 508	0.020	ND	ND	ND	ND	ND	ND	-	-
Endosulfan sulfate	EPA 508	0.020	ND	ND	ND	ND	ND	ND	-	-
Endrin	EPA 508	0.030	ND	ND	ND	ND	ND	ND	2.0	CPMCL-EPMCL
Endrin aldehyde	EPA 508	0.020	ND	ND	ND	ND	ND	ND	-	-
HCH-alpha (α-BHC)	EPA 508	0.010	ND	ND	ND	ND	ND	ND	-	—
HCH-beta (β-BHC)	EPA 508	0.020	ND	ND	ND	ND	ND	ND	-	-
HCH-delta (δ-BHC)	EPA 508	0.030	ND	ND	ND	ND	ND	ND	-	_
HCH-gamma (γ- BHC) (Lindane)	EPA 508	0.010	ND	ND	ND	ND	ND	ND	0.2	CPMCL-EPMCL
Heptachlor	EPA 508	0.010	ND	ND	ND	ND	ND	ND	0.01/0.4	CPMCL/EPMCL
Heptachlor epoxide	EPA 508	0.010	ND	ND	ND	ND	ND	ND	0.01/0.2	CPMCL/EPMCL

Analyte	Method	MDL	City of Seaside 4	FO-7 Deep	FO-7 Shallow	MRWPCA MW-1	PRTIW Mission Memorial	ASR MW-1	R	Regulatory equirements
						ug/L				Туре
Hexachlorobenzene	EPA 508	0.010	ND	ND	ND	ND	ND	ND	1.0	CPMCL-EPMCL
Hexachlorocyclo- pentadiene	EPA 508	0.040	ND	ND	ND	ND	ND	ND	50	CPMCL-EPMCL
Methoxychlor	EPA 508	0.020	ND	ND	ND	ND	ND	ND	30/40	CPMCL/EPMCL
cis-Permethrin	EPA 508	0.070	ND	ND	ND	ND	ND	ND	_	_
trans-Permethrin	EPA 508	0.090	ND	ND	ND	ND	ND	ND	_	_
Propachlor	EPA 508	0.070	ND	ND	ND	ND	ND	ND	_	_
Trifluralin	EPA 508	0.020	ND	ND	ND	ND	ND	ND	-	_
PCB (Aroclor)-1016	EPA 508	0.030	ND	ND	ND	ND	ND	ND	0.5	CPMCL-EPMCL
PCB (Aroclor)-1221	EPA 508	0.030	ND	ND	ND	ND	ND	ND	0.5	CPMCL-EPMCL
PCB (Aroclor)-1232	EPA 508	0.030	ND	ND	ND	ND	ND	ND	0.5	CPMCL-EPMCL
PCB (Aroclor)-1242	EPA 508	0.030	ND	ND	ND	ND	ND	ND	0.5	CPMCL-EPMCL
PCB (Aroclor)-1248	EPA 508	0.030	ND	ND	ND	ND	ND	ND	0.5	CPMCL-EPMCL
PCB (Aroclor)-1254	EPA 508	0.030	ND	ND	ND	ND	ND	ND	0.5	CPMCL-EPMCL
PCB -(Aroclor)1260	EPA 508	0.030	ND	ND	ND	ND	ND	ND	0.5	CPMCL-EPMCL
Total PCBs	EPA 508	0.30	ND	ND	ND	ND	ND	ND	0.5	CPMCL-EPMCL
Toxaphene	EPA 508	0.40	ND	ND	ND	ND	ND	ND	3	CPMCL-EPMCL
Chlordane (tech)	EPA 508	0.030	ND	ND	ND	ND	ND	ND	0.1/2	CPMCL/EPMCL

Table 16D: Chlorinated Pesticides and PCBs (continued)

Analyte	Method	MDL	City of Seaside 4	FO-7 Deep	FO-7 Shallow	MRWPCA MW-1	PRTIW Mission Memorial	ASR MW-1	R	Regulatory equirements
						µg/L				Туре
Alachlor	EPA 507	0.50	ND	ND	ND	ND	ND	ND	2.0	CPMCL-EPMCL
Atrazine	EPA 507	0.30	ND	ND	ND	ND	ND	ND	-	-
Bromacil	EPA 507	0.50	ND	ND	ND	ND	ND	ND	_	_
Butachlor	EPA 507	0.40	ND	ND	ND	ND	ND	ND	_	_
Dimethoate	EPA 507	0.20	ND	ND	ND	ND	ND	ND	_	_
Metolachlor	EPA 507	0.30	ND	ND	ND	ND	ND	ND	_	-
Metribuzin	EPA 507	0.40	ND	ND	ND	ND	ND	ND	_	—
Molinate	EPA 507	0.20	ND	ND	ND	ND	ND	ND	20	CPMCL
Prometryn	EPA 507	0.50	ND	ND	ND	ND	ND	ND	-	-
Propachlor	EPA 507	0.30	ND	ND	ND	ND	ND	ND	_	_
Simazine	EPA 507	0.30	ND	ND	ND	ND	ND	ND	4.0	CPMCL-EPMCL
Thiobencarb	EPA 507	0.20	ND	ND	ND	ND	ND	ND	70/1	CPMCL/CSMCL

Table 16E: Nitrogen and Phosphorus Pesticides

Table 16F: Organic Analytes

Analyte	Method	MDL	City of Seaside 4	FO-7 Deep	FO-7 Shallow	MRWPCA MW-1	PRTIW Mission Memorial	ASR MW-1	R	Regulatory equirements
					ŀ	ug/L				Туре
1,2-Dibromo-3- chloropropane	EPA 504.1	0.0040	ND	ND	ND	ND	ND	ND	0.2	CPMCL-EPMCL
1,2-Dibromoethane (EDB)	EPA 504.1	0.0050	ND	ND	ND	ND	ND	ND	0.5	CPMCL-EPMCL

Table 16G: Chlorinated Acids

Analyte	Method	MDL	City of Seaside 4	FO-7 Deep	FO-7 Shallow	MRWPCA MW-1	PRTIW Mission Memorial	ASR MW-1	R	Regulatory Requirements
						µg/L				Туре
2,4,5-T	EPA 515.1	0.40	ND	ND	ND	ND	ND	ND	_	_
2,4,5-TP (Silvex)	EPA 515.1	0.50	ND	ND	ND	ND	ND	ND		
2,4-D	EPA 515.1	0.80	ND	ND	ND	ND	ND	ND	-	-
2,4-DB	EPA 515.1	4.0	ND	ND	ND	ND	ND	ND	-	-
4-Nitrophenol	EPA 515.1	0.70	ND	ND	ND	ND	ND	ND	-	_
Acifluorfen	EPA 515.1	0.50	ND	ND	ND	ND	ND	ND	-	—
Bentazon	EPA 515.1	0.40	ND	ND	ND	ND	ND	ND	18	CPMCL
Dicamba	EPA 515.1	0.40	ND	ND	ND	ND	ND	ND	_	_
Dichlorprop	EPA 515.1	1.0	ND	ND	ND	ND	ND	ND	—	—
Dinoseb	EPA 515.1	0.80	ND	ND	ND	ND	ND	ND	7	CPMCL-EPMCL
Pentachlorophenol	EPA 515.1	0.20	ND	ND	ND	ND	ND	ND	1	CPMCL-EPMCL
Picloram	EPA 515.1	0.50	ND	ND	ND	ND	ND	ND	500	CPMCL-EPMCL

Table 16H: Carbamates

Analyte	Method	MDL	F Re	Regulatory equirements						
						µg/L				Туре
3-Hydroxycarbofuran	EPA 531.1	0.90	ND	ND	ND	ND	ND	ND	-	-
Aldicarb	EPA 531.1	0.70	ND	ND	ND	ND	ND	ND	3	EPMCL
Aldicarb sulfone	EPA 531.1	0.70	ND	ND	ND	ND	ND	ND	3	EPMCL
Aldicarb sulfoxide	EPA 531.1	0.80	ND	ND	ND	ND	ND	ND	4	EPMCL
Carbaryl	EPA 531.1	0.70	ND	ND	ND	ND	ND	ND	-	-
Carbofuran	EPA 531.1	2.0	ND	ND	ND	ND	ND	ND	18/40	CPMCL/EPMCL
Methiocarb	EPA 531.1	2.0	ND	ND	ND	ND	ND	ND	-	—
Methomyl	EPA 531.1	2.0	ND	ND	ND	ND	ND	ND	-	-
Oxamyl	EPA 531.1	0.80	ND	ND	ND	ND	ND	ND	50/200	CPMCL/EPMCL
Propoxur (Baygon)	EPA 531.1	2.0	ND	ND	ND	ND	ND	ND	_	_

Table 16I: Other Organic Compounds

Analyte	Method	MDL	City of Seaside 4	FO-7 Deep	FO-7 Shallow	MRWPCA MW-1	PRTIW Mission Memorial	ASR MW-1	R Re	legulatory quirements
			Туре							
Diquat	EPA 549.2	2.0	ND	ND	ND	ND	ND	ND	20	CPMCL- EPMCL
Endothall	EPA 548.1	2.0	ND	ND	ND	ND	ND	ND	100	CPMCL- EPMCL
Glyphosate	EPA 547	3.0	ND	ND	ND	ND	ND	ND	700	CPMCL- EPMCL

Analyte	Method	MDL	City of Seaside 4	FO-7 Deep	FO-7 Shallow	MRWPCA MW-1	PRTIW Mission Memorial	ASR MW-1	F Re	Regulatory equirements
						µg/L	•		•	Туре
Acetone	EPA 524.2	0.80	ND	ND	2.0	ND	ND	ND	-	_
Acrylonitrile	EPA 524.2	0.20	ND	ND	ND	ND	ND	ND	_	_
Benzene	EPA 524.2	0.20	ND	ND	ND	ND	ND	ND	1/5	CPMCL/EPMCL
Bromobenzene	EPA 524.2	0.10	ND	ND	ND	ND	ND	ND	_	-
Bromochloromethane	EPA 524.2	0.20	ND	ND	ND	ND	ND	ND	-	—
Bromodichloromethane	EPA 524.2	0.50	ND	ND	ND	ND	ND	ND	80	CPMCL-EPMCL
Bromoform	EPA 524.2	0.50	ND	ND	ND	ND	ND	ND	80	CPMCL-EPMCL
Bromomethane	EPA 524.2	0.20	ND	ND	ND	ND	ND	ND	-	_
n-Butylbenzene	EPA 524.2	0.10	ND	ND	ND	ND	ND	ND	-	-
Sec-Butylbenzene	EPA 524.2	0.10	ND	ND	ND	ND	ND	ND	100/10	CPMCL-EPMCL
Tert-Butylbenzene	EPA 524.2	0.10	ND	ND	ND	ND	ND	ND	-	—
Carbon disulfide	EPA 524.2	0.20	ND	ND	ND	ND	ND	ND	-	-
Carbon tetrachloride	EPA 524.2	0.30	ND	ND	ND	ND	ND	ND	0.5/5	CPMCL/EPMCL
Chlorobenzene	EPA 524.2	0.20	ND	ND	ND	ND	ND	ND	70/100	CPMCL/EPMCL
Chloroethane	EPA 524.2	0.10	ND	ND	ND	ND	ND	ND	-	_
Chloroform	EPA 524.2	0.50	ND	ND	ND	ND	1.2	0.87	80	CPMCL-EPMCL
Chloromethane	EPA 524.2	0.20	ND	ND	ND	ND	ND	ND	-	_
2-Chlorotoluene	EPA 524.2	0.20	ND	ND	ND	ND	ND	ND	-	_
4-Chlorotoluene	EPA 524.2	0.10	ND	ND	ND	ND	ND	ND	-	-
Dibromochloromethane	EPA 524.2	0.50	ND	ND	ND	ND	ND	ND	80	CPMCL-EPMCL
1,2-Dibromo-3-chloropropane	EPA 524.2	0.36	ND	ND	ND	ND	ND	ND	0.2	CPMCL-EPMCL
1,2-Dibromethane (EDB)	EPA 524.2	0.14	ND	ND	ND	ND	ND	ND	0.05	CPMCL-EPMCL
1,2-Dichlorobenzene	EPA 524.2	0.20	ND	ND	ND	ND	ND	ND	600	CPMCL-EPMCL
1,3-Dichlorobenzene	EPA 524.2	0.20	ND	ND	ND	ND	ND	ND	-	-
1,4-Dichlorobenzene	EPA 524.2	0.10	ND	ND	ND	ND	ND	ND	5/75	CPMCL/EPMCL
Trans-1,4-Dichloro-2-butene	EPA 524.2	0.095	ND	ND	ND	ND	ND	ND	-	_

Table 16J: Volatile Organic Compounds (VOCs)

Analyte	Method	MDL	City of Seaside 4	FO-7 Deep	FO-7 Shallow	MRWPCA MW-1	PRTIW Mission Memorial	ASR MW-1	Regulato	ry Requirements
					•	μg/L		•		Туре
Dichlorodifluoromethane	EPA 524.2	0.20	ND	ND	ND	ND	ND	ND	_	_
1,1-Dichloroethane	EPA 524.2	0.10	ND	ND	ND	ND	ND	ND	5	CPMCL
1,2-Dichloroethane	EPA 524.2	0.20	ND	ND	ND	ND	ND	ND	0.5/5	CPMCL/EPMCL
1,1-Dichloroethene	EPA 524.2	0.10	ND	ND	ND	ND	ND	ND	5	CPMCL
Cis-1,2,-Dichloroethene	EPA 524.2	0.20	ND	ND	ND	ND	ND	ND	6/70	CPMCL/EPMCL
Trans-1,2-Dichloroethene	EPA 524.2	0.20	ND	ND	ND	ND	ND	ND	10/100	CPMCL/EPMCL
1,2-Dichloropropane	EPA 524.2	0.20	ND	ND	ND	ND	ND	ND	10/100	CPMCL/EPMCL
1,3-Dichloropropane	EPA 524.2	0.20	ND	ND	ND	ND	ND	ND	_	_
2,2-Dichloropropane	EPA 524.2	0.10	ND	ND	ND	ND	ND	ND	_	_
1,1-Dichloropropene	EPA 524.2	0.10	ND	ND	ND	ND	ND	ND	_	_
Cis-1,3-Dichloropropene	EPA 524.2	0.20	ND	ND	ND	ND	ND	ND	0.5	CPMCL
Trans-1,3,Dichloropropene	EPA 524.2	0.20	ND	ND	ND	ND	ND	ND	—	-
1,3-Dichloropropene(total)	EPA 524.2	0.20	ND	ND	ND	ND	ND	ND	_	_
2-Hexanone	EPA 524.2	0.097	ND	ND	ND	ND	ND	ND	_	_
Ethylbenzene	EPA 524.2	0.10	ND	ND	ND	ND	ND	ND		
Hexachlorobuteadiene	EPA 524.2	0.30	ND	ND	ND	ND	ND	ND	1,200	CPMCL
Isopropylbenzene	EPA 524.2	0.20	ND	ND	ND	ND	ND	ND	-	—
p-Isopropyltoluene	EPA 524.2	0.10	ND	ND	ND	ND	ND	ND	-	-
Methyl ethyl ketone	EPA 524.2	0.40	ND	ND	ND	ND	ND	ND	-	-
Methyl iodide	EPA 524.2	0.12	ND	ND	ND	ND	ND	ND	-	—
Methyl isobutyl ketone	EPA 524.2	0.30	ND	ND	ND	ND	ND	ND	—	-
Methylene chloride	EPA 524.2	0.40	ND	ND	ND	ND	ND	ND	5/5	CPMCL/EPMCL
Naphthalene	EPA 524.2	0.20	ND	ND	ND	ND	ND	ND	_	—
n-Propylbenzene	EPA 524.2	0.20	ND	ND	ND	ND	ND	ND	_	_
Styrene	EPA 524.2	0.10	ND	ND	ND	0.18	ND	ND	100/100	CPMCL/EPMCL
1,1,1,2-Tetrachloroethane	EPA 524.2	0.20	ND	ND	ND	ND	ND	ND	_	
1,1,2,2-Tetrachloroethane	EPA 524.2	0.20	ND	ND	ND	ND	ND	ND	1	CPMCL
Tetrachloroethane	EPA 524.2	0.20	ND	ND	ND	ND	0.20	ND	5/5	CPMCL/EPMCL

Table 16J: Volatile Organic Compounds (VOCs) (continued)

Analyte	Method	MRL	City of Seaside 4	FO-7 Deep	FO-7 Shallow	MRWPCA MW-1	PRTIW Mission Memorial	ASR MW-1	Regulator	y Requirements
					μ	g/L			•	Туре
Toluene	EPA 524.2	0.10	ND	ND	ND	2.0	ND	ND	150/1000	CPMCL/EPMCL
1,2,3-Trichlorobenzene	EPA 524.2	0.10	ND	ND	ND	ND	ND	ND	_	-
1,2,4-Trichlorobenzene	EPA 524.2	0.20	ND	ND	ND	ND	ND	ND	5/70	CPMCL/EPMCL
1,1,1-Trichloroethane	EPA 524.2	0.20	ND	ND	ND	ND	ND	ND	200/200	CPMCL/EPMCL
1,1,2-Trichloroethane	EPA 524.2	0.20	ND	ND	ND	ND	ND	ND	5/5	CPMCL/EPMCL
Trichloroethene	EPA 524.2	0.20	ND	ND	ND	ND	ND	ND	_	_
Trichlorofluoromethane	EPA 524.2	0.20	ND	ND	ND	ND	ND	ND	150	CPMCL
Trichlorotrifluoroethane	EPA 524.2	0.20	ND	ND	ND	ND	ND	ND	-	-
1,2,3-Trichloropropane	EPA 524.2	0.13	ND	ND	ND	ND	ND	ND	_	_
1,2,4- Trimethylbenzene	EPA 524.2	0.10	ND	ND	ND	ND	ND	ND	_	_
1,3,5- Trimethylbenzene	EPA 524.2	0.10	ND	ND	ND	ND	ND	ND	_	_
Vinyl chloride	EPA 524.2	0.10	ND	ND	ND	ND	ND	ND	0.5/2	CPMCL/EPMCL
m,p-Xylene	EPA 524.2	0.20	ND	ND	ND	ND	ND	ND	_	_
o-Xylene	EPA 524.2	0.10	ND	ND	ND	ND	ND	ND	-	—
Xylenes (total)	EPA 524.2	0.20	ND	ND	ND	ND	ND	ND	1,750/10,0 00	CPMCL/EPMCL
Trihalomethanes (total)	EPA 524.2	0.50	ND	ND	ND	ND	1.2	0.87	-	—
Methyl tert-butyl ether	EPA 524.2	0.50	ND	ND	ND	ND	ND	ND	-	-
Ethyl tert-butyl ether	EPA 524.2	0.20	ND	ND	ND	ND	ND	ND	-	-
Tert-amyl methyl ether	EPA 524.2	0.20	ND	ND	ND	ND	ND	ND	-	-

Table 16J: Volatile Organic Compounds (VOCs) (continued)

Table 16K: Semivolatile Organic Compounds (SVOCs)

Analyte	Method	MRL	City of Seaside 4	FO-7 Deep	FO-7 Shallow	MRWPCA MW-1	PRTIW Mission Memorial	ASR MW-1	Regulato	ry Requirements
						μg/L				Туре
Benzo (a) pyrene	EPA 525.2	0.080	ND	ND	ND	ND	ND	ND	-	_
Di(2-ethylhexyl)adipate	EPA 525.2	0.40	ND	ND	ND	ND	ND	ND	400/400	CPMCL/EPMCL
Di(2-ethylhexyl)phthalate	EPA 525.2	0.20	ND	ND	ND	0.29	ND	ND	4/6	CPMCL/EPMCL
2,3,7,8-Tetrachlorodibenzo- p-Dioxin*	EPA 1613	0.000005	ND	ND	ND	ND	ND	ND	0.00003	CPMCL-EPMCL

Notes:

* Dioxin reported in pg/L; converted to μ g/L

Table 16L: Haloacetic Acids

Analyte	rte Methods MRL City of Seaside 4 Deep Shallow MW-1 PRTIW ASR MW-1 Regulator							ory Requirement		
						µg/L				Туре
Monobromoacetic Acid	EPA 552.2	0.8	ND	ND	ND	ND	ND	ND	60	CPMCL-EPMCL
Monochloroacetic Acid	EPA 552.2	1.1	ND	ND	ND	ND	ND	ND	60	CPMCL-EPMCL
Dibromoacetic Acid	EPA 552.2	0.8	ND	ND	ND	ND	ND	ND	60	CPMCL-EPMCL
Dichloroacetic Acid	EPA 552.2	1.0	ND	ND	ND	ND	ND	ND	60	CPMCL-EPMCL
Trichloroacetic Acid	EPA 552.2	1.0	ND	ND	ND	ND	ND	ND	60	CPMCL-EPMCL
Total Haloacetic Acids (HAA5)	EPA 552.2	1.0	ND	ND	ND	ND	ND	ND	*	*

Notes:

* See individual analytes for regulatory requirements.

Analyte	Methods	MRL	City of Seaside 4	FO-7 Deep	FO-7 MRWPCA PRTIW Shallow MW-1 Mission MW-1 Remorial		Reg Requ	Regulatory Requirement		
						µg/L				Туре
НМХ	8330B	0.098	ND	ND	ND	ND	ND	ND	-	_
RDX	8330B	0.098	ND	ND	ND	ND	ND	ND	-	Ι
1,3,5- Trinitrobenzene	8330B	0.20	ND	ND	ND	ND	ND	ND	-	-
1,3-Dinitrobenzene	8330B	0.098	ND	ND	ND	ND	ND	ND	-	-
3,5-Dinitroaniline	8330B	0.098	ND	ND	ND	ND	ND	ND	-	-
Tetryl	8330B	0.10	ND	ND	ND	ND	ND	ND	-	-
Nitrobenzene	8330B	0.098	ND	ND	ND	ND	ND	ND	_	_
4-Amino-2,6- dinitrotoluene	8330B	0.098	ND	ND	ND	ND	ND	ND	_	-
2-Amino-4,6- dinitrotoluene	8330B	0.098	ND	ND	ND	ND	ND	ND	-	Ι
2,4,6-Trinitrotoluene	8330B	0.098	ND	ND	ND	ND	ND	ND	-	-
2,6-Dinitrotoluene	8330B	0.20	ND	0.064*	0.070*	ND	ND	0.037*	-	-
2,4-Dinitrotoluene	8330B	0.098	ND	ND	ND	ND	ND	ND	-	-
2-Nitrotoluene	8330B	0.10	ND	ND	ND	ND	ND	ND	-	_
4-Nitrotoluene	8330B	0.098	ND	ND	ND	ND	ND	ND	-	_
3-Nitrotoluene	8330B	0.098	ND	ND	ND	ND	ND	ND	-	_
Nitroglycerin	8330B	0.98	ND	ND	ND	ND	ND	ND	_	_
Pentaerythritol Tetranitrate	8330B	0.49	ND	ND	ND	ND	ND	ND	_	-

Table 16M: Nitroaromatics and Nitramines (Explosives)

Notes:

* Detected in laboratory blank sample; estimated J value.

Analuta	Mothod	MRL	City of	FO-7	FO-7		PRTIW		Reg	ulatory
Analyte	wiethod		Sedside 4	Deep	Shallow		WIISSION	141 44 - 1	Requi	
N-nitrosodiethylamine	EPA 1625M	0.002	ND		NA		ND	ND	1	Type
N pitrosodimothylamino	EPA 1625M	0.002			NA	ND	0.0054		0.01	NI
		0.002				ND	0.0034		0.01	INL
N-nitrosodi-n-butyiamine	EPA 1625M	0.002	ND	ND	NA	ND	ND	ND	_	
N-nitrosodimethylethylene	EPA 1625M	0.002	ND	ND	NA	ND	ND	ND	-	_
N-Nitrosomorpholine	EPA 1625M	0.002	ND	ND	NA	ND	ND	ND	-	_
N-nitrosopiperdine	EPA 1625M	0.002	ND	ND	NA	ND	ND	ND	_	_
N-Nitrosopyrrolidine	EPA 1625M	0.002	ND	ND	NA	ND	ND	ND	—	-
17-α-ethynlestradiol	EPA 1694M-API	0.001	ND	ND	ND	ND	ND	ND	-	_
17-β-estradiol	EPA 1694M-API	0.001	ND	ND	ND	ND	ND	ND	-	-
Esdtrone	EPA 1694M-API	0.001	ND	ND	ND	ND	ND	ND	0.0009-1.8	DWEL
Progesterone	EPA 1694M-API	0.001	ND	ND	ND	ND	ND	ND	_	_
Testosterone	EPA 1694M-API	0.001	ND	ND	ND	ND	ND	ND	_	_
Bisphenol A	EPA 1694M-ESI-	0.001	0.009*	0.062*	ND*	0.390*	ND*	1.400*	_	_
Gemfibrozil	EPA 1694M-ESI-	0.001	ND	ND	ND	ND	ND	ND	_	1
Ibuprofen	EPA 1694M-ESI-	0.001	ND	ND	ND	ND	ND	ND	_	
lopromide	EPA 1694M-ESI-	0.005	ND	ND	ND	ND	ND	ND	—	-
Naproxen	EPA 1694M-ESI-	0.001	ND	ND	ND	ND	ND	ND	-	_
Salicylic acid	EPA 1694M-ESI-	0.050	52	ND	ND	ND	ND	ND	-	-
Triclosan	EPA 1694M-ESI-	0.002	ND	ND	ND	ND	ND	ND	0.35-2,600	DWEL
Aceltaminophen	EPA 1694M/ESI+	0.020	ND	ND	ND	ND	ND	ND	—	-
Amoxicillin	EPA 1694M=ESI+	0.001	ND	ND	ND	0.014	ND	ND	—	-
Atenolol	EPA 1694M-ESI+	0.001	ND	ND	ND	ND	ND	ND	-	_
Atorvastatin	EPA 1694M-ESI+	0.001	ND	ND	ND	ND	ND	ND	-	-
Azithromycin	EPA 1694M-ESI+	0.010	ND	ND	ND	ND	ND	ND	_	_
Caffeine	EPA 1694M-ESI+	0.001	ND	0.0027	ND	0.0068	ND	ND	0.35	DWEL
Carbamazepine	EPA 1694M-ESI+	0.001	ND	ND	ND	ND	ND	ND		_
Ciprofloxacin	EPA 1694M-ESI+	0.005	ND	ND	ND	0.0059	ND	ND	-	-
Cotinine	EPA 1694M-ESI+	0.002	ND	ND	ND	ND	ND	ND	-	_

Table 16N: Pharmaceutical and Personal Care Products (PPCPs)

Analyte	Method	MRL	City of Seaside 4	FO-7 Deep	FO-7 Shallow	MRWPCA MW-1	PRTIW Mission Memorial	ASR MW-1	Regulatory Requireme	/ ent
					•	µg/L		-		Туре
DEET	EPA 1694M-ESI+	0.001	ND	0.0023	ND	0.006	ND	ND	2.5-6,300	DWEL
Diazepam	EPA 1694M-ESI+	0.001	ND	ND	ND	ND	ND	ND	-	_
Fluoxetine	EPA 1694M-ESI+	0.001	ND	ND	ND	ND	ND	ND	-	-
Methadone	EPA 1694M-ESI+	0.001	ND	ND	ND	ND	ND	ND	—	-
Oxybenzone	EPA 1694M-ESI+	0.001	ND	ND	0.0012	0.087	ND	ND	—	-
Phenyloin	EPA 1694M-ESI+	0.001	ND	ND	ND	ND	ND	ND	—	-
Primidone	EPA 1694M-ESI+	0.001	ND	ND	ND	ND	ND	ND	—	1
Sucralose	EPA 1694M-ESI+	0.005	ND	ND	ND	ND	ND	ND	175,000	DWEL
Sulfamethoxazolke	EPA 1694M-ESI+	0.001	ND	ND	ND	ND	ND	ND	—	-
TCEP	EPA 1694M-ESI+	0.001	0.0067	ND	ND	0.0064	ND	ND	—	Ι
ТСРР	EPA 1694M-ESI+	0.001	0.0052*	0.0025*	0.0026*	0.011*	0.0032*	0.0016*	-	-
TDCPP	EPA 1694M-ESI+	0.001	0.0011	0.0031	ND	0.0038	ND	ND	_	_
Trimethoprim	EPA 1694M-ESI+	0.001	ND	ND	ND	ND	ND	ND	-	_

Table 16N: Pharmaceutical and Personal Care Products (PPCPs) (continued)

Notes:

Laboratory analytical data sheets reported detected values in ng/L; converted to μ g/L.

* Detected in laboratory blank sample

NA = Not analyzed for FO-7 Shallow because laboratory instrumental problems resulted in unsuccessful runs; insufficient sample volume remaining for re-analysis.

Table 16O: Radiogenic

Analyte	Method	DL	City of Seaside 4	FO-7 Deep**	FO-7 Shallow**	MRWPCA MW-1**	PRTIW Mission Memorial	ASR MW-1	Re Re	egulatory quirement
						pCi/L				Туре
Gross Alpha	7110B	3.00	0.29±0.39	3.0±0.5	125±5	6.3±1.2	8.7±1.2	2.8±1.1	15	CPMCL-EPMCL
Gross Beta	7110B	4.0	1.4±0.5	4.5±0.5	114±2	7.5±1.1	8.8±0.9	5.6±1.0	50	CPMCL-EPMCL
Radium 226	7500-RaB	1.00	0.48±0.46	0.47±0.43	22±2.2	0.62±0.31	1.9±0.9	0.73±0.42	‡	_
Radium 228	7500-Ra D	1.00	0.11±0.38	0.44±0.38	16.3±1.2	-0.08±0.51	2.2±0.7	0.45±0.45	‡	-
Combined Radium	calculated	1.00	0.59±	0.91±0.57	38.3±2.4	0.54±0.60	4.1±0.7	1.18±0.62	5	CPMCL-EPMCL
Strontium 90	905.0	2.00*	0.339±0.692	-0.439±0.720	0.748±1.140	0.090±1.070	-1.27±0.850	-0.883±0.948	8	CPMCL-EPMCL
Tritium***	Enriched	-	0.70±0.15 (0.2233)	<1.0 (<3.19)	<1.00 (<3.19)	<1.0 (<3.19)	0.75±0.16 (2.39)	<1.00 (<2.19)	(20,000)	CPMCL
Uranium	200.8	0.080	ND	1.6	0.62	0.33	0.20	1.3	20/30†	CPMCL/EPMCL†

Notes:

* MRL for strontium 90

** Turbid sample

*** Tritium (enriched) reported in tritium units (TU) where 1.0 TU = 3.19 pCi/L. Values in parenthesis are in pCi/L.

† In micrograms per liter (μg/L)

‡ MCL for Ra226+Ra228 only.

		Wate	r (H₂O)		Nitrate (NO₃⁻)				
Sample	δ ¹⁸ Ο		δΙ	כ	δ1	⁵N	δ ¹⁸ Ο		
	‰	1σ	‰	1σ	‰	1σ	‰	1σ	
Monitoring Wells:									
City of Seaside 4	-6.62	0.06	-44.27	0.32	1.4	0.2	0.7	0.4	
FO-7 Deep	-7.18	0.06	-48.55	0.32	*	0.2	*	0.4	
FO-7 Shallow	-6.36	0.06	-45.44	0.32	8.7	0.2	4.2	0.4	
MRWPCA MW-1	-6.56	.0.06	-43.87	0.32	8.9	0.2	4.4	0.4	
PRTIW Mission Memorial	-6.14	0.06	-40.68	0.32	2.5	0.2	1.3	0.4	
ASR MW-1	-6.4	0.06	-45.90	0.32	*	0.2	*	0.4	

Table 16P: Stable Isotopes in Water and Nitrate

Notes:

* Analysis did not produce a reliable compound specific isotope analysis (CSIA) value.

 δD = ratio of deuterium to hydrogen (D/H) against Vienna Standard Mean Ocean Water (VSMOW) standard $\delta^{18}O$ = ratio of $1^8O/1^6O$ against VSMOW standard

 $\delta^{15}N$ = ratio of $^{15}N/^{14}N$ against standard of nitrogen in air

‰ = per mil or parts per thousand

 1σ = analytical precision of one sigma

General Notes for Tables 16A to 16P:

Samples collected from January 29-30, 2014 and February 3, 2014; received and analyzed, unless otherwise noted, by Alpha Analytical Laboratory, Inc., Ukiah, CA

- (dash) = no data reported

EPA = U.S. Environmental Protection Agency

CPMCL = California Department of Public Health (CDPH) (now SWRCB Division of Drinking Water) Primary Maximum Contaminant Level

CSMCL = California Department of Public Health (CDPH) (now SWRCB Division of Drinking Water) Secondary Maximum Contaminant Level

DWEL = U.S. EPA Drinking Water Equivalent Level; advisory only and not to be construed as legally enforceable Federal standards.

EPMCL = U.S. Environmental Protection Agency Primary Maximum Contaminant Level

ESMCL = U.S. Environmental Protection Agency Secondary Maximum Contaminant Level

NL = CDPH (now SWRCB Division of Drinking Water) Notification Level – advisory in nature and not an enforceable standard

California MCL for Gross Beta = 50 pCi/L; U.S. EPA Primary MCL (EPMCL) = 4 millirems per year (mrem/yr) CU = Color Units

MFL = Millions of fibers per liter

 μ g/L = micrograms per liter or parts per billion (ppb)

 μ S/cm = microSiemans per centimeter (formerly μ mohs/cm)

mg/L = milligrams per liter or parts per million (ppm)

pg/L = picograms per liter or parts per quadtrillion (ppq)

pCi/L = picoCuries per liter

TU = tritium units

NTU = Nephalometric Turbidity Units

SM = Standard Method

MFL = Millions of fibers per liter

MRL = Minimum Reporting Limit

ND = Not detected or below MRL

NA = Not analyzed

TEM = Transmission Electron Microscopy
The 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 content than most wells in the Paso Robles Aquifer. Although not clearly demonstrated by the Stiff diagrams, recent TDS concentrations in the ASR-1 and ASR-2 indicate mixing with the injectate (HydroMetrics, March 2014).

3.5.1.2. Source Water (Trilinear) Diagram

Inorganic water quality data from the six wells sampled for this investigation were plotted on a Trilinear Diagram (**Figure 8**). This technique plots the major anions and cations in percent meq/L (% meq/L) to differentiate samples of varying water quality. Data from the wells screened in the Paso Robles Aquifer and Santa Margarita Aquifer are color-coded in yellow and green respectively to facilitate aquifer comparisons. Data from an ASR injectate sample (blue) and the GWR pilot recycled water (purple) are also included on the diagram for comparison.

The figure shows that groundwater in wells from 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 that groundwater in both aquifers is derived from similar sources. There is slight differentiation between the two aquifers. Most of the groundwater samples from the Paso Robles wells (yellow) have a more distinct sodium-chloride (saline) signature, while the Santa Margarita wells have a more neutral signature.

The ASR injectate appears slightly different from the groundwater signature, especially with respect to chloride (lower) and sulfate (slightly higher). However, the sample from ASR MW-1 plots closely to the ASR injectate sample, indicating mixing between local groundwater and injected water.

The GWR project pilot water is a sodium-bicarbonate type. This signature is a product of the stabilization technique of the raw permeate, which involves the addition of calcium chloride, sodium hydroxide and bubbling of CO_2 gas. The signature plots near the edge of other data points.

3.5.1.3. Stable Isotopes – Oxygen/Deuterium in Water and Nitrogen-Oxygen in Dissolved Nitrate

<u>Water - Oxygen-Hydrogen (Deuterium) Isotopes:</u> Molecular water (H₂O) is largely composed of two oxygen isotopes: oxygen-16 (¹⁶O) and ¹⁸O. Water molecules that have more ¹⁶O are less dense than water that has a larger component of the heavier ¹⁸O. This variation occurs when water evaporates from the oceans, resulting in water vapor containing more atoms composed of ¹⁶O.This process is also known as isotopic fractionation. When the "lighter" water vapor condenses as precipitation, the resulting liquid water will have a larger component of ¹⁶O than ¹⁸O. Oxygen isotope fractionation also occurs at different rates at different latitudes and climates because water vapor condensation is temperature-dependent and, therefore the ratio of ¹⁸O/¹⁶O in rain and snow will change with latitude and elevation. The higher the latitude or

the elevation, the lower the $\delta^{18}O^1$ value; these vary from approximately 0‰ Vienna Standard Mean Ocean Water (VSMOW) at the equator to about –50 to –55‰ VSMOW at the poles. The stable isotope of hydrogen, known as hydrogen-2 (²H) or deuterium (D) also fractionates from hydrogen-1 (¹H); therefore δD (¹H/²H) ratios are also directly proportional to ¹⁸O/¹⁶O ratio fractionation.

A plot of the δ^{18} O concentration versus the δ D will therefore show unique characteristics for water samples collected from different latitudes, climates, seasons, hydrologic basins, hot springs, and soil clay minerals. In general, precipitation data can be plotted as a straight-sloping line, known as the Global Meteoric Water Line (MWL) using the equation:

 $\delta D = (8 \delta^{18} O) + 10$

Deviations from the MWL occur by the physicochemical processes described above, particularly evaporation. Local variations also occur and local MWLs can be calculated from precipitation data and shown on the plot.

In the absence of collected or sampled local precipitation, an online calculator (Bowen, 2014) was used to determine the local δ^{18} O- δ D fingerprint" for precipitation. Local O-D isotope precipitation values are determined by inputting latitude, longitude, and elevation (in meters) into the calculator.

Stable isotope (oxygen-deuterium) data are summarized in **Table 16P**. **Figure 9** shows the oxygen-deuterium data for the six water quality samples collected for this investigation. The figure shows the data for the Paso Robles and Santa Margarita Aquifers and for calculated precipitation data. It appears that Paso Robles and Santa Margarita water are from the same or similar sources with little to no influence by infiltrating precipitation. However, in the absence of an isotopic signature for Carmel Valley Alluvial Water, exact sources cannot be determined at this time.

<u>Nitrogen and Oxygen Isotopes in Dissolved Nitrate (NO₃⁻) and Nitrate Containing</u> <u>Compounds:</u> Stable nitrogen and oxygen isotopes are useful in indicating sources when nitrate is present in surface or groundwater. Delta nitrate-nitrogen ($\delta^{15}N_{nitrate}$) and nitrateoxygen ($\delta^{18}O_{nitrate}$) isotope ratios in water can be used to identify nitrate sources and fate in vadose zone soil and in groundwater. Nitrogen has two stable isotopes: ¹⁴N (99.63%) and ¹⁵N (0.37%). The wide difference in the isotopic abundance allows for the determination of distinctive isotopic signatures for determining nitrate sources, including those from natural

¹ By established convention, isotopic ratios are defined as delta (δ) values. The δ value, in per mills (‰), can be obtained by the equation: **\delta** (isotope) = [[R_(sample) - R_(standard)]/R_(standard)] -1 (1,000), where: δ (isotope) = values in per thousand (‰) or per mill and R_(sample) = the ratio of the first and second isotope such as ¹⁸O/¹⁶O, and R_(standard) = the ratio of the isotopes used in international or other standards; a commonly used standard for ¹⁸O/¹⁶O is Vienna - Standard Mean Ocean Water or VSMOW. A δ value with a positive (+) sign corresponds to an increase of the first isotope (e.g. ¹⁸O) with respect to the standard indicating that the sample is enriched with the heavier isotope. A minus (-) sign indicates a decrease in a sample with respect to the standard indicating that the sample is depleted with respect to the heavier isotope. Standards have been established by the International Atomic Energy Agency (IAEA) and the National Institute of Standards and Technology (NIST).

and anthropogenic sources such as septic systems, sanitary sewage effluents, domestic animal wastes, and home and farm usage of nitrogen fertilizer. In analyzed samples, the ratio of ¹⁵N/¹⁴N is compared with the Standard Mean Ocean Chlorine (SMOC) to provide δ^{15} N. The abundance of ¹⁵N in the atmosphere remains relatively constant because of the inert character of atmospheric nitrogen; this value is fixed at 0.36765 percent, which essentially results in a δ^{15} N of zero. The δ^{15} N and δ^{18} O can be shown on a plot with the ranges of known natural and anthropogenic sources (see for example Silva, et al., 2002). Other sources of nitrates include explosives and pyrotechnics such as fireworks, flares, torches and munitions. More recently nitrogen and oxygen isotopic data have become available for these sources (Pennington, et al. 1999, Widory, et al., 2009; Bordeleau, et al., 2013).

Figure 10 shows the plot of δ^{15} N and δ^{18} O for four Paso Robles groundwater samples. Although there are some overlaps in the various source ranges, the plot suggest that the nitrate sources are either from natural soil nitrogen or ammonia in fertilizer and rain and not from nitrate contained in TNT.

3.5.1.4. Groundwater Age Dating

Radiogenic tritium data (summarized in **Table 16O**) were applied to the following equation to estimate the age of groundwater in wells sampled for this investigation:

 $^{3}H = {}^{3}H_{o}ln(e^{-\lambda t})$ $t = ln({}^{3}H_{o}/\lambda)/0.056$

where, ${}^{3}H$ = tritium analysis in water in tritium units (TU)

- $^{3}H_{o}$ = pre-nuclear bomb testing tritium in precipitation
 - λ = decay constant of tritium at 0.056 per year beginning with pre-bomb tritium concentration
 - t = time (age) in years

Calculations using the tritium concentration data indicate that groundwater in two of four wells screened in the Paso Robles Aquifer (PRTIW and City of Seaside #4) are approximately 32 to 33 years old (assuming an average pre-bomb concentration of 4.5 TU). The estimated age of groundwater in the other two Paso Robles Aquifer wells (MRWPCA MW-1 and FO-7 Shallow) and both Santa Margarita Aquifer wells (FO-7 Deep and ASR MW-1) are each greater than 27 years old (tritium concentrations do not allow for more precise estimation). Considering that shallow Carmel Valley Alluvial Aquifer water is currently injected in adjacent ASR wells, the calculated age for ASR MW-1 using tritium data may be overestimated. This is because the tritium concentration of the Carmel Valley Alluvial Aquifer water is near zero, which makes it appear to be very old water, when in fact it has an effective age close to 0 years old.

3.5.2. Potential Constituents of Concern

3.5.2.1. Constituents Exceeding California Primary MCLs

For the more than 300 constituents and parameters analyzed in each of the six wells for this monitoring event, only the constituents in **Table 17** below were not within the California primary MCLs for drinking water standards. In addition, only two wells (FO-7 Shallow and MRWPCA MW-1) had any exceedances. Elevated turbidity values indicate that even these exceedances are not likely representative of actual groundwater concentrations as discussed in more detail below.

Analyte	Method	Units	MDL	FO-7 Shallow	MRWPCA MW-1	California Primary MCL
Turbidity	SM2130B	NTU	0.040	550	71	5*
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

Table 17. Constituents Exceeding California Primary MCLs

*5 NTU is a secondary MCL and is included on the table for comparison purposes.

As shown in **Table 17**, the only constituents with laboratory concentrations above primary MCLs were five metals and several radiogenic parameters. However, these constituents are also the types most affected by 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). One exceedance occurred in one other well (MRWPCA MW-1) and is correlated with the second-highest turbidity value (71 NTU). Turbidity in these samples result from small particles of aquifer material (or pre-development solids from drilling fluids) being entrained in the groundwater sample; these particles interfere with the laboratory methods and result in concentrations of constituents in the solids rather than actual concentrations dissolved in the groundwater. The constituents on Table 17 are all naturally-occurring constituents associated with aquifer materials and/or remnant drilling fluids. Therefore it is likely that all constituents included in the program meet drinking water standards.

Both of these wells are relatively small-diameter monitoring wells. As previously discussed, the small-diameter casings and deep water table have limited the ability to develop these three monitoring wells in order to produce a turbid-free groundwater sample for analysis. As such, it is recommended that future sampling programs incorporate techniques, including sampling with a higher capacity pump (at MRWPCA MW-1) and field filtering to minimize the effects of turbidity.

3.5.2.2. Former Ford Ord Constituents

Given the historical land use of the former Fort Ord lands, the MRWPCA field program included groundwater analyses for chemicals of concern associated with former Fort Ord activities. The six groundwater samples from the MRWPCA 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 drinking water MCLs and SWRCB DDW Notification Levels (NLs) as summarized in **Table 18**. NLs are non-regulatory, health-based advisory levels established by SWRCB DDW for contaminants in drinking water for which MCLs have not been established. NLs represent the concentration of a contaminant in drinking water that SWRCB DDW has determined does not pose a significant health risk, but warrants notification to the local governing body.

As shown in **Table 18**, 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.

For the metals analysis, 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 MRWPCA MW-1, although all of the detections met the California Primary MCL for drinking water. 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, MRWPCA MW-1, and Paralta. The detection in FO-7 Shallow (42 μ g/L) was above the MCL (15 μ g/L), but appears anomalous with respect to other detections of lead in the database. The concentration of 42 μ g/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 μ g/L (also included on **Table 18**). Except for FO-7 Shallow, all of the detections were below the MCL for lead.

Table 18.	Groundwater Analy	yses for Explosives	s and Associated Metals
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Constituent	Wells with Detections*	Minimum Reporting Limit (RL)	Detected or Reported Concentration	California Primary MCL	California NL	Comments	
			μg/L				
Explosives*	Explosives*						
HMX (cyclotetramethylene tetranitramine)	None	0.099-0.12	ND	None	350		
RDX (cyclotrimethylene trinitramine) (cyclonite)	None	0.099-0.12	ND	None	0.3		
1,3,5- TNB (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		
TETRYL (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		
2,4,6-trinitrotoluene (TNT)	None	0.098-0.11	ND	None	1		
2,6-DNT (dinitrotoluene)	FO-7 Shallow	0.20	0.070***	None	None	high turbidity	
	FO-7 Deep	0.23	0.064***	None	None	slightly turbid	
	ASR MW-1	0.10	0.037***	None	None		
2,4-DNT (dinitrotoluene)	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		
NG (nitroglycerine) (triniroglycerol)	None	0.99-1.2	ND	None	None		
pentaerythritol tetranitrate	None	0.49-0.56	ND	None	None		
Metals**							
	ASR-2	0.050	0.7				
Beryllium (Be)	FO-7 Shallow	0.020	0.68	4.0		high turbidity	
	MRWPCA MW-1	0.020	0.044			turbid	
	ASR-1	0.020	0.78				
Lead (Pb)	ASR-2	0.010	3.0				
	FO-7 Shallow	0.020	42.0			high turbidity	
	FO-7 Deep:	0.080	1.3	15.0		slightly turbid	
	PRTIW: Mission Memorial	0.020	0.061				
	MRWPCA MW-1	0.020	1.3			turbid	
	Paralta	0.001	3.0				

Notes:

* 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.

** Metals by U.S. EPA Method 200.8 analyzed by Alpha Analytical Laboratory, Ukiah, CA, February 5-11, 2014.

***Constituent also detected in laboratory blank indicating a laboratory contaminant that may not be present in groundwater. All detections were below Reporting Limits (J values) and are not quantifiable.

 $\mu g/L = micrograms per liter or parts per billion (ppb)$

MCL = Maximum Contaminant Level for drinking water

ND = Not detected above the method detection level for any of the samples from the six wells.

As previously mentioned, the 2014 sampling of FO-7 Shallow was the first time that the small-diameter monitoring well had been sampled for water quality. Sampling produced a highly turbid sample (550 NTU), likely relating to the inability to properly develop the well 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 are suspect), the data do not indicate that former Fort Ord activities have impacted groundwater in the near-project wells.

3.5.2.3. Constituents of Emerging Concern (CoECs)

As defined in the Recycled Water Policy, CoECs are chemicals in personal care products (PCPs), 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 recharge of recycled water.

The SWRCB Recycled Water Policy CoEC monitoring requirements were based on the recommendations of an expert panel. As part of the SWRCB DDW Draft Groundwater Replenishment Regulations for injection projects, a project sponsor's Engineering Report must recommend CoECs for monitoring in recycled water and groundwater in addition to the Recycled Water Policy requirements. 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). The CoECs are health-based, treatment-performance based indicators, or both:

- 17-*B*-estradiol steroid hormone (health-based indicator)
- Caffeine stimulant (health-based and performance-based indicator)
- N-nitrosodimethylamine (NDMA) disinfection byproduct (health-based and performance-based indicator)
- Triclosan antimicrobial (health-based indicator)
- N,N-diethyl-metatoluamide (DEET) personal care product (performancebased indicator)
- Sucralose food additive (performance-based indicator)

None of the CoECs currently have MCLs for drinking water. For NDMA, SWRCB DDW has established an NL of 0.01 $\mu g/L$.

To provide baseline conditions for these CoECs in the Seaside Groundwater Basin, the six wells sampled in the recent MRWPCA field program were analyzed for the six CoECs and other pharmaceuticals/PCPs included in U.S. EPA Laboratory methods 1625M and 1694 (APCI and ESI+). Full results are provided in **Table 16N**. Detections of the six CoECs are summarized in **Table 19**.

Table 19.Groundwater Analyses for CoECs

Constituent*	Constituent* Wells with Detections**		Detected or Reported Concentration	Comments
NDMA (nitrosodimethylamine)	PRTIW (Mission Memorial)	0.002	0.0054	CAEPA NL =0.01
17-β-estradiol	None	0.001	ND	
Triclosan	None	0.002	ND	
Coffeine	FO-7 Deep	0.001	0.0027	
Carreine	MRWPCA MW-1	0.001	0.0068	
DEET	FO-7 Deep	0.001	0.0023	
(n,n-diethyl-m-toluamide)	MRWPCA MW-1	0.001	0.0060	
Sucralose	None	0.005	ND	

Notes:

* NDMA by EPA Method 1625M; 17- β -estradiol and triclosan by EPA Method 1694-APCI; caffeine, DEET, and sucralose by EPA 1694-ESI+.

** Groundwater analyzed from wells ASR-1, City of Seaside 4, FO-7 Shallow, FO-7 Deep, PRTIW Mission Memorial, and MRWPCA MW-1.

*** Analyses reported on laboratory analytical data sheets in nanograms per liter (ng/L) or parts per trillion. Converted to micrograms per liter (μ g/L) or parts per billion (ppb).

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.

CAEPA = California Environmental Protection Agency.

U.S. EPA = U.S. Environmental Protection Agency.

MCL = Maximum Contaminant Level for drinking water.

ND = Not detected.

NL = Notification level.

As indicated in **Table 19**, NDMA was detected in groundwater collected from the PRTIW well at 0.0054 μ g/L; caffeine was detected in FO-7 Deep and MRWPCA MW-1 at 0.0027 and 0.0068 μ g/L, respectively. DEET was detected in FO-7 Deep and MRWPCA MW-1 at 0.0023 and 0.0060 μ g/L, respectively. 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 CoECs have been analyzed in the Seaside Basin. Data will be confirmed through future groundwater sampling events that will support the monitoring program proposed in the SWRCB DDW Engineering Report for the Proposed Project. Nonetheless, only a few constituents were detected and levels were very low (all less than 0.01 μ g/L).

4. GEOCHEMICAL COMPATIBILITY MODELING EVALUATION

When two water types with different water chemistry are mixed (such as the proposed GWR project recycled water and groundwater), the compatibility of the waters requires examination. There are two fundamental concerns related to potential chemical reactions. The first is that combining the two types of water might cause some minerals to precipitate out of solution and clog the pores of the aquifer. Precipitation typically involves common minerals composed of relatively abundant ions, such as carbonates and hydrous silicates. The second concern is that the injected water might cause toxic trace elements to dissolve or desorb from rock surfaces in the aquifer. Examples include arsenic, chromium, lead and mercury.

Geochemical modeling is a tool that can be used to investigate both concerns. Geochemical models are computer programs that simulate mineral dissolution and precipitation, oxidation and reduction, cation exchange, and adsorption of ions onto the surfaces of rock particles that comprise the aquifer matrix. There are hundreds of minerals that share many elements in common. Therefore, the models apply numerical methods to simultaneously solve thousands of equations representing the thermodynamics of the various reactions, drawing on a large database of experimentally-derived coefficients. This study used two geochemical modeling codes developed by the U.S. Geological Survey. PHREEQC simulates the equilibration of one liter of groundwater with the chemistry of the rock materials with which it is in contact by solving a large number of simultaneous equations representing the thermodynamics of all possible mineral dissolution, precipitation, cation exchange, and adsorption reactions given the chemical elements present in the water-rock system Parkhurst and Appelo, 1999). PHREEQC is widely used for investigations of this type. A second model, PHAST, was used to simulate movement of injected water from the Aromas Sand into the Paso Robles Formation. It superimposes PHREEQC geochemical modeling onto a finite-difference groundwater flow and chemical transport model (Parkhurst and others, 2010).

The first step in a geochemical modeling study is to define a conceptual model of the flow system, including flow paths and rates, the elements and minerals present in the aquifer, and the types of reactions that might occur. Data from laboratory analyses of the rock and fluid phases are then incorporated, and parameters are adjusted if needed to successfully simulate existing groundwater quality. The model can then be used to test hypotheses about possible reactions, test the sensitivity of simulated concentrations to parameters such as pH or pe², and simulate proposed project operation.

² The parameter pe is a measure of oxidation-reduction potential (eh is another measure) and can be calculated as p = Eh(volts)/0.05916 at 25°Celsius.

4.1. SITE CONCEPTUAL MODEL

4.1.1. Natural Recharge and Recycled Water Flowpaths

The hydrogeologic system at the GWR project recharge site and for several miles upgradient consists of three layers. The top layer is the Aromas Sand, which is above the water table but transmits about 2 inches per year of rainfall recharge as vertical unsaturated flow. The total thickness is approximately 400 feet in the vicinity of MRWPCA MW-1. The middle layer consists of the Paso Robles Formation, which is estimated to be about 250 feet thick in the vicinity of the GWR project recharge site. Coincidentally, the water table is within a few feet of the top of the formation, so it is considered fully saturated in the conceptual model. Upon arriving at the water table, the natural recharge flow abruptly becomes horizontal and moves westward down the regional water-level gradient. The Santa Margarita Aquifer underlies the Paso Robles Formation and is approximately 250 feet thick beneath the GWR project recharge to the Santa Margarita Aquifer occurs via downward leakage from the Paso Robles Formation, which is accelerated by the substantial amount of groundwater pumping from the Santa Margarita Aquifer. Additionally, recharge to the Santa Margarita Aquifer also occurs to the East where the sandstone unit has a shallow subcrop beneath surficial sands and outcrops near the inland boundaries of the basin.

Figure 11 shows a conceptual diagram of the flow pattern of recycled water injected into the Aromas Sand in cross section. Recycled water injected into the Aromas Sand would create a localized zone of saturation close to the vadose zone well, and the water would flow downward under gravity. The columnar zone of saturation would widen along the descent path due to the effects of subtle layering within the Aromas Sand. The recharge would create a mound in the water table that would result in flow radially outward as well as downward within the saturated Paso Robles materials. Eventually, the injected water could arrive at a well screened in the Paso Robles Formation or leak down to the Santa Margarita Aquifer.

Recycled water injected into the Santa Margarita Aquifer would be under fully saturated conditions and would flow radially outward from the well. The body of injected water would gradually move westward under the influence of the regional water-level gradient.

4.1.2. Potential Geochemical Reactions

Several types of geochemical reactions between the recycled water, ambient groundwater and aquifer materials could potentially cause operational problems for the injection well or pose a health risk for downgradient groundwater users, as follows:

• **Biofouling of the well screen and adjacent aquifer by iron bacteria**. Various types of iron bacteria occur naturally in soil environments and can become established in and near the well screen. Their metabolisms involve oxidation or reduction of iron, and they produce a mucilaginous coating in the process that can quickly clog the well screen, gravel pack and adjacent aquifer materials. Bacterial growth can be limited by the availability of nitrogen or phosphorus; accordingly, if concentrations

of those nutrients in the injected water are greater than in the aquifer, bacterial growth could be stimulated. In any event, the bacterial clogging can be controlled by periodically treating the well with chlorine.

- Clogging of aquifer pores due to precipitation of common minerals (scaling). For example, a previous modeling analysis of Carmel River water injected into the Santa Margarita Aquifer concluded that chalcedony (opaline silica) might precipitate in the injection zone (EcoEngineers, 2008?). Mineral precipitation depends on the solubilities of the minerals that could form from the dissolved ions present in solution.
- Mobilization of toxic metals already present in aquifer rock materials. Metal ions stick to rock surfaces by a combination of chemical bonds and electrostatic forces, and the overall process is called adsorption. The ratio of adsorbed ions to ions in solution varies widely by element and is influenced by the total amount of that element in the system, the type of mineral surface, the types and concentrations of other metallic elements present, the pH and the composition of the solution. It is possible for ions that are adsorbed under natural flow conditions to desorb when a different type of water is injected into the aquifer. For example, adsorption-desorption processes are often quite sensitive to pH.

Some of the possible geochemical reactions listed above can be resolved directly from the empirical data collected for this investigation without geochemical modeling. In the case of biofouling, bacterial growth is not likely to be stimulated if the nitrogen and phosphorus concentrations in the injected water are less than in ambient groundwater. Phosphorus was <0.5 mg/L in the pilot water, and the only nitrate measurement above the detection limit of 0.1 mg/L was the same as measured in a laboratory blank. In contrast, nitrogen averaged 1.6 mg/L in Paso Robles wells (range 0.5-2.9 mg/L). Phosphorus was not measured in the Paso Robles well water samples. Phosphorus was detected above the 0.5 mg/L detection limit in two of the six Aromas pilot water leaching test samples. Both of those samples had elevated turbidity. If phosphorus is present in groundwater, its concentration is typically low because it tends to precipitate as apatite (a mineral that contains phosphorus). Therefore, it is likely that the detected phosphorus was part of the colloidal material that was creating the turbidity. In any case, phosphorus concentrations were low in both the pilot water and leach tests. The lack of biofouling at nearby wells that have been injecting Carmel River water into the Santa Margarita Aquifer for a number of years further suggests that phosphorus and nitrate in recycled water will not create biofouling problems. The phosphorus concentration in river water was 0.34 mg/L, and the concentration neither increased nor decreased when the water was leached through aquifer solids in the laboratory (EcoEngineers, 2008). The nitrogen and phosphorus data suggest that injected GWR recycled water would not stimulate bacterial growth by increasing the supply of nutrients.

With respect to clogging of pores due to mineral precipitation, the major ions in the pilot water are sodium, calcium and bicarbonate, indicating that calcium carbonate (calcite) would be the most likely precipitate. Also, Paso Robles Formation groundwater is near

saturation with respect to calcite. The pilot water is dilute, however, with a TDS concentration of only about 75 mg/L, of which calcium contributes 11 mg/L. Precipitation of a silicate mineral such as chalcedony (SiO₂) is also unlikely due to the low silica concentration in pilot water, which was 1.1 mg/L. Chalcedony is soluble up to 4.9 mg/L at 25°C. Precipitation of chalcedony is unlikely, but the situation with calcite is less clear. Accordingly, carbonate mineral chemistry was evaluated through geochemical modeling.

The metallic elements that could potentially be desorbed from mineral surfaces are indicated primarily by the results of the HA-HCl extraction test. Toxic metals not detected in the HA-HCl extraction test included mercury, selenium and uranium. Chromium was not detected, but the laboratory used an analytical method with a detection limit higher than the expected concentrations. Metals detected in the HA-HCl extraction test included arsenic and lead. Thus, chromium, arsenic, and lead warranted additional evaluation through geochemical modeling.

Although cadmium, nickel, vanadium, and zinc were also detected in pilot water leaching tests, those detections are associated with turbidity produced by mechanical agitation during testing, which would not occur in the aquifer. These metals are expected to remain strongly adsorbed under the relatively high pH conditions present in the vadose zone and aquifer. Therefore, these metals were not further evaluated through geochemical modeling.

Potential geochemical reactions during injection of GWR water into the Santa Margarita Aquifer can be deduced from laboratory and modeling work completed for the existing Carmel River water ASR project (EcoEngineers, 2008). The GWR pilot water is nearly identical to river water with respect to pH and oxidation-reduction potential, which are the principal variables controlling adsorption and desorption. Other major ions are about onethird as concentrated in the pilot water compared to river water. The EcoEngineers study included two leaching tests of aquifer materials: one with river water (representing project operation) and a more aggressive TCLP leach test that strips most adsorbed metals from the solid surfaces (which was probably less aggressive than the HA-HCl leach test used in this study). Both tests were done on materials from two depth intervals in the Santa Margarita. The chromium, arsenic and lead concentrations in the TCLP leachate were below the detection limit of 100 µg/L in both samples. This detection limit is fairly high, but it rules out the possibility of large amounts of those metals in the aquifer. A much lower detection limit of 0.5 μ g/L was used for the river water leach tests, and concentrations of the metals were less than that detection limit in both samples. Mercury was detected at 0.2 to 0.4 μ g/L, which is less than the drinking water MCL (2 μ g/L). Given the similar pH and oxidationreduction potential of river water and GWR water, it can be concluded that GWR recycled water would also not cause any metals to desorb in significant quantities. Laboratory results from the EcoEngineers study are adequate in addressing whether toxic metals would leach during direct injection of GWR recycled water into the Santa Margarita Aquifer, and geochemical modeling is therefore unnecessary.

4.2. MODELING OBJECTIVES

Based on the potential geochemical reactions described above, the geochemical modeling objectives are as follows:

- Determine the likelihood of calcite precipitation (scaling) that could clog pores and decrease aquifer permeability near the injection well or in the Paso Robles Formation.
- Determine whether the injected water could mobilize naturally-occurring chromium, arsenic or lead by desorption or mineral dissolution.
- Calculate mixing and dilution when the injected plume moves from the Aromas Sand into the Paso Robles Formation.
- Determine the sensitivity of all of the above to water quality characteristics of the injected water in order to identify recommended adjustments to condition the water prior to injection.

4.3. MODELING APPROACH

A detailed technical memorandum documenting the geochemical modeling approach, data inputs, and results is presented in **Appendix G**. This section summarizes the model development, calibration, and results.

4.3.1. Injection into Aromas Sand

Injection of recycled water into the Aromas Sand was simulated using PHREEQC. Because the Aromas Sand is unsaturated, mixing with native groundwater was not simulated. The modeling of toxic metals consisted of simulating the adsorption/desorption reactions that occur when the aquifer is saturated with recycled water. The composition of the adsorption surface is almost certainly hydrous ferric oxide (HFO), which is the coating on the quartz sand grains that gives the Aromas Sand its characteristic red color. Equilibrium constants defining the adsorption of chromium, arsenic and lead onto HFO are included in PHREEQC's thermodynamic database. The key steps in modeling were (1) estimating the percentage of total HFO that is in contact with the solution, (2) defining the initial composition of metal ions adsorbed onto the HFO surface, and (3) adjusting the model to represent the water-torock ratio that was used for the pilot water leach test. Three of the laboratory tests provided input values or calibration constraints. The bulk chemistry analysis of aquifer cores indicated the total amount of iron present, which was 3.33 weight percent in the Aromas Sand 200foot sample (see **Table 7**). The HA-HCl test indicated the total amounts of metal ions adsorbed onto the exposed HFO, and the pilot water leach test indicated the amount of each adsorbed element likely to desorb under project operating conditions. Less than 100 percent of the HFO is in contact with pore water because under natural conditions HFO has

usually begun crystallizing into goethite. Typically, only 1 to 10 percent of the HFO actually functions as an adsorption surface in an aquifer.

The model was calibrated by trial-and-error in a two-step process. In the first step, the percent of total HFO that is exposed to pore water was selected, and the surface was "loaded" with chromium, arsenic and lead by assuming concentrations of those metals in a loading solution. Then the loading solution was replaced with pilot water, and the simulated equilibrium concentrations of the three metals in the pore water were compared with the measured concentrations from the pilot water leach test. The percent exposed HFO and the loading solution concentrations were both adjusted during calibration.

The water-to-rock ratio for the pilot water leach test was 30.9 times greater than the volume of water that would normally be in contact with that amount of solid material in the aquifer. To correct for this, the leach test was simulated using PHREEQC's one-dimensional advective transport capabilities. This represented the test as 30.9 pore volumes of water flowing sequentially through a fixed amount of aquifer solids, and averaging the equilibrium concentrations of the 30.9 pore volumes.

4.3.2. Percolation from Aromas Sand into Paso Robles Formation

The flow geometry becomes more three-dimensional when the saturated column of injected water flowing down through the Aromas Sand reaches the water table in the Paso Robles Formation and begins to spread radially and downward, as well as shift laterally under the influence of the regional gradient. A PHAST model was constructed to simulate the transport and mixing of the arriving plume within the Paso Robles Formation. The model grid represented a 5,000 x 5,000-foot square region with 50-foot cell spacing. The total thickness was 300 feet, of which the top 50 feet was unsaturated and represented the Aromas Sand. The Aromas Sand cells included the mineral adsorption surface calibrated from the PHREEQC simulations. Vertical grid spacing was 5 feet for the top 70 feet, 10 feet for the next 90 feet, and 20 feet for the bottom 140 feet.

Flow in the Paso Robles Formation included a regional gradient of about 40 feet per mile established by constant-head boundaries on opposite sides of the grid. The downward gradient caused by groundwater pumping from the underlying Santa Margarita Aquifer was represented by a well 106 feet away from the injection well, screened near the bottom of the model and pumping at a rate of 25 gpm. For both the Aromas Sand and Paso Robles aquifers in the model, the horizontal hydraulic conductivity was assumed to be 5 feet/day; the vertical hydraulic conductivity was assumed to be 0.5 feet/day; and horizontal and vertical dispersivity were assumed to be 50 and 5 feet, respectively. The selected value of vertical hydraulic conductivity is small for a sand formation, but it represents the effects of subtle layering within the sand and is conservative because a low value increases the total volume of formation that becomes saturated during injection and hence the total mass of desorbed metal ions.

Pilot water was injected at a rate of 110 gpm via a well at the center of the grid screened over a 40-foot interval at the base of the Aromas Sand, below the silty horizons noted in

borehole logs. It is noted that the assumed injection rate and Kv are both conservative, because they tend to maximize the saturated volume of Aromas Sand during injection, which maximizes the simulated mass of desorbed chromium. The average maximum injection rate per vadose zone well under project operation is expected to be less than 65 gpm (see Section 3.1.3) based on the potential recycled water delivery schedules for the project summarized in Table 1 of the Recharge Impacts Assessment Report (Todd, 2015). The estimated vertical hydraulic conductivity (Kv) measured in selected coarse-grained cores of the Aromas Sand was about 20 feet per day. This lower pumping rate and higher conductivity would result in a narrower column of saturation descending from the injection well to the water table.

Measured water quality at the FO-7 Shallow well was used to represent ambient groundwater quality in the Paso Robles Formation. This well was selected because it was the only Paso Robles well at which pH was measured at the well screen rather than at the ground surface. Pressure decreases when groundwater is brought up to the ground surface, which causes gases to effervesce out of solution. In the case of carbon dioxide, this lowers the pH of the water, which can strongly affect metal adsorption/desorption processes.

The simulation began with the water table at an elevation equal to the contact between the Aromas Sand and Paso Robles Formation. Injection was simulated over a 6-year period. The injected water created a mounded cone of saturation in the Aromas Sand surrounding the injection well, enabling the injected water to flow in a continuously saturated environment down the cone and then radially outward and downward within the Paso Robles Formation.

4.4. MODEL RESULTS

4.4.1. Injection into Aromas Sand

The calibration targets for metals were the measured concentrations of chromium, arsenic and lead from the pilot water leach tests. For each metal, the measured concentrations from the tests of six Aromas depth intervals were averaged, and that value was compared with the average concentration of the first 30.9 pore volumes of pilot water simulated using the PHREEQC advective model. For chromium, the measured concentration was $1.3 \mu g/L$ and the simulated concentration was 2.6 µg/L. Simulated chromium concentrations dropped rapidly during the course of advection. Almost all of the chromium that had been loaded onto the mineral surfaces desorbed within the first 0.5 pore volumes of displacement. This "first flush" of chromium release resulted in a pore water concentration of 31 μ g/L, which is three times the proposed MCL for drinking water. Over the next two pore volumes, the simulated concentration quickly dropped to the concentration in pilot water, which was $0.21 \,\mu g/L$. The simulated average concentration does not reveal this important sequence of events. There is not much adsorbed chromium at the outset, but at a pH of 7.7 the pilot water desorbed almost all of the available chromium. This process creates a brief spike in dissolved chromium concentration whenever injected water first contacts unsaturated Aromas Sand. As this spike flows through downgradient saturated flow paths in the Paso Robles Formation, the peak concentration quickly declines due to dispersion and mixing

with ambient groundwater. Furthermore, the first flush would occur only during project start-up. The cone of saturation within the Aromas Sand gradually stabilizes at a size corresponding to the conservatively simulated 110 gpm injection rate over a period of less than six years. As long as the zone of saturation does not continue to expand, there would be no further release of chromium.

The measured arsenic concentrations in the pilot water leach tests of the six Aromas Sand depth intervals included four non-detects (less than 5 μ g/L) and two detections at 5.5 and 7.6 μ g/L. Assuming a roughly normal distribution, an average of 4 μ g/L is a reasonable assumption. The arsenic drinking water MCL is 10 μ g/L. The average simulated concentration was 4.2 μ g/L. Unlike chromium, the simulated concentration remained nearly constant over successive pore volume displacements. This is because arsenic has very different adsorption characteristics (partition coefficient) than chromium. It adsorbs much more strongly to HFO, and only a small percentage desorbs with each new pore volume of water. The result is a more sustained release resulting in low concentrations in solution.

Measured lead concentrations were more difficult to average. Five of the six samples were non-detects (less than 5 μ g/L) and one sample (with the highest turbidity) had a concentration of 11 μ g/L. For modeling purposes, an average measured concentration of 3 μ g/L was assumed. The simulated concentration was 0.691 μ g/L and remained constant through successive pore volume displacements at a pH of 7.7. Lead tends to be more strongly adsorbed at higher pH because it is present in solution as a cation, whereas chromium and arsenic are present as chromate and arsenate anions. The measured and simulated concentrations were each below the drinking water MCL of 15 μ g/L.

4.4.2. Percolation from Aromas Sand to Paso Robles Formation

Simulation results from the PHAST model show that the chromium that desorbed when pilot water first wetted the Aromas Sand was rapidly diluted by dispersion (mixing) in the Paso Robles Formation. The chromium release was a one-time event when saturation was established at the onset of injection. That volume of pore water was thereafter diluted by subsequent injection – which did not cause any further release of chromium – and mixing into an ever-expanding plume of injected water moving through the Paso Robles Formation. The relative volumes of source area (saturation within the Aromas Sand) and plume in the Paso Robles after one year of project operation can be seen in **Figure 12**. The figure shows a block diagram of simulated concentrations. The upper (clear) layer of the block is the unsaturated Aromas Sand. The green layer is the Paso Robles Formation. The plume within the Paso Robles forms a chili-pepper shape pointing downward, and the zone of saturation is the "stem" of the pepper pointing upwards into the Aromas Sand. The maximum concentration at any point on the outer surface of the plume was $4.0 \mu g/L$.

A close-up view of the zone of saturation in the Aromas Sand is shown in **Figure 13.** The injection well is represented by the pink column of squares. The colored areas are parts of the surface of the zone of saturation where chromium concentrations are greater than the pilot-water concentration of $0.21 \,\mu\text{g/L}$. The interior of the zone and the underlying plume in the Paso Robles Formation have concentrations equal to or less than the injected water.

After six years of continuous injection, the simulated plume had reached a steady-state size and the largest chromium concentration anywhere in the system was 3.8 μ g/L.

The arsenic and lead concentrations in the injected water were both lower than their respective concentrations in the Paso Robles Formation, even when ambient concentrations were assumed to be less than one-tenth of measured concentrations to correct for suspected turbidity influences. Consequently, the plume of injected water was simply diluting ambient concentrations in the aquifer. **Figure 14** shows the plume for arsenic after six years of injection, with concentrations increasing from 0.4 μ g/L at the center of the plume to 10 μ g/L at the outer edge of the plume and beyond (representative of simulated background concentrations in the surrounding aquifer). The pattern for lead had an identical shape, with concentrations increasing from 0.06 μ g/L at the center to 4.2 μ g/L in the surrounding aquifer.

Calcite is more likely to dissolve than precipitate when the injection plume enters the Paso Robles Formation. Because the pH of the injected water (7.7) is less than the pH of ambient Paso Robles groundwater (8.1), the solubility of calcite increases. The corresponding solubility indices in the simulation were -0.02 (essentially neutral) in Paso Robles groundwater and -0.98 (undersaturated) in the injected water. Consequently, there could be a small amount of initial calcite dissolution when the plume first arrives at a new location in the aquifer, but the total mass of calcite in the aquifer is too large to be substantially diminished.

4.5. CONCLUSIONS

Chromium is present in the Aromas Sand in trace amounts adsorbed onto the hydrous ferric oxide coating of the quartz sand grains. At a pH of 7.7 (the pH of the recycled water produced by pilot tests of the advanced wastewater treatment process) almost all of the adsorbed chromium would de-sorb into solution. This is a transient initial effect, because the amount of chromium adsorbed onto the mineral grains is small. Calibration of a PHREEQC geochemical model to measured concentrations from a pilot water leach test indicated that the initial mass of chromium is quite small. The "first flush" of chromium is rapidly diluted by mixing into the Paso Robles Formation along with subsequent volumes of injected water. When the zone of saturation around the injection well equilibrates with the injection rate, there is no further release of chromium. In the model, steady-state geochemical conditions were reached in about six years. The maximum concentration on the surface of the expanding zone of saturation was 4.0 μ g/L, which occurred after one year of injection.

Arsenic and lead are both adsorbed much more strongly than chromium at the pH levels anticipated. Consequently, only small amounts are released into solution as the injected water flows through the Aromas Sand, resulting in sustained but low concentrations of about 4 μ g/L for arsenic and 0.7 μ g/L for lead.

Aquifer clogging due to calcite precipitation is unlikely in the Aromas Sand because calcium and bicarbonate concentrations are far below levels approaching saturation. Ambient groundwater in the Paso Robles Formation is at saturation with respect to calcite, but the lower pH of the injected water would tend to dissolve rather than precipitate calcite.

The potential for biofouling in the injection wells is low, because the injected water is very low in nitrogen and phosphorus and, therefore, would not tend to stimulate microbial growth.

The risk of trace metal desorption during injection of recycled water into the Santa Margarita Aquifer can be inferred from previous studies of injecting Carmel River water. The two types of injected water are very similar in terms of pH and oxidation-reduction potential and are therefore expected to have similar effects with respect to adsorption/desorption processes. The previous studies found no indications that significant concentrations of metals would be released into solution, and those results can reasonably be extended to injection of recycled water.

5. CONCLUSIONS AND RECOMMENDATIONS

5.1. CONCLUSIONS

5.1.1. Hydrogeologic Conditions

Based on information collected and findings from this field investigation, and assuming that subsurface conditions at the GWR project recharge site are similar to those at MRWPCA MW-1, the following conclusions can be made:

- The Aromas Sand at MRWPCA MW-1 is 392.5 feet thick, composed primarily of coarse-grained sediments. Some fine-grained deposits occur in the lower portion of the formation and may extend across the GWR project recharge site.
- The geologic contact between the Aromas Sand and Paso Robles Formation at the MRWPCA MW-1 site occurs at 392.5 feet-bgs.
- The current groundwater level in MRWPCA MW-1 is 405 feet-bgs, or 12.5 feet below the geologic contact between the Aromas Sand and Paso Robles Formation.
- The thickness of sand deposits either above or below the silt/clay deposits in the lower Aromas Sand are sufficient to accommodate maximum injection rates through four (or possibly fewer) vadose zone injection wells.
- The estimated available storage capacity of the Aromas Sand indicates that the GWR project recharge site can accommodate 350 AFY of recycled water recharge through proposed vadose zone wells. This conclusion is based on an estimated radius of saturation of 24 feet through the coarse-grained deposits composing most of the Aromas Sand and 1,100 feet through the silt and clay units in the lower portion of the unit.
- Estimated travel time of recycled water to flow through the Aromas Sand is dependent on the final depth of vadose zone screens relative to silt/clay deposits in the lower Aromas Sand (assumed to be present across the GWR project recharge site for planning purposes).
 - If vadose zone wells are screened below the silt/clay deposits, injected recycled water is estimated to reach the top of the Paso Robles Formation in a matter of a few days.
 - If vadose zone wells are screened above the silt/clay deposits, injected recycled water is estimated to reach the top of Paso Robles Formation after 5.9 years.
 - An estimated 3.4 years is needed for recycled water to flow through the upper 12.5 feet of unsaturated Paso Robles Formation before reaching the current

water table. However, the water table is expected to rise to or above the geologic contact between the Aromas Sand and Paso Robles Formation following the initial years of GWR project operation.

5.1.2. Groundwater Quality

- Local groundwater quality in the Paso Robles Aquifer meets drinking water standards with the exception of metals and radiogenic parameters detected in the FO-7 Shallow, MRWPCA MW-1, and PRTIW wells. However, FO-7 Shallow and MRWPCA MW-1 had turbidities of 550 and 71 NTU, respectively. The detected metal and radiogenic concentrations were affected by the excessive turbidity and the reported analyses are a reflection of constituents in the solid phase rather than dissolved constituents. The PRTIW well had a turbidity of 0.98 just below the California Primary MCL of 1.0 NTU with a reported radium-228 concentration of 2.2 pCi/L; the California Primary MCL is 2.0 pCi/L. However, the combined radium (radium 226 + radium 228) was below the California Primary MCL of 5.0 pCi/L.
- SWRCB DDW recycled water quality CoECs in sampled Paso Robles wells include NDMA detected in groundwater collected from the PRTIW well at 0.0054 µg/L; caffeine detected in MRWPCA MW-1 at 0.0068 µg/L; and DEET detected in MRWPCA MW-1 at 0.0060 µg/L. Although detectable, CoEC concentrations are very low, not exceeding 0.01 µg/L, and represent the first time that CoECs have been analyzed in the Seaside Basin. These constituents do not have California MCLs but have been designated as recycled water surrogates, which are required in recycled water project monitoring. Future groundwater sampling events, supporting the monitoring program, will confirm either the continued presence or absence of these constituents.
- Local groundwater quality in the Santa Margarita Aquifer meets drinking water standards with the exception of FO-7 Deep which had total iron and manganese at 1,000 μg/L and 83 μg/L, respectively. However, the FO-7 Deep groundwater sample was most likely affected by turbidity and is not considered representative.
- SWRCB DDW recycled water quality constituents of concern in sampled Santa Margarita wells include caffeine and DEET detected in FO-7 Deep at 0.0027 and 0.0023 µg/L, respectively. Although detectable, CoEC concentrations are very low, not exceeding 0.01 µg/L, and represent the first time that CoECs have been analyzed in the Seaside Basin. Future groundwater sampling events, supporting the monitoring program, will confirm either the continued presence or absence of these constituents.
- Soluble nitroaromatic compounds detected in soils in the Inland Ranges were not present in any of the six wells sampled for this investigation.

5.1.3. Geochemical Compatibility of Recycled Water and Groundwater

- Soluble nitroaromatic compounds detected in soils in the Inland Ranges were not present in any of the soil cores analyzed for this field investigation. Therefore, they were not included in the geochemical modeling.
- Potential changes in injected recycled water quality beneath vadose zone wells as a product of geochemical reactions between recycled water and formation materials along vertical flow paths are small. The Aromas Sand contains trace amounts of chromium adsorbed onto the hydrous ferric oxide coatings of the quartz sand grains. Geochemical modeling indicates that with a pH of 7.7 for the pilot recycled water, almost all adsorbed chromium would desorb into solution. However, this is a transient initial effect, because the amount of chromium adsorbed onto the mineral grains is small. Arsenic and lead are both adsorbed much more strongly to hydrous ferrous oxides than chromium. Consequently, only small amounts are released into solution as the injected water flows through the Aromas Sand, resulting in sustained but low concentrations of about 4 μ g/L for arsenic and approximately 0.7 μ g/L for lead.

Aquifer clogging by calcite precipitation is unlikely in the Aromas Sand, because calcium and bicarbonate concentrations are far below levels approaching saturation.

Biofouling would not pose a problem for the injection wells because the injected water is very low in nitrogen and phosphorus and therefore would not tend to stimulate microbial growth.

 The potential for local groundwater quality impacts in the Paso Robles Aquifer beneath vadose zone wells as a result of mixing between recycled water and shallow groundwater is also quite small. The "first flush" of chromium is rapidly diluted by mixing into the Paso Robles Formation along with subsequent volumes of injected water. No further release of chromium will occur when the zone of saturation around the injection well equilibrates with the injection rate. In the model, a steady-state condition was reached in about six years. The maximum concentration on the surface of the expanding zone of saturation was 4.0 µg/L, which occurred after one year of injection.

Ambient groundwater in the Paso Robles Formation is at saturation with respect to calcite, but the lower pH of the injected water would tend to dissolve rather than precipitate calcite.

• Potential local groundwater quality impacts in the Santa Margarita Aquifer in the vicinity of deep injection wells as a result of mixing between recycled water and shallow groundwater are very low. Risk of trace metal desorption during injection of recycled water into the Santa Margarita Aquifer can be 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 would be released into solution, and those results can reasonably be extended to injection of recycled water.

• The potential is also low for groundwater quality impacts due to the presence of site specific constituents of concern in unsaturated sediments and groundwater beneath vadose zone wells. Potential for leaching by recycled water and subsequent groundwater quality impacts is very low, but should be confirmed with subsequent groundwater monitoring.

5.1.4. Knowledge Gaps

Data collected from this field investigation have allowed for considerable refinement of the conceptual hydrogeologic model at the GWR recharge site. However, the following knowledge gaps still exist, some of which can be addressed during drilling and installation of proposed injection wells:

- The occurrence, thickness, and directional tilt of fine-grained layers in the Aromas Sand would dictate the flow direction and vadose zone travel time of recycled water injected above such deposits. Specifically, geologic data suggest that the silt/clay deposits observed in the lower Aromas Sand at MRWPCA MW-1 may occur beneath the GWR project recharge site and pinch out to the west (by General Jim Moore Boulevard) and north (by the Golf Course Reservoir well). Accordingly, additional subsurface data are needed to refine these interpretations.
- Concentrations for metals and other ions in groundwater samples collected from MRWPCA MW-1 and both FO-7 wells are clearly impacted by turbidity (and the subsequent digestion of suspended solids during preparation for laboratory analysis). Additional groundwater quality sampling is needed to confirm analyses from this investigation and further establish baseline groundwater quality conditions.

5.2. RECOMMENDATIONS

Based on the results of the field investigation and existing knowledge gaps, the following additional activities are recommended for GWR project planning purposes:

• During the drilling of initial vadose zone and deep injection wells for the GWR project, subsurface lithologic data should be collected and closely evaluated to determine the extent and thickness of potential fine-grained sediments in the lower Aromas Sand. Findings will be critical to the final design of vadose zone wells (specifically, the placement of well screen intervals).

An additional round of groundwater quality sampling from MRWPCA MW-1 and • both FO-7 wells at a minimum is recommended. To obtain representative groundwater quality samples, groundwater from MRWPCA MW-1 should be pumped using a 3-inch diameter submersible pump (0.75-horsepower Grundfos 5SQE 07-320 used for well development or similar) with water quality samples collected after groundwater is determined to be turbidity-free. Because the casing diameter of both FO-7 wells is 2 inches, a low-flow bladder pump using micro-purge technique (similar to that used by Blaine Tech Services for this field investigation), is recommended for sampling of both FO-7 wells. Samples from FO-7 and MRWPCA-MW-1 should be pre-filtered through 0.45-micron filter paper in the field during sample collection to remove remaining suspended solids. If approved by the analytical laboratory, sample collection bottles should be preservative-free to minimize the potential for digestion of solids in the sample during transport and prior to analysis. This may also be done within the required protocols without field filtering, if samples are submitted and received by the laboratory within at least the first 24 hours after sample collection. The laboratory then filters and/or centrifuges samples prior to acid preservation.

6. **REFERENCES**

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FIGURES




























APPENDIX A

Project Permits

- 1. FORA Right-of-Entry Permit
- 2. City of Seaside Encroachment Permit and Use/Minor Use Permit,
- 3. Monterey County Health Department Well Construction Permit



August 6, 2013

Keith Israel, General Manager Monterey Regional Water Pollution Control Agency 5 Harris Court, Bldg. D Monterey, CA 93940

RE: Right of Entry: Monterey Regional Water Pollution Control Agency Monitoring Well Installation

Dear Mr. Israel:

This Fort Ord Reuse Authority (FORA) Right of Entry (ROE) outlines terms of use for select former Fort Ord areas to support Monterey Regional Water Pollution Control Agency ("MRWPCA" – including its officers, directors, agents, staff and contractors) Monitoring Well Installation. This ROE is limited to the Monitoring Well Installation and improvement work as shown on the attached Exhibit "D," Figure 2 – UXO Support Work Plan and may be canceled by FORA with thirty (30) days notice. FORA may suspend the ROE without notice for cause (such as breach of the ROE).

This ROE provides MRWPCA with limited access to FORA owned property that is currently undergoing Munitions and Explosive of Concern (MEC) remediation efforts. FORA may stop MRWPCA's activities and to perform MEC remediation activities and supporting activities. FORA will work with MRWPCA to attempt to minimize the impacts of MEC remediation efforts on MRWPCA's activities. This ROE may not be assigned.

Usage and restrictions are based on conditions in this ROE and the attached:

- Exhibit "A" FORA Letter to the City of Seaside dated May 24, 2012, Acknowledgment and Acceptance of City of Seaside Application for the Seaside Groundwater Monitoring Well Project
- Exhibit "B" Technical Memorandum Monterey Regional Water Pollution Control Agency Seaside Groundwater Basin Monitoring Well Project, dated August 6, 2013.

- Exhibit "C" Requirements for Soils Management Monterey Regional Water Pollution Control Agency Seaside Groundwater Basin Monitoring Well Project, dated August 6, 2013.
- Exhibit "D" UXO Support Work Plan Monterey Regional Water Pollution Control Agency Seaside Groundwater Basin Monitoring Well Project, dated August 6, 2013.
- Exhibit "E" The DTSC letter dated August 2, 2013 after reviewing the Technical Memorandum, Requirements for Soils Management, UXO Support Work Plan for the proposed MRWPCA Monitoring Well Installation improvements before receiving regulatory site closure.

Use of the described FORA owned Monitoring Well Installation site is permitted under the following terms:

1. FORA makes no representation as to the condition of these properties/facilities. MRWPCA accepts responsibility to inspect the facilities prior to use to determine that the premises are safe and suitable for the proposed activities.

2. MRWPCA will meet the terms for construction of the Monitoring Well Installation improvements, as approved by FORA and DTSC with concurrence by the U.S. Environmental Protection Agency (EPA), to protect the health and safety of MRWPCA personnel, staff and contractors. This ROE terminates upon completion of the work shown in Exhibit "D," Figure 2 – UXO Support Work Plan.

3. MRWPCA agrees to defend, indemnify, and hold FORA, the jurisdictions, DTSC and EPA, their officers, employees, contractors and agents harmless from and against any and all liability, loss, expense, including reasonable attorneys' fees, or claims for injury or damages arising from MRWPCA's activities, work stoppages, delays or time lost for implementing, monitoring, or enforcing any provisions of this ROE including the attached exhibit documents.

4. Use of the property is subject to federal and/or State of California protections from impact to endangered species. MRWPCA agrees to comply with these regulations and instruct their members in awareness of these species.

5. MRWPCA agrees to provide FORA with proof of insurance and add FORA and its agents and the City of Seaside as additionally insured on MRWPCA's general liability insurance policy. This ROE will not be valid until a properly completed certificate of insurance has been submitted to FORA.

6. MRWPCA agrees to refrain from any ground penetrating activities, unless previously approved in writing by FORA.

7. MRWPCA will notify FORA of any dumping that may have occurred on the property as soon as sighted.

8. MRWPCA will not litter and will remove any trash that their contractors may leave.

9. MRWPCA will notify the Seaside Police Department immediately of any illegal activities on the properties and follow up by providing FORA with a description of the activities as soon as possible by calling the FORA ESCA Hotline (831) 883-3506.

10. MRWPCA will survey and stake and fence the ASR well site before beginning construction to insure that soils do not leave the site.

Once this property is transferred to the City of Seaside this ROE becomes void. Upon transfer, MRWPCA work on the transferred land must cease immediately unless the City of Seaside grants permission. MRWPCA is also responsible for obtaining appropriate permission from the City of Seaside to use the subject area not owned by FORA.

Please indicate your agreement to the conditions of this ROE by signing in the space provided below.

Sincerely,

Stan Cook Real Property and Facilities Manager

Acceptance:

Monterey Regional Water Pollution Control Agency

Keith Israel, General Manager

8/8/13

Date:

CITY OF SEASIDE PUBLIC WORKS DEPARTMENT 440 HARCOURT AVENUE, SEASIDE 93955 (831)899-6825

<u>(001)022</u>	PERMIT NO: 6414
APPLICATION AND PERMIT FOR ENCROACHMENT	IN CITY RIGHT OF WAY
NAME OF	
CONTRACTOR/APPLICANT: Cascade Drilling LP	CELL PHONE: 562-964-1691
ADDRESS: 555 S Harbor Blvd. La Habra, CA 90631	PHONE: 542-944-1291
CONTRACTORS LICENSE: 938110 CITY BUSINES	SS LICENSE: Dending
ADDRESS OF PROPOSED WORK; South side Encalyptus 1	Rd. approx 1700'rast
PROPOSED STARTING DATE: November 1, 20/3 (NOTE: PLEASE CALL FOR INSPECTION 48 HOURS PREADE RECOVERING WORK)	of General Jim Moore Blud.
TYPE OF WORK:	
DESCRIBE WORK PROPOSED: Drill Monitoring well	in south bicycle
lane of Eucolyptus Rd, install flush cap,	repair with concrete
SHOW LOCATION OF EXISTING STREET IMPROVEMENTS TO BE REMOVED AND REPLACED AN TO PROPERTY LINES. PROVIDE INSPECTOR WITH GRADE SHEETS FOR STORM DRAINS, SEV CONSTRUCTION. SHOW CROSS STREETS AND NORTH ARROW.	ND LOCATION OF NEW WORK WITH REFERENCE WERS, CURBS, ETC. ONE DAY IN ADVANCE OF
Eucolyptus Road	^ /
Kappiex 1,700 / Monito	5 <u>6</u> 4
S of S	

All work is to be started within 30 days of the initial issuance of this permit and completed in an expeditious manner as determined by the engineer. The applicant agrees to properly maintain said encroachment at no expense to the City and to indemnify the City from any liability arising out of or caused by said encroachment, and that all work shall be in accordance with City Standards. The applicant unconditionally guarantees and implies warranty for all materials and workmanship affected by this permit for a period of one year from the date of acceptance of the work. Acceptance by the City of the work completed under this permit is not a waiver of the applicant's obligations as stated above.

Loc S-	10/02/13						
APPLICANT'S SIGNATURE	APPLICATION DATE						
APPLICANT IS TO NOTIFY THE FOLLOWING:	NOTE/STANDARD PLANS: Adhere to conditions dated 10/7/13.						
DDLICE (899-6748)	Valid only with approved Use Permit.						
MONTEREY-SALINAS TRANSIT (MST) FAX LOCATION TO 899-7789	Call to 48 hours in advance of work. Call to arrange inspection of repair.						
WESTMED AMBULANCE (796-6444)	Install pedestrian traffic control.						
RECEIPT NO:	PERMIT ISSUED BY: 10/8/13 SEASIDE PUBLIC WORKS DEPT. DATE						

I HAVE EXAMINED THE WORK COVERED BY THIS PERMIT AND FIND THAT IT IS IN ACCORDANCE WITH THE STANDARDS OF THE CITY OF SEASIDE AND RECOMMEND ACCEPTANCE.

ENCROACHMENT INSPECTOR

DATE



CITY OF SEASIDE

Resource Management Services | Planning Division Use Permit / Minor Use Permit Application

UP-12_07
MUP-11
File # 102:21

TO E South of and ac Project Address or Location: of General lim	BE COMPLETED BY APPLICANT djacent to Eucalyptus Road; approx. 1,800 ft e Moore Boulevard	east APN: 031-1	151-048-000
Breiset Description (attach if needed): (Sel	e attached Summary Project Descrip	tion, June 6, 2012	
Project Description (attach in needed).			
and Work Plan, March 2012)			
Applicant / Primary Contact:			
Name: Monterey Regional Water Pollution C	Control Agency (MRWPCA) / Robert	Holden	
Address: 5 Harris Ct # D	City: Monterey	State: CA	Zip: <u>93940</u>
Phone Contact: 831-645-4634	Email: bobh@mrv	vpca.com	
Phone Contact. doi: 0101001			
Property Owner:			
Name: Fort Ord Reuse Authority (FORA)/ N	lichael A. Houlemard, Jr Executive	Officer	
A three 020 2nd Ave Suite A	City: Marina	State: CA	Zip: 93933
Address: 920 2110 Ave., Suite A	Email: Michael@f		
Phone Contact: 831-883-3672	Email: Michaellogi	oru.org	

Property Owner's Statement: "By my signature, I hereby certify that I am the legal owner of record of the property identified in this application and that I approve of the requested action herein. I further certify that all data, information, plans and evidence submitted as part of this application is true and correct to the best of my knowledge."

Signature: N/A (See letter from FORA, in Tab 7)

Submittal Requirements

- 1. Plan Set All plans shall be accurate and clearly drawn to scale on sheets a minimum size of 18"x24" and up to a maximum size of 24" x 36" using either an engineer's or architect's scale. Five (5) full-size folded copies shall be submitted with the application for initial review. Once any revisions are made and the application is deemed complete, eight (8) full-size folded copies and one (1) set of reduced copies (11"x17") of the amended plans will be required. The set of reduced plans may be submitted electronically in PDF format.
- 2. Project Description Describe the proposed use of the subject property or tenant space including a description of the business and/or use, operational hours, use of floor area and outside areas, number of employees, number of seats (restaurant uses and meeting spaces), number of fleet vehicles, and any other relevant information.
- 3. Site Plan Show all property lines and dimensions, adjacent streets and alleys, required setbacks, structures, driveways, parking spaces, landscaped areas, signs, trash enclosures, etc. on a scaled plan of the entire subject property. Include all north arrow, structure dimensions, distances from other structures, and distances to adjacent property lines.
- 4. Floor Plan Include existing and proposed plans for all tenant spaces, interior living spaces, windows, walls and doors.
- 5. Elevations Include all exterior elevations. (New Construction only)
- 6. Pre-stamped envelopes for all properties within a 300-foot radius (consult staff for amount)
- 7. Additional information as requested by Staff following initial review of the project.

	TO BE COMPLETED BY STAFF	
Large Commercial (≥ 5,000 sq. ft,) \$2,575 🗌 Small Con	nmercial (< 5,000 sq. ft) \$2,060
/ \ Single-Family Dwelling \$670	🗌 Multi-family (more than 1 dwelling) \$2,266	Minor Use Permit \$515
Fee Collected: 2575.00 Receipt #: _	165519 Accepted By: T.O.	Date Accepted: 6/12/12
		Updated 1/.3/2011

Date: June 7, 2012

MONTEREY COUNTY

DEPARTMENT OF HEALTH ENVIRONMENTAL HEALTH BUREAU 1270 Natividad Road Salinas, CA 93906 (831) 755-4507

WATER WELL CONSTRUCTION PERMIT

WELL PERMIT #13-12301 INTENDED USE: Monitoring Well

SITE LOCATION: Eucalyptus Rd

OWNER:MRWPCA

ADDRESS:5 Harris Ct. BLDG 5

CITY: Monterey

DRILLING CONTRACTOR: Cascade Drilling

LICENSE:988110

ISSUED: 10/29/2013

EXPIRES:10/29/2014

APN:031-151-048-000

PHONE: 831-645-4634

ISSUED BY:

CONDITIONS OF APPROVAL:

- 1. All requirements set forth in Monterey Code Chapter 15.08 and Bulletins 74-81 and 74-90, shall be complied with at all times.
- 2. The well shall be at least 100 feet from any septic tank; any portion of any leach field or animal enclosure; 50 feet from any sewer main, line or lateral; and 150 feet from any seepage pit. If type of absorption field is unknown, the distance shall be 150 feet.
- 3. Location of the well shall not prevent the installation, relocation or expansion of the septic system on any adjoining lot.
- 4. Water well permit shall be kept on site at all times while work is in progress.
- 5. The well shall be drilled in the approved location delineated on the attached map, Exhibit A. The well cannot be drilled in any other location without prior approval from Monterey County Health Department, Environmental Health Bureau (EHB) and receipt of an amended permit.
- 6. Any water well on the premises which is to be abandoned, or which has been abandoned shall be properly destroyed within six months of the completion of this well.
- 7. Notify the EHB at least 24 hours prior to moving on site.
- 8. Notify the EHB 24 hours prior to the time you expect to place any seal.
- 9. If the seal(s) cannot be witnessed by the EHB, a detailed, written description of the seal(s) shall be submitted to the EHB within ten days.
- 10. Surface construction features of the completed well shall be in accordance with the California Well Standards Bulletin 74-81 and Bulletin 74-90 Section 10.



- 11. The permit applicants shall indemnify and hold harmless the County and its officers, agents, and employees from actions or claims of any description brought on account of any injury or damages sustained, by any person or property resulting from the issuance of the permit and the conduct of the activities authorized under said permit.
- 12. Issuance of this permit to construct a water well does not create, transfer, assign or acknowledge any legal rights to water associated with this property.
- 13. Issuance of this permit to construct a water well does not guarantee that the well can be approved for domestic use.
- 14. A geologic log shall be performed and it shall be submitted to the EHB before the well is sealed. Interpretation of the geologic log shall be provided by the contractor indicating the best location(s) for sealing off poor quality water and the proposed seal depth. The exact location of sanitary and strata seals shall be approved by the EHB in consultation with any appropriate water management agency before the well is sealed. The permit applicant may request review of the approved seal depth by a 3rd party licensed hydrogeologist at the applicant's expense if the applicant disagrees with EHB's decision.
- 15. The well shall be constructed as designed in Exhibit B.

PLEASE NOTE THE FOLLOWING:

1. Monterey Peninsula Water Management Requirements (MPWMD): The proposed well is located within the MPWMD boundary and will be subject to MPWMD requirements. It is recommended you review MPWMD requirements prior to construction:





APPENDIX B

Dual Induction – Natural Gamma Ray Geophysical Log

welenco

5201 Woodmere Drive, Bakersfield, CA 93313-- www.welenco.com--(800) 445-9914 California Contractor's License No. 722373

DUAL INDUCTION - GAMMA RAY LOG

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Reco	rded By		Dan	lhde												
Witne	essed By		Bill N	lotze	r											
RUN		BOR	EHOLE RE	ECOR	2D					CA	SING	RECO	RD			
NO.	BIT		FRO	М	то		SIZE TYPE F			FR	ROM TO					
1		In		Ft		Ft		3	In	Sch 8	0		Surf Ft		521	Ft
2		In		Ft		Ft			In				Ft			Ft
3		In		Ft		Ft			In				Ft			Ft

Ν	liscellaneou	is Inform	nation								
Remarks:											
A recreational GPS accurate	A recreational GPS accurate to +/- 45 feet set for Datum NAD27 was used to calculate										
Latitude, Longitude & Elevati	Latitude, Longitude & Elevation values. The Section, Township, and Range then										
determined using the TRS program (TRS accuracy is not guaranteed). The TRS											
program converts Latitude and Longitude to Section, Township, and Range. The											
NOTICE at the bottom of this	heading also applies.										
Steel centralizer at 463 feet											
Drilled By: Cascade Drilling											
Perforated Intervals:	-										
421 Ft. To 516 Ft.											
Line Speed:		1									
Borehole Volume Calculations	:										
Other Information:											
NOTICE: All interpretations are opinions based on inferences from electrical and other measurements and we do not guarantee the accuracy or correctness of any verbal or written interpretation, and we shall not, except in the case of gross or willful negligence on our part, be liable or responsible for any loss, costs, damages or expenses incurred or sustained by anyone resulting from any interpretation made by one of our officers, agents or employees. These interpretations are also subject to our General Terms and Conditions as set out in our current Price Schedule. <i>welenco, inc. January</i> 27, 2014											



APPENDIX C

DWR Well Completion Report

			ly be used to view	and complete	uns ionn. nowever,				iele, save,	anu ieus		John.	
File Origi	nal with I	JWR			St	ate of Cal	fornia			D١	VR Use On	ıly – Do	Not Fill In
Page 1		of	10		Well Co	mpleti	on Repo	ort					
Owner's	Well Nun	nber N	1W-1		Refer No		1 Pamphiet 1 5			Sta	ite Well Nu	mber/Si	te Number
Date Wor	k Began	12/16	6/2013	Date	Work Ended 12/2	20/2013				Latitude	IN		
Local Per	mit Ager	ncv Mo	onterev County	/ Health De	partment	0.20.0				Latitude			Longitudo
Permit Nu	umber 1	3-1230)1	Permit Da	te 10/29/13						APN/	rrs/oth	ner
			Geolo							Wel	Owner		
Orie	ntation		rtical O Hor	izontal		fv		Aontorov	Pogion		r Dollutic	n Cor	trol Agonov
Drilling I	Method S	onic		20110	Drilling Fluid			vionterey					
Depth	from Su	rface		Desc	cription	Mailing	Address <u>5</u>	Harris	Court, I	<u>Suilaing i</u>	<u>D</u>	00040	
Feet	to Fe	eet	Des	cribe material,	grain size, color, etc		City <u>IVI</u>	onterey			Sta	ite <u>CA</u>	Zip <u>93940</u>
0			(SP) 10YR 6/8	3 Brownish	yellow fine sand	l, dry				Well	Locatior	า	
8			(SP) 10YR 6/8	3 Brownish	yellow very fine	to fine	Address	Eucalyp	otus Roa	ad (1,80	0' east c	of Gen	. Jim Moore Blvd)
			sand, dry				City Se	easide			Co	unty <u>M</u>	lonterey
10.0			(SP) 10YR 6/8	3 Brownish	yellow fine sand	l, dry	Latitude	36	37	22	N Longitu	ude <u>1</u> 2	21 48 43 w
12.5			(SP) 10YR 6/8	3 Brownish	yellow fine sand	l, moist		Deq.	Min.	Sec.		C	Deg. Min. Sec.
15.0			(SP) 10YR 5/6	3 Dark yello	wish brown very	/ fine to	Datum	NAD83	Dec. La	t. <u>36.62</u>	269	Dec.	Long. <u>121.8119</u>
			fine sand with	minor rour	nded pebbles up	to 0.5"	APN Bo	ok <u>031</u>	Page	e <u>151</u>		Parce	el <u>048000</u>
			diameter, trac	e silt, mois	t		Townsh	ip <u>15S</u>	Rang	e <u>1E</u>		. Secti	on
16.0			(SP) 10YR 5/0	6 Dark yello	wish brown fine	sand wit	h	Locat	tion Ske	etch			Activity
			minor gravel,	moist			(Sketch	must be draw	n by hand a North	tter form is	printed.)	O N	ew Well
17.5			(SP) 10YR 7/0	3 Yellowish	brown fine sand	l, moist			Horan				Deepen
18.5			(SP-ML) 10YF	R 4/6 Dark	yellowish brown	fine sand						5	Other
			with silty fine	sand mod	ules, moist							OD	
22.5			(SP) 10YR 5/8	3 Yellowish	brown fine sand	l. moist						u U	nder "GEOLOGIC LOG"
25			(SP) 10YR 6/	6 Yellowish	brown fine sand	l. moist							Planned Uses
30			(SP) 10YR 6/	6 Yellowish	brown fine sand	d with						O W	/ater Supply
			with minor silt	nodules s	lightly moist						t.		Domestic Public
32.5			(SP) 10YR 6/8	Rrownish	vellow fine sand	moist	- Nes				Eas		Irrigation Industrial
35			(SP) 10YR 6/	3 Yellowish	brown fine sand	l with					l	Оc	athodic Protection
			minor silt nod	iles slightl	v moist	· ···							ewatering
38				R Vollowish	brown fine sand	l slightly					l		eat Exchange
50			moist	5 1 CIIOWI311	brown nine same	i, siigittiy					l		Ionitoring
40.5	_			Prownich	vollow fine cond						l	Ο R	emediation
40.5	_			DIOWINISH	yenow nine sand	i, signity					l	Ōs	parging
12				S Vollowich	brown find cane		-		South			От	est Well
43	_		(SP) 101R 0/0	5 reliowish	brown line sand	i, siignuy	Illustrate or d	escribe distance	of well from ro	ads. building	is, fences,	O V	apor Extraction
40				Dorkvalla	unich brown fine	a a m d	rivers, etc. ar Please be ac	nd attach a map. ccurate and com	Use additiona plete.	al paper if neo	essary.	00	ther
48			(SP) 10YR 5/0	b Dark yello	wish brown tine	sand,	Water I	evel and	Yield o	of Com	pleted V	Vell	
50.5	_		slightly dry		1 11 6		Depth to	o first wate	r 405			(Fee	t below surface)
50.5			(SP) 10YR 5/8	3 Yellowish	brown silty fine	sand	 Depth to 	Static				_ (
			nodules, dry	_	XV	_	Water L	evel		(Fee	et) Date	Measu	ired
Total D	epth of B	oring	535		Feet		Estimate	ed Yield *		(GP	M) Test	Type _	
Total D	epth of C	omplet	ed Well 521	- N.	Feet		I est Lei	ngth	oontotivo	(Ho	urs) lotal	Drawd	lown(⊦eet)
			-		- L. /		Iviay IIC	t be repres	sentative	UI a we	I S IONY LE	inn ylei	iu.
Denth	from	Boreh	ole	Casi	ngs Wall	Outside	Screen	Slot Size	Dent	h from	Annui	ar ma	terial
Sur	face	Diame	ter Type	Mater	ial Thickness	Diameter	Туре	if Any	Su	rface	Fil	il –	Description
Feet t	• Feet	(Inche	es) Black		(Inches)	(Inches)		(Inches)	Feet	to Feet	Comont		Noat Comont
160	400	3	Blank	PVC Sch. 80	0.0	3.5			50	<u>411</u>	Bentonit		Hydrated pellots
400	421	7	Blank	PVC Sch 80	0.0	3.5			411	521	Filter Par	ć ck	#3 graded sand
421	446	7	Screen	PVC Sch 80	0.0	3.5	Milled Slots	0.020	521	535	Fill		Native fill
446	466	7	Blank	PVC Sch. 80	0.6	3.5	1	0.020			+		
466	516	7	Screen	PVC Sch. 80	0.6	3.5	Milled Slots	0.020		1	1		
		Attac	hmonte					Cortificat	ion Stat	lement			
	Geologia		initerita		I, the undersigned	d. certifv th	at this report	t is comple	te and a	ccurate t	o the best	t of mv	knowledge and belief
	Well Con	struction	on Diagram		Name <u>Edwin Li</u>	n, Todd E	Engineers						
	Geophys	ical Lo	g(s)		Person, 2490 Mariner	Firm or Corpo Salon	ste, 215	Alan	neda		C	A (94501
	Soil/Wate	er Cher	nical Analyses		<u> </u>	Address		7 1101	City	'	St	ate	Zip
	Other				Signed	anaa -1167 1	Mall Country 1			<u> </u>	9	88110)
Attach addi	itional inforr	nation, if i	t exists.		C-57 Lic	ensed Water	vveii Contractor			Date Si	gned C	-57 Lic	ense Number

												u suvcu	<u> </u>			
File Orig	inal with	DWR				Si	tate of Cali	fornia			DW	R Use Or	ly – Do	Not Fill In		
Page 2		of	10		V	Vell Co	mpleti	on Repo	ort		1	1 1	T			
Owner's		$\frac{0}{1}$	/\//_1			Refe	r to Instruction	Pamphlet State Well Number/Site Number								
Date We		12/16	S/2013	Data		UNI 2/21 bobc	• eu1963 20/2012	10				N		W		
	rmit Ago	$\frac{12}{10}$	onterey County		apartme	nt	20/2013							Longitude		
Local Pe	umbor 3	1230	1	Dormit D	oto 10/2	20/2013						APN/	rrs/oth	ner		
		1200		· ·		20/2010		-								
			Geolo	gic Log	<u></u>		-		Well Owner							
Ori	entation	ÖVe	ertical O Hoi	izontal	OAngle	e Speci	fy	– Name <u>Name</u>	Name Monterey Regional Water Pollution Control Agency							
Drilling				Dee	Drilling			- Mailing	Mailing Address <u>5 Harris Court, Building D</u>							
Feet	to F	eet	Des	cribe material	. grain size	e. color. etc		City Monterey State CA Zip 93940								
58			(SP-SM) 10Y	R 5/9 Yello	wish bro	own siltv	fine sand				Well I	ocatio				
			lenses dry			entre entry		Address	Eucalyn		d (1 800)' east c	• of Con	lim Moore Blvd)		
59			(SP) 10YR 5/9	9 Yellowish	brown	fine sand	1 with		Address Eucalyplus Road (1,800 east of Gen. Jim Moore Bivd)							
			minor silt dry					City <u>Se</u>		07 0	0	C0				
60.5					wich br		fine cond	Latitude	<u>36</u>	37 2 Min	Sec 1	V Longitu	Ide 12	21 48 43 W		
00.5			(SF-SIVI) 1011			JWIT SILLY	line sanu	Datum I	NAD83	Dec Lat	36.622	269	Dec	Long 121.8119		
05.5			ienses, dry			C	1 10		ok 031	Page	151		Parc	a 048000		
65.5			(SP) 10YR 6/6	SYEllowish	n brown	tine sand	a with		159	_ Taye	151	-	Casti			
			minor silt, dry					Townsn	ip <u>100</u>	Range			Secu	on		
70			(SP) 10YR 6/0	5 Yellowisł	1 brown	fine sand	d with	(Sketch	Locat	ion Ske	tch er form is n	rinted)		Activity		
			minor silt nod	ules, dry				UNCION		North	οι ισπι ιο μ			ew Well Indification/Repair		
72.5			(SP) 10YR 5/8	8 Yellowisł	n brown	fine sand	d with					2.1		Deepen		
			minor silt nod	ules, dry										Other		
74			(SP) 10YR 6/0	6 Yellowish	n brown	fine sand	d with					· .	OD	estroy		
			minor silt lens	es and no	dules, d	ry						\mathbf{Y}	u	nder "GEOLOGIC LOG"		
75			(ML) 10YR 4/	6 Dark vell	owish b	rown silt	with mino	r						Planned Uses		
			fine sand and	clav. drv									ΟW	/ater Supply		
77 5			(SP-SM) 10Y	R 5/6 Dark	vellowi	sh brown	fine sand					÷		Domestic Public		
11.0			with large silt	nodules d	rv			Ses l				Eas		Irrigation Industrial		
80			(SP) 10VR 6/	R Brownish		fine sand	1 with						Оc	athodic Protection		
00				DIOWING	I yellow	nine sane		- L - 1					OD	ewatering		
025				S Vollowiek	brown	fino conc	l with	- 1 (Он	eat Exchange		
02.5					DIOWII	nine sand								Ijection		
05						C	1 10							remediation		
85			(SP) 10YR 6/0	SYEllowish	nbrown	tine sand	a with						0 s	narging		
			minor silt, dry										От	est Well		
88			(SP) 10YR 7/8	3 Brownish	yellow	fine sand	l, dry	South O Vapor Extraction						apor Extraction		
90.5			(SP) 10YR 6/6	6 Yellowish	n brown	fine sand	d, dry	rivers, etc. ar	escribe distance o id attach a map.	of well from roa Use additional	paper if nece	ssary.	0 o	vther		
93			(SP-SM) 10YI	R 6/6 Yello	wish bro	own silty	fine sand	Please be ad	curate and com	piete.	6 C a mar	Jatad V				
			nodules, dry			-		water L	ever and		i Comp					
96			(SP-SM) 10Y	R 6/6 Yello	wish bro	own silty	fine sand	Depth to	o first water	<u>405</u>			_ (Fee	et below surface)		
			dry					Water L	evel		(Feet) Date	Measu	ured		
Total D	epth of E	Boring	535			Feet		Estimate	ed Yield *		(GPN	í) Test	Туре			
Tatal								Test Ler	ngth		(Hou	rs) Total	Drawd	down(Feet)		
i otai L	pepth of C	Jompie				Feet		*May no	t be repres	sentative of	of a well'	s long te	rm yiel	ld.		
				Cas	inas							Annul	ar Ma	terial		
Dept	h from	Boreh	ole Type	Mato	rial	Wall	Outside	Screen	Slot Size	Depth	from					
Su Feet	to Feet	Diame (Inch	eter (Specific Specific Specif	mato		Thickness (Inches)	(Inches)	Туре	(Inches)	Sur Feet t	f ace o Feet	Fil	I	Description		
516	521	7	Blank	PVC Sch 8)	0.3	3.5		(menes)	1001 1	0 1 000					
	-				-											
							1									
	1			1		1	1									
							1									
		Attor	hmonte				•		ortificati	on State	amont			<u> </u>		
	Coologia	Alla	innents		Lthou	ndorsiano	d cortify th	at this report		to and ac	curate to	the hes	t of my	knowledge and belief		
		, LUY Netructiv	n Diagram		Name	<u>Edwin Li</u>	n, Todd E	ingineers					. or my			
	Geophysical Log(s) Person, Firm or Corpora 2400 Mariner Sal Loop S							ration	Alor			0	A (04501		
	Soil/Wat	er Chei	nical Analyses		2490	wanner	Address	J. Ster, 213 Alameda <u>CA</u> 94501 City State Zip								
	Other Signed							988110								
Attach add	ditional infor	mation, if	it exists.			C-57 Lic	ensed Water	Well Contractor			Date Sig	ned C	-57 Lic	ense Number		
DWR 188	REV. 1/200	6			IF ADDIT	IONAL SPAC	E IS NEEDED	USE NEXT CO	NSECUTIVEL		D FORM					

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File Original with	h DWR		14	St	tate of Califo	ornia Dia india			DWR I	Use Only	– Do l	Not Fill In
Page 3	of	10	W	ell Co	mpletic	on Repo	ort					
Owner's Well Ni	umber M	W-1		Refer No	r to Instruction F	Pamphlet State Well Number/Site Number						
Date Work Beg	an 12/16	/2013	Date Work En	ded 12/2	0/2013	1			titudo	Ν		l ongitudo
Local Permit Ag	$\frac{12}{10}$	nterev County	Health Departme	aca <u>12/2</u> nt	_0/2010			La	lilude			Longitude
Permit Number	13-1230	1	Permit Date 10/2	9/2013						APN/TR	S/Oth	er
	10 1200			0/2010								
	01/	Geolog	gic Log		-				Well O	wner		
Orientatio	n OVer	tical O Hori	zontal OAngle	Speci	fy	Name <u>N</u>	/lonterey	Regional \	Nater Po	ollution	Cont	trol Agency
Drilling Method			Drilling F	luid		Mailing /	Address	5 Harris Co	ourt, Buil	ding D		
Depth from S	Surface	Desc	Description ribe material grain size	color etc		City Monterey State CA Zip 93940						
103.5	1001	SP) 10YR 6/6	Yellowish brown	ine sanc	1 with			1	Noll Lor	ration		
100.0		ninor silt dry		ine surie			Fuebu	ntus Daad			Can	lim Maara Dhud)
106	1		E/6 Dark vallowia	h brown	with oilty	Address		blus Roau	(1,000 €	east of	Gen.	
100	(SF-SIVI) TOTH			with Silty	City Se	aside			_ Coun	ty <u>IVI</u>	onterey
		ine sand hodu	lies, dry		<u> </u>	Latitude	36	<u>37 22</u>	N L	ongitud	e <u>12</u>	<u>1 48 43 w</u>
109.5	(SP-SM) 10YF	R 6/6 Yellowish bro	wn silty	fine sand	Dotum N		Doo Lot	c. 26 6226	0 1		eq. Min. Sec.
		enses, dry							<u>10.0220</u>	<u> </u>		_019000
114.5	(SP) 10YR 6/6	Yellowish brown	ine sanc	d with	APN Bo	ок <u>031</u>	Page	151		Parce	046000
	r	ninor silt, dry				Townshi	p <u>155</u>	Range	IE		Sectio	on
117	(SP-SM) 10YF	R 6/8 Brownish yel	ow silty	fine sand		Loca	tion Sketc	h			Activity
	l r	nodules, drv	2	,		(Sketch r	must be draw	n by hand after	form is print	ed.)	O Ne	ew Well
122	1	SP-SM) 10YF	8 5/8 Yellowish bro	wn siltv	fine sand	1		NOILII	<u> </u>		OM	odification/Repair
<u>}</u> +		drv		only	ound,	11 /						Other
124.5			6/6 Vellowish hrs	wn eiltu	fine cand						O De	estroy
124.0	(<u>36-3101) 1016</u>		wii Siity	nne sanu,						De	escribe procedures and materials der "GEOLOGIC LOG"
107				•••	c					< F		Planned Lises
127	(SP-SM) 10YF	6/6 Yellowish bro	wn silty	tine sand							ator Supply
		enses, dry		-								Domestic Public
129.5	(SP-SM) 10YF	R 6/6 Yellowish bro	wn silty	fine sand,	est				ast		
	C	dry				Š				ш		athodic Protoction
135.5	(ML) 10YR 4/4	Dark yellowish br	own fine	sandy							amoule Frotection
	5	silt, dry									О Це	ewatening Pat Exchange
137	(SP) 10YR 5/8	Yellowish brown	ine sanc	d. drv	11					O Ini	ection
139.5	(SP) 10YR 5/8	Yellowish brown	fine sand	d with						О Мо	onitorina
100.0	r	minor clay, dry		into ounie							Ô Re	emediation
142	1		6/8 Brownish vol	ow fino (cond with						O Sp	barging
142	(SF-SIVI) IUTP		ow line :	Sanu with			Couth		I •	O Te	est Well
4.47		silt nodules, dr	y		<i>c</i> 1	Illustrate or de	escribe distance	of well from roads	buildings fen	Ces	O Va	apor Extraction
147	(SP-SM) 10YF	8 5/6 Dark yellowis	h brown	fine sand	rivers, etc. an	d attach a map.	Use additional pa	per if necessar	ry.	O Ot	her
	١	with silt nodule	es, dry	-		Wator			Complo	tod Wa		
149.5	(SP-SM) 10YF	R 6/6 Yellowish bro	wn fine s	sand with	Dantie (first wet		Somble		/	tholow ourfear)
	5	silt nodules, dr	У		1	Depth to	static	403			(ree	ubelow surface)
152	(SP-SM) 10YF	R 6/8 Brownish yel	ow silty	fine sand,	Water Le	evel		(Feet)	Date M	leasui	red
Total Depth of	Boring	535		Feet		Estimate	ed Yield *		(GPM)	Test Ty	/pe	
Tatal Dauth of		521				Test Ler	ngth		(Hours)	Total D	rawdo	own(Feet)
Total Depth of	Complete			_ Feet		*May no	t be repre	sentative of	a well's l	ong tern	n yield	d.
			Casings			-		1	Δ	nnular	[.] Mat	erial
Depth from	Boreho	le Turne	Motorial	Wall	Outside	Screen	Slot Size	Depth f	rom			
Surface	Diamet	er Type	Wateria	Thickness	biameter	Туре	if Any	Surfa	ce	Fill		Description
Feel to Feel	(inches	5)		(incries)	(incries)		(Inches)	Feel to	reel			
├ ──┤					+ +		1	╢──┼				
├ ──┤			-		+ +		1	╢──┼				
├ ───					+ +		1	╢──┼				
├ ───		2			+ +		1	╢──┼				
┣───┤───								╢──┼				
			1	_								
	Attach	nments		dan 1		C	ertificat	ion Stater	nent	- h - 1	6.	lucasidado de 1977
	lic Log	5	I, the un	aersigneo Edwin I i	a, certity than n Todd Fr	t this report	is comple	ete and accu	rate to th	e best o	or my	knowledge and belief
	onstruction	n Diagram		Person,	Firm or Corpora	tion						
	Soil/Water Chemical Analyzes							<u>), Ste, 215</u> <u>Alameda</u> <u>CA</u> <u>94501</u>				
	☐ Other Address Address							City State Zip 988110				
Attach additional info	ormation. if it	exists.	 	C-57 Lic	ensed Water W	ell Contractor		Da	ate Signe	d C-5	7 Lice	ense Number
DWR 188 REV. 1/20	006		IF ADDITI	ONAL SPAC	E IS NEEDED.	USE NEXT CO	NSECUTIVE		FORM			

File Original w	ith D\MP			SI	tate of Calife	vrnia			Only Do Not Fill In			
File Original w			W /			n D ono	rt	DWR Use (Jniy – Do Not Fill In			
Page 4	of	10	vv		r to Instruction F			State Woll N	Jumbar/Sita Numbar			
Owner's Well I	Number <u>M</u>	W-1		No	e019631	8		State Well N	W			
Date Work Be	gan <u>12/16/</u>	/2013	Date Work En	ded <u>12/2</u>	20/2013			Latitude	Longitude			
Local Permit A	Agency <u>Mo</u>	nterey County	Health Departmer	nt								
Permit Numbe	er <u>13-1230</u>	1	Permit Date 10/2	9/2013					V/TRS/Other			
		Geolog	gic Log					Well Owne	ŧ٢			
Orientati	ion OVer	tical O Horiz	zontal OAngle	Speci	ify	Name N	/lonterey	Regional Water Pollut	ion Control Agency			
Drilling Metho	od		Drilling F	luid		Mailing /	Address	5 Harris Court, Building	a D			
Depth from	N Surface	Doso	Description	color oto		City Mo	onterey	S	State CA Zin 93940			
	1 661	drv	ibe material, grain size			Unity		Woll Locati	on			
154 5	((SP-SM) 10YR	5/8 Yellowish bro	wn silty	fine sand		Eucoly	ven Locatio	of Con Jim Mooro Blud)			
101.0	(<u></u>		in only		Address			or Gen. Jim Moore Diva)			
157	((SP) 10YR 6/8	Brownish vellow f	ine sanc	1 with	City <u>Se</u>						
Latitude <u>36</u> <u>37</u> <u>22</u> N Longitude <u>121</u> <u>46</u> <u>43</u>												
159		(SP-SM) 10VR	5/6 Dark vellowis	h brown	silty fine	Datum N	NAD83	Dec. Lat. 36.62269	Dec. Long. <u>121.8119</u>			
100		and nodules	dry		Sitty Into	APN Bo	ok 031	Page 151	Parcel 048000			
161 5	1		5/8 Yellowich bro	wn eiltu	fine cand	Townshi	p <u>15S</u>	Range <u>1E</u>	Section			
101.0	(drv		wir Silty	nne sanu,			ation Sketch	Activity			
163	1		Yellowish brown	silt dry		(Sketch r	must be drav	wn by hand after form is printed.)	New Well			
164	((SM) 10VD 5/6	Dark vellowich b		fine		-	North	O Modification/Repair			
104	(and dry		own silly	y III C				O Deepen			
169.5		SP) 10VP 6/8	Brownish vellow f	ine sand	with				O Destroy			
109.5	(<u>or) for to the dry</u>	Brownish yellow i						Describe procedures and materials under "GEOLOGIC LOG"			
172	1		5/6 Dark vellowis	h brown	fine to				Planned Uses			
172	(<u>medium coarse</u>	e sand with silt no	hulpe dr	W				O Water Supply			
174.5	1		Vellowish brown f	ine sanc	y 1 with							
174.5	(<u>SF) TOTK 0/0</u>		ine sand		Vest			🖞 🗌 Irrigation 🔲 Industri			
177	1		6/6 Vellowish bro	wn eilty	fine cand	-			O Cathodic Protection			
177	(<u>-01 -010) 10110</u> -		wiri Silty	nne sana,				O Dewatering			
170.5	(5/8 Vollowish bro	wp cilty	fino cond	r (O Heat Exchange			
179.5				wir Silty	nne sanu							
192	1			ailty fino	aand dry				O Remediation			
102	(SIVI) 101R 0/0	Vollowish brown	silty fine	sand, dry				O Sparging			
109.5	(SIVI) 101R 0/0	Prownich vollow	silty fine	sanu, ury			South	O Test Well			
200	(SIVI) 101 R 0/0	C/4 Light vollows		sanu, ury	Illustrate or de	escribe distanc	e of well from roads, buildings, fences,	 O Vapor Extraction 			
202.5	(NIL-SIVI) IUYR	t 6/4 Light yellowis	n brown	SIIL WILL	rivers, etc. and Please be ac	d attach a map curate and co	b. Use additional paper if necessary.	O Other			
205	1			oilty fino	cond dry	Water L	.evel an	d Yield of Completed	Well			
203	(SINI) 101R 0/0	Vellewish brown		Sanu, ury	Depth to	first wate	er_405	(Feet below surface)			
211	(SP) IUTR 0/0	reliowish brown i	ine sand		Depth to	Static		, , , , , , , , , , , , , , , , ,			
Tatal Danth	I Devices			E t		Water Le	evel	(Feet) Dat	ie Measured			
Total Depth	of Boring	535		Feet		Estimate	ed Yield	(GPM) Tes	st Type(East)			
Total Depth	of Complete	ed Well <u>521</u>	\sim	Feet		*May no	t he renre	(nours) Tou	term vield			
			Casings			- May no			ular Matorial			
Depth from	n Boreho	le _	Casiligs	Wall	Outside	Screen	Slot Size	e Depth from				
Surface	Diamet	er Type	Material	Thickness	biameter	Туре	if Any	Surface I	Fill Description			
Feet to Fee	et (Inches	3)		(Inches)	(Inches)		(Inches)	Feet to Feet				
					+ +							
			-									
	Attach	Iments				C	Certifica	tion Statement				
Geolo	ogic Loa		I, the un	dersigned	d, certify tha	t this report	is comple	ete and accurate to the be	est of my knowledge and belie			
U Well (Construction	n Diagram	Name _	<u>Edwin Li</u>	n, Todd Er	ngineers	•					
🗖 Geop	hysical Log	(S)	2490	Mariner	Sq Loop, S	<u>Ste, 21</u> 5	Ala	meda	CA 94501			
Soil/V	Vater Chem	ical Analyses	Signed		City State Zip							
U Other	r	oviste		C-57 Lin	ensed Water W	ell Contractor		Date Signed	50011U C-57 License Number			
DWR 188 REV 1	/2006	EXISIS.					NSECUTIVE					

	adel may be used to view and compl								
File Original with D)WR	State of Califo	rnia	DWR Use O	nly – Do Not Fill In				
Page 5	of 10	Well Completio	n Report						
Owner's Well Num	ber MW-1	Refer to Instruction P	amphlet	State Well Nu	umber/Site Number				
Data Work Pagan	12/16/2013	No. 60196313	2	N N	W				
Local Dormit Agon	w Monterey County Health	Department		Latitude	Longitude				
Dormit Number 13	Cy <u>Monterey County Health</u>	Department							
Permit Number <u>1</u>	Permit	Date 10/29/2015							
	Geologic Log		Well Owner						
Orientation	O Vertical O Horizontal	OAngle Specify	Name Monterey Regional Water Pollution Control Agency						
Drilling Method	·	Drilling Fluid	Mailing Address	5 Harris Court, Building	D				
Depth from Su	rface D	escription	City Monterey State CA Zin 93940						
		lai, grain size, color, etc							
212.0		lowish brown silly line sand		Well Locatio	n				
	lenses, dry		Address Eucalyptus Road (1,800' east of Gen. Jim Moore Blvd)						
215	(SM) 10YR 6/6 Yellow	ish brown very fine sand and	City Seaside County Monterey						
	silt, dry		Latitude 36	37 22 N Longit	ude <u>121 48 43 w</u>				
217.5	(SP) 10YR 6/4 Light ye	ellowish brown fine sand	Deq.	Min. Sec.	Deq. Min. Sec.				
	with minor silt nodules	, dry	Datum NAD83	_ Dec. Lat. <u>36.62269</u>	_ Dec. Long. <u>121.8119</u>				
220	(SP) 10YR 6/4 Light ye	ellowish brown fine sand with	APN Book <u>031</u>	Page <u>151</u>	Parcel 048000				
	minor silt crv		Township 15S	Range <u>1E</u>	Section				
223	(SP) 10VP 6/6 Vellowi	sh brown fine sand with		ation Sketch	Activity				
223		sil blowil lille saild with	(Sketch must be dra	wn by hand after form is printed.)	New Well				
				North	O Modification/Repair				
225.5	(SP) 10YR 6/4 Light y	ellowish brown fine sand			O Deepen				
	with minor silt, dry				O Other				
228	(SP-SM) 10YR 6/6 Ye	lowish brown silty fine sand			Describe procedures and materials				
	nodules, dry				under "GEOLOGIC LOG"				
232.5	(SP-SM) 10YR 5/6 Da	rk yellowish brown silty fine			Planned Uses				
	sand lenses, dry				O Water Supply				
235	(SP) 10YR 6/6, Yellow	ish brown fine sand with			Domestic Public				
200		Ish brown line saild with	Ves	Eas	☐ Irrigation ☐ Industrial				
007.5			-		O Cathodic Protection				
237.5	(SP) 10YR 6/6 Yellow	sn brown medium coarse			O Dewatering				
	sand				O Heat Exchange				
240	(SP) 10YR 4/4 Dark ye	ellowish brown fine sand			O Injection				
	with minor silt, dry				Monitoring				
242.5	(SP) 10YR 5/6 Dark ye	ellowish brown fine sand			O Remediation				
	with minor silt. drv				O Sparging				
245	(SP-SM) 10YE 6/8 Bro	whish vellow silty fine sand	1	South	O Test Well				
			Illustrate or describe distant	ce of well from roads, buildings, fences,	O Vapor Extraction				
247 5		ab vallow find cond with	rivers, etc. and attach a ma Please be accurate and co	 De additional paper if necessary. Des additional paper if necessary. 	O Other				
247.5		si yellow line sand with	Water Level an	d Yield of Completed \	Nell				
	minor slit, dry		Depth to first wat	er 405	(Feet below surface)				
249	(SM) 10YR 5/6 Dark y	ellowish brown silty fine	Depth to Static	100					
	sand, dry		Water Level	(Feet) Date	Measured				
Total Depth of Bo	oring 535	Feet	Estimated Yield *	GPM) Test	Туре				
Total Dopth of C	amplated Wall 521	Foot	Test Length	(Hours) Tota	I Drawdown(Feet)				
Total Depth of Co		1 661	*May not be repr	esentative of a well's long to	erm yield.				
	Ca	isings		Annu	lar Material				
Depth from	Borehole Type Ma	torial Wall Outside	Screen Slot Siz	e Depth from					
Surface	Diameter (Inches)	Thickness Diameter	Type if Any	Surface Fi	II Description				
reel lo reel	(incres)	(inclies) (inclies)	(Inches)						
├ ──┤									
	Attachments		Certifica	tion Statement					
Geologic	Log	I, the undersigned, certify that	t this report is comp	ete and accurate to the bes	st of my knowledge and belief				
U Well Cons	struction Diagram	Name Edwin Lin, I odd En	gineers						
🔲 Geophysi	cal Log(s)	2490 Mariner Sq Loop, S	poration b, Ste, 215 Alameda CA 94501						
Soil/Wate	r Chemical Analyses	Address	City State Zip						
□ Other			Contractor		188110 57 Lissues Number				
Attach additional inform	ation, if it exists.			Date Signed (-57 LICENSE NUMBER				
LWR 188 REV. 1/2006		IE ADDITIONAL SPACE IS NEEDED 1	ISE NEXT CONSECUTIV	ELY NUMBERED FORM					

File Original with DW/R	.,	State	of Californi	a						Not Fill In			
		Woll Comr		Donor	۰ I		DVVF	k Use Oni	y – Do	Not Fill In			
Page 6 of 10 Refer to Instruction P													
Owner's Well Number MW-1 No. e019632(State Well Number/Site Number								
Date Work Began 12/1	013			L	atitude			Longitude					
Local Permit Agency M	lonterey County Health D	epartment			_								
Permit Number <u>13-123</u>	BO1 Permit D	ate <u>10/29/2013</u>			L			APN/I	RS/Oth	er			
	Geologic Log						Well (Owner					
Orientation OV	ertical O Horizontal		Name Monterey Regional Water Pollution Control Agency										
Drilling Method	·		Mailing Address 5 Harris Court, Building D										
Depth from Surface	Describe materia		City Monterey State CA Zip 93940										
250	l with				Woll L	ocation							
200	With	A dalama a	Eucolyn	tue Pood	(1 800	l oast of	f Con	lim Mooro Rhud)					
252	(SP) 10YR 5/6 Dark vellowish brown fine sand dry					City Seaside County Monterey							
257	(SP) 10YR 5/6 Dark yellowish brown fine sand					Latitude 36 37 22 to Languitude 121 49 42							
					Latitude <u>50</u> <u>57</u> <u>22</u> N Longitude <u>121</u> <u>46</u> <u>45</u> W Deg. Min. <u>Sec.</u> Deg. Min. <u>Sec.</u>								
267	(SP) 10VR 5/6 Dark vel	lowish brown fine san	nd dry	Datum NAI	D83	Dec. Lat.	36.622	69	Dec. I	Long. 121.8119			
269 5	(SP) 10YR 5/6 Dark yel	lowish brown fine san	nd, dry	APN Book	031	Page	151		Parce	048000			
200.0	(SP) 10YR 4/6 Dark yel	lowish brown fine san	nd, dry	Township	15S	Range	1E		Section	on			
283.5	(SP-SM) 10VR 5/6 Dark	vellowish brown siltu	v fine	Location Sketch Activity									
200.0	sand dry			(Sketch mus	st be drawn	by hand afte	r form is pri	inted.)	• Ne	ew Well			
287	(SM) 10VP 5/6 Dark ve	lowish brown silty fin			_	North	÷		Ōм	odification/Repair			
207	sand moist		C							Deepen			
289.5	(SM) 10VR 6/4 Light ve	llowish brown silty fin							OD	estroy			
203.5	sand moist	nowish brown sity in	<u> </u>					\sim	De	escribe procedures and materials inder "GEOLOGIC LOG"			
207	(ML) 10VP 3/4 Dark vol	lowish brown dense						i 🖉		Planned Uses			
231	(INL) TOTIC 3/4 Dark ye	iowish brown dense							Οw	ater Supply			
208 5	(ML) 10VP 6/4 Light ve	lowish brown dense (clavev					÷-		Domestic Dublic			
290.0	silt with fine sand mois		clayey	Nes				Eas		Irrigation 🔲 Industrial			
300	(CL) 10VR 6/4 Light vel	Iowish brown silty clay	M	-					O Ca	athodic Protection			
300	moiet		у,						O De	ewatering			
300.7	MOIST								O He	eat Exchange			
201	(SP) 10YR 7/3 Very pale brown sing line sand, dry									pection			
202 5	(SP) 10TR /// Very pale brown line sand, dry								O R	emediation			
207	(SP) 10YR 6/6 Yellowish brown fine sand, dry								O Sr	barging			
307	(SP) 10YR //4 Very pale brown fine sand, dry					South			O Te	est Well			
309	(SP) 10YR 7/6 Yellowish brown fine sand, dry				South O Vapor Extraction								
310	(SP) TUYR 7/6 Yellowis	h brown slity fine sand	a, ary	rivers, etc. and attach a map. Use additional paper if necessary. Please be accurate and complete. O Other									
317 (ML) 10YR 5/8 Yellowish brown fine sandy, clayey				Water Level and Yield of Completed Well									
240.5	Silt $(20/30/50)$, moist	h harring for a smaller of	14	Depth to fi	rst water	405			(Fee	t below surface)			
319.5	(IVIL) TUYR 5/4 Yellowis	n brown fine sandy si	lit	Depth to S	tatic			_	_ `				
	(40/60), moist			Water Leve	el		_ (Feet)	Date I	Measu -	red			
Total Depth of Boring	535	Feet		Estimated Yield * (GPM) Test Type									
Total Depth of Comple	eted Well 521	Feet		*May not b		ontativo o	_ (Hours	s) rotar	Drawd m viel	d (Feet)			
	0.00	lana		iviay not b	e repres					u.			
Depth from Bore	hole _	angs Wall Ou	utside S	Screen S	Slot Size	Depth	from	Annuia	ar iviai	erial			
Surface Diam	eter Type Mate	Thickness Dia	ameter	Туре	if Any	Surfa	ice	Fill		Description			
Feet to Feet (Inch	nes)	(Inches) (In	nches)	((Inches)	⊢eet to	Feet						
						┣───┼							
Attachments Cortification Statement													
		I, the undersianed. ce	ertify that th	nis report is	complet	e and acc	urate to	the best	of mv	knowledge and belief			
Well Construct	ion Diagram	Name <u>Edwin Lin, T</u>	odd Engi	neers	r				,				
Geophysical Lo	og(s)	2490 Mariner Sa L	<u>Loop, Ste</u> .	, 215	Alan	<u>ned</u> a		C	<u>4</u> 9	4501			
Soil/Water Chemical Analyses					City State Zip								
U Other	Contractor Data Signed C.57 License Number												
Attach additional information, if it exists. Date Signed C-57 License Multiple													

* The free Adobe F	Reader may be used to view and complet	e this form. However, software mus	t be purchased to comp	plete, save, and reuse a save	ed form.					
File Original with	h DWR	State of Califo	rnia DWR Use Only – Do Not Fill In							
Page 7	of 10	Well Completio	n Report							
Owner's Well N	umber MW-1	Refer to Instruction P No. o0196321	mphlet State Well Number/Site Number							
Date Work Bega	an 12/16/2013 Date	Work Ended 12/20/2013								
Local Permit Ag	ency Monterey County Health D	epartment								
Permit Number	Permit Number 13-12301 Permit Date 10/29/2013 APN/TRS/Other									
	Geologic Log			Well Own	er					
Orientatio	n OVertical OHorizontal	OAngle Specify	Nama Monterev	Regional Water Pollu	tion Control Agency					
Drilling Method	Drilling Method Drilling Fluid									
Depth from S	Surface Des	scription	Mailing Address		\underline{g}					
Feet to Feet Describe material, grain size, color, etc City Monterey State CA Zip 93940										
323 (CL) 10YR 5/4 Yellowish brown silty clay Well Location										
	(10/90), moist		Address Eucalyptus Road (1,800' east of Gen. Jim Moore Blvd)							
325	(ML) 10YR 5/4 Yellowis	(County Monterey							
	dry		Latitude <u>36</u>	37 22 N Long	gitude <u>121 48 43 w</u>					
327	(ML) 10YR 5/4 Yellowis	h brown fine sandy, clayey	Deq.	Min. Sec.	Deg. Min. Sec.					
	silt (20/20/60), dry		Datum NAD83 Dec. Lat. 30.02209 Dec. Long. 121.8119							
329.5	(SP) 10YR 6/8 Brownish	n yellow fine sand, dry	APN BOOK <u>031</u>	Page <u>151</u>	Parcel					
337	(CL) 10YR 6/6 Yellowisl	h brown fine sandy, silty,	Township 155	Range IE	Section					
	clay, (20/20/60), moist		(Sketch must be draw	tion Sketch	Activity					
339	(ML) 10YR 6/6 Yellowis	h brown fine sandy, clayey,	North							
	silt (30/20/50), dry				O Deepen					
339.5	(ML) 10YR 6/6 Yellowis	h brown fine sandy, clayey,			O Other					
	silt (40/10/50), dry				Describe procedures and materials					
341	(SM) 10YR 5/8 Yellowis	h brown silty fine sand			under "GEOLOGIC LOG"					
	(30/70), dry				Planned Uses					
342	(SP) 10YR 5/8 Yellwois	h brown fine sand, dry								
347	(SP) 10YR 5/8 Yellowis	h brown fine to medium	est							
	coarse sand (70/30), dry	y l	>		Cathodic Protection					
349.5	(SP) 10YR 5/8 Yellowis	h brown fine to medium	× 0		O Dewatering					
	coarse sand (60/40), dr	y la			O Heat Exchange					
352	(SP) 10YR 5/8 Yellowis	h brown fine to medium			O Injection					
	coarse sand (70/30), dr	у	\sim		Monitoring					
353.5	(SP) 10YE 5/8 Yellowisl	h brown fine sand, dry								
354.5	(SP) 10YR 6/4 Light yel	lowish brown fine to			O Test Well					
	medium coarse sand (6	0/40), dry	South O Vapor Extraction							
357	(SW) 10YR 6/4 Light ye	Illustrate or describe distance of well from roads, buildings, fences, rivers, etc. and attach a map. Use additional paper if necessary.								
	coarse sand, dry		Viease be accurate and complete.							
359.5	(SW) 10YR 6/4 Light ye	llowish brown fine to	Depth to first wate	a field of completed	(Feet below surface)					
	coarse sand with silt (80	0/20), dry	Depth to Static	400						
		XV	Water Level	(Feet) Da	ite Measured					
Total Depth of	f Boring 535	Feet	Estimated Yield *	(GPM) Te	st Type					
Total Depth of	f Completed Well <u>521</u>	Feet	Test Length	(Hours) To	tal Drawdown(Feet)					
	0	1	May not be repre							
Depth from	Borehole	Wall Outside	Screen Slot Size	Ann Depth from	ular Material					
Surface	Diameter Type Mate	Thickness Diameter	Type if Any	Surface	Fill Description					
Feet to Feet	(Inches)	(Inches) (Inches)	(Inches)	Feet to Feet						
Attachments Certification Statement										
Geologic Log I, the undersigned, certify that this report is complete and accurate to the best of my knowledge and belief										
Well Construction Diagram Person, Firm or Corporation										
CA 94501										
□ Other Signed City State Zip										
Attach additional inf	Attach additional information, if it exists. C-57 Licensed Water Well Contractor Date Signed C-57 License Number									