# Appendix L

# Recharge Impacts Assessment Report for the Pure Water Monterey Groundwater Replenishment Project

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# Recharge Impacts Assessment Report

March 2015

Pure Water Monterey

Groundwater Replenishment Project

TODD GROUNDWATER

# RECHARGE IMPACTS ASSESSMENT REPORT

## PURE WATER MONTEREY GROUNDWATER REPLENISHMENT (GWR) PROJECT

March 2015

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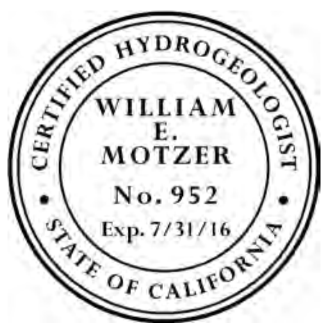


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## TABLE OF CONTENTS

## List of Tables



## List of Figures

## Appendices

# 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 newly-constructed 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.

## Table 1. Product Water Available for Injection

| Product Water Delivery Schedules for Seaside Basin Injection | | | Acre-Feet per Month (AF/month) | | | | | | | | | | | | Total | Add to | Available |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | 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) | | | | | | | | | | | | Maximum |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | 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 | 242 | 217 | 217 | 217 | 217 | 217 | 217 | 242 |
| Total | 2,417 | 2,422 | 2,417 | 2,417 | 2,417 | 2,417 | 2,173 | 2,168 | 2,173 | 2,168 | 2,168 | 2,173 | 2,422 |

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 northeastern-most 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) 2013[2] (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.

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[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.

**Table 2. Injection and Recovery Volumes, ASR Project**

| 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 |

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 units[3] 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 depressions[4] 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 re-development 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.

### Table 3. Estimated Subsurface Conditions in Proposed Project Area

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

*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 ohm-meters 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 ($ft^2$/day) to 1,524 $ft^2$/day, a K value of 20 ft/day and an S value of 0.12 (dimensionless), reflecting an effective porosity of 12 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 $ft^2$/day (Fugro, 1997; Padre, 2002). More recent aquifer tests in ASR-1 indicated a similar, but slightly higher, T value of 13,947 $ft^2$/day (Padre, 2002). The Watermaster model has a T value of about 24,000 $ft^2$/day in the 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 surface[6] 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 well. 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.

## Table 4. Aquifer Considerations for the Proposed Project Injection Well Facilities Site

| Issue | Paso Robles Aquifer | | Santa Margarita Aquifer | |
|---|---|---|---|---|
| | 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. |

#### 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.

**Table 5. Aquifer Allocation of Recharge Water in Model Scenarios**

| Model Scenario | Paso Robles Recharge | Santa Margarita Recharge |
|---|---|---|
| 1 | 100% | 0% |
| 2 | 0% | 100% |
| 3 | 20% | 80% |

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.
$ft^2$/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.

## Table 7. Proposed Project Wells

| GWR PROJECT WELLS | GSE[1] | Groundwater Elevation[2] | Depth to Water | Paso Robles[3] | | Santa Margarita | | Well Depth |
|---|---|---|---|---|---|---|---|---|
| | | | | Depth to Top | Depth to Base | Depth to Top | Depth to Base | |
| | 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 Wells (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 |

[1]Ground 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.
[2]Groundwater elevation and depth to water represents the water table for the VZWs and the Santa Margarita potentiometric surface for DIWs.
[3]Aquifer 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 permitting[7]) 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

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[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 model-based 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.

**Table 8. Summary of Design Criteria For Proposed Project Injection Wells**

| 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) |

## 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 30-inch 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 small-diameter 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.

**Table 9. Summary of Design Criteria for Proposed Vadose Zone Wells**

| 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 |

## 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. Accordingly, the deep injection wells would be designed for an 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 long-term 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 Aquifer (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 ($yds^3$) 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).

1. 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.

# 7. GROUNDWATER IMPACTS ASSESSMENT

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.

### Table 10. Simulated Fastest Travel Times between Injection and Extraction Wells, in days

| Extraction Well | Well of Origin of Particles with Fastest Travel Time (Days) | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| | 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 | - | - |

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, simulated water levels are lower on a seasonal basis under the *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 associated with the Proposed Project during drought conditions for both of these wells (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 pre-project 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 facility[8]. 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 | | |
|---|---|---|---|
| | MPWMD | Cal-Am | MRWPCA |
| *# Wells* | 14 | 8 | 6 |
| *Time Period* | 1990-2012 | 2010 - 2013 | 2014 |
| **Anions** | x | x | x |
| **Metals (including major cations)** | x | x | x |
| **Conventional Chemistry Parameters** | x | x | x |
| **Chlorinated Pesticides and PCBs** | x | x | x |
| **Nitrogen and Phosphorus Pesticides** | x | x | x |
| **Organic Analytes** | x | x | x |
| **Chlorinated Acids** | x | x | x |
| **Carbamates** | | x | x |
| **Volatile Organic Compounds (VOCs)** | x | x | x |
| **Semivolatile Organic Compounds** | | x | x |
| **Haloacetic Acids** | | x | x |
| **Herbicides** | | x | x |
| **Nitroaromatics and Nitramines (Explosives)** | | | x |
| **Other (e.g., isotopes)** | | | x |

*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.

### Table 12. Wells Sampled in 2013-2014 Proposed Project Field Program

| 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 |

*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 ($CaCO_3$) concentrations were recalculated to bicarbonate ($HCO_3^-$) using a conversion factor from Hounslow (1995). To validate the general mineral data, a cation-anion balance error analysis was conducted using the groundwater data.

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:

$$\textbf{Balance} = (\sum \text{cations} - \sum \text{anions}) / (\sum \text{cations} + \sum \text{anions}) * 100$$

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.

**Table 13. Charge and Cation-Anion Balance for Groundwater Data Accuracy**

| Well Designation | Aquifer Screened | Total Cation/Anion Ratio | 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 |

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 ($HCO_3$). 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 ($CO_3$)+$HCO_3$, 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 bicarbonate-carbonate-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 $SO_4$. 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/parameters. In addition to regulated constituents and former Fort Ord constituents, the six groundwater samples were also analyzed for CECs as defined in the SWRCB Recycled Water Policy and other constituents not previously monitored routinely in local groundwater.

#### 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.

### Table 14. Constituents Exceeding California Primary MCLs

| 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 |

*5 NTU is a secondary MCL; turbidity is included on the table for comparison purposes only.

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 |
|---|---|---|---|---|---|---|
| | | µg/L | | | | |
| **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**** | | | | | | |
| Beryllium (Be) | ASR-2 | 0.050 | 0.7 | 4.0 | | |
| | FO-7 Shallow | 0.020 | 0.68 | | | high turbidity |
| | MRWPCA MW-1 | 0.020 | 0.044 | | | turbid |
| Lead (Pb) | ASR-1 | 0.020 | 0.78 | 15.0 | | |
| | ASR-2 | 0.010 | 3.0 | | | |
| | FO-7 Shallow | 0.020 | **42.0** | | | high turbidity |
| | FO-7 Deep | 0.080 | 1.3 | | | slightly turbid |
| | PRTIW: Mission Memorial | 0.020 | 0.061 | | | |
| | 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.

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, 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-*β*-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 (performance-based indicator)
- Sucralose – food additive (performance-based indicator)

None of the CECs currently have either primary MCLs for drinking water. For NDMA, the current NL is 0.01 μg/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 | |
| Caffeine | FO-7 Deep | 0.001 | 0.0027 | |
| | MRWPCA MW-1 | | 0.0068 | |
| DEET (n,n-diethyl-m-toluamide) | FO-7 Deep | 0.001 | 0.0023 | |
| | MRWPCA MW-1 | | 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 (µg/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 µg/L (below the NL); caffeine was detected in FO-7 Deep and MRWPCA MW-1 at 0.0027 and 0.0068 µg/L, respectively (below the Drinking Water Equivalent Level [DWEL] of 0.35 µg/L per Anderson et al., 2010).[11] DEET was detected in FO-7 Deep and MRWPCA MW-1 at 0.0023 and 0.0060 µg/L, respectively (below the DWEL of 81 µg/L per Intertox, 2009). Estradiol (17-β), triclosan, and sucralose were not detected above reporting limits in groundwater collected from any of the six wells.

These data represent the first time that CECs have been analyzed in the Seaside Basin and serve as initial background data. The data will be confirmed through future groundwater sampling events that will 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 (www.envirostor.dtsc.ca.gov) and the SWRCB *Geotracker* web site (http://geotracker.waterboards.ca.gov). The goal of the search was to identify any potential industrial sites or activities that could contribute to groundwater contamination from previous site uses, spills, and/or chemical releases 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 14$^{th}$ 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 ($CaCl_2$) and sodium hydroxide (NaOH) to increase alkalinity. Then, $CO_2$ 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.

## Table 17. Stabilized Pilot Water Analysis

| 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 ($HCO_3^-$)** | 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-Cl 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) @22.3 °C** | SM 2580B | mV | 10.0 | **629.0** | --- | --- |
| **pH @ 25 °C** | SM 4500H+B | pH units | 0.05 | **7.45** | --- | Normal Range |
| Specific conductivity (EC) @ 25 °C | SM 2510B | µmohs/cm or µS/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):*** | | | | | | |
| Antimony (Sb) | EPA 200.8 | µg/L | 0.50 | ND | 6[c] | --- |
| Arsenic (As) | EPA 200.8 | µg/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[c] | 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 | 1,000[a] | 200 |
| Iron (Fe) | EPA 200.8 | µg/L | 20.0 | ND | 300[a] | 5,000 |
| Lead (Pb) | EPA 200.8 | µg/L | 0.50 | ND | 15[c] | 5,000 |
| Magnesium (Mg) | EPA 200.8 | µg/L | 20.0 | ND | --- | --- |
| Manganese (Mn) | EPA 200.8 | µg/L | 20.0 | ND | 50[a] | 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 | 100[a] | --- |
| **Sodium (Na)** | EPA 200.8 | µg/L | 1,000 | **18,000** | --- | <69,000 |
| Thallium (Tl) | 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** | 5,000[a] | |

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 ($SO_4$) analysis proved by Trussell Technologies.

µg/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 µg/L for arsenic and approximately 0.7 µg/L for lead. Concentrations in the zone of saturation meet water quality standards. None of the analyses indicated that groundwater concentrations would exceed regulatory standards for any of the leached constituents.

Additional geochemical analyses indicated that aquifer clogging from calcite precipitation 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 Anti-degradation 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 pumping increases. A more complete analysis of water level impacts associated with the 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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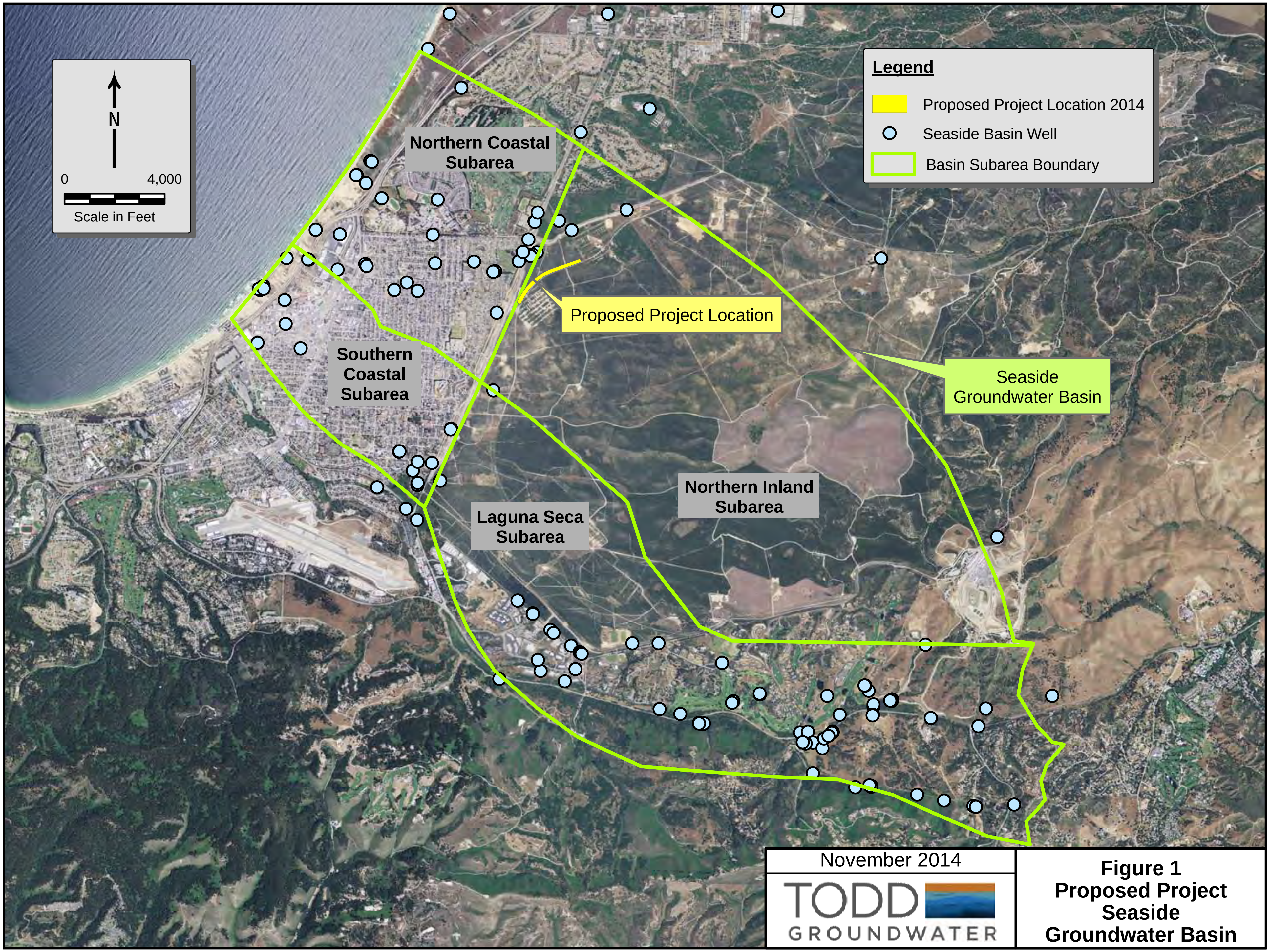
# FIGURES



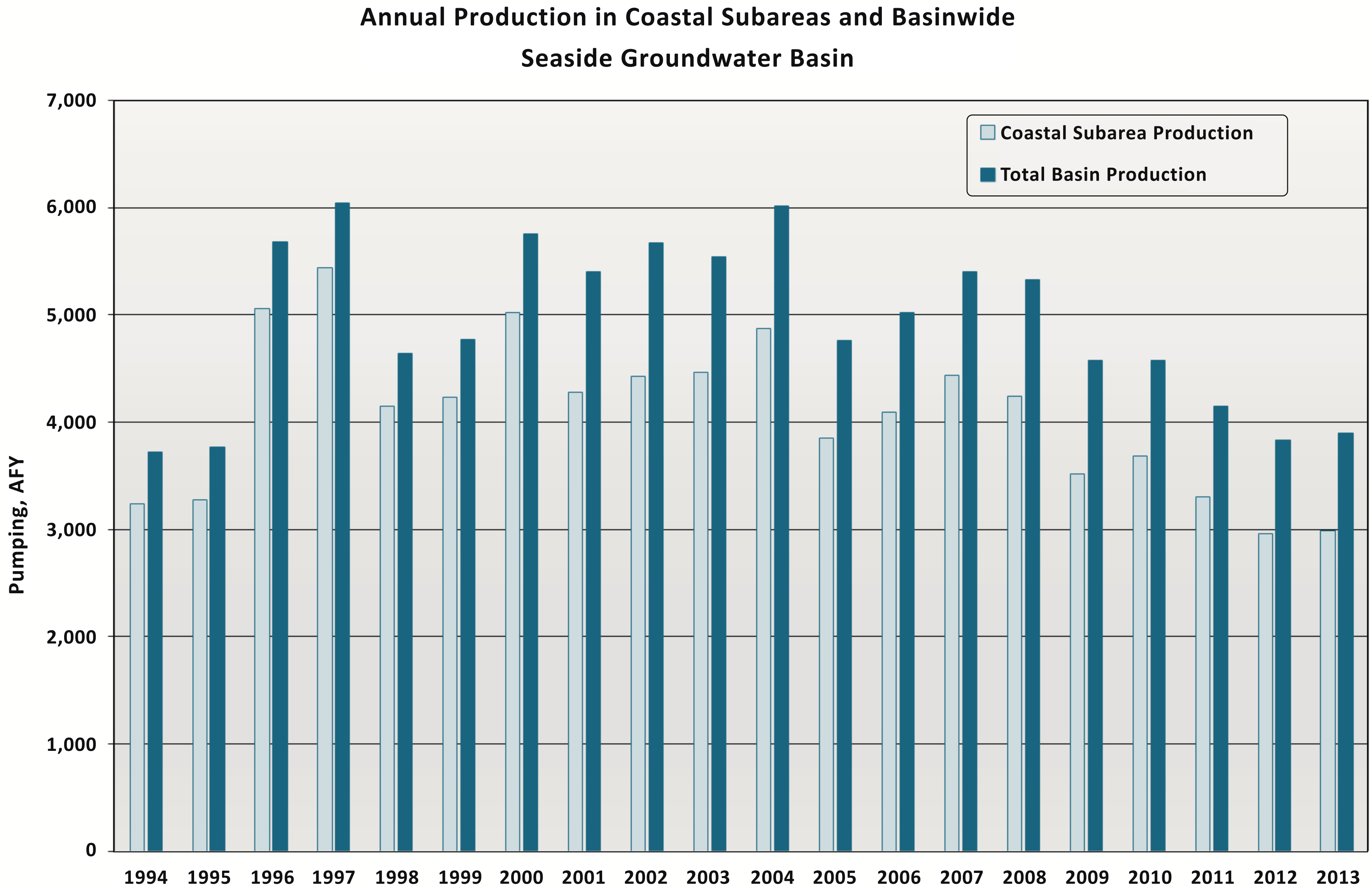

November 2014

TODD GROUNDWATER

**Figure 1**
**Proposed Project**
**Seaside Groundwater Basin**


August 2014

**Figure 2**
**Proposed GWR**
**Project Location Map**

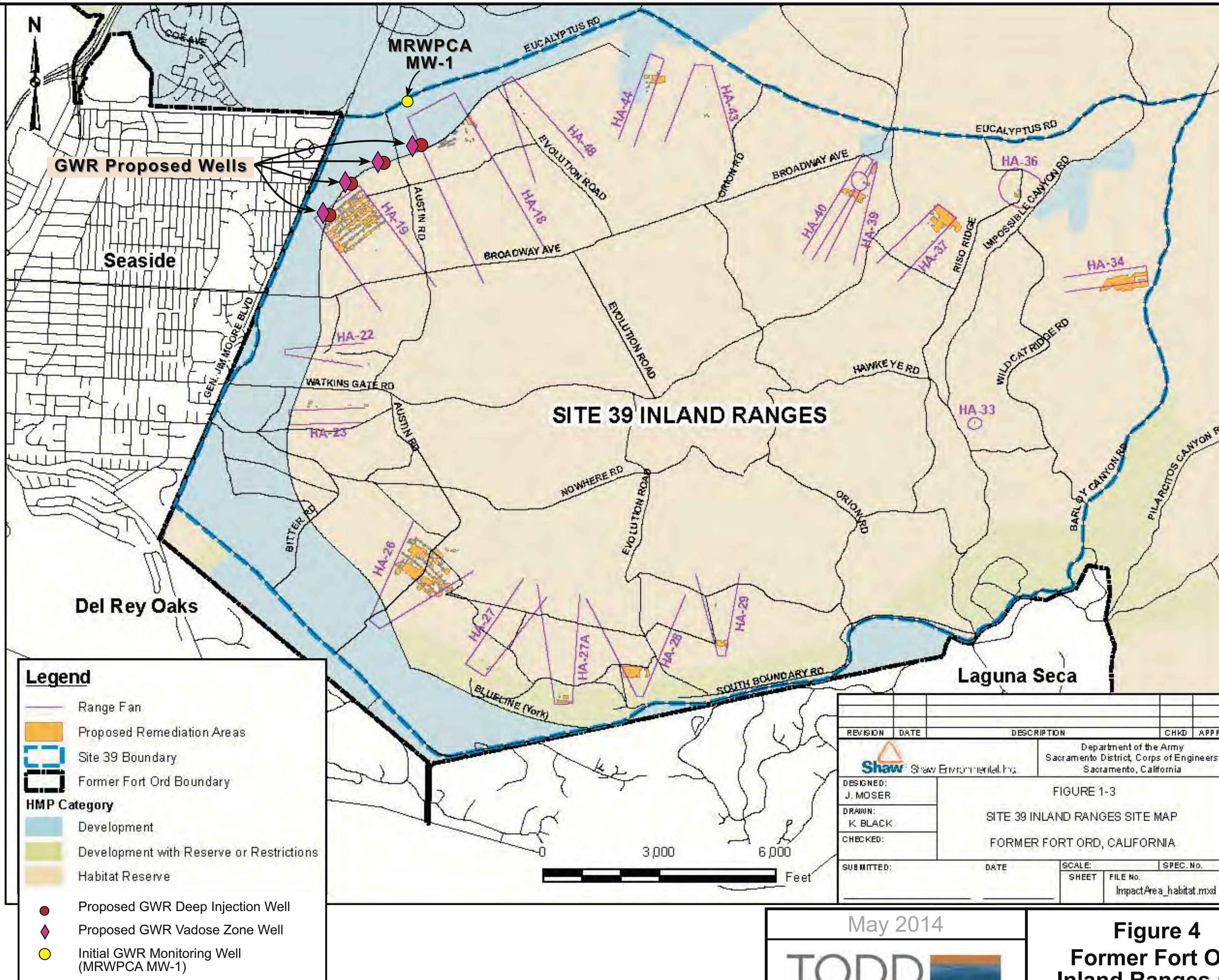



**Notes:** 1994 - 2001 data by Reporting Period (July 1- June 30). 2001 - 2013 data by Water Year (October 1 - September 30).
Pumping data do not include ASR injection or recovery amounts.

May 2014

TODD GROUNDWATER

**Figure 3**
**Coastal and Basin-wide Groundwater Production**




Modified from: Shaw Environmental, 2009.

May 2014

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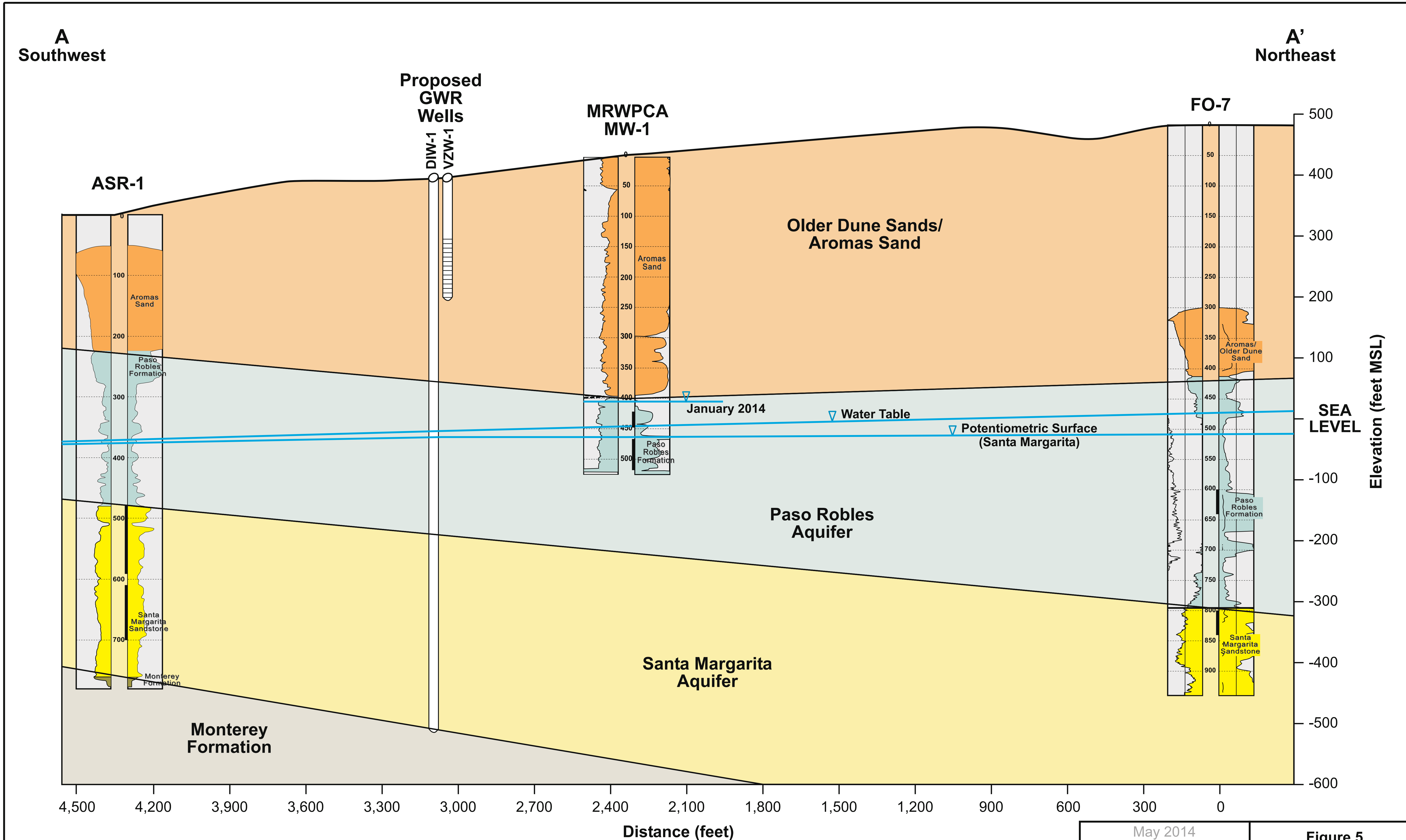
**Figure 4**
**Former Fort Ord Inland Ranges and Proposed Project Wells**



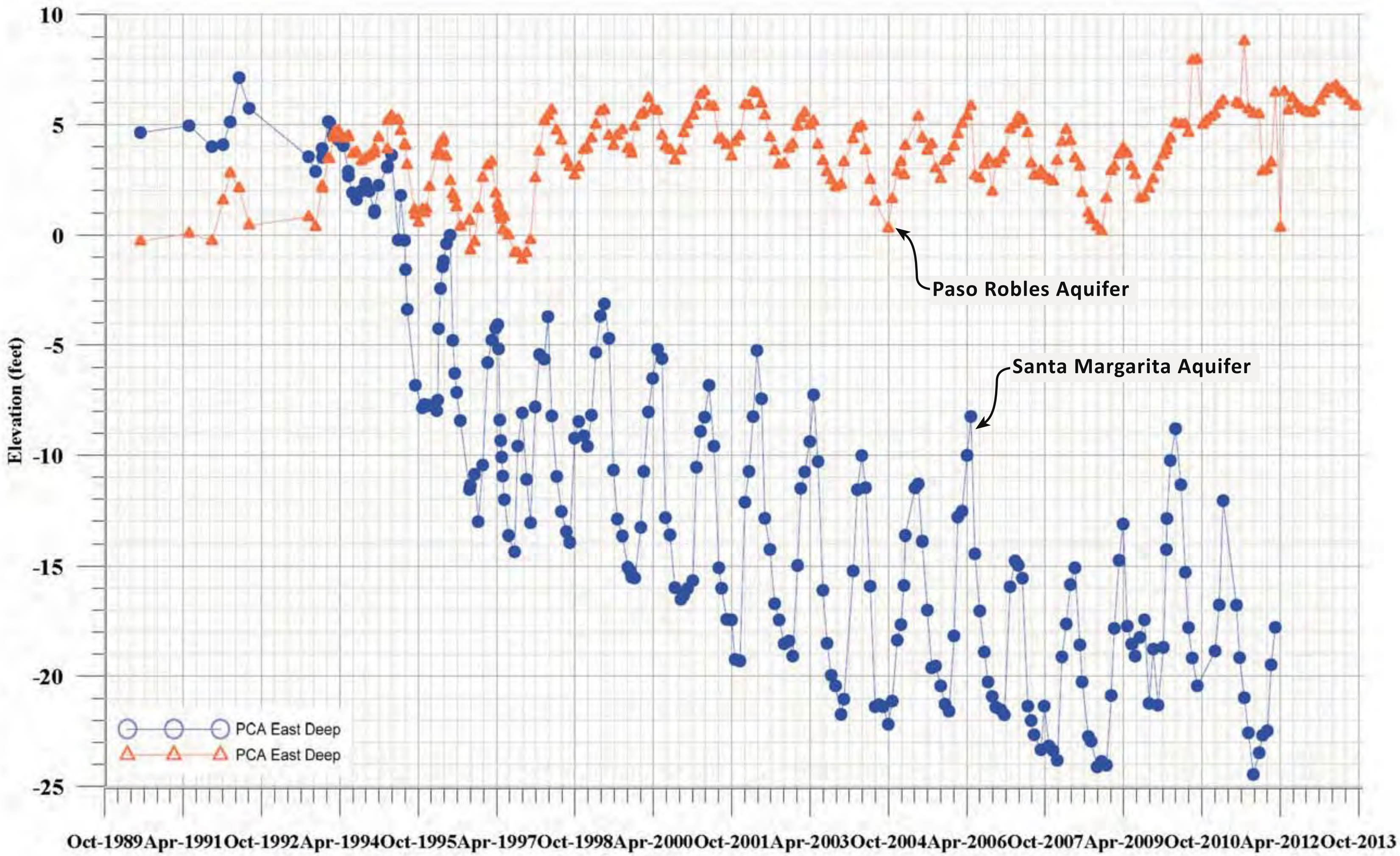

Vertical Exaggeration 2.4x

Water levels from July/August 2013 contour maps in HydroMetrics, December 2013.
Water table in MRWPCA MW-1 measured by Todd Groundwater, January 2014.

May 2014

TODD GROUNDWATER

**Figure 5**
**Cross Section A - A' across Proposed Project Site**




MONTEREY PENINSULA WATER MANAGEMENT DISTRICT

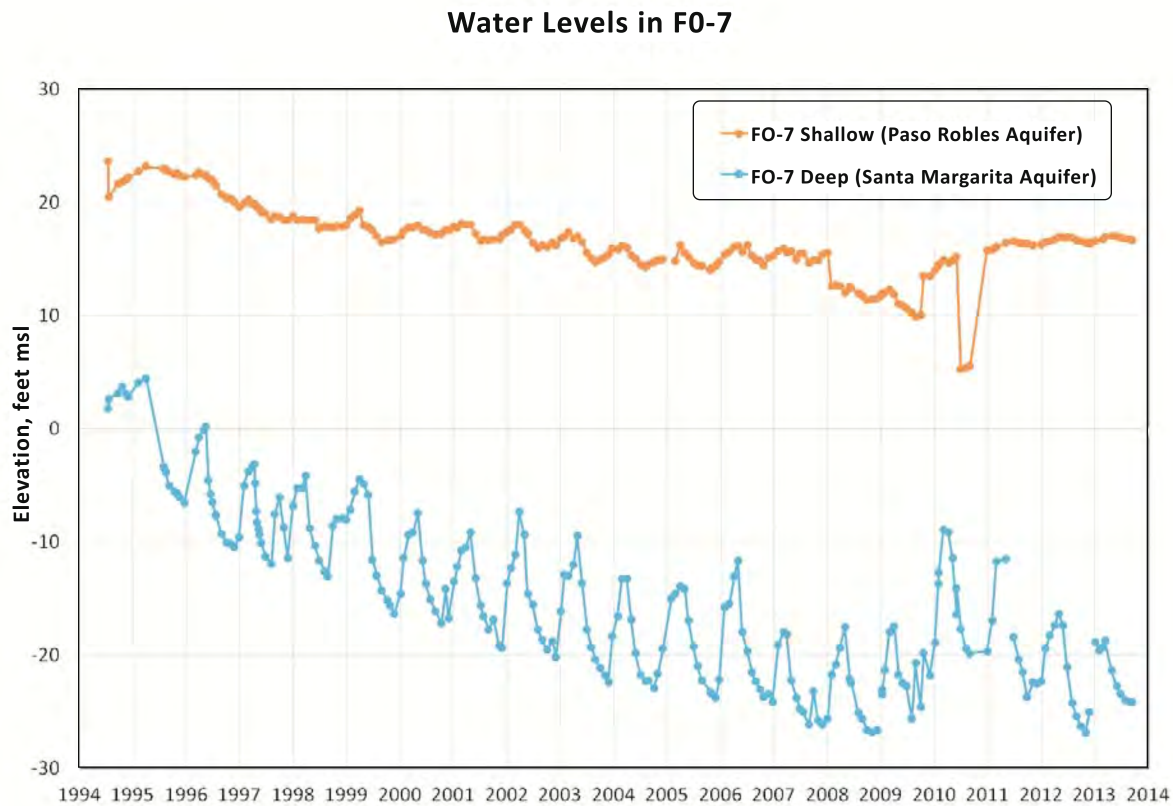
**PCA East (Deep) (15S/1E-15K4)**
Screened from 650-700 (Tsm)
Wellhead Elevation 68.54 MSL
DWR Driller Log No. 338402
Datasource: MPWMD

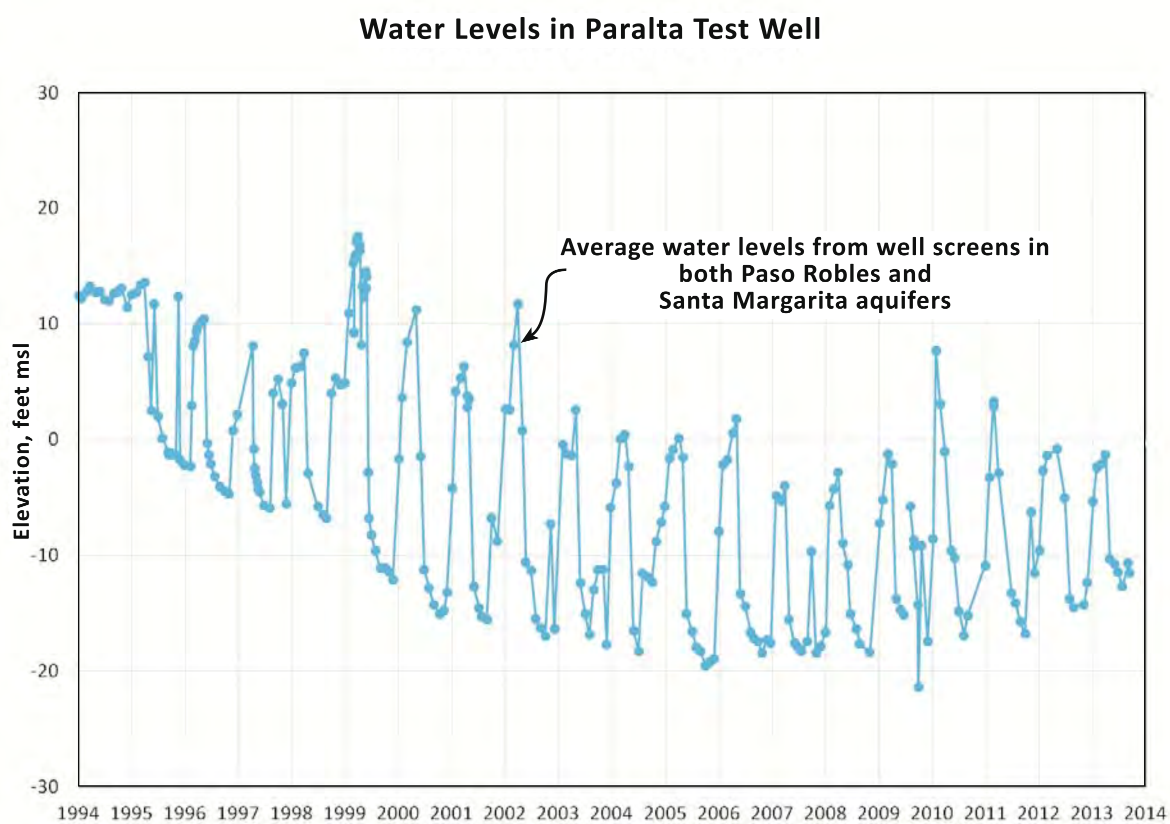
**PCA East (Shallow) (15S/1E-15K5)**
Screened from 350-400 (QTp)
Wellhead Elevation 68.51 MSL
DWR Driller Log No. 338402
Datasource: MPWMD

May 2014

TODD GROUNDWATER

**Figure 6**
**Long-term Hydrograph**
**Coastal Subareas**




May 2014

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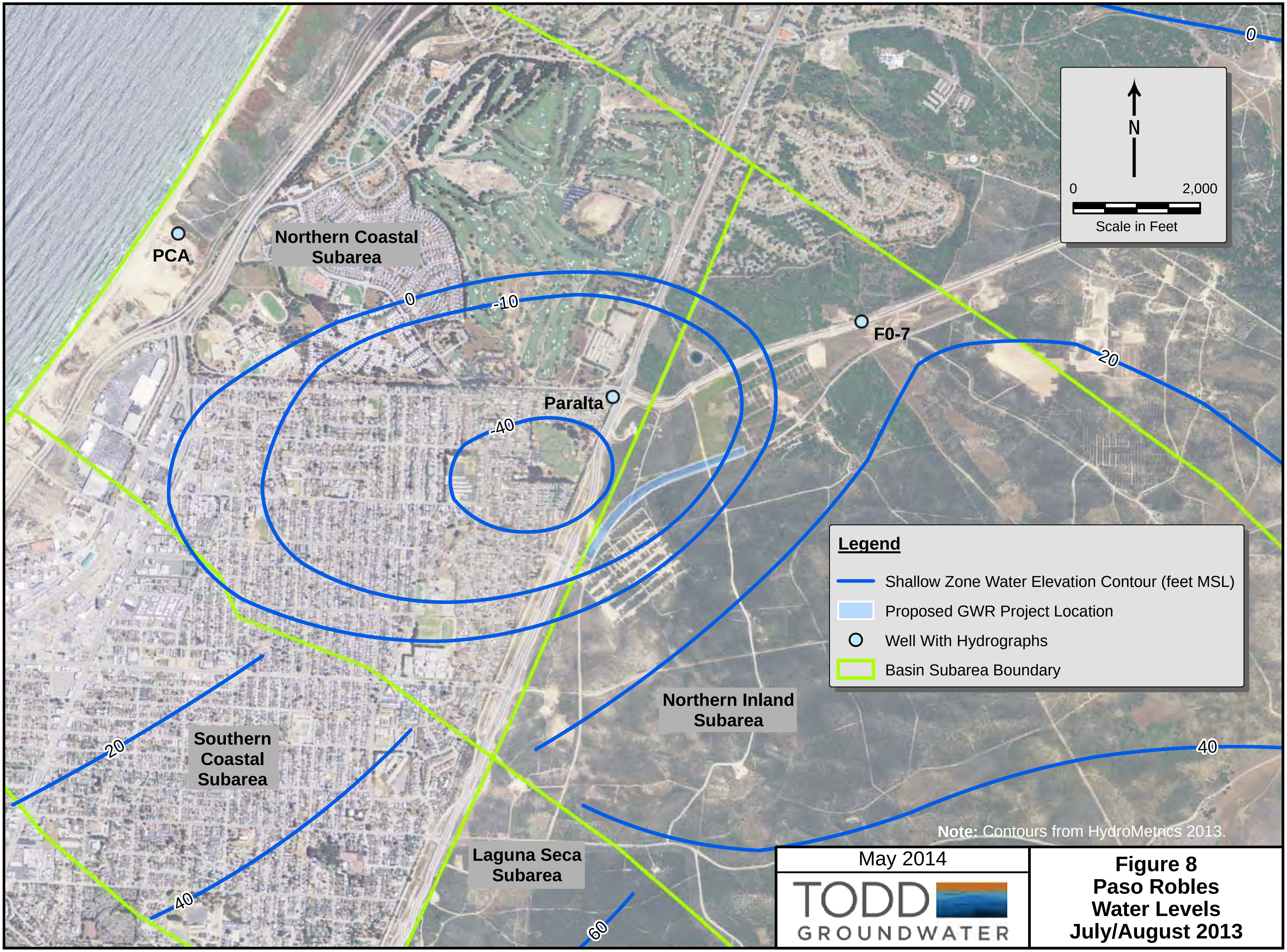
**Figure 7**
**Hydrographs near Proposed Project Area**




May 2014

TODD GROUNDWATER

**Figure 8**
**Paso Robles Water Levels July/August 2013**

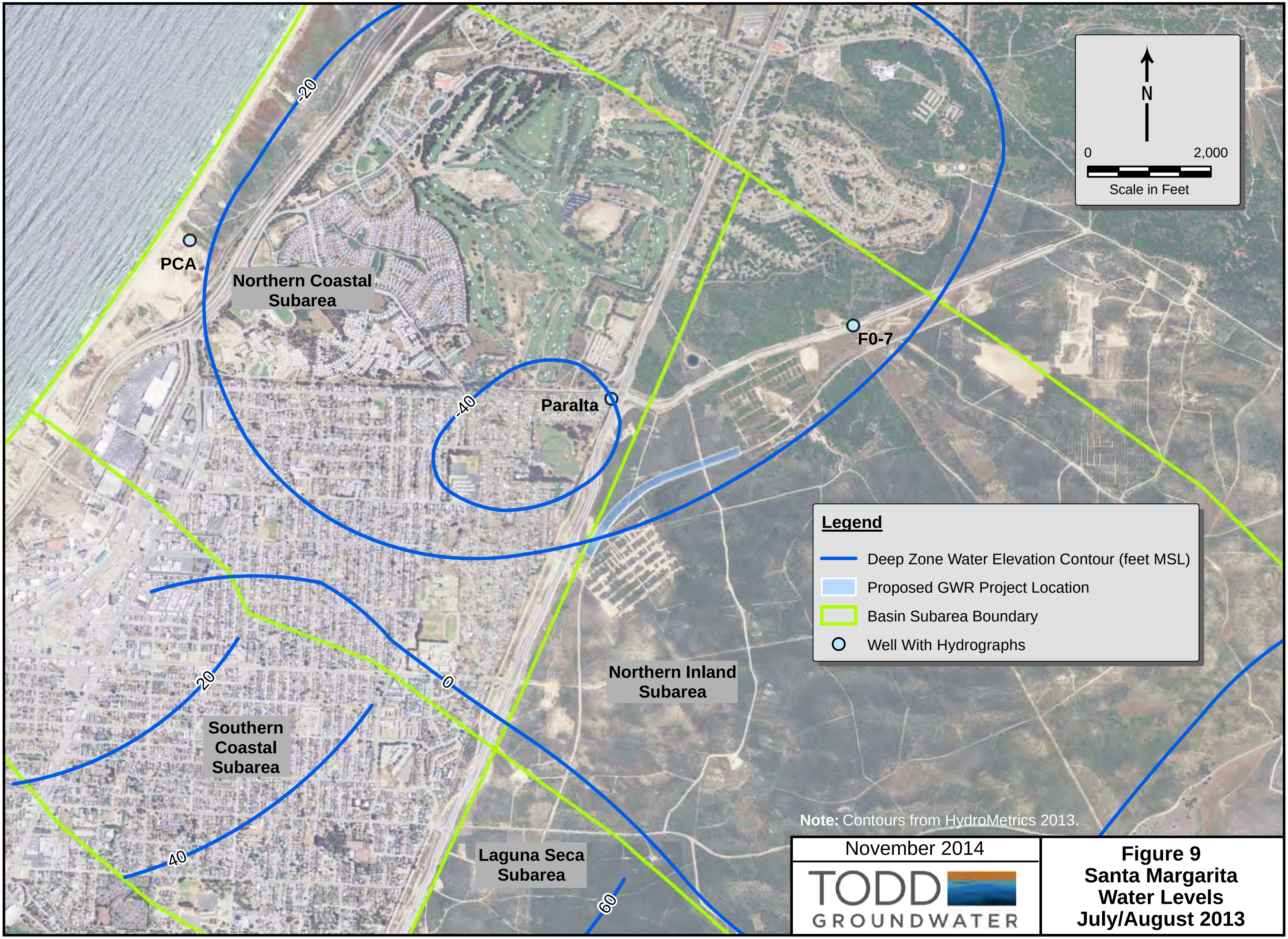
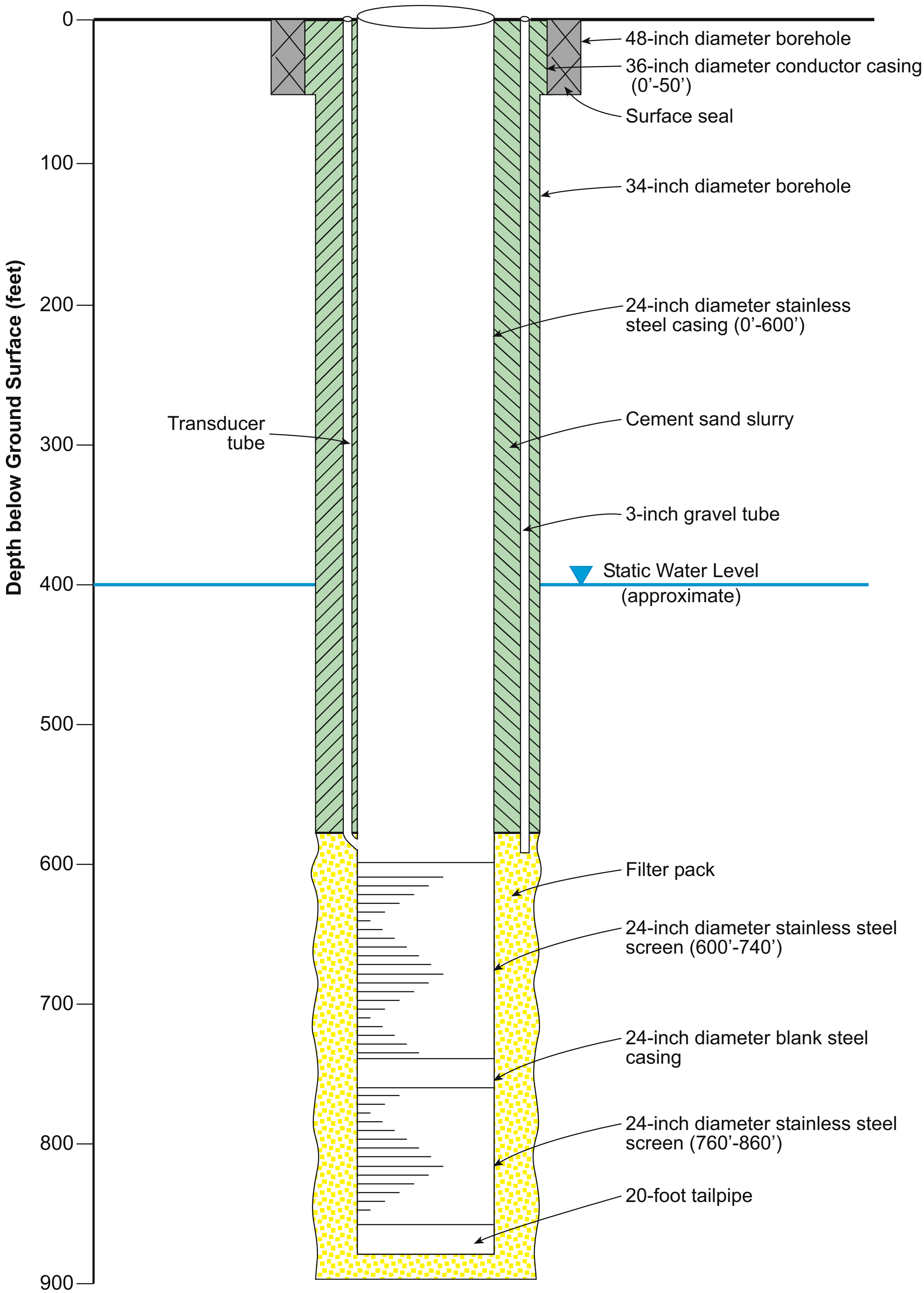



Figure 9
Santa Margarita
Water Levels
July/August 2013


August 2014

TODD GROUNDWATER

**Figure 10**
**Proposed**
**Project Components**

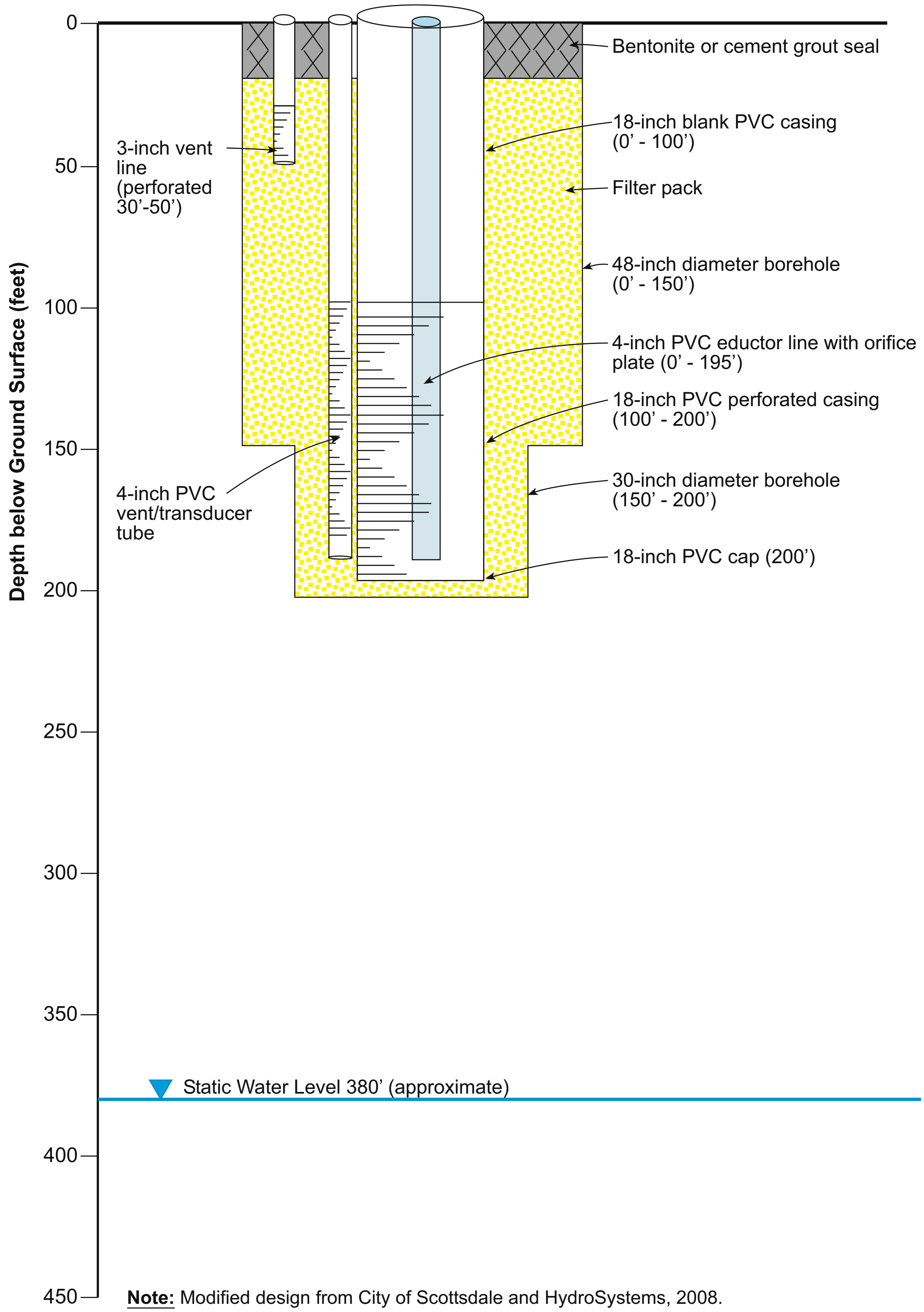



**Note:** Some design components incorporated from Pueblo Water Resources, 2002.

August 2014

TODD GROUNDWATER

**Figure 11**
**Proposed Deep Injection Well Construction Diagram**
**GWR Project**

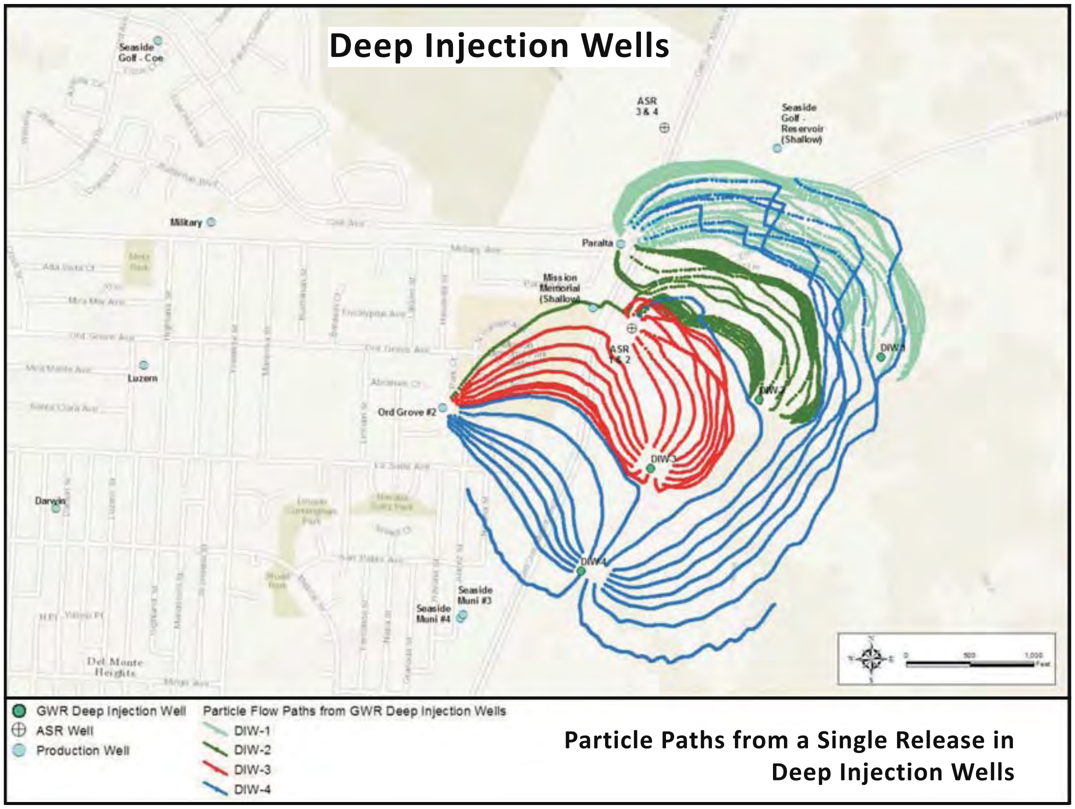



**Note:** Modified design from City of Scottsdale and HydroSystems, 2008.

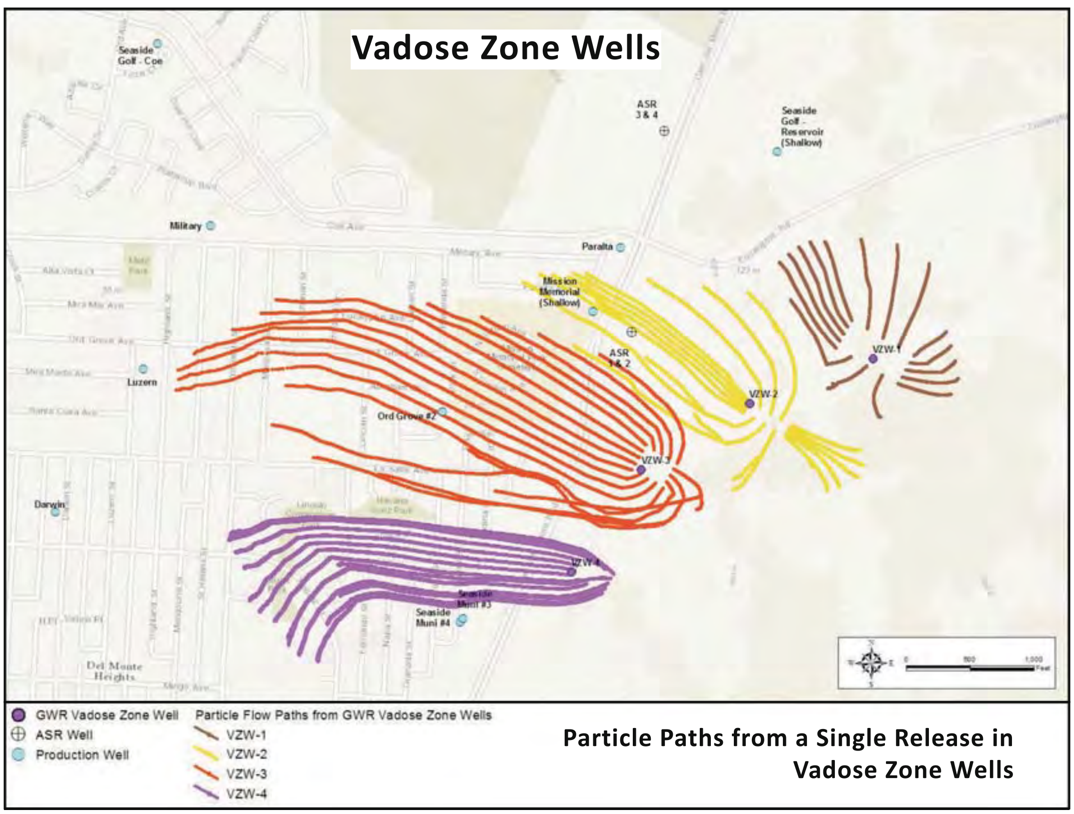
November 2014

TODD GROUNDWATER

**Figure 12**
**Proposed Vadose Zone Well Construction Diagram GWR Project**




Particle Paths from a Single Release in Deep Injection Wells



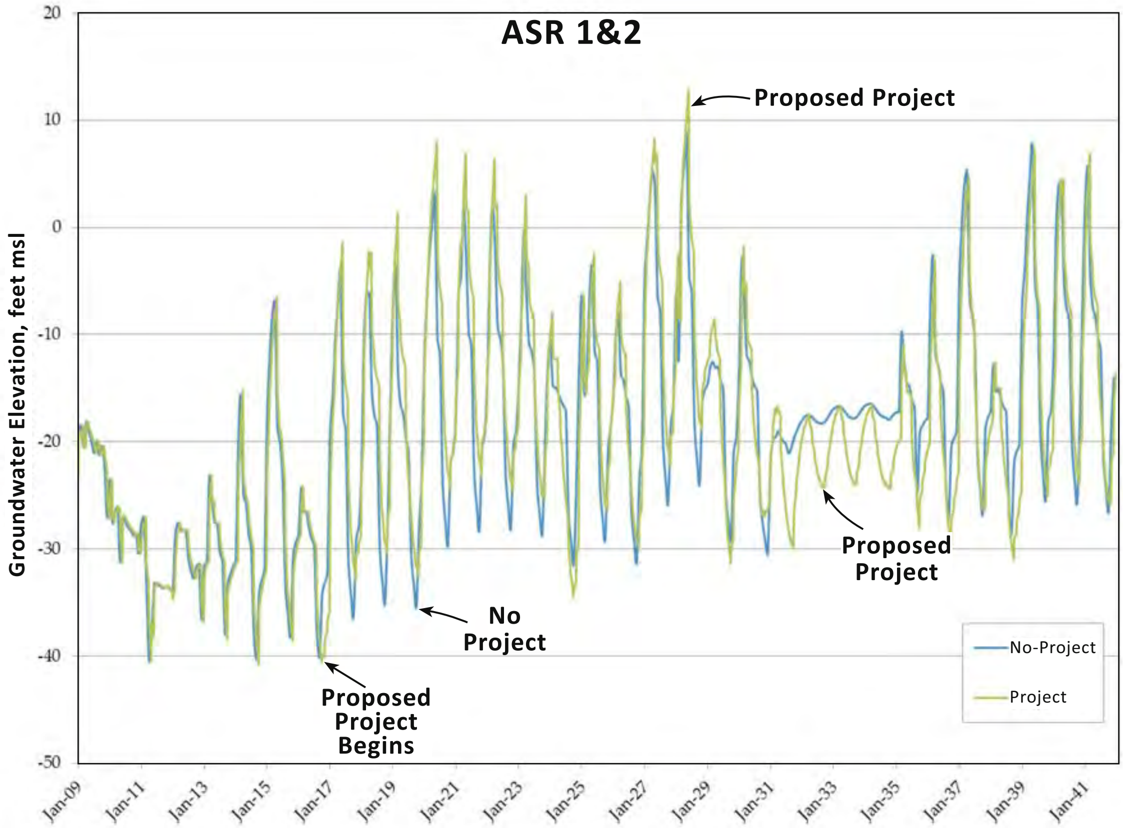

Particle Paths from a Single Release in Vadose Zone Wells

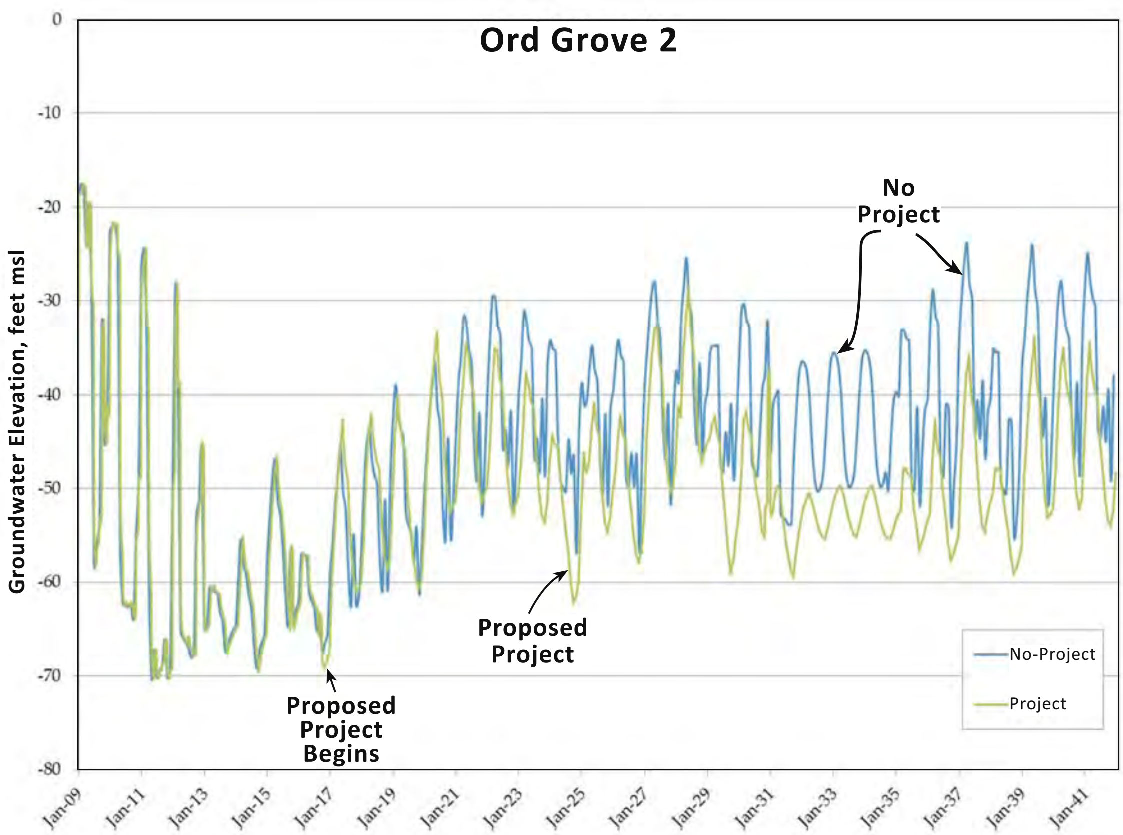
Source: Hydrometrics, November 2014 (See Technical Memorandum in Appendix C)

November 2014

TODD GROUNDWATER

**Figure 13**
**Modeled Flowpaths Proposed Project**



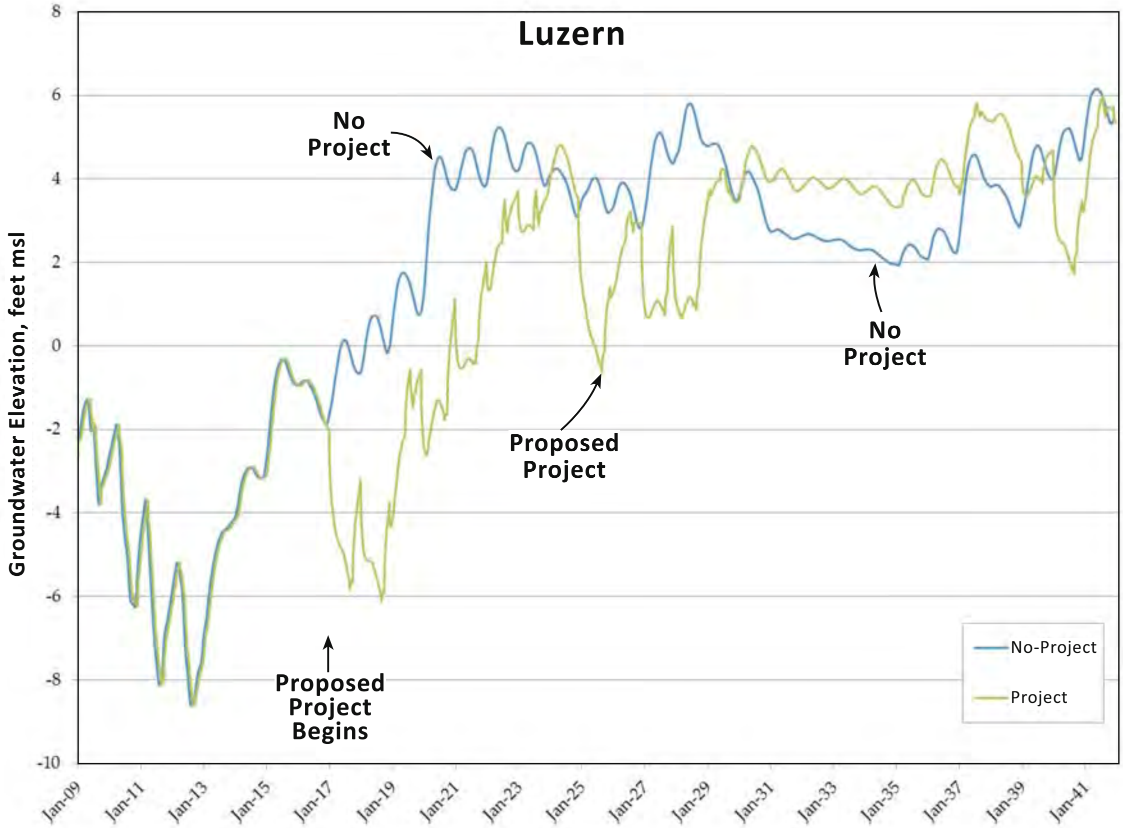



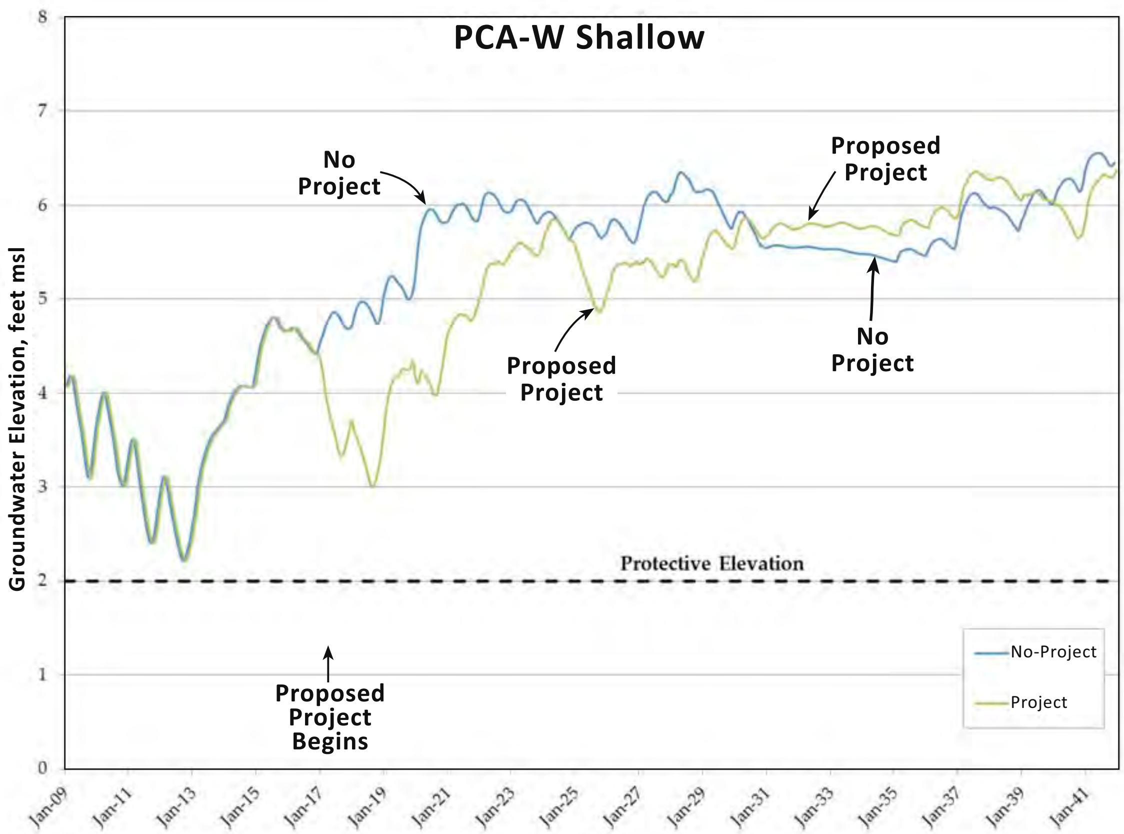

Source: Hydrometrics, November 2014 in Appendix C

November 2014

TODD GROUNDWATER

**Figure 14**
**Proposed Project Impacts to Deep Water Levels**




Source: Hydrometrics, November 2014 in Appendix C

November 2014

TODD GROUNDWATER

**Figure 15**
**Proposed Project Impacts to Shallow Water Levels**

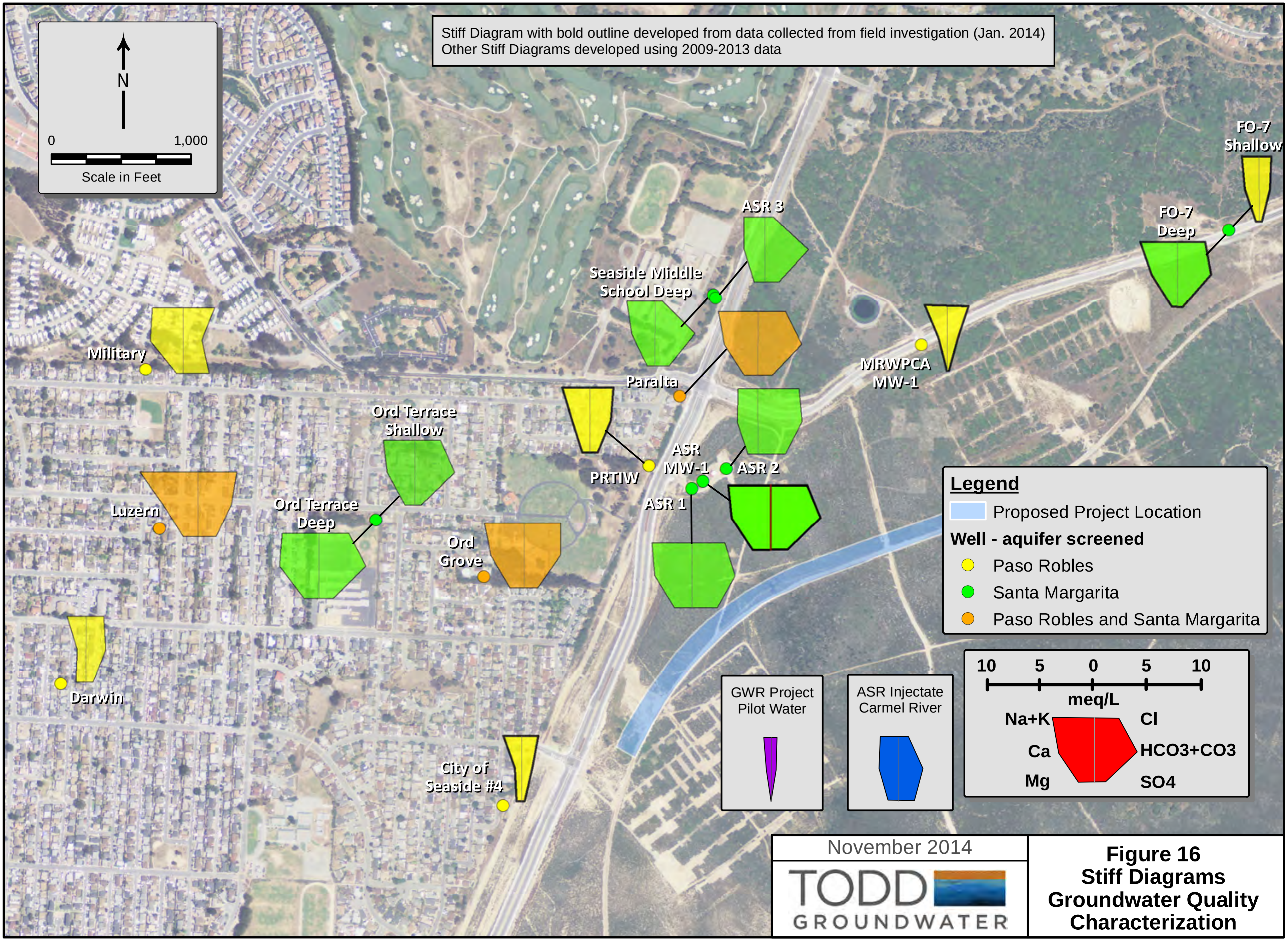
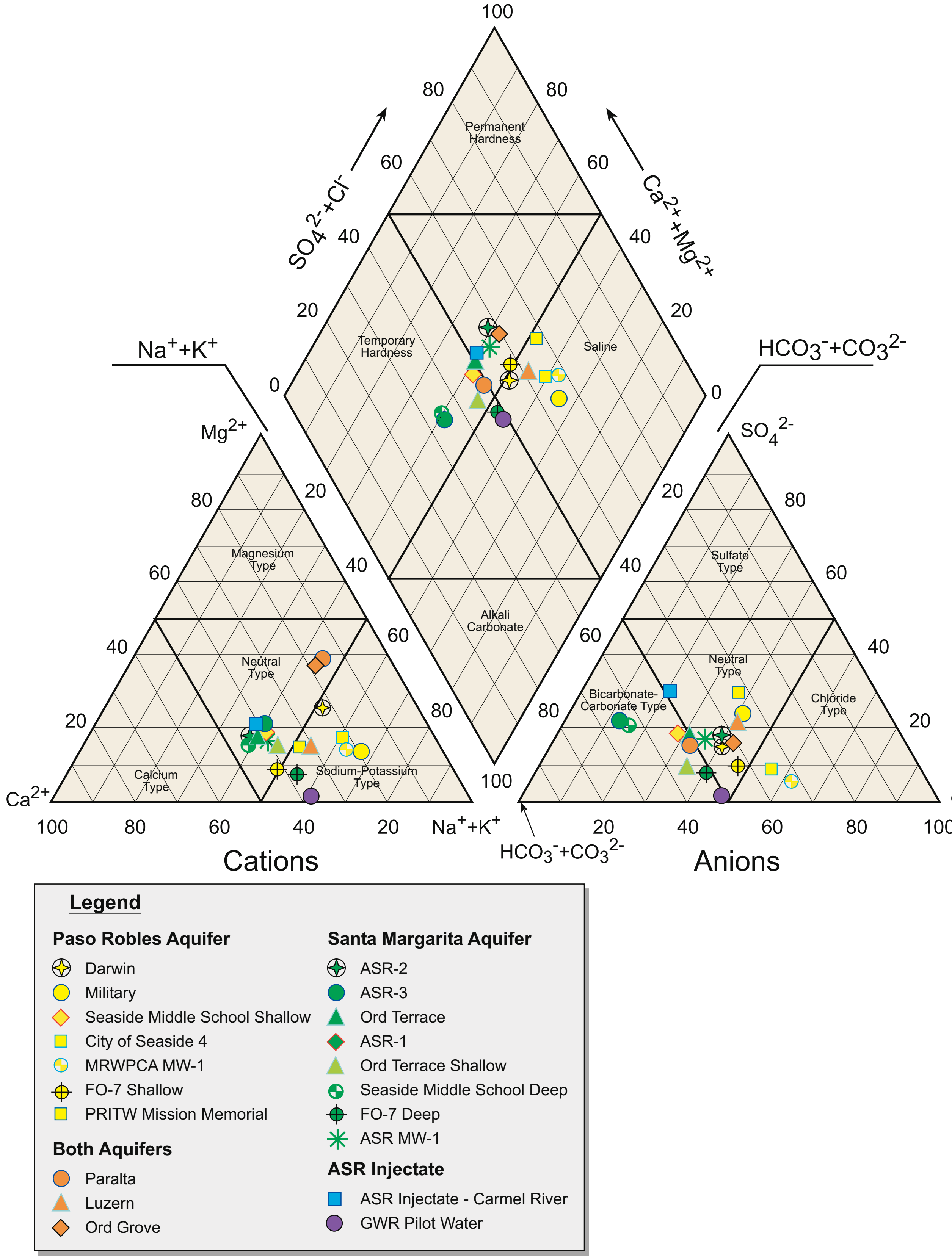



**Figure 16**
**Stiff Diagrams**
**Groundwater Quality Characterization**




May 2014

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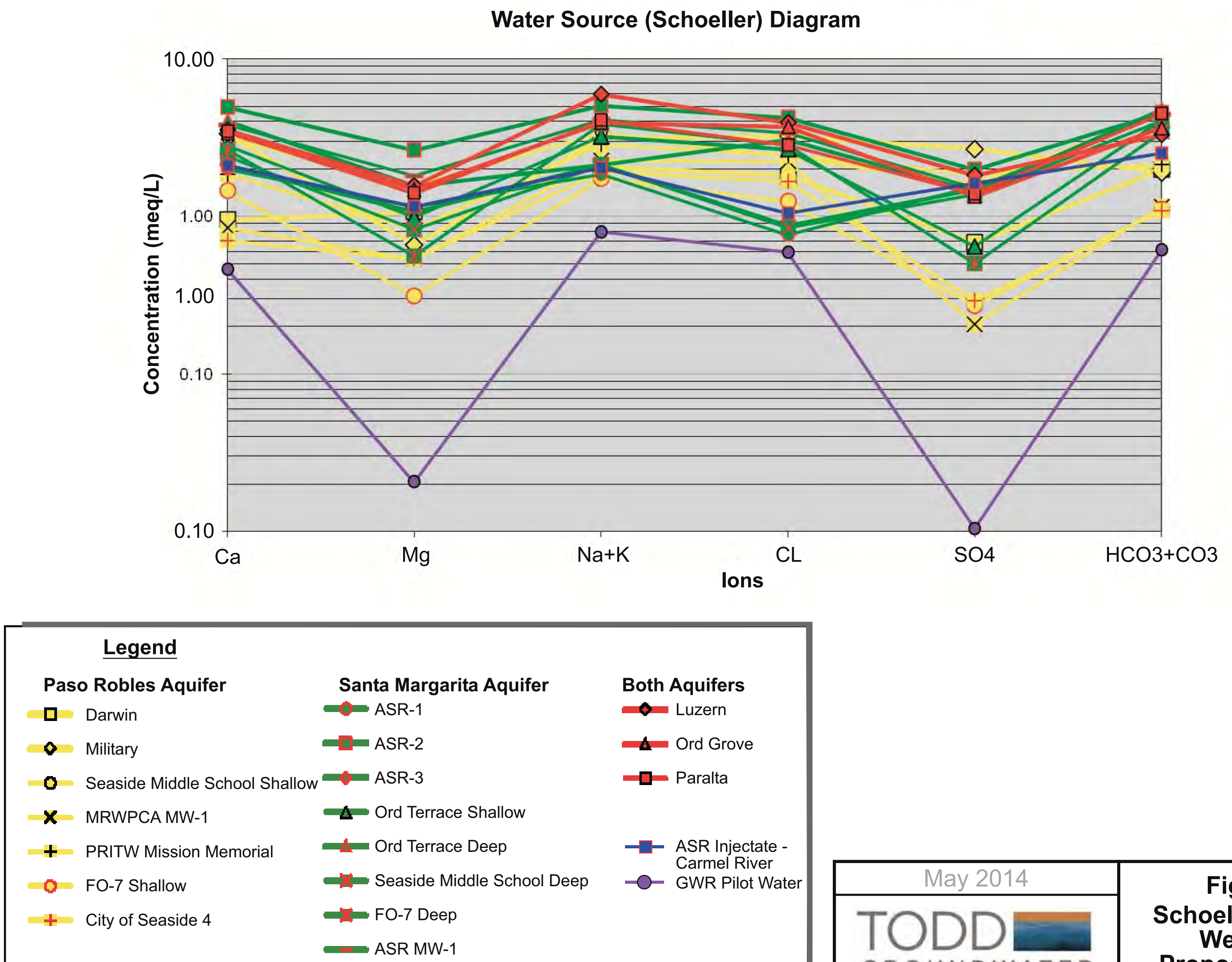
**Figure 17**
**Trilinear Diagram**
**Groundwater Chemistry**
**near Proposed Project**




May 2014

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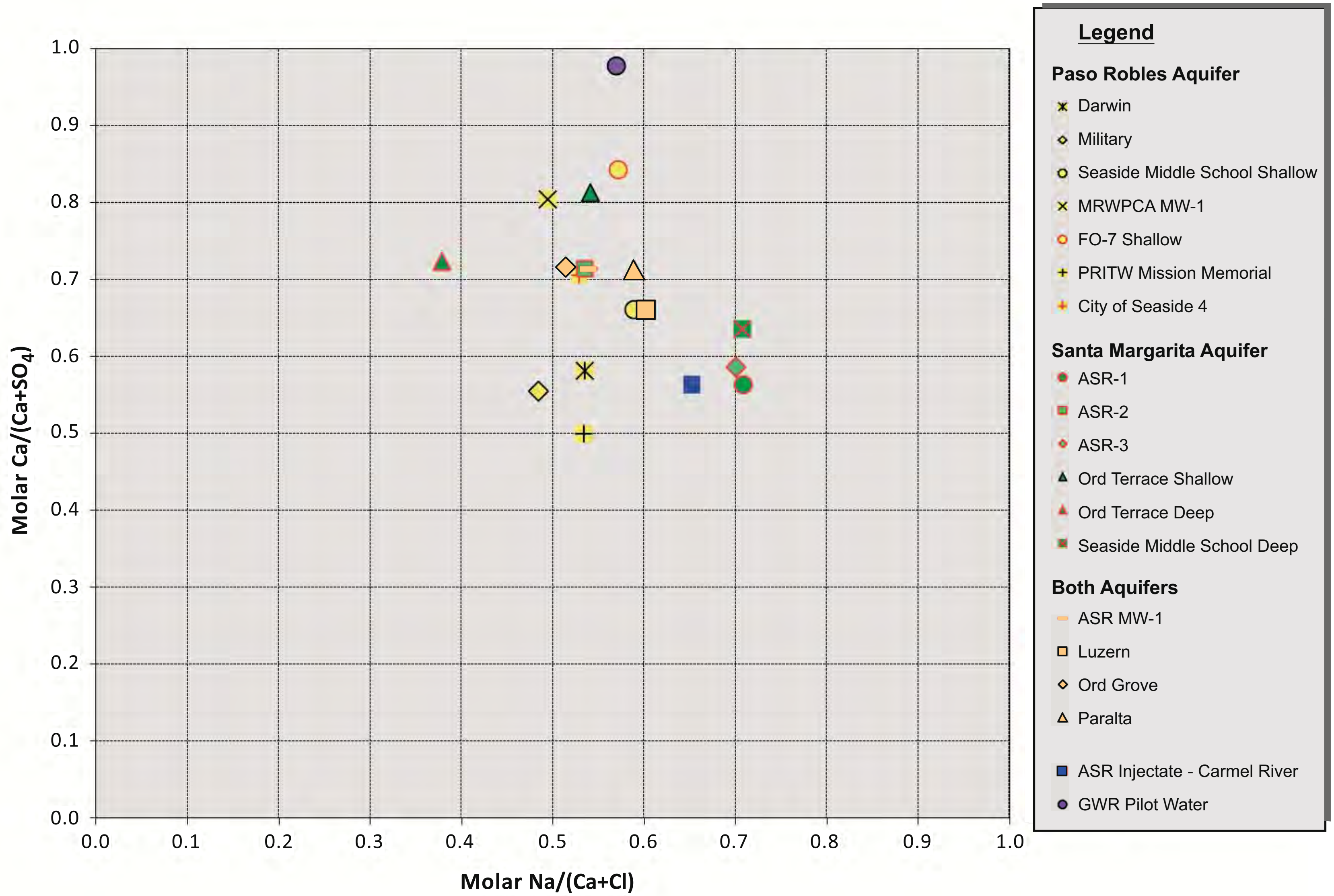
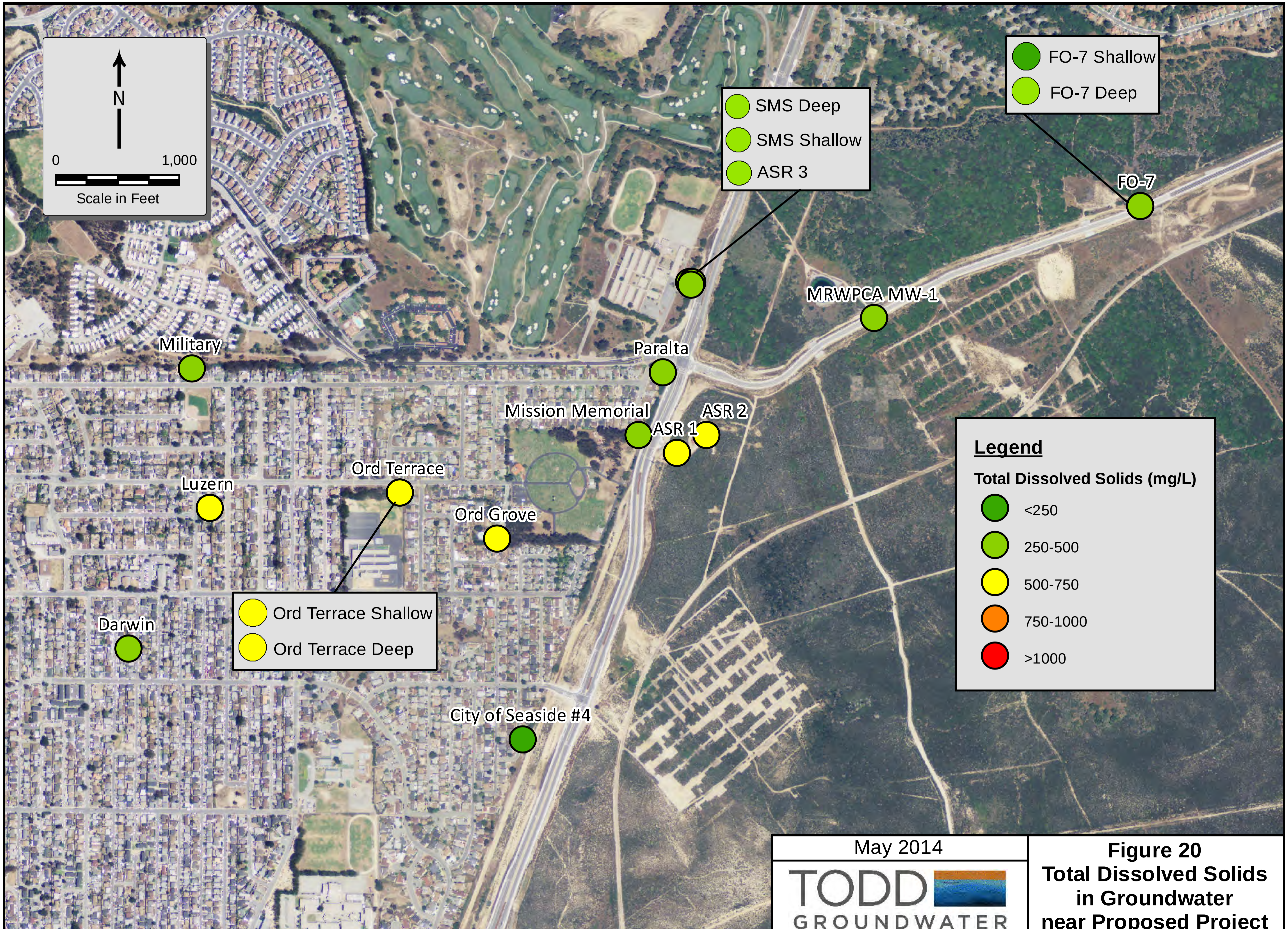
**Figure 18**
**Schoeller Diagram**
**Wells near**
**Proposed Project**




November 2014

TODD GROUNDWATER

**Figure 19**
**Brine Differentiation Plot Wells near Proposed Project**




May 2014

TODD GROUNDWATER

**Figure 20**
**Total Dissolved Solids in Groundwater near Proposed Project**

# APPENDIX A

## Todd Groundwater Technical Memorandum Selection of Recharge Location for GWR Project, Seaside Groundwater Basin, May 29, 2014

TODD GROUNDWATER

May 29, 2014

## TECHNICAL MEMORANDUM

**To:** 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 Locations[1]" 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.

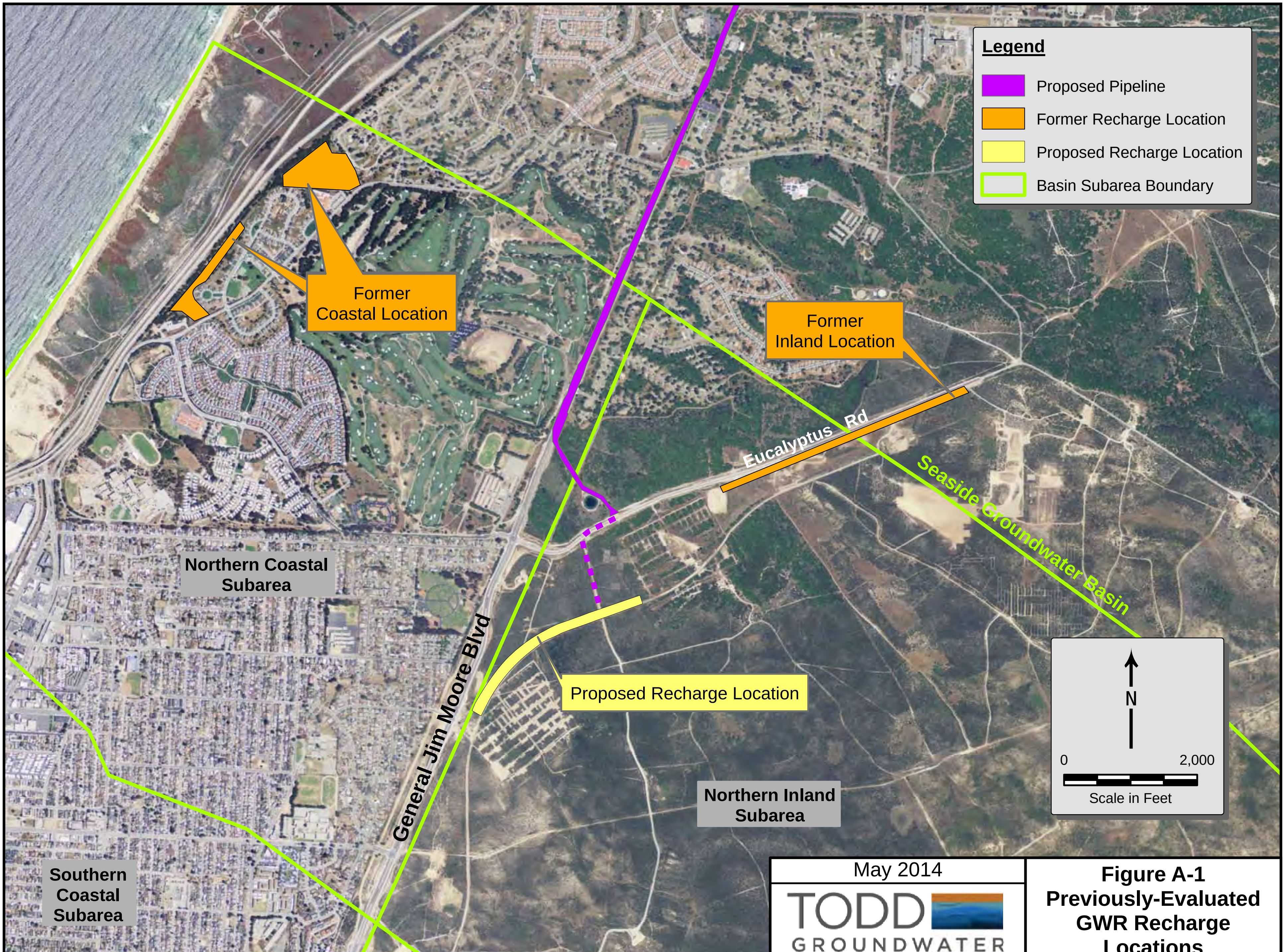
## References

Feeney, Martin B., PG, CHg, Seaside Groundwater Basin Watermaster, Seawater Sentinel Wells Project, Summary of Operations, For Seaside Groundwater Basin Watermaster, with assistance from Pueblo Water Resources, Inc., October 2007.

HydroMetrics WRI (HydroMetrics), Water Year 2013, Seawater Intrusion Analysis Report, Seaside Basin, Monterey County, California, prepared for: Seaside Basin Watermaster, December 2013.

HydroMetrics Water Resources Inc. (HydroMetrics), Technical Memorandum, To: Seaside Groundwater Basin Board of Directors, From: Georgina King and Derrik Williams, July 19, 2013, Subject: Groundwater Modeling Results of Coastal Injection in the Seaside Basin.

HydroMetrics Water Resources Inc. (HydroMetrics), Seaside Groundwater Basin Modeling and Protective Groundwater Elevations, prepared for: Seaside Basin Watermaster, November 2009.




May 2014

TODD GROUNDWATER

**Figure A-1**
**Previously-Evaluated GWR Recharge Locations**

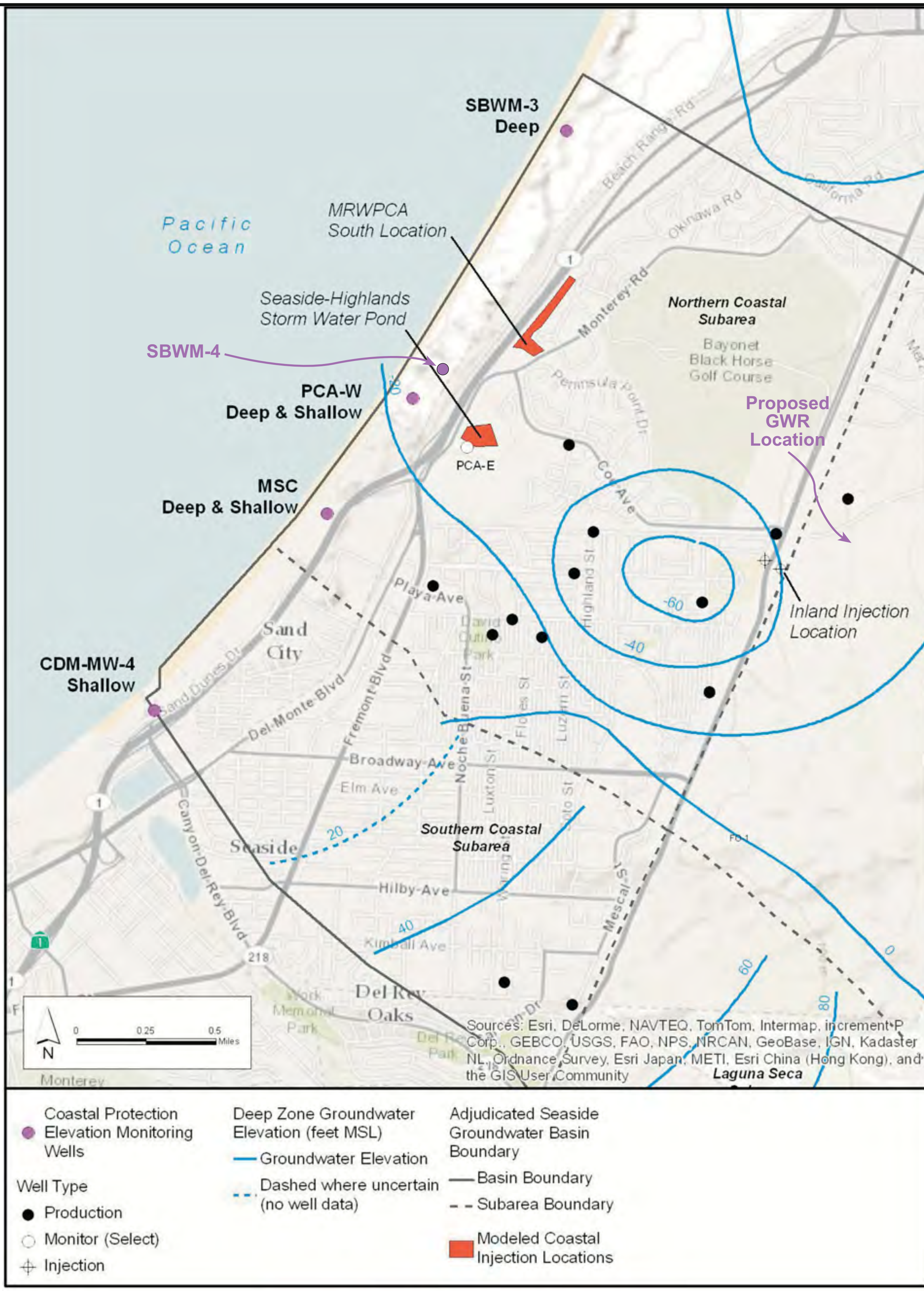


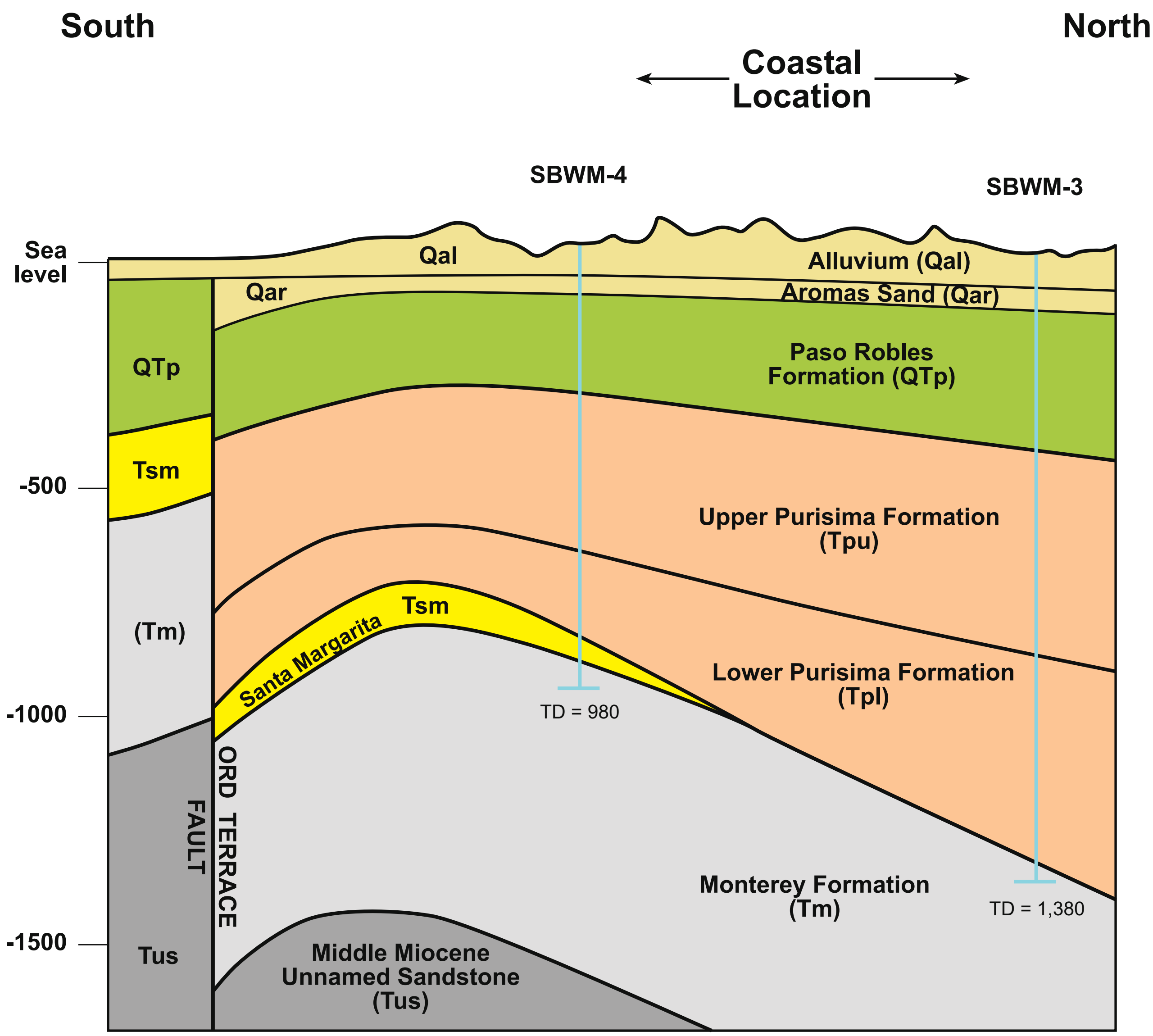

*Figure 1: Modeled Injection Locations*

Modified from: HydroMetrics, July 19, 2013.

April 2014

TODD GROUNDWATER

**Figure A-2**
**Modeled Coastal Injection Location**




From: Feeney (2007), reproduced from a portion of Figure 3 with labels and colors added.

May 2014

TODD GROUNDWATER

**Figure A-3**
**Hydrogeology near the Former Coastal Location**

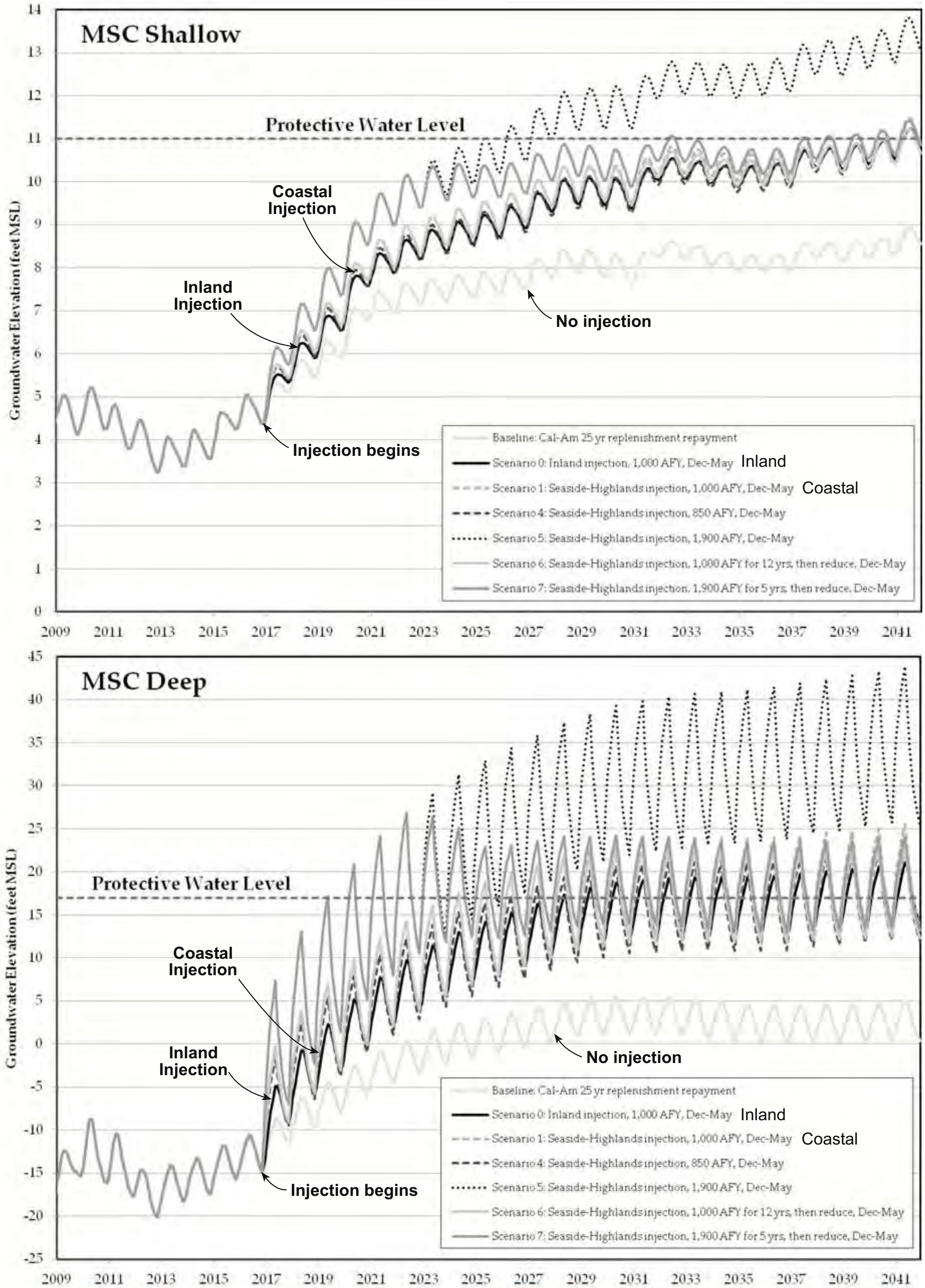



*Figure 2: Predicted Groundwater Elevations and Protective Elevations for the MSC Wells*

From: HydroMetrics, July 19, 2013.

April 2014

TODD GROUNDWATER

**Figure A-4**
**Coastal Injection Modeling Results**

# APPENDIX B

## HydroMetrics Memorandum

## Groundwater Replenishment Project Development Modeling, October 2, 2013

HydroMetrics WRI

519 17th Street, Suite 500
Oakland, CA 94612

Mr. Bob Holden
Monterey Regional Water Pollution Control District
5 Harris Court, Bldg. D
Monterey, CA 93940

October 2, 2013

Subject: Groundwater Replenishment Project Development Modeling

Dear Mr. Holden:

The letter below discusses the results of modeling completed in support of the Groundwater Replenishment Project (GWR) project development efforts.

The GWR is a central component of the Monterey Regional Water Pollution Control Agency's (MRWPCA's) plans to maintain a sustainable supply of fresh water to its customers. The GWR will recharge an average of 3,500 acre-feet (AF) of water into the Seaside groundwater basin throughout the year. This recharge will be matched by an increase of 3,500 AF per year of additional extraction from the basin. While this strategy produces no net change to the average water balance of the basin, the location and the timing of recharge and extraction may alter the flow dynamics of the basin. The impact that the recharged water has, whether it will produce additional storage that can be extracted or whether it force extra water to flow offshore or into the Salinas basin, depends upon the details of the project.

## Background and Approach

Our simulations incorporated certain assumptions about the recharge and pumping. These assumptions were detailed discussed in a letter from HydroMetrics WRI dated August 29, 2013. We assumed the recharge will be distributed evenly throughout the year. The increased pumping will follow a seasonal cycle based upon the observed current seasonal water demand of Cal-

Am customers. The additional extraction of GWR water is projected to occur entirely through six existing wells:

- ASR 1- 4
- Ord Grove #2
- Paralta
- Luzern
- Playa #3
- Plumas #4

Tentative sites have been selected for the placement of GWR vadose zone wells and deep injection wells. Up to four vadose zone wells have been proposed for delivering water into the shallow Paso Robles formation, and up to three deep injection wells have been proposed for injecting water into the deep Santa Margarita formation.

Four model simulations were conducted to investigate the impact of different strategies for recharging the GWR water. These simulations consisted of one baseline scenario in which no GWR water is recharged or extracted, and three scenarios in which the GWR water is recharged to the Paso Robles and Santa Margarita formation in varying proportions. The proportion of water recharged into each formation is shown in Table 1.

**Table 1: Recharge Distribution in Model Scenarios**

| | Percent Recharged into Paso Robles | Percent Recharged into Santa Margarita |
|---|---|---|
| **Scenario 1** | 100% | 0% |
| **Scenario 2** | 0% | 100% |
| **Scenario 3** | 20% | 80% |

The first and second scenario are included as end-member cases to predict the most extreme impacts expected from the project, and to compare the behavior of shallow versus deep injection. The third scenario recharges water in accordance with the historical pumping distribution in the Seaside basin: historically, Cal-Am extracts approximately 80% of its water from the deeper Santa Margarita Formation and 20% from the shallow Paso Robles Formation.

## Model Setup

To model the scenarios, HydroMetrics WRI extended the 2012 TAC baseline model. The baseline model originally simulated the Seaside Basin through 2030. The model was extended from 2030 through 2041 for these simulations. The year 2041 was chosen using the assumption that Cal-Am's repayment would begin in 2017, and the repayment would take 25 years.

All boundary conditions for the added simulation period are held constant at their 2030 levels. These include the general head boundaries along the coast, constant head boundaries adjacent to the Salinas Basin, and all no flow boundaries.

The same hydrology (rainfall and recharge) used in previous model runs was applied to the baseline scenario and all pumping scenarios. To extend the hydrology through the predictive period, the 1987 through 2008 hydrology data were repeated for model years 2009 through 2030, and 2031 through 2041 (Figure 1). Because there are only 22 years of hydrology data between 1987 and 2008, these 22 years have been repeated in succession through 2041. 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.

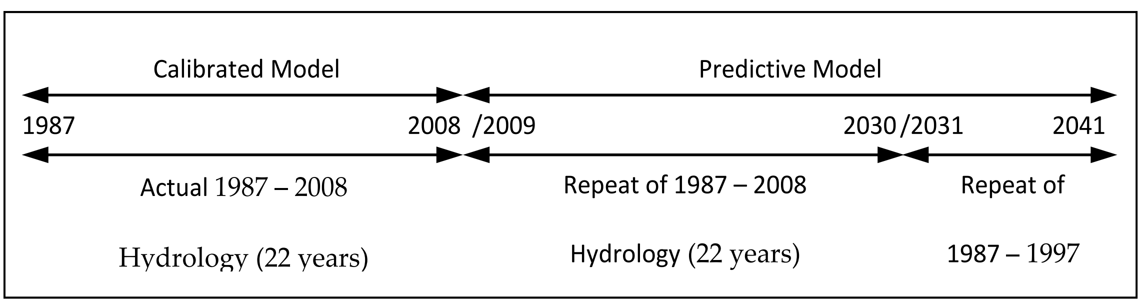



**Figure 1: Repetition of Hydrology for Predictive Model**

Deep injection is simulated in the model as wells that are located in the fifth, and lowest, model layer using MODFLOW's well package. The vadose zone wells are simulated in the model by applying water to the surface of the appropriate model cells using MODFLOW's recharge package. While conceptually the water is applied near the surface, the recharge package will deliver this water to the shallowest layer that remains saturated during any stress period. As a result, the water recharged through the vadose zone wells is not always applied to the top model layer, and the application layer varies throughout the simulation.

## Performance Measures

The GWR's purpose is to provide potable water to Cal-Am. Water recharged by GWR must be available for extraction by Cal am wells. Performance measures must therefore show that the recharged water is not lost to the ocean or nearby basins. Two criteria were used to assess each scenario's performance: whether the project increased outflow to the ocean, and whether the project increased or decreased overall storage in the basin. Because the recharge of GWR water is intended solely for storage and reuse in the short term, we believe that the ideal scenario would result in no long-term changes in the amount of water stored in the basin and would not alter the flow that occurs through any of the basin boundaries. Therefore, the best scenario is the one that is most similar to the baseline.

### Coastal Outflow Criterion

Outflow from the Seaside Basin to the ocean was the primary criterion used to assess project performance. A project that increases the amount of outflow to the ocean is theoretically recharging water that cannot be captured by Cal-Am. The best scenarios are those that do not increase outflow to the ocean.

The amount of water flowing to the ocean was estimated by analyzing the flow at every cell along the model's general head boundary (GHB) that simulates the ocean boundary. These flows were summarized for all cells within boundaries of the adjudicated basin. Only flows directed from the basin to the ocean were summarized: inflow from the ocean was not part of the performance criterion.

Figure 1 through Figure 4 show the results for model layers 1, 3, 4, and all for all layers combined. Layer 2 is not shown because it only experienced inflow and layer 5 is not shown because we have assumed that the Santa Margarita aquifer is not directly connected to the ocean. Each figure comprises two graphs. The top graph shows the overall outflow rates in acre-feet per day for each scenario and for the entire model period. The bottom graph shows the difference in the outflow rate between the recharge scenarios and the baseline scenario. On this figure positive values indicate that a scenario has more outflow than the baseline, and negative values indicate that a scenario has less outflow than the baseline.

Scenario 1, with 100% of recharge occurring through the vadose wells, has the greatest outflow for each of the model layers. Scenarios 2 and 3 have outflows that are much more similar to the baseline, with scenario 2 tending to have less outward flow than baseline and scenario 3 switching between less and more outward flow than baseline over time.

A comparison of the outflow from layer 1 (Figure 1) and the outflow from all layers (Figure 4) reveals that most of the increased total outflow are accounted for by layer 1. This is the layer in which recharge usually occurs, and which is most removed from the deep Santa Margarita formation from which the majority of Cal-Am's water is pumped. This demonstrates that concentrating recharge in the shallow Paso Robles Formation will results in water flowing tot the coast without percolating into the deeper formations.

These results suggest that scenario 2 with 100% of water injected through the deep injection wells will lose the least amount of water to the coast, while scenario 3, with 80% injected through the deep injection wells, and 20% through the vadose wells will have the least overall impact on the flow along the coast.

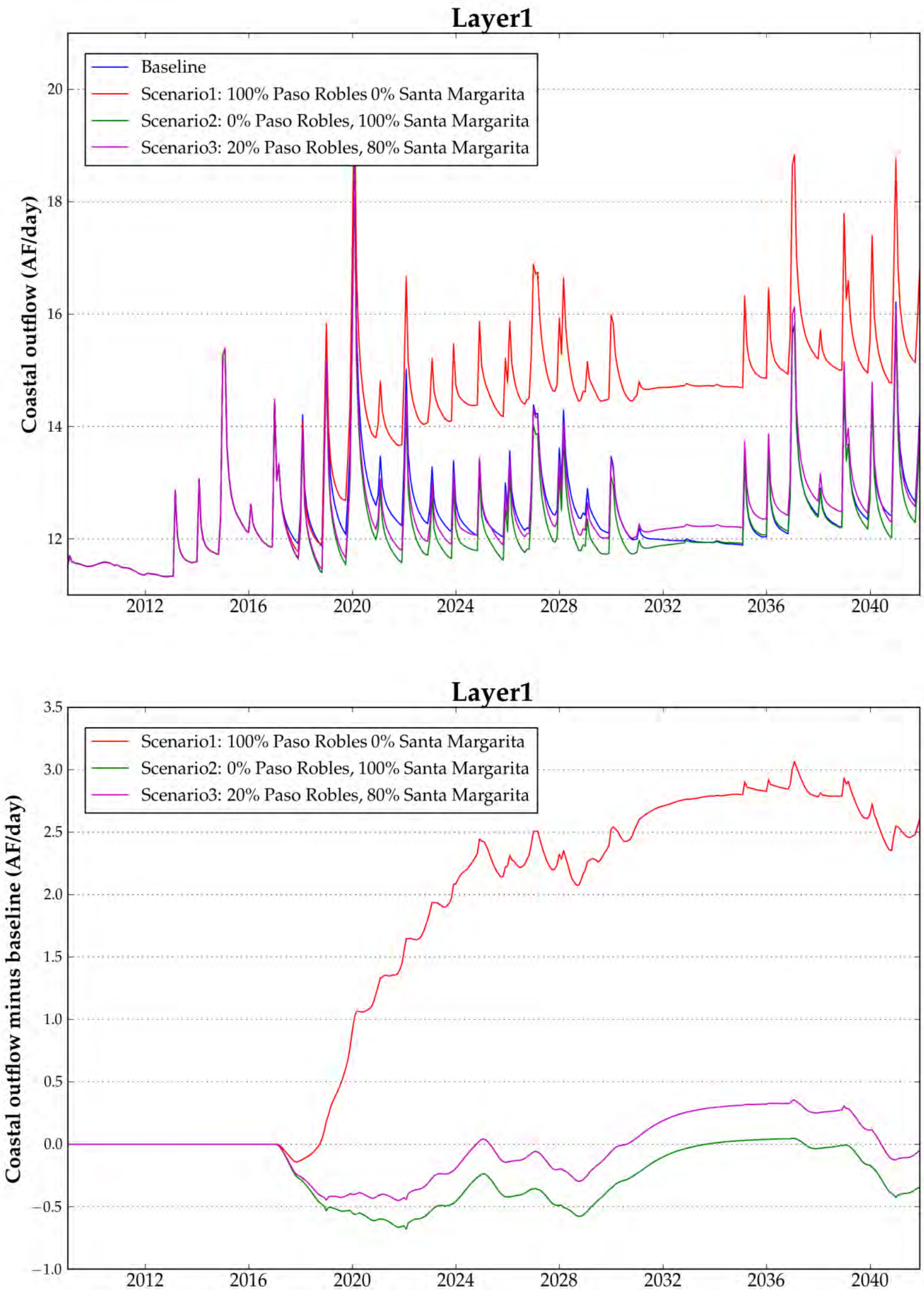
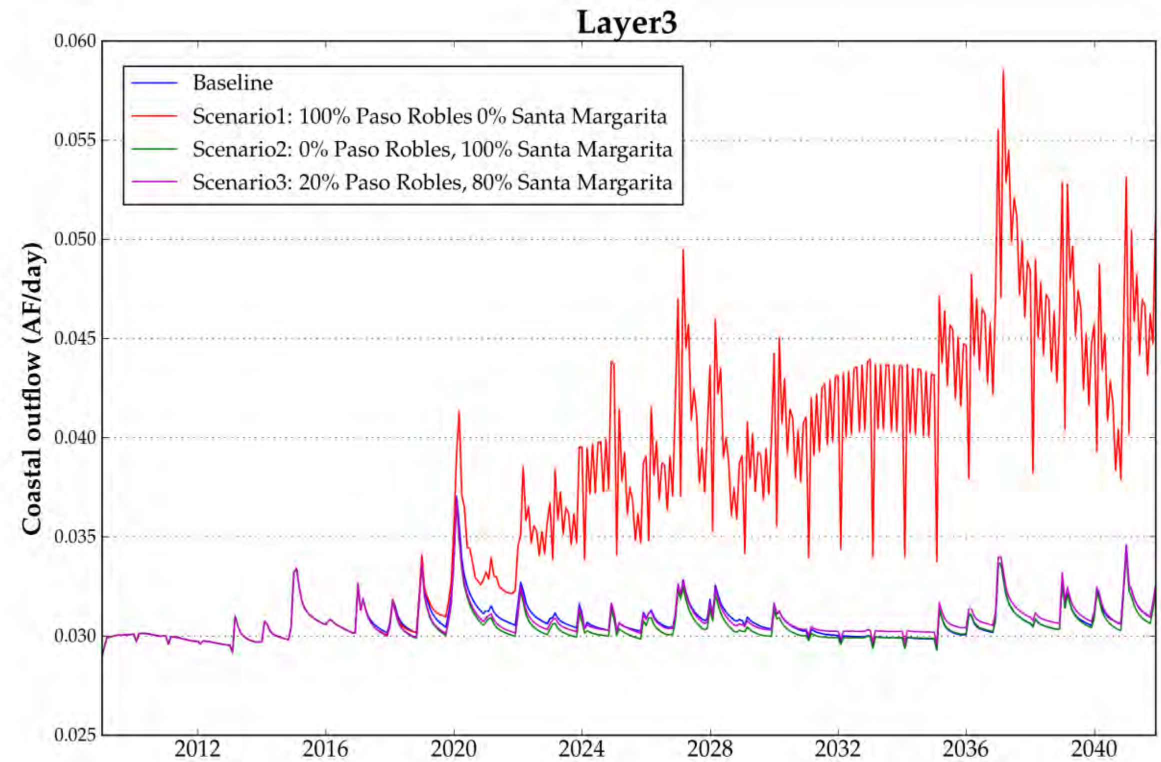



**Figure 1: Coastal Outflow along Layer 1 General Head Boundary**



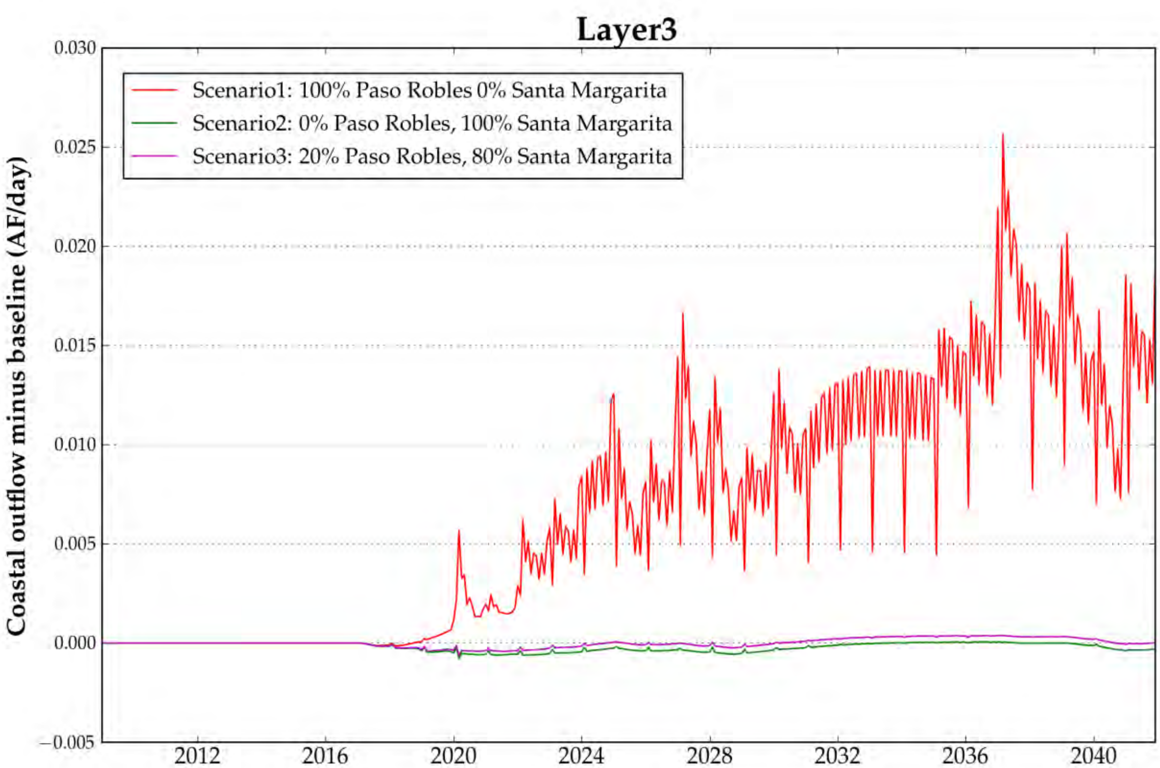
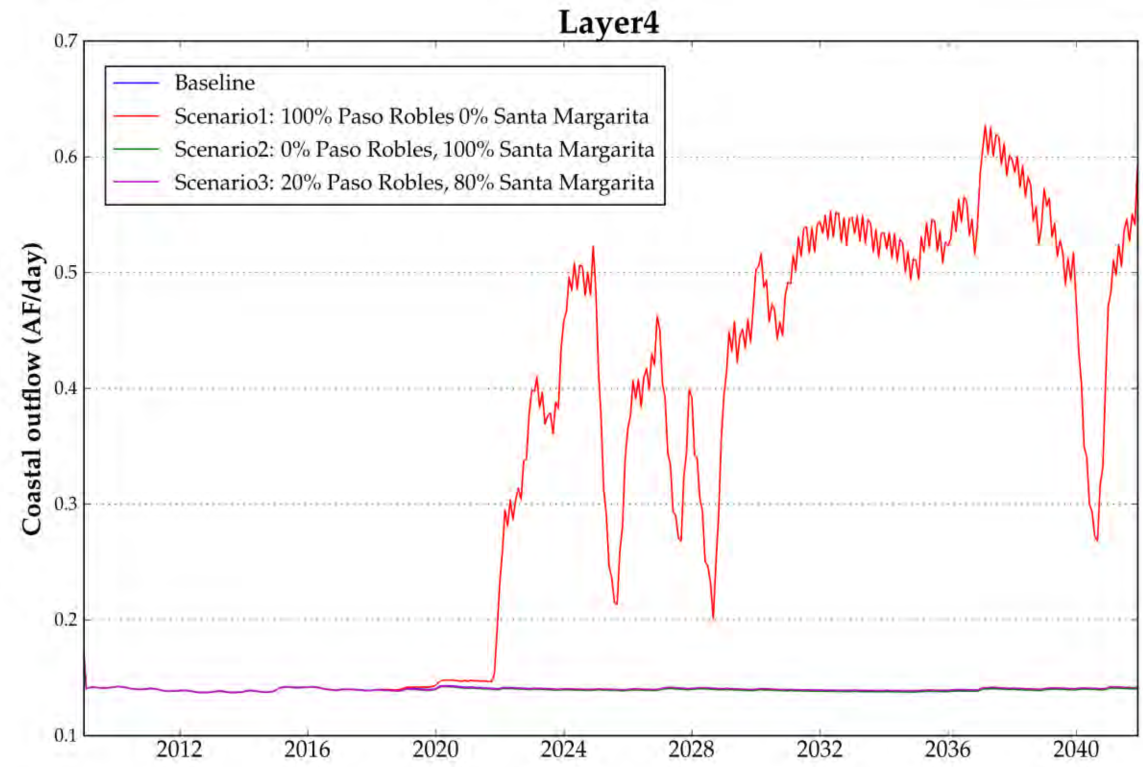




**Figure 2: Coastal Outflow along Layer 3 General Head Boundary**



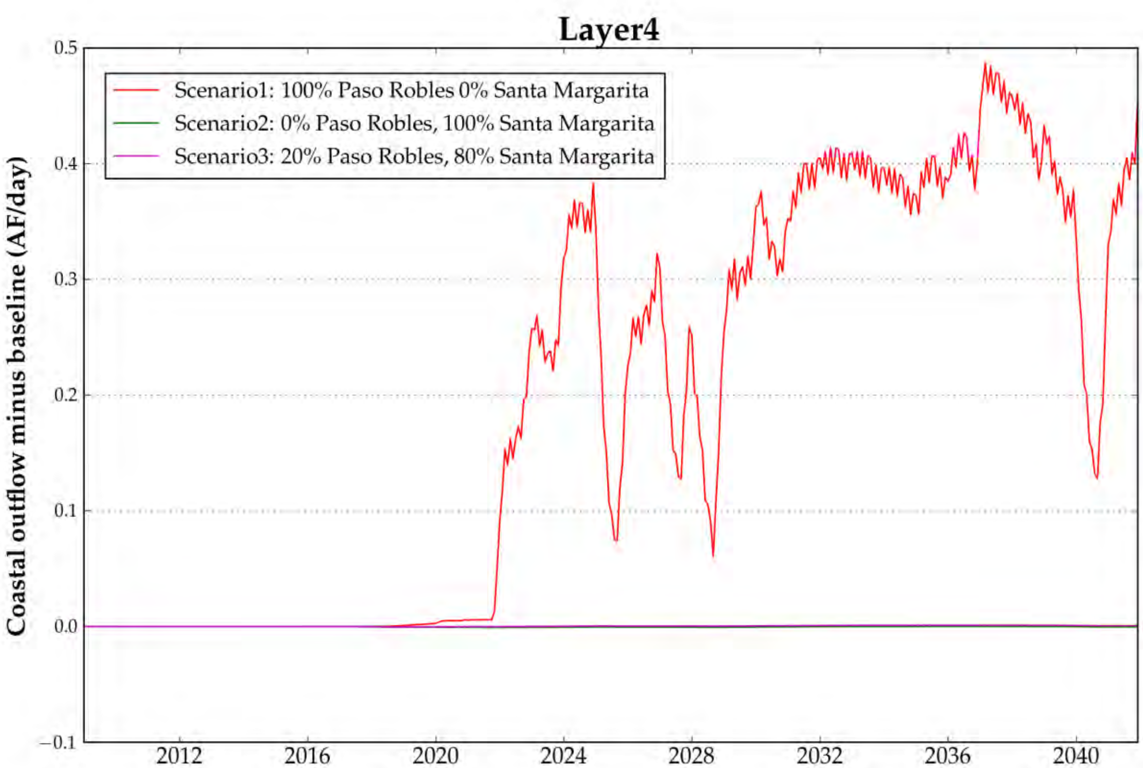




**Figure 3: Coastal Outflow along Layer 4 General Head Boundary**

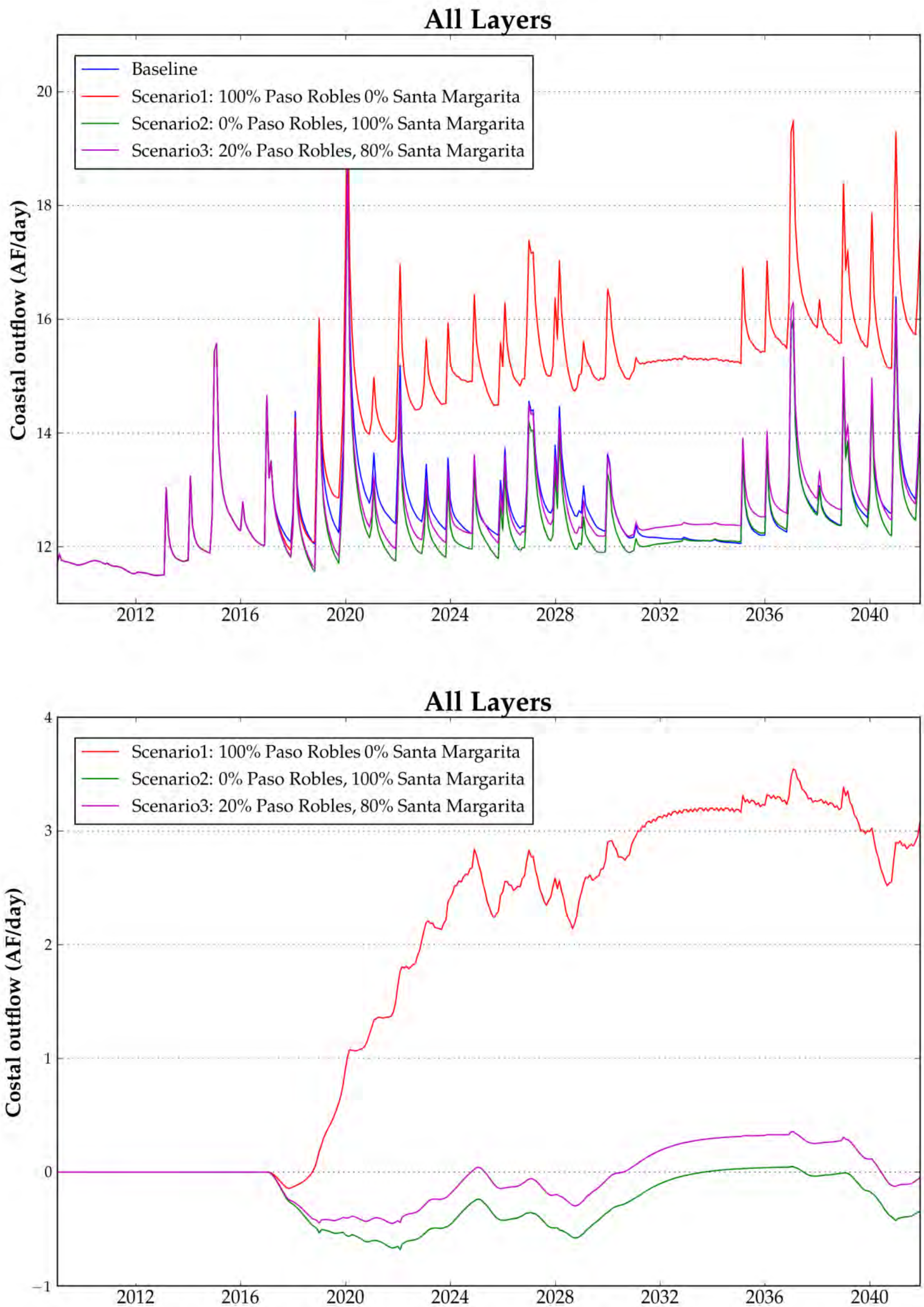



**Figure 4: Coastal Outflow along Layers 1-4 General Head Boundaries**

**Storage Changes Criterion**

The change in the amount of water stored in the basin under each simulation was a second criterion for assessing the impact caused by GWR recharge. A basin in which inflows and outflows are balanced over time will have no average change in storage (at the same time that it will have stable water levels). The inflows and outflows of the Seaside Basin are not currently balanced, but as stated above, it is not the goal of the GWR project to change the water balance. As with the outflow criterion, the changes in storage for each scenario were compared to those of the baseline to assess the performance of each scenario, with the smallest difference indicating the least impact.

Table 2 shows the total volumetric changes in storage, with positive numbers indicating increases in the amount of water in storage and negative numbers indicating decreases in the amount of water in storage. The imbalance present in scenario 1 between the shallow layers that are recharged and the deep layers that are preferably pumped can be plainly seen. Under this scenario there is a large increase in storage in the shallow layers and a large decrease in storage in deep layer 5. These results show that the largest changes occur within the adjudicated basin, but that there are also differences in the storage occurring outside of the adjudicated basin. This indicates that changes in flow are taking place along the inland boundaries and not just the coastal boundary. This was not investigated further.

Table 3 shows the difference in the volumetric storage changes for each scenario compared to the baseline, and Table 4 expresses these as a percent of the total volume of GWR water. Positive values indicate that a scenario has more water in storage than baseline conditions and negative values indicate that a scenario has less water in storage than baseline conditions. These results indicate that scenarios 2 and 3 do a much better than scenario 1 at minimizing changes in the basin relative to the baseline. Each scenario shows changes in storage that only a few percent of the total water recharged (and extracted) with the GWR project. Scenario 2 appears better if the scope is limited to the adjudicated basin while scenario 3 appears better if the entire model region is considered.

## Table 2: Total Change in Storage (AF)

| Scenario | Adjudicated Basin | | | | | | Outside of Adjudicated | Entire Model |
|---|---|---|---|---|---|---|---|---|
| | Layer1 | Layer2 | Layer3 | Layer4 | Layer5 | All Layers | | |
| Baseline | 1,794 | 95 | -198 | -858 | -3,738 | -2,905 | -35,079 | -37,984 |
| Scenario1 | 2,895 | 19,406 | 5,871 | 3,664 | -15,626 | 16,211 | -49,993 | -33,782 |
| Scenario2 | 1,697 | -78 | -17 | -824 | -1,528 | -749 | -32,498 | -33,247 |
| Scenario3 | 1,772 | 2,651 | 786 | -364 | -4,723 | 121 | -36,811 | -36,690 |

+ : More into Storage (higher water levels/ pressure)

- : Less into Storage (lower water levels/ pressure)

## Table 3: Difference from Baseline

| Scenario | Adjudicated Basin | | | | | | Outside of Adjudicated | Entire Model |
|---|---|---|---|---|---|---|---|---|
| | Layer1 | Layer2 | Layer3 | Layer4 | Layer5 | All Layers | | |
| Scenario1 | 1,102 | 19,311 | 6,070 | 4,523 | -11,889 | 19,116 | -14,914 | 4,202 |
| Scenario2 | -97 | -173 | 182 | 34 | 2,210 | 2,156 | 2,581 | 4,737 |
| Scenario3 | -22 | 2,556 | 984 | 495 | -986 | 3,026 | -1,732 | 1,294 |

+ : More into Storage (higher water levels/ pressure)

- : Less into Storage (lower water levels/ pressure)

## Table 4: Difference from Baseline as Percent of Total Recharged Water (AF)

| Scenario | Adjudicated Basin | | | | | | Outside of Adjudicated | Entire Model |
|---|---|---|---|---|---|---|---|---|
| | Layer1 | Layer2 | Layer3 | Layer4 | Layer5 | All Layers | | |
| Scenario1 | 1.2% | 21.8% | 6.9% | 5.1% | -13.5% | 21.6% | -16.9% | 4.8% |
| Scenario2 | -0.1% | -0.2% | 0.2% | 0.0% | 2.5% | 2.4% | 2.9% | 5.4% |
| Scenario3 | 0.0% | 2.9% | 1.1% | 0.6% | -1.1% | 3.4% | -2.0% | 1.5% |

+ : More into Storage (higher water levels/ pressure)

- : Less into Storage (lower water levels/ pressure)

## Conclusion

These analyses suggest that recharging between 80% and 100% of GWR water into the Santa Margarita formation through deep injection wells will result in minimal disturbance to the basin and to only small amounts of water being lost to outflow from basin. These results are consistent with the idea that the water should be delivered into the same formations from which water is drawn.

If you have any questions, do not hesitate to contact me.

Sincerely,

Derrik Williams

Derrik Williams, President
HydroMetrics Water Resources Inc.

# APPENDIX C

## HydroMetrics Technical Memorandum

## GWR Project EIR: Project Modeling Results, January 12, 2015

1814 Franklin St, Suite 501
Oakland, CA 94612

# TECHNICAL MEMORANDUM

To: Bob Holden/MRWPCA

From: Stephen Hundt and
Derrik Williams

Date: January 12, 2015

Subject: GWR Project EIR: Project Modeling Results

## Executive Summary

The Monterey Regional Water Pollution Control Agency (MRWPCA) is developing a Groundwater Replenishment (GWR) project for the Seaside Basin. This project will recharge the Seaside groundwater basin with high quality purified water. The current analysis seeks to assess the environmental impacts of operating the GWR project, in fulfillment of the GWR project's Environmental Impact Report (EIR) requirement.

The calibrated groundwater model of the Seaside Groundwater Basin (HydroMetrics WRI, 2009) was used to estimate impacts from the GWR 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.

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 GWR 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.

Model results show that the GWR project is generally neutral compared to the no project conditions. Groundwater elevations are generally similar under the project conditions as under the no project conditions, with increasing groundwater elevations experienced under both scenarios. These higher groundwater levels will tend to slow or stop seawater intrusion.

Particle tracking was used to estimate the travel time of GWR water from the point of recharge to the closest point of extraction. Particle tracking showed that the shortest travel time for any recharged GWR water is about 11 months. Travel times of less than 12 months occur in 5 years out of the 25-year simulation period when the GWR project is in operation.

# Project Description

The Monterey Regional Water Pollution Control Agency (MRWPCA) is developing a Groundwater Replenishment (GWR) project for the Seaside Basin. This project will recharge the Seaside groundwater basin with high quality purified 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 when water is in the reserve account. The locations of the project's facilities, along with other operating production wells, are shown on Figure 1.

HydroMetrics Water Resources Inc. (WRI) has completed groundwater flow and particle tracking simulations of the proposed GWR project. This simulation was undertaken to predict impacts on groundwater levels and the fate and travel time of injected GWR water. This modeling was completed in support of the GWR project's environmental impact report (EIR).


*Figure 1: Production and GWR Injection Well Locations*

# Model Background and Assumptions

The calibrated groundwater model of the Seaside Groundwater Basin (HydroMetrics WRI, 2009) was used to estimate the impacts from the GWR 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. The GWR project was assumed to start in October 2016 and was operating throughout the remaining 25 years of the simulation. Recent estimates indicate that the project start-up may be delayed until late 2017, but the project was simulated with the previous start date to provide an additional year of analysis.

## 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 2). 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.

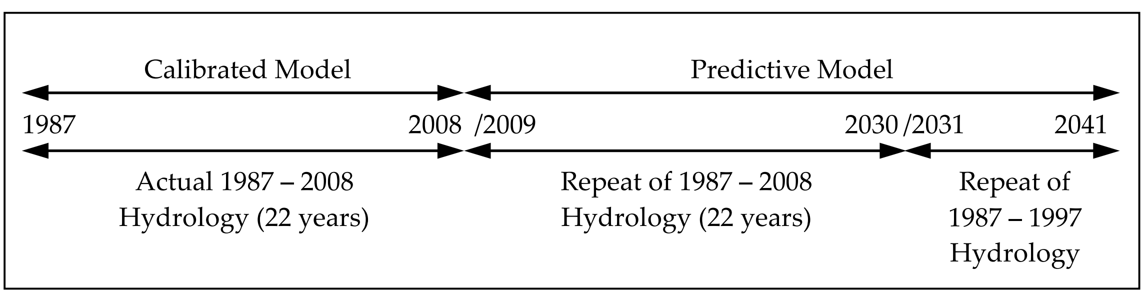



*Figure 2: Repetition of Hydrology for Predictive Model*

## 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 3 shows the estimated available monthly ASR injection volumes for the predictive simulation. Appendix A includes the historic and projected ASR Wells Site injection schedule that was developed by MPWMD. 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.

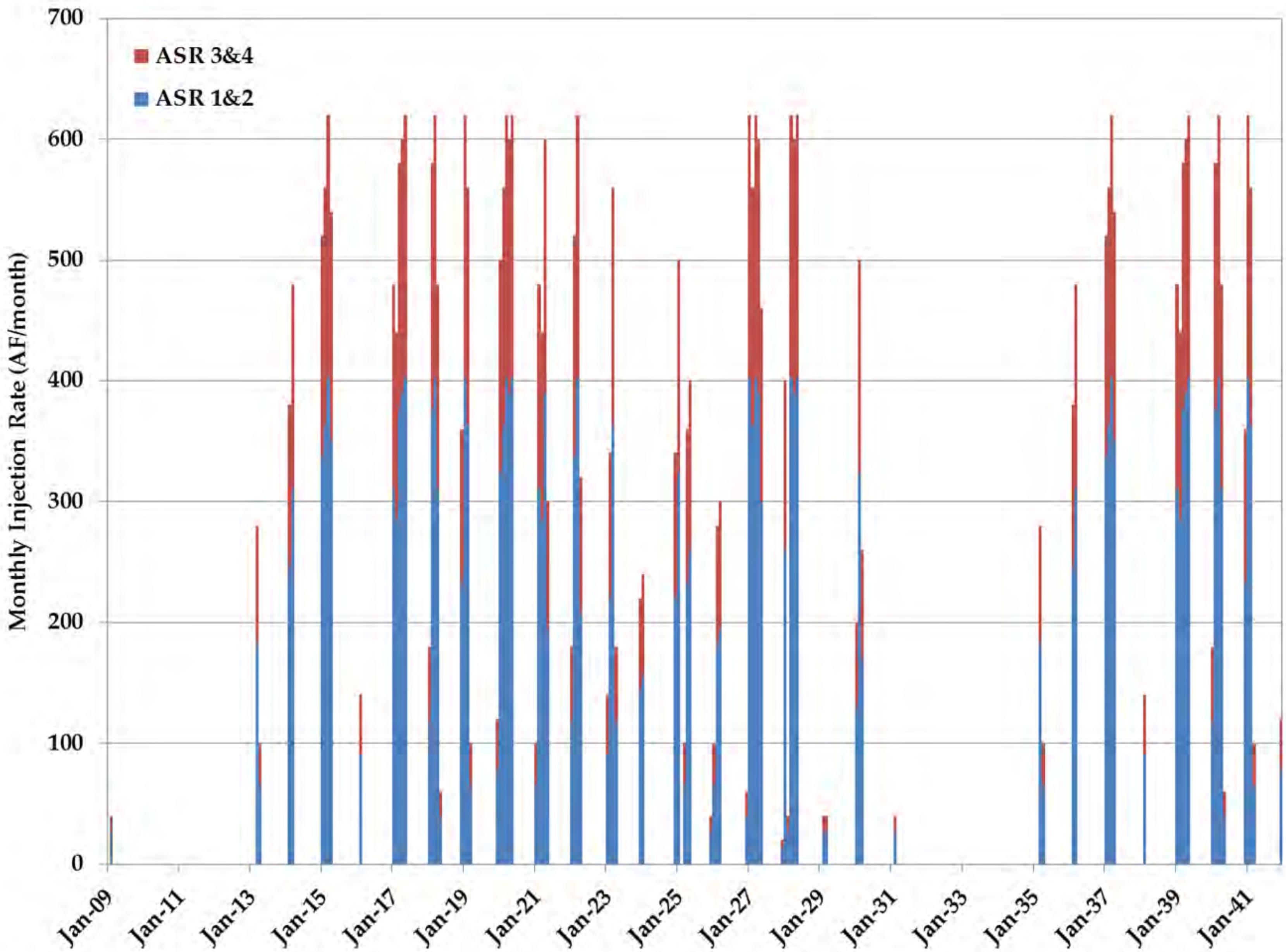



*Figure 3: Estimated Monthly Carmel River ASR Injection Volumes*

## PREDICTED GWR RECHARGE ASSUMPTIONS

GWR Project water is recharged through four deep wells and four vadose zone wells in the predictive model. The simulated GWR project recharges varying volumes of water each year, with an average of 3500 acre-feet recharged per year. Of this, 90% of the water is delivered to the Santa Margarita aquifer through four deep injection wells, and the remaining 10% is delivered to the Paso Robles aquifer through four vadose zone well. 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 4 shows the volume of water recharged by the GWR project for each water year. While the annual recharge of GWR water varies from year to year, the recovery of water through Cal-Am's pumping wells is maintained at a constant 3500 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 at the end of this technical memorandum.

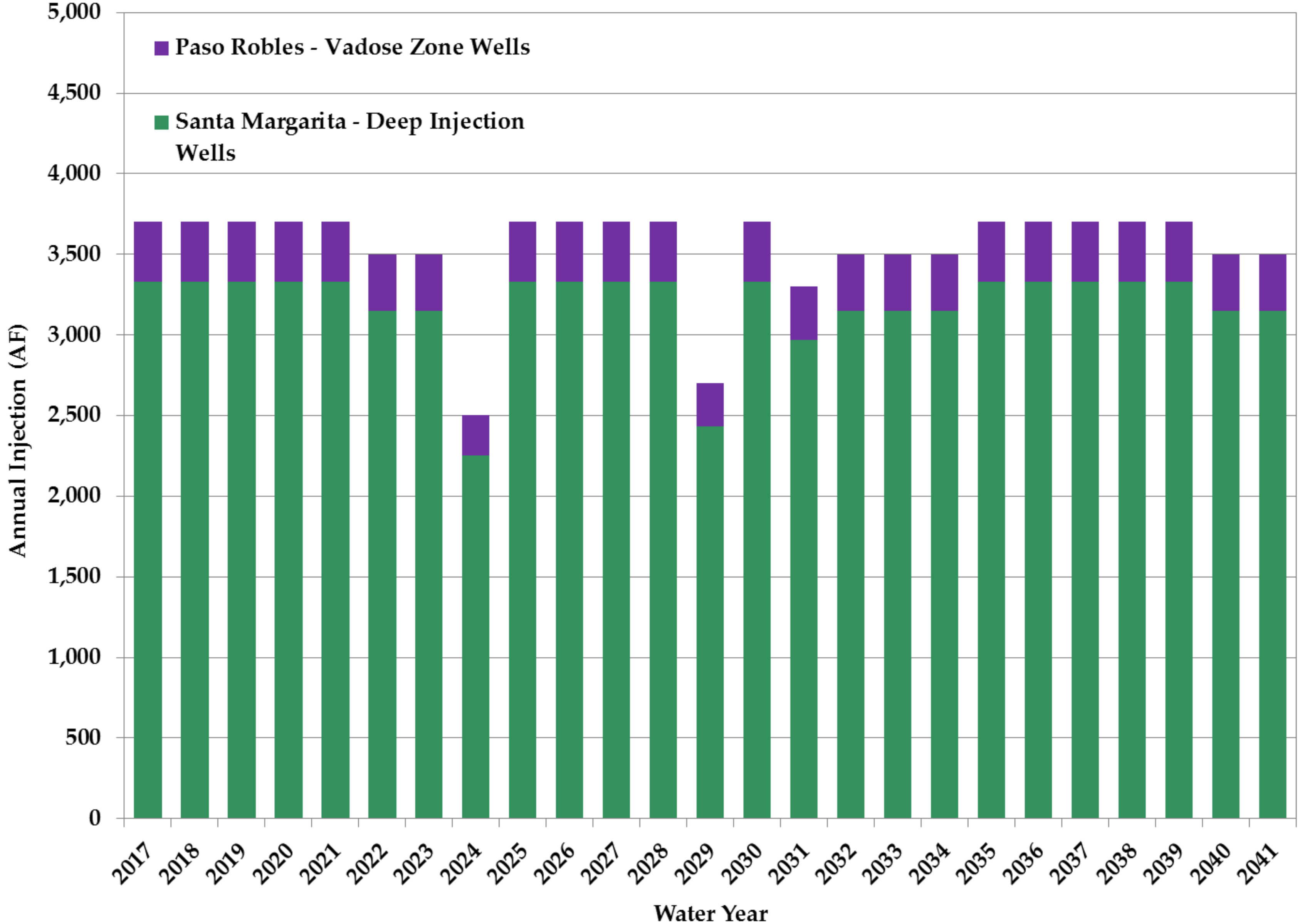



*Figure 4: Annual GWR Recharge*

## PREDICTED PUMPING ASSUMPTIONS

HydroMetrics WRI 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 PUPMPING 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 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 Monterey Peninsula Water Management District (MPWMD), we assumed that each

ASR well site could 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.

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. 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.

**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 total demand from Cal-Am customers in the Seaside Basin is currently supplied from a variety of sources. 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. The values are based on average water deliveries for the years 2001-2010.

Table 1 shows the calculations used to estimate Cal-Am's future monthly pumping demand. The current 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) far exceeds the assumed combined well capacity of about 31.6 acre-feet per day.

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.

*Table 1: Cal-Am Estimated Seasonal Demand*

| Month | Cal-Am Current Average Monthly Demand (AF) | Percent of Annual Production | Percent of July Production | Estimated Future Monthly Pumping (AF) |
|---|---|---|---|---|
| October | 1242 | 8.96% | 0.83 | 816 |
| November | 1005 | 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 | 1049 | 7.57% | 0.70 | 689 |
| May | 1307 | 9.43% | 0.88 | 858 |
| June | 1400 | 10.10% | 0.94 | 919 |
| July | 1490 | 10.75% | 1.00 | 978 |
| August | 1469 | 10.60% | 0.99 | 965 |
| September | 1363 | 9.84% | 0.92 | 895 |

Based on these 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 (GWR) project water
- Aquifer storage and recovery (ASR) project water

The availability of these resources is graphed on Figure 5. 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 increases from 2013 through 2017.

- GWR water (green) is projected to become available in 2017, and supply 3500 acre-feet every year.
- 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 dashed purple line on Figure 5 is Cal-Am's 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.

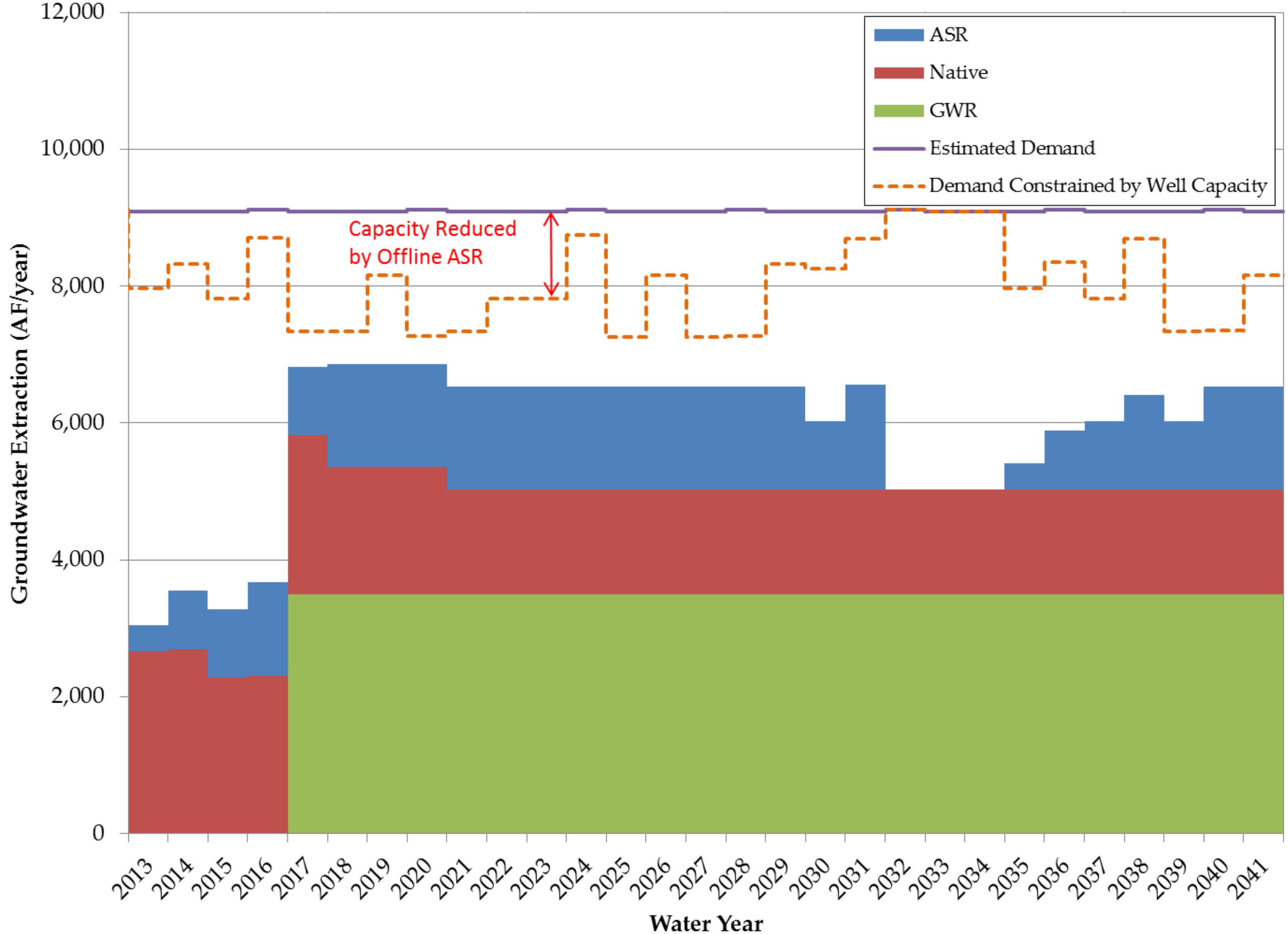



*Figure 5: Annual Cal-Am Water Allocation by Water Right Source*

**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 rainfall. Figure 6 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 GWR water up to their remaining capacity.

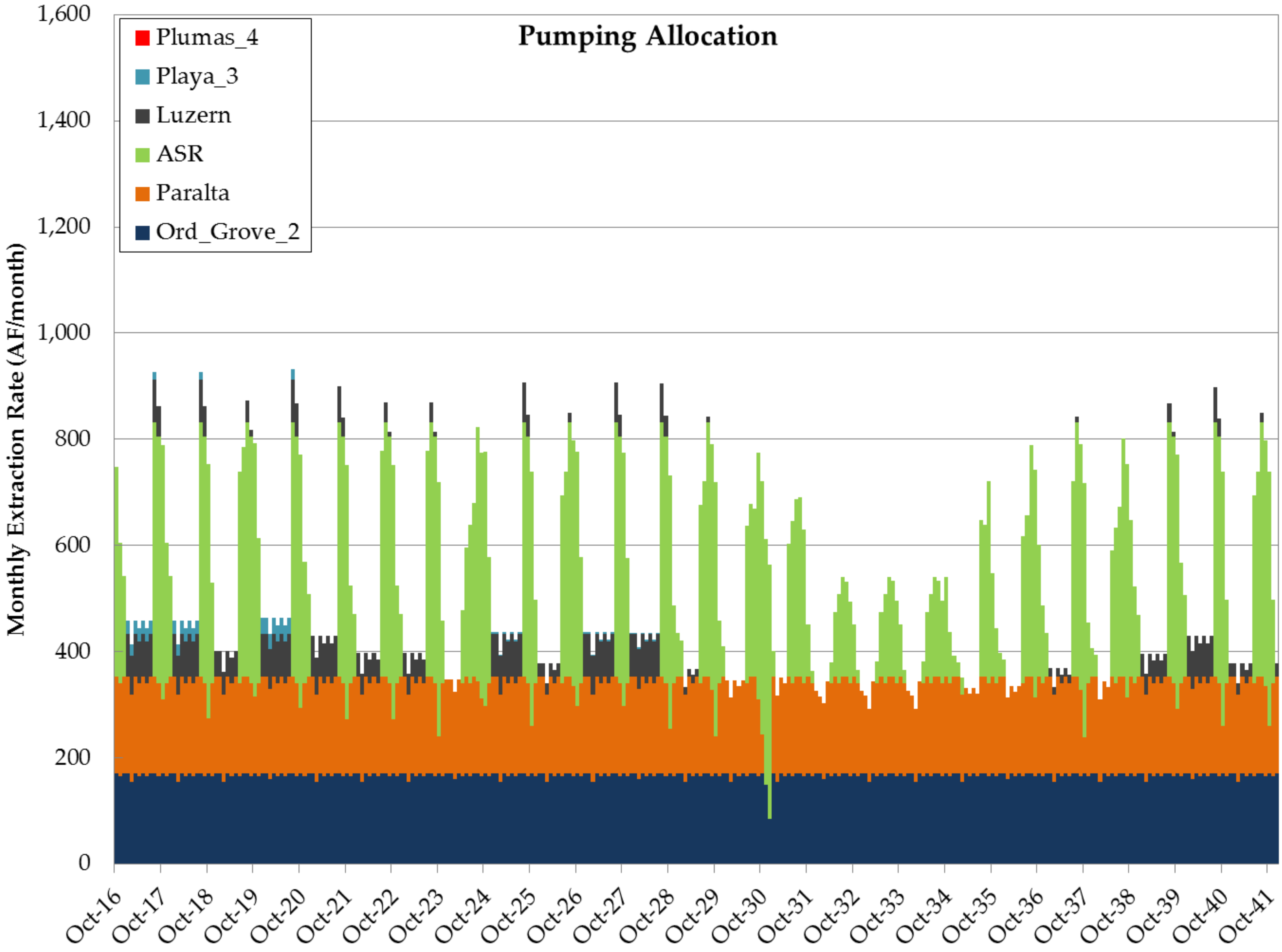



*Figure 6: Monthly Pumping Totals by Well*

## GOLF COURSE PUMPING FROM WATER YEAR 2013 ONWARDS

Predicted golf course pumping is based on the hydrologic year. For example, pumping in January 2015 equals 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 Producer pre-adjudication exceeded the Producer's adjudicated right, pumping was capped at the Producer's adjudicated amount.

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

- The Bayonet and Blackhorse golf courses pump no water until September, 2016. This is based on an in-lieu replenishment program the City of Seaside has with its golf course pumping. Under this program, Marina Coast Water District provides water in-lieu of the City pumping from the Seaside Basin. The City expects to start pumping its golf course wells again starting September 2016.

- In 2007, Bayonet and Black Horse golf courses had irrigation upgrades that have reduced irrigation demand by approximately 10% from historical amounts.

- The City of Seaside expects 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 is set at measured Water Year (WY) 2011 volumes from WY 2013 onwards. All other pumpers that are not covered by the Decision, including Cal Water Service and private wells, also pump at WY 2011 volumes from WY 2013 onwards.

Pumping exceptions taken into account in the simulation are:

- 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 is planned to start in 2013, and use 25 AFY of water. Water usage thereafter is estimated to be:

- 2014 - 30 AFY
- 2015 – 50 AFY
- 2016 onwards – 70 AFY

## No-Project Scenario

Prior to simulating impacts from GWR injection, a No-Project scenario was run to establish baseline conditions. 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. No GWR 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 GWR water was available for extraction. The total annual amount of water pumped by Cal-Am is shown on Figure 7. The monthly pumping by well for the No-Project scenario is shown in Figure 8.

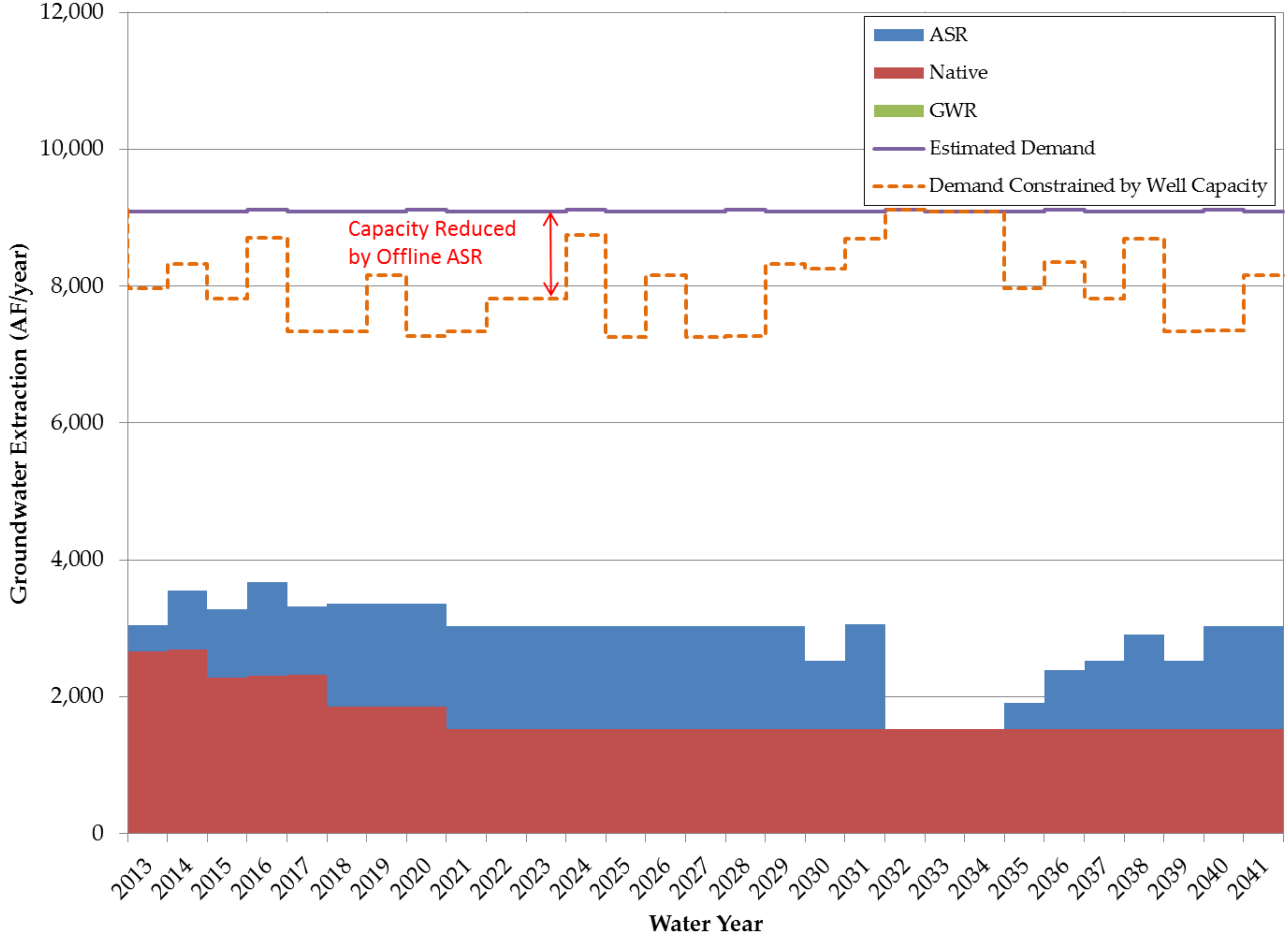



*Figure 7: Annual Cal-Am Water Allocation by Water Right Source for No-Project Scenario*

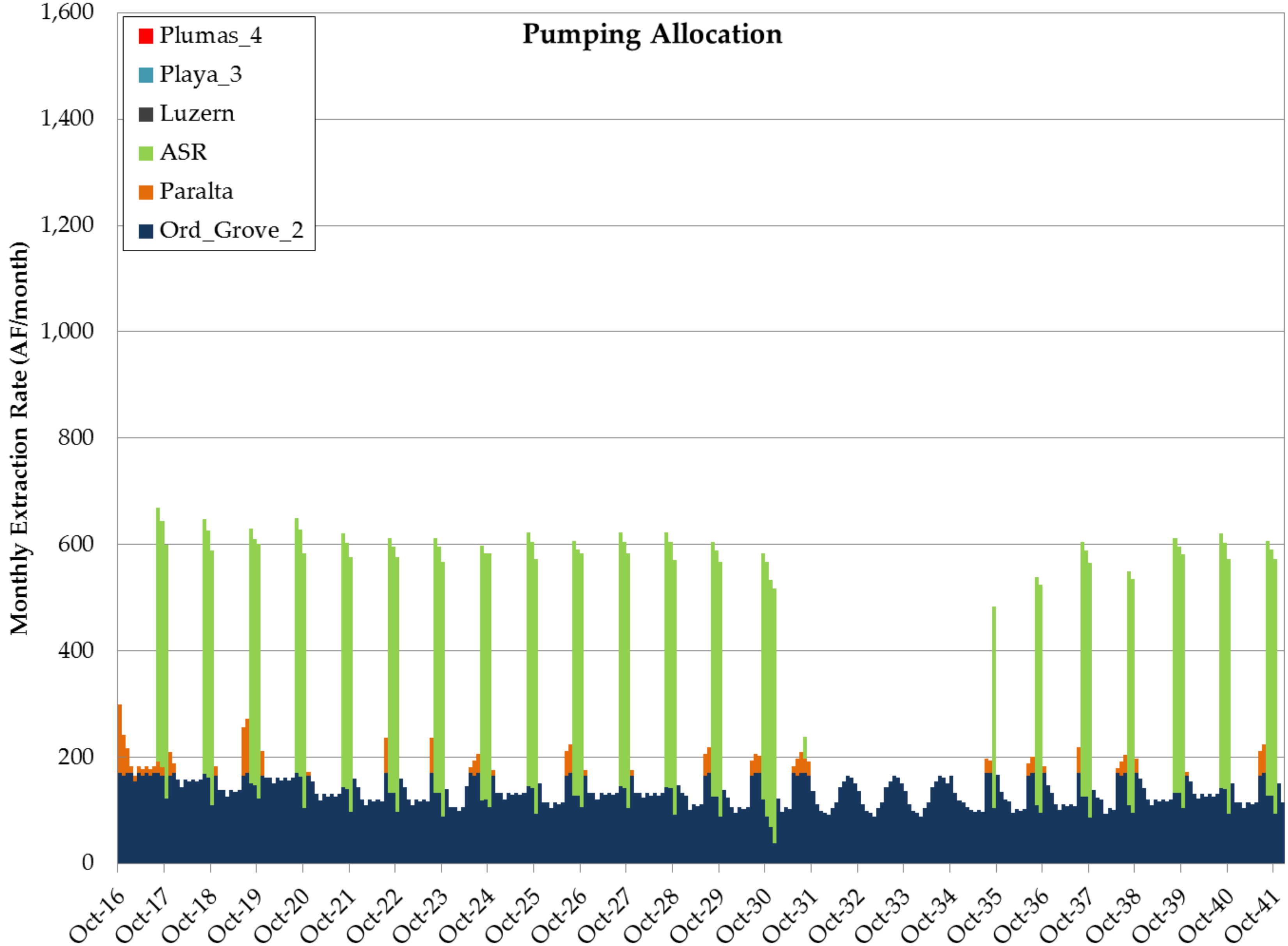



*Figure 8: Monthly Pumping Totals by Well for No-Project Scenario*

# Particle Tracking Approach

Particle tracking was conducted to estimate the fate and transport of GWR water under the Project Scenario. Particles were first introduced around all eight GWR 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 cells that contained the injection and vadose wells. 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 particles closer to the extraction wells, effectively resulting in faster simulated travel times.

Particles are captured by wells not when they reach the exact location of the extraction wells, but when they reach the edge of the cell that contains an extraction well. This also leads to faster simulated travel times. The results shown below should therefore be considered conservative estimates.

# Model Results

## GROUNDWATER ELEVATION RESULTS

The impact of the GWR project on groundwater elevations was determined by comparing results from the Project scenario with results from the No-Project scenario. The No-Project scenario simulates future groundwater conditions without the GWR project.

Simulated groundwater elevations from the three scenarios were compared at the following seven wells:

- ASR 1&2
- City of Seaside #3
- Ord Grove #2
- Paralta
- Luzern
- PCA-West (Shallow)
- PCA-West (Deep)

Figure 9 shows the location of these wells and the GWR injection wells. These wells span the area between the GWR injection wells and the coast. Several of the major recovery wells for the GWR project water are included in this set of wells.

Hydrographs for simulated groundwater elevations under the No-Project and Project scenarios are shown on Figure 10 through Figure 16. The blue lines represent the simulated static groundwater elevation under the No-Project scenario and the green lines represent the simulated static groundwater elevation under the with-Project scenario. Over the simulation period, the with-Project hydrographs deviate both below and above the No-Project hydrographs for several wells. The long term groundwater elevation trends of the with-Project hydrographs, however, are generally similar to the long-term trends of the No-Project hydrographs.

The largest relative reduction in groundwater levels under the with-Project scenarios are observed in the Ord Grove #2 well during the drought simulated between 2030 and 2035. During this period, the behaviors of the Ord Grove #2 hydrographs differ in several ways from the other deep wells: ASR wells #1 and #2, City of Seaside well #3, the Paralta well, and PCA-West Deep well. In all wells, there are large seasonal fluctuations throughout the simulation period that greatly diminish during the drought years. These drought year fluctuations tend to remain larger for the with-Project scenarios than for the No-Project scenarios and produce with-Project water levels that rise above No-Project water levels at their peak and fall below at their trough. In the Ord Grove #2 well, seasonal fluctuations under the with-Project scenario diminish during drought years, but not under the No-Project scenario. The with-Project groundwater elevations remain consistently lower than the No-Project groundwater elevations during the drought period.

There are several factors that control the seasonal fluctuations that occur in simulated groundwater elevations and help to explain the behavior of the Ord Grove #2 well hydrographs. First, the extraction and injection cycle of the ASR wells have a large impact on the seasonal cycles of nearby wells. ASR water is injected during the wet season, lifting groundwater elevations, and extracted during the dry season, dropping groundwater elevations. Injection and extraction of ASR water ceases entirely during the drought years leading to diminished fluctuations in groundwater elevations during these years.

For the with-Project scenarios, injection and extraction of GWR water does not cease, therefore with-Project scenarios experience greater groundwater level fluctuations than the no-Project scenario during the drought years. A second important factor controlling seasonal fluctuations are the seasonal pumping cycles of nearby (and coincident) production wells. Pumping tends to be heavier during the dry season, leading to declining water levels, and lighter during the wet season, leading to recovering water levels. This appears to be the most important factor causing the behavior seen in the Ord Grove #2 well. Figure 17 shows the pumping schedule of the Ord Grove #2 well for the No-Project and with-Project scenarios. While pumping fluctuates greatly under the No-Project scenario, the well is operated close to capacity during all months of the with-Project scenario. This general pattern continues during the drought period, with extended periods of light pumping during the winter months. This behavior compares closely to the Ord Grove #2 hydrographs, where the no-Project scenario sees greater fluctuations during the drought years than the with-Project scenarios. This helps to explain why the magnitude of fluctuations is higher in the Ord Grove #2 well, and why it appears to be much less sensitive to the ASR injection and extraction than its own pumping cycle.

The Luzern well and PCA-West Shallow well show relative reductions in groundwater elevations of one to six feet over the medium term of the simulations. At each of these wells the predicted groundwater elevations for the with-Project scenarios fall below the No-Project elevations soon after the GWR project comes online. Groundwater elevations then slowly recover to exceed or match the no-Project groundwater elevations by the end of the simulation. This behavior is likely a result of how the injection and additional pumping from the GWR project are distributed within the basin. The Luzern and PCA-West Shallow wells pump from the upper aquifers, not the Santa Margarita aquifer which receives most of the GWR injection. In the upper aquifer, the drop in groundwater elevation due to additional pumping from the Luzern and PCA-West Shallow wells is observed immediately. However the groundwater elevation rise due to both injection in the underlying aquifer and percolation of water through the upper aquifer is delayed. Wells screened in the underlying Santa Margarita aquifer do not show this delayed response because the pressure from GWR injection is transmitted quickly through the aquifer.

Comparing with-Project and No-Project Hydrographs of the PCA-West wells allows us to evaluate how the GWR project may impact seawater intrusion in the Seaside Basin. The simulated groundwater elevations at the PCA-West Deep well are very similar for the with-Project and No-Project scenarios, indicating that the GWR Project would not worsen the potential for seawater intrusion at this location. As previously discussed, hydrographs at the PCA-West Shallow well show relative reductions over the medium term for the Project Scenarios. While the initial relative decline is up to two feet, groundwater elevations remain above the predictive groundwater elevation for this location, and steadily rise to above four feet higher than protective elevations. Therefore, it does not appear that the GWR project would cause this location to become vulnerable to seawater intrusion.


*Figure 9: Locations of Wells with Groundwater Elevation Comparisons*

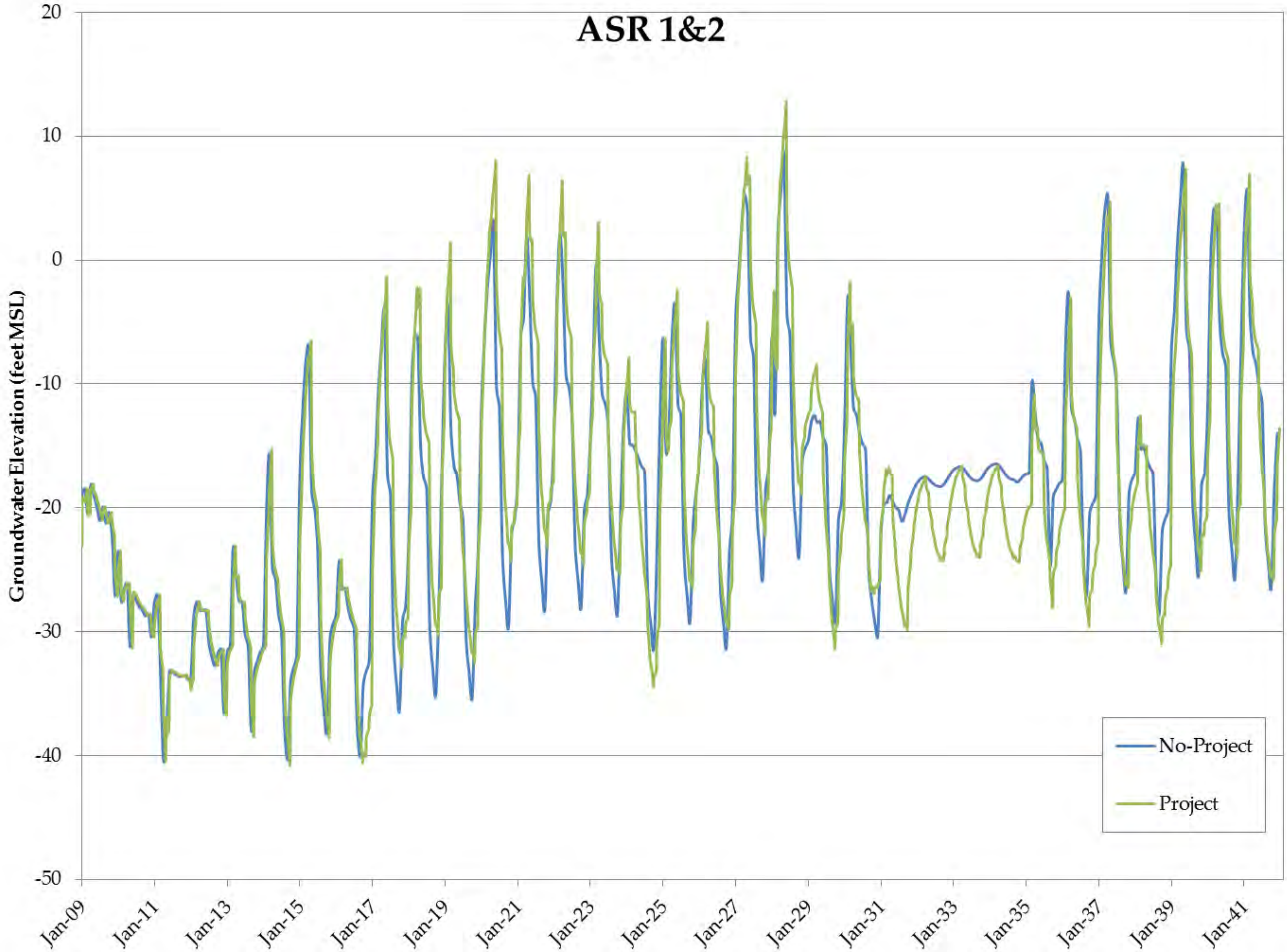



*Figure 10: Predicted Static Groundwater Elevations at ASR 1&2 Wells*

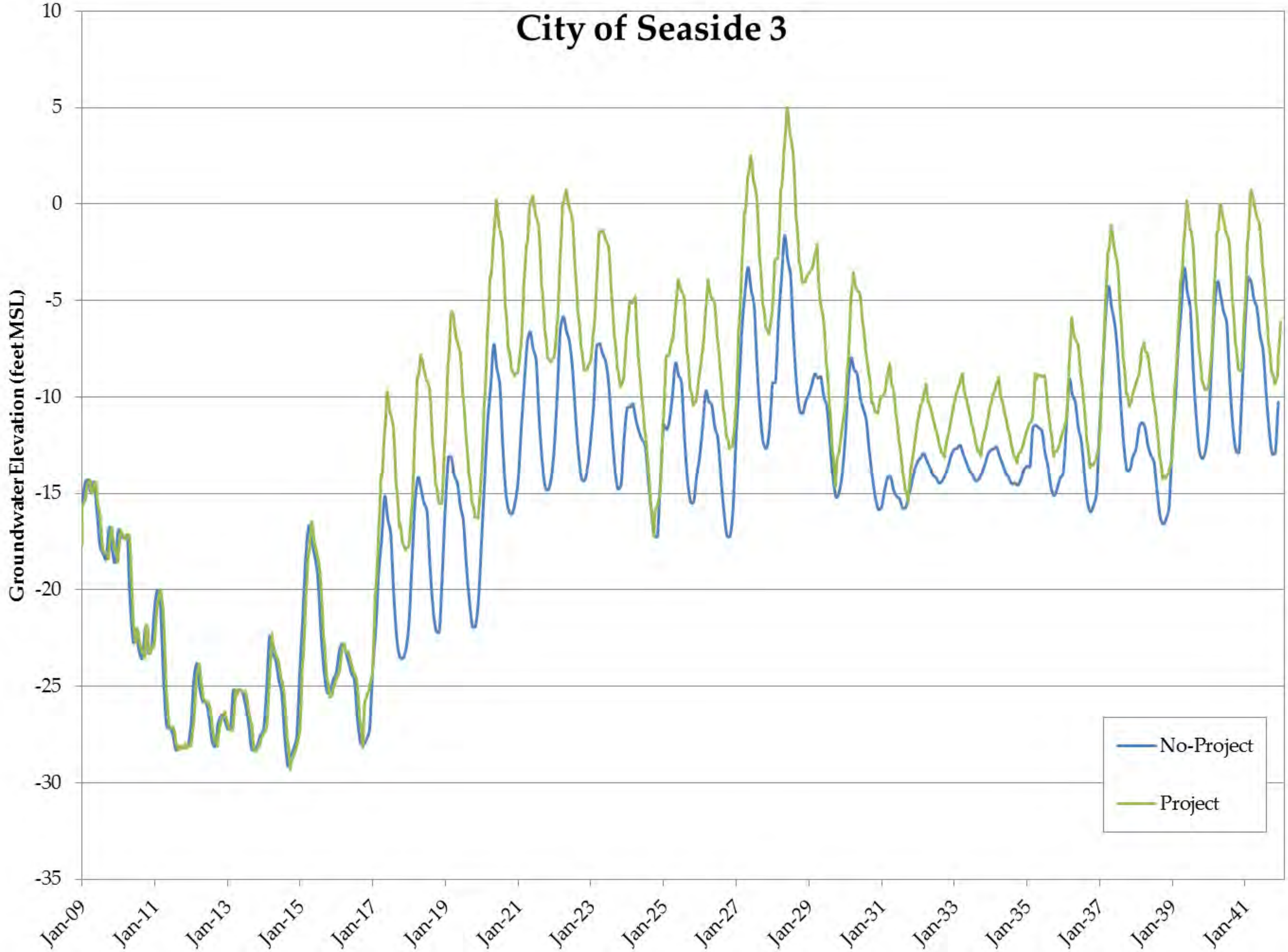



*Figure 11: Predicted Static Groundwater Elevations at City of Seaside 3 Well*

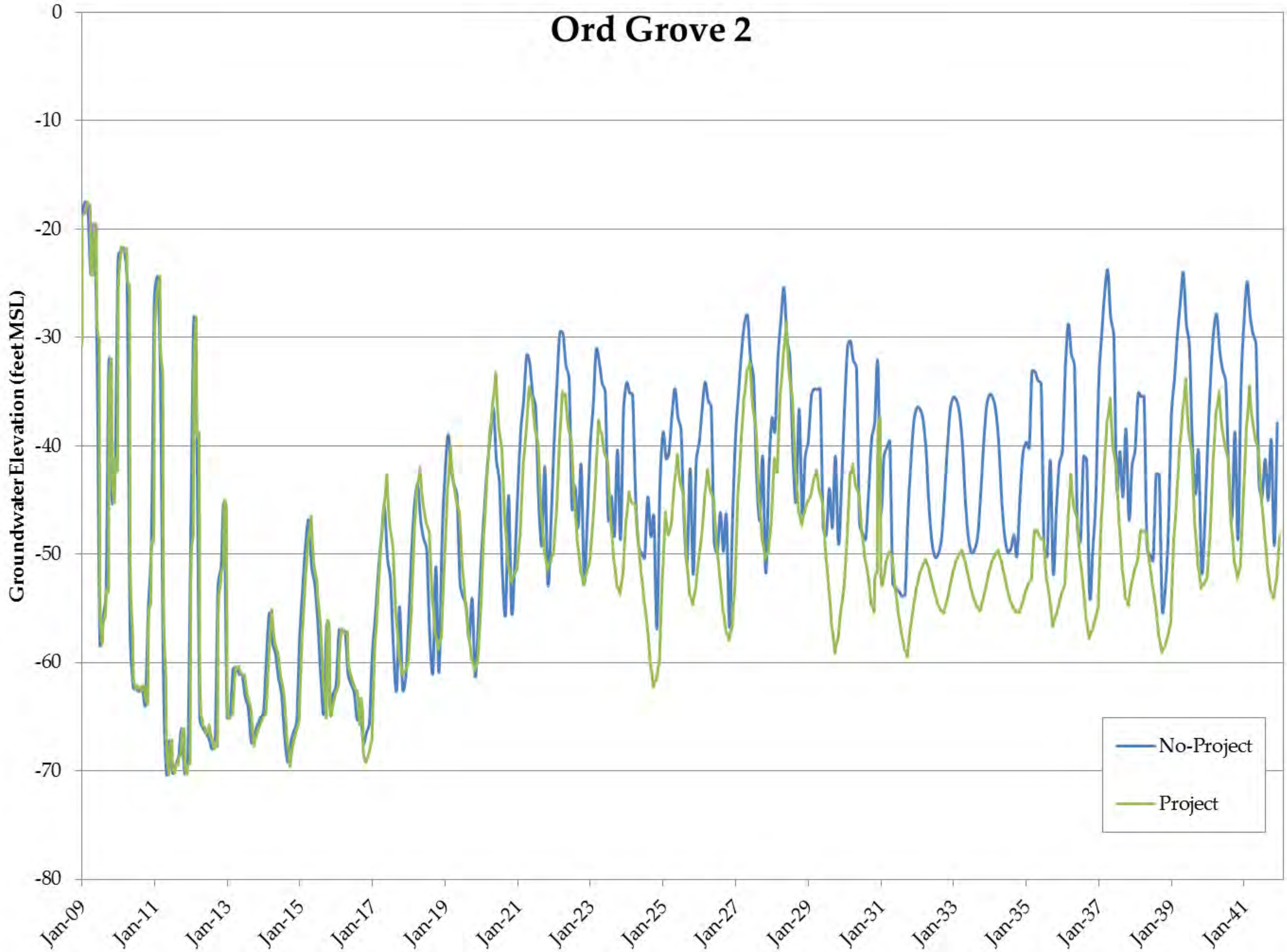



*Figure 12: Predicted Static Groundwater Elevations at Ord Grove 2 Well*

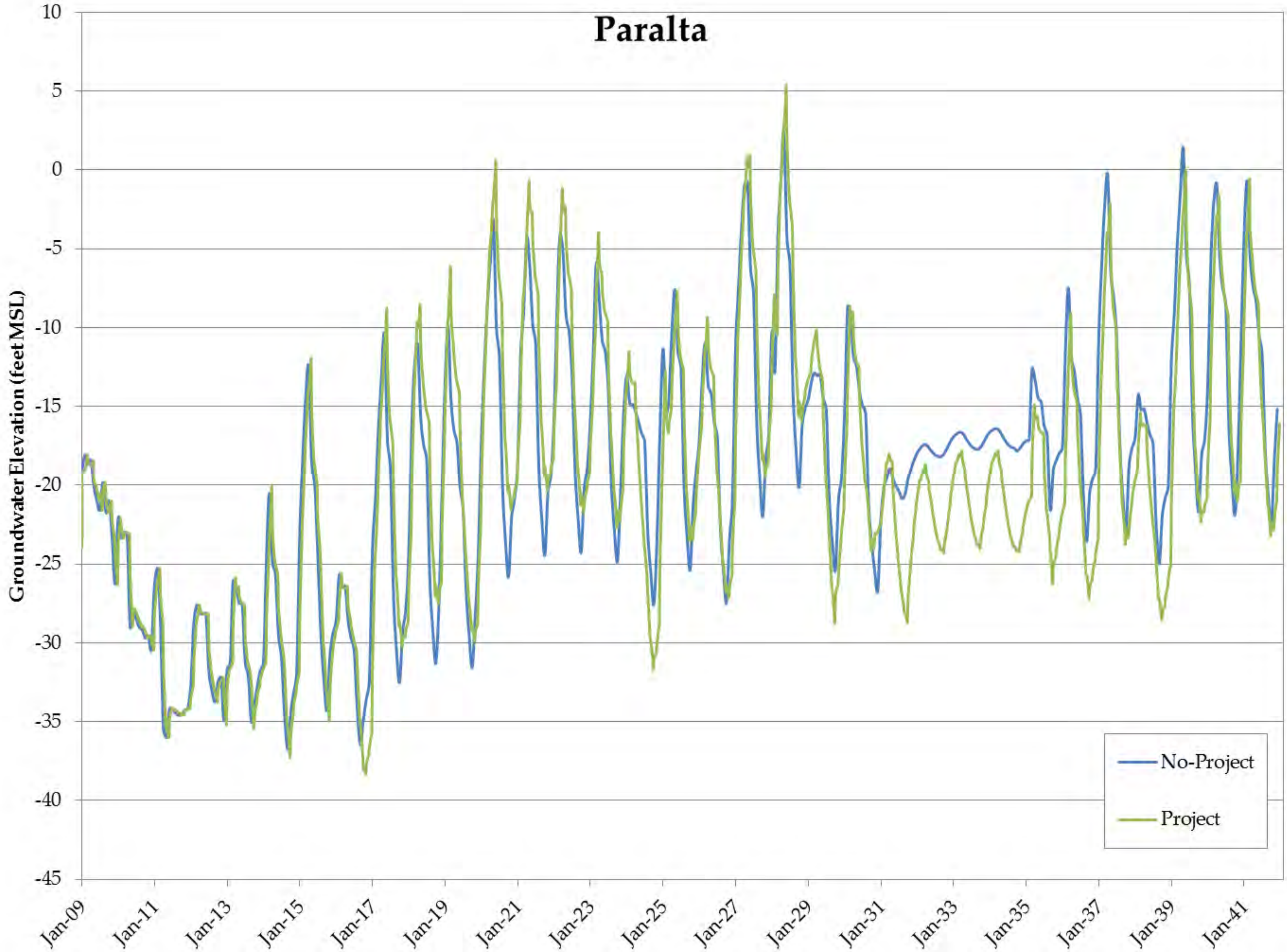



*Figure 13: Predicted Static Groundwater Elevations at Paralta Well*

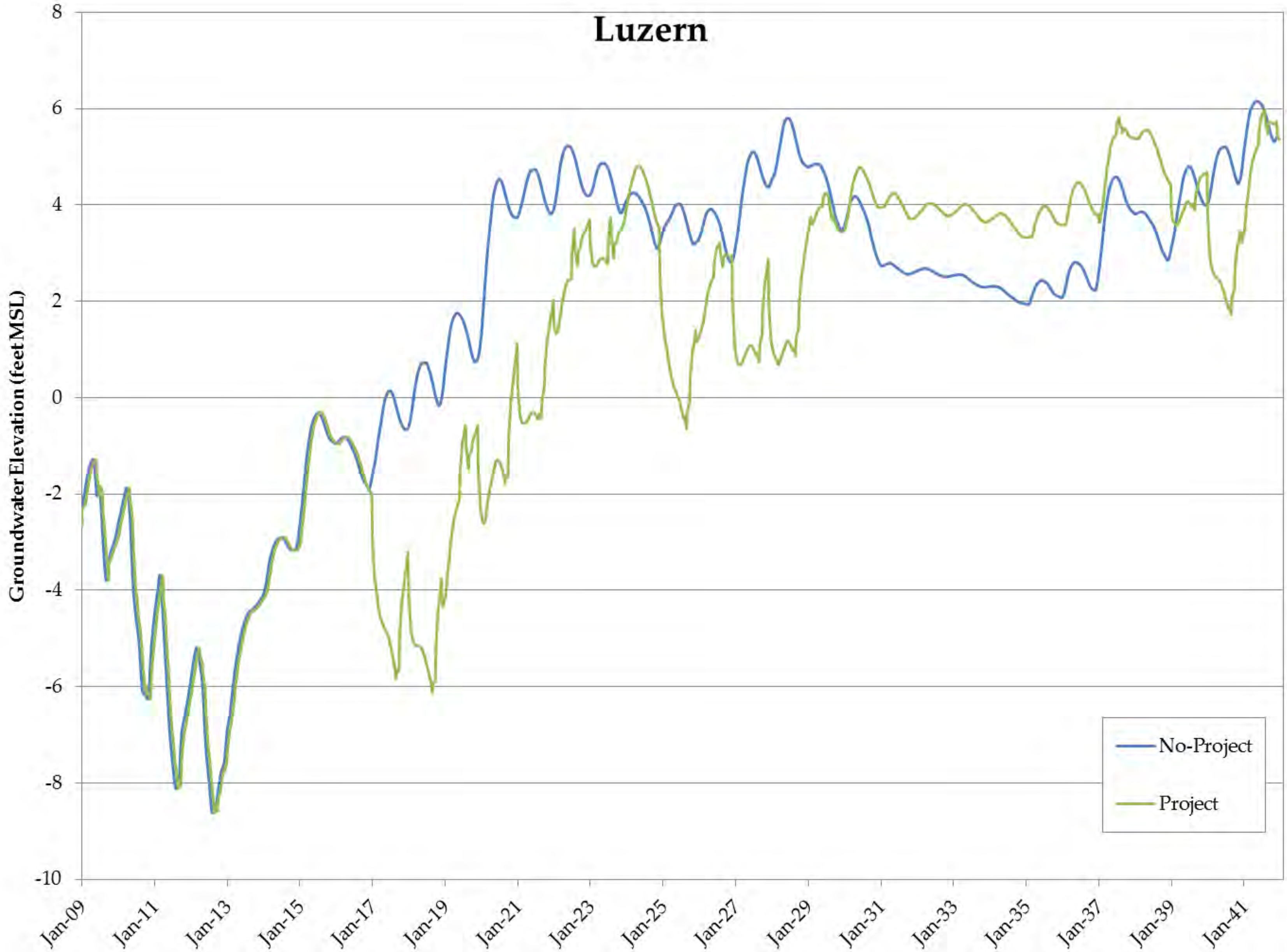



*Figure 14: Predicted Static Groundwater Elevations at Luzern Well*

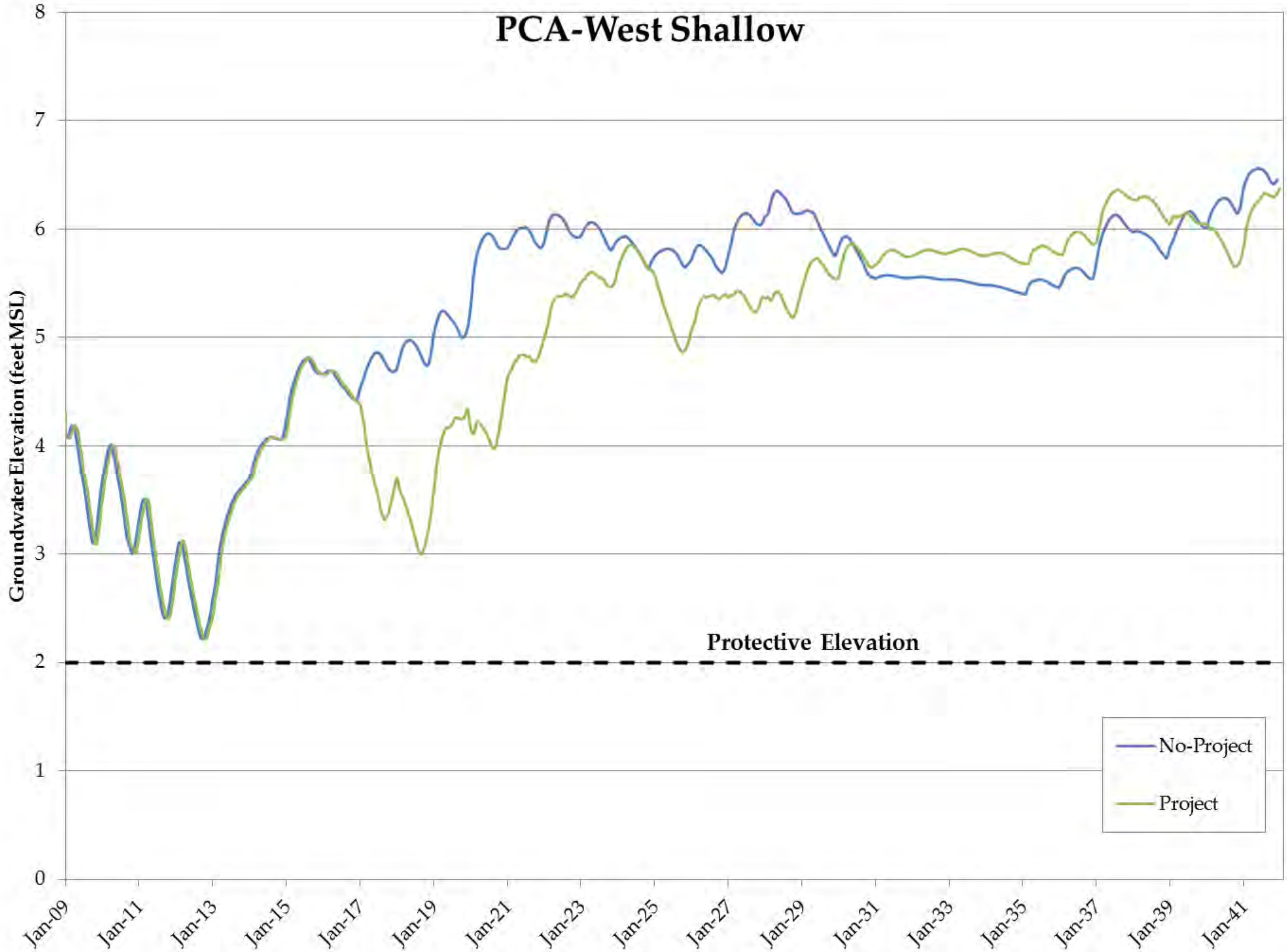



*Figure 15: Predicted Static Groundwater Elevations at PCA-West Shallow Well*

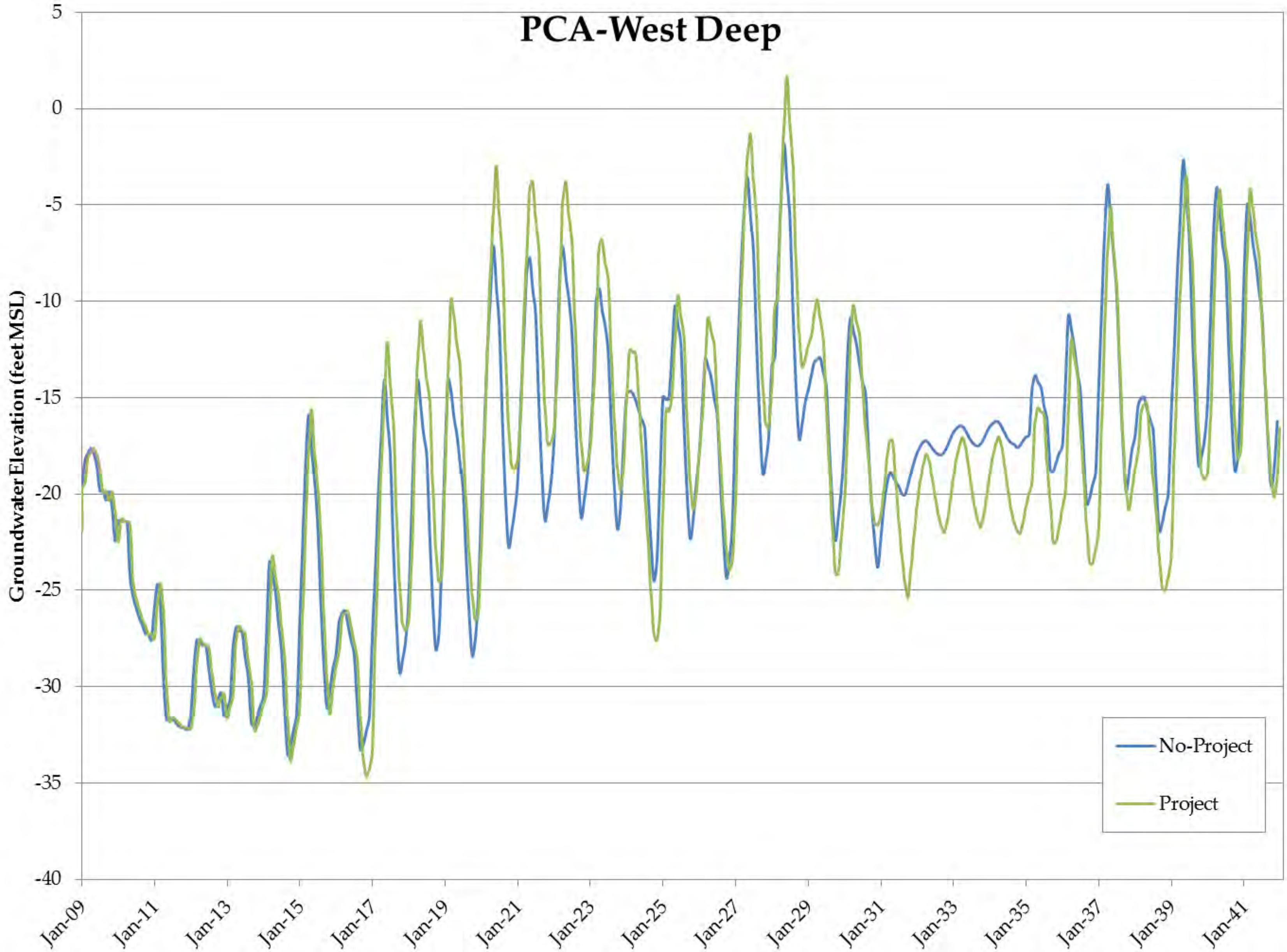



*Figure 16: Predicted Static Groundwater Elevations at PCA-West Deep Well*

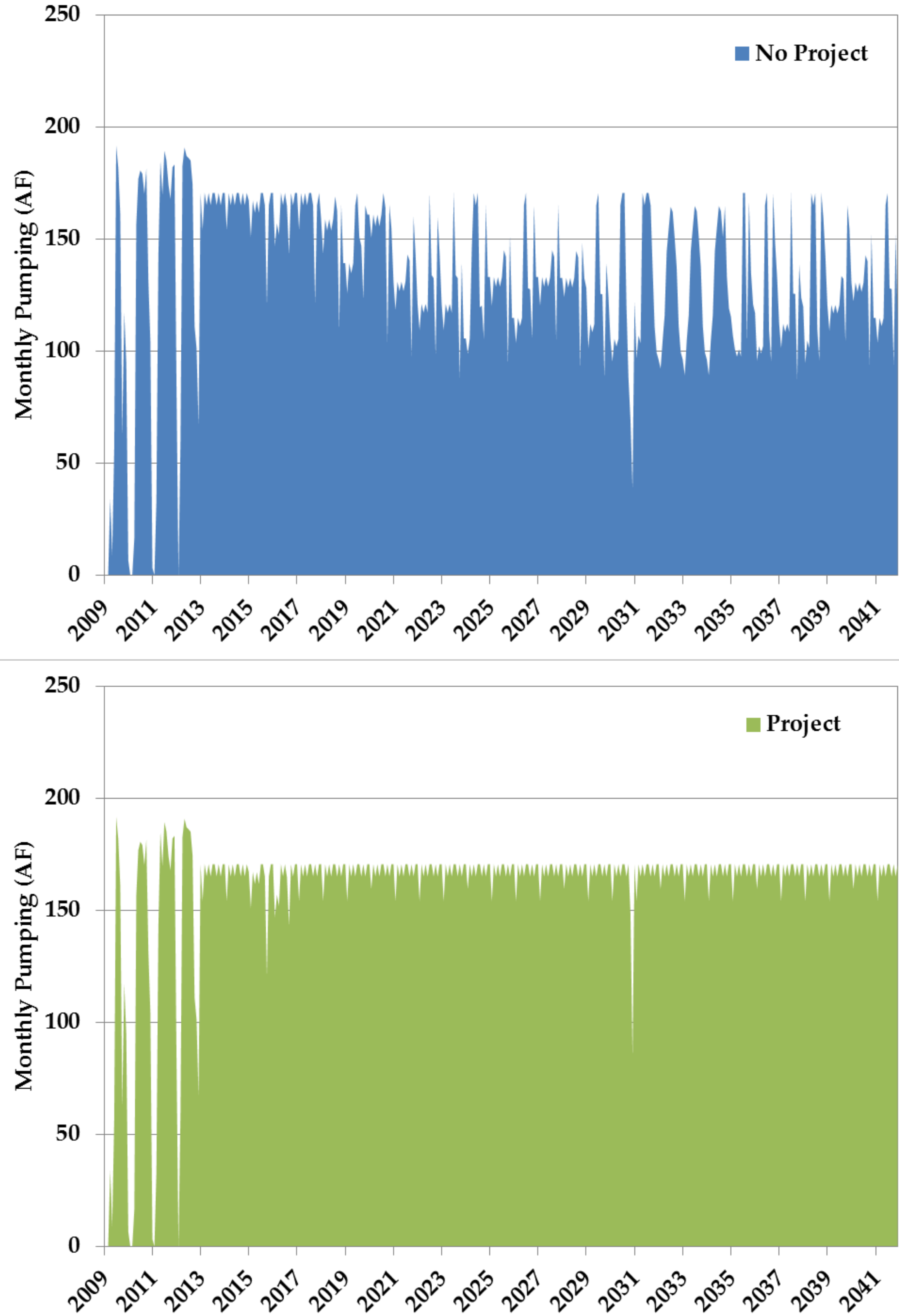



*Figure 17: Pumping Rates for Ord Grove #2 Well*

## PARTICLE TRACKING RESULTS

Figure 18 shows how travel times between the GWR 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 light blue, green, red, and dark blue dots show travel times from the locations of the deep injection wells DIW-1, DIW-2, DIW-3, and DIW-4, respectively. The black, yellow, orange, and magenta dots show travel times from the locations of the vadose zone wells VZW-1, VZW-2, VZW-3, and VZW-4, respectively.

The fastest particles are those released from well DIW-3, 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 approximately 327 days. Travel times from deep injection well DIW-1 are the next fastest; taking approximately 724 days for the fastest particles to reach the ASR 3&4 Well Site. The fastest particles released at the remaining wells take between 2 and 14 years to reach an extraction well, with particles released from vadose zone well VZW-1 never reaching an extraction well after 24 years of simulation.

For most of the wells, there is a notable variation throughout the simulation in the minimum travel time taken by the released particles. For all four deep injection wells, the variations in travel times are strongly influenced by the ASR wells. 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-3 in the early winter 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 the summer 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 that to draw them toward a well.

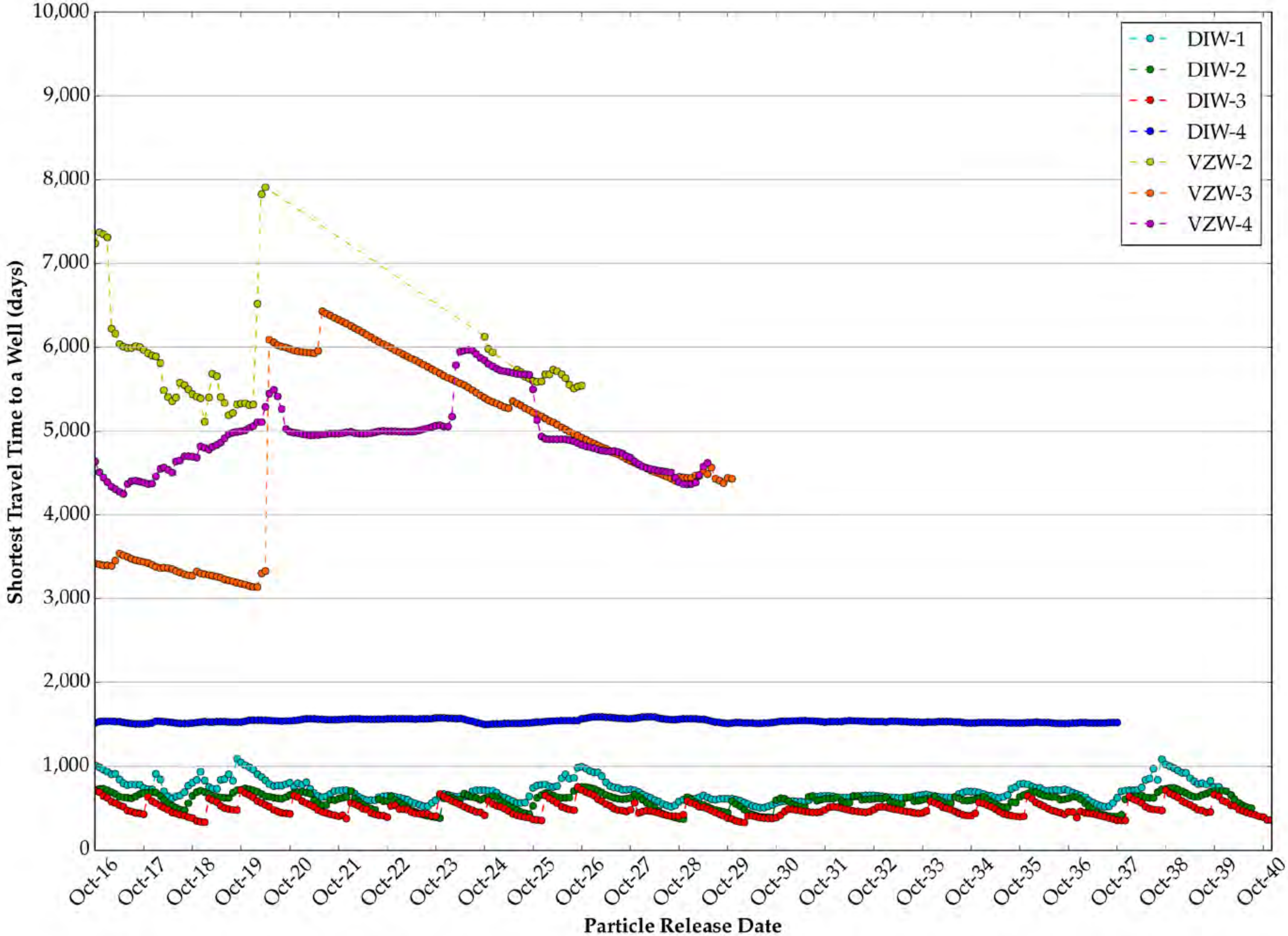



*Figure 18: Fastest Travel Times to a Pumping Well*

The vadose zone wells also display variations in minimum travel times throughout the simulation. 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 or desaturation of shallow model cells which in turn cause rapid changes in vertical and horizontal gradients in these cells. This type of behavior is likely to explain the stepped changes in minimum travel times that are seen in vadose zone wells VZW-2, VZW-3, and VZW-4.

The only production wells that capture particles released from the eight injection locations are the two ASR Well Sites, the Ord Grove #2 well; the Paralta well; and the Luzern well. The following tables summarize how particles from each injection site are captured by nearby wells under the Project scenario.

Table 2 shows the fastest travel times between each injection location and the six groups of extraction wells. A value is not shown if there was no particle travelling between the two wells.

*Table 2: Fastest Travel Times between Injection and Extraction Wells, in days*

| Extraction Well | Well of Origin | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| | 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 | - | - |

Note: — = no particle traveling between wells

Table 3 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 and Ord Grove 2 well capture the greatest share of the particles even though it takes considerably longer for particles to travel to these two wells, as shown on Table 2.

*Table 3: Percent of Particles Travel between Injection and Extraction Wells*

| Extraction Well | Well of Origin | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| | DIW-1 | DIW-2 | DIW-3 | DIW-4 | VZW-1 | VZW-2 | VZW-3 | VZW-4 |
| ASR 1&2 | - | 16% | 44% | 3% | - | - | - | - |
| ASR 3&4 | 34% | - | - | 3% | - | - | - | - |
| Luzern | - | - | - | - | - | - | 100% | - |
| Ord Grove | 3% | 2% | 44% | 55% | - | - | - | 100% |
| Paralta | 63% | 82% | 12% | 39% | - | 100% | - | - |

Note: — = no particle traveling between wells

Figure 19 and Figure 20 show the path each particle takes from its initial injection location to either an extraction well or its final location when the simulation ends. Separate maps for paths originating from deep injection wells and paths originating from vadose zone wells are included. The particle tracks shown on each figure display the fate of particles that were released in the model period corresponding to February, 2030. This date was selected as it is the release period with the fastest travel times.

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 of the particles from the deep injection wells. As noted above, there are several particle paths that fluctuate towards and away from the ASR wells before the particles are captured. These fluctuations are the result of the injection and extraction pattern at the ASR wells.

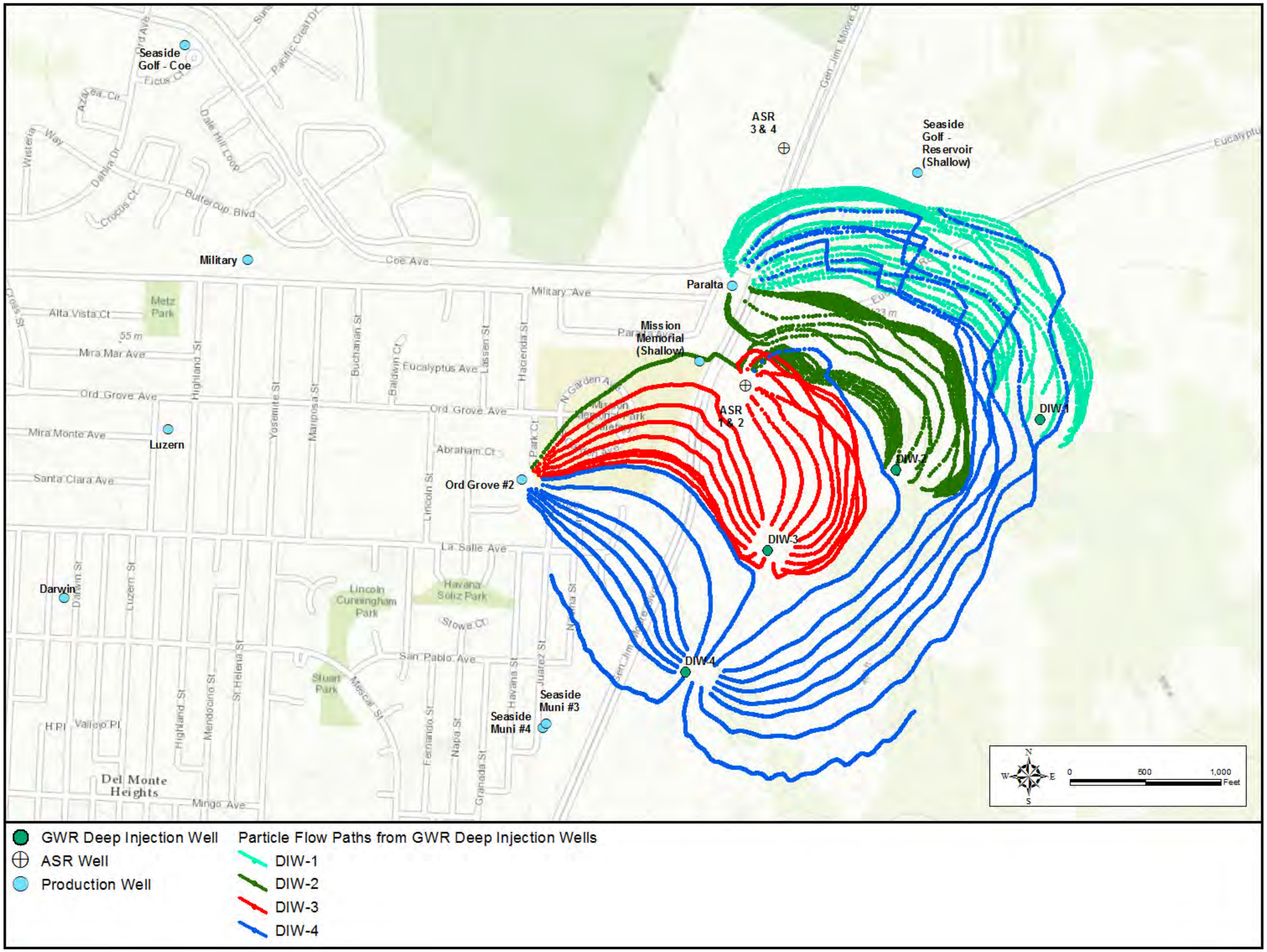



*Figure 19: Particle Paths from a Single Release in Deep Injection*

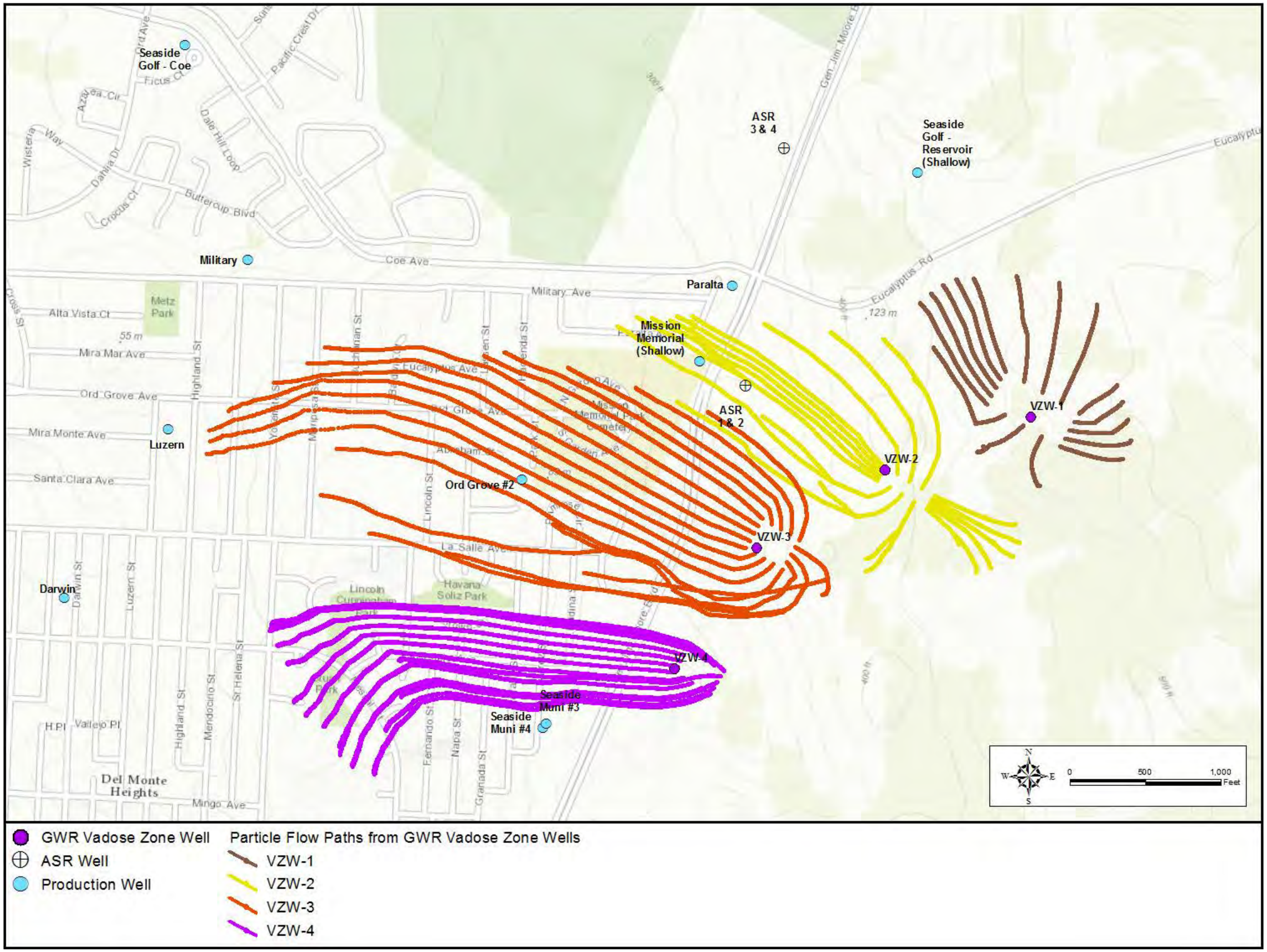



*Figure 20: Particle Paths from a Single Release in Vadose Zone*

Figure 21 and Figure 22 show the greatest particle extent from each injection location at four separate times. Separate maps for paths originating from deep injection wells and paths originating from vadose zone wells are included. Four times are shown: 90 days (yellow), 180 days (orange), 270 days (red), and 360 days (blue). These contours show the same general spatial pattern as Figure 19 and Figure 20 but represent the extent of all particles at any time rather than individual paths. The fourth (blue) contour, representing 360 days, is 33 days shorter than was taken by the fastest particle to travel from injection well DIW-3 to the ASR 1&2 Well Site.

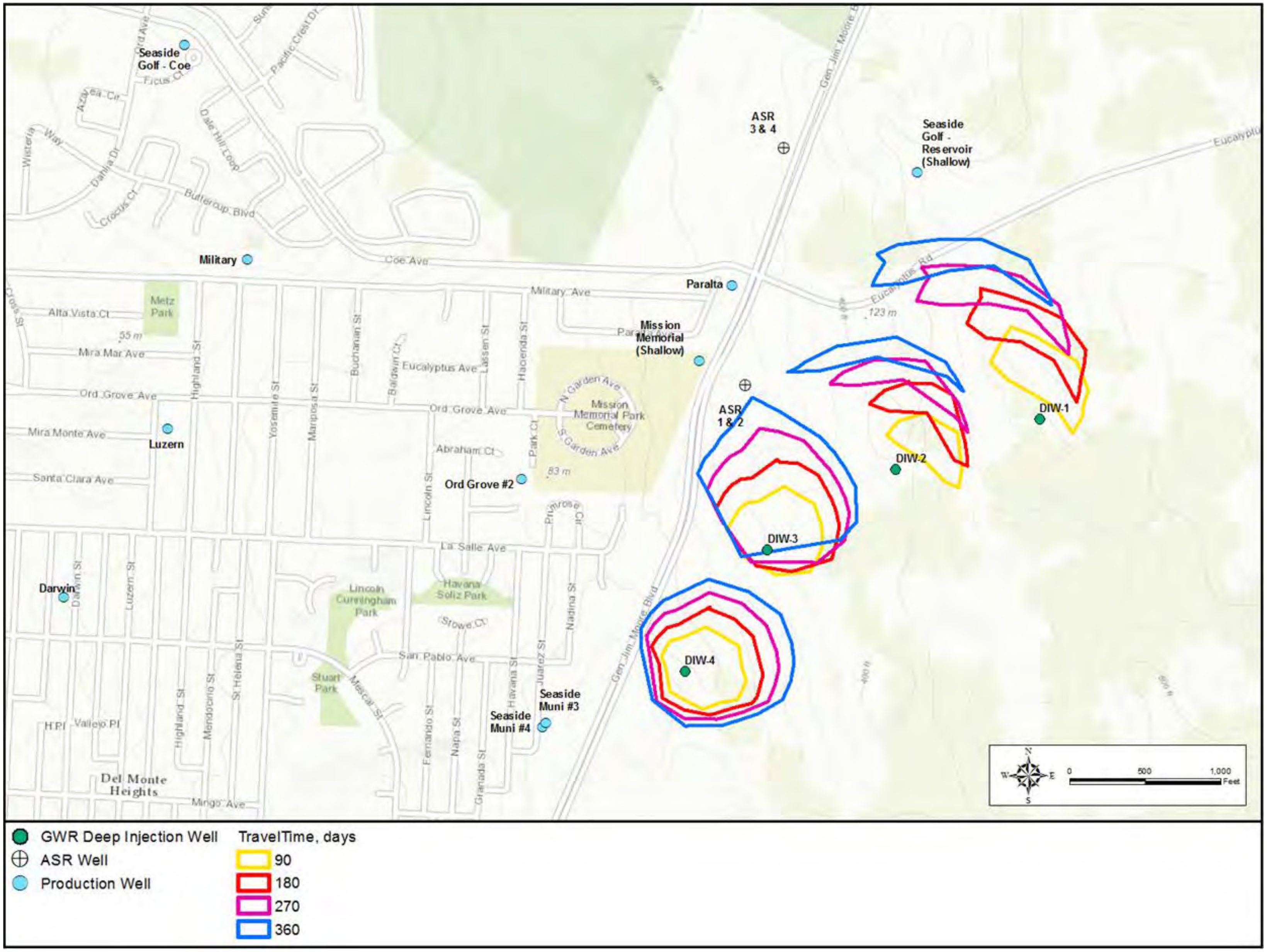



*Figure 21: Travel Time Extents from Deep Injection Wells*

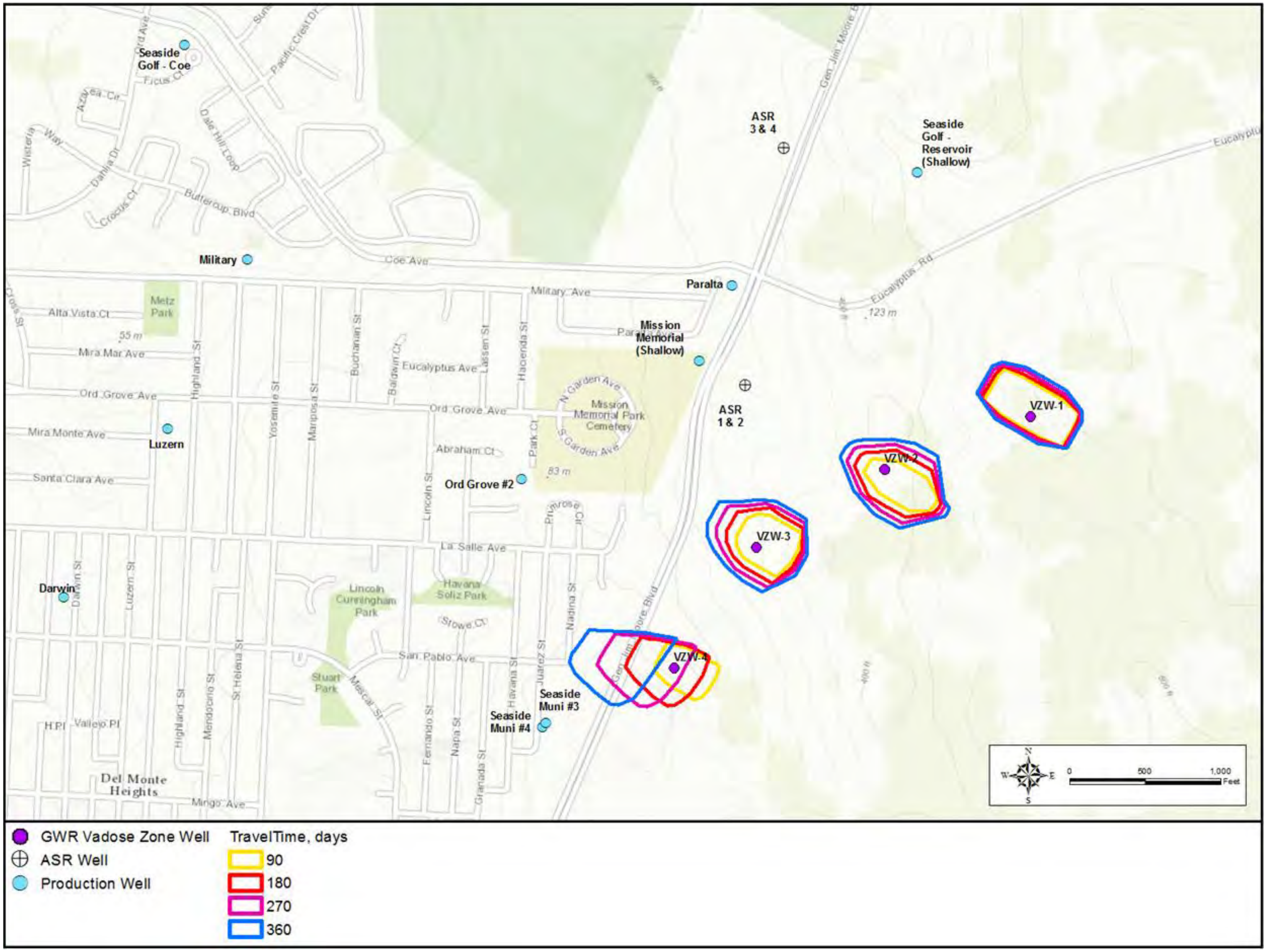



*Figure 22: Travel Time Extents from Vadose Zone Wells*

# References

*California American Water v. City of Seaside et al.* Monterey County Superior Court, Case Number M66343, filed in Monterey County Superior Court on March 27, 2006, amended on February 9, 2007

HydroMetrics Water Resources Inc. 2009. *Seaside groundwater basin modeling and protective groundwater elevations*, prepared for Seaside basin watermaster, November, 151 p.

## *Planned Project Water Injection Schedule and CSIP Storage and Delivery Operation*

| Water Year | Simulated Historical Climate Water Year | Salinas Station Precip (% of Ave.) | Drought Year Criteria (<75% of Average) | Injection Delivery Schedule | Injection Volume (AF) | Annual Recycled Water to CSIP (AF) | Drought Reserve Change (AF) | Cumulative Drought Reserve (AF) | Injection Delivery Schedule (AFM) | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | | | | 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% | | B | 3,500 | - | - | 1,000 | 297 | 288 | 297 | 297 | 268 | 297 | 288 | 297 | 288 | 297 | 297 | 288 | 3,500 |
| 2023 | 2001 | 93% | | B | 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% | | B | 3,500 | - | - | 1,000 | 297 | 288 | 297 | 297 | 268 | 297 | 288 | 297 | 288 | 297 | 297 | 288 | 3,500 |
| 2041 | 1997 | 123% | | B | 3,500 | - | - | 1,000 | 297 | 288 | 297 | 297 | 268 | 297 | 288 | 297 | 288 | 297 | 297 | 288 | 3,500 |

| Injection Delivery Schedule (AF/month) | | | Oct | Nov | Dec | Jan | Feb | Mar | Apr | May | June | July | Aug | Sep | Total |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| before drought reserve complete | wet/normal year | A | 331 | 321 | 331 | 331 | 299 | 331 | 288 | 297 | 288 | 297 | 297 | 288 | 3,700 |
| after drought reserve complete | wet/normal year | B | 297 | 288 | 297 | 297 | 268 | 297 | 288 | 297 | 288 | 297 | 297 | 288 | 3,500 |
| before drought reserve complete | drought year (min. AWTF delivery) | C | 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 |

***APPENDIX A:***
***MPWMD HISTORIC AND PROJECTED ASR WELL SITE INJECTION***

| | | | | | | | Carmel River Water Injection | | ASR sites available for extraction | |
|---|---|---|---|---|---|---|---|---|---|---|
| Model Stress Period | Model Date | Historic Date | Monthly Injection | 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 |
| | | | (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 | N | N | Y | Y |
| Before | Feb-89 | 1989/2 | 0 | 0 | 0 | YES | N | N | Y | Y |
| Before | Mar-89 | 1989/3 | 0 | 0 | 0 | YES | N | N | Y | Y |
| Before | Apr-89 | 1989/4 | 0 | 0 | 0 | YES | N | N | Y | Y |
| Before | May-89 | 1989/5 | 0 | 0 | 0 | YES | N | N | 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 | N | Y | Y |
| Before | Aug-89 | 1989/8 | 0 | 0 | 0 | YES | N | N | Y | Y |
| Before | Sep-89 | 1989/9 | 0 | 0 | 0 | YES | N | N | Y | Y |
| Before | Oct-89 | 1989/10 | 0 | 0 | 0 | YES | N | N | Y | Y |

| | | | | | | | Carmel River Water Injection | | ASR sites available for extraction | |
|---|---|---|---|---|---|---|---|---|---|---|
| Model Stress Period | Model Date | Historic Date | Monthly Injection | 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 |
| | | | (AF) | (AF) | (AF) | (Yes/NO) | (Y/N) | (Y/N) | (Y/N) | (Y/N) |
| Before | Nov-89 | 1989/11 | 0 | 0 | 0 | YES | N | N | Y | Y |
| Before | Dec-89 | 1989/12 | 0 | 0 | 0 | YES | N | N | Y | Y |
| Before | Jan-90 | 1990/1 | 0 | 0 | 0 | YES | N | N | Y | Y |
| Before | Feb-90 | 1990/2 | 0 | 0 | 0 | YES | N | N | Y | Y |
| 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 | N |
| Before | Mar-92 | 1992/3 | 480 | 312 | 168 | NO | Y | Y | N | N |
| Before | Apr-92 | 1992/4 | 0 | 0 | 0 | NO | N | N | N | N |
| Before | May-92 | 1992/5 | 0 | 0 | 0 | NO | N | N | N | N |
| Before | Jun-92 | 1992/6 | 0 | 0 | 0 | YES | N | N | Y | Y |
| Before | Jul-92 | 1992/7 | 0 | 0 | 0 | YES | N | N | Y | Y |
| Before | Aug-92 | 1992/8 | 0 | 0 | 0 | NO | N | N | 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 | N | Y | Y |
| Before | Nov-92 | 1992/11 | 0 | 0 | 0 | YES | N | N | Y | Y |

| | | | | | | | Carmel River Water Injection | | ASR sites available for extraction | |
|---|---|---|---|---|---|---|---|---|---|---|
| Model Stress Period | Model Date | Historic Date | Monthly Injection | 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 |
| | | | (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 | Y |
| 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 | N | N |
| Before | Apr-93 | 1993/4 | 540 | 351 | 189 | NO | Y | Y | N | N |
| Before | May-93 | 1993/5 | 0 | 0 | 0 | NO | N | N | N | N |
| Before | Jun-93 | 1993/6 | 0 | 0 | 0 | NO | N | N | N | N |
| 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 | N | Y | Y |

| | | | | | | | Carmel River Water Injection | | ASR sites available for extraction | |
|---|---|---|---|---|---|---|---|---|---|---|
| Model Stress Period | Model Date | Historic Date | Monthly Injection | 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 |
| | | | (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 | N |
| Before | Feb-96 | 1996/2 | 580 | 377 | 203 | NO | Y | Y | N | N |
| Before | Mar-96 | 1996/3 | 620 | 403 | 217 | NO | Y | Y | N | N |
| Before | Apr-96 | 1996/4 | 480 | 312 | 168 | NO | Y | Y | N | N |
| Before | May-96 | 1996/5 | 60 | 39 | 21 | NO | Y | Y | N | N |
| Before | Jun-96 | 1996/6 | 0 | 0 | 0 | NO | N | N | N | N |
| Before | Jul-96 | 1996/7 | 0 | 0 | 0 | NO | N | N | N | N |
| Before | Aug-96 | 1996/8 | 0 | 0 | 0 | NO | N | N | Y | Y |
| Before | Sep-96 | 1996/9 | 0 | 0 | 0 | NO | N | N | Y | Y |
| Before | Oct-96 | 1996/10 | 0 | 0 | 0 | NO | N | N | Y | Y |
| Before | Nov-96 | 1996/11 | 0 | 0 | 0 | YES | N | N | Y | Y |
| Before | Dec-96 | 1996/12 | 360 | 234 | 126 | NO | Y | Y | N | N |
| Before | Jan-97 | 1997/1 | 620 | 403 | 217 | NO | Y | Y | N | N |
| Before | Feb-97 | 1997/2 | 560 | 364 | 196 | NO | Y | Y | N | N |
| Before | Mar-97 | 1997/3 | 100 | 65 | 35 | NO | Y | Y | N | N |
| Before | Apr-97 | 1997/4 | 0 | 0 | 0 | NO | N | N | N | N |
| Before | May-97 | 1997/5 | 0 | 0 | 0 | NO | N | N | N | N |
| Before | Jun-97 | 1997/6 | 0 | 0 | 0 | YES | N | N | Y | Y |
| Before | Jul-97 | 1997/7 | 0 | 0 | 0 | YES | N | N | Y | Y |
| Before | Aug-97 | 1997/8 | 0 | 0 | 0 | NO | N | 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 | N | N | Y | Y |
| Before | Nov-97 | 1997/11 | 0 | 0 | 0 | YES | N | N | Y | Y |
| Before | Dec-97 | 1997/12 | 120 | 78 | 42 | NO | Y | Y | N | N |
| Before | Jan-98 | 1998/1 | 500 | 325 | 175 | NO | Y | Y | N | N |
| Before | Feb-98 | 1998/2 | 560 | 364 | 196 | NO | Y | Y | N | N |
| Before | Mar-98 | 1998/3 | 620 | 403 | 217 | NO | Y | Y | N | N |
| Before | Apr-98 | 1998/4 | 600 | 390 | 210 | NO | Y | Y | N | N |
| Before | May-98 | 1998/5 | 620 | 403 | 217 | NO | Y | Y | N | N |
| Before | Jun-98 | 1998/6 | 0 | 0 | 0 | NO | N | N | N | N |
| Before | Jul-98 | 1998/7 | 0 | 0 | 0 | NO | N | N | N | N |
| 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 | Y |
| Before | Oct-98 | 1998/10 | 0 | 0 | 0 | NO | N | N | Y | Y |
| Before | Nov-98 | 1998/11 | 0 | 0 | 0 | YES | N | N | Y | Y |
| Before | Dec-98 | 1998/12 | 0 | 0 | 0 | YES | N | N | Y | Y |
| Before | Jan-99 | 1999/1 | 100 | 65 | 35 | NO | Y | Y | N | N |

| | | | | | | | Carmel River Water Injection | | ASR sites available for extraction | |
|---|---|---|---|---|---|---|---|---|---|---|
| Model Stress Period | Model Date | Historic Date | Monthly Injection | 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 |
| | | | (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 | N | N |
| Before | May-99 | 1999/5 | 300 | 195 | 105 | NO | Y | Y | N | N |
| Before | Jun-99 | 1999/6 | 0 | 0 | 0 | NO | N | N | N | N |
| 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 | N | N |
| Before | Feb-00 | 2000/2 | 520 | 338 | 182 | NO | Y | Y | N | N |
| Before | Mar-00 | 2000/3 | 620 | 403 | 217 | NO | Y | Y | N | N |
| Before | Apr-00 | 2000/4 | 320 | 208 | 112 | NO | Y | Y | N | N |
| Before | May-00 | 2000/5 | 0 | 0 | 0 | NO | N | N | N | N |
| Before | Jun-00 | 2000/6 | 0 | 0 | 0 | NO | N | N | N | N |
| Before | Jul-00 | 2000/7 | 0 | 0 | 0 | YES | N | N | Y | Y |
| Before | Aug-00 | 2000/8 | 0 | 0 | 0 | NO | N | N | Y | Y |
| Before | Sep-00 | 2000/9 | 0 | 0 | 0 | NO | N | N | Y | Y |
| Before | Oct-00 | 2000/10 | 0 | 0 | 0 | NO | N | N | Y | Y |
| Before | Nov-00 | 2000/11 | 0 | 0 | 0 | YES | N | N | Y | Y |
| Before | Dec-00 | 2000/12 | 0 | 0 | 0 | YES | N | N | Y | Y |
| Before | Jan-01 | 2001/1 | 140 | 91 | 49 | NO | Y | Y | N | N |
| Before | Feb-01 | 2001/2 | 340 | 221 | 119 | NO | Y | Y | N | N |
| Before | Mar-01 | 2001/3 | 560 | 364 | 196 | NO | Y | Y | N | N |
| 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 | N |
| Before | Jun-01 | 2001/6 | 0 | 0 | 0 | NO | N | N | N | N |
| 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 | Y |
| Before | Nov-01 | 2001/11 | 0 | 0 | 0 | YES | N | N | Y | Y |
| Before | Dec-01 | 2001/12 | 220 | 143 | 77 | NO | Y | Y | N | N |
| 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 | N |

| | | | | | | | Carmel River Water Injection | | ASR sites available for extraction | |
|---|---|---|---|---|---|---|---|---|---|---|
| Model Stress Period | Model Date | Historic Date | Monthly Injection | 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 |
| | | | (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 | N | Y | Y |
| Before | Aug-02 | 2002/8 | 0 | 0 | 0 | NO | N | N | Y | Y |
| Before | Sep-02 | 2002/9 | 0 | 0 | 0 | NO | N | N | Y | Y |
| Before | Oct-02 | 2002/10 | 0 | 0 | 0 | NO | N | N | Y | Y |
| Before | Nov-02 | 2002/11 | 0 | 0 | 0 | YES | N | N | Y | Y |
| Before | Dec-02 | 2002/12 | 340 | 221 | 119 | NO | Y | Y | N | N |
| Before | Jan-03 | 2003/1 | 500 | 325 | 175 | NO | Y | Y | N | N |
| Before | Feb-03 | 2003/2 | 0 | 0 | 0 | NO | N | N | N | N |
| Before | Mar-03 | 2003/3 | 100 | 65 | 35 | NO | Y | Y | N | N |
| Before | Apr-03 | 2003/4 | 360 | 234 | 126 | NO | Y | Y | N | N |
| Before | May-03 | 2003/5 | 400 | 260 | 140 | NO | Y | Y | N | N |
| Before | Jun-03 | 2003/6 | 0 | 0 | 0 | NO | N | N | N | N |
| 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 | N |

| | | | | | | | Carmel River Water Injection | | ASR sites available for extraction | |
|---|---|---|---|---|---|---|---|---|---|---|
| Model Stress Period | Model Date | Historic Date | Monthly Injection | 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 |
| | | | (AF) | (AF) | (AF) | (Yes/NO) | (Y/N) | (Y/N) | (Y/N) | (Y/N) |
| Before | Apr-05 | 2005/4 | 600 | 390 | 210 | NO | Y | Y | N | N |
| Before | May-05 | 2005/5 | 460 | 299 | 161 | NO | Y | Y | N | N |
| Before | Jun-05 | 2005/6 | 0 | 0 | 0 | NO | N | N | N | N |
| Before | Jul-05 | 2005/7 | 0 | 0 | 0 | NO | N | N | N | N |
| Before | Aug-05 | 2005/8 | 0 | 0 | 0 | NO | N | 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 | N | Y | Y |
| Before | Dec-05 | 2005/12 | 20 | 13 | 7 | NO | Y | Y | N | N |
| Before | Jan-06 | 2006/1 | 400 | 260 | 140 | NO | Y | Y | N | N |
| Before | Feb-06 | 2006/2 | 40 | 26 | 14 | NO | Y | Y | N | N |
| Before | Mar-06 | 2006/3 | 620 | 403 | 217 | NO | Y | Y | N | N |
| Before | Apr-06 | 2006/4 | 600 | 390 | 210 | NO | Y | Y | N | N |
| Before | May-06 | 2006/5 | 620 | 403 | 217 | NO | Y | Y | N | N |
| Before | Jun-06 | 2006/6 | 0 | 0 | 0 | NO | N | N | N | N |
| Before | Jul-06 | 2006/7 | 0 | 0 | 0 | NO | N | N | N | N |
| Before | Aug-06 | 2006/8 | 0 | 0 | 0 | NO | N | N | Y | Y |
| Before | Sep-06 | 2006/9 | 0 | 0 | 0 | NO | N | N | Y | Y |
| Before | Oct-06 | 2006/10 | 0 | 0 | 0 | NO | N | N | Y | Y |
| Before | Nov-06 | 2006/11 | 0 | 0 | 0 | YES | N | N | Y | Y |
| Before | Dec-06 | 2006/12 | 0 | 0 | 0 | YES | N | N | Y | Y |
| Before | Jan-07 | 2007/1 | 0 | 0 | 0 | YES | N | N | Y | Y |
| Before | Feb-07 | 2007/2 | 40 | 26 | 14 | NO | Y | Y | N | N |
| Before | Mar-07 | 2007/3 | 40 | 26 | 14 | NO | Y | Y | N | N |
| Before | Apr-07 | 2007/4 | 0 | 0 | 0 | NO | N | N | N | N |
| Before | May-07 | 2007/5 | 0 | 0 | 0 | NO | N | N | N | N |
| Before | Jun-07 | 2007/6 | 0 | 0 | 0 | YES | N | N | Y | Y |
| Before | Jul-07 | 2007/7 | 0 | 0 | 0 | YES | N | N | Y | Y |
| Before | Aug-07 | 2007/8 | 0 | 0 | 0 | NO | N | N | Y | Y |
| Before | Sep-07 | 2007/9 | 0 | 0 | 0 | NO | N | N | Y | Y |
| Before | Oct-07 | 2007/10 | 0 | 0 | 0 | NO | N | N | Y | Y |
| Before | Nov-07 | 2007/11 | 0 | 0 | 0 | YES | N | N | Y | Y |
| Before | Dec-07 | 2007/12 | 0 | 0 | 0 | YES | N | N | Y | Y |
| Before | Jan-08 | 2008/1 | 200 | 130 | 70 | NO | Y | Y | N | N |
| Before | Feb-08 | 2008/2 | 500 | 325 | 175 | NO | Y | Y | N | N |
| Before | Mar-08 | 2008/3 | 260 | 169 | 91 | NO | Y | Y | N | N |
| Before | Apr-08 | 2008/4 | 0 | 0 | 0 | NO | N | N | N | N |

| | | | | | | | Carmel River Water Injection | | ASR sites available for extraction | |
|---|---|---|---|---|---|---|---|---|---|---|
| Model Stress Period | Model Date | Historic Date | Monthly Injection | 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 |
| | | | (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 | N | N | Y | Y |
| Before | Aug-08 | 2008/8 | 0 | 0 | 0 | YES | N | N | Y | Y |
| Before | Sep-08 | 2008/9 | 0 | 0 | 0 | NO | N | N | 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 | N |
| 3 | Mar-09 | 1987/3 | 0 | 0 | 0 | NO | N | N | N | N |
| 4 | Apr-09 | 1987/4 | 0 | 0 | 0 | NO | N | N | N | N |
| 5 | May-09 | 1987/5 | 0 | 0 | 0 | YES | N | 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 | N | N | Y | Y |
| 8 | Aug-09 | 1987/8 | 0 | 0 | 0 | YES | N | N | Y | Y |
| 9 | Sep-09 | 1987/9 | 0 | 0 | 0 | YES | N | N | Y | Y |
| 10 | Oct-09 | 1987/10 | 0 | 0 | 0 | YES | N | 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 | N | N | Y | Y |
| 13 | Jan-10 | 1988/1 | 0 | 0 | 0 | YES | N | N | Y | Y |
| 14 | Feb-10 | 1988/2 | 0 | 0 | 0 | YES | N | N | Y | Y |
| 15 | Mar-10 | 1988/3 | 0 | 0 | 0 | YES | N | N | Y | Y |
| 16 | Apr-10 | 1988/4 | 0 | 0 | 0 | YES | N | N | Y | Y |
| 17 | May-10 | 1988/5 | 0 | 0 | 0 | YES | N | N | Y | Y |
| 18 | Jun-10 | 1988/6 | 0 | 0 | 0 | YES | N | N | Y | Y |
| 19 | Jul-10 | 1988/7 | 0 | 0 | 0 | YES | N | 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 | N | N | Y | Y |

| | | | | | | | Carmel River Water Injection | | ASR sites available for extraction | |
|---|---|---|---|---|---|---|---|---|---|---|
| Model Stress Period | Model Date | Historic Date | Monthly Injection | 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 |
| | | | (AF) | (AF) | (AF) | (Yes/NO) | (Y/N) | (Y/N) | (Y/N) | (Y/N) |
| 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 | 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 | Y | Y |
| 39 | Mar-12 | 1990/3 | 0 | 0 | 0 | YES | N | N | Y | Y |
| 40 | Apr-12 | 1990/4 | 0 | 0 | 0 | YES | N | N | Y | Y |
| 41 | May-12 | 1990/5 | 0 | 0 | 0 | YES | N | N | Y | Y |
| 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 | YES | N | N | Y | Y |
| 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 | YES | N | N | Y | Y |
| 48 | Dec-12 | 1990/12 | 0 | 0 | 0 | YES | N | N | Y | Y |
| 49 | Jan-13 | 1991/1 | 0 | 0 | 0 | YES | N | N | Y | Y |
| 50 | Feb-13 | 1991/2 | 0 | 0 | 0 | YES | N | N | Y | Y |
| 51 | Mar-13 | 1991/3 | 280 | 182 | 98 | NO | Y | Y | N | N |
| 52 | Apr-13 | 1991/4 | 100 | 65 | 35 | NO | Y | Y | N | N |
| 53 | May-13 | 1991/5 | 0 | 0 | 0 | NO | N | N | N | N |
| 54 | Jun-13 | 1991/6 | 0 | 0 | 0 | NO | N | N | N | N |
| 55 | Jul-13 | 1991/7 | 0 | 0 | 0 | YES | N | N | Y | Y |
| 56 | Aug-13 | 1991/8 | 0 | 0 | 0 | YES | N | N | Y | Y |
| 57 | Sep-13 | 1991/9 | 0 | 0 | 0 | NO | N | N | Y | Y |
| 58 | Oct-13 | 1991/10 | 0 | 0 | 0 | YES | N | N | Y | Y |
| 59 | Nov-13 | 1991/11 | 0 | 0 | 0 | YES | N | N | Y | Y |
| 60 | Dec-13 | 1991/12 | 0 | 0 | 0 | YES | N | N | Y | Y |
| 61 | Jan-14 | 1992/1 | 0 | 0 | 0 | YES | N | N | Y | Y |
| 62 | Feb-14 | 1992/2 | 380 | 247 | 133 | NO | Y | Y | N | N |
| 63 | Mar-14 | 1992/3 | 480 | 312 | 168 | NO | Y | Y | N | N |
| 64 | Apr-14 | 1992/4 | 0 | 0 | 0 | NO | N | N | N | N |
| 65 | May-14 | 1992/5 | 0 | 0 | 0 | NO | N | N | N | N |
| 66 | Jun-14 | 1992/6 | 0 | 0 | 0 | YES | N | N | Y | Y |

| | | | | | | | Carmel River Water Injection | | ASR sites available for extraction | |
|---|---|---|---|---|---|---|---|---|---|---|
| Model Stress Period | Model Date | Historic Date | Monthly Injection | 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 |
| | | | (AF) | (AF) | (AF) | (Yes/NO) | (Y/N) | (Y/N) | (Y/N) | (Y/N) |
| 67 | Jul-14 | 1992/7 | 0 | 0 | 0 | YES | N | N | Y | Y |
| 68 | Aug-14 | 1992/8 | 0 | 0 | 0 | NO | N | N | Y | Y |
| 69 | Sep-14 | 1992/9 | 0 | 0 | 0 | NO | N | 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 |
| 74 | 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 |
| 79 | 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 |
| 84 | 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 |
| 94 | 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 |
| 97 | 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 | N |

| | | | | | | | Carmel River Water Injection | | ASR sites available for extraction | |
|---|---|---|---|---|---|---|---|---|---|---|
| Model Stress Period | Model Date | Historic Date | Monthly Injection | 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 |
| | | | (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 | N | 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 | N |
| 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 | N |
| 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 | May-19 | 1997/5 | 0 | 0 | 0 | NO | N | N | N | N |
| 126 | Jun-19 | 1997/6 | 0 | 0 | 0 | YES | N | N | Y | Y |
| 127 | Jul-19 | 1997/7 | 0 | 0 | 0 | YES | N | N | Y | Y |
| 128 | Aug-19 | 1997/8 | 0 | 0 | 0 | NO | N | N | Y | Y |
| 129 | Sep-19 | 1997/9 | 0 | 0 | 0 | NO | N | N | Y | Y |
| 130 | Oct-19 | 1997/10 | 0 | 0 | 0 | NO | N | N | Y | Y |
| 131 | Nov-19 | 1997/11 | 0 | 0 | 0 | YES | N | N | Y | Y |
| 132 | Dec-19 | 1997/12 | 120 | 78 | 42 | NO | Y | Y | N | N |
| 133 | Jan-20 | 1998/1 | 500 | 325 | 175 | NO | Y | Y | N | N |
| 134 | Feb-20 | 1998/2 | 560 | 364 | 196 | NO | Y | Y | N | N |
| 135 | Mar-20 | 1998/3 | 620 | 403 | 217 | NO | Y | Y | N | N |
| 136 | Apr-20 | 1998/4 | 600 | 390 | 210 | NO | Y | Y | N | N |
| 137 | May-20 | 1998/5 | 620 | 403 | 217 | NO | Y | Y | N | N |
| 138 | Jun-20 | 1998/6 | 0 | 0 | 0 | NO | N | N | N | N |
| 139 | Jul-20 | 1998/7 | 0 | 0 | 0 | NO | N | N | N | N |
| 140 | Aug-20 | 1998/8 | 0 | 0 | 0 | NO | N | N | Y | Y |

| | | | | | | | Carmel River Water Injection | | ASR sites available for extraction | |
|---|---|---|---|---|---|---|---|---|---|---|
| Model Stress Period | Model Date | Historic Date | Monthly Injection | 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 |
| | | | (AF) | (AF) | (AF) | (Yes/NO) | (Y/N) | (Y/N) | (Y/N) | (Y/N) |
| 141 | Sep-20 | 1998/9 | 0 | 0 | 0 | NO | N | N | Y | Y |
| 142 | Oct-20 | 1998/10 | 0 | 0 | 0 | NO | N | N | Y | Y |
| 143 | Nov-20 | 1998/11 | 0 | 0 | 0 | YES | N | N | Y | Y |
| 144 | Dec-20 | 1998/12 | 0 | 0 | 0 | YES | N | N | Y | 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 | N | 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 | N | Y | Y |

| | | | | | | | Carmel River Water Injection | | ASR sites available for extraction | |
|---|---|---|---|---|---|---|---|---|---|---|
| Model Stress Period | Model Date | Historic Date | Monthly Injection | 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 |
| | | | (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 | N | Y | Y |

| | | | | | | | Carmel River Water Injection | | ASR sites available for extraction | |
|---|---|---|---|---|---|---|---|---|---|---|
| Model Stress Period | Model Date | Historic Date | Monthly Injection | 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 |
| | | | (AF) | (AF) | (AF) | (Yes/NO) | (Y/N) | (Y/N) | (Y/N) | (Y/N) |
| 215 | Nov-26 | 2004/11 | 0 | 0 | 0 | YES | N | N | Y | Y |
| 216 | Dec-26 | 2004/12 | 60 | 39 | 21 | NO | Y | Y | N | N |
| 217 | Jan-27 | 2005/1 | 620 | 403 | 217 | NO | Y | Y | N | N |
| 218 | Feb-27 | 2005/2 | 560 | 364 | 196 | NO | Y | Y | N | N |
| 219 | Mar-27 | 2005/3 | 620 | 403 | 217 | NO | Y | Y | N | N |
| 220 | Apr-27 | 2005/4 | 600 | 390 | 210 | NO | Y | Y | N | N |
| 221 | May-27 | 2005/5 | 460 | 299 | 161 | NO | Y | Y | N | N |
| 222 | Jun-27 | 2005/6 | 0 | 0 | 0 | NO | N | N | N | N |
| 223 | Jul-27 | 2005/7 | 0 | 0 | 0 | NO | 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 | 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 | N | N | Y | Y |

| | | | | | | | Carmel River Water Injection | | ASR sites available for extraction | |
|---|---|---|---|---|---|---|---|---|---|---|
| Model Stress Period | Model Date | Historic Date | Monthly Injection | 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 |
| | | | (AF) | (AF) | (AF) | (Yes/NO) | (Y/N) | (Y/N) | (Y/N) | (Y/N) |
| 252 | Dec-29 | 2007/12 | 0 | 0 | 0 | YES | N | N | Y | Y |
| 253 | Jan-30 | 2008/1 | 200 | 130 | 70 | NO | Y | Y | N | N |
| 254 | Feb-30 | 2008/2 | 500 | 325 | 175 | NO | Y | Y | N | N |
| 255 | Mar-30 | 2008/3 | 260 | 169 | 91 | NO | Y | Y | 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 | Jun-30 | 2008/6 | 0 | 0 | 0 | YES | N | N | Y | Y |
| 259 | Jul-30 | 2008/7 | 0 | 0 | 0 | YES | N | N | Y | Y |
| 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 | N | N | N |
| 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 | N | N | 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 | N | Y | Y |

| Model Stress Period | Model Date | Historic Date | Monthly Injection | Santa Margarita Site Injection | Seaside Middle School Site Injection | ASR Wells Available for GWR extraction | Carmel River Water Injection: Active Injection Santa Margarita | Carmel River Water Injection: Active Injection Seaside Middle School | ASR sites available for extraction: Santa Margarita Available for Extraction | ASR sites available for extraction: Santa Margarita Available for 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 | N | 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 | N | N | Y | Y |
| 311 | Nov-34 | 1990/11 | 0 | 0 | 0 | YES | N | 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 | N | N | Y | Y |
| 314 | Feb-35 | 1991/2 | 0 | 0 | 0 | YES | N | 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 | N |
| 317 | May-35 | 1991/5 | 0 | 0 | 0 | NO | N | N | N | N |
| 318 | Jun-35 | 1991/6 | 0 | 0 | 0 | NO | N | N | N | N |
| 319 | Jul-35 | 1991/7 | 0 | 0 | 0 | YES | N | N | 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 River Water Injection | | ASR sites available for extraction | |
|---|---|---|---|---|---|---|---|---|---|---|
| Model Stress Period | Model Date | Historic Date | Monthly Injection | 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 |
| | | | (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 | N | N | N | N |
| 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 | N | N | 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 | N | 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 River Water Injection | | ASR sites available for extraction | |
|---|---|---|---|---|---|---|---|---|---|---|
| Model Stress Period | Model Date | Historic Date | Monthly Injection | 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 |
| | | | (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 | N |
| 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 | N | N |

# 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-1O |
| 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-1O |

**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 | Regulatory Requirements | |
|---|---|---|---|---|---|---|---|---|---|---|
| | | mg/L | | | | | | | | Type |
| Bicarbonate ($HCO_3^-$) | 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 $NO_3^-$ | 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 |

## Table D-1B: Metals (Including Major Cations)

| Analyte | Method | Units | MDL | City of Seaside 4 | FO-7**** Deep | FO-7**** Shallow | MRWPCA MW-1**** | PRTIW Mission Memorial | ASR MW-1 | Regulatory 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 (Tl) | 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 |

**Notes:** * Reporting Level or RL. ** Proposed April 15, 2014. *** Reported in laboratory blank. ****Analysis questionable due to high turbidity (see Table D-1C)

## Table D-1C: 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 | Regulatory Requirement | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | Concentration | | | | | | | | Type |
| 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 ($ClO_4^-$) | 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

## Table D-1D: Chlorinated Pesticides and PCBs

| 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 | | | | | | | | Type |
| 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 |

Table 1D: 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 | Regulatory Requirements | |
|---|---|---|---|---|---|---|---|---|---|---|
| | | µg/L | | | | | | | | Type |
| 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 D-1E: Nitrogen and Phosphorus Pesticides

| Analyte | Method | MDL | City of Seaside 4 | FO-07 Deep | FO-07 Shallow | MRWPCA MW-1 | PRTIW Mission Memorial | ASR MW-1 | Regulatory Requirements | |
|---|---|---|---|---|---|---|---|---|---|---|
| | | µg/L | | | | | | | | Type |
| 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 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 | Regulatory Requirements | |
|---|---|---|---|---|---|---|---|---|---|---|
| | | µg/L | | | | | | | | Type |
| 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 | Regulatory Requirements | |
|---|---|---|---|---|---|---|---|---|---|---|
| | | µg/L | | | | | | | | Type |
| 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 | Regulatory Requirements | |
|---|---|---|---|---|---|---|---|---|---|---|
| | | µg/L | | | | | | | | Type |
| 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-1I: 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 | Regulatory Requirements | |
|---|---|---|---|---|---|---|---|---|---|---|
| | | µg/L | | | | | | | | Type |
| 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 |

Table D-1J: 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 | Regulatory Requirements | |
|---|---|---|---|---|---|---|---|---|---|---|
| | | µg/L | | | | | | | | Type |
| 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) (continued)

| 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 | | | | | | | | Type |
| 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)

| Analyte | Method | MRL | City of Seaside 4 | FO-7 Deep | FO-7 Shallow | MRWPCA MW-1 | PRTIW Mission Memorial | ASR MW-1 | Regulatory Requirements | |
|---|---|---|---|---|---|---|---|---|---|---|
| | | µg/L | | | | | | | | Type |
| 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 | 1,750/10,000 | 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-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 | Regulatory Requirements | |
|---|---|---|---|---|---|---|---|---|---|---|
| | | | µg/L | | | | | | | Type |
| 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 µg/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 | Regulatory Requirement | |
|---|---|---|---|---|---|---|---|---|---|---|
| | | µg/L | | | | | | | | Type |
| 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.

## Table D-1M: Nitroaromatics and Nitramines (Explosives)

| Analyte | Methods | MRL | City of Seaside 4 | FO-7 Deep | FO-7 Shallow | MRWPCA MW-1 | PRTIW Mission Memorial | ASR MW-1 | Regulatory Requirement | Type |
|---|---|---|---|---|---|---|---|---|---|---|
| | | µg/L | | | | | | | | Type |
| 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 | – | – |

**Note:**
***** Detected in laboratory blank sample; estimated J value.

## Table D-1N: Pharmaceutical and Personal Care Products (PPCPs)

| Analyte | Method | MRL | City of Seaside 4 | FO-7 Deep | FO-7 Shallow | MRWPCA MW-1 | PRTIW Mission | ASR MW-1 | Regulatory Requirements | |
|---|---|---|---|---|---|---|---|---|---|---|
| | | μg/L | | | | | | | | Type |
| 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 | – | – |
| Iopromide | 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) (continued)

| Analyte | Method | MRL | City of Seaside 4 | FO-7 Deep | FO-7 Shallow | MRWPCA MW-1 | PRTIW Mission Memorial | ASR MW-1 | Regulatory Requirement | |
|---|---|---|---|---|---|---|---|---|---|---|
| | | µg/L | | | | | | | | Type |
| 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 | – | – |
| TCPP | 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 | – | – |

**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-1O: Radiogenic

| Analyte | Method | DL | City of Seaside 4 | FO-7 Deep** | FO-7 Shallow** | MRWPCA MW-1** | PRTIW Mission Memorial | ASR MW-1 | Regulatory Requirement | |
|---|---|---|---|---|---|---|---|---|---|---|
| | | pCi/L | | | | | | | | Type |
| 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)

†† MCL for combined concentrations of Radium 226 and Radium 228

## Table D-1P: Stable Isotopes in Water and Nitrate

| Sample | Water ($H_2O$) | | | | Nitrate ($NO_3^-$) | | | |
|---|---|---|---|---|---|---|---|---|
| | $\delta^{18}O$ | | $\delta D$ | | $\delta^{15}N$ | | $\delta^{18}O$ | |
| | ‰ | 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 |

**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 $1^8O/^{16}O$ 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 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
μg/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