Preliminary Feasibility Study
Aquifer Storage and Recovery Project Concepts to Address Seawater Intrusion

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Prepared for Salinas Valley Basin Groundwater Sustainability Agency

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Round 1 Sustainable Groundwater Management Implementation Grant
for the 180/400-Foot Aquifer Subbasin

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TABLE OF CONTENTS

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ACRONYMS AND ABBREVIATIONS

180/400 Subbasin, or Subbasin....180/400-Foot Aquifer Subbasin
AACE..Advancement of Cost Engineering
AF ....acre-feet
AF/WY.......................................acre-feet per water year
AFY..acre-feet per year
ASR..Aquifer Storage and Recovery
Basin Plan ....Water Quality Control Plan for the Central Coastal Basin
BO ....Biological Opinion
BOD ....Board of Directors
CCCMP.......................................Central Coast Cooperative Monitoring Program
CDFW ....California Department of Fish & Wildlife
CEDEN ....California Environmental Data Exchange Network
CEQA...California Environmental Quality Act
cfs...cubic feet per second
COCs..constituents of concern
CSIP ....Castroville Seawater Intrusion Program
CWA ....Clean Water Act
DDW ....State Water Board Division of Drinking Water
DSOD...Division Safety of Dams
DWR ....California Department of Water Resources
EIR ....Environmental Impact Report
EIS..Environmental Impact Statement
ELAP..environmental laboratory accreditation program
ESA ....Endangered Species Act
FERC..Federal Energy Regulatory Commission
FMP..Farm Process
Gpm...gallons per minute
GSP ....Groundwater Sustainability Plan
HCP..Habitat Conservation Plan
IOP ....Interim Operations Plan
LCG..Life Cycle Geo
M1W ....Monterey One Water
MCLs ....Maximum contaminant levels
MCWRA.....................................Monterey County Water Resources Agency
mg/L...milligrams per liter
NEPA ....National Environmental Policy Act
NMFS...National Marine Fisheries Service
NPDES.......................................National Pollutant Discharge Elimination System

RWQCB or Regional Water Board Central Coast Regional Water Quality Control Board
SFR ....Streamflow Routing
SRDF...Salinas River Diversion Facility
SRPOHCP...................................Salinas River Operations Habitat Conservation Plan
SVBGSA.....................................Salinas Valley Basin Groundwater Sustainability Agency
SVIHM..Salinas Valley Integrated Hydrologic Model
SVOM..Salinas Valley Operational Model
SVRP...Salinas Valley Reclamation Project
SVWC..Salinas Valley Water Coalition
SVWP ....Salinas Valley Water Project
SWI Model...................................Seawater Intrusion Model
SWO..surface water operations
SWRCB or State Water Board.....State Water Resources Control Board
TDS...total dissolved solids
TMs...Technical Memorandums
TSS..total suspended solids
U/S ....Upstream
USACE ....U.S. Army Corps of Engineers
WBS...Water Balance Subregion
WDRs...Waste Discharge Requirements
WY ....Water Year

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SUMMARY REPORT

with Preliminary Feasibility Study Findings

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1 INTRODUCTION

1.1 Overview

The 180/400-Foot Aquifer Subbasin (180/400 Subbasin, or Subbasin) is designated by the California Department of Water Resources (DWR) as critically overdrafted, in part due to seawater intrusion. The 180/400 Subbasin Groundwater Sustainability Plan (GSP) and GSP Amendment 1, prepared in 2020 and 2022 respectively, include projects and management actions to address seawater intrusion and the other sustainability indicators identified in the GSP. Seawater intrusion can potentially be addressed through 3 main mechanisms, 1 of which is to inject water into the aquifers on the landward side of the intrusion, which raises groundwater elevations and helps reduce or push back the intrusion. The other 2 mechanisms, which include creating a barrier through extraction, brackish water treatment, and delivery of in lieu supply, as well as demand management, are being addressed in other feasibility studies.

The Salinas Valley Basin Groundwater Sustainability Agency (SVBGSA), with assistance from Montgomery & Associates (M&A), has evaluated the feasibility of Aquifer Storage and Recovery (ASR) project concepts for the purpose of addressing seawater intrusion. The work is described in a series of 4 Technical Memorandums (TMs). This Summary Report synthesizes the key findings from the feasibility work conducted for the ASR project concept, and is accompanied by the 4 TMs (as attached).

1.2 GSP Project Concept and Alternatives 1 and 1A

GSP Amendment 1 identified projects and management actions that include a project referred to as Seasonal Release with ASR. Generally, ASR indicates that after water is injected, some or all of the water is pumped back out for use. Injection is only an option if there is source water available to inject, so this project concept initially paired shifting reservoir releases with ASR to use re-diverted stored reservoir water for injection into the aquifers. During the progression of the feasibility work, an alternative project concept was identified to use a new diversion structure and diversion of Salinas River winter flows instead of stored reservoir water, herein referred to as Alternative 1 and Alternative 1A, New Diversion of Winter High Flows for ASR. Both project concepts would include ASR as the mechanism to address seawater intrusion.

1.3 Purpose of Preliminary Feasibility Study and this Summary Report

The goal of this preliminary feasibility study is to complete a conceptual analysis that explores the potential for ASR project concepts to meet GSP sustainability goals and objectives related to addressing seawater intrusion in the critically overdrafted 180/400 Subbasin, as well as for using ASR to address related chronic declining groundwater levels below sea level in this subbasin and other adjacent overdrafted subbasins. The objectives of this preliminary feasibility analysis are to focus on key aspects that need to be understood in the early phases of conceptual project development, prior to conducting a comprehensive feasibility study. This acknowledges that ASR could not proceed without consideration of source water and related water rights implications.

Specific objectives of the preliminary feasibility work include the following:

1. Assess whether and how the existing infrastructure poses constraints with respect to the project concept.
2. Review water rights and permitting requirements and identify the permitting and regulatory steps that would be needed for the project concept to proceed.
3. Conduct preliminary analysis of water quality and develop a water quality sampling plan.
4. Evaluate the availability of source water for aquifer injection.
5. Evaluate whether this project concept could effectively achieve GSP goals to mitigate seawater intrusion in the 180/400 Subbasin.

The feasibility work conducted for the ASR project concepts identified here do not constitute a full feasibility study. Rather, the work includes critical aspects that must be considered prior to additional comprehensive analyses, each of which is presented in its own TM. TM1 addresses project constraints and identifies alternatives. TM2 addresses permit requirements, including water rights. TM3 identifies water quality and treatment considerations and recommends a sampling plan. Lastly, TM4 describes the modeling outcomes of the project concepts and the effects of them on seawater intrusion.

The purpose of this summary report is to bring these TMs together to relay their key conclusions about the challenges associated with the project concepts referred to here as Seasonal Release with ASR and New Diversion of Winter High Flows for ASR, pros and cons of each concept, and next steps that would be needed to move an ASR project forward. This summary report is intended to relay the findings in a clear, concise, brief document for consideration by the GSA committees and board, regional partners, stakeholders, and regulatory agencies.

2 BACKGROUND AND PROBLEM STATEMENT

While the Salinas Valley Basin has a long history of groundwater management, additional actions are necessary to eliminate overdraft in several of its subbasins, address seawater intrusion, and conjunctively use supplemental sources of supply. The purpose of these additional projects and management actions is to ensure groundwater resources are sustainable for long-term community, economic, and environmental benefits, and to avoid undesirable effects like lasting groundwater level declines, loss of groundwater storage, and groundwater quality degradation, including seawater intrusion.

Groundwater makes up over 95% of water used within the Salinas Valley, providing for domestic, agricultural, and other beneficial uses. Agriculture in Salinas Valley heavily relies on groundwater, attributing to about 90% of the extractions in the basin. Agriculture provides 1 in 5 jobs in Monterey County and is important nationally in growing a diverse selection of produce. Groundwater extraction has been the primary source of water for the Salinas Valley for over 150 years.

The 2 shallowest aquifers by the coast, the 180-Foot and 400-Foot Aquifers, have direct connectivity with the Pacific Ocean, providing a pathway for seawater intrusion. Seawater intrusion into the 180-Foot and 400-Foot Aquifers occurs due to groundwater levels chronically below sea level. The Deep Aquifers are also directly connected with the Pacific Ocean, and though they have not been impacted by seawater intrusion to date, they are at risk of degradation. Over many decades, Monterey County Water Resources Agency (MCWRA) has studied and implemented several projects to slow the progression of seawater intrusion and provide in lieu water supplies for use instead of groundwater.

Groundwater elevation contour maps document a landward groundwater gradient in the 180-Foot and 400-Foot Aquifers from the coast toward the City of Salinas and the Gabilan Mountain Range, with seawater intrusion reported since the 1940s. A prominent and persistent groundwater characteristic in the Eastside Aquifer Subbasin is the large groundwater depression referred to as the Eastside trough. Groundwater levels east of the seawater intrusion front, including in portions of the shallow and deeper zones of the Eastside Aquifer, remain below sea level.

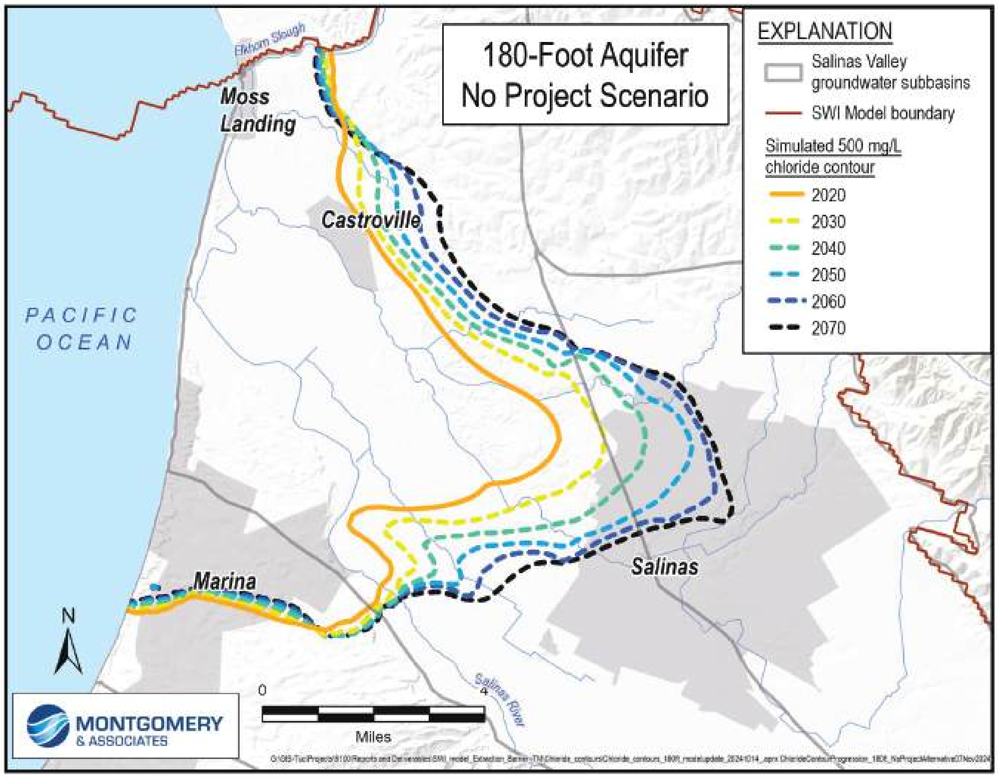
MCWRA owns and operates Nacimiento and San Antonio Reservoirs, which release water into the Salinas River. In addition, since 1998, MWCRA and Monterey One Water (M1W) have cooperated to implement Monterey County Water Recycling Projects. The Salinas Valley Reclamation Project (SVRP) provides advanced treatment of municipal wastewater and delivers it to the Castroville Seawater Intrusion Program (CSIP) to augment groundwater supplies for agricultural irrigation on about 12,000 acres in the seawater intruded area near Castroville. In 2010, MCWRA began to operate the Salinas River Diversion Facility (SRDF) to add surface water to the CSIP water supply. This was done as part of the Salinas Valley Water Project, which also reoperated the reservoirs to release water during the summers when it is needed for irrigation. MCWRA operates the reservoirs for multiple purposes including storage, flood control, environmental purposes, recharge of the Salinas Valley groundwater basin, surface water diversion at the SRDF, recreational use of the reservoirs, and power generation. Reservoir operations need to take into account fish habitat and migration at different times of the year.

MCWRA is currently developing the Salinas River Operations Habitat Conservation Plan (SROHCP) to obtain federal Endangered Species Act (ESA) permits for its water management activities.

While investments in the existing supplemental supply projects have slowed the rate of seawater intrusion, they have not fully mitigated the problem. Groundwater elevations remain below sea level and have continued to decline. Landward sloping groundwater level gradients have increased during recent periods of drought. Following the 2014-2016 drought, MCWRA identified new islands of seawater intrusion in the 400-Foot Aquifer, prompting new investigations for actions to slow or halt the advancement of seawater intrusion in this principal aquifer.

Modeling of current and future conditions (see Figure 1) show that groundwater levels are likely to continue to decline across the northern part of the Salinas Valley and that seawater will advance inland into the City of Salinas, compromising both agricultural and urban water supplies from Salinas to the coast. Continued groundwater extraction within and nearby the seawater intruded area, including in the CSIP supplemental wells, is projected to be impacted by increasing chloride concentrations over time. As seawater intrusion has advanced, new wells have been drilled into the Deep Aquifers underlying the 180-Foot and 400-Foot Aquifers for a replacement supply. However, the Deep Aquifers are also overdrafted given that recharge does not occur on a usable timescale and therefore they are not considered a sustainable new source of water supply. Declining groundwater elevations and loss of storage increase the risk of seawater intrusion or subsidence in the Deep Aquifers.

Actions will be needed to ensure the long-term viability of current and future water supplies, especially within areas considered to be vulnerable due to the presence of pathways and conduits for seawater intrusion. As required by the State of California, SVBGSA has prepared a GSP that lays out potential projects, including the ASR project concept evaluated in this report, with the goal of addressing these problems and managing groundwater sustainably.



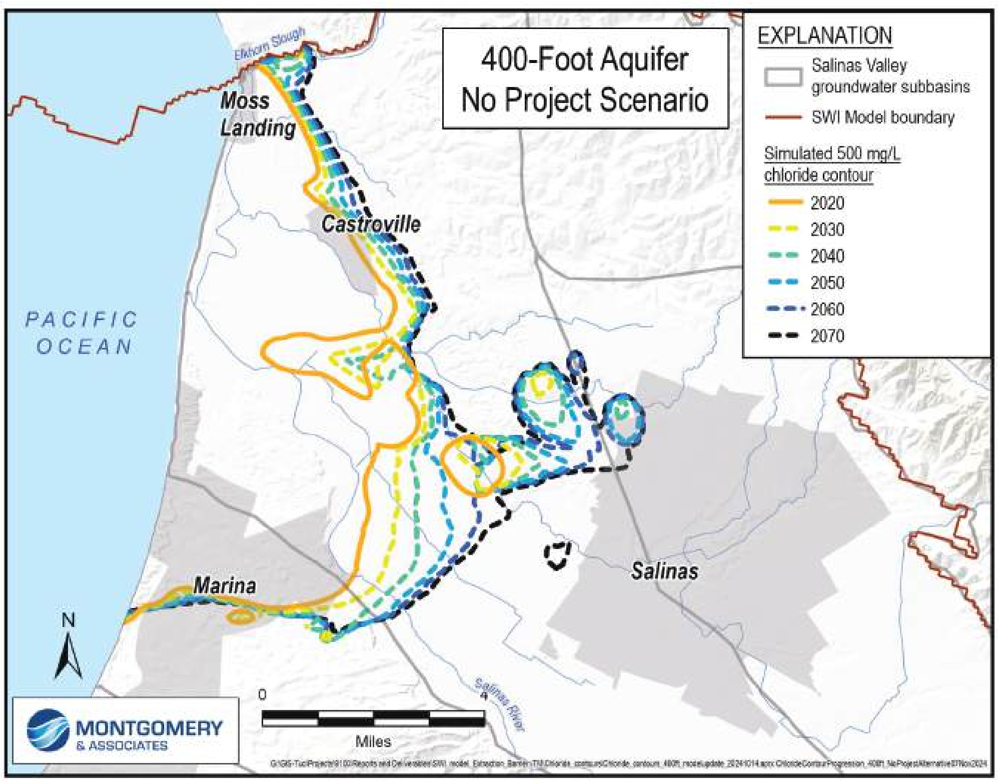


Figure 1.Anticipated Progression of Seawater Intrusion under the No Project Scenario (Do Nothing)

3 PRELIMINARY FEASIBILITY FINDINGS

3.1 General Concept of ASR Project

The ASR project concepts aim to address seawater intrusion while maintaining water supply needs in the CSIP delivery area by:

1. Increasing surface water diversions for recharge during the wet season
2. Injecting diverted surface water inland of the seawater intruded area to raise groundwater elevations
3. In the Seasonal Release with ASR project concept, partially recovering injected water during the growing season to augment CSIP supplies and reduce pumping of native groundwater

As summarized in the sections below, this preliminary feasibility study has included consideration of physical and operational constraints, a review of water rights and permitting requirements, groundwater flow modeling, and high level cost estimates for the Seasonal Release with ASR project concept in the GSP, as well as for newly identified Alternatives 1 and 1A for the New Diversion of Winter High Flows for ASR project concept.

3.2 Seasonal Release with ASR Project Concept

GSP Amendment 1 included the project ***Seasonal Release with ASR or Direct Delivery***. This project concept modified the 2020 GSP Preferred Project 9, SRDF Winter Flow Injection based on further discussions with MCWRA, stakeholder input, and preliminary groundwater modeling.

Similar to the 2020 GSP project concept, the Seasonal Release with ASR project concept would increase diversions by shifting reservoir releases from primarily during the summer/fall to the winter/spring. Diverted water would be pumped to a surface water treatment plant where it would be treated to the standard necessary for groundwater injection and then conveyed to new ASR wells in the 180-Foot and 400-Foot Aquifers. New injection well facilities would include separate wells completed in both aquifers, back-flush facilities including back wash pumps and percolation basins for water disposal into the vadose zone, electrical and power distribution, and motor control facilities.

Injected water would help raise groundwater elevations, improve water quality, and prevent further seawater intrusion. The aquifers would function as storage, and a portion of this water would then be recovered and provided to CSIP during the summer/fall irrigation season.

Figure 2 depicts ASR injection within the 180-Foot and 400-Foot Aquifers. ASR injection and CSIP supplemental extraction wells would be located inland of the seawater intrusion front to most effectively help address seawater intrusion.

Through the constraints analysis discussed in TM1, a new alternative was identified, referred to here as Alternative 1 and 1A, New Diversion of Winter High Flows for ASR.

In addition to direct injection for groundwater recharge, seasonal releases could be used for direct delivery for municipal supply. Direct delivery of seasonal releases may be a less expensive option but may provide less benefit to halting seawater intrusion. Direct delivery was not analyzed in this preliminary feasibility study, which focuses on ASR, but this is planned to be further evaluated in other studies.

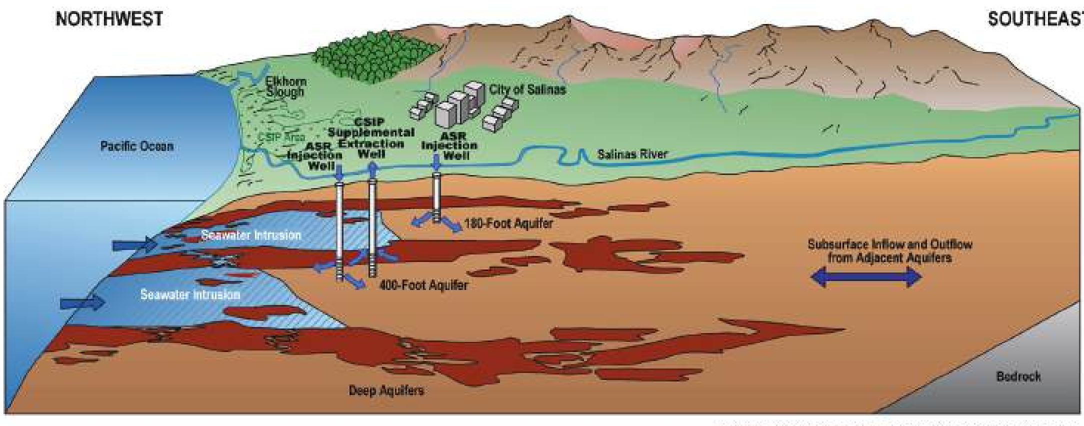


Figure 2. Conceptual Depiction of ASR Injection in 180-Foot and 400-Foot Aquifers

3.2.1 Water Rights and Permitting

MCWRA has several obligations to honor and consider for reservoir operations: water rights requirements (environmental compliance, groundwater recharge, and SRDF operations); San Luis Obispo County and Salinas Valley Water Coalition settlement agreements; and flood control operations. These need to be considered when proposing new operations to implement the Seasonal Release with ASR project concept.

Existing MCWRA Nacimiento and San Antonio Reservoir water rights (License 7543, License 12624, and Permit 21089) authorize collection to storage only at the existing reservoirs, with re-diversion of previously stored water at the SRDF from April 1 to October 31. The Seasonal Release with ASR project concept would require modifying the licenses and permits to also allow re-diversion during the winter and to allow for diversion to underground storage. Doing so may constrain the amount of water that can be re-diverted at the SRDF during the peak growing season, affect flood control release timing, affect groundwater recharge, and must still provide the required SRDF fish bypass and lagoon needs. The relationship of these potential modifications with existing settlement agreements and current Salinas Valley Water Project assessments would need to be further addressed. Water rights, permitting, and regulatory constraints are discussed further TM2.

3.2.2 Constraints of Using Existing System for Seasonal Release with ASR

The Seasonal Release with ASR project concept would use existing water rights and facilities to the extent feasible. In 2023 and 2024, SVBGSA and MCWRA, as well as M1W, held focused meetings on the existing infrastructure systems and operations to uncover any potential constraints associated with using the Monterey County Recycled Water Projects to add the ASR project concept to these existing facilities.

MCWRA identified a number of operational challenges related to changing the reservoir releases to earlier in the year, as described below.

- **Reservoir Operational Challenges:** Winter reservoir releases are challenging primarily due to the need to respond to uncertain reservoir inflows while trying to prevent flooding and maintain as much water in storage as possible for later in the year, in order to meet supply demands and environmental requirements.

- **SRDF Operational Challenges:** There are also challenges with operating the SRDF earlier in the year. High winter flows are typically associated with high turbidity, water quality issues, debris, and clogging and filtration problems. This would result in accelerated wear of pumping components and high flows that can impact the facilities and result in operational uncertainties. MCWRA noted the high likelihood of damage, potential for downstream erosion, and inaccessibility of the pump station during high flows.

- **Diversion Capacity and Conveyance:** SRDF has a permitted maximum diversion capacity of 48 cubic feet per second (cfs) but is not operated above 36 cfs due to operational limitations. This limits the ability to divert additional water at a higher diversion rate under the Seasonal Release with ASR project concept. While the project concept would use the existing SRDF, it would require its own conveyance system—including storage and treatment—before being conveyed to the ASR wells for injection so that the water would not be mixed with recycled water. The storage and treatment would need to be sized to accommodate large wet season flows, which are intermittent.

- **Water Quality:** It is assumed that the project would need to treat water to Title 22 drinking water standards to meet the injected water requirements of the SWRCB's Water Quality Order 2012-0010 General Waste Discharge Requirements for Aquifer Storage and Recovery Projects that Inject Drinking Water into Groundwater (ASR General Order). Existing water quality data were analyzed as part of this feasibility work to develop a future sampling plan and inform water treatment needs. While data are limited, they indicate a potential need for additional treatment for salts (total dissolved solids, nitrates, and sulfates) and metals.

New infrastructure needed for the project concept includes conveyance from the SRDF to storage and water treatment, conveyance to the ASR wells, ASR injection and extraction wells, and distribution from the extraction wells to CSIP system.

The system components necessary for realizing the Seasonal Release with ASR project concept are shown on Figure 3. Constraints of the existing infrastructure system for this project concept are discussed further in TM1, and the water quality analysis and sampling plan are included in TM3.

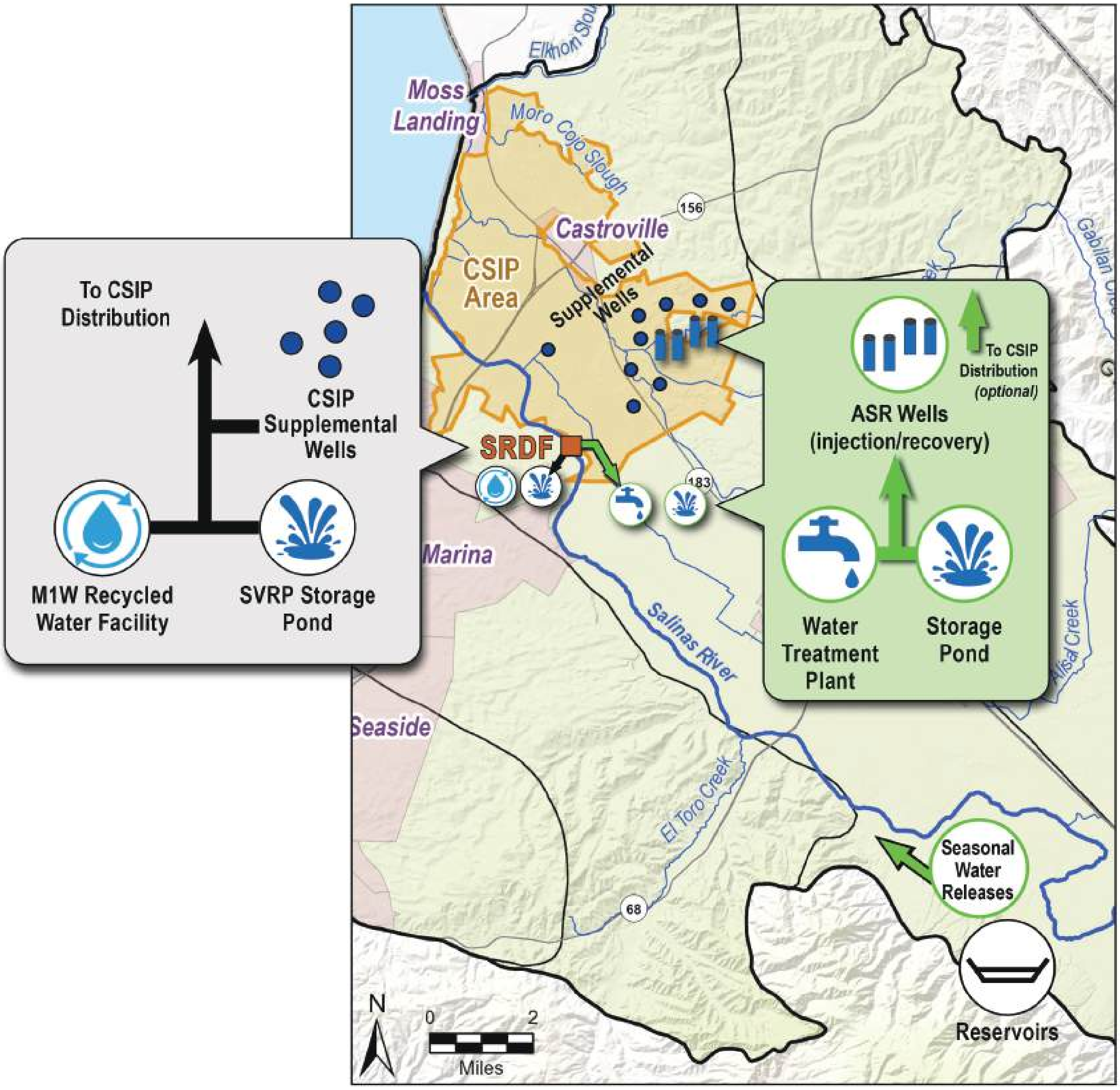


Figure 3. Seasonal Release with ASR Project Concept System Components

3.2.3 Groundwater Flow Modeling

Groundwater flow modeling was conducted to assess: 1) the water available for re-diversion at the SRDF when operating the reservoirs in a different season, 2) optimizing the location and injection/extraction rates of ASR wells, and 3) assessing the ability of this project concept to address seawater intrusion in the 180-Foot and 400-Foot Aquifers.

Modeling was completed with the provisional Valley-wide Salinas Valley Operational Model (SVOM)[1] (which is based on the Salinas Valley Integrated Hydrologic Model – SVIHM) to identify water available for diversion and then using that information with the Seawater Intrusion Model (SWI Model) for ASR wells operations and resulting effects on the aquifers. Project modeling was compared to a No Project Scenario that projects average groundwater conditions in 2070 if no new projects or management actions are implemented.

Results from the SVOM corresponding to the hydrology of WY 1996-2018 are extracted and imported into the SWI Model. WY 1996-2018 was selected as a period representative of recent hydrological conditions (referred to as the representative period). Hydrological conditions from WY 1996-2018 were assigned to the model as proxy years starting in October 2020 (October 2020 represents October 1995). The proxy years WY 1996-2018 cycle through the end of the SWI Model simulation in 2070. The modeling assumes the ASR project becomes operational in 2030, and thus when the project starts in 2030 the proxy year is 2005.

The Seasonal Release with ASR project concept, as outlined in the 180/400 Subbasin GSP, assumes the SRDF operation would be shifted from its current spring to fall diversion to a winter to summer diversion. In this scenario, the SRDF begins operating December 1, at a maximum diversion rate of 36 cfs, and ends on June 30. This represents a change in seasonal diversions of stored water at the Nacimiento and San Antonio Reservoirs and re-diversion at the SRDF between December 1 and July 1 each year. All water diverted at the SRDF would be injected into both the 180-Foot and 400-Foot Aquifers through 16 ASR wells, 8 in each aquifer. The CSIP Area water demand would be supplied as needed through a combination of SVRP recycled water, CSIP supplemental wells, and extraction of injected and stored water from ASR wells. This project concept would cease pumping from private standby wells within the Zone 2B area, as it assumes that all unmet demand in the CSIP distribution system would be met through ASR pumping.

[1] These data (SVIHM and SVOM model and/or model results) are preliminary or provisional and are subject to revision. This model and model results are being provided to meet the need for timely best science. The model has not received final approval by the USGS. No warranty, expressed or implied, is made by the USGS or the U.S. Government as to the functionality of the model and related material nor shall the fact of release constitute any such warranty. The model is provided on the condition that neither the USGS nor the U.S. Government shall be held liable for any damages resulting from the authorized or unauthorized use of the model.

TM 4 provides details of modeling assumptions and results. Key modeling results are summarized below.

The modeled wintertime operation of the SRDF resulted in an average diversion of 12,900 acre-feet per water year (AF/WY), which is more than in the No Project Scenario. The Seasonal Release with ASR Scenario resulted in an average increase in SRDF diversions because the SRDF was more likely to be able to operate in drier conditions. By shifting SRDF operation to the winter, reservoir releases would not need to be as large to maintain desired flows. This is because simulated water levels along the Salinas River are higher and losses through the riverbed are therefore less. This would allow the storage in the reservoirs to remain higher year-to-year, such that when a drier period starts, the reservoirs are more likely to meet minimum storage requirements.

With the Seasonal Release with ASR project concept, more groundwater pumping would be needed to meet CSIP demands because the SRDF diversions would be used for ASR injection instead of for direct CSIP supply. The average total groundwater pumping would be 14,300 AF/WY for the representative period. This included 11,600 AF/WY of pumping from CSIP supplemental wells and an additional 2,700 AF/WY from ASR wells. ASR injection totaled 12,900 AF/WY on average during the modeled representative period.

Figure 4 compares the simulated 2070 intrusion extent (blue dashed line), with the 2070 No Project intrusion extent (red dashed line) and the current seawater intrusion minimum threshold (black line.) In the 180-Foot Aquifer (top map), there is some improvement in controlling seawater intrusion relative to the No Project Scenario on the northern side of the intruded area and near the City of Salinas. However, on the southern side the 500 milligrams per liter (mg/L) chloride contour has been pushed farther to the southeast by ASR_08. In the 400-Foot Aquifer (bottom map), the 500 mg/L chloride contour is pushed closer to the coast and away from the City of Salinas near ASR_09 through ASR_12. The area of seawater intrusion migrating downward from the 180-Foot Aquifer to the 400-Foot Aquifer appears to be pushed farther north and pulled westward by increased pumping at the CSIP supplemental wells. In general, the Seasonal Release with ASR project concept with a seasonal diversion scenario is not very effective at pushing the 500 mg/L chloride contour closer to the minimum threshold in either the 180- or 400-Foot Aquifers.

Figure 5 shows the impact of ASR injection on chloride concentrations. Figure 5 shows that even in areas where the ASR wells appear to be effective at slowing down seawater intrusion, saline water with concentrations below 500 mg/L are able to pass through the barrier of ASR wells. In the 400-Foot Aquifer (bottom right map), increased pumping at the CSIP supplemental wells results in increased chloride concentrations compared to the No Project Scenario in the portion of the 400-Foot Aquifer that is already impacted by seawater.

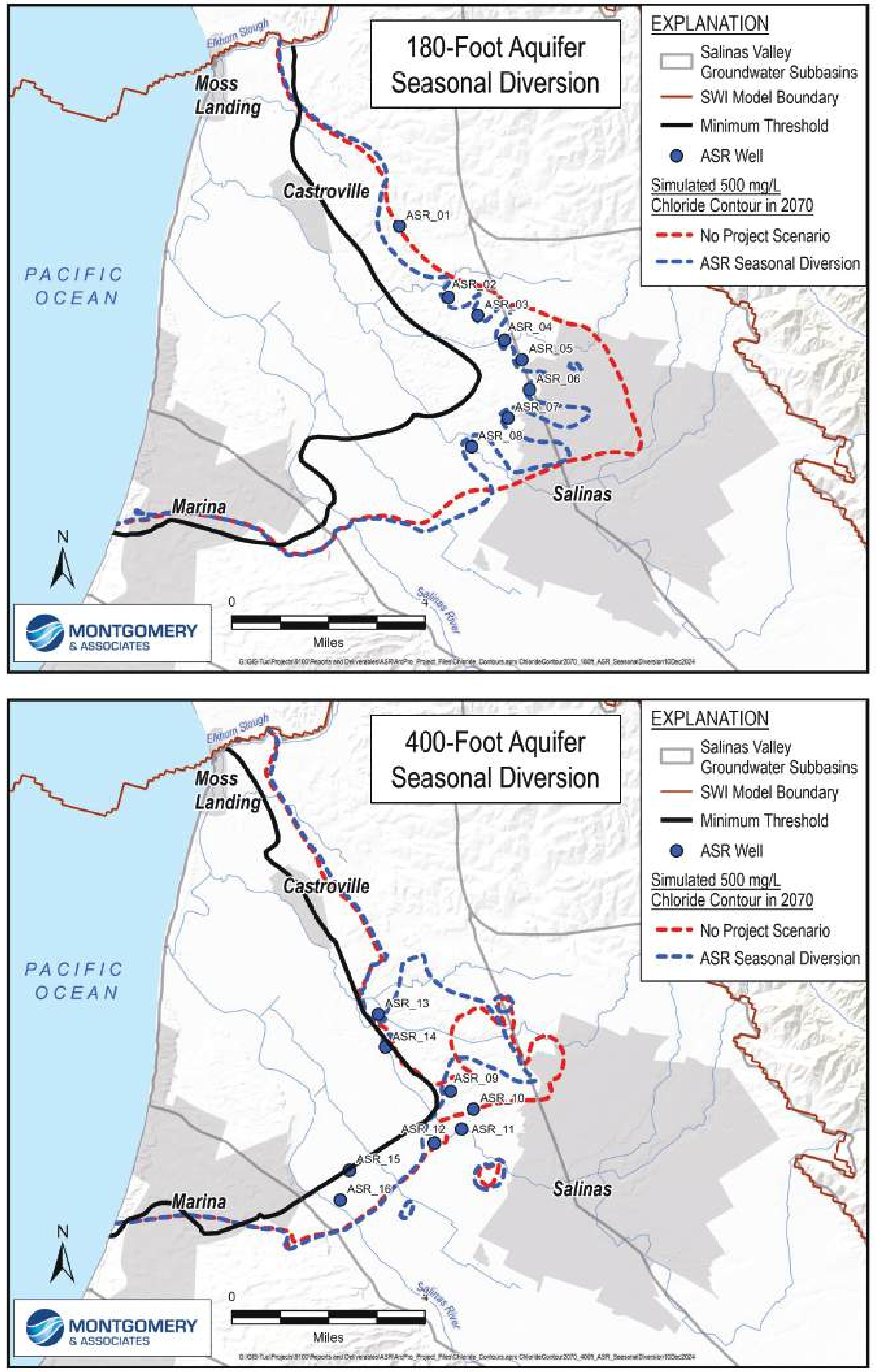


Figure 4. Seasonal Diversion Scenario – 2070 500 mg/L Chloride Contours Comparison to No Project Scenario and Minimum Threshold

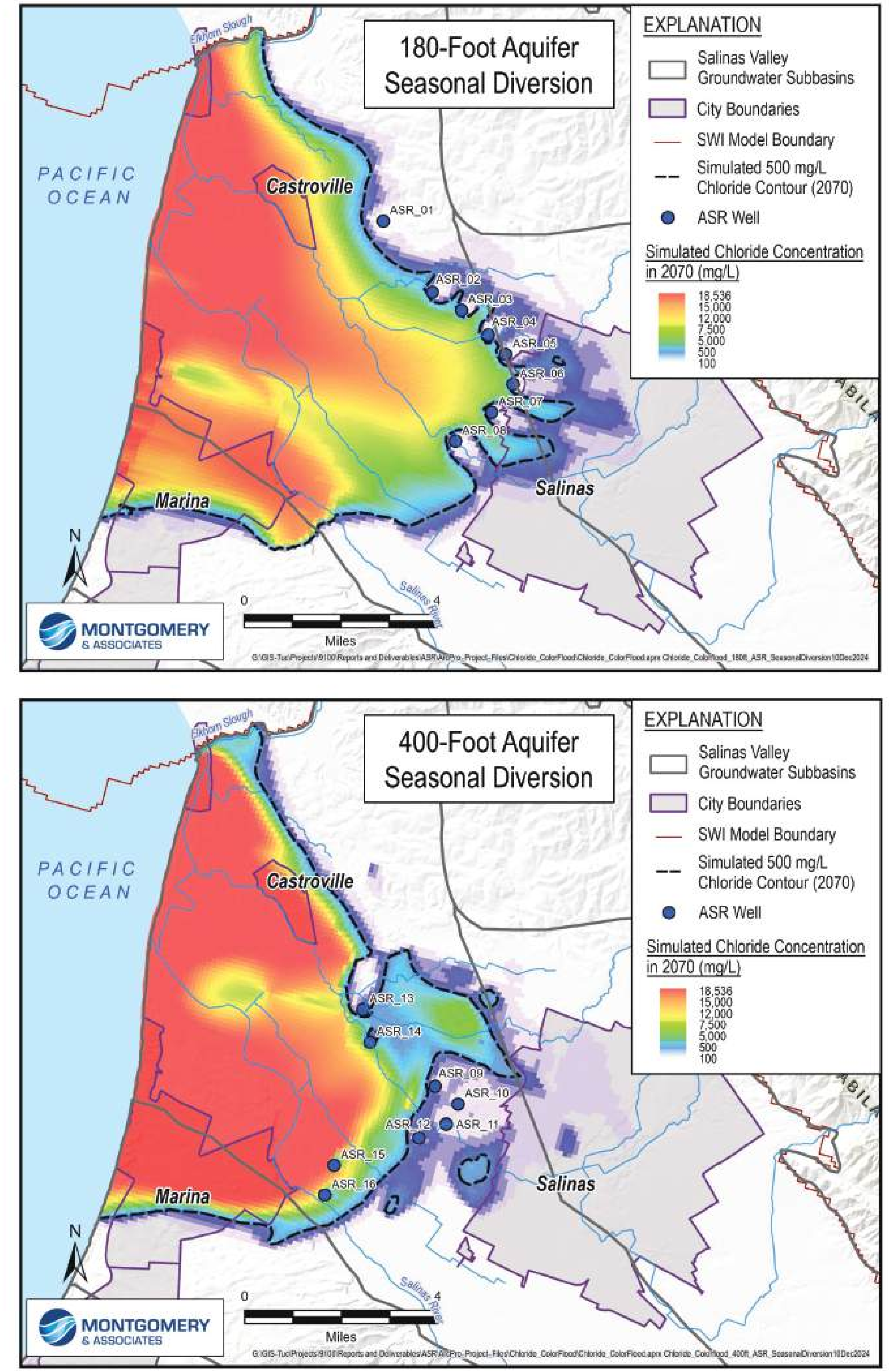


Figure 5. Seasonal Diversion Scenario: Chloride Concentrations (2070)

3.2.4 Cost Estimate

The Wallace Group completed a high level cost estimate (AACE Class 5 – Preliminary Opinion of Probably Cost2) that reflects the revised project concept. The total capital cost of additional infrastructure was estimated at $343,930,000. This high-level cost estimate was estimated with the minimum infrastructure required. With operations and maintenance costs included and annualized based on the facility life and interest rates, the unit cost was estimated at $2,390/AF for each of the maximum 15,000 acre-feet per year (AFY) injected and injected. This maximum diversion differs from the available water identified in the modeled scenarios. See Table 5 for the cost estimate.

3.3 Alternatives 1 and 1A – New Diversion of Winter High Flows for ASR

Based on the constraints identified for the Seasonal Release with ASR concept, Alternatives 1 and 1A, referred to here as New Diversion of Winter High Flows for ASR were identified to accommodate existing system constraints. For water to be considered able to be re-diverted at the SRDF, it must be stored in 1 of the reservoirs for 30 days. This restricts the ability to reliably release and re-divert stored water during the winter months when inflow to the reservoirs is high. Further, given the operational constraints of releasing and re-diverting water in the winter, MCWRA recommended keeping normal reservoir operations in support of the conservation program and SRDF operations from April through October, and developing a separate, parallel ASR diversion and conveyance system.

Alternatives 1 and 1A, the New Diversion of Winter High Flows with ASR project concept, would maintain the current reservoir and SRDF operation schedules, with SRDF diversions occurring between April and October to supply CSIP irrigation demand. This project concept would provide for the diversion of excess winter watershed flows that bypass the reservoirs and divert them downstream at a new diversion structure, upstream of the SRDF structure. The new diversion facility could be developed using Ranney Collector wells screened in the alluvium under the river (discussed below). That water would then follow a similar path to the ASR wells as described for the Seasonal Release with ASR project concept. In this scenario, the ASR wells are intended to be used only for injection, since the SRDF is used for irrigation diversion with the CSIP supplemental wells. The New Diversion of Winter High Flows for ASR project concept Alternatives 1 and 1A differ in that Alternative 1 injects into both aquifers and Alternative 1A injects into only the 400-Foot Aquifer, since seawater intrusion has slowed in the 180-Foot Aquifer.

3.3.1 Water Rights and Permitting

New Diversion of Winter High Flows for ASR project concept could either use MCWRA's existing Permit 11043 Salinas River water right with some modifications, or a new water right application could be filed. Permit 11043 would need to be modified to change the location of diversion to the new diversion location and include diversion for underground storage.

3.3.2 Constraints of Developing a New Diversion System for Alternatives 1 and 1A

The New Diversion of Winter High Flows for ASR project concept would use all the same new infrastructure as required for the Seasonal Release with ASR project concept—except the conveyance to the ASR wells would be from the new diversion, not from the SRDF—and no new conveyance to the CSIP system would be needed. A different diversion structure would be needed to accommodate more frequent flow diversions on the Salinas River with a new or modified water right. The water right process is discussed in TM2.

This preliminary feasibility study and identification of potential constraints does not include an evaluation of potential sites for a new diversion structure or the feasibility of different types of diversion structures. Further analysis would be needed for consideration of this alternative approach. However, 1 potential option is radial well collectors, which are also known as Ranney Collector wells from the original company that developed the systems most commonly in use in the United States, as they offer many advantages as a diversion system for this ASR project. A Ranney Collector is a type of radial well used to extract water from an aquifer with direct connection to a surface water source like a river or lake. Collectors are built to induce infiltration from a surface water body to divert and distribute that naturally filtered water from a surface water point of diversion. TM1 provides more information about this type of diversion.

Ranney Collector wells would require considerable additional evaluation and field studies to assess if it may be feasible to construct and operate on the lower Salinas River. For example, 1 challenge of building a new diversion and pumping facility is that there may be limited suitable land available adjacent to the Salinas River. This type of new diversion system would require a separate pipeline to a treatment facility and separate storage to support ASR injections.

Key challenges for developing the New Diversion of Winter High Flows for ASR project concept include:

- **Water Rights:** Reservoir bypass flows primarily pertain to winter flow water that is not stored and is typically only available from about December through March or April. This water would require modification to an existing Salinas River water right, or a new water right to divert to storage underground.

- **Water Availability:** The proposed Interlake Tunnel and San Antonio Spillway Modification project (Interlake Tunnel) is projected to reduce reservoir bypass flows by increasing quantities of winter inflow diverted to storage in the San Antonio Reservoir under MCWRA's modified water rights (petitions have been filed to modify existing water rights for this project). Modeling for the Interlake Tunnel projects an average annual increase in combined storage in both reservoirs of 53,300 AF. If this project proceeds, there would likely not be enough water available to also divert for ASR to support applying for a new water right.

- **New Infrastructure Challenges:** The New Diversion of Winter High Flows for ASR project concept requires major new infrastructure, which will be costlier than the Seasonal Release with ASR project concept, and it includes more uncertainties about the siting of a new diversion and its viability in the Salinas Valley.

- **Maintenance:** Maintaining the new infrastructure will likely be challenging because of the intermittent nature of the flow available for diversion.

Overall, the system components needed for the New Diversion of Winter High Flows for ASR project concept are shown on Figure 6.

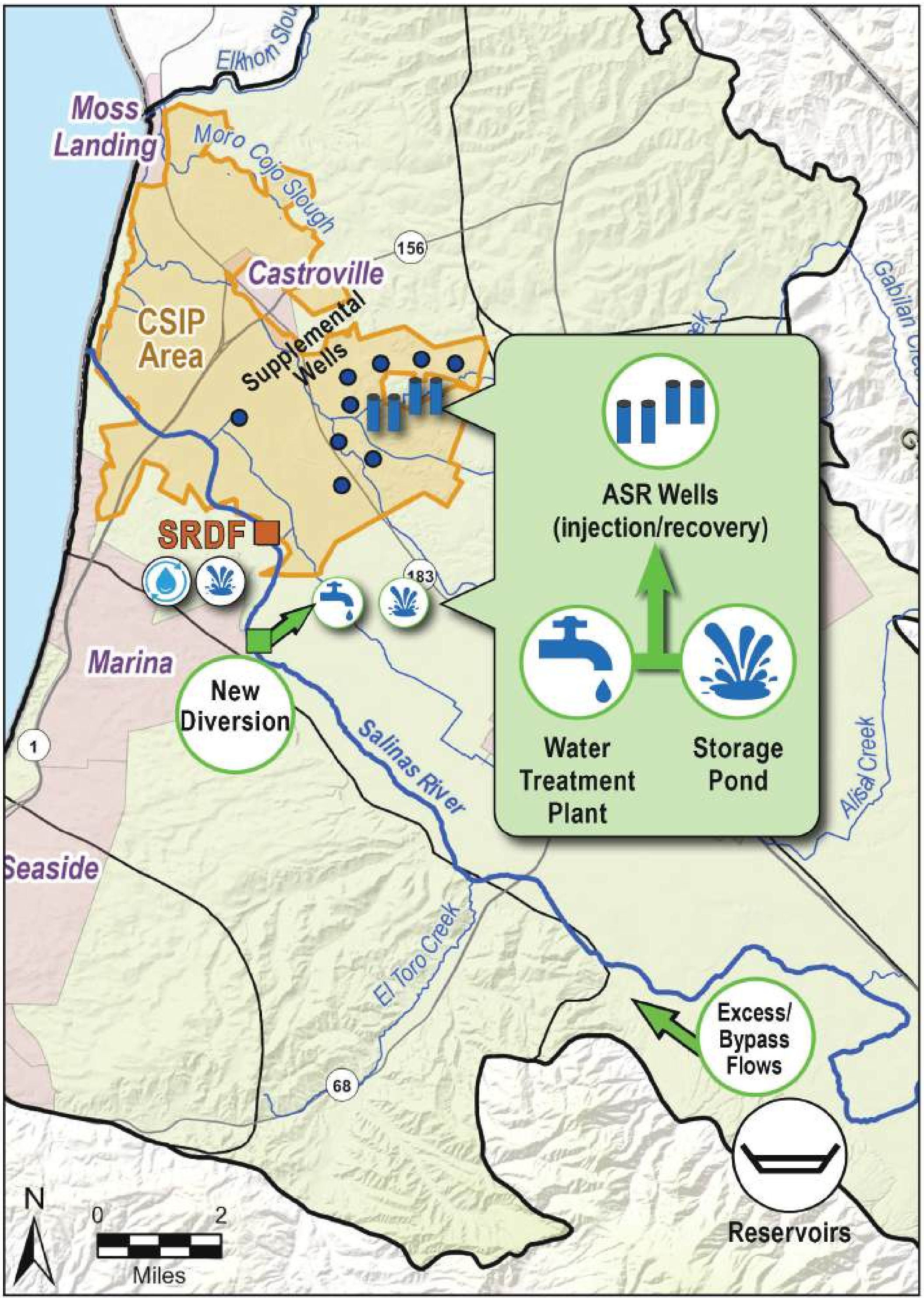


Figure 6. New Diversion of Winter High Flows for ASR Project Concept System Components

3.3.3 Groundwater Flow Modeling

The 2 alternative scenarios, Alternative 1 and Alternative 1A of the New Diversion of Winter High Flows for ASR project concept, were simulated using the groundwater models as described in 3.2.3. This project concept maintains the current reservoir and SRDF operation schedules, with SRDF diversions occurring between April and October to supply CSIP irrigation demand. Modeling assumptions for the New Diversion of Winter High Flows for ASR project concept include a new diversion, referred to as the ASR diversion, immediately downstream of the SRDF that operates between November and May. The diverted water would be injected via the ASR wells. None of the ASR wells in the New Diversion of Winter High Flows for ASR scenario are used for extraction, and private standby well pumping would continue within Zone 2B. Like the current practice, CSIP water demand is met with SVRP recycled water, SRDF diversion, and CSIP supplemental wells.

Alternative 1A of the New Diversion of Winter High Flows for ASR project concept keeps the same assumptions as Alternative 1, except that all water diverted for ASR is injected solely into 8 ASR wells in the 400-Foot Aquifer.

TM 4 provides details of modeling assumptions and results. Key modeling results are summarized below.

Simulation results show that SRDF would operate every year except during exceptionally dry periods. The ASR diversion also would operate almost every year, but diversion amounts would be more variable than the SRDF diversion. This is because 1 of the objectives of the normal reservoir operations is to carry over winter water for summer releases to SRDF when the ASR diversions would not be active. Thus, there would be years when reservoir storage allowed SRDF to operate during the summer, but due to a lack of high winter flows the ASR diversions in those years would be very small.

The modeled amounts of water supplied by the SRDF diversions and groundwater pumping to CSIP operations are 10,800 AF/WY and 5,500 AF/WY, respectively. The amount available to divert to ASR injection totaled 6,700 AF/WY on average during the representative period.

Figure 7 compares the simulated 2070 intrusion extent (blue dashed line), with the 2070 No Project intrusion extent (red dashed line) and the current intrusion minimum threshold (black line.) In the 180-Foot Aquifer (top map), there is some improvement in controlling seawater intrusion relative to the No Project Scenario on the northern side of the intruded area. There is very little improvement near the City of Salinas and to the south. The 500 mg/L chloride contour in the 400-Foot Aquifer (bottom map) is nearly the same as the No Project Scenario, with minimal improvements near the City of Salinas. The New Diversion of Winter High Flows for

ASR Scenario is not very effective at achieving the seawater intrusion minimum threshold in either the 180-Foot or 400-Foot Aquifers.

Figure 8 shows the impact of ASR injection on chloride concentrations at 2070 for both the 180-Foot Aquifer and the 400-Foot Aquifer. The top map shows that the ASR wells are not creating an effective barrier and are not preventing lower concentrations of seawater from passing between the wells in the 180-Foot Aquifer.

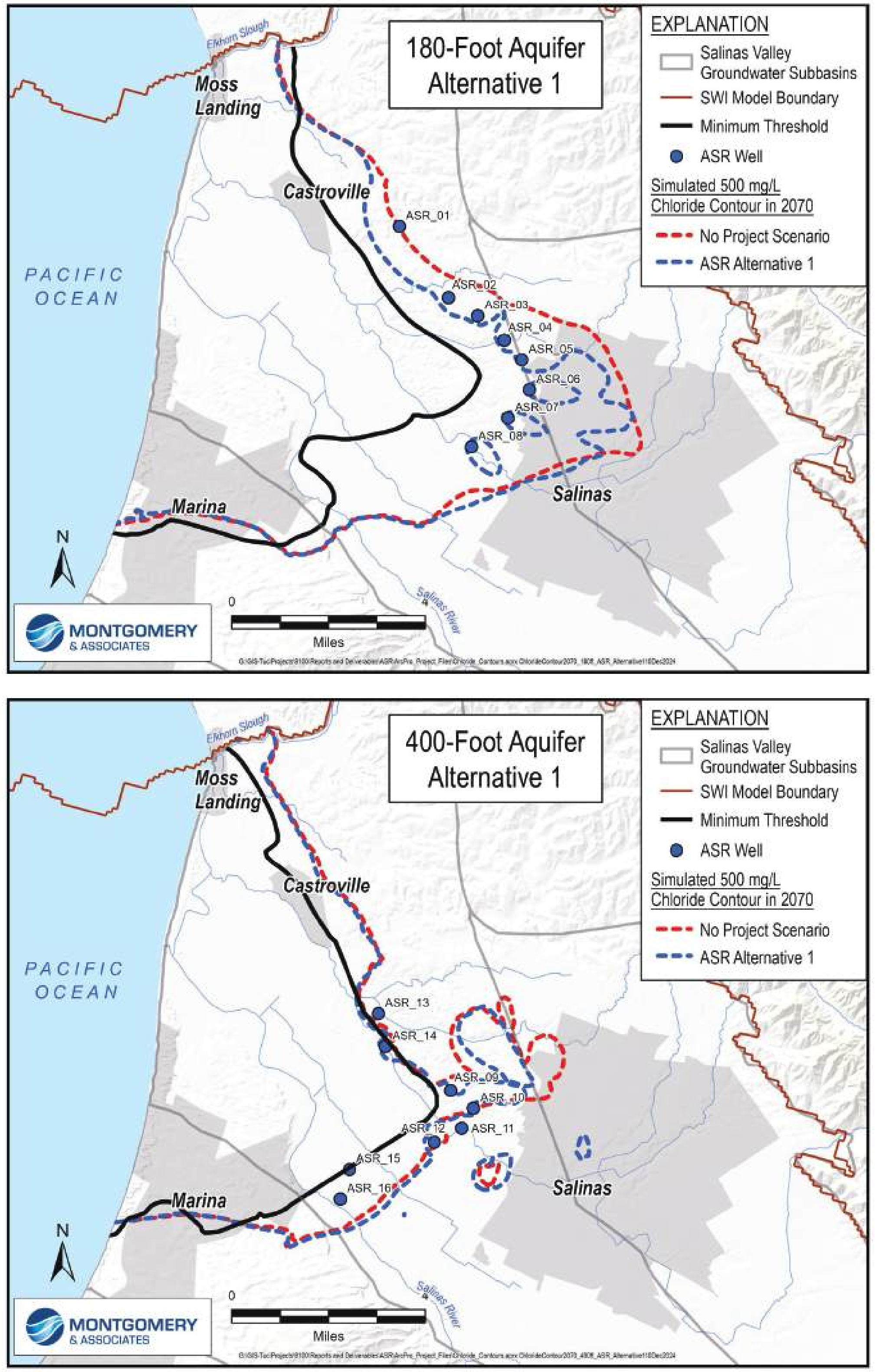


Figure 7. Alternative 1 Scenario 2070 500 mg/L Chloride Contours
Comparison to No Project Scenario and Minimum Threshold

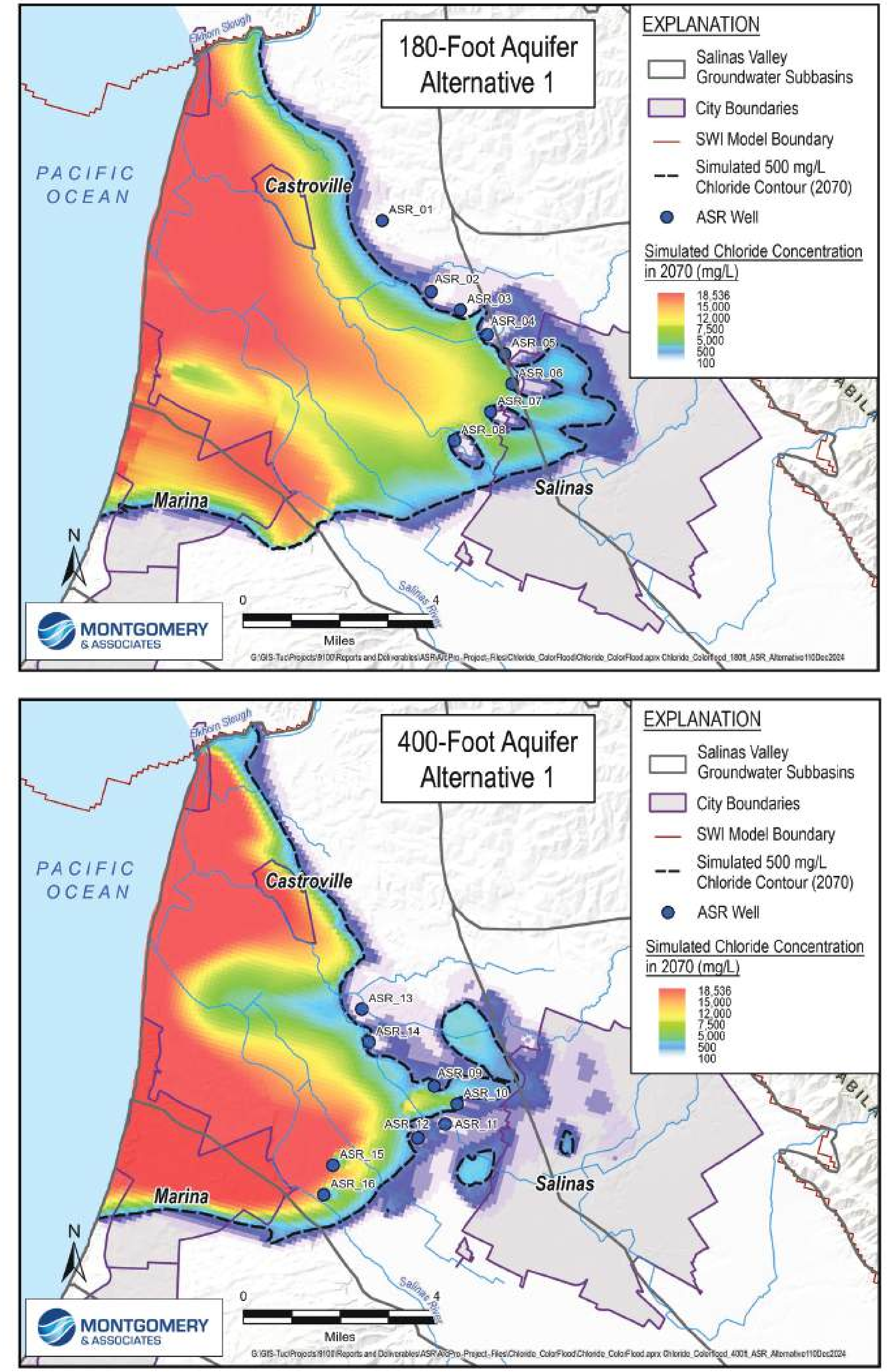


Figure 8. Alternative 1 Scenario Chloride Concentrations (2070)

3.3.4 Cost Estimate

The Wallace Group completed a high level cost estimate (AACE Class 5 – Preliminary Opinion of Probably Cost3) that reflects the revised project concept. The total capital cost of additional infrastructure was estimated at $249,270,000. This high-level cost estimate was estimated with the minimum infrastructure required. With operations and maintenance costs included and annualized based on the facility life and interest rates, the unit cost was estimated at $3,080/AF for each of the maximum 8,000 acre-feet per year (AFY) diverted and injected. This maximum diversion differs from the available water identified in the modeled scenarios. See Table 4 for the cost estimate.

4 SUMMARY, CONCLUSIONS, AND NEXT STEPS

4.1 Summary of Scenarios

Table 1 summarizes the 3 ASR project scenarios evaluated in this preliminary feasibility study: Seasonal Release with ASR project concept, New Diversion of Winter High Flows for ASR project concept - Alternative 1, and New Diversion of Winter High Flows for ASR project concept with injection into 400-Foot Aquifer only - Alternative 1A.

Table 1. Summary of ASR Scenarios

Scenario	Description
Seasonal Release with ASR project concept	Shifts reservoir releases and diversions at SRDF to December-June up to 36 cfs from stored water; injects treated water via new ASR wells; summer extraction from ASR wells
New Diversion of Winter High Flows for ASR project concept – Alternative 1	No change to current SRDF operations; SRDF operates April-October (business as usual CSIP; assume 36 cfs diverted at SRDF). For ASR: use available high flows to divert up to 45 cfs November-April and inject (no extraction from ASR wells)
New Diversion of Winter High Flows for ASR project concept with injection into 400-Foot Aquifer only – Alternative 1A	Same as New Diversion of Winter High Flows for ASR project concept, except all diverted water is injected into 400-foot aquifer only

4.2 Comparison of Scenarios

Table 2 summarizes the key observations from the simulations for each scenario.

Table 2. Key Observations for Comparison of Seasonal Release with ASR and New Diversion of Winter High Flows for ASR

Seasonal Release with ASR	New Diversion of Winter Flows for ASR
Average diversion for ASR injection: 12,900 AFY	Average diversion for ASR injection: 6,700 AFY
CSIP wells pumping high due to lack of SRDF diversion available to meet demand (max capacity pumping)	CSIP wells pump under current operations (not increased during peak months)
Meeting CSIP demands (summer) requires additional pumping of injected water from ASR wells	No unmet CSIP demands except during severe drought
More pumping than injection	More injection than pumping
SWI front is not stopped (not enough water to inject)	SWI front is not stopped (not enough water to inject)
Main constraints: SRDF structure limits and not enough supply for CSIP	Main constraints: volume of water available and need for a new diversion structure

4.3 Comparison of Key Features/Constraints for both Project Concept Options

Both project concepts (i.e., Seasonal Release with ASR project concept and New Diversion of Winter High Flows for ASR project concept) provide multiple constraints and challenges, further described in Table 3 below to illustrate and compare which parts of the systems may require the most additional evaluation and could be the most difficult to implement. High-level cost estimates for the Seasonal Release with ASR and New Diversion of Winter Flows for ASR project concepts are included in Table 4 and Table 5, respectively

Table 3. Summary of Constraints for Each Project Concept Option

Component	Seasonal Release with ASR	New Diversion of Winter High Flows for ASR
Reservoir releases	Requires re-operation for releases earlier in the year	Keep same reservoir operations
Diversion	Keep existing SRDF diversion – assume it would operate at maximum capacity	Need new diversion(s) – e.g. Ranney Collectors (existing SRDF diversion would still be operated for CSIP)
ASR Injection	Seasonal (Dec-June)	Winter high flows (Nov-April)
Water rights	Keeps existing MCWRA stored water rights, but shifts them to a different season and adds underground storage use through a modification process	Use a new water right or modify existing MCWRA right to divert available watershed flows to underground storage
CSIP needs	Unmet demands due to lack of summer SRDF diversion need to be supplied by ASR production	No changes made to existing system and water supplies (not needed to accommodate project)
Water quality	Turbidity and wet weather runoff pollutants challenge for diversion and treatment	Fewer potential constraints if using Ranney Collectors due to filtering below riverbed
Permitting	Need permits and environmental review for new pipeline, treatment plant, and storage and injection/recovery wells	Need permits and environmental review for new pipeline, treatment plant, storage and injection wells, and new diversion structure
Infrastructure challenges	SRDF diversion capacity; finding land suitable for treatment plant and associated piping and storage	Same – also, Ranney Collectors are not common, would need special expertise

MONTGOMERY & ASSOCIATES

Table 4. Cost Estimate for Seasonal Diversion with ASR

Capital and Annualized Costs
Seasonal Release with ASR (Diversions at SRDF)
(AACE Class 5 - Preliminary Opinion of Probable Cost)

Date: 1/28/2025

Line No.	Description		Units		Total
1	Project Yield		acre-feet per year		15,000
2	Facility Life		years		25
3	Interest Rate		%		6
4	Capital Cost		$		$343,930,000
5	Cost Recovery Factor		--		0.078
6	Annualized Capital Cost		$		$26,905,600
7	Annual O&M Cost		$		$9,000,000
8	Total Annualized Cost		$		$35,905,600
9	**Unit Cost**		$/AF		**$2,390**
CAPITAL COSTS					
Line No.	**Capital**	**Quantity**	**Unit**	**Unit Cost**	**Total Cost**
10	General Conditions	1	LS	$4,460,000	$4,460,000
11	Pipeline (SRDF line to treatment, treatment to injection well field)	26,000	LF	$680	$17,680,000
12	Pipeline (ASR extraction wells to CSIP)	15,000	LF	$500	$7,500,000
13	Booster Pump System (24 MGD firm capacity, includes CE,ME,SE,E&IC)	1	LS	$20,800,000	$20,800,000
14	Surface Water Treatment Facility	1	LS	$156,000,000	$156,000,000
15	Injection Wells (includes CE,ME,SE,E&IC)	16	EA	$1,200,000	$19,200,000
16	Equalization Basin (70 AF)	1	LS	$4,800,000	$4,800,000
17	Land Costs (40 ac treatment facility, 8 ac injection wells, 20 ac EQ basin)	68	$/AC	$55,000	$3,800,000
18	Allowance for SRDF Modifications[8]	1	LS	$4,600,000	$4,600,000
19	*Subtotal*				$238,840,000
Line No.	**Markups**	**Quantity**	**Unit**	**Unit Cost**	**Total Cost**
20	Contingency			30%	$71,652,000
21	Planning, Engineering, Design			10%	$23,884,000
22	Construction Management			3%	$7,165,200
23	Legal, Admininstrative			1%	$2,388,400
24	***Total Capital Cost***				$343,930,000
OPERATIONS AND MAINTENANCE					
Line No.	**Description**	**Quantity**	**Unit**	**Unit Cost**	**Total Cost**
25	Annual O&M	1	LS	$6,000,000	$6,000,000
26	Miscellaneous Allowance			20%	$1,200,000
27	Contingency			30%	$1,800,000
28	***Total O&M Cost***				$9,000,000

NOTES:
1. "Project Yield" based on: 36 cfs delivery, 214 days per year.
2. "Facility Life" selected based on 25-yr anticipated life of facilities.
3. "Interest Rate" selected within expected range for public-financing options.
4. "Capital Cost" includes additional treatment costs.
5. "Cost Recovery Factor" based on anticipated Facility Life and Interest Rate.
6. "Annualized Capital Cost" based on facility life and interest rate.
7. "Unit Cost" estimate includes unit cost for treatment components of project.
8. Required modifications not specified at this time; assume 2% of other infrastructure costs (lines 11-17).
9. This opinion is considered a Class 5 preliminary level estimate with an expected accuracy range of up to +30 to +50 % and -20% to - 30% in accordance with AACE guidelines.

Table 5. Cost Estimate for New Diversion of Winter High Flows for ASR

Capital and Annualized Costs
Alternative 1, New Diversion for ASR (Radial Well Diversion)
(AACE Class 5 - Preliminary Opinion of Probable Cost)

Date: 1/28/2025

Line No.	Description		Units		Total
1	Project Yield		acre-feet per year		8,000
2	Facility Life		years		25
3	Interest Rate		%		6
4	Capital Cost		$		$249,270,000
5	Cost Recovery Factor		--		0.078
6	Annualized Capital Cost		$		$19,500,400
7	Annual O&M Cost		$		$5,100,000
8	Total Annualized Cost		$		$24,600,400
9	**Unit Cost**		$/AF		**$3,080**
CAPITAL COSTS					
Line No.	**Capital**	**Quantity**	**Unit**	**Unit Cost**	**Total Cost**
10	General Conditions	1	LS	$3,230,000	$3,230,000
11	Pipeline (radial well to treatment, treatment to injection well field)	34,000	LF	$680	$23,120,000
12	Booster Pump System (29 MGD firm capacity, includes CE,ME,SE,E&IC)	1	LS	$25,100,000	$25,100,000
13	Radial Collector (1 well), Concrete Structures and Laterals (includes CE,ME,SE,E&IC)	1	LS	$18,900,000	$18,900,000
14	Treatment Facility	1	LS	$75,000,000	$75,000,000
15	Equalization Basin (90 AF)	1	LS	$6,200,000	$6,200,000
16	Injection Wells	16	EA	$1,200,000	$19,200,000
17	Land Costs (assume 20 ac treatment facility, 5 ac radial collector well, 25 ac equalization basin, 8 ac injection wells)	58	$/AC	$55,000	$3,200,000
18	*Subtotal*				$173,950,000
Line No.	**Markups**	**Quantity**	**Unit**	**Unit Cost**	**Total Cost**
19	Contingency			30%	$52,185,000
20	Planning, Engineering, Design			10%	$17,395,000
21	Construction Management			3%	$5,218,500
22	Legal, Admininstrative			1%	$521,900
23	***Total Capital Cost***				$249,270,000
OPERATIONS AND MAINTENANCE					
Line No.	**Description**	**Quantity**	**Unit**	**Unit Cost**	**Total Cost**
24	Annual O&M	1	LS	$3,400,000	$3,400,000
25	Miscellaneous Allowance			20%	$680,000
26	Contingency			30%	$1,020,000
27	***Total O&M Cost***				$5,100,000

NOTES:
1. "Project Yield" based on: 45 cfs delivery, approximately 90 days per year.
2. "Facility Life" selected based on 25-yr anticipated life of facilities.
3. "Interest Rate" selected within expected range for public-financing options.
4. "Capital Cost" includes additional treatment costs.
5. "Cost Recovery Factor" based on anticipated Facility Life and Interest Rate.
6. "Annualized Capital Cost" based on facility life and interest rate.
7. "Unit Cost" estimate includes unit cost for treatment components of project.
8. This opinion is considered a Class 5 preliminary level estimate with an expected accuracy range of up to +30 to +50 % and -20% to - 30% in accordance with AACE guidelines.

4.4 Conclusions

In summary, considerations related to implementing the 2 approaches to an ASR project concept are as follows:

- Seasonal Release with ASR project concept has significant operational constraints associated with releasing stored reservoir water and rediverting it at SRDF in winter.
- Modified or new water rights would be needed for either approach.
- Existing CSIP and SRDF infrastructure upgrades are likely required to implement either approach.
- Neither approach would achieve staying above the minimum threshold for seawater intrusion defined in the GSP.
- The timing of diversions and injection is key for meeting CSIP demands in the peak season.
- Seasonal release/re-diversion scenario may create additional issues with not being able to meet CSIP demands, exacerbating the need to pump more groundwater (from both CSIP supplemental wells and ASR wells).
    - It appears the recharge volume would not be enough to offset the required pumping to avoid seawater intrusion. (i.e. pumping is too high and not allowing enough water left behind in storage to mitigate sweater intrusion).
    - The current available CSIP supplemental wells could not handle additional pumping requirements in the summer, therefore ASR wells would need to recover stored water to make up the unmet demand.

During this preliminary feasibility study, it became clear that an ASR project concept hinges on many other related projects and activities developed by other agencies. The Seasonal Release with ASR project concept's main challenges are due to trying to link with an existing system, which results in both physical challenges and additional permitting requirements. MCWRA and M1W should continue efforts to fully optimize the existing Monterey County Recycled Water Projects (CSIP, SVRP, and SRDF) before further consideration of the addition of an ASR system to further address seawater intrusion.

Moving forward with an ASR project concept would need to consider other related actions or projects being evaluated for SGMA implementation purposes, such as:

- CSIP optimization
- New in-lieu surface water supplies to areas at risk of seawater intrusion not currently being served by CSIP, including diversions for direct delivery

- Salinas River Operations Habitat Conservation Plan implementation
- Salinas River diversion permit and associated water rights use (11043 diversion project)
- Brackish Groundwater Restoration Project

Once these projects have been evaluated separately, they could be re-evaluated to combine the best features of each to maximize solutions to mitigate seawater intrusion and ensure the viability and sustainability of water supplies for all beneficial users. Further consideration of ASR project concepts should take into account other projects proposed, such as the Interlake Tunnel, to better understand any effects on increasing the diversion of stored water or new downstream diversions.

4.5 Next Steps

To complete a more robust feasibility study for the ASR project concept, next steps to developing a conceptual design and determining physical infrastructure improvements would include:

1. Distribution system modeling, including tie-ins into CSIP system
2. Water quality sampling (surface water and shallow groundwater)
3. Additional permitting discussions with Central Coast Water Quality Control Board
4. ASR well siting and complete hydrogeology analysis at prospective well sites
5. Geochemical mixing model of injected water at injection well locations
6. Treatment plant site identification and design
7. Ranney collector diversion location and site feasibility and design
8. Detailed cost estimates for both Seasonal Release with ASR concept and New Diversion of Winter High Flows for ASR options
9. Final reservoir operations and groundwater modeling and subsequent feasibility and engineering reports
10. Identification of land resources that could be acquired for project

In addition, the uncertainty of future hydrology and flows available for diversion with respect to climate change will need to be further assessed.

Preliminary Feasibility Study
Aquifer Storage and Recovery Project Concepts
to Address Seawater Intrusion

TECHNICAL MEMORANDUM 1

Project Constraints and Alternatives Evaluation

Prepared by:

Salinas Valley Basin
Groundwater Sustainability Agency

MONTGOMERY
& ASSOCIATES
Water Resource Consultants

1 INTRODUCTION

The purpose of this preliminary feasibility study is to evaluate ASR project concepts, specifically the Seasonal Release with ASR project concept described in GSP Amendment 1 for the 180/400-Foot Subbasin.

The 180/400 Subbasin is designated by DWR as a critically overdrafted basin in part due to seawater intrusion in both the 180-Foot and 400-Foot Aquifers. One approach to address seawater intrusion is through injection of source water to raise groundwater elevations close to the inland extent of intrusion. The Seasonal Release with ASR project concept in the GSP pairs injection with capturing additional stored wet seasonal release flows using existing infrastructure. SVBGSA worked with MCWRA as part of initial efforts to conduct high level review and refinement of this project concept. This provided a better understanding of the existing water capture, storage, conveyance, and delivery system to CSIP, how such a project concept could work with existing infrastructure, and constraints that either need to be addressed through adjusting the project concept or considered in project design, should project feasibility steps move forward. This memorandum summarizes the outcomes of that work by describing the existing system, identifying system constraints that pertain to this project concept, and new infrastructure requirements. The results informed the development of Alternatives 1, New Diversion of Winter High Flows for ASR and 1A, New Diversion of Winter High Flows for ASR (400-Foot Aquifer).

As conceptualized in the GSP, the Seasonal Release with ASR project would be achieved through 2 separate but related processes. First, MCWRA's conservation releases from Nacimiento and San Antonio Reservoirs would be shifted in time from primarily spring and summer to winter and spring. Conservation releases would still contribute to Salinas Basin groundwater recharge along the Salinas River and would be rediverted at the SRDF. Second, the re-diverted reservoir water would be injected into the 180-Foot and 400-Foot Aquifers for storage and later use. Injected water and reduced extraction would help increase groundwater levels, improve water quality, and prevent further seawater intrusion.

Figure 1 depicts this concept using ASR injection wells, and later extraction of injected water through CSIP supplemental wells.

The intent of the Seasonal Release with ASR project concept is to inject more water than is extracted for CSIP and raise groundwater levels and storage just outside of the seawater intruded area to halt and push back seawater intrusion.

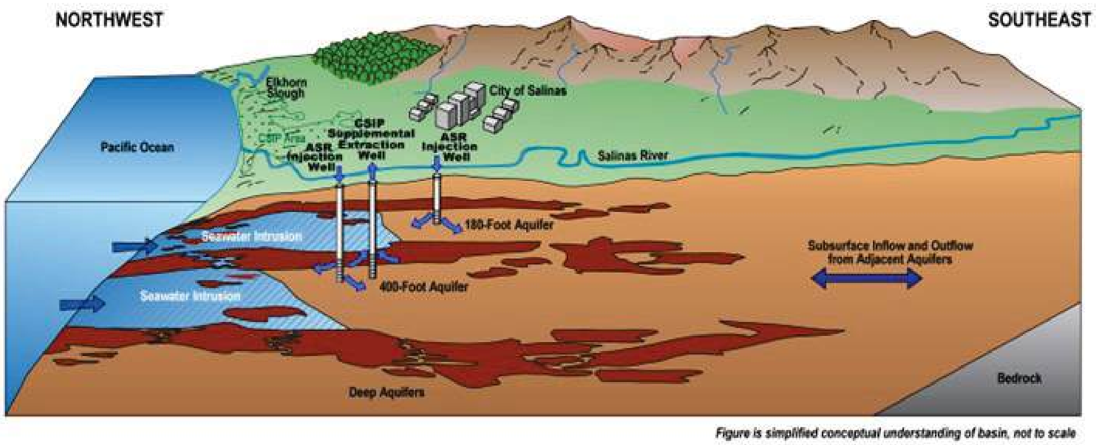


Figure 1. Conceptual Depiction of ASR Injection in 180-Foot and 400-Foot Aquifers

The Seasonal Release with ASR project concept has been further refined during this initial phase of the Feasibility Study, as described in the following sections.

TM1 of this preliminary feasibility study further evaluates the project components by identifying known and potential constraints of the existing water supply system related to the project concept. In addition, it provides a summary of revisions to and potential alternatives for a potential suitable approach to the Seasonal Release with ASR project concept.

2 EXISTING SYSTEM COMPONENTS

The Seasonal Release with ASR project concept would leverage existing infrastructure and add new components to it. Therefore, it is important to understand the existing system and how it functions to best accommodate potential new infrastructure and uses.

As shown on Figure 2, starting at the upstream end of the system in the southern portion of the Valley, the Nacimiento and San Antonio Dams impound water from tributary watersheds and MCWRA releases the stored water into the mainstem Salinas River for beneficial uses. The Salinas Valley Groundwater Basin is recharged by water released into the Salinas River. A portion of the stored reservoir water is conveyed via the Salinas River to the SRDF where MCWRA re-diverts it for irrigation use in the CSIP area (Figure 2) (MCWRA, 2024a). The sections below describe each existing component of this system in more detail.

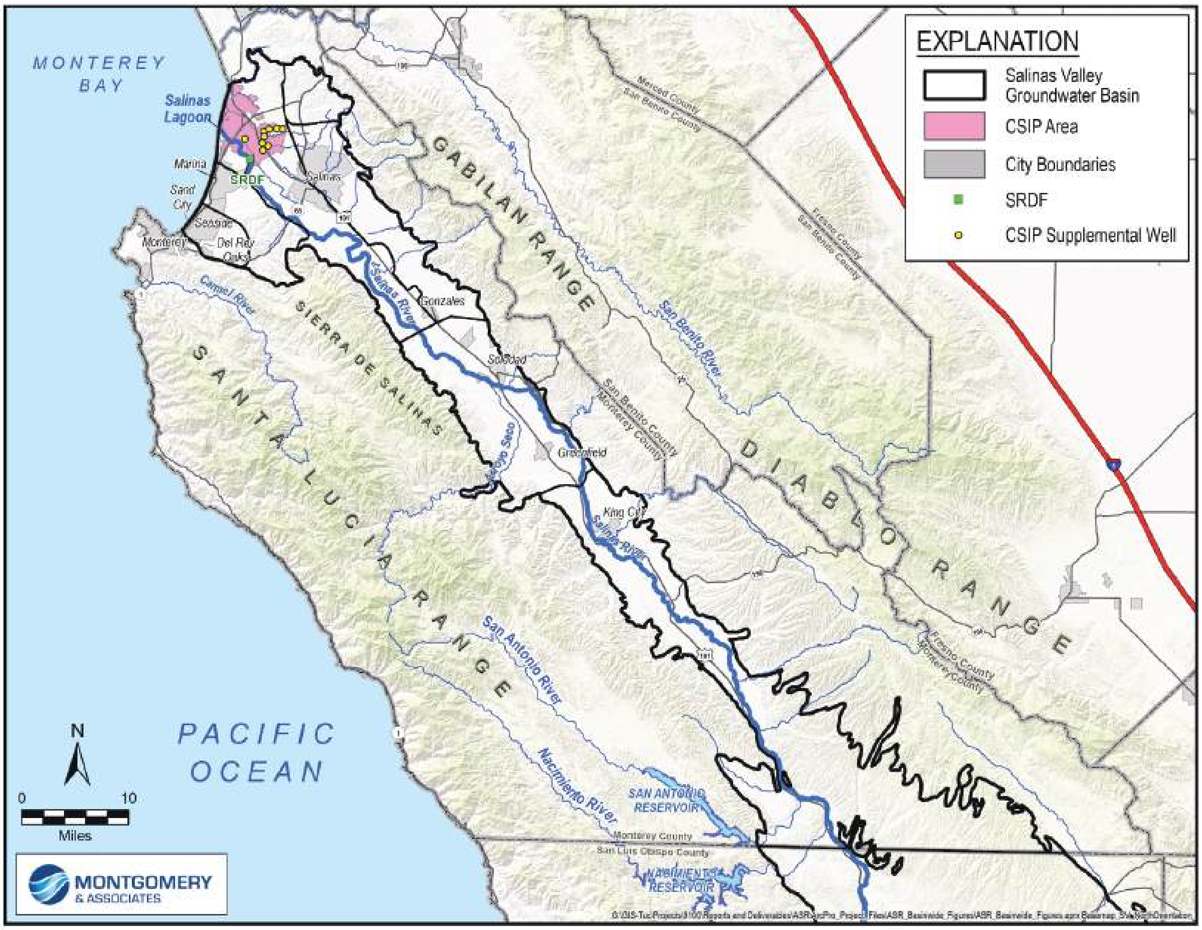


Figure 2. Salinas Valley and Existing Water Conveyance and Distribution System

2.1 Reservoirs and Releases

Nacimiento Reservoir is located in northern San Luis Obispo County and its dam impounds water from the Nacimiento River watershed. San Antonio Reservoir is located in southern Monterey County and its dam impounds water from the San Antonio River watershed. The Nacimiento River, along with the San Antonio River, flows into the Salinas River after crossing into Monterey County from San Luis Obispo County (at Camp Roberts).

MCWRA owns and operates Nacimiento and San Antonio reservoirs for multiple goals including flood protection, water conservation, and Salinas Valley Water Project operation, which includes releases for groundwater recharge and re-diversion at the SRDF (MCWRA, 2024b). Another beneficial use of the reservoirs is recreation, primarily between Memorial Day and Labor Day. Both dams are regulated by DWR DSOD. Nacimiento Dam is also regulated by FERC due to the presence of a hydroelectric plant at that facility. Operation of the reservoirs is guided by the

Reservoir Operations Advisory Committee, which provides recommendations to the MCWRA BOD.

MCWRA BOD adopted the Nacimiento Operations Policy on February 20, 2018 (MCWRA, 2018), and the San Antonio Operations Policy on May 21, 2001 (MCWRA, 2001). These policies outline several obligations for MCWRA to follow:

1. Water Rights Requirements:
    a. Environmental compliance, including the Salinas Valley Water Project Flow Prescription for Steelhead Trout in the Salinas River (Flow Prescription)
    b. Storage, withdrawals, and beneficial uses
2. Settlement Agreements:
    a. San Luis Obispo County Allotment
    b. SVWC terms
3. Flood Control Operations

In addition to these key operational requirements, operators need to consider various dam safety requirements, physical constraints, recreation uses, and incidental power generation. Each year, MCWRA develops a reservoir release schedule that guides operations and is adapted as needed based on changing conditions. The schedule is an initial high-level estimate of monthly reservoir releases and storage; actual operations are guided by the release schedule with real-time adjustments based on dynamic demands and conditions.

Table 1 provides a brief overview of the water rights limits.

Table 1. MCWRA Water Rights Limits

Reservoir	Water Right License/Permit No.	Maximum Annual Storage (AF)	Maximum Annual Withdrawal (AF)
Nacimiento	7543	350,000	180,000
	21089	27,900	
San Antonio	12624	220,000	210,000

AF = acre-feet

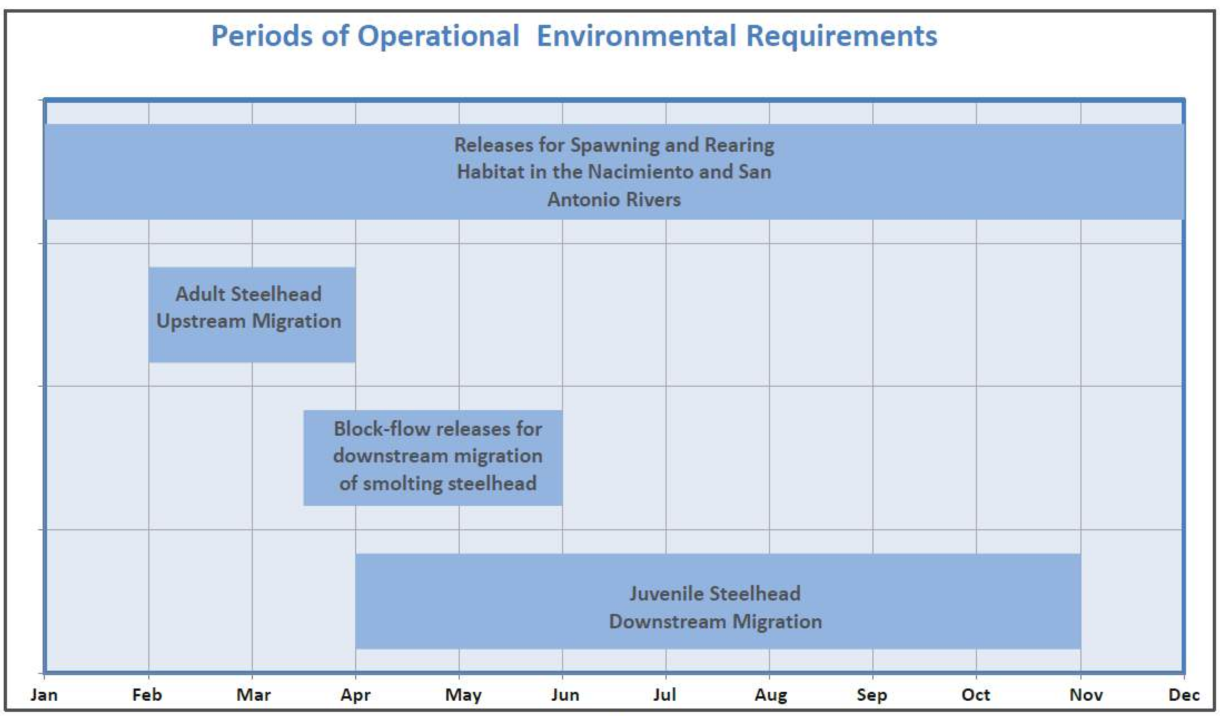
Environmental Compliance Requirements

Reservoir operations need to consider fish habitat and migration at different times of the year, as shown on Figure 3. Releases must maintain Flow Prescription and water rights requirements, including specified flows to the Salinas River Lagoon.

The USACE permit for construction of the Salinas Valley Water Project included a formal consultation with NMFS under Section 7 of the Endangered Species Act. NMFS issued a BO on the project that included the Flow Prescription. The BO and Flow Prescription have guided reservoir operations since the Salinas Valley Water Project began operating in 2010. The reservoir release components of the Flow Prescription were also incorporated into MCWRA water rights for Nacimiento and San Antonio reservoirs.

The Flow Prescription includes requirements for the different fish life cycle and migration periods. For example, the conservation release season, which typically runs from April through October, requires from 2 to 45 cfs flow at the USGS gage, Salinas River near Spreckels, for juvenile steelhead downstream migration. The periods of operational environmental requirements can be summarized as follows:

- Spawning and rearing habitat below Nacimiento and San Antonio Dams (year-round)
- Adult Upstream Migration (February-March)
- Downstream smolt migration (March-May)
- Downstream juvenile (April – October)



(Source: MCWRA)

Figure 3. Operational Environmental Requirements for Reservoir Releases

When the USACE permit expired in 2017, NMFS determined that the Flow Prescription did not meet all of its intended goals, thus warranting the development of an HCP to revise the Flow Prescription and restore MCWRA's take coverage under the ESA. The first phase of HCP development began with the creation of the Salinas River Long-Term Management Plan. MCWRA is currently developing the SROHCP, which is intended to provide an effective framework to protect natural resources within the portions of Monterey and San Luis Obispo Counties where MCWRA performs water management activities. The SROHCP is also the mechanism by which MCWRA will obtain federal ESA permits for the activities associated with the ongoing operation and maintenance of MCWRA facilities including Nacimiento and San Antonio Reservoirs.

In November 2022, with the SROHCP and new reservoir operations protocols under development, the MCWRA BOD adopted supplemental adaptive management through the IOP. The IOP builds on the Flow Prescription and provides additional opportunities for the creation of steelhead passage conditions in the Salinas River system and provides an opportunity to evaluate these operations to inform the development of the SROHCP.

The SROHCP currently under development will include a reservoir re-operation plan that forms the basis for an incidental take permit for compliance with the federal ESA and is intended to minimize or mitigate environmental impacts from reservoir operations.

Groundwater Recharge and SRDF Operations Requirements

MCWRA makes releases for both groundwater recharge along the Salinas River and to operate the SRDF, referred to as conservation releases. Conservation releases begin following cessation of natural flow or to supplement natural flows for groundwater recharge and/or SRDF diversion and continue into the fall. Reservoir releases are managed both for aquifer recharge that benefits agricultural, urban, and domestic usage, and for surface water re-diversion at SRDF to supplement the use of recycled water for irrigation use in the CSIP area. Releases must maintain Flow Prescription and water rights requirements, including specified minimum flows to the Salinas River Lagoon.

Flood Control Operations

Flood control operations are guided by the rule curves developed in coordination with DSOD and FERC that establish the maximum operational elevations for each reservoir. These rule curves are intended to protect the dams and the hydroelectric power plant at Nacimiento Reservoir and minimize the occurrence of reservoir spills. MCWRA's operations are developed to maintain reservoir space to be able to attenuate storm inflows while minimizing flooding downstream. The rule curves set maximum target water surface elevations by month.

Reservoir Release Schedule Development

To develop an annual release schedule for the reservoirs, MCWRA implements a rigorous approach that includes the following:

- Estimate spring inflow based on watershed conditions and available weather outlooks
- Develop reservoir storage projections for April 1
- Identify goals such as conservation releases timing, retaining carryover storage, maximizing length of conservation season, meeting rule curve elevations, and accommodating planned maintenance activities
- Estimate releases needed to meet water conservation goals and establish required flow rates to the Salinas River Lagoon
- Determine available volume for conservation and environmental compliance releases
- Develop Release Schedule that:
    - Is operationally feasible
    - Complies with permits, regulations, agreements, and MCWRA Operations Policy
    - Considers stakeholder interests
- Adjust for changing conditions and compliance requirements

Recreational considerations include minimizing differential elevation decline rates when feasible during holiday periods between Memorial Day and Labor Day.

2.2 Salinas River Conveyance

With this delivery system, the Salinas River effectively acts as a conveyance feature to route released Nacimiento and San Antonio Reservoir flows downstream for re-diversion at the SRDF for delivery through the CSIP system during the irrigation season. Along the way, surface water percolates into the groundwater basin to maintain groundwater levels and allow for groundwater pumping for municipal, industrial, and agricultural purposes.

2.3 SRDF Diversions

In 2010, as part of the SVWP, MCWRA began to re-divert a portion of the released reservoir water at the SRDF. The SRDF includes a pneumatic dam operated seasonally to impound river water and provide supplemental source water to growers within the CSIP area during peak usage demand. It is located approximately 5 miles upstream of the Salinas River Lagoon and diverts stored water released from the Nacimiento and San Antonio Reservoirs approximately 100 river miles south. Table 2 provides key facts and describes components of the SRDF.

Table 2. SRDF Description and Key Information

SRDF - Quick Facts
• Pneumatic bladders with steel weir gate dam structure • Operational Season from April 1 to October 31 • Provides treated (filtered and chlorinated) river water for irrigation • Diverts water for delivery to growers in the CSIP area • Diversion constraints due to turbidity and river stage
Components of SRDF
• 128-foot Obermeyer Main Weir with accompanying 10-foot regulating weir • With gates fully raised – impounds an estimated 3 miles upstream, provides approximately 123 AF of temporary storage • 3 intakes that include rotating fish screens • Fish ladder: max flow is 15 cfs; 5 bays of gaining elevation to circumvent weirs • Pump station includes wet well with four 18" vertical turbine pumps • Combined discharge of 36 cfs with 3 pumps operating; currently cannot operate all 4 pumps due to high differential pressure in the filtration structure so 1 pump is kept in rotating reserve

The diverted water is filtered and then receives liquid chlorination injected before entering the 80 AF SVRP storage pond, where it mixes with recycled water, before being distributed to the CSIP area.

Constraints related to diverted water storage capacity and operations are as follows:

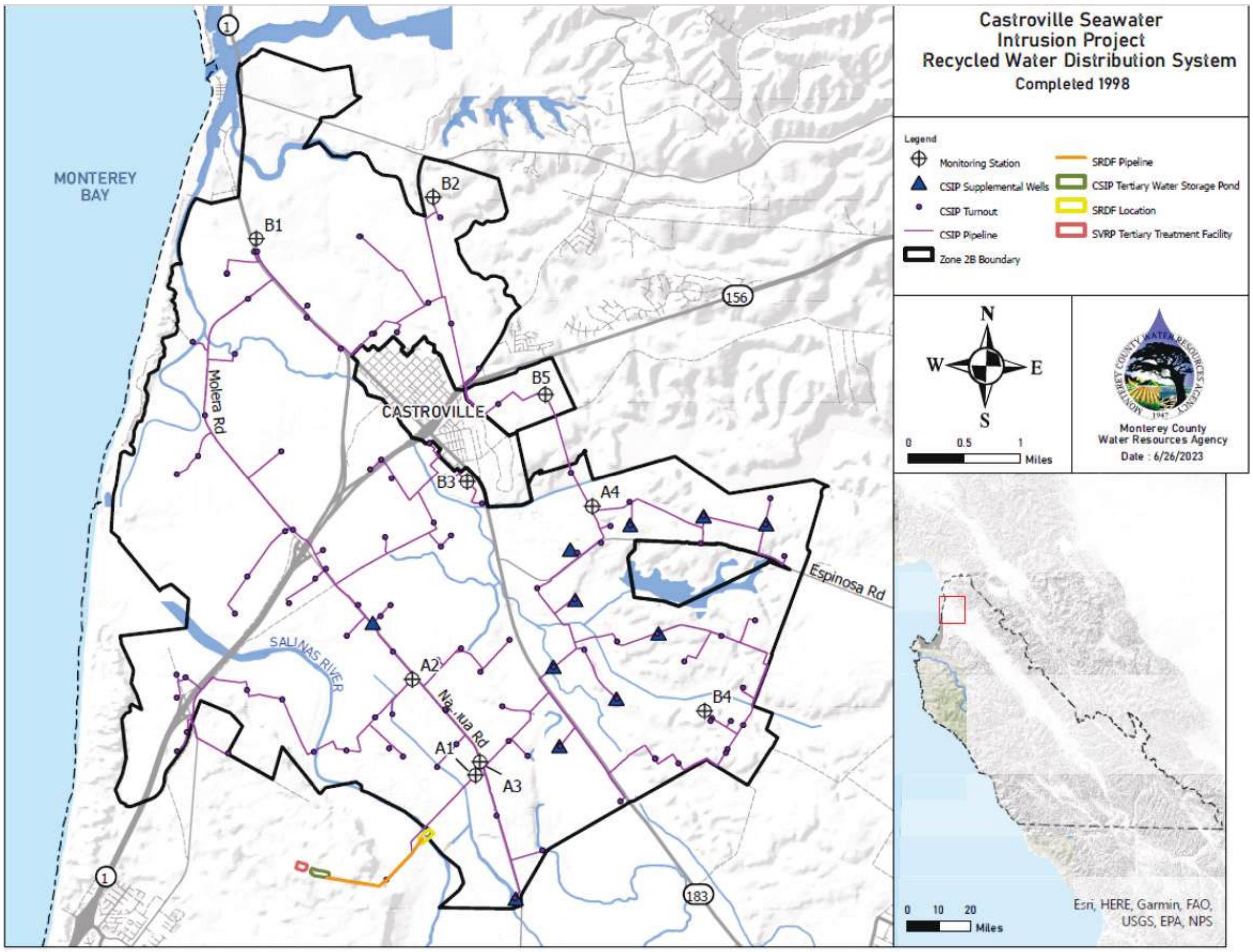
- The capacity of the existing recycled water storage pond was not increased when SRDF came online, and MCWRA does not have additional space available to store surface water.
- Under current operational conditions, the storage pond is fully drained within a day to prevent hits or bacterial growth.
- Current storage capacity is insufficient for meeting a full day's demand during the peak season. Additional storage is needed to better align water diversion with demand or modify pond management strategies.
- A key SRDF goal is to target reservoir releases from 100 miles upstream to equal daily use at the facility and meet the bypass requirements.

At the end of the season, the impoundment behind the inflatable dam is drained after diversions cease by slowly releasing the impounded water over 27 to 29 days. The gates are then fully lowered, and winter site preparation occurs.

2.4 CSIP Distribution System

CSIP construction was completed in 1998 as an alternative irrigation supply to groundwater pumping in a coastal seawater intruded area. The CSIP distribution system delivers in-lieu supplies to approximately 12,000 acres of irrigated land in the Castroville area (Zone 2B). CSIP consists of approximately 46 miles of a pipeline distribution system to deliver recycled water and re-diverted surface water to agricultural lands for irrigation supplies. The recycled water is provided by the SVRP tertiary treatment processing facility, operated by M1W and co-located at M1W's Regional Treatment Plant. The SRDF augments the sources of supply to CSIP and reduces the amount of water that needs to be pumped from groundwater within the distribution area.

SVRP recycled water and SRDF re-diverted water are both temporarily stored in the 80 AF storage pond at the M1W treatment facility before being piped to the CSIP distribution system (Figure 4). MCWRA-owned production wells (CSIP supplemental wells) are also pumped to add water to the distribution system (as needed to meet irrigation demand) and to regulate hydraulic pressure. Currently 8 of 22 wells are operational from the wells constructed at the start of the project (1998), with 1 additional new well installed in 2022. 12 CSIP supplemental wells have been destroyed, several due to high chloride concentrations and others because they had reached the end of their useful life.



(Source: MCWRA)

Figure 4. CSIP Components and Distribution System

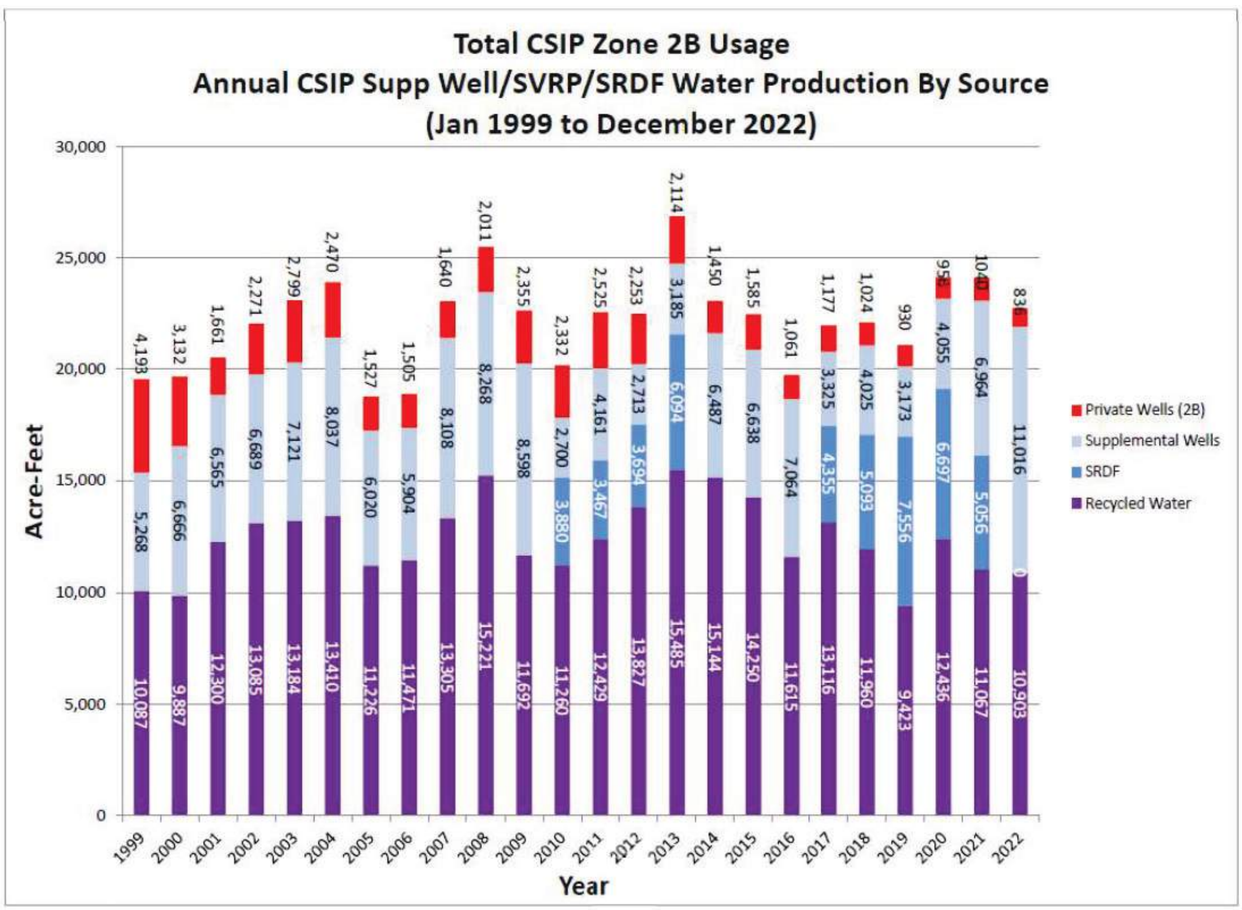
CSIP annually delivers an average of approximately 21,000 AF of irrigation water. Water quality is monitored at 9 stations throughout the system. When pressure or flow is insufficient to meet irrigation demands within the CSIP system, growers may turn on private agricultural wells to meet their irrigation supply needs pursuant to MCWRA Ordinance 03790, which allows for limited operation of standby wells within Zone 2B.

In summary, CSIP system delivers water from the following 3 sources:

1. **Recycled water:** SRVP tertiary recycled water from M1W treatment plant
2. **Surface water:** MCWRA Water Rights for SRDF re-diversion from stored reservoir water (April through October)
3. **Groundwater:** Groundwater from CSIP supplemental wells pumped directly into the CSIP distribution system

Some growers within Zone 2B operate private irrigation pumping wells, either as the sole source of water if they are not connected to the CSIP distribution system or for standby use as additional supply to CSIP sources, under specified conditions.

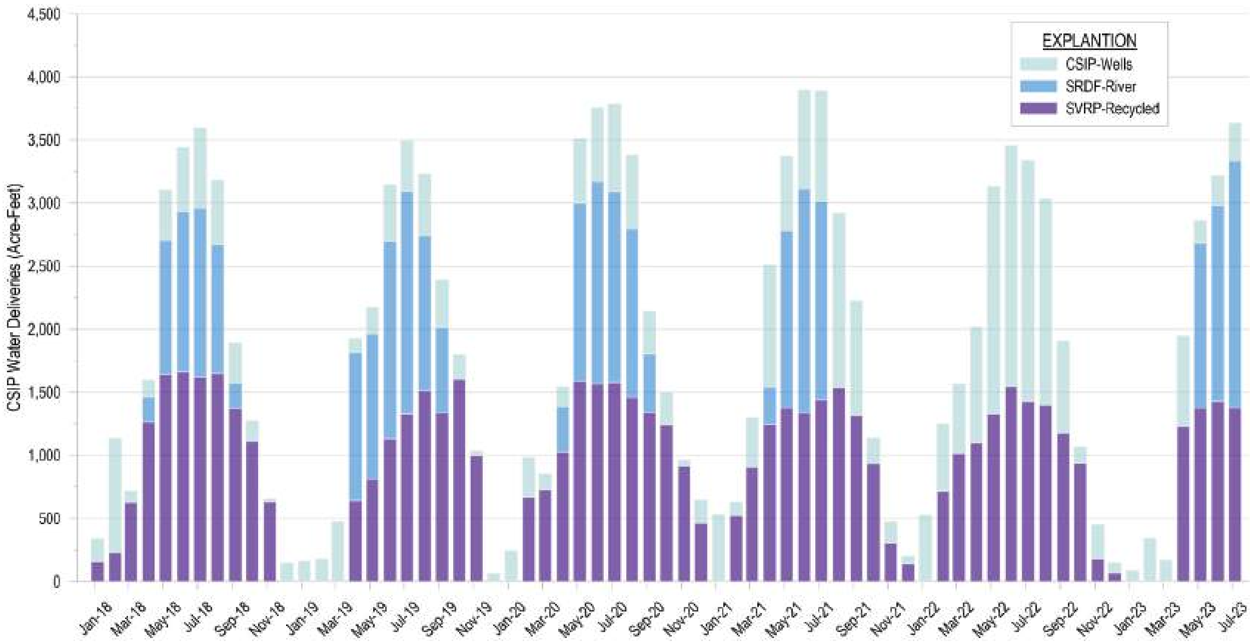
The annual distribution of water from the different sources of water to the CSIP area for the past 2 decades is shown on Figure 5. Recycled water supply has been fairly constant since 2016, at approximately 11,000 AFY on average, though there have been some slight declines in recent years resulting from reduced inflows and recycled water demands elsewhere. However, SRDF re-diversions are linked to natural hydrologic cycles and reservoir storage capacities. During multi-year droughts there may not be enough water to make releases from the reservoirs to achieve the flows required to re-divert at the SRDF. Accordingly, CSIP supplemental well water is an important source of supply to meet irrigation demands within the system, particularly in drought years and when the SRDF is not operational. Private well pumping within Zone 2B has decreased since 2018 and has since stayed below 1,000 AFY.



(Source: MCWRA)

Figure 5: Annual Distribution of Water to CSIP Area by Source

Monthly water deliveries through the CSIP distribution system, by source since 2018, are shown on Figure 6. This figure displays the seasonality of the system and the increased water supply needs during the summer irrigation season.



(Source: MCWRA)

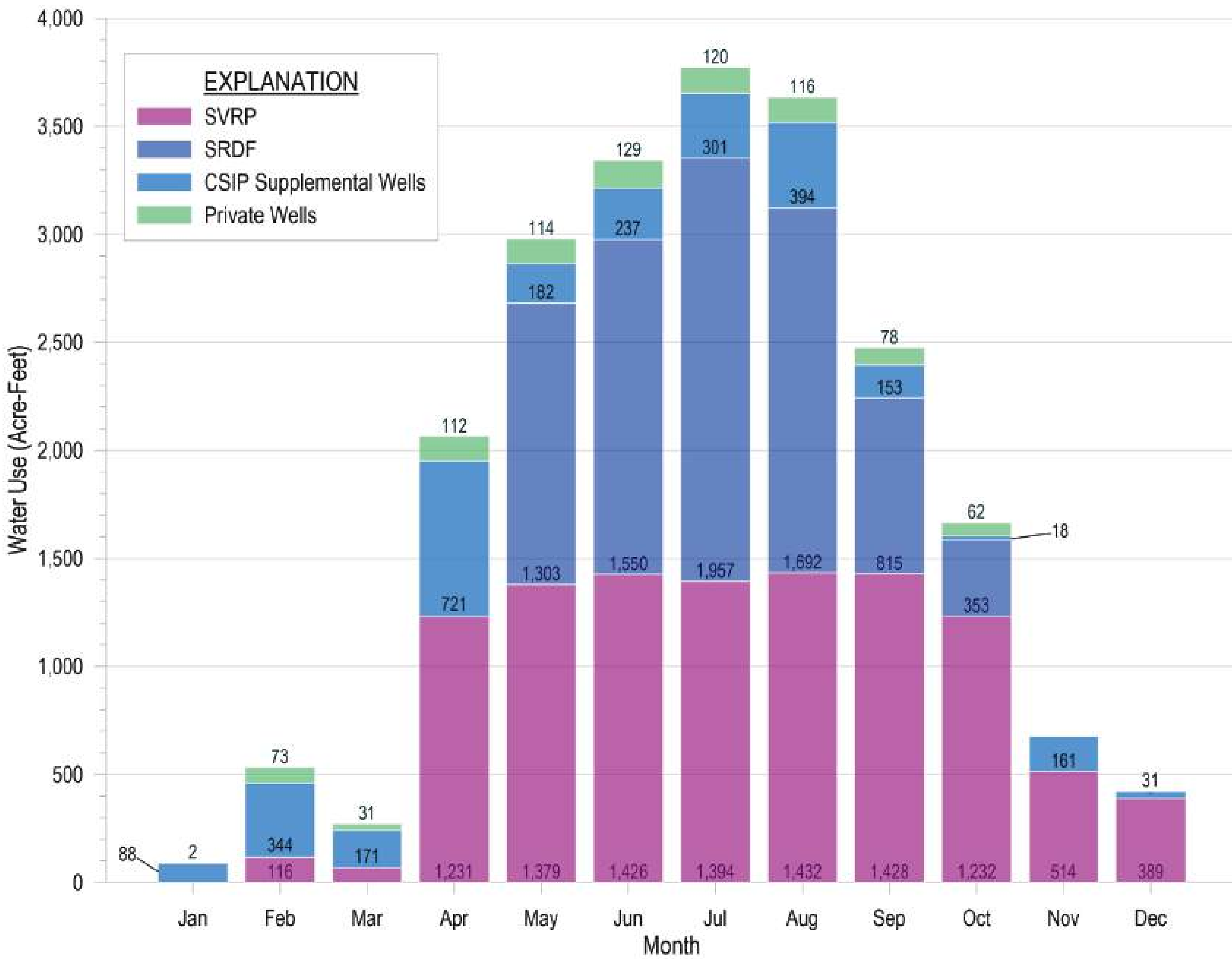
Figure 6: Monthly CSIP Water Delivery by Source

Total CSIP water production for the 2023 irrigation season was 21,070 AF and is provided on Figure 7. This was a wet year and resulted in the highest SRDF diversion volume recorded to date (7,669 AF). CSIP deliveries were 50% from SVRP recycled water, 36% from SRDF, and 13% from supplemental wells. Private pumping was 118 AF on average per month for April through August.

The quantity of SRDF diversions are tied to CSIP growers' demand for irrigation water. Several scheduling constraints were identified that reduce diversion amounts, including the following:

- There are often no diversions on Sundays due to low irrigation needs.
- CSIP is operated as an instantaneous demand system; there is not a big enough reservoir for recycled water and diverted surface water storage and the existing pond cannot meet peak demand storage needs.
- Peak demands are diurnal and far exceed the flow rate of the SRDF and recycled water production rate, which results in the use of supplemental groundwater wells to mitigate unsustainable system hydraulics.

To remedy the above challenges, MCWRA is currently working with growers on using a new irrigation scheduling system/dashboard. At the same time, MCWRA is modeling distribution system constraints and determining efficiency improvements to optimize the use of recycled and surface waters and reduce groundwater well pumping.



(Source: MCWRA/GEMS)

Figure 7. CSIP Water Production Summary for 2023

3 EXISTING SYSTEM CONSTRAINTS FOR SEASONAL RELEASE WITH ASR PROJECT CONCEPT

The Seasonal Release with ASR project concept would use existing infrastructure to maximize surface water diversions at SRDF for ASR near the CSIP area to halt seawater intrusion. This would be achieved by seasonally storing water at the Valley's north end using existing aquifer space.

The Seasonal Release with ASR project concept would use existing water rights and facilities to the extent feasible. Therefore, the purpose of this analysis is to uncover any potential constraints in the existing system to be able to add this project concept and to better evaluate the most effective approach to doing so. To that end, SVBGSA and MCWRA, as well as M1W, held focused meetings on the existing systems and operations of the reservoirs and re-diversion under MCWRA's water right licenses for these facilities, and considered the feasibility of and constraints to the Seasonal Release with ASR project concept. This section describes the key constraints discussed during the meetings with MCWRA staff responsible for implementing reservoir releases and with MCWRA and M1W staff that operate the SVRP recycled water treatment facility, SRDF, and CSIP distribution systems.

The key assessments of potential constraints revolved around the following:

- Water availability to divert and store water in the aquifers (done through modeling analysis, as described in TM4)
- Regulatory constraints such as water rights licenses and permits (further described in TM2)
- Operational constraints
    - Proposed reservoir and SRDF operations under the Seasonal Release with ASR project concept and challenges with shifting reservoir releases and SRDF diversions to the winter and spring
    - CSIP user demands in summer
- Water quality constraints and treatment needed for injection (further described in TM3)
- Infrastructure challenges
    - Diversion structure, water treatment, ASR wells, distribution pipelines, surface storage

3.1 Reservoir Operations Considerations

MCWRA staff provided an overview of current reservoir operations, including associated water rights, in order to identify feasibility issues and considerations for the Seasonal Release with ASR project concept. Key points SVBGSA and MCWRA staff discussed during the preparation of this TM related to reservoir operations are provided in the following sections.

3.1.1 Water Rights Constraints

The reservoir releases for MCWRA use under their water rights are based on water withdrawn from storage. The withdrawal is calculated using the 30-day rule based on daily change in reservoir storage. These water right licenses and permits are further described in TM2.

The existing MCWRA Nacimiento and San Antonio Reservoir water rights authorize collection to storage only at the existing reservoirs, with points of diversion at the existing dams, and re-diversion of previously stored water at the SRDF. The water rights do not authorize direct diversion, diversion of natural surface water flow at the SRDF (not from previously stored water), or collection to underground storage.

MCWRA water right licenses for the Nacimiento and San Antonio reservoirs allow for released surface water that has been stored at least 30 days and allow for re-diversion of that water at the SRDF. Water that has not been in the reservoir for 30 days, such as flows released for flood control, do not count as stored water and are not allowed to be diverted under these water rights.

Any additional water available in the system—such as wet weather inflows that need to be released to manage flood control storage capacity in the existing reservoirs—could be available under a new water right. A new water right permit would be needed to divert these types of flows at the SRDF to ASR (see TM2 for further discussion of additional water rights options).

In summary, for possible direct diversions of Salinas River water, it is important to distinguish between reservoir withdrawals and re-diversion at SRDF under existing water rights (held by MCWRA) versus new water rights that could be applied for through the State Water Resources Control Boards' appropriative water rights program. Water rights are issued according to a priority date and water use follows that same prioritization (see TM2).

3.1.2 Current Reservoir Release Operations and Seasonal Release with ASR Constraints

MCWRA has several obligations to honor and consider for reservoir operations: water rights requirements (including environmental compliance, groundwater recharge, and SRDF operations); San Luis Obispo County and Salinas Valley Water Coalition settlement agreements; and dam safety and flood control operations, which also need to be considered when proposing new operations to implement the Seasonal Release with ASR project concept as described in the GSP.

Historical inflows to the reservoirs have varied greatly, resulting in limited available water in storage for releases during extended drought periods. MCWRA coordinates the operations of the 2 reservoirs to meet downstream demands while balancing available storage. Under existing practice, the bulk of releases from storage are made during the late spring/summer based on available reservoir water and system demands and are primarily for environmental compliance purposes, groundwater recharge along the Salinas River channel, and re-diversion at the SRDF. Key constraints on changing reservoir operations for the Seasonal Release with ASR project concept include:

- Natural (non-stored) flows cannot be diverted at the SRDF currently because they are not part of the water right for SRDF re-diversion that is permitted to be operational April 1 to October 31, constraining the amount of water that could be diverted.
- Flood control release timing and unpredictability would make it difficult to adaptively manage the downstream diversion outside of the permitted operational period.
- Groundwater recharge is crucial for groundwater users in Zone 2C[1] of the Salinas Valley and is more effective in the summer.
- Releases must provide the minimum flows required for SRDF fish bypass and lagoon needs.

Flood control releases during high inflow events are made strictly for dam safety and downstream safety. These flood control flows are not available to be put to beneficial use by MCWRA under the Nacimiento and San Antonio licenses and permit; however, these flows could be claimed as direct diversion water rights for beneficial use through the State Water Board's permitting process. Flood control operations are constrained by the need to bypass certain reservoir inflows to be released almost immediately after entering the reservoir to preserve space for additional storm flows. These flood control bypass flows are not collected to storage and therefore do not count against the maximum annual withdrawal limits. In accordance with "last in, first out" water rights logic, any releases made when reservoir levels are rising are not considered withdrawals under current water rights.

Lastly, the SROHCP development process is currently underway, and the reservoirs are being operated according to the operations plans adopted by the MCWRA Board of Directors. MCWRA has convened a technical advisory committee to discuss re-operations scenarios to be considered in the SROHCP, which focus on environmentally beneficial flow enhancements (alternative operations that could enhance fish passage).

3.1.3 Key winter/spring release challenges and considerations

MCWRA identified several operational challenges related to changing the reservoir releases to earlier in the year to meet Seasonal Release with ASR project concept goals.

[1] Zone 2C consists of 7 subareas: Above Dam, Below Dam, Upper Valley, Arroyo Seco, Forebay, East Side and Pressure.

Winter reservoir releases are challenging primarily because of uncertain reservoir inflows and storage volumes later in the year. Operators cannot predict with enough certainty what the inflows over the winter/spring or water year type will be. If too much inflow is released early in the rainy season, instead of being collected to storage, there might not be enough available in storage to satisfy water rights and obligations later in the year.

A challenge for flood control operations arises because of the uncertainties of other storm flows at tributaries downstream of the reservoirs, which can add to the total Salinas River flow at the SRDF. This would add significant challenges to reaching a target flow rate for diversion that is safe for the existing infrastructure during the wet season months.

Groundwater recharge in the spring and summer is an important beneficial use for groundwater pumpers within the Salinas Valley (Zone 2C). Groundwater recharge in the winter is typically of lesser magnitude and is less predictable than summer recharge, which can be delivered to Salinas Valley aquifers via reservoir releases with higher infiltration rate due to lower velocity streamflow rates and lower groundwater levels.

A summary of key winter release challenges identified by MCWRA include the following:

- Planning and operating with less certain storage volumes
- Planning and operating with less certainty regarding water year type
- Operating through highly variable winter conditions
- Potential impacts on flood control efficacy
- Downstream water rights allowed only for withdrawal from storage
- Groundwater recharge in winter is less efficient than in summer
- Natural flows are less likely before January
- Uncertain effects on hydropower production

3.2 SRDF Operations Considerations

Since 2010, the SRDF facility has had 10 operational seasons with source water available from the reservoirs. Extended drought cycles prevented use in 4 of the years because of insufficient water available in storage to re-divert (drought years of 2014, 2015, 2016, and 2022). Generally, the CSIP distribution system fed by SVRP and SRDF water sources has not been able to meet demands within the CSIP area without supplemental well pumping. In addition, constraints related to current design/operations and storage limitations do not always allow for full utilization of surface water for CSIP. Additional details about these constraints are provided below. These challenges need to be considered when proposing new operations to implement the Seasonal Release with ASR project concept.

3.2.1 Water Rights Constraints

Water rights constraints at the SRDF diversion are linked to similar constraints described above for reservoir operations, including the following:

- Re-diversion of the Nacimiento and San Antonio water rights can only be used within the CSIP distribution system and not for underground storage (ASR).
- A new water right would be needed for other Salinas River watershed flows for diversion at the SRDF.

Additional information on MCWRA water rights is provided in TM2.

3.2.2 SRDF Diversion Physical Constraints

Some components of the SRDF were downsized from its original concept design from a maximum diversion capacity of 85 cfs to 48 cfs. Water routing was also modified: diverted water does not go directly to the distribution system since during the SRDF design phase, it was determined that treatment was necessary to meet users' needs. This added a filtration and chlorination system and storage in the recycled water pond.[2] These aspects of the SRDF limit the ability to divert additional water at a higher diversion rate under the Seasonal Release with ASR project concept.

Discussions on SRDF structure challenges included:

- Structure was sized to meet demand with the limited available storage in the SVRP pond and current operational approach; however, there is additional potential water available in some years for diversion and distribution to CSIP.
- Modifications would be needed to the treatment, storage, and distribution system to support more diversions.

3.2.3 Water Portfolio Mix Challenges

The 4 sources of water available in the CSIP area need to be well balanced to meet the irrigation demands. Constraints include the following:

[2] Salinas Valley Water Project EIR Addendum, July 17, 2007.

- Recycled water production has been generally steady but has seen declines in recent years due to less influent water available for the treatment plant and demands for recycled water elsewhere.
- SVRP supplies less than 50% of the total CSIP delivered water during the peak demand season (April – October), which is why SRDF re-diversion of stored reservoir water is crucial to supplying water to CSIP growers for irrigation.
- In drought years, when there is no stored reservoir water available to redivert at SRDF, this delivery amount is made up with groundwater pumping from CSIP supplemental wells and private standby wells.
- Currently, well water must be pumped into the CSIP system if irrigation water is needed in winter because SRDF is not operational outside of the permitted diversion season. The SVRP is shut down for annual maintenance and is unable to operate when demands are less than 5 million gallons day.

3.2.4 Key Winter/Spring Diversion Challenges and Considerations

- There are several SRDF constraints and operational concerns for winter flow diversions under the Seasonal Release with ASR project concept, in addition to the diversion period limitations discussed above. High flows can impact diversion facilities and create operational uncertainties, such as turbidity and water quality issues—especially with high flows in the wet season—which could create a need for debris cleaning, increase clogging and filtration problems, and require more frequent filter backwashes.
- Accelerated wear of pumping components from increased turbidity and needed filter backwash cycles could occur.
- Winter flows have unpredictable and highly fluctuating water surface elevations.
- Damage can occur due to unknown responses to operations (e.g. gates rated at full erect; should not be partially erected during high flows).
- Past experiences of erosion of the downstream apron after high flow through the regulating weir (above 100 cfs) caused an emergency repair to be conducted.
- Diversions go directly into the pond, which does not have capacity to take high winter flows.
- The pump station could be inaccessible during high winter flows.

MCWRA described an example of challenges during a high winter flows situation. In 2023, there was a late start for SRDF operations because high winter flows were at 300 cfs at the beginning of the diversion period and there was too much turbidity to properly operate it. Trees and debris had to be cleaned out of various pieces of the facility before MCWRA could operate the facility and divert with acceptable water quality (after May 8). High flows at the beginning of the diversion period were similar in 2024, which also caused a delay in the start of operations until the second week of May.

With climate change, large winter flows may occur more often.

From a water rights perspective, SRDF cannot be operated when Salinas River flows are high and MCWRA is not releasing stored water from the reservoirs.

4 NEW INFRASTRUCTURE REQUIREMENTS

In addition to the existing system considerations discussed above, the Seasonal Release with ASR project concept for aquifer storage and recovery would require new infrastructure to supplement the existing system. The new infrastructure components consist of 3 main categories:

1. Conveyance from SRDF and storage
2. Water treatment and distribution to ASR wells
3. ASR wells and distribution to CSIP system

4.1 Conveyance from SRDF and Storage

The Seasonal Release with ASR project concept would use the existing SRDF but would require its own conveyance system, including storage and treatment, before being sent to the ASR wells for injection. Diverted water would need to be stored before it gets injected into the aquifer via the ASR wells. In addition to its limited capacity, the existing SVRP storage pond cannot be used for this purpose because the water to be injected would need to be treated separately. Although not planned to be used by domestic systems, the injected water would most likely need to be treated to drinking water standards because the injection would occur in an aquifer pumped for this beneficial use.

4.2 Water Treatment and Distribution to ASR Wells

The Seasonal Release with ASR project concept assumes the need to treat diverted water prior to injection, as typically required for conventional ASR projects relying on use of recycled water. If less treatment were needed, it would be determined by the Central Coast Regional Water Quality Control Board (Regional Water Board) following source water characterization and development of project-specific Waste Discharge Requirements (WDRs). For general guidance, it is assumed that the same injected water limitations from the SWRCB’s Water Quality Order 2012-0010 General Waste Discharge Requirements for Aquifer Storage and Recovery Projects that Inject Drinking Water into Groundwater (ASR General Order) would likely apply to the Seasonal Release with ASR project concept, even though recovered water would not be intended for drinking water uses. If so, the injected water would have to meet primary and secondary maximum contaminant levels (MCLs) and Basin Plan water quality objectives dependent on the aquifer's beneficial uses. The General Order does allow projects to meet background groundwater quality in cases where the aquifer's water reflects concentrations in exceedance of drinking water MCLs. Further discussion on permitting constraints for injecting surface water at the ASR wells is provided in TM2.

Any water injected into an aquifer serving domestic users would need to be treated to Title 22 drinking water standards beforehand. As described in TM3, an analysis of existing river water quality shows more sampling would be required to identify the type and size of treatment plant needed. This should also consider how it would connect to the SRDF and CSIP distribution systems.

For the Seasonal Release with ASR project concept, infrastructure would likely include the following:

- Enhancements to the SRDF diversion structure and pumping station
- Conveyance pipeline from pumping station to a treatment plant
- Treatment unit processes including:
  - Screening
  - Pre-treatment (pH adjustment and pre-oxidation)
  - Clarification (coagulation/rapid mix, flocculation/sedimentation)
  - Medial filtration
  - Disinfection
  - Treated water storage and distribution facilities
  - Solids management and wash water recovery systems
  - Ancillary systems including chemical storage and feed, electrical power, instrumentation, and controls

There are several constraints to developing a new water treatment plant. A water treatment plant for aquifer injection would need to address the following key considerations:

1. <u>Intermittent Water Supply and Plant Sizing</u>

A treatment plant is intended to treat diverted flows—typically available during the wet weather season—when river flows exceed permitted environmental base flows. The diversion flow rate is not anticipated to be constant because river stage and the allowable diversion rate will vary over time. With the goal of the project to maximize seawater intrusion mitigation, the diversion and treatment facilities would be sized for peak diversion flow rates requiring substantially larger conveyance and treatment facilities than would be required for treatment of lower, more constant flow rates.

To better match influent flows and treatment throughput, the plant would have to incorporate turndown capabilities which may include placing parallel process trains in standby mode during periods of low flow. Operations would vary in intensity as these process flow rates vary.

An alternative approach to on-demand treatment in which diversion flow rates are directly fed to the treatment plant would be to install influent equalization facilities that would accept diverted flows and store them temporarily while flows for treatment would be metered into the treatment plant at a more constant rate. Further analysis would be required for sizing such equalization basins.

2. Project Siting

A water treatment plant would require an approximate footprint of 10 to 20 acres. An additional area would be required for a treated water storage reservoir depending on the design capacity; at 1 day's storage of 70 AF, 10 to 15 acres may be assumed for this purpose. Further, influent equalization storage would add to this footprint but is not estimated at this time.

The existing SRDF pump station, conveyance, and storage facilities are located on the west side, or left bank, of the Salinas River. The proposed injection wells under this project would be located on the east side, or right bank, of the Salinas River, which would make this side of the river preferable for water treatment facilities for proximity to the injection wells and ease of conveyance design. Land use in this area is primarily privately owned agricultural land. Right bank lands within 1 mile of the SRDF location are within flood hazard areas (Figure 8).

The left bank of the river includes publicly owned land, specifically parcels owned by the City of Marina and Marina Coast Water District. Generally, the FEMA flood maps identify parcels on the west side of the river as having minimal flood hazard (as they are higher in elevation relative to the river). These areas may be more suitable to site a large-scale water treatment plant but would involve a crossing of the Salinas River, adding additional permitting, infrastructure need, and construction costs.

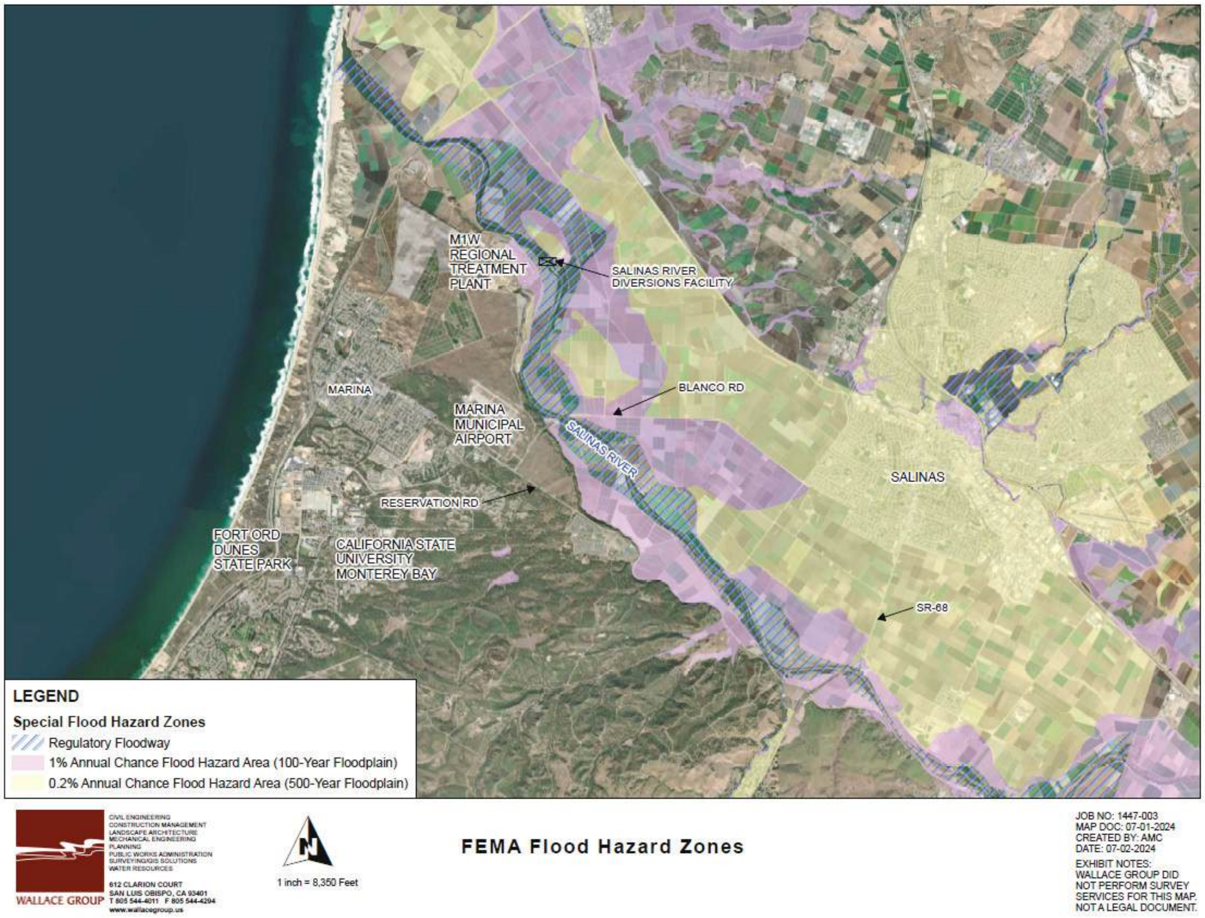


Figure 8. Flood Hazard Areas Near the Salinas River

3. <u>Water Quality</u>

Preliminary water quality data reviewed indicate the Salinas River near the SRDF location is characterized by several constituents that exceed CCR Title 22 MCLs (see TM3). Inorganics such as salts (total dissolved solids, nitrates, and sulfates) and metals have been identified as constituents that would need to be considered in subsequent stages of planning and treatment plant design. The Salinas River is known to be impacted by agricultural and urban runoff, therefore anthropogenic volatile organic compounds, semi-volatile organic compounds, and pesticides are other potential contaminant types that would be considered. A surface water quality sampling plan is discussed in TM3 and would need to be implemented to further assess these constituents of concern.

M1W has indicated that the existing SRDF cartridge filtration system experiences frequent backwash cycles due to the high levels of turbidity in the diverted surface water. Accordingly, wet-weather diversions would be of similar quality and the high levels of turbidity and associated organic carbon would increase operating costs for the water treatment plant, increasing chemical usage and solids management.

If contaminants are largely associated with colloids and larger solids, a high degree of removal may be possible through the clarification processes. However, the presence of anthropogenic constituents of concern may require additional treatment processes beyond those in a conventional surface water treatment train (e.g., use of granular activated carbon or ozone for organics, ion exchange for salts or metals, and/or membrane treatment). UV irradiation is assumed for pathogen inactivation to avoid a disinfectant residual not amenable for underground injection. An appropriate treatment train would be recommended after water quality is more fully characterized. At this stage of planning, a conventional surface water treatment plant is assumed.

A treated water pump station and conveyance pipeline from the proposed treatment plant would be needed to deliver water to the proposed ASR well field. The well field is assumed to be located approximately 5 miles to the northeast of the SRDF. Since there is no public roadway connecting the SRDF location to the proposed wellfield, the pipeline would traverse multiple privately owned agricultural parcels requiring acquisition of utility and temporary construction easements; however, there may be opportunity to install the pipeline within existing utility easements established for the CSIP distribution system. For the proposed project flow rate, a 36-inch diameter pipeline is assumed.

4.3 ASR Wells and Distribution Network to CSIP System

Groundwater wells equipped for both injection and recovery would be installed upgradient of the intruded area to help mitigate the seawater intrusion front in the area between the City of Salinas and the CSIP distribution system. These wells would primarily be used for injection of treated fresh water to stop advancement of the seawater intrusion front. The preliminary number, size, capacity, and location of these wells is assessed using a calibrated groundwater flow and transport model, the Salinas Valley SWI developed to investigate seawater intrusion in the Salinas Valley. Modeling assumptions and results are provided in TM4.

Model runs estimate that 8 wells would need to be installed at depths within the 180-Foot Aquifer, and another 8 wells would need to be installed within the 400-Foot Aquifer. Pumping and injection capacities vary between the wells, largely due to their locations and the need to inject more water in areas at the easternmost leading edge of the seawater intrusion front to effectively stop the plume in both aquifers from advancing more.

In times when ASR wells would need to be pumped to supplement water sources, shared use of the existing CSIP distribution system could be explored to reduce the length of new pipeline required. Subsequent phases of this feasibility study could evaluate the possibility to tie back into the CSIP system when ASR wells would need to pump groundwater to make up for reduced pumping by supplemental wells, since standby wells are assumed to not be operating with this project concept. Therefore, additional groundwater may be required to be supplemented from the ASR wells. It is assumed that not all ASR wells would pump water back into the CSIP system; only the wells that would be pumped would be equipped with valving to tie into a pipeline that would be connected into the distribution system. CSIP distribution system modeling will be needed to evaluate the feasibility and potential constraints of the existing pipe sizes and pressure conditions.

Overall, the system components needed to realize the Seasonal Release with ASR project concept are shown on Figure 9.

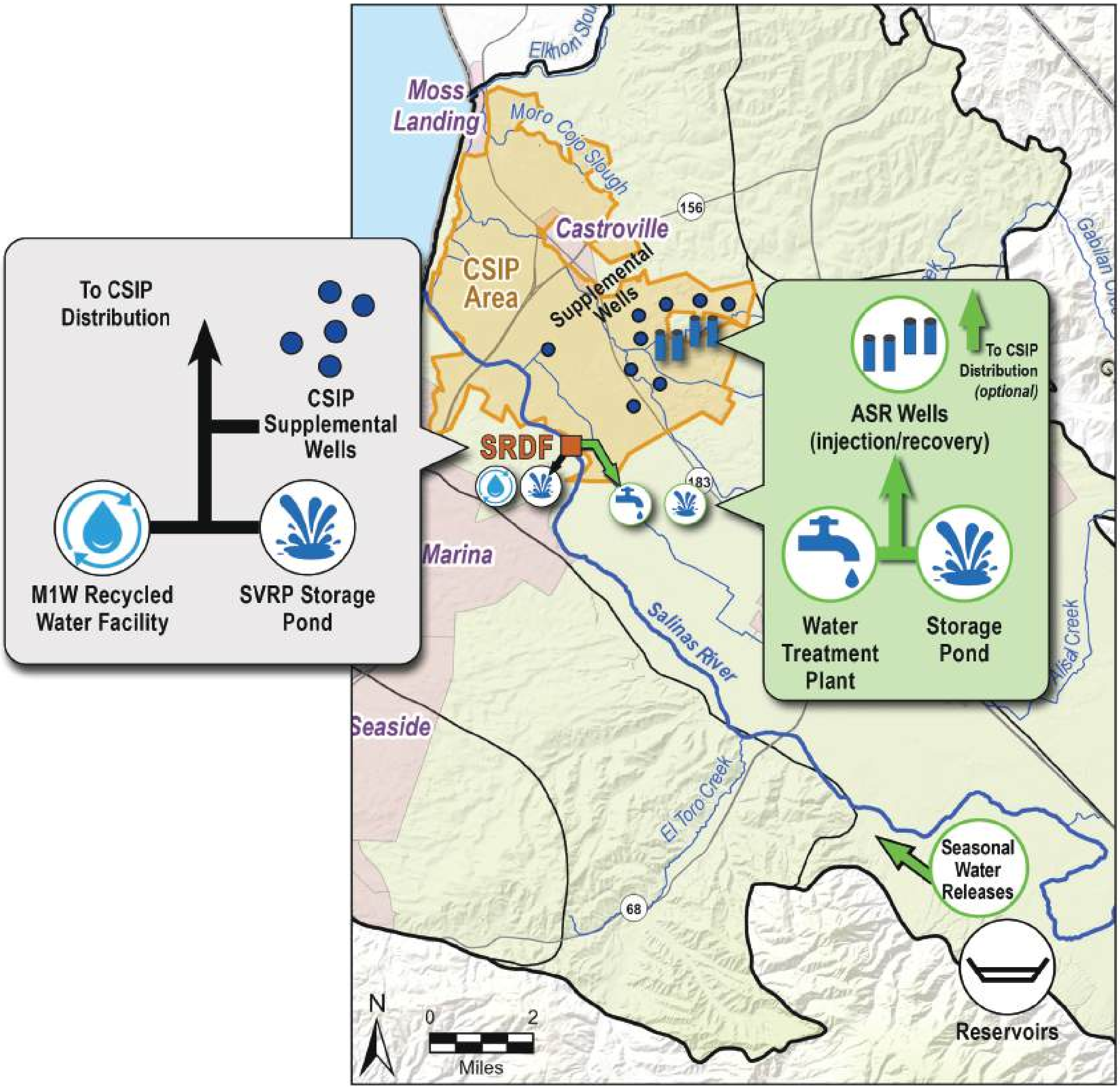


Figure 9. Seasonal Release with ASR Project Concept System Components

5 ALTERNATIVE DEVELOPMENT AND DESIGN ASSUMPTIONS

Based on the constraints identified for the Seasonal Release with ASR project concept, as discussed above, a new Alternative 1 was developed to accommodate the existing system constraints, referred to here as New Diversion of Winter High Flows for ASR.

Existing system constraints and new infrastructure requirements informed the refinement of key goals and the design of additional modeling scenarios to evaluate how effectively ASR project concepts could address seawater intrusion (described in TM 4) and resulted in the identification of alternatives. The following additional items were discussed with MCWRA staff to identify important refinements of key goals and an alternative ASR project approach.

5.1 Key Constraints to be Addressed with New Alternative

The 2 key constraints for the Seasonal Release with ASR project concept are related to challenges with water rights limitations for the existing MCWRA rights for water released from the 2 reservoirs and winter flow diversions at the SRDF (as described in Sections 3.1 and 3.2.4).

The 30-day storage rule on MCWRA's water right licenses restrict the ability to reliably release and redivert stored water during the winter months when inflow to the reservoirs is high.

To maximize additional water to use for ASR recharge, it is worth looking at a combination of 2 water sources:

1. Use existing MCWRA water rights to fully utilize water rights for the reservoirs by rediverting all available flow at the SRDF during the entire operational season while continuing to bypass all required flows to the lagoon.
2. Use other MCWRA water rights on the Salinas River to capture other flows within the watershed.

Alternatively, an application for a new water right may also be submitted.

Preliminary modeling uncovered additional constraints related to diversions and injection and pumping needs, summarized as follows:

- Current available CSIP supplemental wells would not be able to handle the additional pumping required to meet CSIP demands if recovery of stored water were to replace SRDF diversions from July to October, given the maximum pumping capacity of existing CSIP supplemental wells compared to the SRDF diversion capacity.

- Assumption of maximum 36 cfs diversion at SRDF results in approximately 15,000 AFY of available injection volume; but modeling shows this amount of injection is not enough to effectively address seawater intrusion in both aquifers.

These new items were critical in identifying potential alternatives to the Seasonal Release with ASR project concept. Additional scenarios were developed that may alleviate some of the constraints linked to it due to existing infrastructure challenges and water rights permitting.

5.2 Alternative Assumptions and Key Design Concepts

Through discussions with the partner agencies, an alternative design concept from the one proposed in the GSP was identified.

MCWRA staff recommended keeping normal reservoir operations in support of the conservation program and SRDF operations from April through October, and instead developing an ASR system by either increasing the reservoir releases during that time for additional re-diversion, or capturing other watershed flows as available during the rest of the year with a different diversion facility for aquifer injection. MCWRA did not recommend using SRDF during peak demand season, due to the increase in CSIP supplemental well pumping that would be needed and concern that CSIP supplemental wells will not be able to absorb that increased demand. MCWRA noted CSIP wells may not last in the seawater intruded area if they continue being used more regularly during peak demand season, as they may draw in more seawater and may also be used beyond their capacity. Additional pumping during this time could also mean drawdown that may exacerbate the seawater intrusion front.

One suggestion was to focus only on injection into the 400-Foot Aquifer. The rate of seawater intrusion front in the 180-Foot Aquifer has slowed and this aquifer is no longer used as much as a source of supply due to the extent of intrusion and previous actions to reduce pumping from this aquifer due to it. Therefore, priority for ASR injection could be given to halting seawater intrusion on the 400-Foot Aquifer. However, per SGMA requirements, other projects or actions would need to address the 180-Foot Aquifer seawater intrusion front.

Two new alternatives were developed that identify the use of a new diversion structure in addition to the SRDF to divert water as an option. With continued use of the SRDF and per current operations, a new diversion structure could be used for diversions in winter months.

In summary, the key design concepts for Alternative 1, New Diversion of Winter High Flows for ASR include the following:

1. Keep normal conservation releases and current SRDF operations.
2. Use excess amounts of available watershed flows for ASR injection.

3. Focus on the 400-Foot Aquifer for halting seawater intrusion with ASR; this becomes Alternative 1A, New Diversion of Winter High Flows for ASR (400-Ft. Aquifer).

Key design and operational assumptions for the New Diversion of Winter High Flows for ASR project concept include:

- SRDF operates from April to October: "business as usual CSIP operations," assume maximum diversion at the SRDF of 36 cfs.
- For ASR: use available watershed flows to inject into the aquifer.
  - Assume a separate diversion structure from SRDF, operated independently year-round.
  - Modify an existing Salinas River water right or obtain a new water right with a different diversion schedule assumed to be year-round.
  - No net extraction from ASR wells is needed.

Therefore, Alternative 1 provides for the design of a parallel system to the current SRDF/CSIP system to avoid existing constraints and to allow for more flexibility in operations for the ASR project concept. Alternative 1A is essentially the same as Alternative 1, except the injection occurs only in the 400-Foot Aquifer.

5.3 New Diversion of Winter High Flows for ASR Project Concept

The New Diversion of Winter High Flows for ASR project concept provides for the diversion of excess winter watershed flows that bypass the reservoirs and divert them downstream at a new diversion structure, , upstream of the SRDF structure. That water would then follow a similar path as described for the Seasonal Release with ASR project concept to the ASR wells. In this scenario, the ASR wells are intended to be used only for injection, since the SRDF is used for irrigation diversion with the CSIP supplemental wells.

5.3.1 Water availability and rights

As described above, the New Diversion of Winter High Flows for ASR project concept could either make use of the existing Salinas River water rights held by MCWRA (e.g. Permit 11043) with some modifications, or a new water right application could be filed.

5.3.2 Relationship to Existing System

The intent of the Seasonal Release with ASR project concept was to use the existing CSIP system as much as possible; however, due to the constraints described above, it was determined that the New Diversion of Winter High Flows for ASR project would be a separate system and interfere with the existing CSIP system operation as little as possible. Namely, reservoir operations would remain unchanged, with MCWRA operating per their current rules and obligations. The New Diversion of Winter High Flows for ASR project concept would divert the excess winter flow, which is not part of the MCWRA stored water rights. It would not use the SRDF diversion or storage pond. Since the ASR wells would only be used for injection, there would be no need to tie into the CSIP distribution system. However, this "injection only" use of the ASR wells will likely result in some increased cost for periodic well rehabilitation to maintain injection capacity, compared to using the wells for both injection and recovery[3].

5.3.3 Additional Infrastructure Requirements

The New Diversion of Winter High Flows for ASR project concept would require the same new infrastructure types as needed for the Seasonal Release with ASR project concept—except the conveyance to the ASR wells would be from a new diversion, not from the SRDF—and no new conveyance to the CSIP system would be needed. However, additional infrastructure would be required as described below.

A different diversion structure would be needed to accommodate flow diversions on the Salinas River with a new water right (see TM2 for discussion on the process to obtain a new water right). This preliminary feasibility study does not include an evaluation of potential sites for a new diversion structure or the feasibility of different types of diversion structures. Further analysis would be required to further investigate a new diversion.

However, radial well collectors (also known as Ranney collectors from the original company that developed the systems most commonly in use in the United States) have become of interest to Salinas Valley stakeholders and offer many advantages as a diversion system for this ASR project. The following discussion provides more information about this type of diversion.

A Ranney Collector is a type of radial well used to extract water from an aquifer with direct connection to a surface water source like a river or lake (French, 2008; City of St. Helens, 2024). Collectors are built to induce infiltration from a surface water body to divert and distribute that naturally filtered water from a surface water point of diversion.

In California, 2 agencies currently use Collector Wells for water supply: Sonoma County Water Agency[4], and Carmichael Water District[5].

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[3] Studies and experience with ASR well operations indicate that well rehabilitations tend to be needed more frequently when the wells are not operated to recover water after extended injection periods.
[4] Sonoma Water. 2025. "Water Supply." Available at: https://www.sonomawater.org/water-supply.
[5] Carmichael Water District. 2025. Water Treatment Plan. Available at: https://carmichaelwd.org/194/Water-Treatment-Plant.

The following are key advantages of using such a diversion structure:

- Generally, there are fewer/minimal treatment requirements: in good condition river systems, this approach can be used as drinking water intake and it requires minimal or no treatment due to sand filtration (often referred to as "riverbank filtration system," with numerous examples around the country)
- Environmental benefits: the diversion would not physically impede fish flows, but constrained pumping could be necessary to ensure minimum river flows
- Construction: proven, well-established construction techniques
- Potential for high-capacity diversions
- Ability to divert surface water during high river flows due to lack of infrastructure within the riverbed

Some challenges that remain to be evaluated for use in the Salinas River include:

- Footprint: Ranney Collectors need more land space than a conventional vertical well due to the above-ground pumping structure.
- Location: the facility would need to be constructed above the 100-year floodplain and may need to be raised above the riverbed to be able to pull surface/river water.
- Physical constraints: further analysis is needed to determine if the alluvial aquifer system would be capable of producing the amount of water necessary for ASR.
- Siting: the radial collector well(s) would need to be in an area that is not constrained by the occurrence of shallow low permeability clays (e.g., Salinas Valley Aquitard).
- Operations and maintenance depend on the type of underlying river sediments in which the radial wells are placed and the shallow aquifer materials that are being pumped from, which can cause clogging issues due to potential geochemical reactions that can occur such as in reduced oxidation-reduction (redox) aquifer conditions.
- Specialized maintenance is required to regularly clean the horizontal laterals and the large vertical caisson pumping chambers. Typically, it is important to plan for regular infiltration capacity assessments to identify issues with infiltration and verify the viability of the different components of the radial collectors.
- Mechanical maintenance—for example on the pumping system—is required for the above-ground infrastructure.

This concept would require considerable additional evaluation and field studies to assess if it may be feasible to construct and operate radial collector wells (e.g. Ranney Collector type) on the lower Salinas River. For example, one challenge of building a new diversion and pumping facility is that there may be limited suitable land available adjacent to the Salinas River. This type of new diversion system requires a separate pipeline to a treatment facility and separate storage to support ASR injections.

Further feasibility analysis would be needed for the following:

- On the ground investigations (aquifer site characterization, pumping capacity estimate, water quality considerations, land suitability, etc.) like those required for a conventional vertical well
- Analysis of saturated depth of the shallow aquifer near the river
- Water quality analysis for the shallow aquifer beneath the river and potential treatment needs due to groundwater impacted by agricultural activities
  - SRDF pump station and treatment vs Ranney Collector well pump station and treatment needs
  - Level of treatment required to be investigated to satisfy Regional Water Quality Control Board and if possible, avoid "groundwater under the influence of surface water" designation
- Cost assumptions compared to using an existing or similar type of diversion structure as SRDF, which would likely depend on whether an additional treatment would be required for the Ranney Collector or if simple chlorination would be sufficient

5.3.4 Summary of Key New Diversion of Winter High Flows for ASR Project Concept Challenges

Reservoir bypass flows primarily pertain to winter flow of water that is not stored and is typically only available during the months of about December through March or April, therefore, not year-round. This water would require modification to an existing Salinas River water right or a new water right to divert to storage underground.

The proposed Interlake Tunnel and San Antonio Spillway Modification project (Interlake Tunnel) is projected to reduce reservoir bypass flows by increasing quantities of winter inflow diverted to storage in the San Antonio Reservoir under MCWRA's modified water rights (petitions have been filed to modify existing water rights for this project). Modeling for the Interlake Tunnel projects an average annual increase in combined storage in both reservoirs of 53,300 AF. If this project proceeds, the New Diversion of Winter High Flows for ASR project concept may be more challenging to implement as it is likely that not enough water would be available to also divert for ASR to support applying for a new water right.

The New Diversion of Winter High Flows for ASR project concept requires a major new infrastructure, which will be costlier than the Seasonal Release with ASR project concept and it includes more uncertainties about the siting of a new diversion and its viability in the Salinas

River system. The intermittent nature of the flow available for diversion is challenging to maintain the new infrastructure.

Overall, the system components needed for the New Diversion of Winter High Flows for ASR project concept are shown on Figure 10.

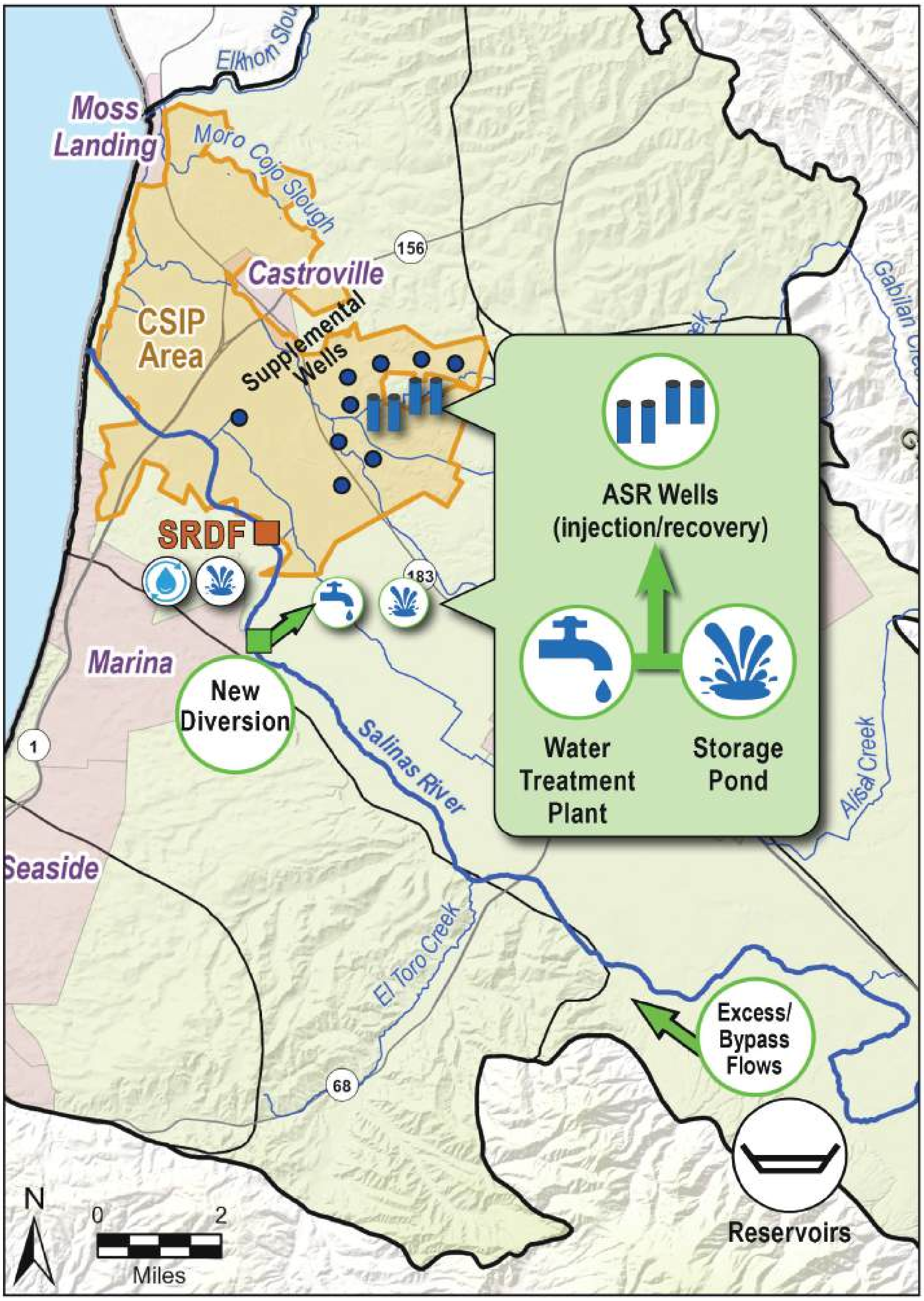

Figure 10. Alternative 1 ASR Project Concept System Components

6 SUMMARY AND CONCLUSIONS

In summary, constraints related to implementing the Seasonal Release with ASR project concept in the GSP are as follows:

- Many constraints and challenges exist from a permitting, operational, and structural perspective.
- Existing CSIP and SRDF infrastructure upgrades would be required to implement either the primary or alternative option.
- Neither approach would achieve staying above the minimum threshold for seawater intrusion defined in the GSP.
- The timing of diversions and injection would be key for meeting CSIP demands in the peak season.
- The seasonal release/diversion scenario may create additional issues with unmet CSIP demands, exacerbating the need to pump more groundwater.
  - It appears the recharge volume would not be enough to offset the required pumping to avoid seawater intrusion.
  - The current available CSIP supplemental wells could not handle the additional pumping requirements in the summer, therefore ASR wells would need to recover stored water to make up the unmet demand.

<u>Comparison of Key Features/Constraints for both Project Concept Options:</u>

Both project concepts (i.e., Seasonal Release with ASR and New Diversion of Winter High Flows for ASR) present multiple constraints and challenges, further described in Table 3 below to illustrate and compare which system components would require the additional evaluation and which could be the most difficult to implement.

Table 3. Summary of Constraints for Each Project Concept Option

Component	Seasonal Release with ASR Project Concept: Seasonal Release and SRDF Diversion	New Diversion of Winter High Flows for ASR
Reservoir releases	Requires re-operation for releases earlier in the year	Keep same reservoir operations
Diversion	Keep existing SRDF diversion – assume it would operate at maximum capacity	Need new diversion(s) – e.g. Ranney Collectors (existing SRDF diversion would still be operated for CSIP)
ASR Injection	Seasonal (Dec-June)	Winter high flows (Nov-April)
Water rights	Keeps existing MCWRA stored water rights, but shifts them to a different season and adds underground storage use through a modification process	Use a new water right or modify existing MCWRA right to divert available watershed flows to underground storage
CSIP needs	Unmet demands due to lack of summer SRDF diversion need to be supplied by ASR production	No changes made to existing system and water supplies (not needed to accommodate project)
Water quality	Turbidity and wet weather runoff pollutants challenge for diversion and treatment	Fewer potential constraints if using Ranney Collectors, due to filtering below river bed
Permitting	Need permits and environmental review for new pipeline, treatment plant, storage and injection/recovery wells	Need permits and environmental review for new pipeline, treatment plant, and storage, injection wells and new diversion structure
Infrastructure challenges	SRDF diversion capacity; finding land suitable for treatment plant and associated piping and storage	Same – also, Ranney Collectors are not common, would need special expertise

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Preliminary Feasibility Study
Aquifer Storage and Recovery Project Concepts
to Address Seawater Intrusion

TECHNICAL MEMORANDUM 2

Permit and Regulatory Requirements

Prepared by:

Salinas Valley Basin
Groundwater Sustainability Agency

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1 INTRODUCTION

This TM2 is part of a preliminary feasibility study to evaluate ASR project concepts, specifically the Seasonal Release with ASR project concept described in GSP Amendment 1 for the 180/400 Subbasin.

The 180/400 Subbasin is designated by DWR as a critically overdrafted basin in part due to seawater intrusion in both the 180-Foot and 400-Foot Aquifers. One approach to address seawater intrusion is through injection of source water to raise groundwater elevations close to the inland extent of intrusion. The Seasonal Release with ASR project concept in the GSP pairs injection with capturing additional wet season reservoir releases using existing infrastructure. SVBGSA worked with MCWRA as part of initial efforts to conduct high level review and refinement of this project concept. During the progression of the feasibility work, an alternative project concept was identified, to use a new diversion structure and diversion of Salinas River winter flows instead of stored reservoir water, here referred to as Alternative 1 and 1A, the New Diversion of Winter High Flows with ASR project concept. Both project concepts include ASR as the mechanism to address seawater intrusion.

TM1 describes outcomes of the work with MCWRA by describing the existing system, identifying system constraints that pertain to the project concepts, and identifying new infrastructure requirements. It provides a better understanding of the existing water capture, conveyance and delivery system to the CSIP, how the Seasonal Release with ASR project concept would work with existing infrastructure, constraints to it, and new infrastructure requirements. TM1 then discusses how Alternative 1 and 1A, the New Diversion of Winter High Flows with ASR project concept, was identified and similarly considers constraints and new infrastructure requirements associated with it.

TM2 evaluates feasibility of these 2 project concepts in terms of permit requirements and regulatory constraints. It identifies permit requirements for both ASR project concepts, including water rights and other permits that would likely be needed for project implementation and construction.

A different GSP project, referred to as CSIP Optimization, is evaluating system deficiencies and potential improvements needed to modernize and enhance existing operations and water deliveries to the 12,000 acres served by these existing projects. Permit requirements for system upgrades that may be identified under CSIP Optimization are not addressed here.

2 WATER RIGHT LICENSES AND PERMITS

A water right permit from the State Water Resources Control Board (State Water Board or SWRCB) provides the legal authorization to develop a project and divert water in accordance with specified conditions and within a time schedule. Licensing is the process of reviewing a permitted project that is complete to confirm the amount of water put to beneficial use and that the permit conditions were met. A license is the final confirmation of the water right and remains effective as long as its conditions are met and beneficial use continues.

As described in TM1, the Seasonal Release with ASR project concept would use existing facilities and water rights associated with MCWRA's Nacimiento and San Antonio reservoirs and the SRDF. The following sections describe MCWRA's water rights and identify constraints associated with their use for the GSP ASR project concept. This TM also describes water right considerations for the New Diversion of Winter High Flows with ASR project concept.

2.1 Overview of Applicable MCWRA Water Rights

MCWRA holds both permits and licenses for water rights associated with the reservoirs and SRDF. MCWRA's SRDF operations are authorized under License 7543, License 12624, and Permit 21089. In addition, MCWRA holds Permit 11043 for diversions from the Salinas River. Lastly, MCWRA holds applications for diversions and collection to underground storage from Tembladero Slough, Reclamation Ditch No.1665, and the Blanco Drain, which have not yet been permitted.

2.1.1 Nacimiento Reservoir Water Rights

License 7543 was issued on November 4, 1965, with a priority date of November 4, 1954. License 7543 authorizes 350,000 AFY to be collected from October 1 of each year to July 1 of the succeeding year. The maximum withdrawal in any one year shall not exceed 180,000 AF. The point of diversion under this license is Nacimiento Dam and the SRDF is a point of re-diversion. The license also includes fish flow requirements consistent with specifications of the June 20, 2007, National Marine Fisheries Service Biological Opinion. The license is subject to the agreement dated October 19, 1959, between San Luis Obispo County Flood Control and Water Conservation District and MCWRA.

Permit No. 21089 was issued on March 23, 2001, with a priority date of April 23, 1996. Permit 21089 allows the Agency to store an additional 27,900 AF per annum in Nacimiento Reservoir to be collected from October 1 of each year to July 1 of the succeeding year. The point of diversion under this permit is Nacimiento Dam and the SRDF is a point of rediversion. The permit also includes fish flow requirements consistent with specifications of the June 20, 2007, National Marine Fisheries Service Biological Opinion.

Accordingly, the total annual quantity of water collected to storage at Nacimiento Reservoir under License 7543 and Permit 21089 shall not exceed 377,900 AFY (i.e., 350,000 + 27,900). Both rights identify municipal, domestic, industrial, irrigation, recreational, and incidental power beneficial uses.

MCWRA filed Petitions for Change in 2021 to facilitate the proposed Interlake Tunnel Project and a Petition for Extension of Time to complete use of water under its Permit 21089. The SWRCB has not yet issued orders on these petitions, so the requested changes remain outstanding.

2.1.2 San Antonio Reservoir Water Right

License No. 12624 was issued on April 26, 1990, with a priority date of December 2, 1955. License 12624 authorizes 220,000 AFY to be collected from October 1 of each year to July 1 of the succeeding year; the maximum withdrawal in any one year shall not exceed 210,000 AF. The point of diversion is the San Antonio Dam and the SRDF is a point of re-diversion. The license also includes fish flow requirements consistent with specifications of the June 20, 2007, National Marine Fisheries Service Biological Opinion. The license includes municipal, domestic, industrial, irrigation, and recreational beneficial uses.

MCWRA filed a Petition for Change in 2021 to facilitate its proposed modifications and improvements to the San Antonio Reservoir spillway in conjunction with the proposed Interlake Tunnel Project. The SWRCB has not yet issued an order on this petition, so the requested changes remain outstanding.

2.1.3 Salinas River Water Right

SWRCB Permit No. 11043 dates back to water right applications MCWRA filed in 1949 following the findings of California Department of Water Resources Bulletin 52 in 1946. Permit 11043 authorizes 400 cfs by direct diversion from January 1 to December 31, and a maximum diversion of 135,000 AFY. The source of water under this permit is the Salinas River and the 2 specified points of diversion are the Castroville and Eastside Canal Intakes. The purposes of use are irrigation and municipal. The permit contains natural flow calculations used for required monthly bypass flows, which may limit the potential use of this permit, and a series of milestones to demonstrate progress toward implementation of the Salinas Valley Water Project, Phase II.

2.1.4 Pending Water Right Applications

MCWRA filed water right applications A032263C, A032263D, and A032263E on May 9, 2014, for which the SWRCB has not yet issued permits. The quantities identified are up to 1,500 AFY, 9,800 AFY, and 8,700 AFY, respectively, for a total of 20,000 AFY. These applications include both direct diversion and diversion to underground storage, in the Adjudicated Seaside Groundwater Basin, with year-round seasons. The points of diversion identified are Tembladero Slough, Reclamation Ditch No.1665, and the Blanco Drain. The purposes of use are irrigation and municipal.

Table 1. Summary of Existing MCWRA Water Rights and Potential Changes Required for ASR Project Concepts

Water Rights	Total Diversion Volume	Description	Purpose/Beneficial Use	ASR Project Concept	Changes Needed
Nacimiento Reservoir (License 7543 and Permit No. 21089)	180,000 AFY	Collection to storage at reservoir with diversion at dam and re-diversion at SRDF	Municipal, domestic, industrial, irrigation, recreational, and incidental power	Seasonal Release with ASR project concept (divert at SRDF with existing infrastructure and modification of existing right)	Collection to underground storage, and beneficial use to address seawater intrusion
San Antonio Reservoir (License No. 12624)	210,000 AFY	Collection to storage at reservoir with diversion at dam and re-diversion at SRDF	Municipal, domestic, industrial, irrigation, recreational	Seasonal Release with ASR project concept (divert at SRDF with existing infrastructure and modification of existing right)	Collection to underground storage, and beneficial use to store underground to address seawater intrusion
Salinas River (Permit 11043)	135,000 AFY	Direct diversion of 400 cfs at 2 diversion points (Castroville and Eastside Canal Intakes)	Irrigation and municipal	New Diversion of Winter High Flows for ASR project concept (direct diversion of Salinas River water with modification of existing permit)	Collection to underground storage and beneficial use to address seawater intrusion; add or move the existing points of diversion
Applications A032263C, A032263D, and A032263E	20,000 AFY	Direct diversion and diversion to underground storage, in Seaside Basin, year-round. Points of diversion at Tembladero Slough, Reclamation Ditch No.1665, and Blanco Drain	Irrigation and municipal	Potential additional source of surface water for New Diversion of Winter High Flows for ASR project concept	Beneficial use to address seawater intrusion, and change place of underground storage

2.2 Existing Water Rights Constraints

The Seasonal Release with ASR project concept is focused on use of the existing SRDF, which is operated under the water rights described above for Nacimiento and San Antonio Reservoirs. The reservoirs and other operational considerations and related constraints are discussed in TM1. The existing Nacimiento and San Antonio Reservoir water rights authorize collection to storage only at the existing reservoirs, with points of diversion at the existing dams, and the re-diversion of previously stored water at the SRDF. The water rights do not authorize direct diversion, diversion of additional Salinas River flow at the SRDF, and do not authorize collection to underground storage.

Any changes to the existing water rights to accommodate the development of the Seasonal Release with ASR project concept would require Petitions for Change with the State Water Board. The petition process would take time, have costs, and open the related water rights to modification through a protest process. The approval of Petitions for Change takes a number of years and typically includes additional terms and conditions on the water rights. The current pending Petitions for Change relative to the Interlake Tunnel Project may add further complications for the potential use of these water rights by the Seasonal Release with ASR project concept and New Diversion of Winter High Flows with ASR project concept.

Permit 11043 authorizes year-round direct diversions at specific points of diversion but does not include collection to underground storage. Future utilization of this water right for the New Diversion of Winter High Flows with ASR project concept would require a Petition for Change to add or move the existing points of diversion and add collection to underground storage. If no extractions of the water are to occur under the New Diversion of Winter High Flows with ASR project concept, then the water right's purpose of use would also need to be changed. Any potential changes to this permit may be further complicated by the Salinas Valley Water Project, Phase II milestones and the permitted schedule to complete project construction and begin beneficial use.

Permits have not yet been issued on A032263C, A032263D, and A032263E but the types of applications generally align with the concepts for the New Diversion of Winter High Flows with ASR project concept. For example, the year-round season and inclusion of diversion to underground storage would align with the New Diversion of Winter High Flows with ASR project concept implementation. Changes to these applications to facilitate development of this project concept, such as to move or add a point of diversion and add a purpose of use, could be requested through Petitions for Change. However, the water rights would be limited to the amounts of water initially applied for.

2.3 New Potential Water Right (New Diversion of Winter High Flows with ASR project concept)

Diversion of additional surface flows at the SRDF or any other point of diversion from the Salinas River or its tributaries (i.e. not a withdrawal from previously stored water) may require a new water right.

An additional water right permit would be needed for the New Diversion of Winter High Flows with ASR project concept if the above MCWRA rights cannot be used for this project, such as if existing water rights do not authorize an adequate diversion volume to meet project goals, or if competing uses do not allow for existing permits to be modified for the ASR project concept. In this case, the New Diversion of Winter High Flows with ASR project concept would require SWRCB's acceptance of an application for a new water right and the issuance of a new permit if it determines that water is available for appropriation.

Prior to applying for a permit, further study and analysis would be needed to confirm the total availability of unappropriated water, as well as to review existing water rights which may be a limiting factor. The SWRCB's issuance of a permit would include consideration of all prior rights, the availability of water in the basin, and the flows needed to preserve instream uses such as fish and wildlife habitat.

An application to the SWRCB would include detailed information about the proposed project, including the source, location, amount of water, purpose of use, point of diversion, and place of storage. Such an application would specify that diversions could potentially occur year round, any time flows are available, subject to senior water rights, and in accordance with environmental flows (i.e., only flows beyond fish flow requirements).

Through the permitting process, CEQA compliance and related analysis would be required to demonstrate that the proposed project would not cause significant environmental harm or that any adverse impacts can be adequately mitigated. Both the environmental review and permit processes require public noticing, review periods and opportunities for the public to submit comments to express concerns or objections. The water rights process provides for formal protests if objections are raised during the public comment period. Protests can be based on concerns such as injury to existing water rights, environmental impacts, or public interests. Any protests would need to be resolved, or a public hearing may be required to address contested issues. These steps would also be required for petitions for change to the existing water rights MCWRA holds,

Once the SWRCB determines that an application meets all requirements, a water right permit may be issued. The permit would outline the conditions under which the water may be diverted, including limits on the amount, timing, and purpose of use, as well as conditions to protect water quality, fish and wildlife, and other public trust resources. A permit holder is then required to measure and account for water use and submit regular reports to the SWRCB, demonstrating compliance with the permit conditions. Other requirements may include developing the necessary project infrastructure—such as pipelines or diversion works—within a specified timeframe.

2.4 Beneficial Use of Aquifer Recharge to Address Seawater Intrusion

Both the Seasonal Release with ASR project concept and the New Diversion of Winter High Flows with ASR project concept are intended to provide aquifer recharge through injection of diverted surface water near the most inland extent of the mapped seawater intrusion 500 mg/L chloride contours. The Seasonal Release with ASR project concept aims to recharge more water than is extracted by wells to meet CSIP demand, thus augmenting the total net aquifer volume to counteract seawater intrusion.

As stated in the SWRCB Fact Sheet titled "Purposes of Use for Underground Storage Projects" (updated June 2020), groundwater recharge is not a beneficial use of water on its own. Any water right permit application or a petition on an existing water right that involves diversion of surface water to underground storage and non-extractive beneficial use should describe the reason or need to keep the water in the basin. The SWRCB Fact Sheet states that recharge of an aquifer to maintain or restore a groundwater gradient necessary to keep seawater out of the aquifer is a beneficial use of water. The prevention of seawater or salinity intrusion is a Water Quality Use as identified in the beneficial use listings in the California Code of Regulations (Cal. Code Regs., tit. 23, § 670).

TM-4 summarizes assumptions and results of modeling scenarios to evaluate how well the project concept options would address seawater intrusion. This analysis is a starting point to quantify the effects of the injected and stored water. A water right permit or license would require a robust accounting method to demonstrate the amount of water injected into the basin under the permit or license, the amount of water subject to the permit or license that remains in the basin after addressing losses over time, the amount extracted (if applicable), and the volume of water applied to beneficial use.

Lastly, the State Water Board fact sheet states that in basins with a GSP under SGMA, the GSP may provide an adequate accounting method that the SWRCB will require water right holders to comply with in storing or using water within the groundwater basin. The GSP water budget should be considered an adequate accounting approach for this purpose. In other circumstances, the applicant or petitioner must demonstrate an accounting method that the SWRCB deems adequate to demonstrate beneficial use and avoid injury to other users of water.

3 PERMIT REQUIREMENTS FOR NEW FACILITIES

Both the Seasonal Release with ASR project concept and the New Diversion of Winter High Flows with ASR project concept would require new infrastructure, including surface water treatment facilities, injection/recovery well facilities, and associated pipelines and distribution systems. In this preliminary feasibility study, while the need for new facilities is identified in TM1, this analysis does not include the siting of any facilities or conceptual design. Therefore, the following discussion of potential permit requirements for new facilities is preliminary and would need to be revisited if the project is further developed, for example during an environmental review process.

3.1 Surface Water Treatment Plant, Pipelines and Distribution Network

To meet water quality standards for aquifer injection, treatment would be required. A surface water treatment plant, with a treated water storage reservoir and influent equalization storage, would likely require an approximate footprint of 10 to 20 acres. Water quality requirements for injection are discussed further in the next section. TM-3 includes water quality data and analysis that would inform treatment design and includes a sampling plan that would need to be implemented.

Because neither the Seasonal Release with ASR or the New Diversion of Winter High Flows with ASR project concepts would serve drinking water systems, the treatment plant would not require a Drinking Water Permit or Public Water System Permit from the SWRCB Division of Drinking Water.

Likely, RWQCB would provide regulatory oversight over the treatment plant design through their regulatory authorities. RWQCB approval would be needed for WDRs for discharges of treated water residuals to land or water bodies, including effluent quality and monitoring requirements. As discussed below for the ASR/Injection wells, even though the extracted water is only used for irrigation or other non-potable uses, the permitting of this facility would likely still require that the injectate be treated to meet drinking water standards. If discharges are made to surface waters, the plant may also need a National Pollutant Discharge Elimination System (NPDES) permit, also issued by the RWQCB.

Local land use and zoning requirements would need to be further assessed once potential treatment plant sites, pipeline alignments, and other distribution facility locations are identified. A new treatment plant may require a conditional use permit to demonstrate compliance with all rules and regulations pertaining to zoning uses from the applicable land use agency. A treatment plant for this project would most likely be located within the land use jurisdictional authority of either the County of Monterey or the City of Salinas. In unincorporated agricultural zones, water treatment facilities are not identified as a permitted use. Therefore, a change in the zoning designation to public/quasi-public uses would likely be required, similar to the land use designation for the City of Salinas' industrial ponds.

3.2 ASR/Injection Wells

The primary permitting requirement for new ASR wells would be met through a WDR. WDRs are issued by the RWQCB and are a key part of California's regulatory framework for protecting water quality. WDRs provide regulatory guidelines and permits that govern the discharge of waste into land, water bodies, or groundwater. The purpose of WDRs is to ensure that such discharges do not harm public health, degrade water quality, or negatively impact the environment. They typically involve protection of water quality and regulation of discharges, and they provide compliance with the Clean Water Act, Safe Drinking Water Act, and other federal, state, and local regulations.

To understand the permitting requirements for the ASR facilities in the GSP project concept, SVBGSA representatives met with representatives from the Central Coast RWCQB to discuss potential requirements for a WDR. Topics covered in the discussions included source water quality and treatment considerations (discussed further in TM-3) to ensure that the injected water would meet state water quality standards to prevent existing water quality degradation. The injectate would need to comply with water quality objectives in the Water Quality Control Plan for the Central Coastal Basin (Basin Plan) and consider the separate objectives for the 180-Foot and 400-Foot Aquifers.

The State Water Board has adopted general waste discharge requirements for ASR projects that recharge groundwater with treated drinking water (General Order) on September 19, 2012. The purpose of the General Order is to streamline the permitting process and ensure consistent requirements for ASR projects. The other established regulatory approach for projects that intend to recharge groundwater via injection wells is for indirect potable reuse projects, such as the Pure Water Monterey project injection wells in the Seaside Basin.

Because the ASR wells in the Seasonal Release with ASR project concept are not planned to be used to recover water for drinking water purposes, based on discussion with both CC RWQCB staff and State Water Board Division of Drinking Water (DDW) staff, the ASR General Order may not be applicable. However, even though the extracted water is only used for irrigation or other non-potable uses, the permitting of this facility would likely still require that the injectate be treated similar to a DDW permit for a public water system to meet drinking water standards since it would be injected into an aquifer that is used for drinking water.

Therefore, the likely permitting path for the ASR wells would be similar to the requirements for indirect potable reuse projects and would include submitting a Report of Waste Discharge and Monitoring and Reporting Program. Drinking water is identified in the Central Coast Basin Plan as a beneficial use in both the 180-Foot and 400-Foot Aquifers. Although the ASR wells in this project concept would not be used for drinking water, the report of waste discharge would need to demonstrate that the injectate would not impair drinking water beneficial uses. Geochemical analysis to evaluate interactions of native water with injected water would also be required as part of this permit process.

Both of the established CC RWQCB regulatory approaches for groundwater injection well projects (ASR General order and indirect potable reuse) require sampling prior to injection for all water quality constituents with an MCL. Sampling occurs as part of the drinking water permit process. CC RWQCB staff suggested that a pilot project may be recommended for permitting of a full-scale project. A pilot project would provide needed information on water quality of the Salinas River during the diversion period. TM-3 provides recommendations for a water quality sampling plan.

Lastly, injection of the treated water into the groundwater basin would require registration of the injection wells and operation under the EPA Underground Injection Control Program. Wells used for the injection of potable water are considered Class V wells.

3.3 New Diversion Structure (New Diversion of Winter High Flows with ASR project concept)

Like other potential new infrastructure for the project concepts, this feasibility study does not include any siting analysis or proposed location for a new diversion structure identified in New Diversion of Winter High Flows with ASR project concept. Further, it does not assess a full array of diversion structure types or designs.

Construction of a new diversion system would result in impacts to waters of the United States or waters of the State and would require permits from USACE and the RWQCB. Waters within the Project area, below the ordinary high-water mark, would most likely fall under the jurisdiction of USACE as a water of the United States and construction activities in this area would be subject to USACE permit requirements pursuant to Section 404 of the Clean Water Act (CWA).

In addition, if a USACE 404 permit is required, Section 401 of the CWA Water Quality Certification from the RWQCB is also required and activities must meet State water quality standards. In situations where a water source is determined to be jurisdictional under State regulations but is not jurisdictional under federal regulations, an SWRCB WDR would be issued in lieu of a 401 Certification. A WDR is designed to manage and regulate discharges to prevent pollution and protect water resources and allows a facility or activity to discharge waste into State waters while ensuring compliance with water quality standards. These permits and certifications are typically issued on the condition that the applicant agrees to provide mitigation that results in no net loss of wetland functions, jurisdictional waters, or beneficial uses. Compliance with each permit requires avoidance, minimization, and mitigation measures to ensure that Project-related impacts to jurisdictional waters are less-than-significant in nature or are fully mitigated.

Project activities with potential to alter natural waters including the bed, bank, floodplain, and associated riparian habitat, would be within CDFWs jurisdiction, pursuant to Section 1602 of the California Fish and Game Code, requiring notification to CDFW that the Project's activities have potential to impact rivers, streams, or the riparian corridor of aquatic features on site that may be beneficial to fish or wildlife resources. If CDFW determines that the Project would potentially adversely affect fish and wildlife resources and/or riparian habitat, a Lake or Streambed Alteration Agreement (Agreement) would need to be issued prior to construction. Agreements are typically issued with mandatory avoidance and minimization measures, protective measures for special status species, and required compensatory mitigation for removal of riparian trees, shrubs, and herbaceous cover along stream banks. These measures would be designed so that compliance would ensure that the Project's impacts to aquatic features and riparian habitat within CDFW's jurisdiction remain less-than-significant or are fully mitigated.

Any new diversion structure would require numerous permits, including but not limited to:

- USACE Permit pursuant to Section 404 of Clean Water Act and/or Section 10 of Rivers & Harbors Act
- USFWS Potential Federal Endangered Species Act incidental take permit
- NMFS)Potential Federal Endangered Species Act incidental take permit
- California Department of Fish & Wildlife (CDFW) Streambed Alteration Agreement (1600)
- CDFW Potential California Endangered Species Act incidental take permit
- RWQCB NPDES Permit (for construction)
- RWQCB Water Quality Certification Pursuant to Section 401 of the CWA
- Monterey Bay Unified Air Pollution Control District Authority to Construct (for devices that emit air pollutants)
- Monterey County Design level review and approval of structures, consideration of General Plan and Zoning Consistency

These permit requirements would apply to a new facility similar to the existing SRDF or for a new diversion structure type, such as a Ranney Well Collector.

4 SUMMARY OF ANTICIPATED PERMITS AND APPROACHES

Table 2 summarizes the various permits that may be required for the construction of the Project Concept options.

Table 2. Summary of Anticipated Permits and Approvals

Agency or Department	Permit or Approval	Project Component/Facility	Notes
Federal Agencies			
USACE	Permit under Section 404 of the Clean Water Act (33 USC §1344)	Modifications to SRDF or new diversion facilities	Projects that would discharge dredged or fill material into waters of the United States, including wetlands, require a USACE permit under Clean Water Act Section 404.
USACE	Section 10 Permit of the Rivers and Harbors Act of 1899	Modifications to SRDF or new diversion facilities	Projects that would place structures below the Ordinary High-Water elevation of navigable waters of the United States require approval by the USACE.
USFWS	Consultation, Determination, or Incidental Take Statement in accordance with FESA Section 7, as amended (16 USC §1531 et seq.)	Modifications to SRDF or new diversion facilities Other potential facilities in riparian or other ESA habitat areas	The USFWS authorizes the incidental take of federally listed species through an Incidental Take Statement that is supported by, and often attached to, the Biological Opinion, consistent with Section 7 of the FESA.
NMFS	Consultation, Determination, or Incidental Take Statement in accordance with FESA Section 7, as amended (16 USC §1531 et seq.)	Modifications to SRDF or new diversion facilities in Salinas River	The Federal Endangered Species Act (FESA) requires federal agencies to consult with the NMFS before implementing actions that may affect a federally listed species under their jurisdiction or may adversely modify designated critical habitat.
EPA	Underground Injection Control (UIC) Program under the Safe Drinking Water Act (SDWA) Class V Injection Well Permit	Injection wells	Most ASR wells fall under Class V, requiring compliance with specific EPA guidelines.
EPA	Endangerment Demonstration	Injection wells	Evidence that the ASR activity will not endanger drinking water sources

Agency or Department	Permit or Approval	Project Component/Facility	Notes
State Agencies			
RWQCB	Compliance with National Pollutant Discharge Elimination System (NPDES) General Permit for Discharges of Storm Water Associated with Construction Activity (Order 2010-0014-DWQ)	Project Construction	Any discharge of stormwater to surface waters of the United States from a construction project that encompasses 1 acre or more of soil disturbance requires compliance with the General Permit. This includes: − Development and implementation of a stormwater pollution prevention plan that specifies best management practices (BMPs) to prevent construction pollutants from contacting stormwater, with the intent of keeping all products of erosion from moving offsite into receiving waters − Elimination or reduction of non-stormwater discharges to storm sewer systems and other waters of the U.S. − Inspection of all BMPs
RWQCB	Waste Discharge Requirements under the Porter-Cologne Water Quality Control Act (Cal. Water Code §13000 et seq.)	Injections Wells, Surface Water Treatment Plant	Any activity that results or may result in a discharge of waste that directly or indirectly impacts the quality of waters of the state (including groundwater or surface water) or the beneficial uses of those waters is subject to waste discharge requirements. "Special Use Permit" – does not fit under ASR General Order
RWQCB	Water Quality Certification under Section 401 of the Clean Water Act (33 USC §1341)	Modifications to SRDF or new diversion facilities in Salinas River	Under Section 401 of the Clean Water Act, the RWQCB must certify that actions authorized under Section 404 of the Clean Water Act also meet state water quality standards. Any applicant for a federal license or permit to conduct any activity including, but not limited to, the construction or operation of facilities, which may result in any discharge into navigable waters, must provide the licensing or permitting agency a certification that the activity meets state water quality standards.
CDFW	Incidental Take Permit under the California Endangered Species Act (CESA) (Cal. Fish and Game Code §2081)	Modifications to SRDF or new diversion facilities in Salinas River	The take of any endangered, threatened, or candidate species may be permitted if it is incidental to an otherwise lawful activity and if the impacts of the authorized take are minimized and fully mitigated. No permit may be issued if the activity would jeopardize the continued existence of the species.

Agency or Department	Permit or Approval	Project Component/Facility	Notes
	Lake/Streambed Alteration Agreement (Cal. Fish and Game Code §1602)	Modifications to SRDF or new diversion facilities in Salinas River	It is unlawful to substantially divert, obstruct, or change the natural flow or the bed, channel, or bank of any river, stream, or lake in California that supports wildlife resources, or to use any material from the streambeds, without first notifying the CDFW.
SWRCB	Petition of Change to existing water right	Additional diversion at SRDF	Modify existing MCWRA water right to allow for direct diversion, diversion of additional Salinas River flow at the SRDF, collection to underground storage, and for a different beneficial use (i.e. recharge to address/prevent seawater intrusion)
State Water Resources Control Board (SWRCB)	Water right permit	New diversion of Salinas River flows (New Diversion of Winter High Flows with ASR project concept)	Acquisition of a post-1914 appropriative water right
Local Agencies			
Monterey County Public Works Department	Encroachment Permit (Monterey County Code [MCC] Chapter 14.04)	Pipelines and associated distribution system facilities	Designated activities within the right-of-way of a county highway require an Encroachment Permit from the director of the Public Works Department, whose decisions may be appealed to the Monterey County Board of Supervisors.
Monterey County Health Department, Environmental Health Bureau	Well Construction Permit (MCC Chapter 15.08)	Injection wells	Monterey County's health officer must issue a written permit before anyone can build new wells. Those decisions may be appealed to the Board of Supervisors.
Monterey County Housing and Community Development Department	Conditional Use Permit (MCC Chapter 21.74)	Surface Water Treatment Plant	The Monterey County Zoning Ordinance requires a conditional use permit issued by the appropriate planning authority (e.g., the zoning administrator or the Planning Commission) for certain uses in specific zones. The permit decisions may be respectively appealed to the Planning Commission or the Board of Supervisors.
Monterey County Housing and Community Development Department	Grading Permit (MCC Chapter 16.08)	Project Construction	Subject to certain exceptions, grading requires a permit from the Monterey County Planning and Building Inspection Department. Grading permit decisions may be appealed to the 5-member Board of Appeals, and then to the Board of Supervisors.

Agency or Department	Permit or Approval	Project Component/Facility	Notes
Monterey County Housing and Community Development Department	Erosion Control Permit (MCC Chapter 16.12)	Project Construction	The Director of Building Inspection must issue an Erosion Control Permit for any project development and construction activities (such as site cleaning, grading, and soil removal or placement) that are causing or are likely to cause accelerated erosion. Permit decisions may be appealed to the Board of Appeals and then to the Board of Supervisors.
Monterey Bay Unified Air Pollution Control District	Authority to Construct permit under Local Rule 3.1	Project Construction	Projects that propose to build, erect, alter, or replace any article, machine, equipment, or other contrivance that may emit air contaminants from a stationary source or may be used to eliminate, reduce, or control air contaminant emissions require an authorization to construct permit.
Monterey Bay Unified Air Pollution Control District	Permit to Operate under Local Rule 3.2	Surface Water Treatment Plant	Operating the diesel fuel-powered emergency generators, and any other articles, machines, equipment, or other contrivances that may emit air contaminants from a stationary source requires a permit to operate.

5 PRE-CONSTRUCTION ENVIRONMENTAL REVIEW

Prior to and as part of the issuance of any permits or approvals, a detailed assessment of the potential effects of the project and identification of avoidance, minimization, and mitigation measures where applicable would be needed. Project-specific environmental documentation would need to be prepared in compliance with the National Environmental Policy Act (NEPA) and the California Environmental Quality Act (CEQA). This would include preparation of an ESA Biological Assessment and other supporting studies. Environmental review would also need to be completed before any water right changes or new water right permits could be issued.

If selected for implementation, both the Seasonal Release with ASR project concept and the New Diversion of Winter High Flows with ASR project concept would likely require preparation of an environmental impact report (EIR) in accordance with CEQA and/or an Environmental Impact Statement (EIS) in accordance with NEPA for federal permit requirements. Additional technical studies needed to assess environmental effects and inform permit requirements are beyond the scope of this preliminary feasibility analysis. The feasibility study is preliminary to these environmental reviews, but they would be a fundamental step to a future permitting phase of project development.

Preliminary Feasibility Study
Aquifer Storage and Recovery Project Concepts
to Address Seawater Intrusion

TECHNICAL MEMORANDUM 3

Surface Water Quality Assessment and Sampling Plan

Prepared by:

LIFECYCLEGEO

MONTGOMERY & ASSOCIATES
Water Resource Consultants

1 INTRODUCTION

Life Cycle Geo (LCG) was contracted by M&A to assess Salinas River basin surface water quality and general data availability to support a preliminary ASR feasibility study and to support future water treatment design. A sampling and analysis plan was designed to help inform water treatment requirements of the Salinas River prior to being diverted for ASR. Surface water would be required to meet California drinking water standards (Title 22) prior to underground storage. As part of the preliminary feasibility study project concepts, water from the Salinas River would be injected into the 180-Foot and 400-Foot groundwater aquifers year-round. This injected river water would help limit seawater intrusion in the 180-Foot and 400-Foot aquifers and support groundwater supply in the region during the dry season when drawdown is high from increased irrigation demand.

The sampling plan was developed to address the data gaps in the currently available water quality dataset. Previous water sampling campaigns have focused on agricultural standards—and did not monitor drinking water standards—because current diversions from the Salinas River are primarily for agricultural irrigation. Sampling campaigns have typically been conducted in the summer when these irrigation rates are the highest, limiting understanding of how constituents of concern (CoCs) change throughout the year. Sampling outside of this summer window is recommended to properly assess future year-round water treatment requirements.

2 CURRENT WATER QUALITY DATASET

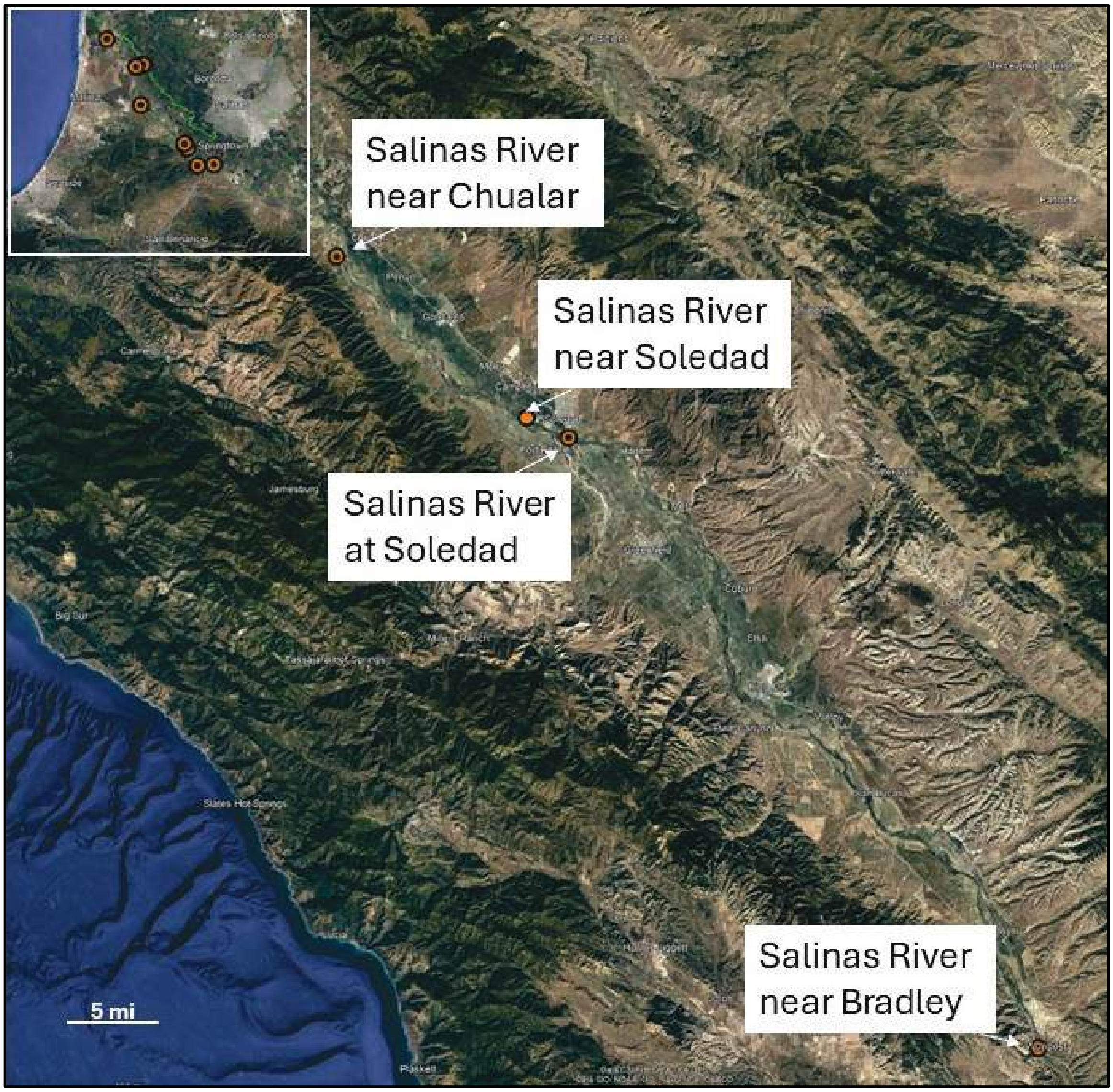
2.1 Data Sources

M&A compiled water quality data for this surface water assessment. Water quality sampling and analysis was previously completed by USGS, MCWRA, M1W, and Preservation Inc., with data stored within the California Environmental Data Exchange Network (CEDEN).

2.2 Sampling Locations

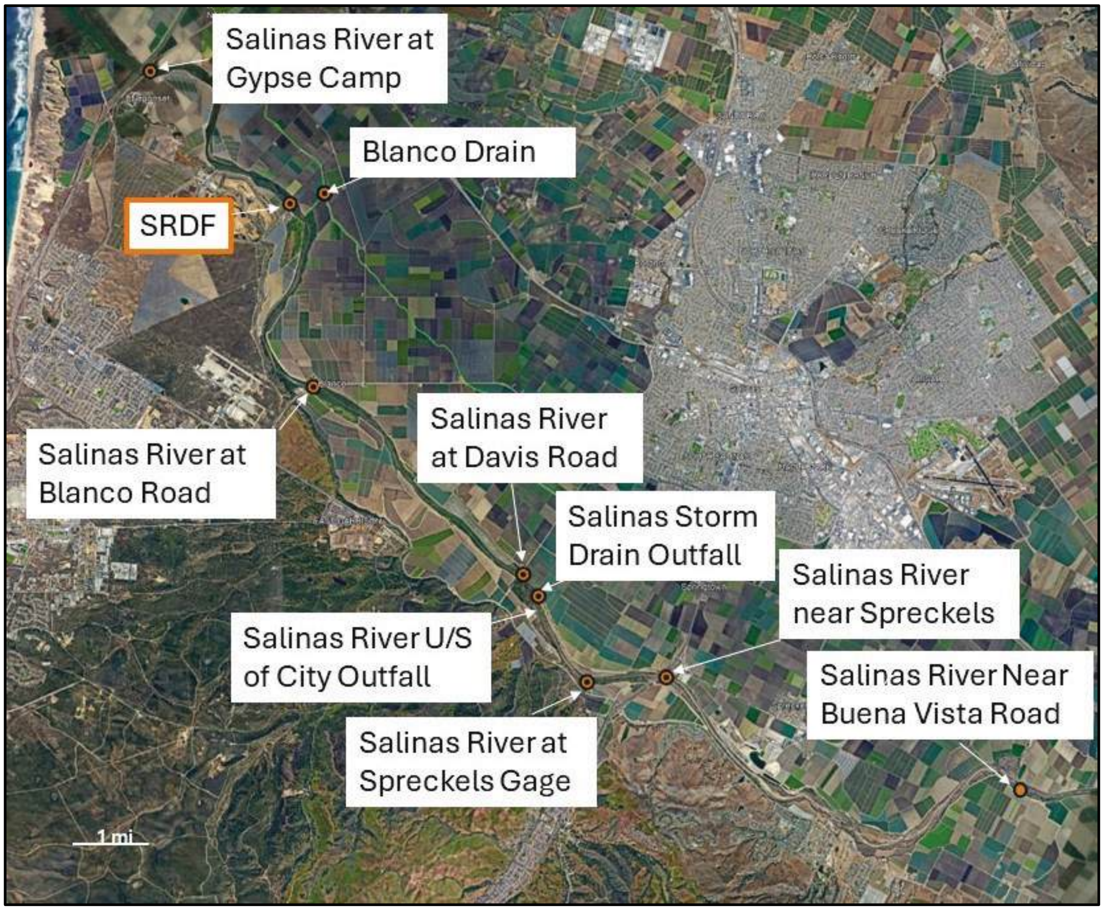
From the available data sources 14 sampling locations were identified. These locations range along an 80-mile stretch of the Salinas River from Bradley up the Salinas Valley to Gypse Camp—which is west of Salinas—and near the Pacific Ocean. The Salinas River flows to the northwest toward the Pacific Ocean. The sampling locations are shown on Figure 1 and Figure 2. Sampling locations were separated into 4 groups: 1) locations that are upstream of Salinas in the Salinas Valley; 2) locations downstream near the city of Salinas; 3) the Blanco drain, which directs runoff from agriculture fields; 4) and the SRDF, which is the proposed location of surface water diversion for ASR. Locations from each group are outlined below:

- Upstream – Southeast of Salinas
    - Salinas River near Bradley
    - Salinas River at Soledad
    - Salinas River near Soledad
    - Salinas River near Chualar
- Downstream – near the city of Salinas
    - Salinas River near Buena Vista Road
    - Salinas River near Spreckels
    - Salinas River at Spreckels Gage
    - Salinas River Upstream (U/S) of City Outfall
    - Salinas Storm Drain Outfall
    - Salinas River at Davis Road
    - Salinas River at Blanco Road
    - Salinas River at Gypse Camp
- Blanco Drain
- SRDF



Note: Area in white box enlarged on Figure 2

Figure 1. Upstream Salinas River Sampling Locations



Note: The current proposed diversion location (SRDF) is highlighted with an orange box.

Figure 2. Downstream Salinas River Sampling Locations

3 DATA TRENDS

3.1 Water Quality Data Distribution

Water quality data from the 14 locations were processed and compiled to review sample populations and period of observation. Sampling has occurred intermittently at the various monitoring locations over the last 70 years. Over the duration of monitoring, more than 1,500 different sampling events have occurred. However, the sampling is not evenly distributed spatially or temporally. Some locations were regularly monitored with hundreds of sampling events occurring over decades, whereas others only have a handful of sampling events over a short duration. This is highlighted by the fact that only 2 upstream locations (Near Bradley and Near Chualar), 3 downstream locations (Near Spreckels, Spreckels Gage, and Davis Road), and the SRDF make up less than half of the locations sampled, but account for up to 87% of the sample events. The duration and number of sampling events at each location is shown in Table 1.

Table 1. Water Quality Sample Distribution at Each Location

Sample Location	Area	Start	End	Count
Salinas River near Bradley, CA	upstream	2/5/1958	5/6/2017	89
Salinas River at Soledad, CA	upstream	10/28/1971	7/10/1992	23
Salinas River near Soledad	upstream	4/21/2004	8/24/2004	33
Salinas River near Chualar, CA	upstream	12/7/1966	8/27/2013	276
Salinas River near Buena Vista Road	downstream	6/17/2004	8/26/2008	51
Salinas River near Spreckels, CA	downstream	10/30/1951	8/13/1990	349
Salinas River at Spreckels Gage	downstream	1/27/2005	9/19/2019	129
Salinas River U/S of City Outfall	downstream	10/5/2011	3/24/2012	2
Salinas Storm Drain Outfall	downstream	1/15/1998	4/12/2017	62
Salinas River at Davis Road	downstream	2/1/1999	2/21/2023	302
Salinas River at Blanco Road	downstream	12/11/2003	6/26/2013	3
Blanco Drain	Agriculture Drain	5/5/2003	10/9/2007	21
SRDF	SRDF	1/26/2005	3/23/2022	190
Salinas River at Gypse Camp	downstream	5/2/2009	5/7/2016	8

Sample counts for the major analytes for each sample location are shown in Table 2. These elements (pH, total dissolved solids (TDS), sulfate, nitrogen species, calcium, magnesium, sodium, potassium, chloride, and boron) were selected for review as they typically comprise the bulk of dissolved mass in most water quality samples and were frequently measured at multiple sampling locations. In addition, trace metals were measured at several locations. However, such analyses are sparse, both spatially and temporally. For this reason, trace metals (e.g. antimony, beryllium, nickel, and thallium) that were analyzed only a few times and did not exceed Title 22 Standards are not discussed in this memorandum.

Table 2. Sample Counts for Major Analytes at Each Sampling Location

Location	pH	TDS	SO4	NO3+NO2 as N	NO3-N	NO2	Ca	Mg	Na	K	Cl	B
Total Count	**984**	**819**	**280**	**563**	**424**	**100**	**227**	**222**	**364**	**216**	**579**	**400**
Salinas River near Bradley CA	76	26	32	38	40	12	32	32	72	32	72	35
Salinas River at Soledad CA	6			19	19	5						
Salinas River near Soledad		31										
Salinas River near Chualar CA	130	146	118	105	77	72	116	116	120	116	122	9
Salinas River near Buena Vista Road	5	27	5		1		8	8	5	5	5	3
Salinas River near Spreckels CA	145	30	32	10	41	9	44	39	142	39	142	119
Salinas River at Spreckels Gage	97	97		83								2
Salinas River U/S of City Outfall		2		2								
Salinas Storm Drain Outfall	47	41	7	2		1	7	7	7	7	7	4
Salinas River at Davis Road	283	232	75	132	229		6	6	6	6	219	209
Salinas River at Blanco Road	2	1	1		2		1	1	1	1	1	
Blanco Drain	13	11	10		4	1	13	13	11	10	11	11
SRDF	175	175		172	3							8
Salinas River at Gypse Camp	5				8							

3.2 Seasonal Water Quality Trends

The impact of seasonal fluctuations in precipitation/recharge as well as agricultural activities may impact the concentrations of analytes along the Salinas River. While many of the locations sampled do not have sufficient data density to facilitate evaluation of seasonal trends, the monitoring locations Near Chualar, Davis Road, and at the SRDF do have adequate data available to support such analysis. Here we focus seasonal analysis on nitrate plus nitrite, sulfate, and TDS concentrations as these constituents are linked with agricultural activity, which is prominent in the area. The monitoring location Near Chualar is upstream of Salinas, whereas the Davis Road location is downstream, near Salinas.

Average concentrations for nitrate and nitrite are shown in Table 3 and presented on Figure 3. Average water quality at the location upstream of Salinas (Near Chualar) does not exceed Title 22 Standards for nitrate and nitrite (10 mg/L). Concentrations generally peak from March to May and then gradually decrease throughout the rest of the year. This is in contrast to water quality at the downstream Davis Road location, which peaks in nitrate and nitrite concentrations from May through November and exceeds Title 22 Standards during this time, as shown with the green highlighted cells in Table 3. Average water quality at the SRDF monitoring location exceeds Title 22 Standards the entire year and does not appear affected by seasonal trends. Generally speaking, nitrate and nitrite concentrations increase downstream, likely reflecting cumulative impact of upgradient agricultural activity and discharges.

Average concentrations for TDS are shown in Table 4 and on Figure 4. Average TDS concentrations increase downstream, with TDS concentrations at the Near Chualar location consistently below Title 22 Standards (1,000 mg/L), ranging between 200 and 400 mg/L, whereas the SRDF sampling location is consistently above Title 22 Standards, with concentrations consistently near 2,000 mg/L. The average TDS concentrations at the Davis Road location tend to be higher during the dry season (July through October), ranging between 800 and 1,000 mg/L and lower during the wet season (November through February), ranging between 600 and 800 mg/L. Slight exceedances the TDS Title 22 Standard occur in July and November. In contrast to the Davis Road location, average TDS concentrations are relatively stable year-round at the SRDF and Near Chualar locations.

Average concentrations for sulfate at Near Chualar and Davis Road are shown in Table 5 and on Figure 5. Sulfate concentration trends are similar to those of nitrate and nitrite. Near Chualar peak sulfate concentrations occur in March through May, whereas peak sulfate concentrations downstream at the Davis Road location occur during the second half of the year. Sulfate concentrations also generally appear to increase downstream, however the average sulfate concentrations do not exceed Title 22 Standards (500 mg/L) for either of these locations. Sulfate was not measured at the SRDF.

Over the last decade, TDS concentration trends have decreased slightly at the SRDF, with concentrations from 2014 through 2016 averaging ~1900 mg/L and concentrations from 2017 to 2020 averaging ~1700 mg/L (Figure 6A). This trend was not observed at other sampling locations. The location at Davis Road exhibits large swings in concentrations (300-3000 mg/L) throughout the year (Figure 6B), and the location at Spreckels Gage remains relatively stable over the year (100-350 mg/L; Figure 6C).

In addition to this dataset, the Central Coast Cooperative Monitoring Program (CCCMP) completed routine monitoring and statistical analysis of Salinas River water quality to assess the long-term seasonal trends on select parameters. Salinas River locations at Chualar Bridge, Spreckels Gage, and the Blanco Drain Below Pump (part of the SRDF) were analyzed for trends from 2005 to 2022 using the Mann-Kendall test. The following trends were observed:

- **Flow rate** is decreasing at all 3 locations.
- **Turbidity** is decreasing at the Blanco Drain and Chualar Bridge locations and increasing at the Spreckels Gage location.
- **Specific Conductivity** is decreasing at all 3 locations.
- **Nitrate** concentration trends are increasing in the Blanco Drain but decreasing at Chualar Bridge and Spreckels Gage.
- **TDS** concentration trends are decreasing at all 3 locations.
- **Orthophosphorous** is decreasing at all 3 locations.

In general, analysis from the CCCMP has shown that concentrations of major CoCs are decreasing over time along the river, with the exception of nitrate at the Blanco Drain which has been increasing.

Based on this data, it appears that seasonal trends may have a different impact on water quality depending on the location. The area upstream (near Chualar) indicates its highest concentrations of nitrate and nitrite as well as sulfate occur from March through May; this may reflect increased agricultural activity during this time period, such as fertilizer applications. In contrast, the highest nitrate, TDS, and sulfate concentrations observed at the monitoring location downstream at Davis Road occur during the summer months. The mechanism for this observation is likely complex and in the absence of additional data, poorly understood at this time. Possible hypotheses could include mechanisms such as elements concentrating in water due to lower stream volumes, or nutrient buildup in soil and on roads introduced into surface waters during periodic flushing events. However, additional hypotheses and supporting lines of evidence need to be developed with additional water quality sampling collected at regular intervals. This location is immediately downstream of the Salinas City storm drain, which discharges runoff from a large upgradient tributary area during storm events.

The SRDF appears unimpacted by seasonal trends, maintaining relatively consistent nitrate and nitrite and TDS concentrations. TDS concentrations increase downstream, which is likely a function of loading from runoff. This trend is present for nitrate and nitrite and sulfate concentrations as well. Insufficient data is available to evaluate additional analytes for seasonal trends at these or other sampling locations.

Table 3. Average Nitrate and Nitrite Concentrations by Month

Month	Salinas River Near Chualar, CA (1979-2013)		Salinas River at Davis Road (1999-2022)		SRDF (2005-2019)	
	NO3+NO2 as N (mg/L)	Count	NO3+NO2 as N (mg/L)	Count	NO3+NO2 as N (mg/L)	Count
Jan	1.2	9	4.9	11	71	15
Feb	1.1	7	6.1	12	61	14
Mar	1.9	13	8.6	14	68	14
Apr	1.8	7	6.8	11	57	15
May	2.0	10	10	11	58	15
June	1.6	11	15	11	59	15
July	0.68	7	23	11	66	15
Aug	0.33	12	10	13	71	15
Sept	0.42	12	26	10	71	15
Oct	0.20	2	22	8	59	13
Nov	0.83	12	18	11	63	13
Dec	0.63	3	7.3	9	59	13

Note: Chemicals that exceed Title 22 Standards are highlighted in green.

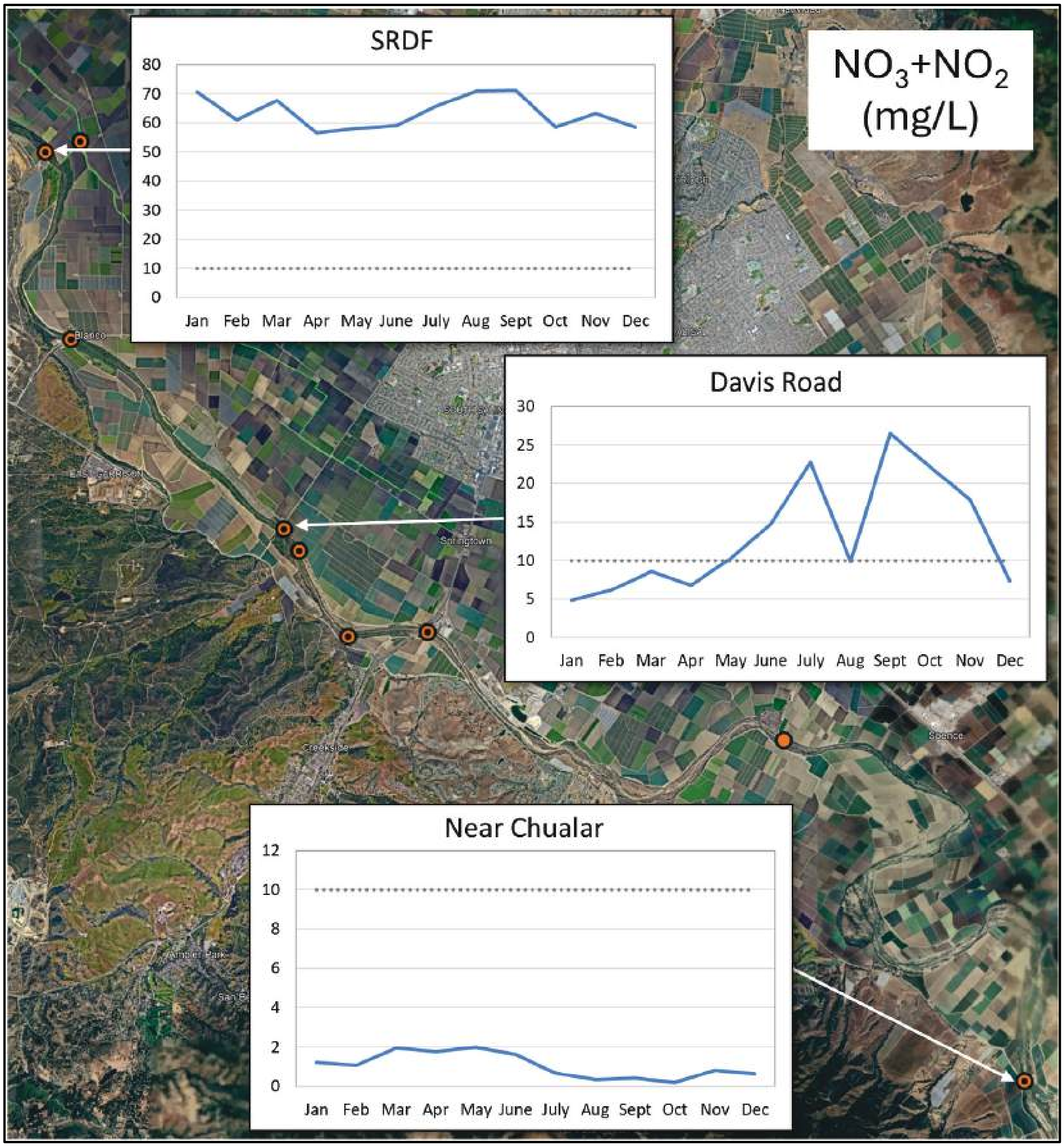


Figure 3. Average Monthly Nitrate + Nitrite Concentration Trends Compared with the Title 22 Standard of 10 mg/L

Table 4. Average TDS Concentrations by Month

Month	Salinas River Near Chualar (1966-2013)		Salinas River at Davis Road (1999-2022)		SRDF (2005-2019)	
	TDS	Count	TDS	Count	TDS	Count
Jan	333	10	605	19	1944	14
Feb	301	8	795	19	1885	14
Mar	352	13	651	21	1918	14
Apr	388	10	571	20	2005	15
May	399	19	703	24	1913	15
June	292	19	882	20	1953	15
July	294	16	1078	19	1909	15
Aug	234	22	788	23	1980	15
Sept	282	11	903	17	1859	15
Oct	289	3	947	14	1959	14
Nov	304	11	1025	19	1871	14
Dec	274	4	782	17	1917	15

Note: Chemicals that exceed Title 22 Standards are highlighted in green.

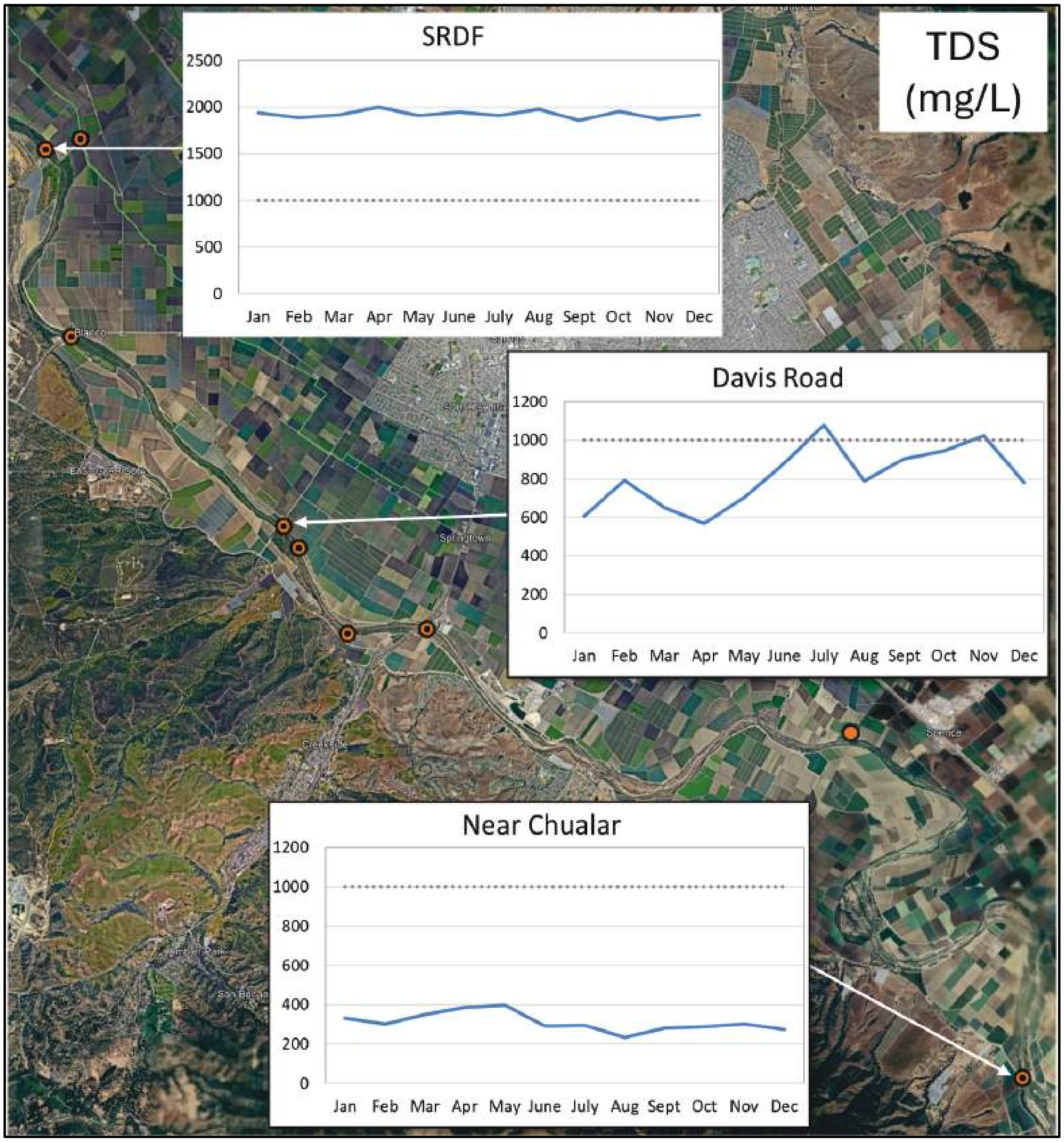


Figure 4. Average Monthly TDS Concentration Trends Compared with the Title 22 Standard of 1,000 mg/L

Table 5. Average Sulfate Concentrations by Month

Month	Salinas River Near Chualar (1966-2013)		Salinas River at Davis Road (2001-2022)	
	SO4 (mg/L)	Count	SO4 (mg/L)	Count
Jan	105	10	177	6
Feb	89	7	287	5
Mar	110	13	132	7
Apr	116	9	147	7
May	136	12	194	8
June	80	11	301	8
July	97	8	278	7
Aug	54	16	285	6
Sept	66	13	211	5
Oct	77	3	360	4
Nov	82	12	333	6
Dec	76	4	275	6

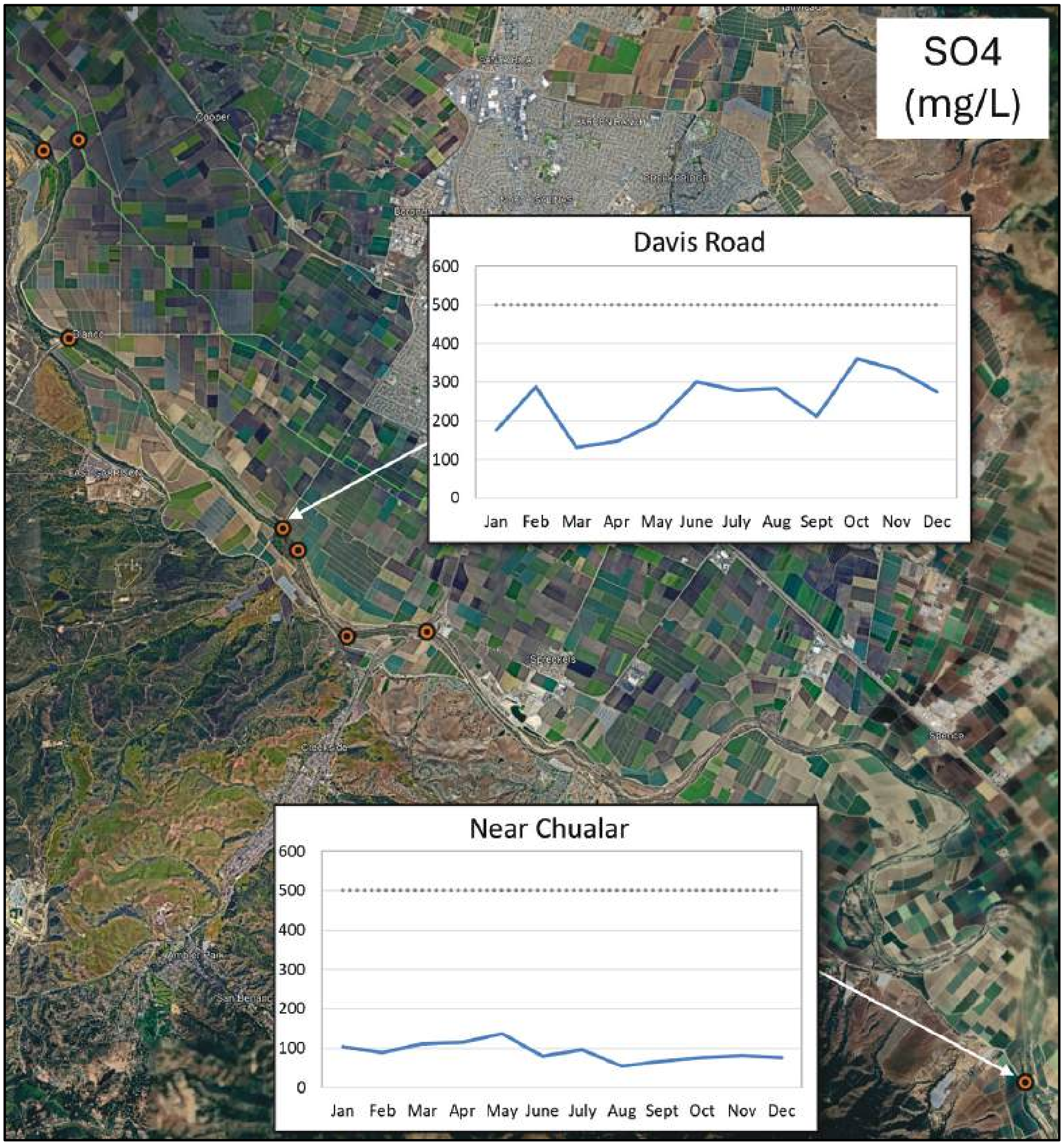


Figure 5. Average Monthly Sulfate Concentration Trends Compared with the Title 22 Standard of 500 mg/L

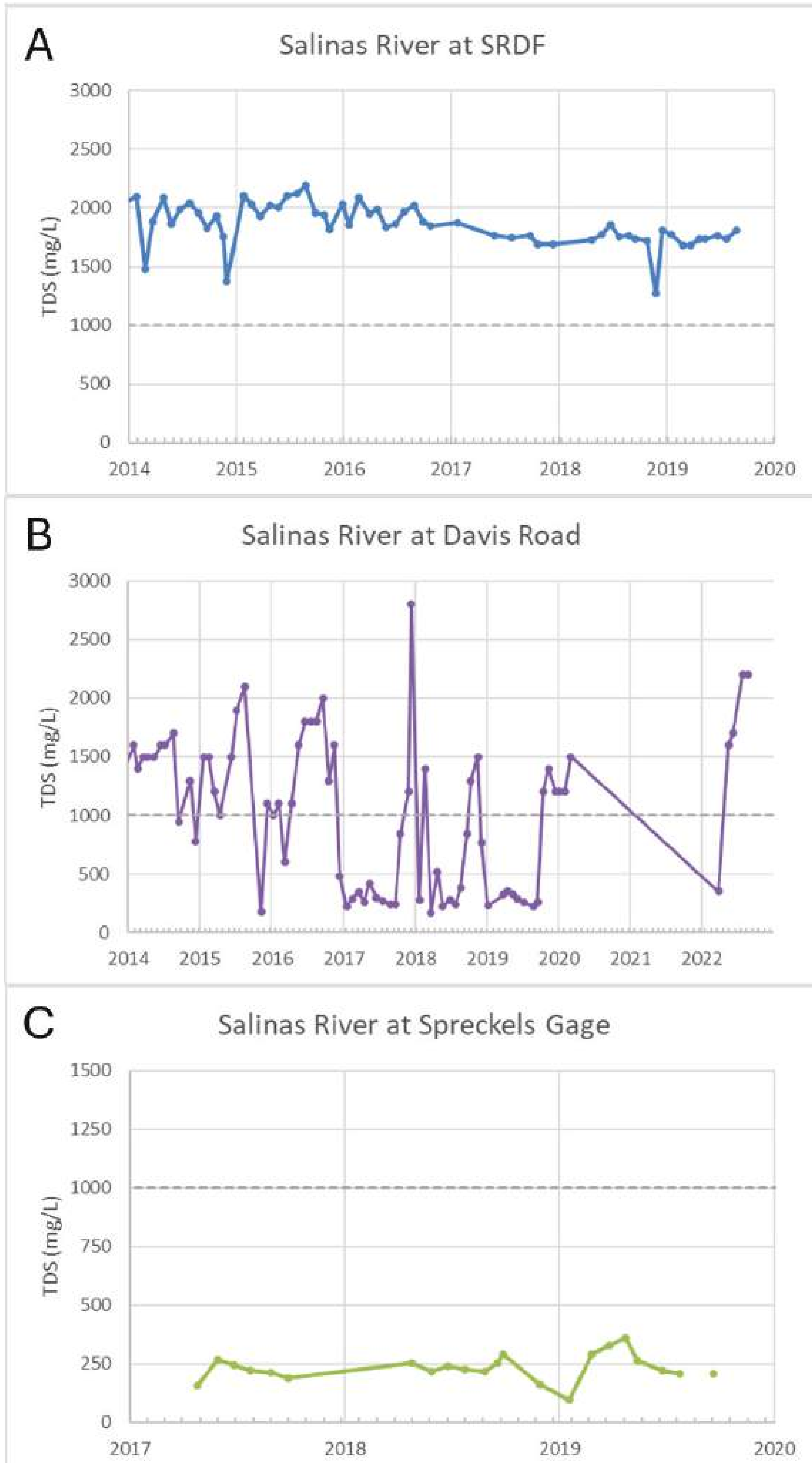


Figure 6. TDS Concentrations Trends Over the Past Decade

3.3 Stream Flow Trends

Stream flow volumes vary throughout the year and appear to largely reflect seasonal climatic variability. In addition, the effects of upstream reservoir releases also play a role in stream flows at the sampling locations. Stream flow data was collected at USGS and MCWRA Salinas River monitoring locations including 4 upstream (Near Bradley, Soledad, Near Soledad, Near Chualar) and 3 downstream (Near Spreckels, Near Buena Vista Road, and Davis Road) sampling locations. Measurement date ranges and number of sampling events are presented in Table 6. Available stream flow data started in 1951 at the monitoring location near Spreckels and continues at various locations until 2008. Some locations had continuous monitoring for only 1 season, such as the sampling locations near Soledad and Davis Road, whereas others were monitored for over 20 years.

Correlating flow data with water quality data can inform the trends observed in the water quality parameters and provide insight to processes contributing to the trends, such as seasonality. Available flow volumes along with TDS concentrations are presented on Figure 7. TDS was selected for interpretation as it was widely measured at each location and because TDS measurements often coincided with the frequency and duration of flow measurements. Other analytes such as nitrate and sulfate, which are helpful for tracking agricultural activity, were not sampled over the same time period as flow measurements. TDS concentrations are colored by different informal yearly time periods: blue for the wet season (November through February), green for increased agricultural activity (March through June) and yellow for the dry season (July through October).

Analysis of correlations between flow and water quality data (represented as TDS) explored both temporal and spatial distributions. In general, it is difficult to draw many conclusions from this dataset, particularly for Near Chualar and Davis Road where the available data does not align well with the flow monitoring period. The location near Soledad is also difficult to interpret for long-term temporal trends as the monitoring period occurred over a single 4-month period (April to August) during which TDS concentrations generally decrease while the discharge volumes increase. However, at the Bradley and Buena Vista Road monitoring locations, periods of higher flow generally coincide with higher TDS concentrations. The area near Spreckels has no correlation between TDS and flow rate.

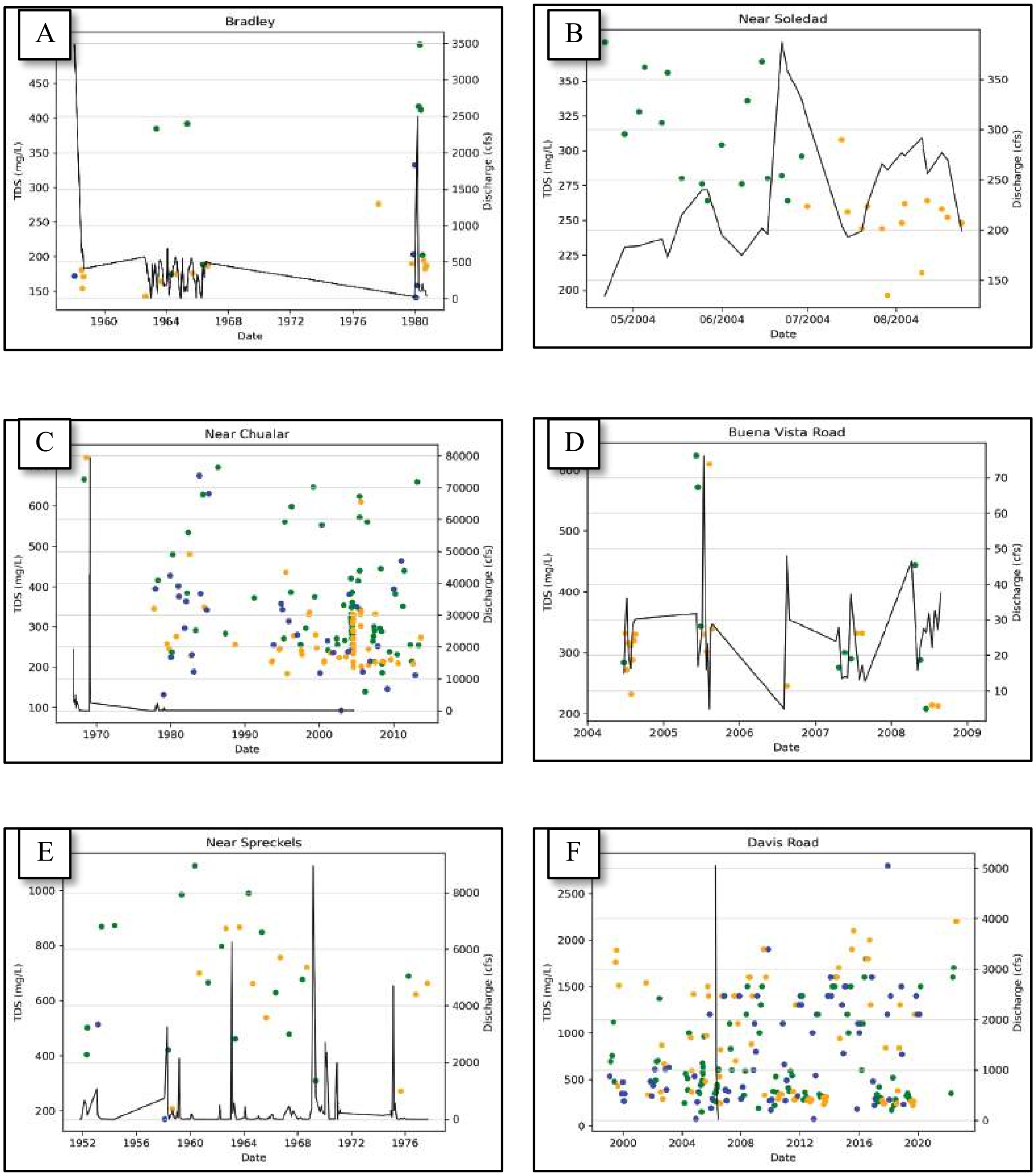


Figure 7. River Flow Volume and TDS Concentrations at A) Bradely, B) Near Soledad, C) Near Chualar, D) Buena Vista Road, E) Near Spreckels, and F) Davis Road Monitoring Locations

Note: Blue (November-February), Green (March-June), Yellow (July-October), Black line is flow data (discharge) in cfs.

Table 6. Salinas River Flow Monitoring Duration at Each Location

Sample Location	Area	Start Date	End Date	Count
Salinas River near Bradley CA	upstream	2/5/1958	9/23/1980	65
Salinas River at Soledad CA	upstream	10/28/1971	7/10/1992	23
Salinas River near Soledad	upstream	4/21/2004	8/24/2004	31
Salinas River near Chualar CA	upstream	12/7/1966	8/24/2004	101
Salinas River near Buena Vista Road	downstream	6/24/2004	8/26/2008	42
Salinas River near Spreckels CA	downstream	10/30/1951	9/1/1977	182
Salinas River at Davis Road	downstream	4/13/2006	6/22/2006	6

3.4 Title 22 Exceedances

Prior to diverting surface water for underground injection through ASR, water will need to comply with Title 22 Drinking Water Standards. A complete list of Title 22 Standards is provided in Table 7. In total, under Title 22 there are 96 constituents with standards (MCLs) which encompass both organic and inorganic constituents.

No monitoring location has been monitored for the entire suite of Title 22 Standards. Therefore, it remains a possibility that some constituents exist in exceedance of Title 22 and would require treatment but are not currently identified as such. The group of analytes evaluated to date and known to exceed the Title 22 Standards are shown in Table 8 and Table 9. These tables are organized from upstream to downstream. Chemicals that exceed Title 22 Standards are highlighted in green. Some metals such as arsenic, cadmium, iron, and manganese appear at elevated concentrations along the length of the river, suggesting a natural or background source, whereas chemicals such as nitrate, sulfate, chloride, and TDS generally increase downstream suggesting cumulative impacts of anthropogenic sources.

The concentrations of total iron and manganese in some instances are significantly elevated in comparison to their dissolved counterparts. In the case of the monitoring location Near Chualar, the average total iron and manganese concentrations are 24 and 0.5 mg/L, which both exceed the Title 22 Standard. However, the average dissolved concentrations for iron and manganese are 0.02 and 0.004 mg/L, which would both be below Title 22 Standards. Depending on the colloid particle size, reducing the concentrations of these constituents, as well as any sorbed constituents, may be accomplished through filtration. Additional testing would need to be completed to confirm if any trace elements are associated with suspended iron in the river water.

Trends over time for arsenic, cadmium, iron, manganese, nitrate and nitrite, and sulfate were evaluated and are shown on Figure 8. Timeseries extend from the 1970s to the present. Most of the analyses for arsenic, cadmium, iron, and manganese occurred in the 1970s and 1980s, with only a handful of samples analyzed within the past 4 years. Regardless, the concentrations of these elements exceed the Title 22 Standard throughout the monitoring period, indicating that these may be elements of concern moving forward. Sulfate and nitrate plus nitrite also have been monitored over a long duration, but generally do not exceed standards until after the year 2000 at sites farther downstream (Davis Road and SRDF). Monitoring at these downstream locations did not start until this time, so it is unclear if timing or location plays a larger role, though it is likely that location of urban and agriculture drains have a large impact on the water quality at these locations.

The SRDF is downstream of the Salinas City drain and the Blanco Drain which contributes to the elevated concentrations reported at this location. Water quality at this location is considered most representative of the water that will require treatment, however, the data is sparse. Table 10 shows the analytes that exceed Title 22 Standards at the SRDF. Metals are limited to 4 analyses and are typically not analyzed at most other sampling locations. This makes it difficult to assess whether some of the exceedances of these metals at SRDF are related to drainage from the city and agriculture fields, or if other upgradient sites along the river are contributing. Given that average concentrations at the SRDF generally exceed Title 22 Standards, it is likely that surface water will need to be treated for these elements, and possibly other Title 22 elements, prior to underground storage.

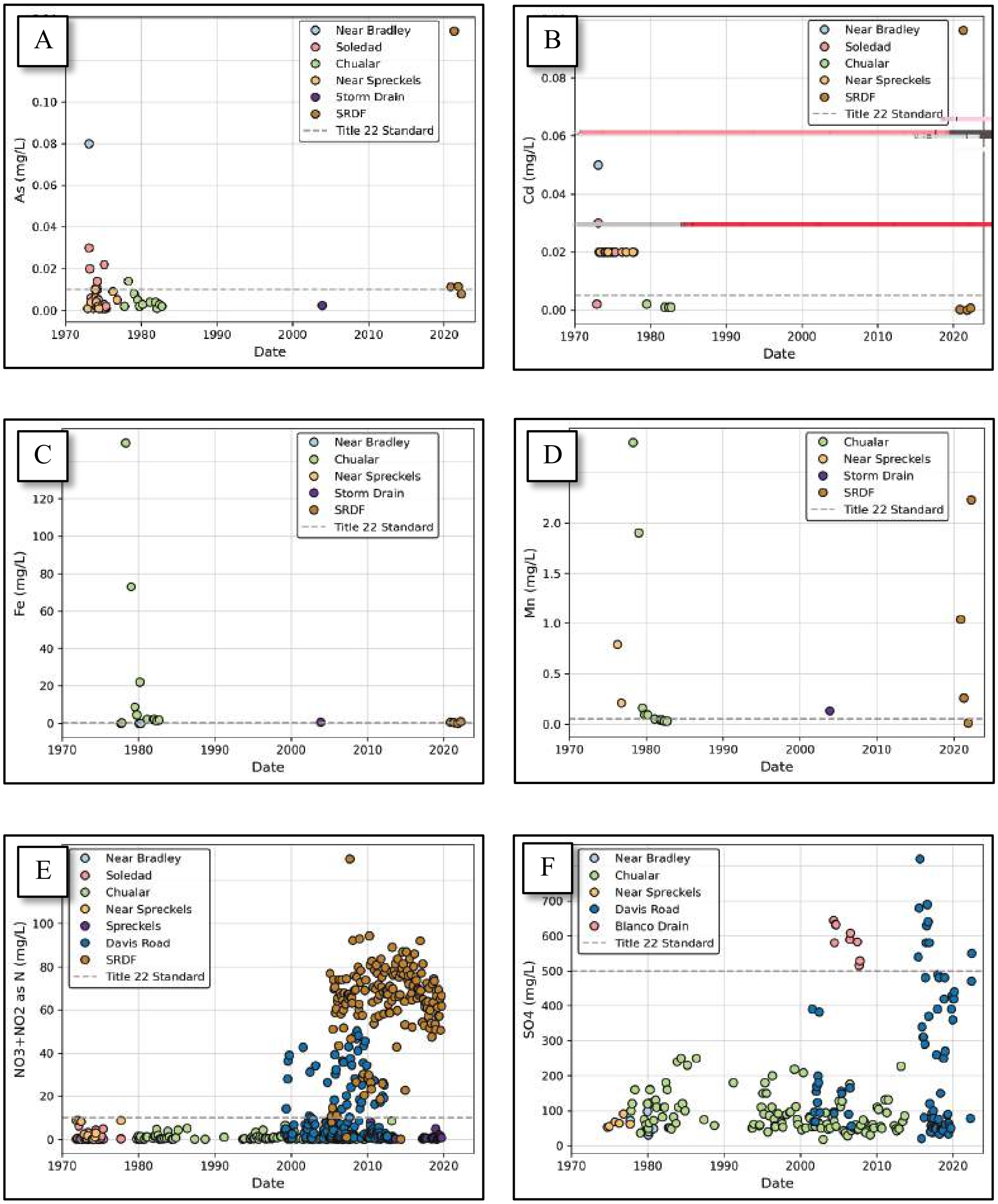


Figure 8. Concentrations for Select Metals Exceeding Title 22 Standards including A) Arsenic, B) Cadmium, C) Iron, D) Manganese, E) Nitrate plus Nitrite, and F) Sulfate

Table 7. Complete List of Title 22 Standards

Chemical	Units	Standard	Chemical	Units	Standard	Chemical	Units	Standard
1,1 Dichloroethylene (1,1 DCE)	mg/L	0.006	Carbon tetrachloride	mg/L	0.0005	Nickel	mg/L	0.1
1,1,1-Trichloroethane	mg/L	0.2	Chlordane	mg/L	0.0001	Nitrate as N	mg/L	10
1,1,2,2 Tetrachloroethane (PCA)	mg/L	0.001	Chloride	mg/L	500	Nitrate+Nitrite as N	mg/L	10
1,1,2-Trichloro-1,2,2-Trifluoroethane	mg/L	1.2	Chlorobenzene	mg/L	0.07	Nitrite	mg/L	1
1,1,2-Trichloroethane	mg/L	0.005	Chromium	mg/L	0.05	Oxamyl	mg/L	0.05
1,1-Dichloroethane (1,1 DCA)	mg/L	0.005	cis-1,2 Dichloroethylene	mg/L	0.006	Pentachlorophenol (PCP)	mg/L	0.001
1,2 Dibromoethane (EDB)	mg/L	0.00005	Copper	mg/L	1.3	Perchlorate	mg/L	0.006
1,2 Dichlorobenzene (1,2-DCB)	mg/L	0.6	Cyanide (CN)	mg/L	0.15	Picloram	mg/L	0.5
1,2 Dichloroethane (1,2 DCA)	mg/L	0.0005	Dalapon	mg/L	0.2	Polychlorinated Biphenyls (PCBs)	mg/L	0.5
1,2 Dichloropropane (1,2 DCP)	mg/L	0.005	Di(2-ethylhexyl)adipate	mg/L	0.4	Radium-226 + Radium-228	mg/L	5
1,2,3-Trichloropropane (1,2,3 TCP)	mg/L	0.000005	Di(2-ethylhexyl)phthalate (DEHP)	mg/L	0.004	Selenium	mg/L	0.02
1,2,4- Trichlorobenzene (1,2,4 TCB)	mg/L	0.004	Dichloromethane (Methylene Chloride)	mg/L	0.005	Silver	mg/L	0.1
1,2-Dibromo-3-chloropropane (DBCP)	mg/L	0.0002	Dinoseb	mg/L	0.007	Simazine	mg/L	0.004
1,3-Dichloropropene	mg/L	0.0005	Diquat	mg/L	0.02	Specific Conductivity	umhos/cm	1600
1,4-Dichlorobenzene (p-DCB)	mg/L	0.005	Endothall	mg/L	0.1	Strontium-90	pCi/L	8
2,3,7,8-tetrachlorodibenzodioxin	mg/L	0.00000003	Endrin	mg/L	0.002	Styrene	mg/L	0.1
2,4,5-TP (Silvex)	mg/L	0.05	Ethylbenzene	mg/L	0.001	Sulfate	mg/L	500
2,4-D	mg/L	0.07	Fluoride	mg/L	2	Tetrachloroethene (PCE)	mg/L	0.005
Alachlor	mg/L	0.002	Foaming Agents (MBAS)	mg/L	0.5	Thallium	mg/L	0.002
Aluminum	mg/L	1	Glyphosate (Round-up)	mg/L	0.7	Thiobencarb	mg/L	0.07
Antimony	mg/L	0.006	Gross Alpha	pCi/L	15	Toluene	mg/L	0.15
Arsenic	mg/L	0.01	Heptachlor	mg/L	0.00001	Total Dissolved Solids	mg/L	1000
Asbestos	mg/L	0.007	Heptachlor Epoxide	mg/L	0.00001	Toxaphene	mg/L	0.003
Atrazine	mg/L	0.001	Hexachlorobenzene (HCB)	mg/L	0.001	trans-1,2, Dichloroethylene	mg/L	0.01
Barium	mg/L	1	Hexachlorocyclopentadiene	mg/L	0.05	Trichloroethene (TCE)	mg/L	0.005
Bentazon	mg/L	0.018	Iron	mg/L	0.3	Trichlorofluoromethane (Freon 11)	mg/L	0.15
Benzene	mg/L	0.001	Lead	mg/L	0.015	Tritium	pCi/L	20000
Benzo(a)pyrene	mg/L	0.2	Lindane (Gamma-BHC)	mg/L	0.0002	Uranium	pCi/L	20
Beryllium	mg/L	0.004	Manganese	mg/L	0.05	Vinyl Chloride	mg/L	0.0005
Beta/photon emitters	mrem/yr	4	Mercury	mg/L	0.002	Xylenes (Total)	mg/L	1.75
Boron	mg/L	1	Methoxychlor	mg/L	0.03	Zinc	mg/L	5
Cadmium	mg/L	0.005	Molinate	mg/L	0.02			
Carbofuran	mg/L	0.018	MTBE (Methyl-tert-butyl ether)	mg/L	0.013			

Table 8. Maximum Concentration for Analytes with Title 22 Exceedance

Location	SO4	TDS	Cl	F	NO3+NO2 as N	NO3-N	NO2	As	B	Cd	Cr	Fe	Hg	Mn	Se
	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L
Title 22	**500**	**1000**	**500**	**2**	**10**	**10**	**1.0**	**0.01**	**1.0**	**0.005**	**0.05**	**0.3**	**0.002**	**0.05**	**0.02**
Salinas River near Bradley CA	161	506	54	0.5	0.6	0.6	0.10	0.08	0.30	0.05	0.94	0.020	0.0015		0.010
Salinas River at Soledad CA					6.2	6.2	0.3	0.03		0.03	0.34		0.006		
Salinas River near Soledad		378													
Salinas River near Chualar CA	250	721	144	0.4	8.5	19	0.29	0.014	0.58	0.02	0.46	150	0.0003	2.8	0.002
Salinas River near Buena Vista Road	142	624	60			1.6			0.24						
Salinas River near Spreckels CA	207	1090	190	2.4	8.8	19	11	0.010	0.8	0.02	0.00007	0.04	0.0005	0.8	0.0010
Salinas River at Spreckels Gage		2266			8.1				0.06						
Salinas River U/S of City Outfall		1400			22										
Salinas Storm Drain Outfall	337	2186	111		23		0.03	0.002	0.38		0.004	0.62		0.13	0.005
Salinas River at Davis Road	820	2800	1070	0.5	50	50			0.98				0.00004		
Salinas River at Blanco Road	135	584	88			2									
Blanco Drain	644	2108	261			74	0.32		1.11						
SRDF		2446			130	65		0.13	0.76	0.10	0.13	0.89		2.23	0.12
Salinas River at Gypse Camp						40									

Note: Chemicals that exceed Title 22 Standards are highlighted in green.

Table 9. Average Concentration for Analytes with Title 22 Exceedance

Location	SO4	TDS	Cl	F	NO3+NO2 as N	NO3-N	NO2	As	B	Cd	Cr	Fe	Hg	Mn	Se
	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L
Title 22	**500**	**1000**	**500**	**2**	**10**	**10**	**1.0**	**0.01**	**1.0**	**0.005**	**0.05**	**0.3**	**0.002**	**0.05**	**0.02**
Salinas River Near Bradley CA	59	233	16	0.3	0.2	0.2	0.02	0.010	0.13	0.02	0.27	0.013	0.0005		0.010
Salinas River at Soledad CA					1.3	1.3	0.2	0.009		0.02	0.19		0.0009		
Salinas River near Soledad		283													
Salinas River Near Chualar CA	91	312	26	0.2	1.1	1	0.04	0.004	0.23	0.01	0.06	24	0.0001	0.5	0.001
Salinas River near Buena Vista Road	86	331	31			1.6			0.21						
Salinas River Near Spreckels CA	105	641	95	0.6	4.3	4	2	0.005	0.3	0.02	0.00004	0.04	0.0004	0.5	0.0010
Salinas River at Spreckels Gage		324			1.5				0.05						
Salinas River U/S of City Outfall		745			11										
Salinas Storm Drain Outfall	213	1012	66		12		0.03	0.002	0.25		0.004	0.62		0.13	0.005
Salinas River at Davis Road	243	803	85	0.3	13	14			0.25				0.00001		
Salinas River at Blanco Road	135	584	88			2									
Blanco Drain	595	2029	229			71	0.32		0.43						
SRDF		1836			64	26		0.04	0.63	0.02	0.03	0.47		0.89	0.03
Salinas River at Gypse Camp						20									

Note: Chemicals that exceed Title 22 Standards are highlighted in green.

Table 10. Title 22 Exceedances at the SRDF

Analytes	Units	Title 22 Standard	SRDF Average	SRDF Max	Sample Count
As	mg/L	0.01	0.04	0.13	4
Be	mg/L	0.004	0.03	0.08	3
Cd	mg/L	0.005	0.02	0.10	4
Cr	mg/L	0.05	0.03	0.13	4
Fe	mg/L	0.3	0.5	0.89	4
Mn	mg/L	0.05	0.9	2.2	4
Ni	mg/L	0.10	0.04	0.13	4
NO3+NO2 as N	mg/L	10	64	130	172
NO3 as N	mg/L	10	26	65	3
Sb	mg/L	0.006	0.03	0.11	4
Se	mg/L	0.02	0.03	0.12	4
Tl	mg/L	0.002	0.09	0.09	1

Note: Chemicals that exceed Title 22 Standards are highlighted in green.

3.5 Section 303(d) Pollutants

In addition to the Title 22 exceedances identified in this dataset, the RWQCB has identified the constituents listed in Table 11 to be known pollutants in the Salinas River. The state maintains a list of impaired waters known as the CWA Section 303(d) list; the Salinas River is a listed water body under Section 303(d) with water quality impaired by these referenced constituents. The sampling and analysis for these elements were not consistent among the various monitoring locations, making it difficult to extrapolate trends from one location to another.

Table 11. Salinas River 303(d) Pollutant List

303(d) Listed Pollutant		
Arsenic	Dieldrin	pH
Benthic Community Effects	Enterococcus	Selenium
Bifenthrin	E. coli	Sodium
Chlordane	Fipronil	Temperature
Chloride	Imidacloprid	TDS
Chromium	Manganese	Toxaphene
DDD	Nickel	Toxicity
DDE	Nitrate	Turbidity
DDT	PCBs	

4 PRELIMINARY CONCLUSIONS AND TREATMENT IMPLICATIONS

Surface water data from along the Salinas River was reviewed to understand trends in water quality with the aim of developing preliminary treatment guidelines prior to injection of water near the proposed SRDF monitoring location. The following conclusions can be made:

- Many elements exceed Title 22 standards at the SRDF including TDS, arsenic, beryllium, cadmium, chromium, iron, manganese, nickel, nitrate, antimony, selenium, and thallium. It is likely that additional chemicals will exceed Title 22 Standards at this location after the full Title 22 chemical suite is analyzed.
- Some metals, such as iron and manganese, are significantly elevated in total concentrations relative to their dissolved fraction and may be adequately removed from the water through filtration. Some trace metals, such as arsenic and nickel, readily sorb to iron colloids and may also have concentrations significantly reduced through filtration. Additional testing and/or modeling would be necessary to confirm this relationship.
- Water quality analysis has occurred intermittently at multiple points along the Salinas River over the last 70 years.
- The surface water quality dataset consists largely of major constituents such as pH, TDS, sulfate, nitrogen species, calcium, magnesium, sodium, potassium, chloride, and boron. For the most part, trace metals and organic chemicals were measured very infrequently. No monitoring location has ever been assessed for the complete list of Title 22 Standards.
- Metals such as arsenic, cadmium, iron, and manganese appear at elevated concentrations along the length of the river, suggesting a natural or background source, whereas chemicals such as nitrate, sulfate, chloride, and TDS generally increase downstream, suggesting cumulative impacts of anthropogenic sources.
- Flow volume data is available at select locations including near Bradley, Soledad, near Soledad, Near Chualar, near Spreckels, near Buena Vista Road, and Davis Road sampling locations. Flow data is available intermittently from 1951 to 2008.
- Seasonal fluctuations in flow variably impact water quality depending on the location. Some areas upstream have higher concentrations in March through May, which may correlate with increased agricultural activity, such as fertilizer applications. Whereas some downstream locations appear to be more largely impacted by the dry season, perhaps as a result of buildup in soil and roads and flushing during storm events. This could be associated with city and agriculture drains in the vicinity of downstream locations.
- Additional precipitation, river flow, or irrigation data can help in evaluating additional seasonal trends for major elements.

5 SAMPLING AND MONITORING PLAN

Evaluation of the current dataset has identified gaps in previous monitoring programs, with water quality samples collected with a seasonal bias and only for a handful of Title 22 constituents. To assess seasonal variability along the Salinas River, monthly sampling would be needed at multiple locations. A sampling and monitoring plan to address the data gaps is presented in the following sections. This plan is aimed at gaining a better understanding of the temporal and spatial variability of river water quality and to inform the final identification of constituents of concern for future treatment design.

Future assessments would build upon the previous dataset to understand how Salinas River water quality responds to direct seasonal variations including precipitation and temperature, as well as to indirect seasonal variations including agricultural activity and water usage. Understanding the impact of weather events, time of year, and other factors would be important for designing a water treatment facility to manage the range of water quality likely to be encountered.

5.1 Sampling Locations

Sampling locations are selected to support the existing dataset and provide a better understanding of how the Salinas River water quality changes spatially. The locations selected are from various points along the Salinas River, upstream, and near the proposed diversion location. These locations are presented on Figure 9 and include:

- Near Chualar
- Near Spreckels
- Davis Road
- SRDF

These locations have a robust sampling history, making up the majority of previous samples, and are appropriately and spatially distributed along the river corridor. The Near Chualar sampling location is upstream of the city of Salinas and represents the river water quality prior to receiving city runoff. The Near Spreckels location is upriver of the Salinas storm drain outfall, which may be contributing concentrated waters to the river, and the Davis Road location is downstream of the storm drain outfall. The SRDF would be the location of the river diversion for the Seasonal Release with ASR project concept and would be an important location to understand variations in water quality when designing a water treatment system.

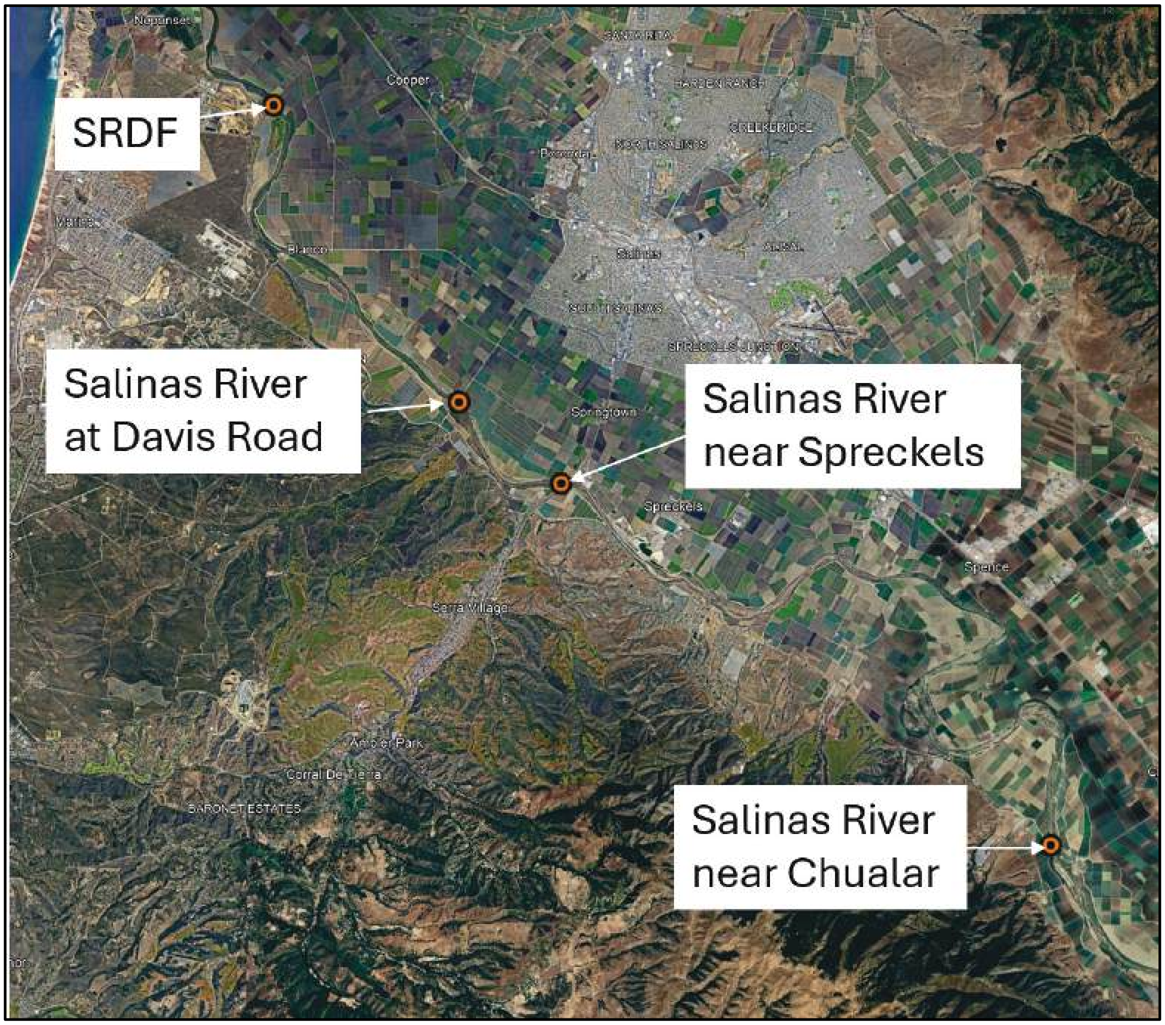


Figure 9. Map of Proposed Sampling Locations

5.2 Sampling Frequency and Analysis

Sampling should occur monthly for 2 years to establish a detailed baseline, which would facilitate a more comprehensive understanding of the variations that occur along the river over time. If conditions permit, additional samples should be collected after major storm events which have the potential to increase runoff or river flow (>0.5 inches in 24 hours). Sample collection dates within a month will be coordinated to capture storm event flows. The highest priority sampling location is the SRDF, but all locations should be sampled if possible.

The following field parameters and conditions should be noted at the time of sampling:

- Date and time
- Current weather

- Any recent notable weather events impacting river conditions (e.g. drought conditions, rain for multiple days, etc.)
- River conditions (e.g. low water levels, localized flooding, increased runoff from city drains, etc.)
- Field parameters including pH, temperature, specific conductivity, ORP, TDS, dissolved oxygen, and turbidity

Information on reservoir releases (i.e., from Nacimiento and San Antonio Lakes) and river discharge volumes (using USGS stream gages) should also be obtained to consider any potential water quality effects due to these releases.

A laboratory with California environmental laboratory accreditation program (ELAP) certification should be selected for analysis. Samples should be kept cold and filtered and preserved according to laboratory instructions. Samples should be sent to the laboratory in a timeframe that avoids exceeding the shortest analytical hold time.

In all cases, samples should be analyzed for the full Title 22 analysis suite (Table 7) plus the additional pollutants identified in Table 11. In addition to the regulatory requirements, general chemistry parameters—including total organic carbon, dissolved organic carbon, total alkalinity, bicarbonate, carbonate, total hardness, bromide, calcium, magnesium, sodium, potassium, orthophosphate, and total suspended solids (TSS)—should be analyzed to better understand river water quality. A complete analytical suite is provided in Table 12.

After 1 year of monitoring, if there are parameters that have not been detected at concentrations warranting further evaluation, those analytes can be removed from future water quality analysis. The reduced analytical suite should be monitored for an additional year (2 years total) to determine the range of river water qualities that could be expected under different seasons and weather conditions. At that time, a reassessment for future sampling frequency and elemental analysis can be completed.

5.3 Data Evaluation

Monthly monitoring of the Salinas River would be used to provide concentration ranges of COCs measured in river water. These concentration ranges would be used to inform the design of a water treatment facility. Routine monitoring would assess the impact of seasonal trends and storm events on river water quality and allow for predictions of future water quality trends. This would allow water treatment engineers to anticipate and respond to seasonal or rapid changes in river water quality.

The monthly monitoring data collected through this monitoring program would be used to finalize the list of CCCs requiring treatment under the proposed project. Based on the water quality sampling results, specific treatment technologies can be identified for evaluation in subsequent design phases. It should be noted that supplemental data collection may be required depending on the specific treatment technologies proposed.

Table 12. Proposed Analytical Suite for Water Quality Sampling

Analytical Suite for Water Quality Sampling		
1,1 Dichloroethylene (1,1 DCE)	Chlorobenzene	Nitrate+Nitrite as N
1,1,1-Trichloroethane	Chromium	Nitrite
1,1,2,2 Tetrachloroethane (PCA)	cis-1,2 Dichloroethylene	Orthophosphate
1,1,2-Trichloro-1,2,2-Trifluoroethane	Copper	Oxamyl
1,1,2-Trichloroethane	Cyanide (CN)	Pentachlorophenol (PCP)
1,1-Dichloroethane (1,1 DCA)	Dalapon	Perchlorate
1,2 Dibromoethane (EDB)	Di(2-ethylhexyl)adipate	pH
1,2 Dichlorobenzene (1,2-DCB)	Di(2-ethylhexyl)phthalate (DEHP)	Picloram
1,2 Dichloroethane (1,2 DCA)	Dichlorodiphenyldichloroethane (DDD)	Polychlorinated Biphenyls (PCBs)
1,2 Dichloropropane (1,2 DCP)	Dichlorodiphenyldichloroethylene (DDE)	Potassium
1,2,3-Trichloropropane (1,2,3 TCP)	Dichlorodiphenyltrichloroethane (DDT)	Radium-226 + Radium-228
1,2,4- Trichlorobenzene (1,2,4 TCB)	Dichloromethane (Methylene Chloride)	Selenium
1,2-Dibromo-3-chloropropane (DBCP)	Dieldrin	Silver
1,3-Dichloropropene	Dinoseb	Simazine
1,4-Dichlorobenzene (p-DCB)	Diquat	Sodium
2,3,7,8-tetrachlorodibenzodioxin	Dissolved Organic Carbon	Specific Conductivity
2,4,5-TP (Silvex)	Endothall	Strontium-90
2,4-D	Endrin	Styrene
Alachlor	Enterococcus	Sulfate
Aluminum	Escherichia coli (E. coli)	Temperature
Antimony	Ethylbenzene	Tetrachloroethene (PCE)
Arsenic	Fipronil	Thallium
Asbestos	Fluoride	Thiobencarb
Atrazine	Foaming Agents (MBAS)	Toluene
Barium	Glyphosate (Round-up)	Total Alkalinity
Bentazon	Gross Alpha	Total Dissolved Solids
Benthic Community Effects	Heptachlor	Total Hardness
Benzene	Heptachlor Epoxide	Total Organic Carbon
Benzo(a)pyrene	Hexachlorobenzene (HCB)	Total Suspended Solids
Beryllium	Hexachlorocyclopentadiene	Toxaphene
Beta/photon emitters	Imidacloprid	Toxicity
Bicarbonate	Iron	trans-1,2, Dichloroethylene
Bifenthrin	Lead	Trichloroethene (TCE)
Boron	Lindane (Gamma-BHC)	Trichlorofluoromethane (Freon 11)
Bromide	Magnesium	Tritium
Cadmium	Manganese	Turbidity
Calcium	Mercury	Uranium
Carbofuran	Methoxychlor	Vinyl Chloride
Carbon tetrachloride	Molinate	Xylenes (Total)
Carbonate	MTBE (Methyl-tert-butyl ether)	Zinc
Chlordane	Nickel	
Chloride	Nitrate as N	

6 FUTURE RECOMMENDED ASSESSMENTS

In addition to surface water quality, it is recommended that groundwater quality be evaluated to determine if seasonal or spatial water quality trends exist. LCG recommends that groundwater quality from wells in the 180-Foot and 400-Foot Aquifers be characterized to establish a background and seawater-impacted water quality, and to determine if other localized trends exist.

Creating a comprehensive water quality dataset would allow for the modeling of groundwater and surface water reactions in the aquifer after treated surface water has been injected for ASR. It is important to understand potential geochemical reactions that would occur within the aquifer. Oxides, clays, and organics in soils, have the potential to alter the water quality through chemical attenuation. Additional chemical reactions have the potential to limit pore size through precipitation of minerals, limiting injection efficiency. Reactive transport modeling could be used to assess the impact of geochemical mixing and surface reactions in the aquifer to help maintain a long operational lifespan and limit unforeseen operational expenses.

Further, should the New Diversion of Winter High Flows with ASR project concept be pursued (i.e., Ranney collector wells) additional sampling would be needed to evaluate water quality of shallow groundwater. Under this alternative, water would be withdrawn from shallow depths where water quality is expected to be enhanced through natural filtration of sand and sediments underneath the river channel. As such, treatment requirements would be expected to vary from those of a surface water source. An amended sampling and analysis plan would be proposed should this alternative be retained for future development.

7 REFERENCES

Central Coast Water Quality Preservation, Inc., 2024. *Central Coast Cooperative Monitoring Program 2022 Annual Water Quality Report*. Revision No. 1. March 29, 2024.

Preliminary Feasibility Study
Aquifer Storage and Recovery Project Concepts
to Address Seawater Intrusion

TECHNICAL MEMORANDUM 4

Project Scenarios Modeling Results

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1 INTRODUCTION

SVBGSA received Sustainable Groundwater Management (SGM) Round 1 Implementation Grant funding to conduct a preliminary feasibility study for the Seasonal Release with ASR project concept. The purpose of this preliminary feasibility study is to further evaluate the project concept described in the GSP for the 180/400 Subbasin.

As conceptualized in the 2022 GSP Amendment 1 (SVBGSA, 2022), the Seasonal Release with ASR project concept consists of 2 separate but related processes. First, MCWRA Nacimiento and San Antonio Reservoir conservation releases would be shifted to the winter and spring. These releases would contribute to recharge along the Salinas River and would be re-diverted at the SRDF. Second, the re-diverted reservoir water would be injected into the 180-Foot and 400-Foot Aquifers for storage and later use. Injected water and reduced extraction would help increase groundwater levels, improve water quality, and prevent further seawater intrusion.

Based on the constraints identified for the Seasonal Release with ASR project concept and as discussed in TM1, a new Alternative 1, New Diversion of Winter High Flows for ASR project concept, was developed to accommodate the existing system constraints. It provides for the diversion of excess winter flows that bypass the reservoirs and divert them downstream at a new diversion structure, upstream of the SRDF structure. The diverted water would then be piped to the ASR wells. Under this project concept, the ASR wells are intended to be used only for injection, and the SRDF would continue to be used to re-divert stored reservoir water that is provided for irrigation with “business as usual” CSIP operations (along with groundwater provided by the CSIP supplemental wells).

A third scenario, based on the New Diversion of Winter High Flows for ASR Alternative 1 project concept, Alternative 1A, would focus injection into the 400-Foot Aquifer for halting seawater intrusion with ASR. The reasoning for this alternative is that the 180-Foot Aquifer is no longer as significant a source of supply in the coastal portion of the Subbasin due to the extent of intrusion. The vast majority of pumping in the Subbasin occurs in the 400-Foot Aquifer. Therefore, priority for ASR injections could be given to halting seawater intrusion in the 400-Foot Aquifer, while other measures would be implemented to halt seawater intrusion in the 180-Foot Aquifer.

The primary purpose of the Feasibility Study is to evaluate the project’s effectiveness at halting additional seawater intrusion in the 180/400-Foot Aquifer Subbasin. Groundwater modeling was conducted to investigate the effectiveness of an ASR project concept and help assess the preliminary location and operation of ASR wells. Modeling simulations compare effectiveness of the 3 potential project alternatives to estimated conditions without a project. Results from the modeling analysis supports overall findings of project effectiveness to complement the work conducted in TMs 1 (Project Constraints), 2 (Project Permitting), and 3 (Water Quality Considerations). The following sections present results from the modeling scenarios.

This TM4 presents results for 3 alternative project concepts using 2 linked modeling tools, and compares and contrasts results between the scenarios and the No Project Scenario. The overall conclusions of this preliminary feasibility study are presented in the accompanying Summary Report.

2 GROUNDWATER MODELS

Simulations for the ASR Project Concept Scenarios use 2 linked groundwater models: the SVOM and the SWI Model, which are further described below.

2.1 Salinas Valley Operations Model

The SVOM was used to evaluate reservoir operations, flows in the Salinas River, and SRDF diversion opportunities for the project alternatives. The SVOM estimates how much water is available for diversion for the ASR project alternatives, and when the water is available.

The SVOM is a predictive integrated hydrologic model that spans the entire Salinas Valley Basin based on the SVIHM, which simulates historical conditions in the Salinas Valley. This model was developed by the USGS on behalf of MCWRA to predict reservoir releases and associated groundwater recharge along the Salinas River under varying climatic and operational conditions.

Groundwater conditions are simulated in SVOM using the MODFLOW-OWHM Version 2 code (Boyce *et al.*, 2020). This version of MODFLOW simulates a dynamic interaction between water demand and supply. Agricultural water demands are estimated by the SVOM based on crop type and climate. Agricultural water demands are met by precipitation, surface water deliveries and diversions if available, recycled water, and groundwater pumping. The Surface Water Operations (SWO) package in the SVOM regulates releases from San Antonio and Nacimiento reservoirs based on MCWRA's existing operating policies.

The SRDF diversion, which re-diverts stored reservoir water from the Salinas River to the CSIP area, is explicitly simulated in SVOM. SRDF diversions are made throughout the duration of the SVOM simulations whenever reservoir storage and streamflow conditions allow for them during the operational period from April through October. The SVOM also includes recycled water deliveries to CSIP throughout the duration of the simulation.

The SVOM simulates variable hydrology by repeating the climatic conditions between water years (WY) 1967-2018. Potential impacts from climate change were not incorporated into these simulations. The SVOM keeps 2017 land uses constant throughout the simulation.

The latest SVOM version 12.3, made available by the USGS, is used for this project. No formal model documentation is currently available (USGS plans to provide model documentation with the published model in early 2025). However, a model progress report was provided by the USGS, describing the key model features and functionalities (USGS, 2021). The extent of the model is shown on Figure 1.

The SVOM simulates 3 key components that are needed for the ASR project concept feasibility study analysis:

1. Reservoir operations and releases into the Salinas River
2. SRDF diversions
3. CSIP Demands

In essence, the SVOM helps answer the question: *for each scenario, how much water will be available to divert and inject, and when?*

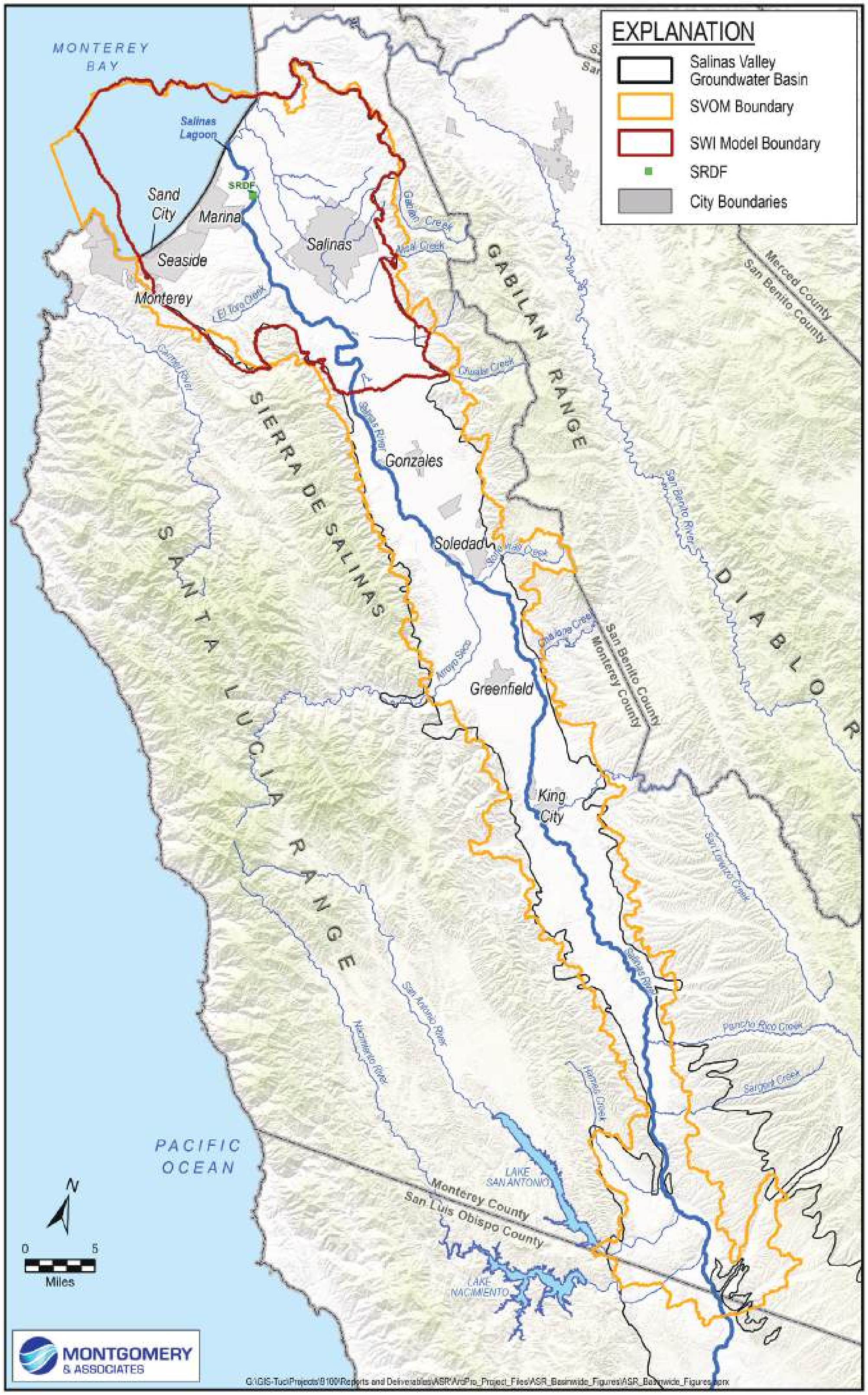


Figure 1. Map of Model Extents in the Salinas Valley

2.2 Seawater Intrusion Model

The Salinas Valley SWI Model is used to predict future seawater intrusion rates and extents for the various ASR project alternatives based on selected outputs from the SVOM. The SWI Model estimates the effectiveness of the ASR projects for controlling seawater intrusion, and what the optimal ASR well placement is for controlling seawater intrusion.

The SWI Model is a variable density regional groundwater flow model (M&A, 2023 and 2024) developed by M&A to simulate seawater intrusion in the 180/400-Foot Aquifer and Monterey Subbasins. It is calibrated to the historical rate and direction of seawater intrusion, based largely on the 500 mg/L chloride isocontours mapped by MCWRA and historical groundwater elevations. The SWI model simulates groundwater conditions on a regional scale and may not reflect specific conditions in any particular location. The extent of the SWI Model is shown on Figure 2.

A version of the SWI Model was developed that estimates future groundwater conditions if no projects and management actions are implemented (M&A, 2024). This simulation is referred to as the No Project Scenario. It simulates potential seawater intrusion starting from the end of the historical model, WY 2021, through 2070. The ASR Project Scenarios are assessed by comparing ASR project simulation results to the No Project Scenario model results.

The SWI Model simulates 2 key components that are needed for the ASR project concept feasibility study analysis:

1. Pumping and injection effects on seawater intrusion
2. ASR well placement and operations

Essentially, the SWI Model helps answer the questions: *does the injection of available water through ASR help prevent seawater intrusion? What is the optimal placement of ASR wells so that the injection helps prevent seawater intrusion?*

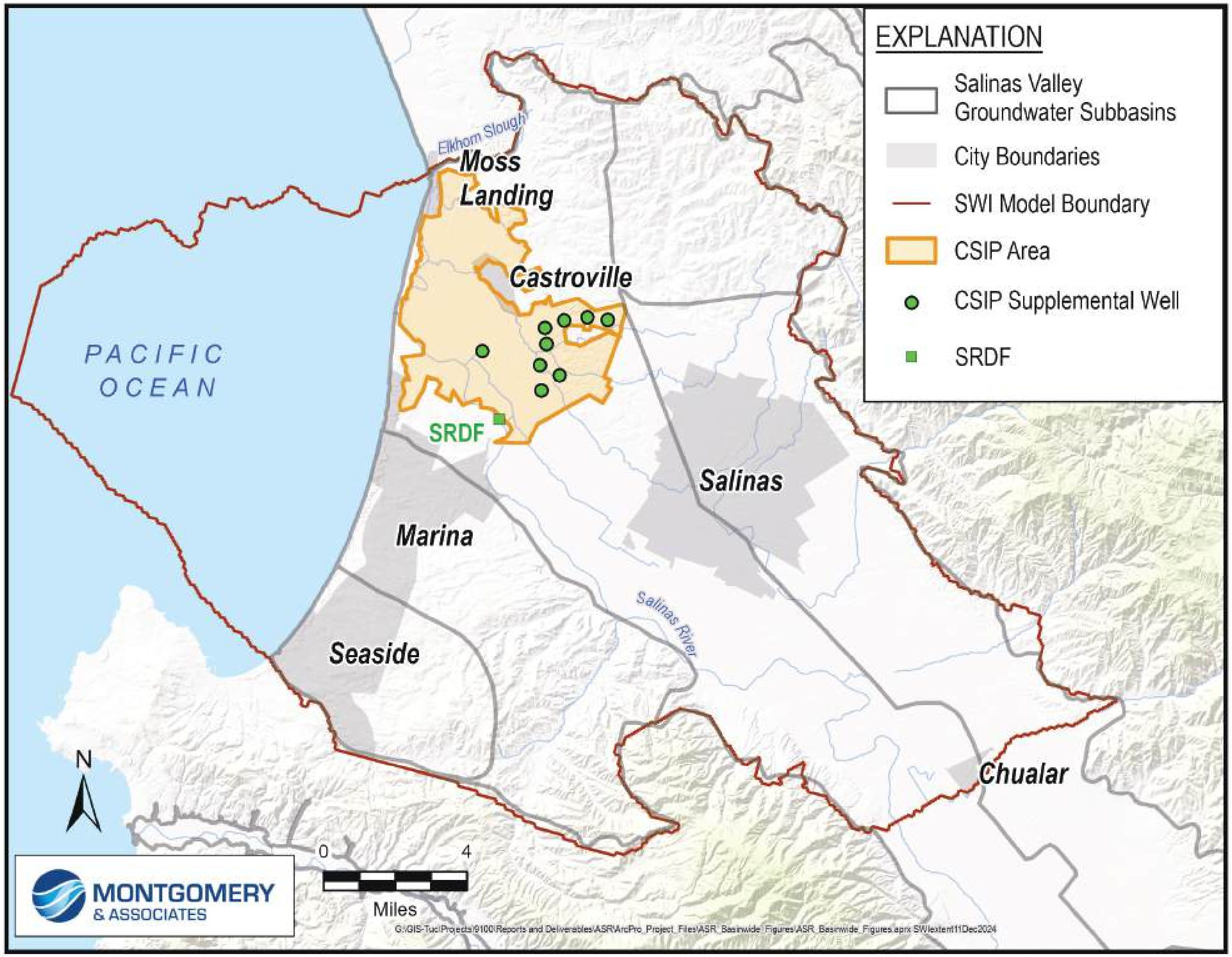


Figure 2. SWI Model Extent

3 MODEL SCENARIOS

The SVOM version 12.3 was modified to include specific assumptions needed for the various ASR project alternatives. A summary of the scenarios is presented in Table 1. Descriptions of how the 2 models were modified and used to simulate each of the 3 ASR Project Scenarios are included in this section. ASR project simulations are compared to the No Project Scenario model results.

Table 1. Summary of Scenarios

Scenario	Description
Seasonal Release with ASR project concept	Shifts reservoir releases and diversions at SRDF to December-June up to 36 cfs from stored water; injects treated water via new ASR wells; summer extraction from ASR wells
New Diversion of Winter High Flows for ASR project concept – Alternative 1	No change to current SRDF operations; SRDF operates April-October (business as usual CSIP; assume 36 cfs diverted at SRDF). For ASR: use available high flows to divert up to 45 cfs November-April and inject (no extraction from ASR wells)
New Diversion of Winter High Flows for ASR project concept with injection into 400-Foot Aquifer only – Alternative 1A	Same as New Diversion of Winter High Flows for ASR project concept, except all diverted water is injected into 400-foot aquifer only

3.1 ASR Projects Modeling Sequence

The SVOM and SWI Model are used in sequence to model each of the project alternatives. The SVOM is run first, and select outputs from the SVOM are used as inputs to the SWI Model. The SVOM outputs used as SWI model inputs are shown in Table 2.

The SVOM simulates the interaction between water demand and supply, applies reservoir operations logic, and calculates resulting diversion amounts available for ASR injection and to supply agricultural water demands.

Results from the SVOM corresponding to the hydrology of WY 1996-2018 are extracted and imported into the SWI Model. WY 1996-2018 was selected as a period representative of recent hydrological conditions (referred to as the representative period). Hydrological conditions from WY 1996-2018 were assigned to the model as proxy years starting in October 2020 (i.e. October 2020 represents October 1995). When the ASR project starts a decade later in 2030, the proxy year is therefore 2005. The proxy years WY 1996-2018 cycle through the end of the SWI Model simulation in 2070.

The SWI Model is used to simulate seawater intrusion (by simulating chloride transport through the aquifer). The SWI Model includes injecting diverted water into ASR wells and extracting water necessary to meet remaining agricultural water demands in the CSIP Area.

Table 2. Inputs and Outputs for Each Groundwater Model

Groundwater Model	Inputs	Outputs
SVOM	ASR Scenario in reservoir operations (SWO) rules: • Seasonal Release (stored re-diversion Dec. – Jul.) • New Diversion of Winter High Flows for ASR Alternative 1 (high flows Nov. - April)	• ASR diversion rates (used for ASR injection) • CSIP Area pumping rates (from both CSIP supplemental wells and private wells) • CSIP Area unmet demand (used for ASR extraction) • Salinas River flows at Chualar
SWI Model	• Diversions from Salinas River for ASR and SRDF • ASR injection and/or extraction rates at ASR wells • Extraction rates from CSIP Supplemental wells • Salinas River inflows at Chualar	• Chloride concentrations over time • Groundwater levels

3.2 No Project Scenario

The No Project Scenario simulates conditions if there are no changes to current groundwater management or use patterns. A No Project Scenario was developed for both the SVOM and SWI Model.

The SVOM No Project Scenario includes the following key assumptions:

- Recycled water deliveries to CSIP reflect WY 2020-2022 monthly averages.
- CSIP supplemental well pumping reflects the active wells as of the start of the modeling exercise in 2024 and their capacity: 9 total with a combined capacity of approximately 16,500 gallons per minute (gpm).
- Land use represents 2017, which is the most recent land use year in the SVIHM.
- No climate change or sea level rise is assumed.
- SRDF operates at maximum rate of 36 cfs.

The SWI Model No Project Scenario includes the following key assumptions:

- Land use remains constant throughout the simulation. Land use is not simulated directly; however, the groundwater demands at the end of the historical SWI Model (WY 2016-2020 monthly average) are carried forward.

- Boundary conditions are a continuation of recent hydrologic conditions (WY 1996-2018) in the Salinas Valley through WY 2070.
- Climate change and sea level rise are not simulated.

For a detailed summary of the No Project Scenario, see Attachment 2 of the *2024 Seawater Intrusion Model Updates (Addendum 2 to the Salinas Valley Seawater Intrusion Model Report)* technical memorandum (M&A, 2024).

ASR Project Scenarios are developed by modifying the No Project Scenario. The base assumptions used in the SVOM also hold true for the other scenarios. For the SVOM, additional modifications were made to the SWO and Streamflow Routing (SFR) packages, and Farm Process (FMP). These modifications include adjustments to the rules that control operation of the reservoirs and SRDF, diversions from the Salinas River, and supply of diverted water to CSIP. For the SWI Model, modifications include the addition of ASR wells in the 180-Foot and 400-Foot Aquifers, and modification of pumping in the CSIP Area according to rates simulated in the SVOM. The ASR project concept is assumed to start operating in October 2030, 10 years after the start of the predictive model runs.

3.3 Seasonal Release with ASR Scenario

The Seasonal Release with ASR project concept, outlined in the 180/400-Foot Aquifer Subbasin GSP, assumes the SRDF operation is shifted from its current spring to fall diversion to a winter to summer diversion. In this scenario, the SRDF starts operating December 1, ends June 30, and operates at a maximum diversion rate of 36 cfs. This represents a change in seasonal diversions of stored water at the Nacimiento and San Antonio Reservoirs and re-diversion at the SRDF between December 1 and July 1 each year. All water diverted at the SRDF is injected into both the 180-Foot and 400-Foot Aquifers through 16 ASR wells, 8 in each aquifer. The CSIP Area water demand is supplied as needed through a combination of SVRP recycled water, CSIP supplemental wells, and extraction from ASR wells. This project concept does not include pumping from private standby wells within the Zone 2B area, as it assumes that all unmet demand from CSIP will be met through ASR pumping.

3.3.1 SVOM Reservoir Operations and Diversion Assumptions

The Seasonal Release with ASR Scenario is represented in the SVOM through the following modifications to the SVOM No Project Scenario:

- Rules controlling the operation of the reservoirs and SRDF were modified so that the SRDF diversion season starts December 1 and ends June 30. Rules governing environmental flow requirements and water rights restrictions are kept intact.

- All water diverted at the SRDF is injected into the ASR wells. SRDF diversions are used for ASR and are not used to supply demand in the CSIP Area, which is represented as its own Water Balance Subregion (WBS) in the model, representing Zone 2B.
- CSIP supplemental wells pump to meet CSIP Area demand when necessary. Private standby wells in Zone 2B do not pump in the Seasonal Release with ASR Scenario.

3.3.2 SWI Model Assumptions

The Seasonal Release with ASR Scenario starts in October 2030 in the SWI Model. Prior to October 2030 the SWI model simulates the Seasonal Release with ASR Scenario identically to the No Project Scenario. The Seasonal Release with ASR Scenario is represented in the SWI Model through the following modifications to the SWI Model No Project Scenario, starting in October 2030:

- 16 ASR wells—8 in each the 180-Foot and 400-Foot Aquifer—are added to the model, as described in Section 3.3.3.
- ASR injection rates are simulated based on the SRDF diversion rates from the Seasonal Release with ASR SVOM simulation. We assume that there is no delay between diversion at the SRDF and injection at the ASR wells. The injection rate per well is calculated based on assumptions described in Section 3.3.3.
- Extraction from ASR wells is simulated during corresponding months in which the Seasonal Release with ASR SVOM predicts that the CSIP supplemental wells cannot keep up with CSIP area demand.
- Extraction rates from CSIP supplemental wells are based on the monthly rates simulated in the SVOM.
- Extraction from private wells in the CSIP Area is set to zero.
- Salinas River flows at Chualar and diversions from the Salinas River at the SRDF are based on the corresponding rate in the Seasonal Release with ASR SVOM.

3.3.3 ASR Wells

Figure 3 shows the placement of the ASR wells in the 180-Foot and 400-Foot Aquifers, along with the location of the 9 active CSIP wells simulated in the models. The ASR wells are placed near the leading edge of the current seawater intrusion front to stop it from advancing toward Salinas. These wells are sited to create a hydraulic mound that prevents further seawater intrusion.

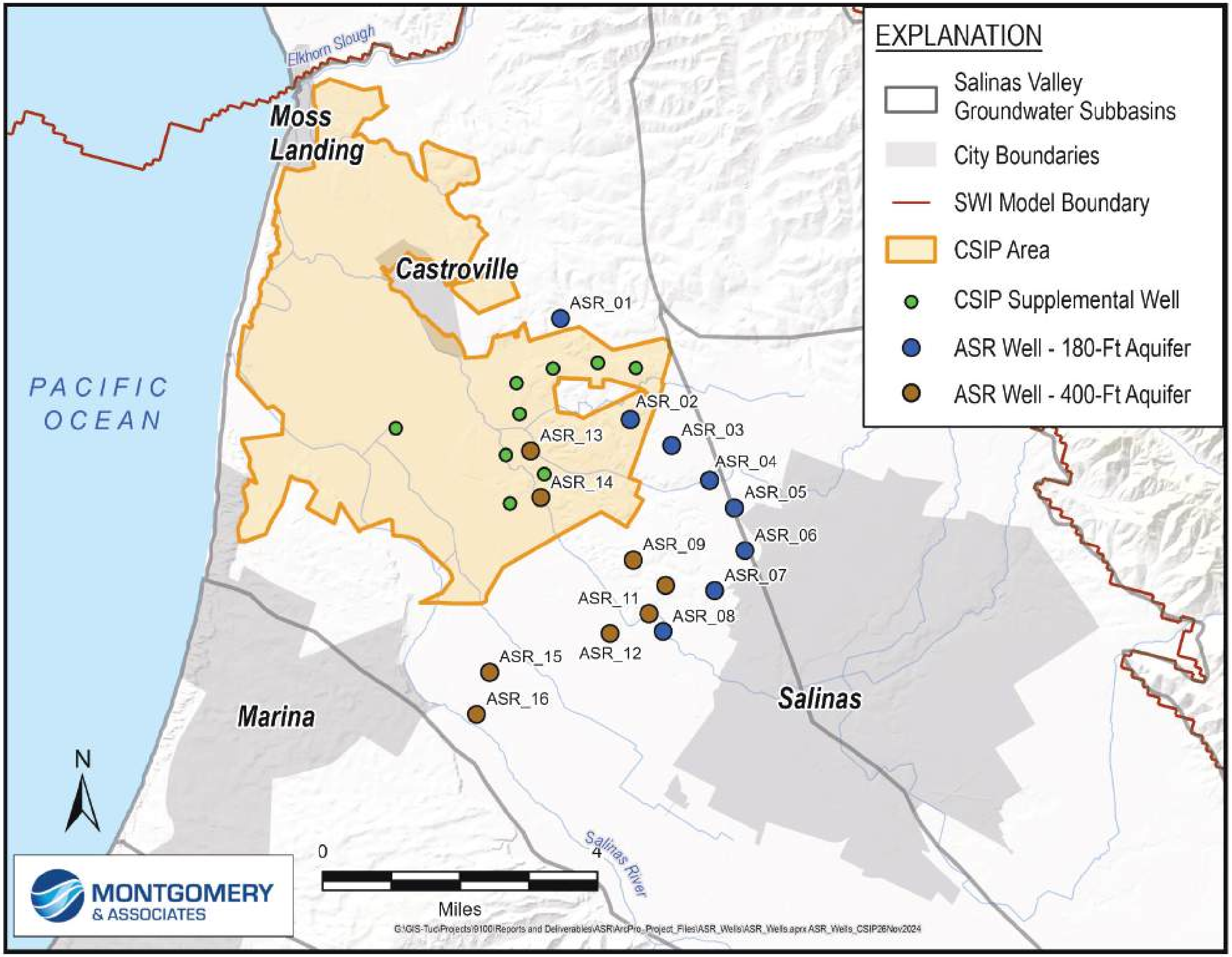


Figure 3. ASR Well Location Map

Two-thirds of the diverted water is injected into the 180-Foot Aquifer, and one-third is injected into the 400-Foot Aquifer. This split reflects the fact that the 180-Foot Aquifer requires more water to slow seawater intrusion. During ASR well extraction, 55% comes from the 180-Foot Aquifer and 45% from the 400-Foot Aquifer. This extraction split is driven by the well capacity due to the aquifers' conductivities, using plausible extraction rates. The ASR wells are operated with a general seasonal pattern as follows:

- Winter (December – March): wells inject only
- Spring (April – June): some wells inject, and some wells extract for CSIP supply
- Summer/Fall (July – October)[1]: all wells extract to meet demand in Zone 2B

The assumed maximum injection and extraction capacity in the ASR wells is shown in Table 3.

Table 3. Simulated Maximum Injection and Extraction Capacity of ASR Wells in Seasonal Release with ASR Scenario

Aquifer	Wells	When injecting only (gpm) – rate per well	When extracting only (gpm) – rate per well	Some wells injecting, some wells extracting (gpm) – rate per well
180-Foot	ASR_01, 02, 03, 04	+1,100	-2,400	-4,500
	ASR_05, 06, 07, 08	+1,600	-2,400	+2,000
400-Foot	ASR_09, 10, 11, 12	+700	-2,000	+2,000
	ASR_13, 14, 15, 16	+700	-2,000	-3,700

3.4 Alternative Project Concepts and Scenarios

Two alternative project concepts, New Diversion of Winter High Flows for ASR project concept referred to as Alternative 1 and Alternative 1A, were simulated using the groundwater models. New Diversion of Winter High Flows for ASR project concept maintains the current reservoir and SRDF operation schedules, with SRDF diversions occurring between April and October to supply CSIP irrigation demand. Modeling assumptions for the New Diversion of Winter High Flows for ASR Scenario include a new diversion, referred to as the ASR diversion, immediately downstream of the SRDF that operates between November and May. The diverted water would be injected through the ASR wells. None of the ASR wells in the New Diversion of Winter High Flows for ASR Scenario are used for extraction, and private standby well pumping is allowed

[1] Wells do not operate in November, for 2 reasons: there is no release from storage and re-diversion, so no injection; and there is no demand for extraction. The month of November could be used for well maintenance.

within Zone 2B. CSIP water demand is met with SVRP recycled water, SRDF diversion, and CSIP supplemental wells, similar to the current practice.

Alternative 1A keeps the same assumptions as New Diversion of Winter High Flows for ASR Alternative 1, except that all water diverted for ASR is injected solely into the 8 ASR wells in the 400-Foot Aquifer.

3.4.1 ASR Diversion Assumptions

The ASR diversion in the New Diversion of Winter High Flows for ASR Scenario is a separate diversion structure from the SRDF. This structure could be one or more Ranney Collector wells with an assumed maximum diversion rate of 45 cfs. TM1 includes further descriptions of this type of diversion. The ASR diversion is simulated as a single diversion point. The ASR diversion is active between November 1 and April 30 to capture excess winter runoff flows that are released from the reservoirs during normal operations. The reservoir operation rules in the New Diversion of Winter High Flows for ASR Scenario SVOM simulations are unmodified from the No Project Scenario SVOM. No specific new rule of operations at the reservoir were included in SVOM for this scenario.

The New Diversion of Winter High Flows for ASR Scenario is represented in the SVOM through the following modifications to the SVOM No Project Scenario:

- Rules controlling operations of the reservoirs, SRDF diversions, and supply of water to CSIP were not modified from the No Project Scenario.
- A new diversion was simulated immediately downstream of the SRDF. This ASR diversion has not been sited yet and was simulated downstream of the SRDF to reflect an assumption that the SRDF should divert its water prior to the new diversion taking any water.
- Diversions occur at the ASR diversion structure between November 1 and April 30. The diversion amount is whatever flow is in excess of the median flow below the SRDF as calculated from the SVOM No Project Scenario, up to 45 cfs.

ASR diversions were calculated such that 1) the new ASR diversion would not interfere with operation of the SRDF, and 2) a semblance of natural flow conditions in the Salinas River downstream of the SRDF would be maintained. For this reason, the New Diversion of Winter High Flows for ASR Scenario diversion rate is calculated based on flows measured immediately downstream of the SRDF. Only flows above the monthly median flows at this point are diverted for ASR. The monthly median flows are calculated based on the No Project Scenario SVOM simulation. Table 4 presents the simulated monthly median flow immediately downstream of the SRDF.

Table 4. No Project Scenario Median Flow Downstream of SRDF

Month	SVOM No Project Scenario median flow (cfs)
January	**216**
February	**303**
March	**242**
April	**60**
May	22
June	8
July	5
August	4
September	3
October	5
November	**29**
December	**95**

3.4.2 SWI Model Assumptions

The New Diversion of Winter High Flows for ASR Scenario starts in October 2030 in the SWI Model. Prior to October 2030, the SWI model simulates the New Diversion of Winter High Flows for ASR Scenario identically to the No Project Scenario. Results from the New Diversion of Winter High Flows for ASR Scenario SVOM simulation are extracted and applied to the SWI Model similarly to the Seasonal Release with ASR Scenario simulations. The New Diversion of Winter High Flows for ASR Scenario is represented in the SWI Model through the following modifications to the SWI Model No Project Scenario, starting in October 2030:

- 16 ASR wells—8 in each the 180-Foot and 400-Foot Aquifer—are added to the model, as described in Section 3.3.3.
- ASR injection rates are simulated based on the ASR diversion rates from the New Diversion of Winter High Flows for ASR Scenario SVOM simulation. We assumed that there is no delay between diversion at the ASR diversion and injection at the ASR wells. The injection rate per well is calculated based on assumptions described in Section 3.4.3.
- Extraction rates from CSIP supplemental wells are based on the monthly rates simulated in the New Diversion of Winter High Flows for ASR Scenario SVOM.
- Extraction rates from private wells in the CSIP Area are based on the monthly rates simulated in the SVOM.
- Salinas River flows at Chualar and diversions from the Salinas River at the SRDF and the new ASR diversion are based on the corresponding rates calculated by the New

Diversion of Winter High Flows for ASR Scenario SVOM simulation. The SRDF and ASR diversions from the Salinas River were assumed to be co-located in the SWI Model.

No extraction from ASR wells is simulated in the New Diversion of Winter High Flows for ASR Scenario. Additionally, extraction from private wells in the CSIP Area is unmodified from the No Project Scenario.

3.4.3 ASR Wells

The same ASR wells are used for the New Diversion of Winter High Flows for ASR Scenario as were used for the Seasonal Release with ASR Scenario. However, in the New Diversion of Winter High Flows for ASR Scenario, these wells only inject water; they do not extract water. Similar to the Seasonal Release with ASR Scenario, 66% of the diverted water is injected into the 180-Foot Aquifer and 33% is injected into the 400-Foot Aquifer. In the New Diversion of Winter High Flows for ASR Alternative 1A Scenario, all diverted water is injected into the 400-Foot Aquifer.

The assumed maximum injection capacities of the ASR wells for the New Diversion of Winter High Flows for ASR Scenario (for both Alternative 1 and Alternative 1A) are shown in Table 5.

Table 5. Simulated Maximum Injection Capacity of ASR Wells for the New Diversion of Winter High Flows for ASR Scenario Alternative 1 and Alternative 1A

Aquifer	Wells	Injection Rate Capacity per well (gpm) New Diversion of Winter High Flows for ASR (Alternative 1)	Injection Rate Capacity per well (gpm) New Diversion of Winter High Flows for ASR (Alternative 1A)
180-Foot	ASR_01, 02, 03, 04	+1,300	N/A
	ASR_05, 06, 07, 08	+2,000	N/A
400-Foot	ASR_09, 10, 11, 12	+800	+2,500
	ASR_13, 14, 15, 16	+800	+2,500

4 MODEL RESULTS

The following sections summarize the results of the No Project Scenario and 3 ASR project concept scenarios. SVOM results provide a relative understanding of water available for injection and water needed for extraction to meet demands, while SWI Model results demonstrate the estimated effects of each of the modeled scenarios on seawater intrusion and groundwater levels in the 180- and 400-Foot Aquifers. The following criteria are evaluated for each project simulation:

1. Progression of the 500 mg/L chloride isocontour from 2020 to 2070 compared to the following:
    a. The 2017 simulated 500 mg/L chloride isocontour (GSP seawater intrusion minimum threshold)
    b. The No Project Scenario 2070 simulated 500 mg/L chloride isocontour
2. Change in the spatial distribution of chloride within the seawater intruded area, showing the extent and location of the high salinity areas
3. Change in average groundwater levels from the beginning of the simulation to the end of the simulation

The SWI Model chloride concentrations discussed in the following sections represent the Lower 180-Foot Aquifer because the lower portion of the aquifer generally exhibits more advanced seawater intrusion.

The change in average groundwater level is calculated by comparing the average heads of the first 10 years (2020-2030, pre-project) of the simulation to the average heads of the last 10 years (2060-2070, 30 years after the project starts) as simulated by the SWI Model.

4.1 No Project Scenario

4.1.1 No Project Scenario SVOM Results

Table 5 summarizes the water supplied to the CSIP Area in the No Project Scenario SVOM simulation. The SVOM meets the simulated CSIP demand first through natural sources including available precipitation, then groundwater root uptake, followed by supplied sources such as recycled water, then SRDF diversions, followed by pumping from CSIP supplemental wells and private wells. Note that though recycled water and SRDF diversions are supplied to CSIP, it is not always needed to meet current demand. In that case, SVOM does not deliver excess (unused) recycled water and the excess (unused) SRDF diversions return to the Salinas River as runoff. The average amount of water supplied to CSIP was 28,200 AF/WY during the years corresponding to WY 1996-2018 hydrology. This includes an average of 5,200 AF/WY of groundwater pumping from CSIP supplemental and private wells. The average simulated consumptive use within the CSIP area was approximately 34,000 AF/WY. Consumptive use represents evapotranspiration and does not reflect irrigation efficiency losses.

Table 6. CSIP Area Water Supply Summary – No Project Scenario SVOM

SVOM Annual Average (AF/WY)	No Project Scenario SVOM
Recycled Water Supplied	11,900
SRDF Diversions (at 36 cfs)	11,100
CSIP/Zone 2B Well Pumping (Supplemental well + private)	5,200
Total Supply:	*28,200*
Total Pumping:	*5,200*

Note: all values rounded to the nearest 100 AF

Figure 4 presents the annual SRDF diversions simulated by the No Project Scenario. When the SRDF operates a full season at 36 cfs, it diverts approximately 15,000 AF/WY. The annual average SRDF diversion during the representative period was 11,100 AF/WY. The SRDF season ended early due to dry conditions in some years. The SRDF was unable to operate during extended dry periods.

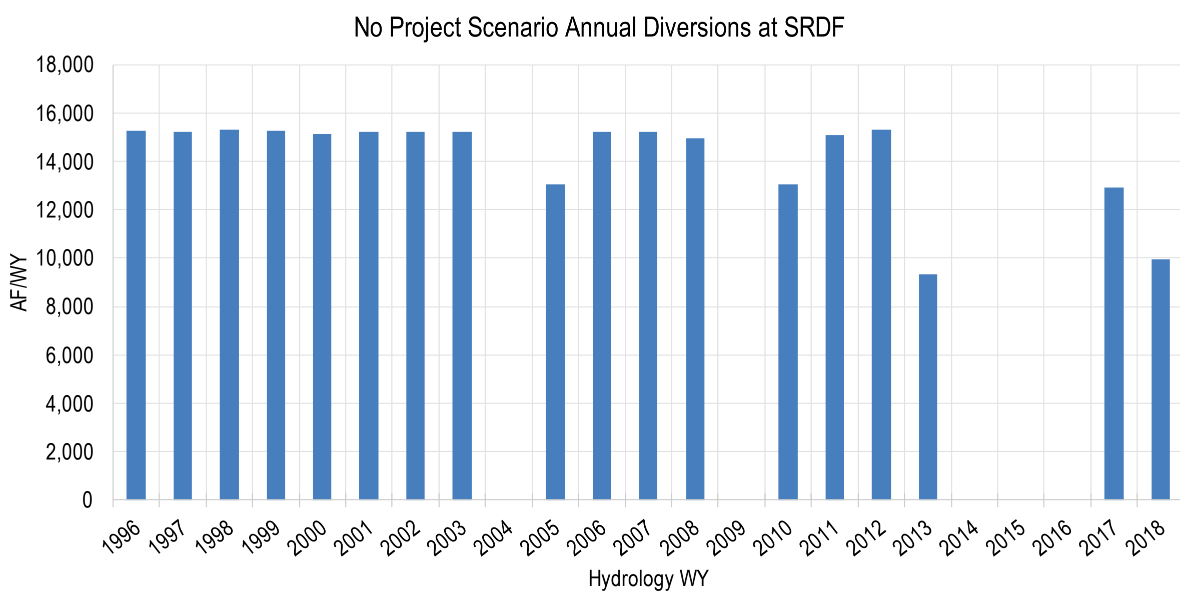


Figure 4. No Project Scenario Annual Diversions at SRDF

Figure 5 shows the monthly supplies of water to CSIP during the representative period in the No Project Scenario. The stacked bars represent the combined water supplies of recycled water, SRDF diverted water, CSIP supplemental well pumping, and private well pumping. Recycled water is used every year but not always needed in shoulder season months depending on demand. Pumping from CSIP supplemental wells and private wells is not necessary every year because adequate supply is available from the other sources. During dry periods when the SRDF is not able to operate, the CSIP supplemental wells and private wells are necessary to meet CSIP demand. During these dry periods, the capacity of the CSIP supplemental wells and private wells in Zone 2B were unable to keep up with the demand. Thus, a portion of the CSIP demand was not met during these periods in the No Project Scenario.

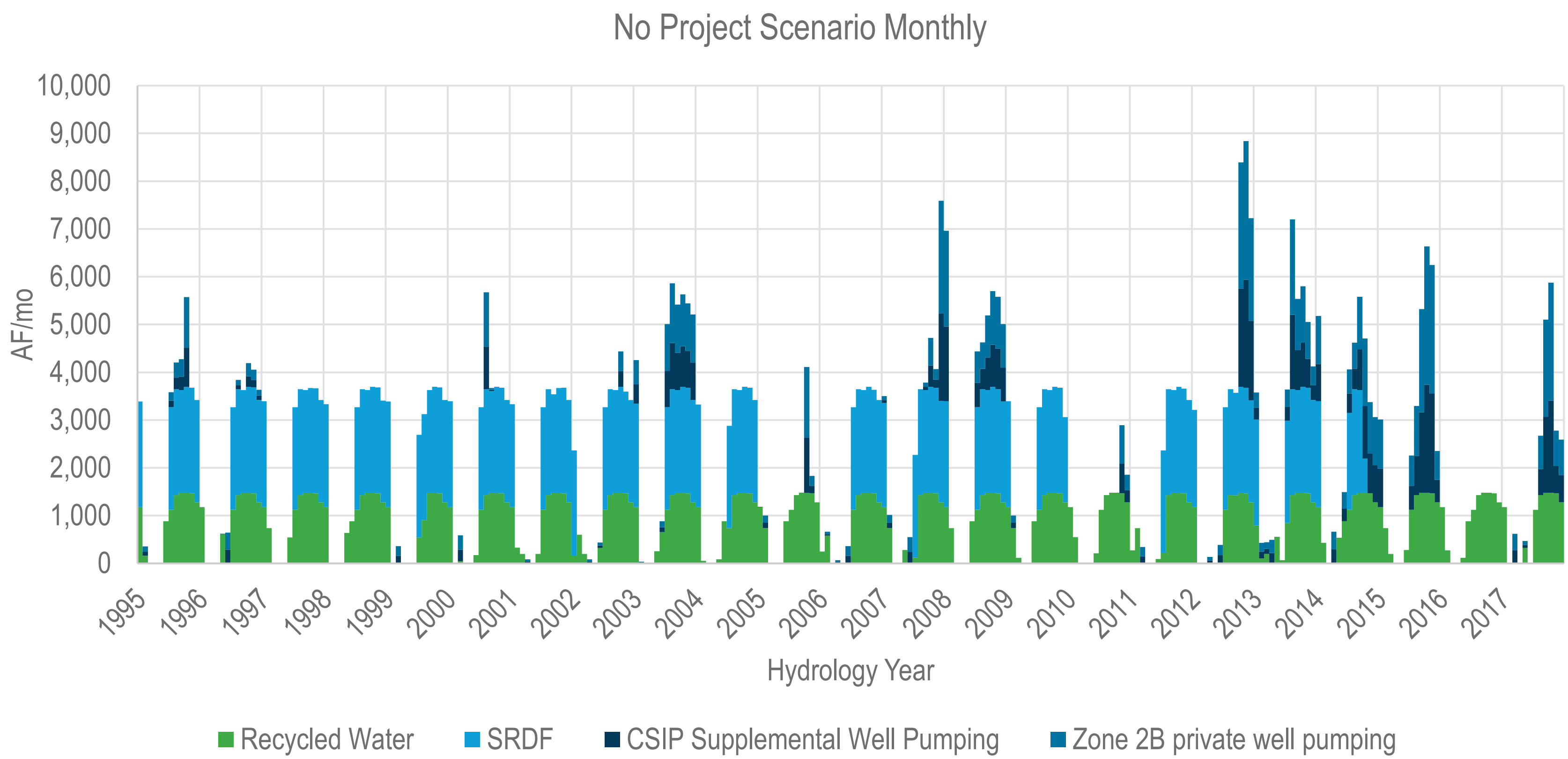


Figure 5. Monthly Diversions and CSIP Supply – No Project Scenario SVOM

4.1.2 No Project Scenario SWI Model Results

In the No Project Scenario, seawater intrusion in the 180- and 400-Foot Aquifers is projected to continue advancing inland from 2020 through 2070. The progression of the chloride isocontours in the No Project Scenario is shown on Figure 6. Each line on Figure 6 shows the 500-mg/L chloride front's progress every 10 years after 2020. Seawater intrusion progresses inland toward the City of Salinas in both the 180- and 400-Foot Aquifers. The 500 mg/L chloride isocontour reaches the City of Salinas in the 180-Foot Aquifer between 2030 and 2040.

In the 400-Foot Aquifer, seawater intrusion advances toward the northern portion of the City of Salinas. The main lobe of seawater advances as far as where the isolated island of seawater was in 2020. The island of seawater slowly disperses and shrinks in size while continuing to move inland. On the northern side of the seawater intrusion front in the 400-Foot Aquifer near Castroville, seawater intrusion is projected to continue but at a slower rate than near Salinas. On the southern side of the seawater intrusion front, additional seawater intrusion is projected east of the City of Marina between 2020 and 2070. Some additional seawater intrusion is projected in the southern direction near the City of Marina.

From 2030 through 2070, additional seawater islands appear between the advancing front of seawater in the 400-Foot Aquifer and the City of Salinas. The appearance of these seawater islands in the 400-Foot Aquifer is caused by downward vertical flow from the 180-Foot Aquifer through wells screened across both aquifers. These model results demonstrate that seawater could flow from the 180-Foot Aquifer into the 400-Foot Aquifer in the future through cross-screened wells. However, the locations of wells screened in multiple aquifers are only estimated in the model. These model results should not be interpreted as an accurate prediction of where new seawater intrusion islands may appear due to either wells screened across multiple aquifers or the localized absence of the 180/400-Foot aquitard. These results highlight the importance of gathering accurate data on wells screened in multiple aquifers to prevent this as a potential migration pathway in the future.

Figure 7 shows simulated 2070 chloride concentrations in the 180-Foot Aquifer and 400-Foot Aquifer. By 2070, seawater intrusion in the 180-Foot Aquifer is projected to advance an additional 3 miles inland at concentrations generally between 500 mg/L and 5,000 mg/L. In the 400-Foot Aquifer, chloride concentrations are highest south of the Salinas River and near Castroville. In the 400-Foot Aquifer there are areas west of the City of Salinas with concentrations between 100 mg/L and 500 mg/L due to chloride migrating downward from the 180-Foot Aquifer.

Figure 8 shows simulated change in average groundwater levels between 2020 and 2070. Average groundwater levels generally decrease in the models between 1 and 20 feet in both the

180-Foot and 400-Foot Aquifers under the No Project Scenario. There is an area with increasing groundwater levels predicted in the Granite Ridge area in eastern Langley; however, it is poorly calibrated in the model and the predicted results are likely unreliable in this area.

Figure 9 shows the average simulated groundwater levels during the last 10 years of the predictive model period between 2060 and 2070 relative to sea level (simulated as an approximate 3 feet NAVD88 in the predictive model). At the beginning of the predictive model period, groundwater elevations inland of the seawater intrusion front are already up to 80 feet below sea level, and the No Project Scenario shows further decline from those levels. By 2070, groundwater elevations along the coast continue to be below sea level in both aquifers. The groundwater gradient is inland from the coast toward the depression north and to the east of the City of Salinas in the Eastside Subbasin.

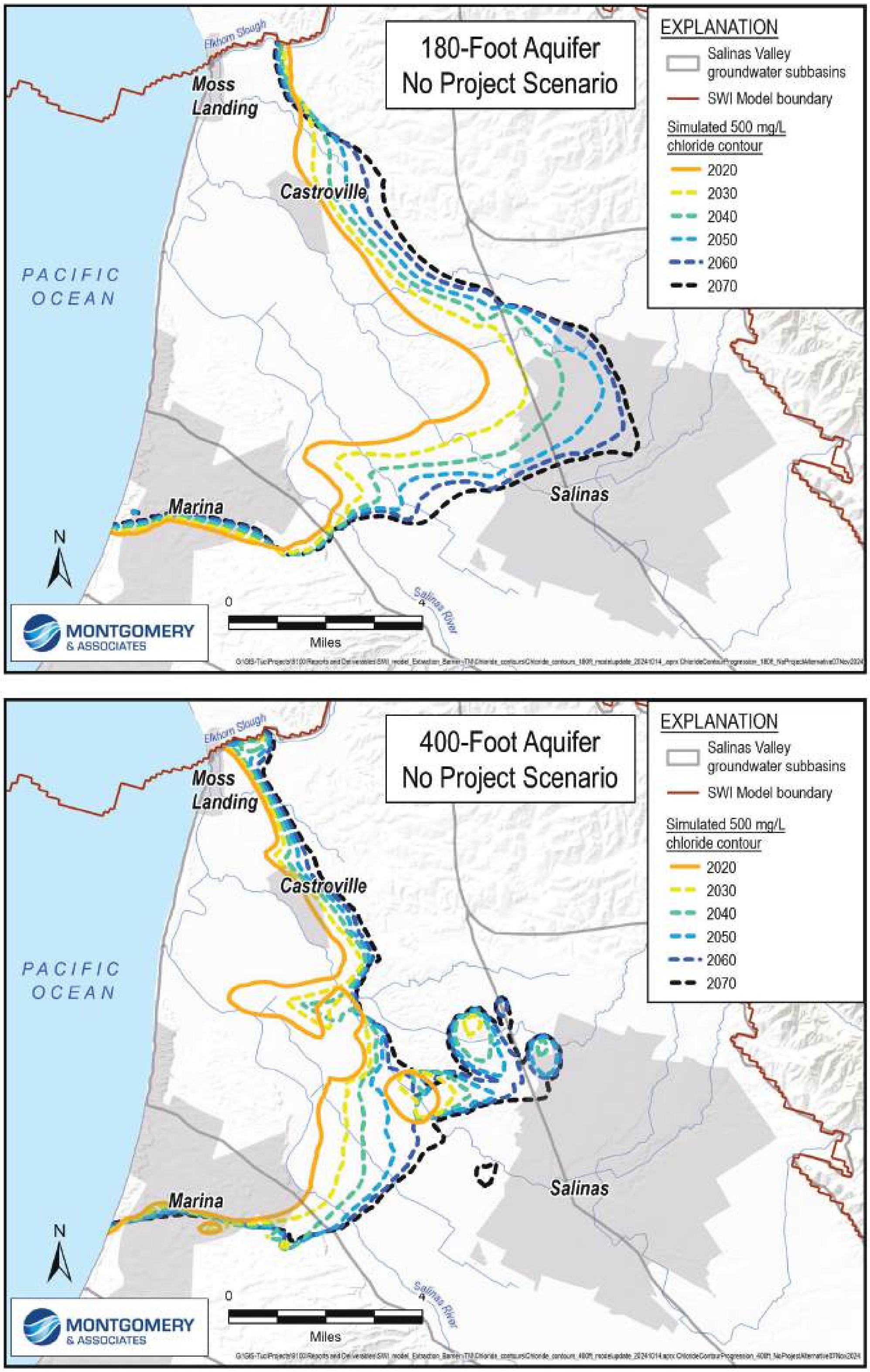


Figure 6. Progression of Simulated Chloride Contours for the No Project Scenario

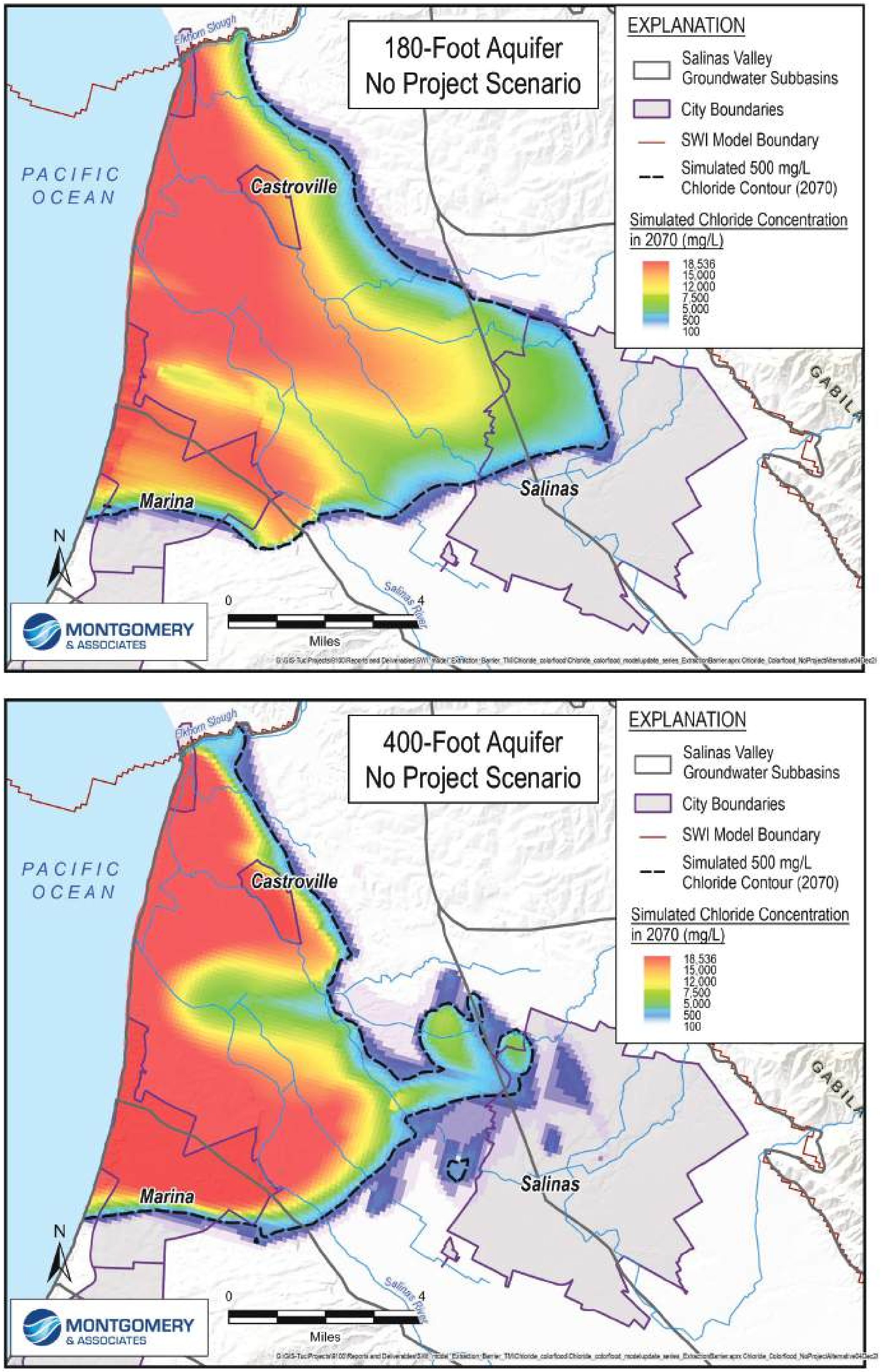


Figure 7. Simulated Chloride Concentration in 2070 for the No Project Scenario

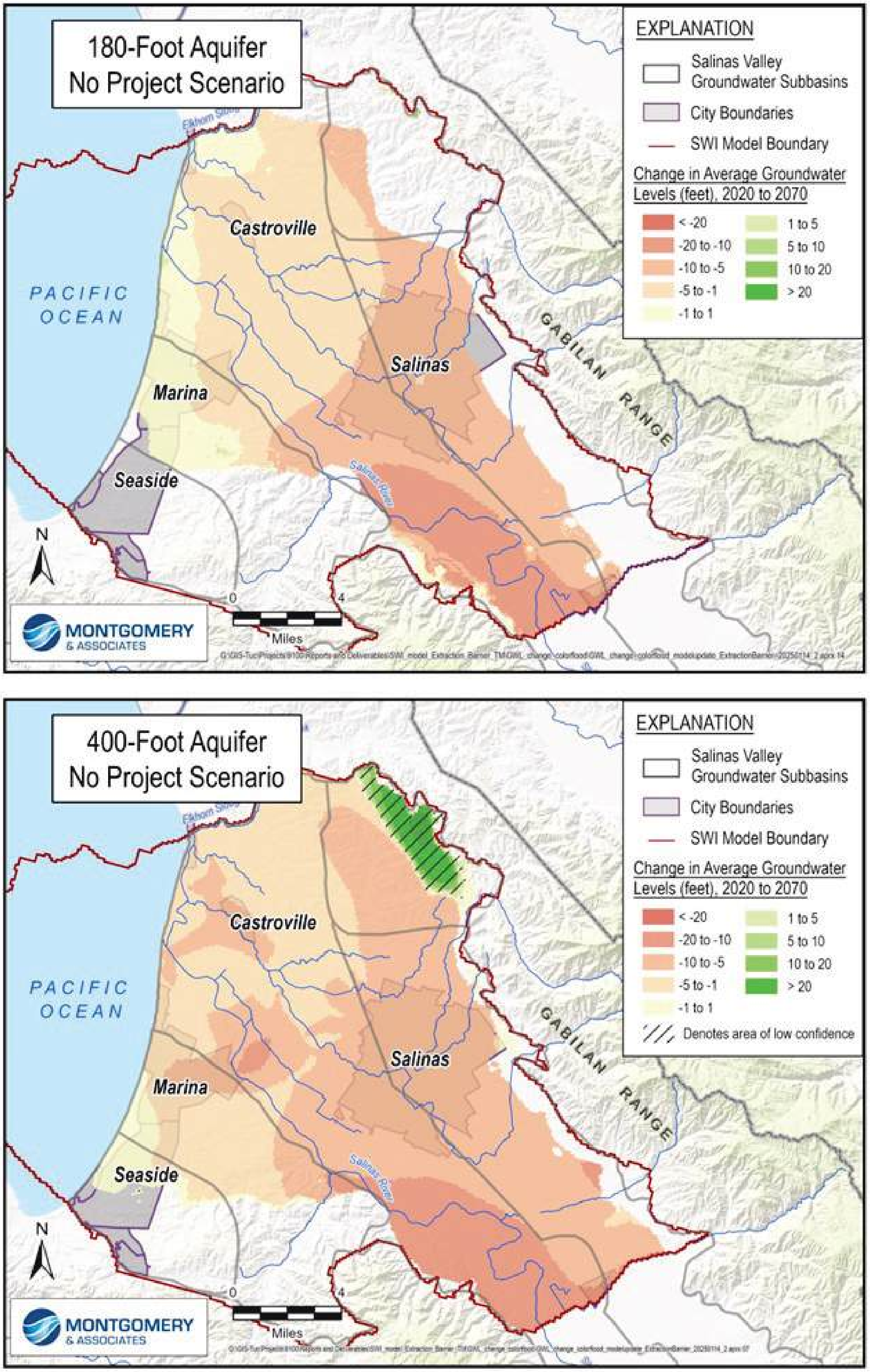


Figure 8. Simulated Change in Groundwater Levels for the No Project Scenario

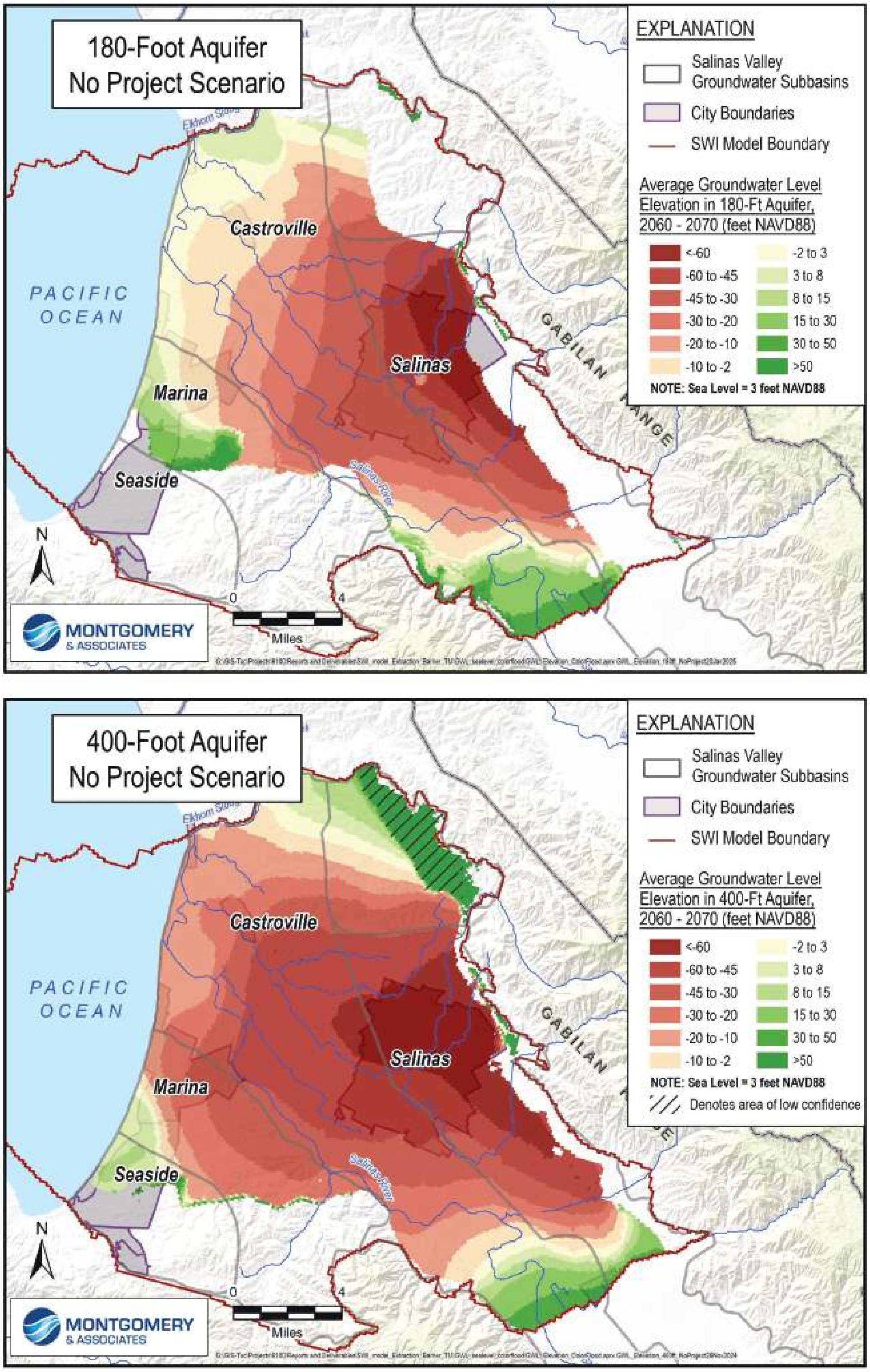


Figure 9. Simulated Groundwater Elevation for the No Project Scenario

4.2 Seasonal Release with ASR Scenario

4.2.1 Seasonal Release with ASR Scenario SVOM Results

Table 7 summarizes the ASR diversions and other water sources supplied to the CSIP Area in the Seasonal Release with ASR SVOM Scenario. The total average amount of water supplied to CSIP was 26,200 AF/WY during the representative period. More groundwater pumping is needed to meet CSIP demands because the SRDF diversions are used for ASR injection instead of CSIP supply. The average total groundwater pumping was 14,300 AF/WY for the representative period. This included 11,600 AF/WY of pumping from CSIP supplemental wells and an additional 2,700 AF/WY from ASR wells. Though the total supply in the Seasonal Release with ASR Scenario appears to be slightly less than in the No Project Scenario, it represents the same consumptive use of approximately 34,000 AF/WY.

Table 7. CSIP Area Water Supply Summary – Seasonal Release with ASR SVOM Scenario

SVOM Annual Average (AF/WY)	Seasonal Release with ASR
Recycled Water Supplied	11,900
CSIP Supplemental Well Pumping (no private pumping)	11,600
ASR Well Extraction (to meet pumping demand in Zone 2B)	2,700
Total Supply:	*26,200*
Total Pumping:	*14,300*
ASR injection from SRDF diversions (at 36 cfs)	12,900
Net ASR Injection (ASR injection – ASR extraction)	10,200

Note: all values rounded to the nearest 100 AF

The wintertime operation of the SRDF resulted in an average diversion of 12,900 AF/WY, which is more than in the No Project Scenario. The Seasonal Release with ASR Scenario resulted in an average increase in SRDF diversions because the SRDF was more likely to be able to operate in drier conditions. By shifting SRDF operation to the winter, reservoir releases do not need to be as large to maintain desired flows. This is because simulated water levels along the Salinas River are higher and losses through the riverbed are therefore less. This allows the storage in the reservoirs to remain higher year-to-year, such that when a drier period starts, the reservoirs are more likely to meet minimum storage requirements for SRDF operation. Figure 10 compares the annual SRDF diversions between the Seasonal Release with ASR Scenario and the No Project Scenario.

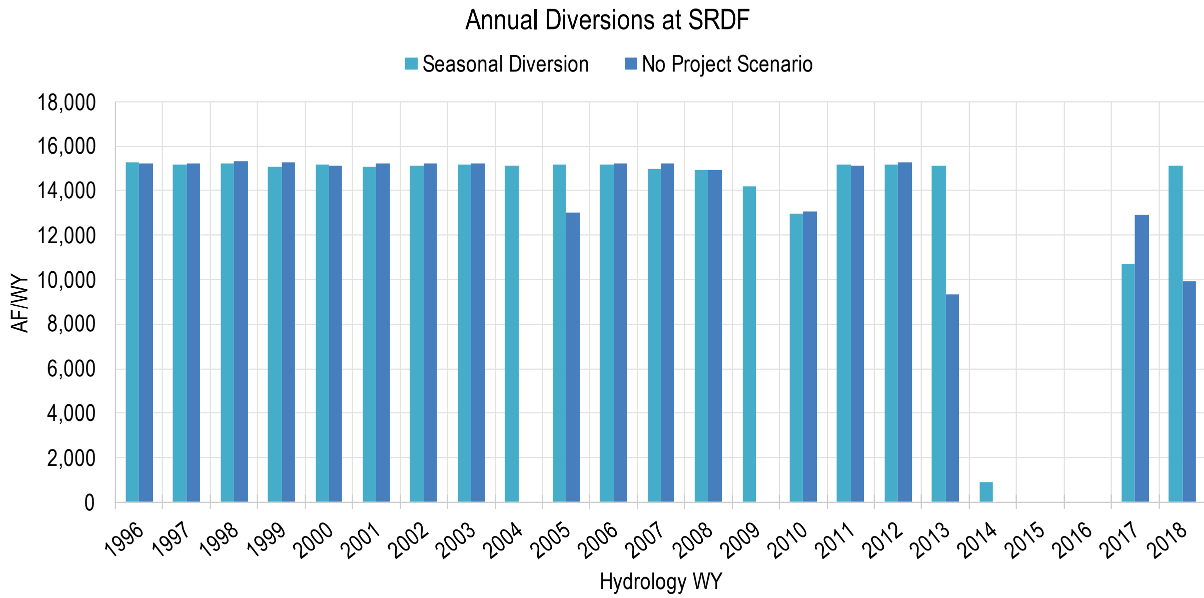


Figure 10. Annual SVOM SRDF Diversions

Figure 11 shows the monthly supplies of water to CSIP and the SRDF diversions during the representative period in the Seasonal Release with ASR SVOM Scenario. The stacked bars represent the combined water supplies of recycled water, CSIP supplemental well pumping, and extraction from ASR wells. The yellow line represents SRDF diversions for ASR injection. Recycled water is used every year but is not always needed in shoulder season months depending on climate. CSIP supplemental wells pump continuously during the growing season and often near their maximum capacity in the Seasonal Release with ASR Scenario. Extraction from ASR wells is not necessary every year but can be high during dry periods: up to 8,000 to 10,000 AF/WY. The SRDF diversions for ASR occur almost every year during the representative period except during the extended drought.

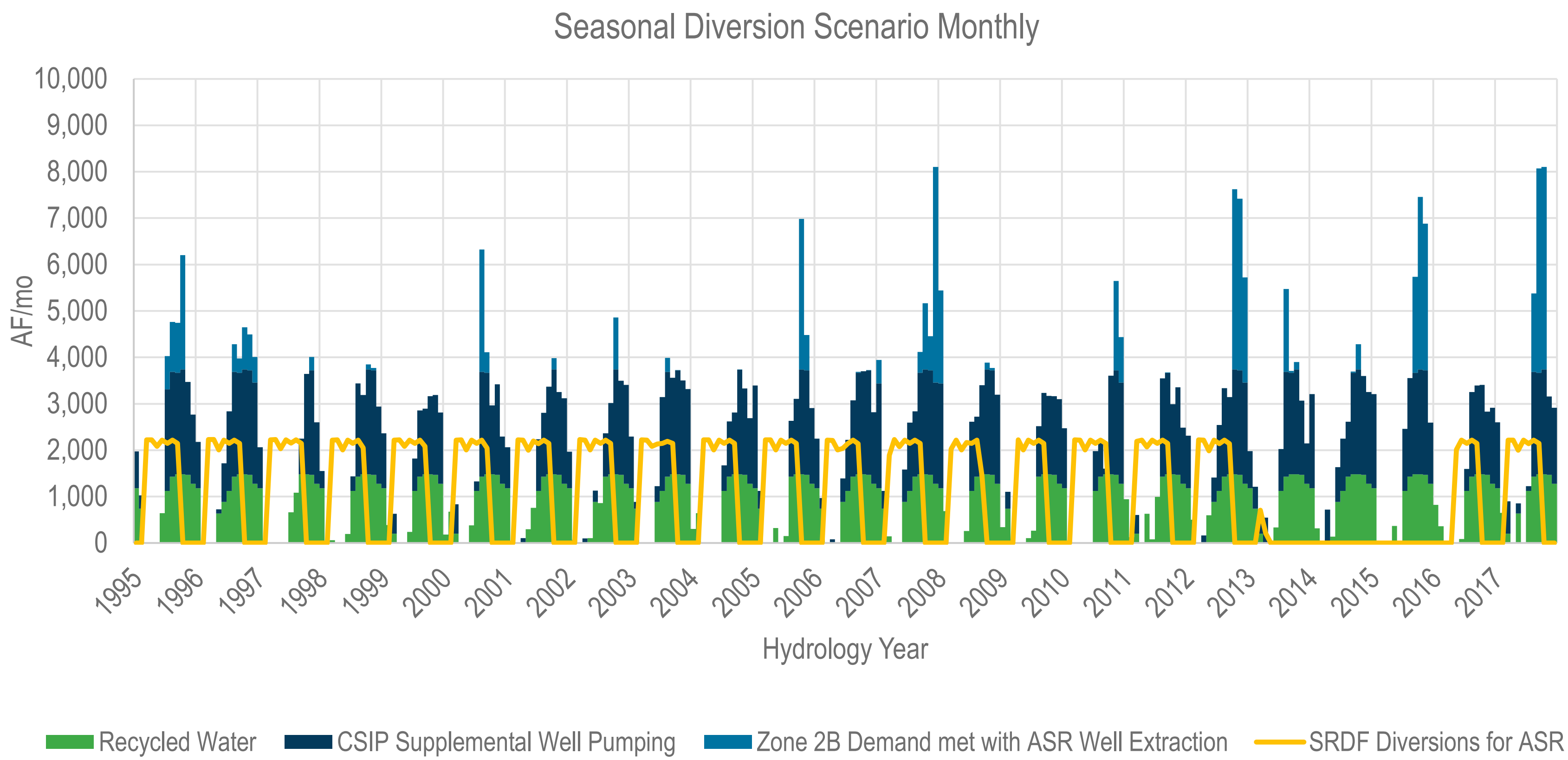


Figure 11. Monthly Diversions and CSIP Supply – Seasonal Release with ASR SVOM

Table 8 summarizes the simulated ASR well injection and extraction rates for the representative period. There was no injection during 2 exceptionally dry years when the SRDF could not be operated. Extraction from ASR wells was not necessary every year, but during drier years approximately 5,000 AF/WY up to 10,000 AF/WY was needed. The net injection rates (total injection minus extraction) were greater than 0 every year except during the exceptionally dry 2-year period. On average the extracted volume by the ASR wells was approximately 20% of the injected volume, resulting in a net injection rate at the ASR wells of 80%.

Table 8 also shows the increase in CSIP supplemental well pumping due to the Seasonal Release with ASR Scenario compared to the No Project Scenario, as described above. Supplemental well pumping increased by approximately 80% compared to the No Project Scenario. While supplemental well pumping in the No Project Scenario is not necessary everywhere, in the Seasonal Release with ASR Scenario, additional annual pumping during the representative period ranges from approximately 4,900 AF to 14,000 AF.

Table 8. ASR Injection and Extraction Summary – Seasonal Release with ASR SVOM

Hydrology WY	ASR Injection (AF/WY)	ASR Extraction (AF/WY)	Net Injection (AF/WY)	Additional CSIP Supplemental Well Pumping (AF/WY)
1996	15,250	5,334	9,916	11,888
1997	15,190	3,141	12,050	13,924
1998	15,219	286	14,933	7,391
1999	15,076	156	14,920	10,579
2000	15,185	0	15,185	9,936
2001	15,063	3,085	11,978	8,578
2002	15,134	245	14,889	11,216
2003	15,163	1,122	14,041	9,604
2004	15,136	305	14,831	8,850
2005	15,181	4	15,177	8,593
2006	15,174	4,007	11,168	10,136
2007	14,970	30	14,940	12,600
2008	14,909	7,760	7,149	12,154
2009	14,218	2,202	12,016	7,767
2010	12,948	0	12,948	8,300
2011	15,170	2,902	12,268	8,762
2012	15,198	8	15,190	9,169
2013	15,140	9,846	5,295	7,292
2014	912	1,991	-1,079	6,969
2015	0	571	-571	8,620
2016	0	8,948	-8,948	4,890
2017	10,729	0	10,729	9,134
2018	15,149	10,457	4,692	6,932
Average	***12,875***	***2,713***	***10,162***	***9,273***

4.2.2 Seasonal Release with ASR Scenario SWI Model Results

Figure 12 shows maps of the 500 mg/L chloride front simulated by the SWI Model for the Seasonal Release with ASR Scenario. The maps show the 2070 location of the 500 mg/L chloride front (black dashed line) relative to its position in 2020 (orange solid line). The colored dashed lines represent the progression of the 500 mg/L chloride contour every decade starting in 2030. The ASR wells are positioned near the 500 mg/L chloride contour in 2030, which is the start date of the ASR project.

In the 180-Foot Aquifer, the ASR wells appear to be effective at slowing seawater intrusion on the northern side of the seawater intruded area. The 500 mg/L chloride contour does not proceed far beyond the barrier made by ASR wells ASR_01 through ASR_06. However, the ASR wells are not effective at preventing additional seawater intrusion in the 180-Foot Aquifer in the main path of the plume or along the southern side of the seawater intruded area in the 180/400 Subbasin. The 500 mg/L chloride contours show that seawater passes between and around some of the ASR wells. This is because the injection volumes are not large enough to form a significant mound in the high transmissivity 180-Foot Aquifer.

In the 400-Foot Aquifer, wells ASR_09 through ASR_12 appear to effectively slow down seawater intrusion toward the City of Salinas. However, wells ASR_13 and ASR_14 on the north side of the seawater intruded area and ASR_15 and ASR_16 on the south side of the intruded area are not effective. This is partially because wells ASR_13 through ASR_16 sometimes extract water to meet CSIP demand and their net injection rates are not high enough to form enough of a mound to slow seawater intrusion.

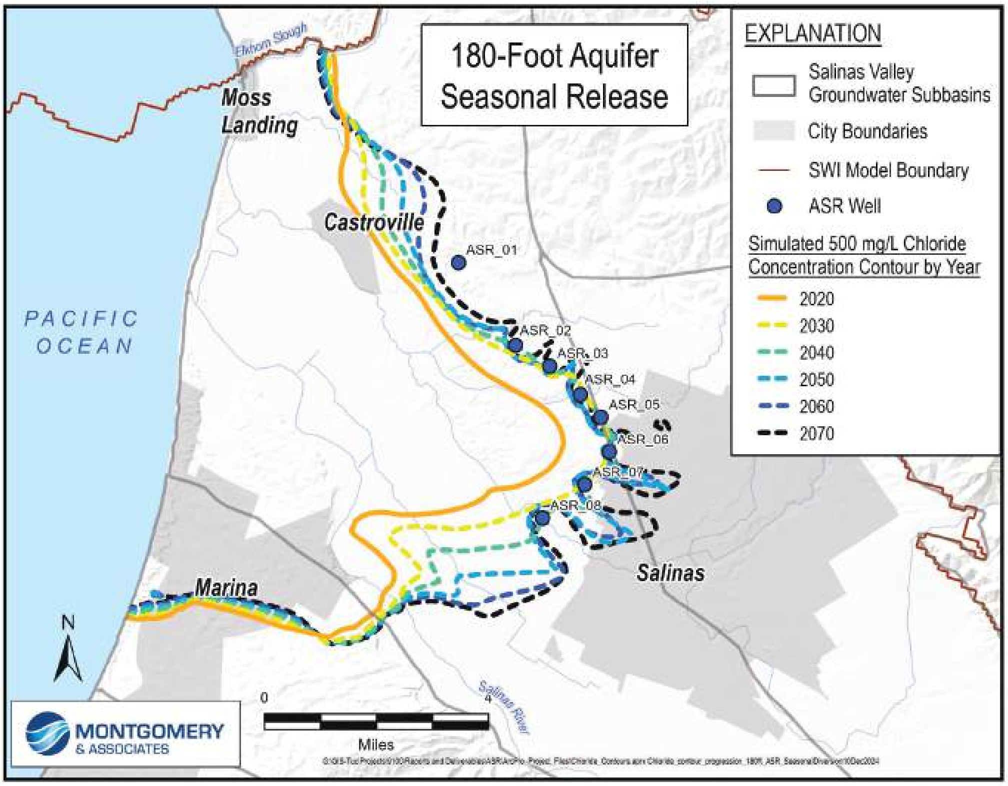
Figure 13 compares the simulated 2070 intrusion extent (blue dashed line), with the 2070 No Project intrusion extent (red dashed line) and the current seawater intrusion minimum threshold (black line.) In the 180-Foot Aquifer, there is some improvement in controlling seawater intrusion relative to the No Project Scenario on the northern side of the intruded area and near the City of Salinas. However, on the southern side the 500 mg/L chloride contour has been pushed farther to the southeast by ASR_08. In the 400-Foot Aquifer, the 500 mg/l chloride contour is pushed closer to the coast and away from the City of Salinas near ASR_09 through ASR_12. The area of seawater intrusion migrating downward from the 180-Foot Aquifer to the 400-Foot Aquifer appear to be pushed farther north and pulled westward by increased pumping at the CSIP supplemental wells. In general, the Seasonal Release with ASR Scenario is not very effective at pushing the 500 mg/L chloride contour closer to the minimum threshold in either the 180- or 400-Foot Aquifers.

Figure 14 shows the impact of ASR injection on chloride concentrations. Figure 14 shows that even in areas where the ASR wells appear to be effective at slowing down seawater intrusion, saline water with concentrations below 500 mg/L is able to pass through the barrier of ASR wells. In the 400-Foot Aquifer (bottom map), increased pumping at the CSIP supplemental wells results in increased chloride concentrations compared to the No Project Scenario (Figure 7) in the portion of the 400-Foot Aquifer that is already impacted by seawater.

Figure 15 shows average groundwater level changes between 2020 and 2070 in the Seasonal Release with ASR Scenario. In general, the trend in groundwater levels in the Seasonal Release with ASR Scenario is similar to the No Project Scenario, except near the ASR wells. In the 180-Foot Aquifer, average groundwater levels are projected to increase by around 5 feet. In the 400-Foot Aquifer, average groundwater levels only noticeably increase in a localized area near ASR_09 through ASR_12. ASR injection in the 400-Foot Aquifer is barely able to counter the overarching trend of declining groundwater levels seen in the No Project Scenario (Figure 8).

Figure 15 shows the change in groundwater levels, not absolute groundwater levels. Therefore, the green area on Figure 15 should not be interpreted as being above sea level.

Figure 16 shows the average groundwater levels for the Seasonal Release with ASR Scenario between 2060 and 2070 relative to sea level. The groundwater levels in the 180-Foot Aquifer and 400-Foot Aquifer are still projected to be below sea level in 2070, even where average groundwater levels increase. The groundwater depression near the City of Salinas in the Eastside Subbasin is still projected to remain in 2070. Groundwater elevations in the 400-Foot Aquifer near the CSIP supplemental wells are somewhat lower in the Seasonal Release Scenario than the No Project Scenario due to the additional extraction from these wells.



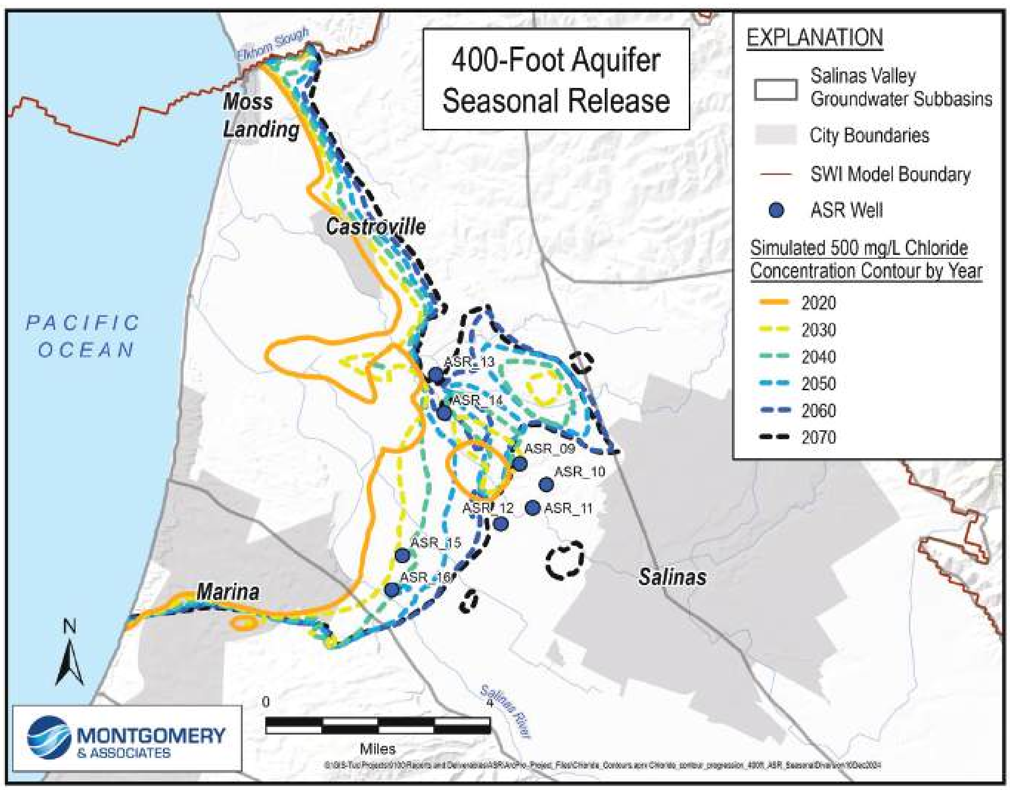
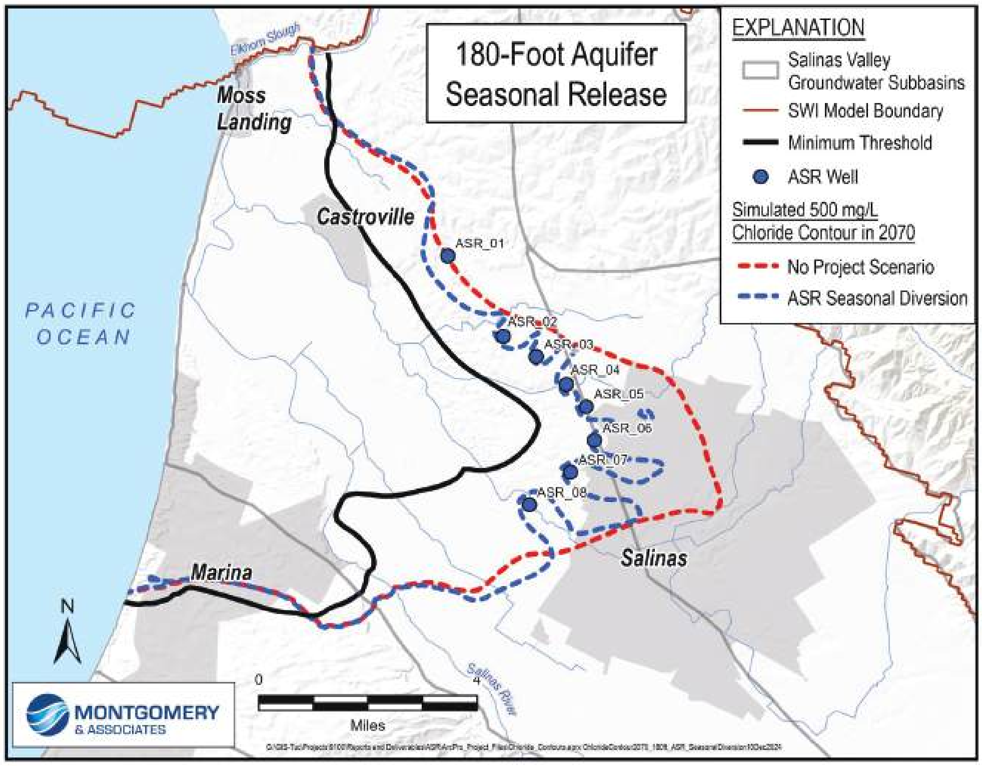


Figure 12. Seasonal Release with ASR Scenario – 500 mg/L Chloride Contours (2020 to 2070)



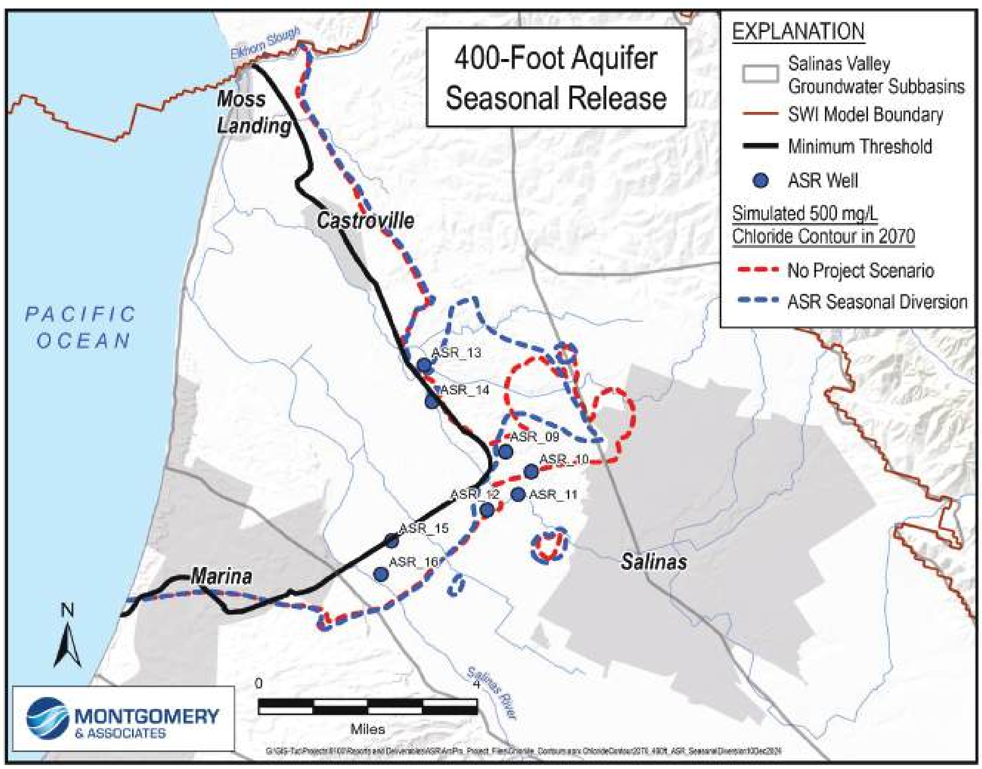


Figure 13. Seasonal Release with ASR Scenario – 2070 500 mg/L Chloride Contours Comparison to No Project Scenario and Minimum Threshold

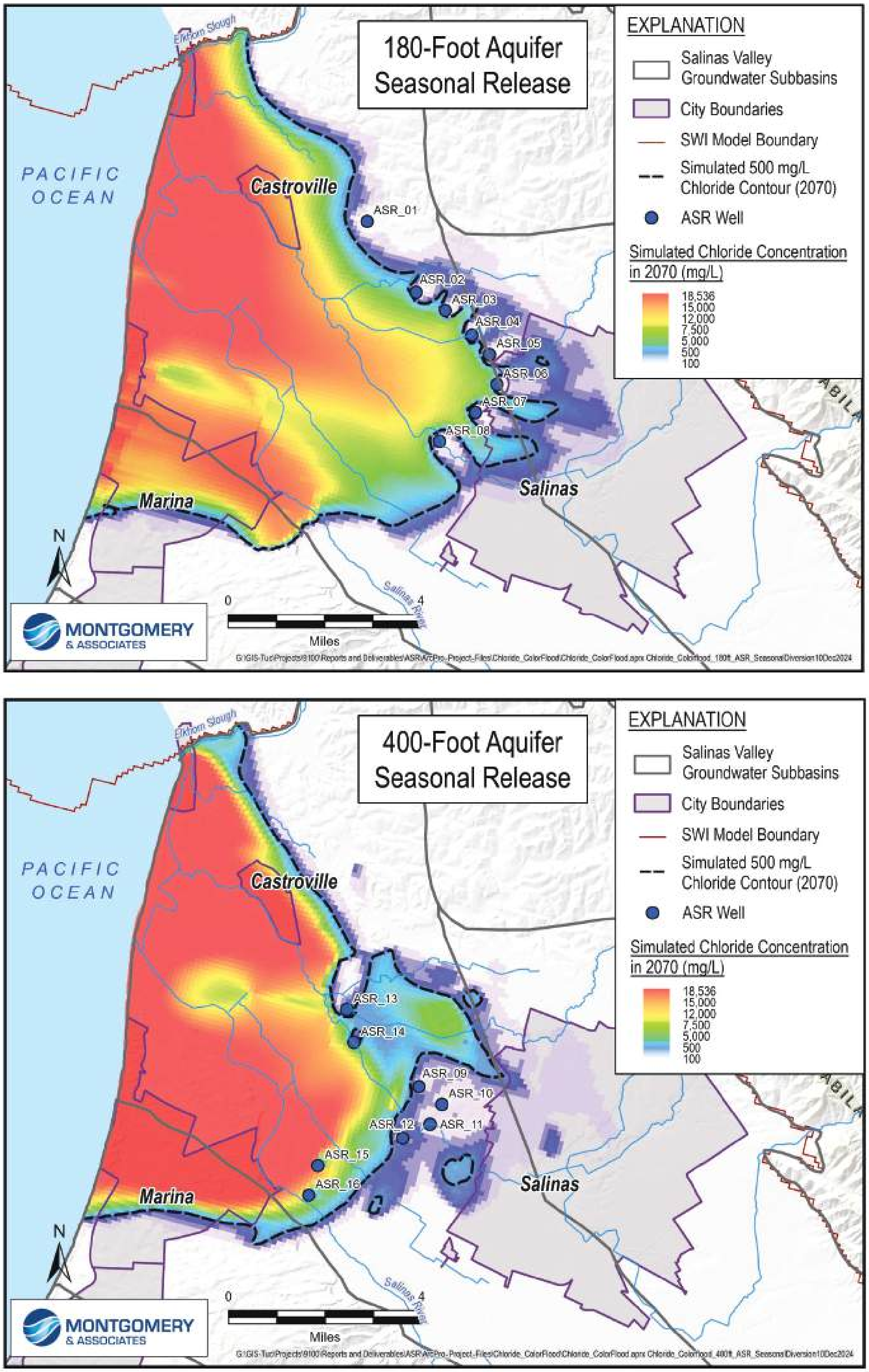


Figure 14. Seasonal Release with ASR Scenario: Chloride Concentrations (2070)

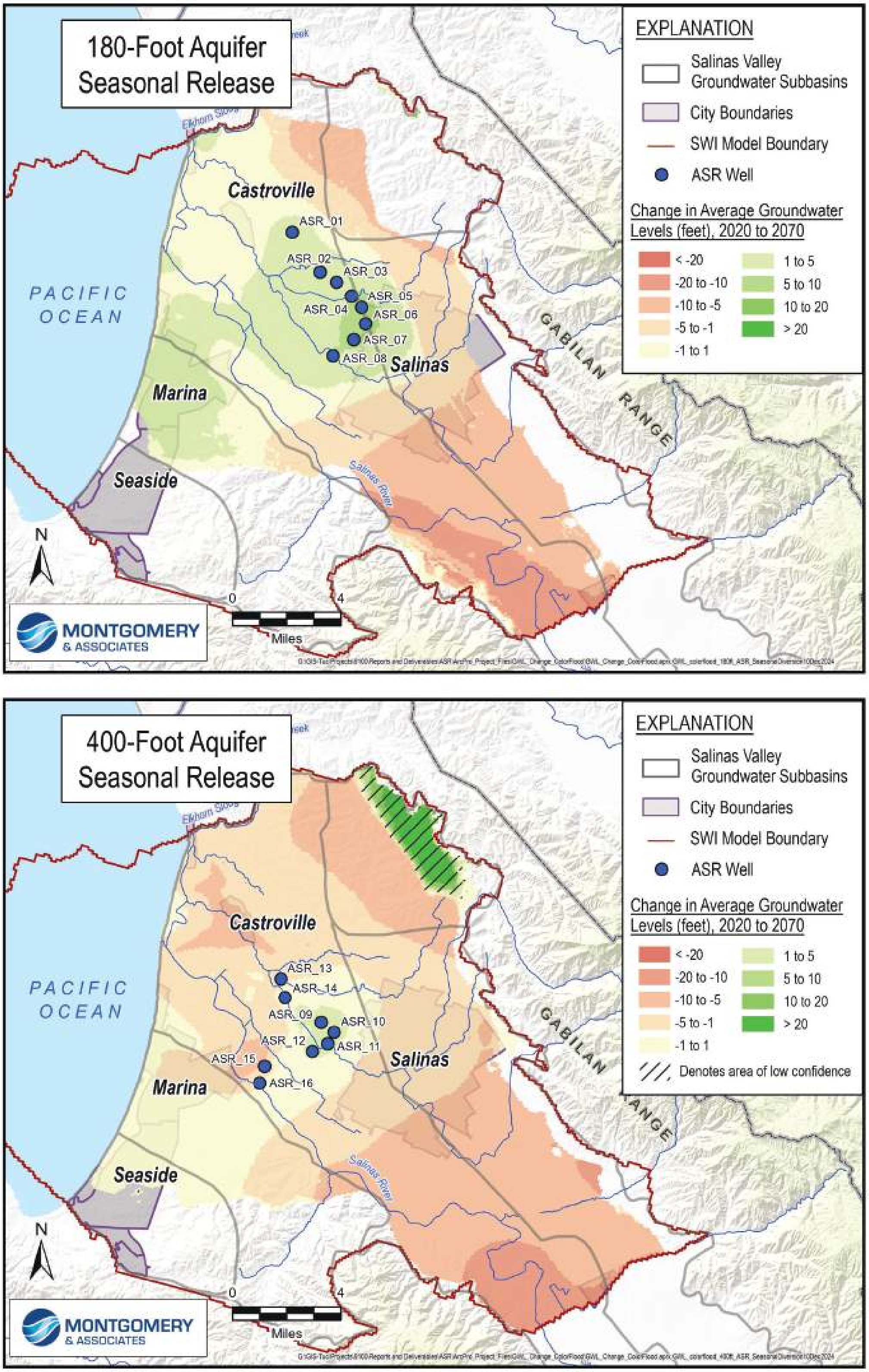


Figure 15. Seasonal Release with ASR Scenario: Average Groundwater Level Change (2020 to 2070)

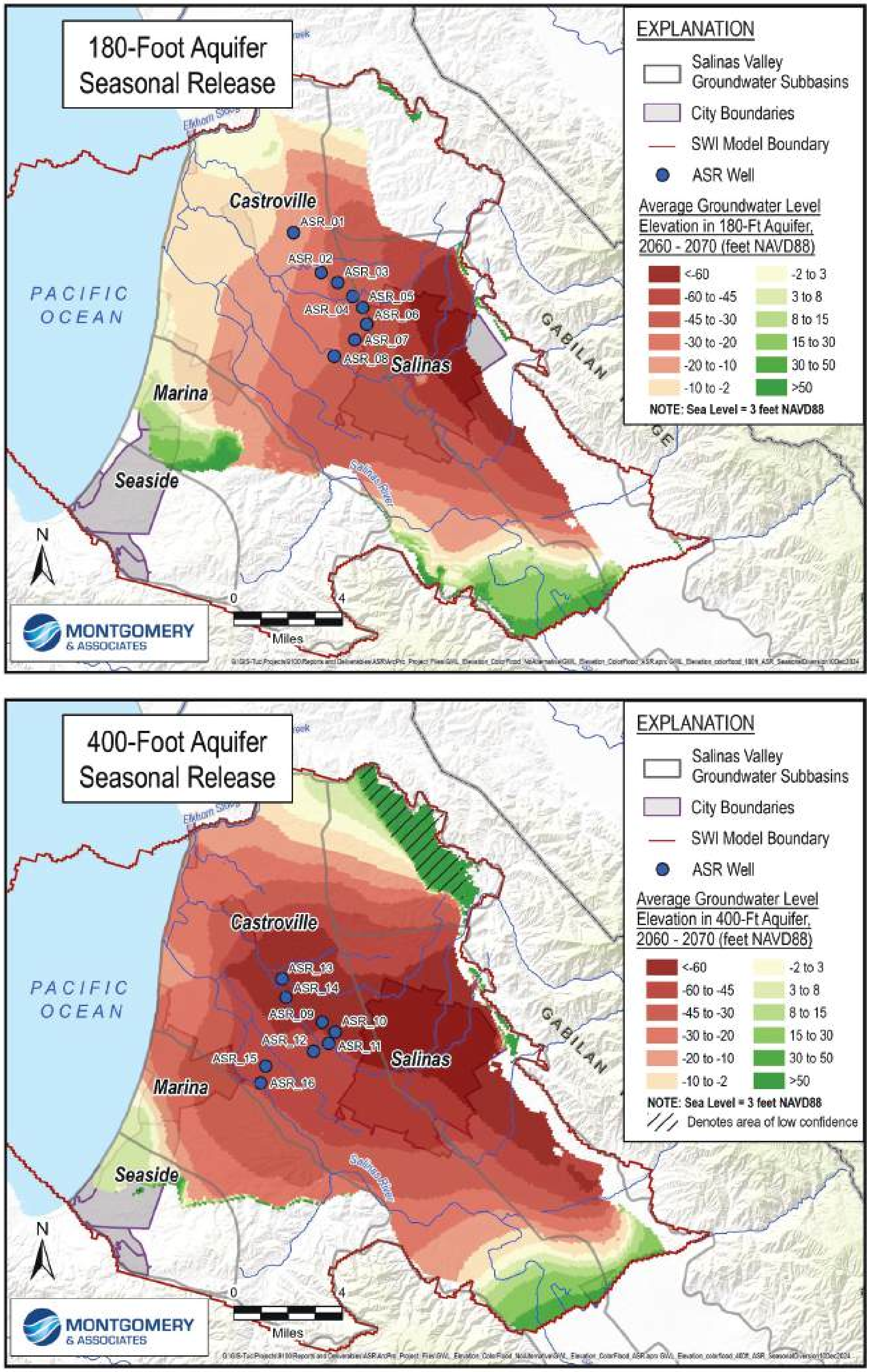


Figure 16. Simulated Groundwater Elevation for the Seasonal Release Scenario

4.3 New Diversion of Winter High Flows for ASR - Alternative 1 Scenario

4.3.1 New Diversion of Winter High Flows for ASR - Alternative 1 Scenario SVOM Results

Table 9 summarizes the ASR diversions and other water sources supplied to the CSIP Area in the New Diversion of Winter High Flows for ASR Alternative 1 SVOM Scenario. The average total amount of water supplied to CSIP was 28,200 AF/WY during the representative period. This is the same amount supplied in the No Project Scenario. The amounts of water supplied by the SRDF diversions and groundwater pumping were 10,800 AF/WY and 5,500 AF/WY, respectively. The slight differences are due to cascading effects of variations in simulated streamflows between the No Project Scenario and New Diversion of Winter High Flows for ASR Alternative 1 Scenario in the SVOM. The consumptive use was the same in the New Diversion of Winter High Flows for ASR Alternative 1 Scenario as the No Project Scenario, approximately 34,000 AF/WY.

Table 9. CSIP Area Water Supply Summary – New Diversion of Winter High Flows for ASR Alternative 1 SVOM

SVOM Annual Average (AF/WY)	New Diversion of Winter High Flows for ASR Alternative 1
Recycled Water Supplied	11,900
SRDF Diversions (at 36 cfs)	10,800
CSIP/Zone 2B Well Pumping (Supplemental well + private)	5,500
Total Supply:	*28,200*
Total Pumping:	*5,500*
ASR injection via new diversion structure	6,700
Net ASR injection	6,700

Note: all values rounded to the nearest 100 AF

Figure 17 shows the annual total simulated diversions from the Salinas River by both the SRDF and a new ASR diversion. The SRDF operates all years except during exceptionally dry periods. The ASR diversion also operates almost every year, but diversion amounts are more variable than the SRDF diversion. This is because 1 of the objectives of the normal reservoir operations is to carry over winter water for summer releases to SRDF when the ASR diversions are not active. Thus, there are years when reservoir storage allowed SRDF to operate during the summer, but due to a lack of high winter flows the ASR diversions that year were very small.

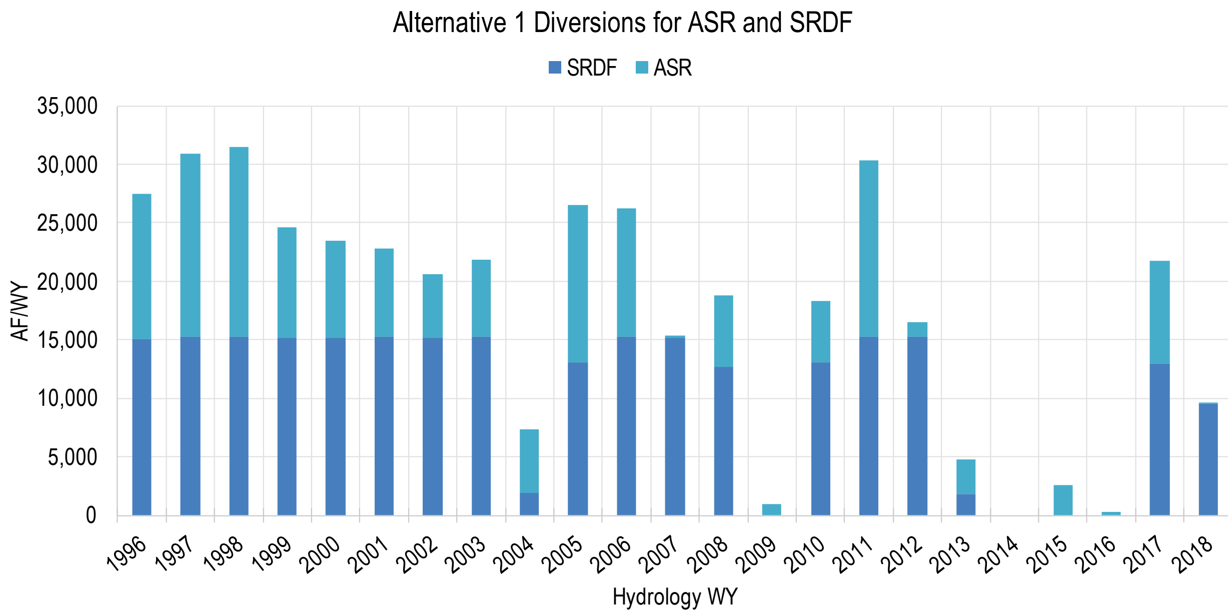


Figure 17. New Diversion of Winter High Flows for ASR Alternative 1 Diversions for ASR and SRDF

Table 10 includes the annual ASR injection amounts for the representative period. During wet periods, ASR diversions were as high as 16,000 AF/WY. This represents a nearly continuous diversion of the maximum rate of 45 cfs from November 1 through April 30. During dry years, ASR diversions didn't exceed 3,000 AF/WY. The overall average ASR diversion rate during the representative period was 6,700 AF/WY. This is only slightly more than half the amount of net ASR injection available through Seasonal Release with ASR.

Table 10. ASR Injection Summary – New Diversion of Winter High Flows for ASR Alternative 1

Hydrology WY	ASR Injection (AF/WY)
1996	12,347
1997	15,673
1998	16,155
1999	9,420
2000	8,282
2001	7,523
2002	5,445
2003	6,590
2004	5,412
2005	13,478
2006	10,992
2007	113
2008	6,112
2009	959
2010	5,266
2011	15,057
2012	1,228
2013	2,998
2014	0
2015	2,541
2016	333
2017	8,774
2018	35
Average	***6,728***

Figure 18 shows the monthly supplies of water to CSIP and ASR diversions during the representative period in the New Diversion of Winter High Flows for ASR Alternative 1 SVOM Scenario. The stacked bars represent the combined water supplies of recycled water, SRDF diversions, CSIP supplemental well pumping, and private pumping. The yellow line represents diversions for ASR injection. The supply of water to CSIP in New Diversion of Winter High Flows for ASR Alternative 1 Scenario is similar to the No Project Scenario. Unlike in the Seasonal Release with ASR Scenario, pumping from CSIP supplemental wells and private wells is not necessary every year because adequate supply is available from the other sources: recycled water and SRDF. During dry periods when the SRDF is not able to operate, the CSIP supplemental wells and private wells are still necessary to meet CSIP demand. The ASR diversions occur in the winter when there is not as much demand.

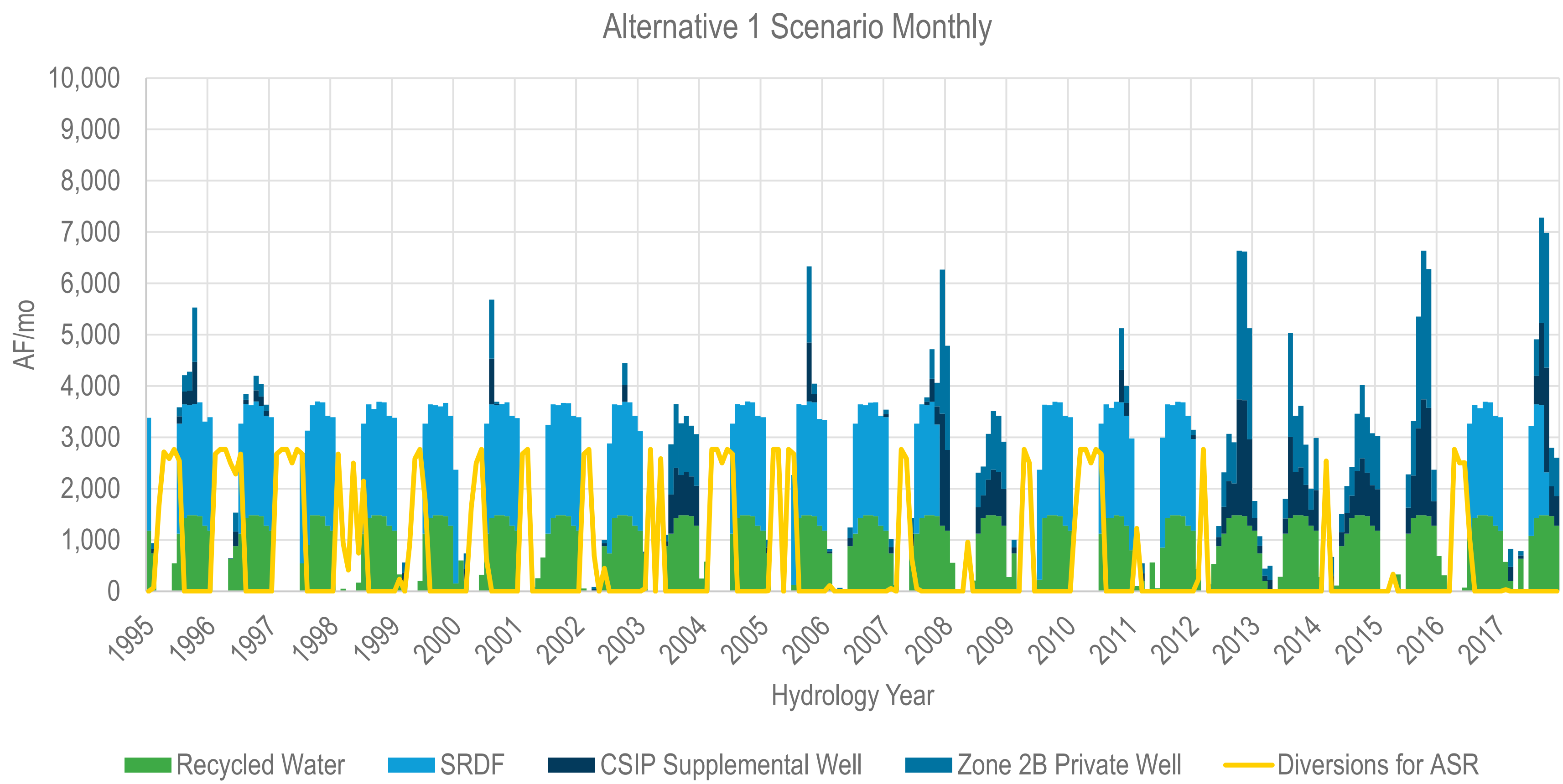


Figure 18. Monthly Diversions and CSIP Supply – New Diversion of Winter High Flows for ASR Alternative 1 SVOM Scenario

4.3.2 New Diversion of Winter High Flows for ASR - Alternative 1 Scenario SWI Model Results

Figure 19 shows maps of the 500 mg/L chloride front simulated for the New Diversion of Winter High Flows for ASR Alternative 1 Scenario. The maps show the 2070 location of the 500 mg/L chloride front (black dashed line) relative to its position in 2020 (orange solid line). The colored dashed lines represent the progression of the 500 mg/L chloride contour every decade starting in 2030.

Although there is much less injection in New Diversion of Winter High Flows for ASR Scenario compared to the Seasonal Release with ASR Scenario, the progression of the 500 mg/L chloride contour in both the 180- and 400-Foot Aquifers is very similar. This is because the higher injection rates of the Seasonal Release with ASR Scenario are countered by higher extraction rates from the CSIP supplemental wells and additional extraction from the ASR wells. The 500 mg/L chloride contour progresses beyond the ASR wells towards the City of Salinas in New Diversion of Winter High Flows for ASR Alternative 1 Scenario. The seawater progression inland in the 400-Foot Aquifer in New Diversion of Winter High Flows for ASR Alternative 1 Scenario is almost the same as the No Project Scenario, demonstrating how little impact the New Diversion of Winter High Flows for ASR Alternative 1 Scenario injection volumes have on seawater intrusion.

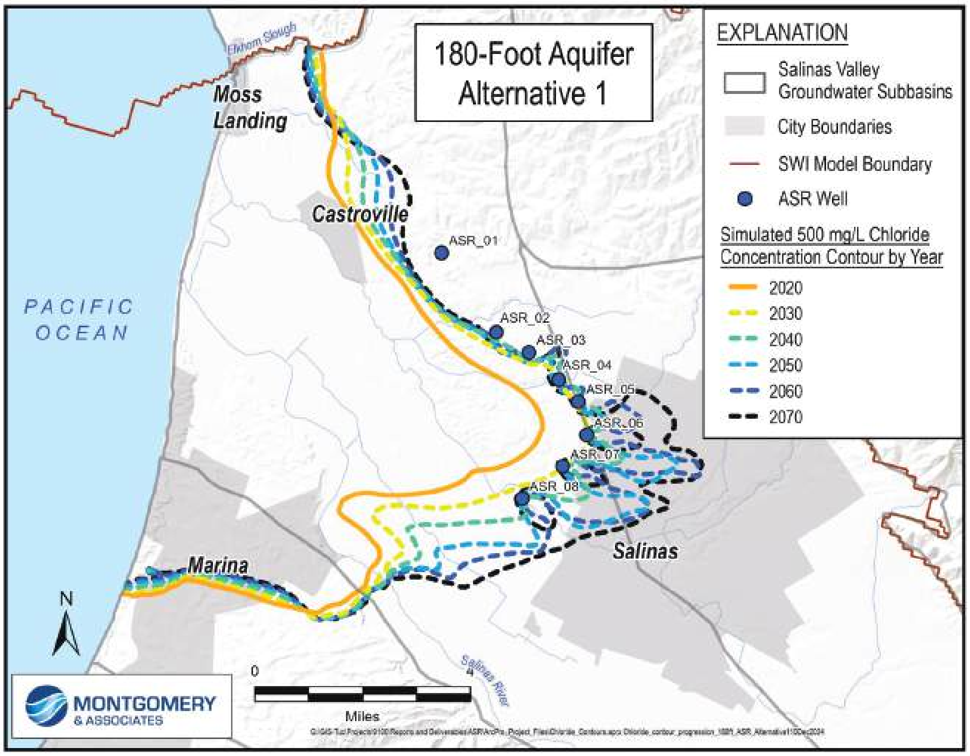
Figure 20 compares the simulated 2070 intrusion extent (blue dashed line), with the 2070 No Project intrusion extent (red dashed line) and the current intrusion minimum threshold (black line.) In the 180-Foot Aquifer, there is some improvement in controlling seawater intrusion relative to the No Project Scenario on the northern side of the intruded area. There is very little improvement near the City of Salinas and to the south. The 500 mg/L chloride contour in the 400-Foot Aquifer is nearly the same as the No Project Scenario, with minimal improvements near the City of Salinas. The New Diversion of Winter High Flows for ASR Alternative 1 Scenario is not effective at achieving the seawater intrusion minimum threshold in either the 180- or 400-Foot Aquifers.

Figure 21 shows the impact of ASR injection on chloride concentrations at 2070 for both the 180-Foot Aquifer and the 400-Foot Aquifer. The top map shows that the ASR wells are not creating an effective barrier and are not preventing lower concentrations of seawater from passing between the wells in the 180-Foot Aquifer. Figure 21 shows that New Diversion of Winter High Flows for ASR Alternative 1 Scenario chloride concentrations are similar to the No Project Scenario in the 400-Foot Aquifer (Figure 7).

Figure 22 shows average groundwater level changes between 2020 and 2070 in the New Diversion of Winter High Flows for ASR Alternative 1 Scenario. In general, the groundwater level trends in the New Diversion of Winter High Flows for ASR Alternative 1 Scenario appear to be similar to the trends seen in the Seasonal Release with ASR Scenario. In the 180-Foot Aquifer, average groundwater levels are projected to increase by approximately 5 feet in the immediate vicinity of the ASR wells. In the 400-Foot Aquifer, ASR injection is only able to counter the declining groundwater level trend but does not result in noticeable increase in average groundwater levels.

Figure 22 shows change in groundwater levels, not absolute groundwater levels. Therefore, the green area on Figure 22 should not necessarily be interpreted as being above sea level.

Figure 23 shows the average groundwater levels for the New Diversion of Winter High Flows for ASR Alternative 1 Scenario between 2060 and 2070. The groundwater levels in the 180-Foot Aquifer and 400-Foot Aquifer are still projected to be below sea level in 2070, even where average groundwater levels increase.



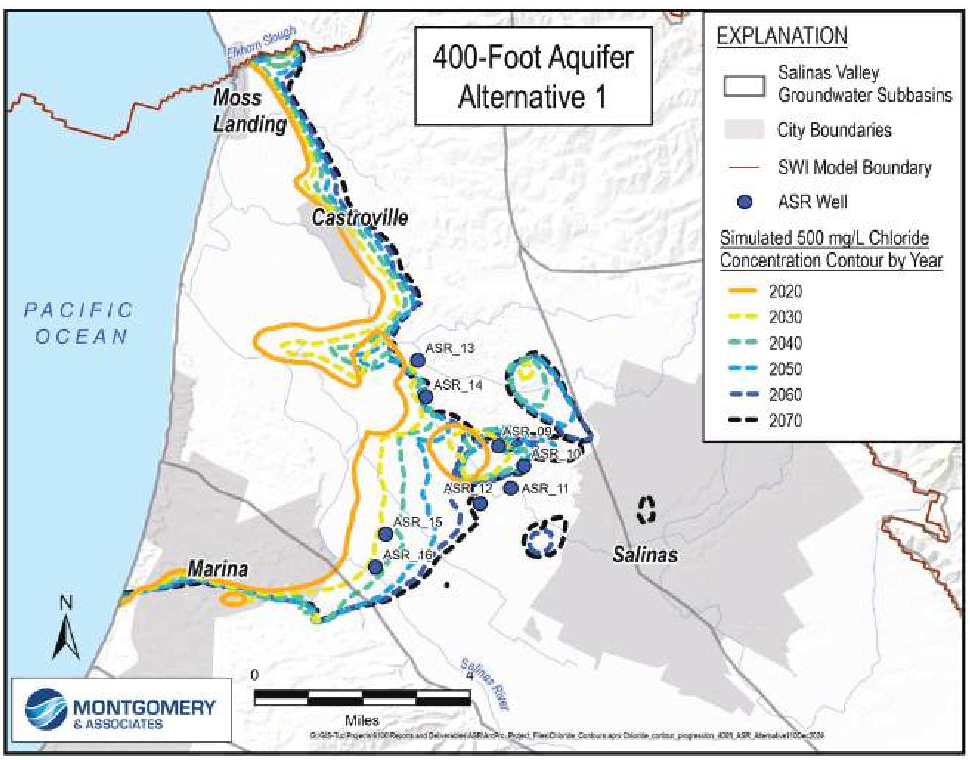


Figure 19. New Diversion of Winter High Flows for ASR Alternative 1 Scenario – 500 mg/L Chloride Contours (2020 to 2070)

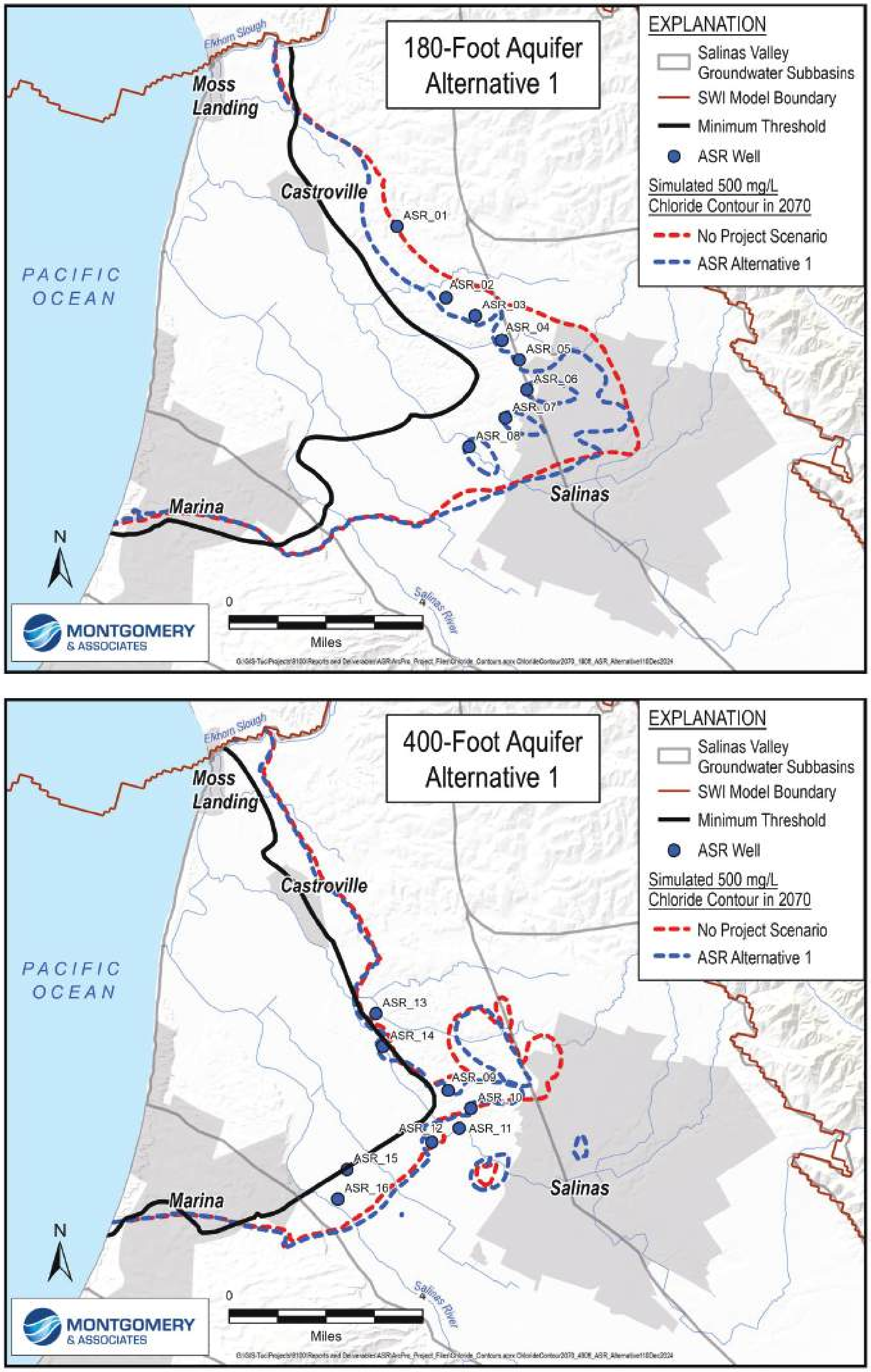


Figure 20. New Diversion of Winter High Flows for ASR Alternative 1 Scenario – 2070 500 mg/L Chloride Contour and Comparison to No Project Scenario and Minimum Threshold

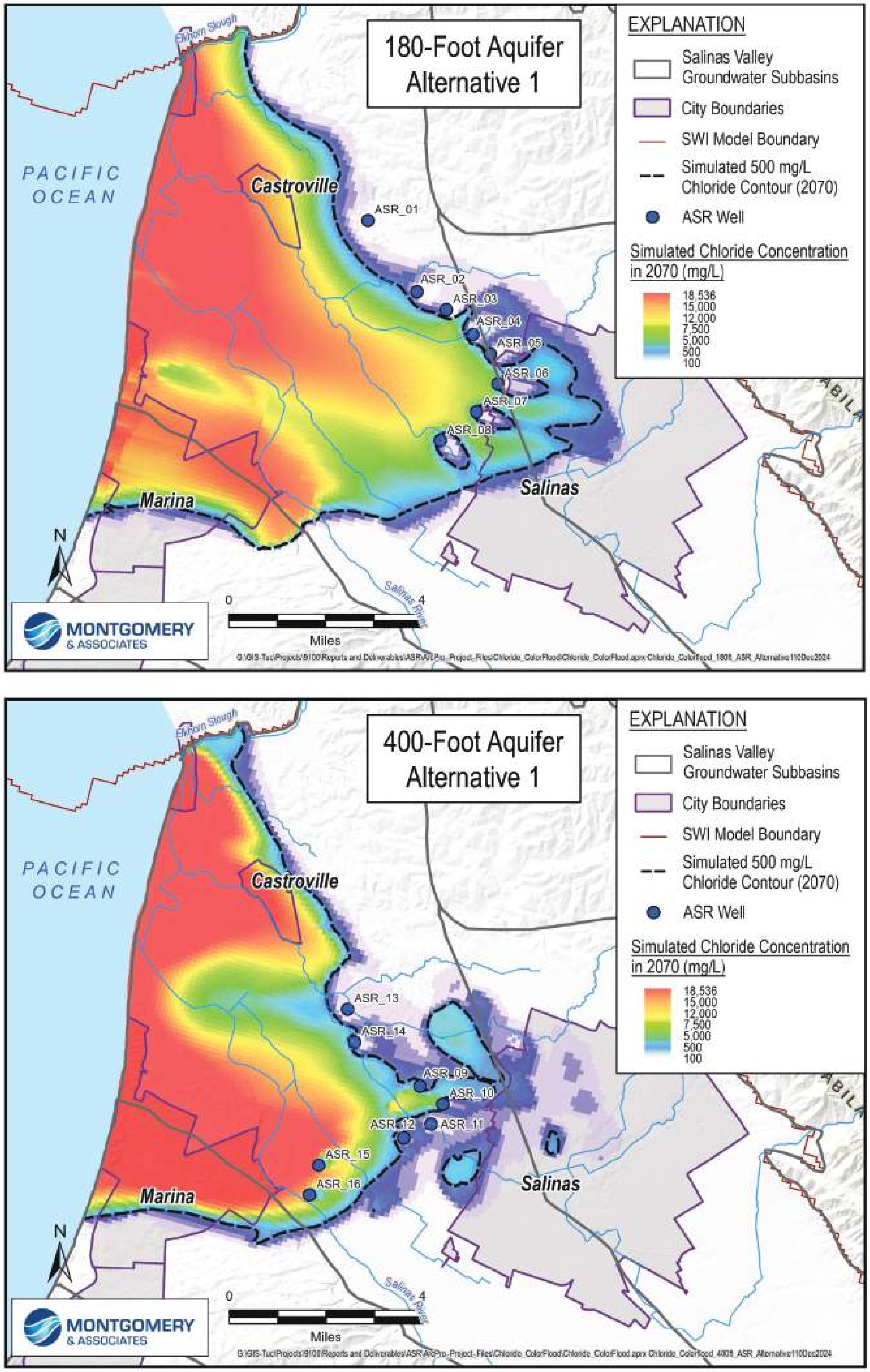


Figure 21. New Diversion of Winter High Flows for ASR Alternative 1 Scenario: Chloride Concentrations (2070)

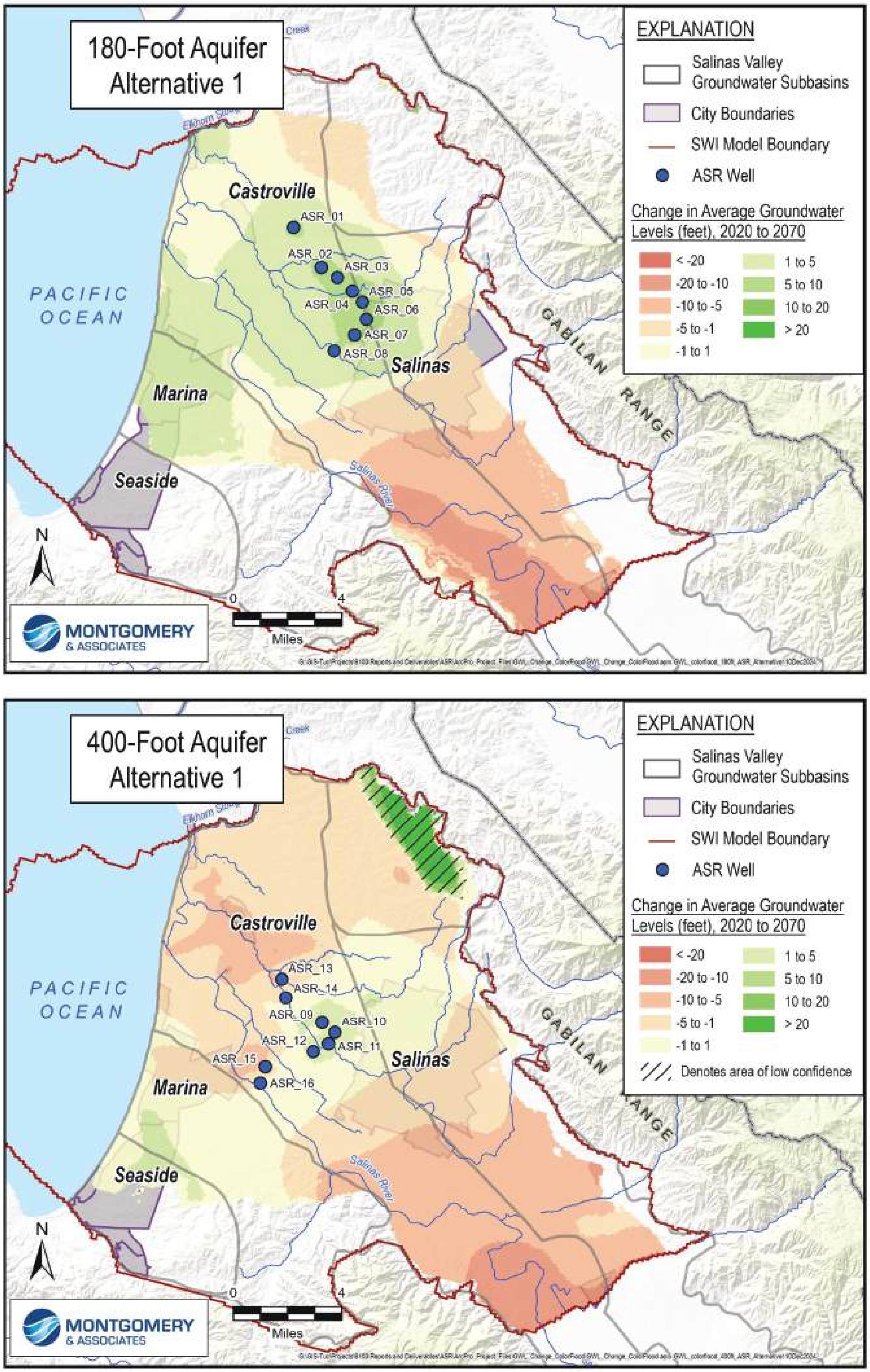
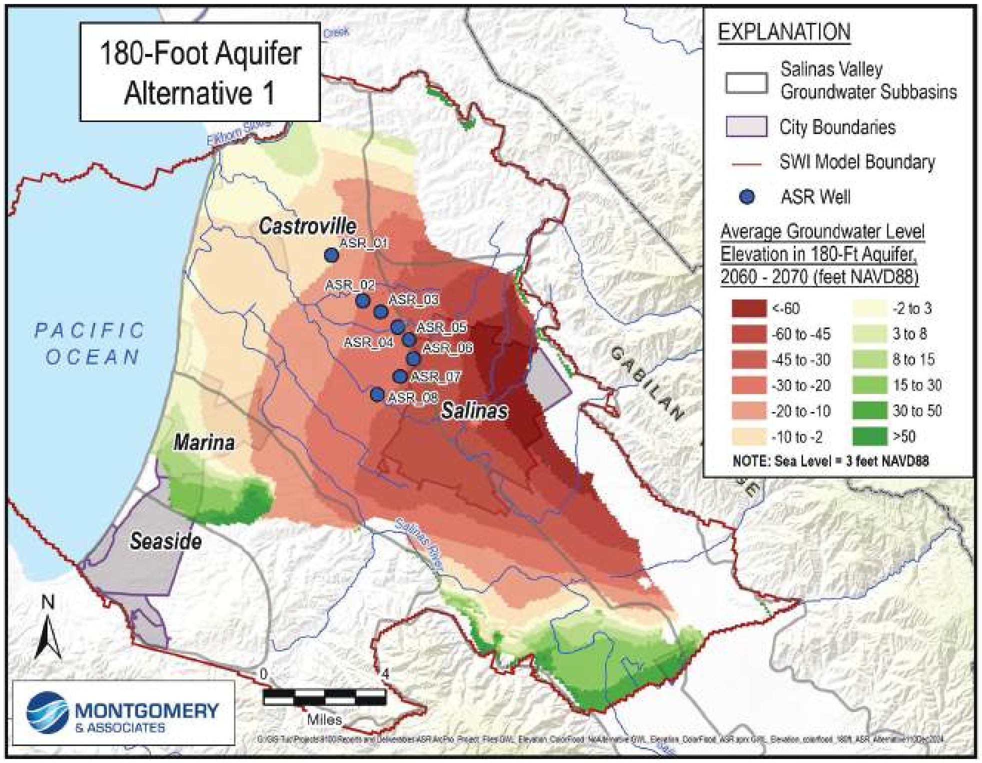


Figure 22. New Diversion of Winter High Flows for ASR Alternative 1 Scenario: Average Groundwater Level Change (2020 to 2070)



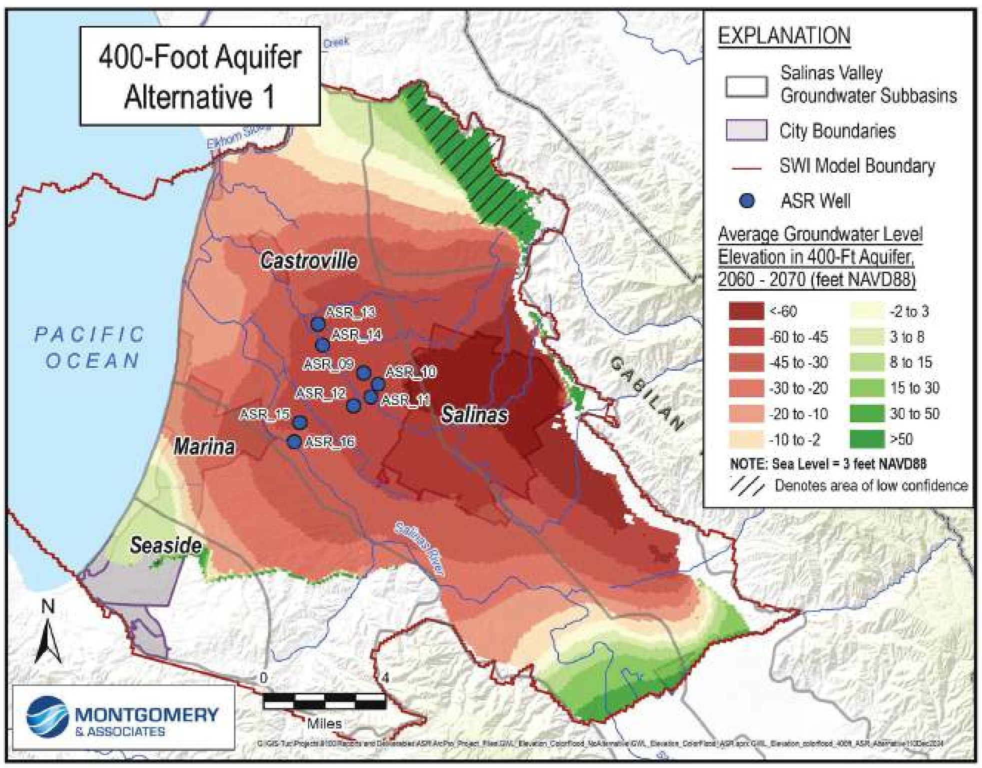


Figure 23. Simulated Groundwater Elevation for the New Diversion of Winter High Flows for ASR Alternative 1 Scenario

4.4 New Diversion of Winter High Flows for ASR, 400-Foot Aquifer Injection Only - Alternative 1A Scenario

4.4.1 New Diversion of Winter High Flows for ASR, 400-Foot Aquifer Injection Only - Alternative 1A Scenario SVOM Results

Alternative 1A uses the same assumptions in the SVOM as the New Diversion of Winter High Flows for ASR Scenario. Refer to Section 4.3.1 for the SVOM results applicable to Alternative 1A. Alternative 1A only differs from the New Diversion of Winter High Flows for ASR Alternative 1 Scenario in the SWI Model simulation, in which ASR injection occurs in the 400-Foot Aquifer only.

4.4.2 New Diversion of Winter High Flows for ASR, 400-Foot Aquifer Injection Only - Alternative 1A Scenario SWI Model Results

Because ASR injection occurs only in the 400-Foot Aquifer in the New Diversion of Winter High Flows for ASR Alternative 1A Scenario, the 180-Foot Aquifer SWI Model results are similar to the No Project Scenario. For that reason, only the SWI Model results for the 400-Foot Aquifer are presented here.

Figure 24 shows a map of the 500 mg/L chloride front simulated for the Alternative 1A Scenario. The map shows the 2070 location of the 500 mg/L chloride front (black dashed line) relative to its position in 2020 (orange solid line). The colored dashed lines represent the progression of the 500 mg/L chloride contour every decade starting in 2030.

The progression of the 500 mg/L chloride contour in the 400-Foot Aquifer shows notable improvements compared to both New Diversion of Winter High Flows for ASR Alternative 1 Scenario and the Seasonal Release with ASR Scenario. The ASR wells in the 400-Foot Aquifer slow seawater intrusion to the north and east. As in the other scenarios, the more southern ASR wells are not able to effectively slow seawater intrusion, but they do have more effect in Alternative 1A than in the other scenarios.

Figure 25 compares the simulated 2070 intrusion extent (blue dashed line) with the 2070 No Project intrusion extent (red dashed line) and the current intrusion minimum threshold (black line). Seawater intrusion to the north and east is slowed noticeably in the 400-Foot Aquifer in the Alternative 1A Scenario relative to the No Project Scenario. The seawater intrusion is almost slowed to the point where it is near the minimum threshold in these areas. However, seawater intrusion is still well beyond the minimum threshold to the north of ASR_13 and near ASR_15 and ASR_16.

Figure 26 shows the effect of ASR injection on chloride concentrations. The map shows that the northern and eastern ASR wells slow progress of the higher chloride concentrations. However, it appears that chloride is able to pass around and between the southern ASR wells and none of the ASR wells are addressing lower chloride concentrations below 500 mg/L, which suggests that some seawater is still passing around and between the ASR wells.

Figure 27 shows average groundwater level changes between 2020 and 2070 in the Alternative 1A Scenario. The ASR injection into the 400-Foot Aquifer results in noticeable increases in average groundwater levels by 2070 of up to 5 feet in most areas near the ASR wells, and up to 10 feet near wells ASR_09 through ASR_12 and ASR_14.

Figure 27 shows change in groundwater levels, not absolute groundwater levels. Therefore, the green area on Figure 27 should not necessarily be interpreted as being above sea level.

Figure 28 shows the average groundwater levels for the Alternative 1A Scenario between 2060 and 2070. The groundwater levels in the 180-Foot Aquifer and 400-Foot Aquifer are still projected to be below sea level in 2070, even where average groundwater levels increase.

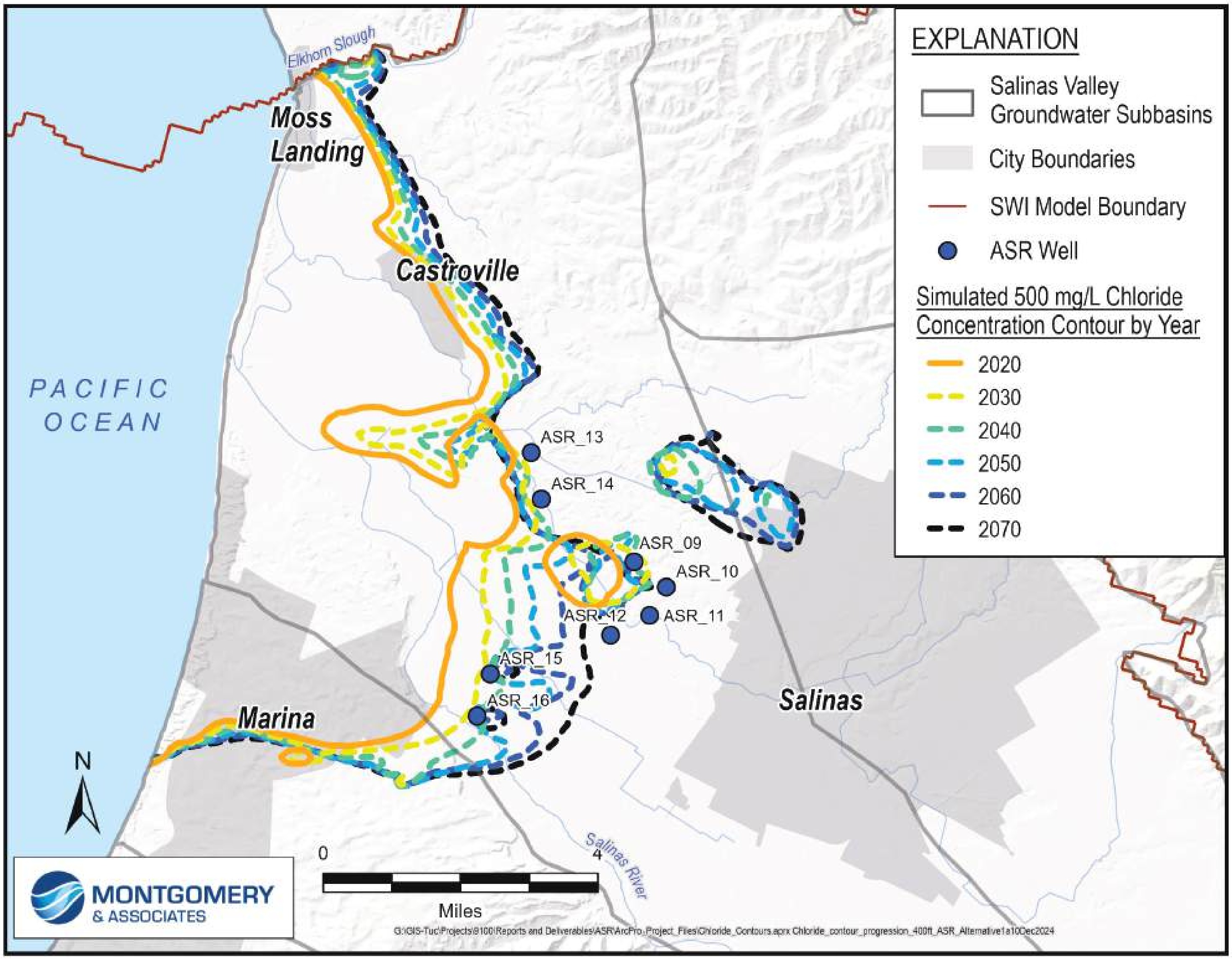


Figure 24. Alternative 1A Scenario – 500 mg/L Chloride Contours (2020 to 2070) in the 400-Foot Aquifer

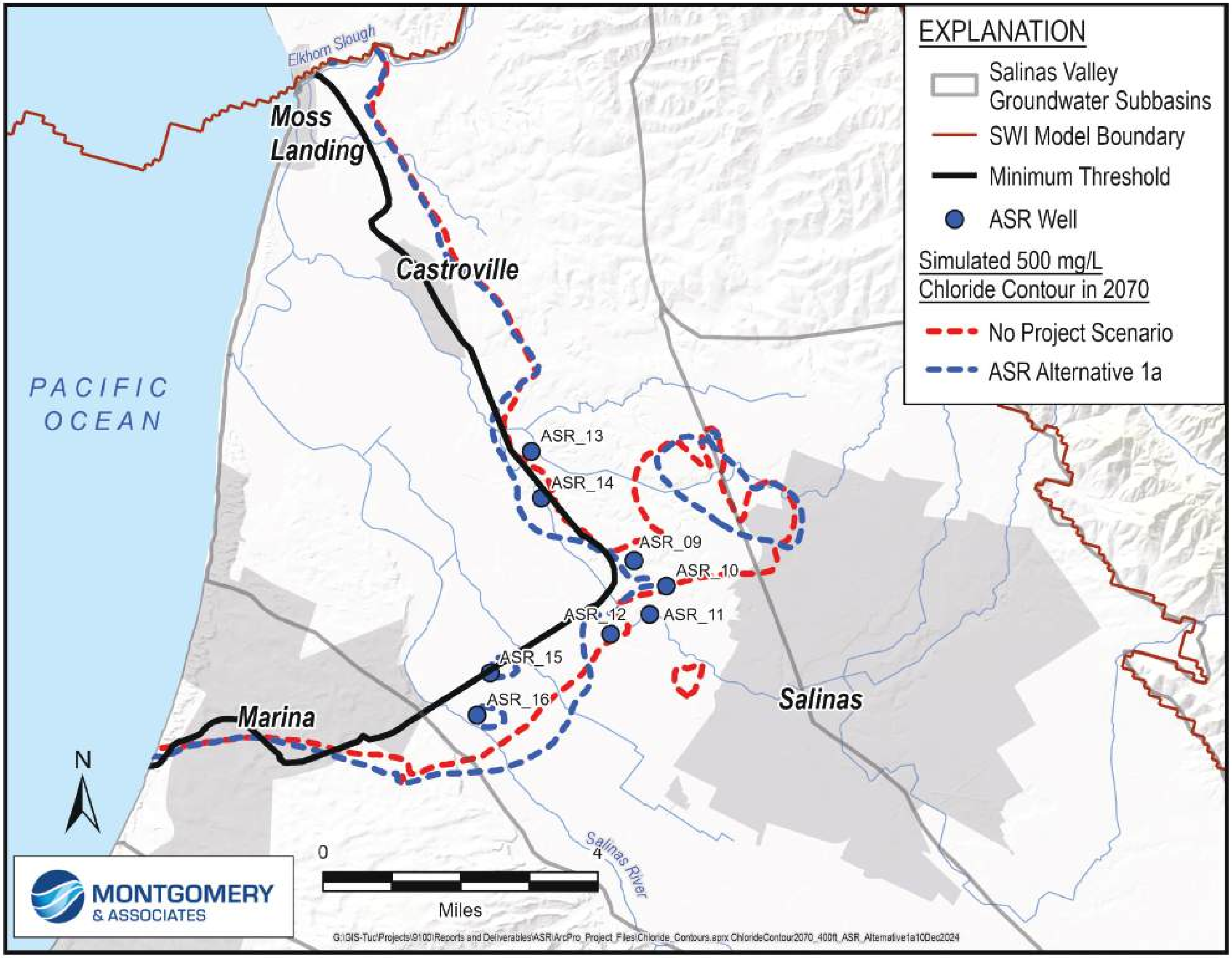


Figure 25. Alternative 1A Scenario – 2070 500 mg/L Chloride Contour and Comparison to No Project Scenario and Minimum Threshold

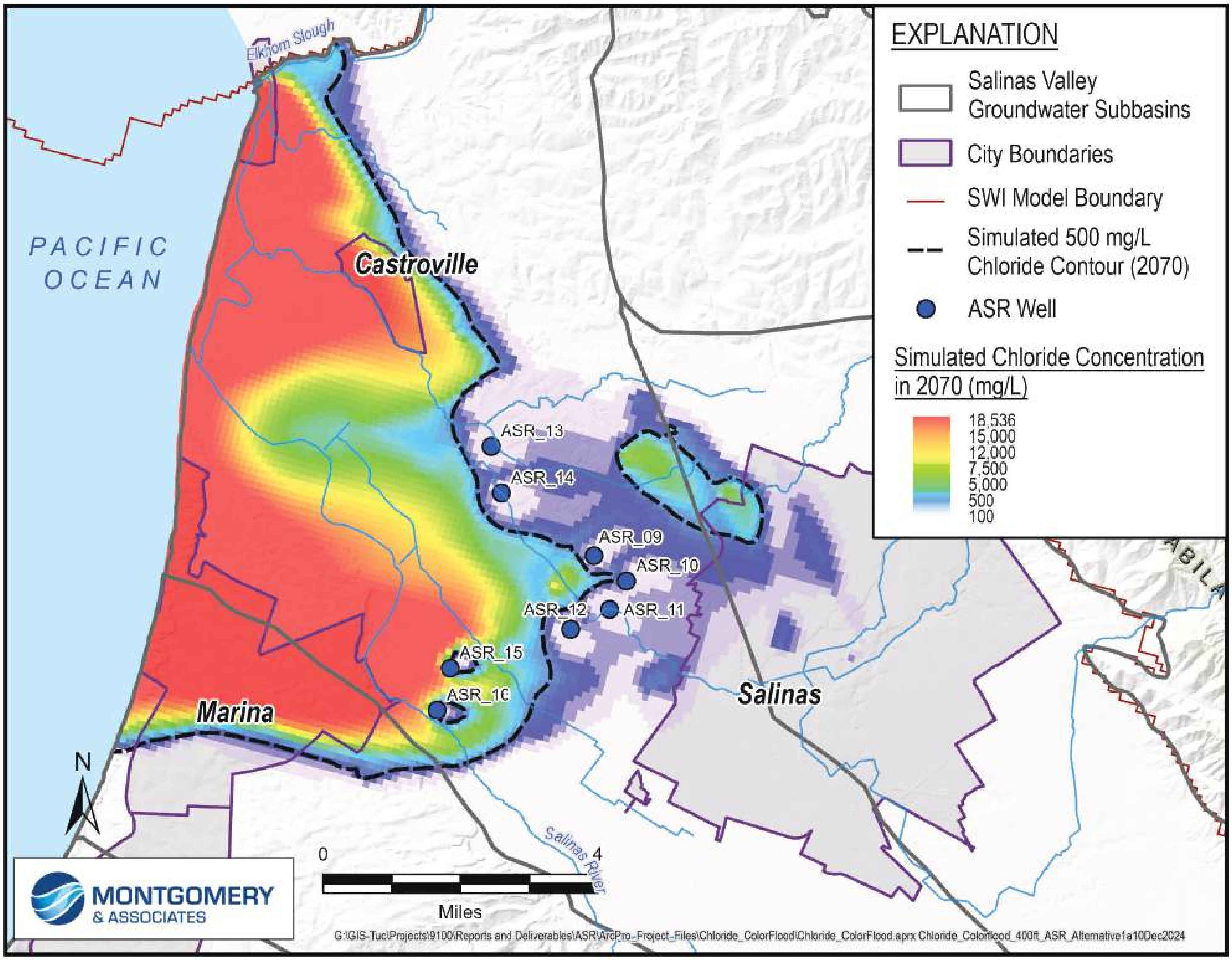


Figure 26. Alternative 1A Scenario: Chloride Concentrations (2070) in the 400-Foot Aquifer

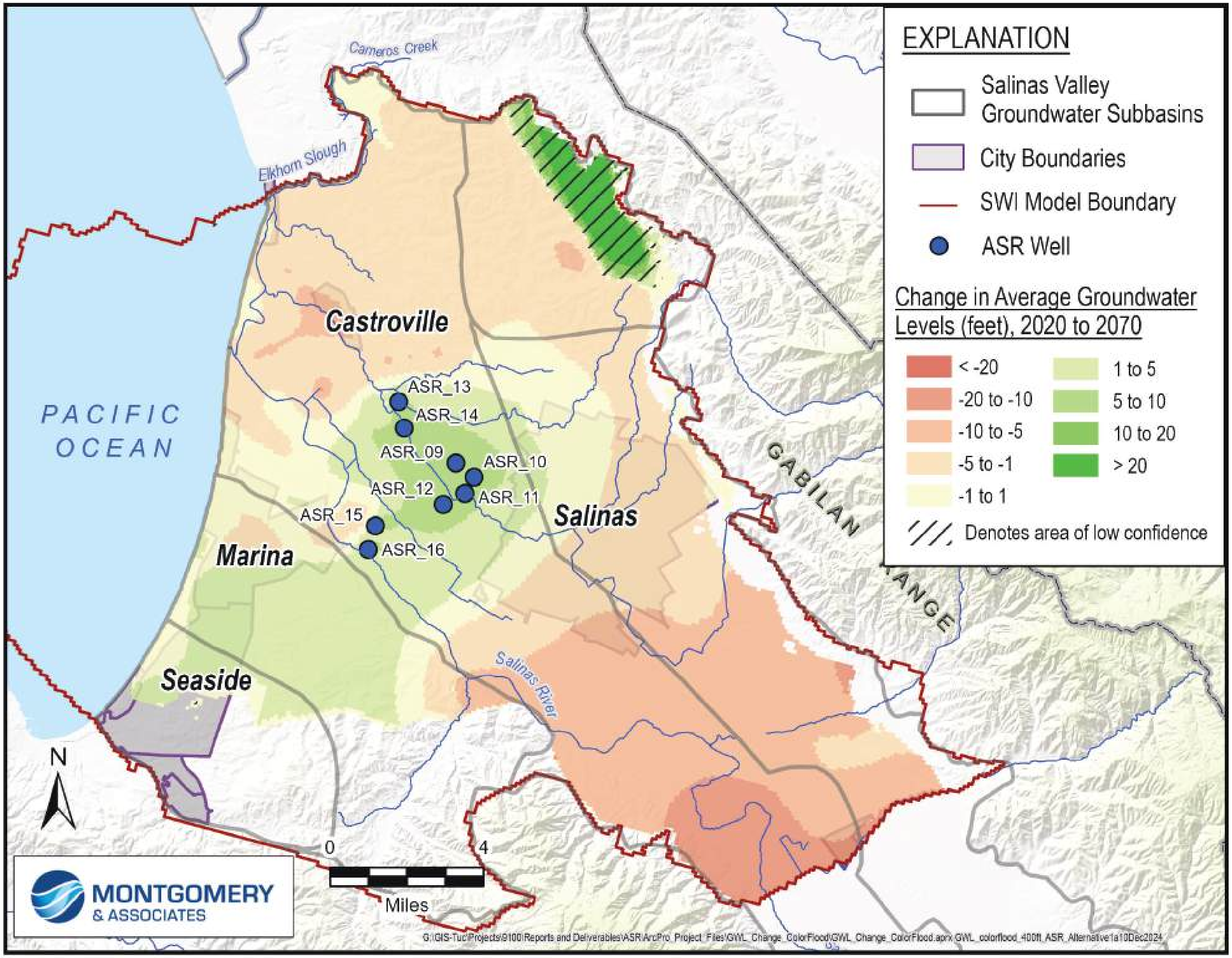


Figure 27. Alternative 1A Scenario: Average Groundwater Level Change (2020 to 2070) in the 400-Foot Aquifer

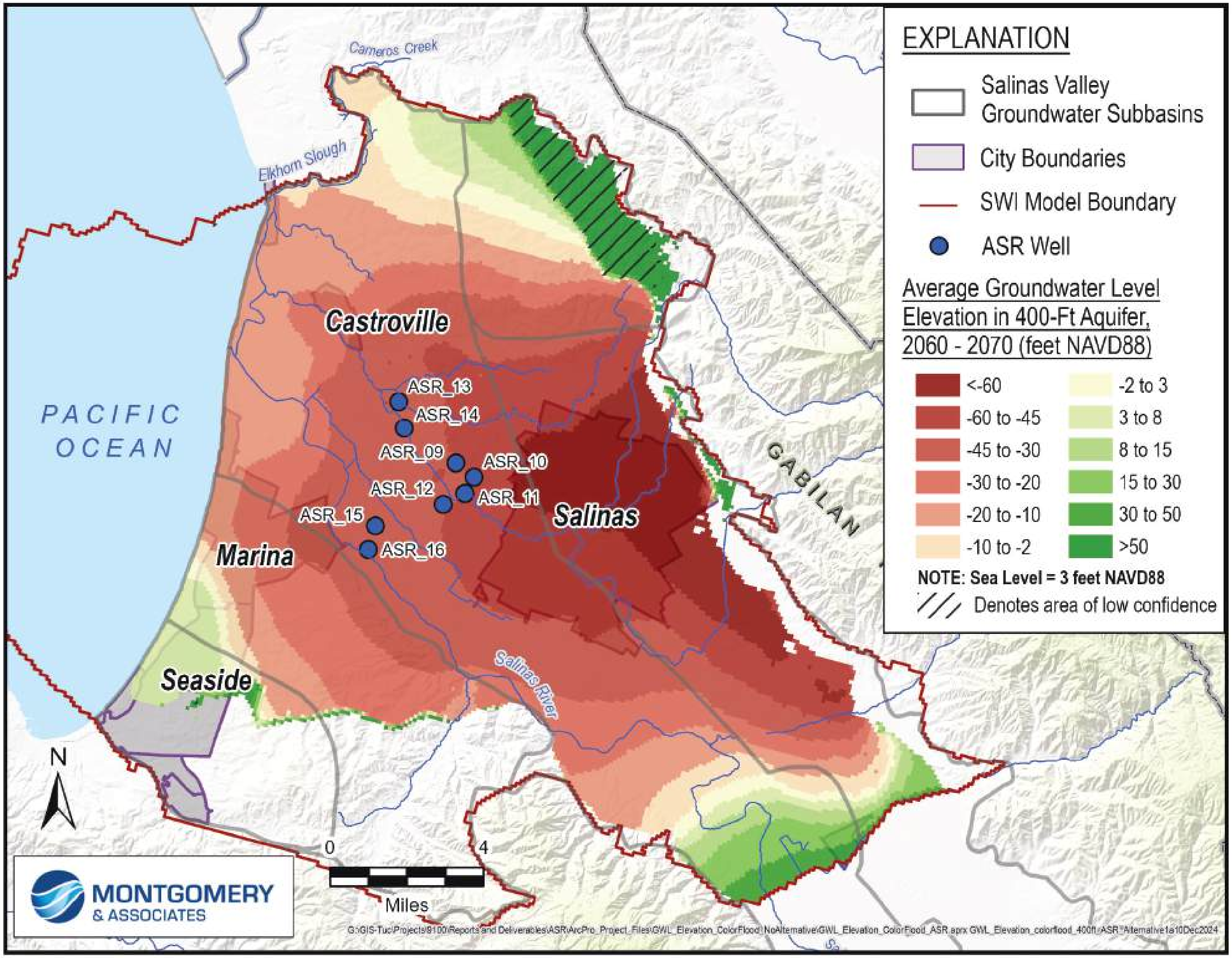


Figure 28. Simulated Groundwater Elevation for the New Diversion of Winter High Flows for ASR Alternative 1A Scenario

5 CONCLUSIONS

5.1 Comparison of Scenarios

Figures and tables in this section summarize the ASR Scenarios and demonstrate the relative differences between the simulated ASR Scenarios.

Table 11 compares CSIP supply and ASR diversions in the Seasonal Release with ASR and the New Diversion of Winter High Flows for ASR Alternatives 1 and 1A SVOM Scenarios. The total amount of water supplied to the CSIP Area was slightly different between the simulations due to variations in how the model supplies water from each source. All simulations, however, satisfy the same consumptive use, indicating the crop demand is the same and adequately met in all simulations. More groundwater pumping is needed in the Seasonal Release with ASR Scenario to meet CSIP demands because the SRDF diversions are used for ASR injection instead of CSIP supply. The average total groundwater pumping supply was 14,300 AF/WY for the representative period, while it was only 5,500 AF/WY in the New Diversion of Winter High Flows for ASR Alternative 1 Scenario. The water diverted for ASR injection is about twice as much in the Seasonal Release with ASR Scenario compared to the New Diversion of Winter High Flows for ASR Alternative 1 Scenario. However, the total net groundwater pumping, or total groundwater pumping minus total groundwater injected, is similar between the 2 scenarios, with a slightly negative amount for the Seasonal Release with ASR Scenario (-1,400 AF/WY) and a slightly positive number for the New Diversion of Winter High Flows for ASR Alternative 1 Scenario (+1,200 AF/WY).

Figure 29 compares the diverted water available for injection on an annual basis for each scenario. The Seasonal Release with ASR Scenario provides more regular water available for injection, as all the diverted water at the SRDF for the first 6 months of the year and including December, are used for injection. For New Diversion of Winter High Flows for ASR Alternative 1 (and 1A) only the months of November through April are available for injection via the new ASR diversion. Reservoir operations are not optimized for the New Diversion of Winter High Flows for ASR diversions; New Diversion of Winter High Flows for ASR only diverts water available from regular high flow releases.

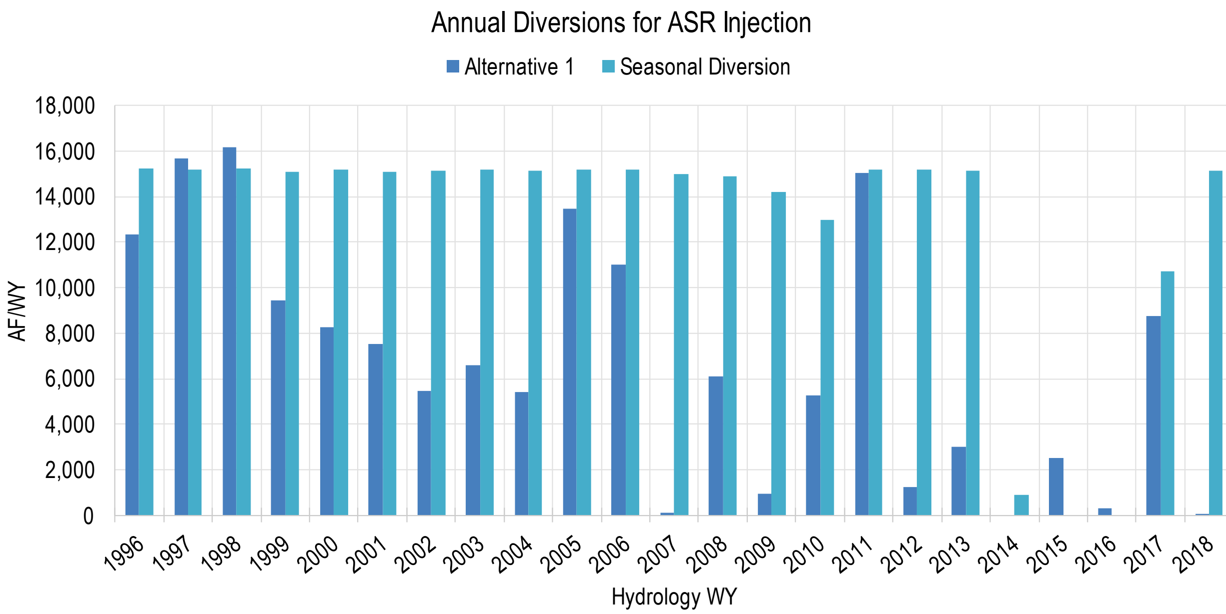


Figure 29. Comparison of Annual Diversions for ASR Injection Between the Seasonal Diversion Scenario and the New Diversion of Winter High Flows for ASR Alternative 1 Scenario

Figure 30 compares the simulated 2070 intrusion extent in the 180-Foot and the 400-Foot Aquifers for all 3 simulated scenarios with the 2070 No Project intrusion extent (red dashed line) and the current intrusion minimum threshold (black line.) These maps show that none of the scenarios fully stop seawater intrusion, and none of the scenarios achieve the minimum threshold.

Table 11. CSIP Water Supply Summary – Comparison of SVOM Results from Seasonal Release with ASR and New Diversion of Winter High Flows for ASR

SVOM Annual Average (AF/WY)	**Seasonal Release with ASR**	**SVOM Annual Average (AF/WY)**	**New Diversion of Winter High Flows for ASR**
Recycled Water Supplied	11,900	Recycled Water Supplied	11,900
SRDF Diversions (at 36 cfs)	N/A	SRDF Diversions (at 36 cfs)	10,800
CSIP Supplemental Well Pumping (no private pumping)	11,600	CSIP/Zone 2B Well Pumping (Supplemental well + private)	5,500
ASR Well Extraction (to meet pumping demand in Zone 2B)	2,700	ASR Well Extraction	N/A
***Total Supply**: *the total supply numbers are different but represent the same consumptive use*	*26,200*	***Total Supply**:*	*28,200*
Total Pumping:	*14,300*	*Total Pumping:*	*5,500*
ASR injection from SRDF diversions	12,900	ASR injection via new diversion structure	6,700
Net ASR Injection (ASR injection – ASR extraction)	**10,200**	Net ASR Injection (ASR injection – ASR extraction)	**6,700**
Net Total Pumping (ASR injection – total pumping)	-1,400	Net Total Pumping (ASR injection – total pumping)	+1,200

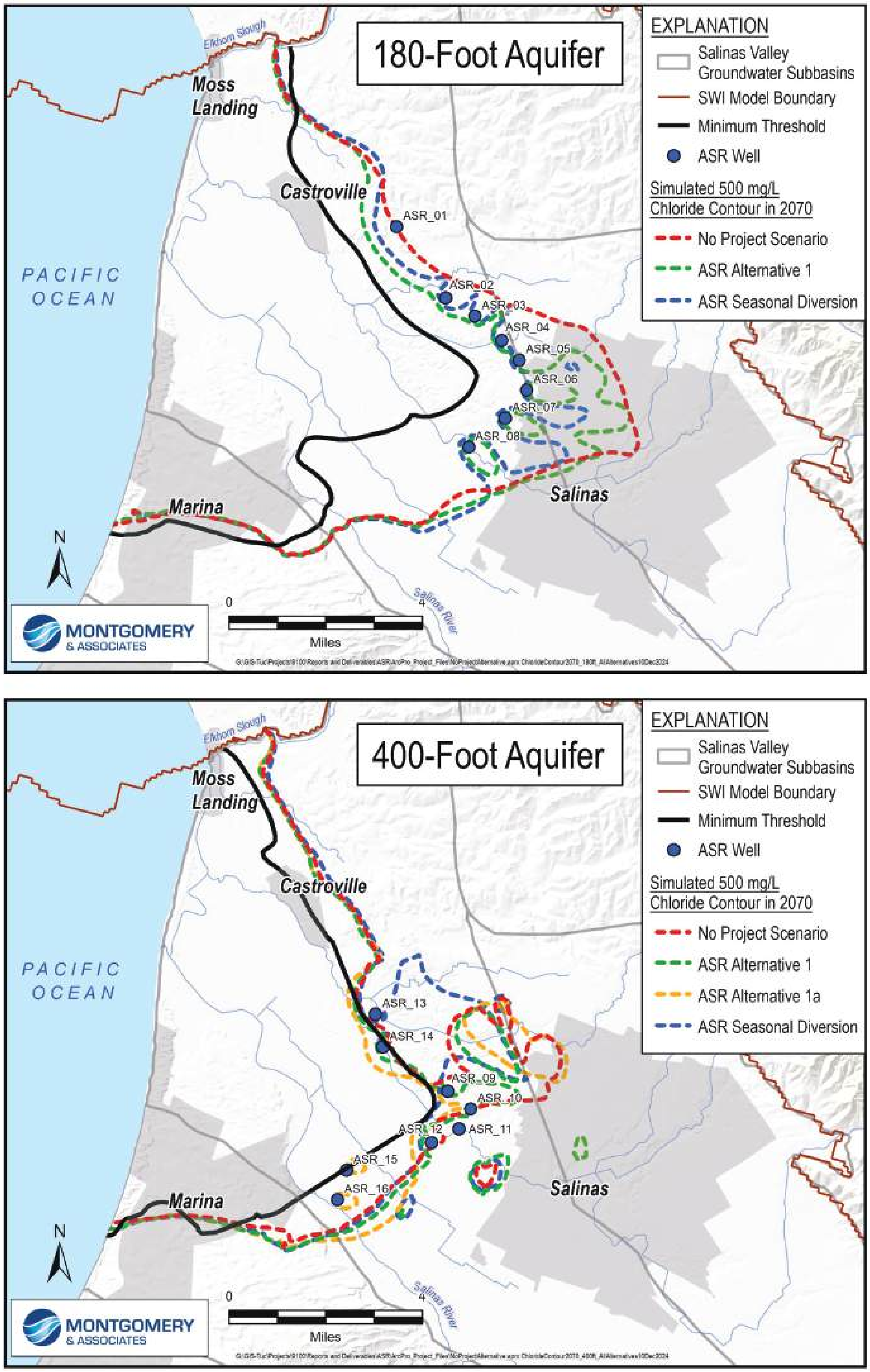


Figure 30. 2070 500 mg/L Chloride Contour for All Simulated Scenarios and Comparison to Minimum Threshold

Table 12 summarizes the key observations from the simulations for each scenario.

Table 12. Key Observations for Comparison of Seasonal Release with ASR and New Diversion of Winter High Flows for ASR Scenarios

Seasonal Release with ASR	New Diversion of Winter Flows for ASR
Average diversion for ASR injection: 12,900 AFY	Average diversion for ASR injection: 6,700 AFY
CSIP wells pumping high due to lack of SRDF diversion available to meet demand (max capacity pumping)	CSIP wells pump under current operations (not increased during peak months)
Meeting CSIP demands (summer) requires additional pumping of injected water from ASR wells	No unmet CSIP demands except during severe drought
More pumping than injection	More injection than pumping
SWI front is not stopped (not enough water to inject)	SWI front is not stopped (not enough water to inject)
Main constraints: SRDF structure limits and not enough supply for CSIP	Main constraints: volume of water available and need for a new diversion structure

5.2 Key Take-aways from Modeling

In summary, model simulations resulted in the following take-aways:

- Neither alternative provides full solution to seawater intrusion in both aquifers (i.e., not enough water available to inject)
- Seasonal Release with ASR Project Concept: additional pumping needed to meet CSIP demands
  - Injected volume is not enough to offset pumping and avoid seawater intrusion
  - Current CSIP wells cannot handle the additional pumping needed in the summer, therefore ASR wells need to pump to make up the unmet demand
- Timing of diversions and injection is key to meet CSIP demands

6 DISCLAIMERS AND NEXT STEPS

These model simulations helped compare and contrast relative effects of the ASR Project Concept Scenarios with the No Project Scenario. The model simulations reflect professional judgement and represent the best available estimates of potential future groundwater conditions. The model's accuracy is affected by the simplifying assumptions and data limitations that underpin the model. Given the nature of this initial preliminary feasibility analysis these simplifying assumptions were a necessary step. Any future modeling will include additional information and details related to ASR well construction and placement, as for now these were conceptual in nature.

Examples of simplifying assumptions for the current model simulations include:

- There was no assumed water loss from conveyance between the diversion structure and the ASR wells; the models use a conservatively large estimate of potential water available for recharge.
- Potential interactions between diversions on the river were not considered.
- The number of ASR diversions could be more than 1 with Ranney Collector wells; for modeling purposes, and without more detailed analysis on collector well capacity at the site of diversion, 1 diversion was assumed.
- The model does not include the potential delay in time needed for treatment and transport from the diversion to the ASR wells (instant diversion and injection assumption).
- The model assumes no diverted water storage capacity restrictions prior to conveyance and injection at ASR wells.

As the feasibility study progresses and more specific design assumptions are made, model inputs would be modified which may alter model results. Future modeling will include additional information and details related to ASR well construction and placement.

7 REFERENCES

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